



COST-BENEFIT ANALYSIS FOR COMMUNITY-BASED

Disaster Risk Reduction in Kailali, Nepal

Authors

¹Bo A. White

²Mary M. Rorick

Photo Contribution:

Mercy Corps Nepal

Cover Photo

Front: River Bank Protection Work

Back: Street Drama

Published by:

Mercy Corps Nepal, Lalitpur, Nepal, 2010

ISBN No.:

978-9937-2-2707-0

Design & Printing:

Mind Share Communications Pvt. Ltd.

The views expressed in this document should not be taken in a way to reflect the European Commission; and it is not liable for any use that be made of the information contained herein.

¹Bo White received a BA in Economics and Geology and a MEM at the Yale School of Forestry and Environmental Studies. Robert.a.white@aya.yale.edu

²Mary (Molly) Rorick received a BA in Biology and a M.Phil in Genetics. She is currently a doctoral candidate in the Department of Ecology and Evolutionary Biology and the Department of Genetics at Yale University. mmrorick@gmail.com

Cost-Benefit Analysis for Community-Based

Disaster Risk Reduction in Kailali, Nepal

**Bo A. White
Mary M. Rorick**

Table of Contents

Foreword	3
Executive Summary	4
Introduction	5
Theoretical Approaches to Community-Based CBAs	6
Project Context	8
Methodology	11
Results and Interpretation	18
Conclusions	22

Foreword

As the world faces an increase in the frequency and severity of natural hazards, assistance organizations continue to struggle to meet the challenges posed by scarce economic resources and competing development priorities. Mercy Corps works in many countries around the world, implementing programs that help communities prepare for and become more resilient to natural disasters. We believe it is necessary to evaluate our work not only in terms of its immediate impact, but also from an economic standpoint as we determine how best to protect development investments made by communities and those who support them.

Mercy Corps views Disaster Risk Reduction (DRR) as an essential part of our mission to help people build secure, productive and just communities and therefore incorporates DRR strategies to help communities become more resilient to hazards and reduce the likelihood that their development may be undermined by one or more disasters. With this in mind, Mercy Corps is pleased to present the first Cost Benefit Analysis undertaken for one of our DRR programs.

This Cost Benefit Analysis was undertaken to provide Mercy Corps with a quantitative analysis to complement the qualitative benefits that we have observed throughout the life of our DRR project which is being implemented in Nepal. The Kailali Disaster Risk Reduction Initiatives (KDRR) project, at the heart of this study, assists riverside communities in the far western Kailali District of Nepal where we are working in cooperation with the Nepali Red Cross Society (NRCS) Kailali District Chapter. The project is funded by ECHO, under its DIPECHO Fourth and Fifth Action Plans for South Asia, and includes local capacity building and training for community disaster management committees, the development of early warning systems, small scale mitigation works, and support to young rescuers clubs in schools that are devoted to learning about and passing on knowledge of disaster risk management.

Mercy Corps would like to thank all those who made this cost benefit analysis possible, including: the community of Bisanpur where this study was carried out; Bo White and Molly Rorick, the co-authors of this study; Yale University's School of Forestry and Environmental Studies, for continuing to provide Mercy Corps with excellent research assistance; the Mercy Corps Nepal team implementing the Kailali Disaster Risk Reduction Initiatives project, especially the project manager Ulla Dons; ECHO and its DIPECHO Fourth and Fifth Action Plans for South Asia; and the Emergency Capacity Building (ECB) 3 Project, funded by the Bill and Melinda Gates Foundation, for providing funding support for this study.

As we continue to learn from our DRR activities and develop tools to better measure impact, Mercy Corps will refine and adapt program methodologies to ensure that we are doing our best work to help communities protect their development gains, prepare for the effects of climate change, and save lives and livelihoods.

Susan Romanski

Director, Disaster Risk Reduction, Mercy Corps
sromanski@hq.mercycorps.org

³ The Emergency Capacity Building (ECB) Project is a partnership between CARE, CRS, Mercy Corps, Oxfam, Save the Children and World Vision. The ECB Project aims to improve the speed, quality, and effectiveness of the humanitarian community in saving lives, improving welfare, and protecting the rights of people in emergency situations. Visit www.ecbproject.org or e-mail info@ecbproject.org for more information

Executive Summary

The following study is a cost benefit analysis (CBA) of The Kailali Disaster Risk Reduction Initiatives (KDRRI)-- the disaster risk reduction (DRR) project undertaken by Mercy Corps Nepal and the Nepal Red Cross Society (Kailali District Chapter) during 2007-2009 in Kailali, Nepal to help selected communities address the adverse impacts of severe annual flooding.

The study has two primary goals: 1) to assess the cost effectiveness of the KDRRI project, and 2) to create a quantitative methodology for assessing the cost-effectiveness of community-based DRR projects that is generalizable (applicable to various types of DRR projects, in various cultural, economic or environmental contexts), and which can be quickly, cheaply, and easily applied.

To accomplish these goals the study employs social science research methods (structured surveys, field visits, and interviews) for data collection in combination with a mathematical model and computer program called Community-based Sigmoid Exponential Disaster Risk (CSEDR) for data analysis. Both methodologies were developed especially for the unique scenario of evaluating community-based DRR projects. This CBA represents the first field-test of these methods.

Benefit: Cost (B: C) ratios over one were found under a broad range of conditions, and for a set of highly conservative assumptions.⁴ Using a rigorous and conservative estimate, the project yielded a B:C ratio of 3.49. This means that for every Euro spent, there are 3.49 Euros in economic benefits. These benefits represent the prevention of economic losses or the avoidance of otherwise necessary humanitarian assistance. This B:C ratio does not include the important qualitative benefits of the DRR programming to the community, some of which are highlighted in this report and others in a recent Mercy Corps case study of how the project has contributed to the Hyogo Framework for Action (available from Mercy Corps at <http://www.mercycorps.org/fordevelopmentprofessionals/communitybaseddisasterriskreduction/15781>).

Through in-depth discussions with villagers, community leaders and local development workers, it was determined that the KDRRI project provided significant economic, social, and environmental benefits that were unquantifiable. For example, benefits associated with increased social cohesion, education, empowerment, saved lives, and indirect impacts on economic capital were not considered in determining the B:C ratio, but were considered in the qualitative analysis. Had it been possible to more thoroughly quantify the KDRRI benefits to the beneficiaries, the final B:C ratio would have certainly been significantly greater.

We therefore conclude, that a community investing in a similar type of disaster risk reduction activity to the KDRRI project evaluated here, in a similarly hazard prone area to the Kailali region of Nepal, can expect to save at least 3.49 times their original investment.

⁴If the B:C ratio is over 1, the benefits are greater than the costs and it can be concluded that the DRR project is economically viable. If this ratio is below 1, the costs are greater than the benefits, so the economic viability of the project should be questioned.

I. Introduction

Cost benefit analysis (CBA) is a tool that businesses, NGOs, and government organizations commonly use to estimate the efficiency of a given project, compare competing options, and more easily comprehend the costs and benefits of a course of action. More recently, CBA is being used in the field of natural disaster risk management to determine whether preparedness activities in a community before a potential natural disaster occurs provide substantial benefits that can reduce the need for costly response efforts after an emergency. NGOs and development agencies tend to argue that preparedness activities, especially in disaster prone or poor communities, are important for both protecting development investments and avoiding costly post-disaster aid. Donor institutions, on the other hand, faced with uncertain quantitative information on the net economic and social benefits for disaster risk reduction (DRR) projects, tend to conserve scarce resources for emergency response as opposed to DRR interventions. Demonstrating the benefits of DRR through quantitative methodologies such as CBA could allow funders to see the true value of these interventions.⁵

The cost-effectiveness of a given DRR project will depend on many factors, such as the frequency and magnitude of disasters (floods, earthquakes, volcano eruptions, landslides, etc.), the ability to predict where they will occur, the extent to which communities are impacted given a disaster, and the cost of the intervention. Such factors can vary widely; thus, it is important that the cost effectiveness of DRR projects are evaluated in their context or compared to CBAs that were conducted under similar contexts. To date, the vast majority of DRR CBAs have been carried out in environments where there is plentiful data available either from extensive surveying of educated populations that can reliably provide information regarding the monetary value of various forms of capital, or where the benefits of a DRR project are otherwise more easily and directly quantifiable into monetary amounts⁶. Such CBA studies typically evaluate large scale

DRR interventions (e.g., retrofitting a subway system for earthquakes), and are generally carried out by professional consulting firms or through such agencies as the World Bank, the Federal Emergency Management Agency (FEMA), and the United Nations.

There are very few examples of community level DRR interventions being evaluated using CBA. Community level DRR CBAs, particularly in developing countries or in remote communities, provide an additional set of constraints such as limited person-hours and financing for any assessment process, a scarcity of available data from reliable government or NGO sources, and a partially or wholly illiterate population of beneficiaries. Thus, while many DRR CBAs begin at the level of data analysis, community-based DRR CBAs such as this one start at the level of data collection.

⁵Benson, C., and J. Twigg (2004), "Measuring mitigation": Methodologies for Assessing Natural Hazard Risks and the Net Benefits of Mitigation - A Scoping Study, International Federation of the Red Cross and Red Crescent Societies, ProVention Consortium.

⁶Examples of these can be found on the prevention website such as the World Bank Earthquake Vulnerability Reduction Program in Colombia or A Case Study of Caribbean Infrastructure Projects that have Failed Due to the Effects of Natural Hazards, OAS (1998). See <http://www.proventionconsortium.org/?pageid=26#projects>

II. Theoretical Approaches to Community-Based CBAs

For a community-based DRR CBA, one needs to compare the impact of disasters with and without DRR interventions. There are three different approaches that can be used to obtain data for these two different situations.

1. Hypothetical Approach- In order to perfectly control for particularities of individual communities and differences in disaster magnitudes, you can compare the impact of a given disaster in a community with DRR to the hypothetical impact of this same disaster in this same community had it not had the DRR programming. This is a so-called “backward looking” method. It is also possible to perform a so-called “forward-looking” CBA in order to evaluate a potential DRR project, by comparing the realized impacts in a community without DRR programming to the hypothetical impacts of the same disaster in that community had there been DRR. Obviously, the limitation of the Hypothetical Approach is that it relies on inferences of impact, rather than realized impacts and these may be of questionable accuracy depending on the circumstances. On the other hand, in some cases it may be very obvious how DRR influences disaster impacts, so hypothetical losses with or without DRR may be easy to assess accurately.

2. Comparative Approach- In theory, it is possible to compare two different communities: one with and one without DRR. This is especially possible if the effective magnitude of disasters is exactly the same in the two communities. However, the effective disaster magnitude may be different in the two different locations, even when comparing the same disaster event and so one needs some

way of assessing “effective disaster magnitude” (of course, this index must be independent of impact, because this is also a factor of DRR programming!). If the relative effective magnitudes of the disasters can be accurately assessed for the two communities, then it is possible to use such data for the construction of “Non-DRR” and “With-DRR” impact curves.⁷ The comparative method is appropriate if you have data for a very limited number of disasters, or if you have extremely comparable communities that only differ by whether they have DRR. Such comparable communities would probably be very large and homogenous, very close to each other, and affected by disasters in highly similar ways.

3. Before-and-After Approach- The third option for community-based DRR CBAs is comparing impact data from the same community for similar disasters occurring before and after DRR programming. The limitation of this option is that impact data for pre-DRR programming disasters may not be available in the same format or conducted with the same methodology as the impact data that is consistently collected immediately following a disaster occurring in a community where Mercy Corps has conducted DRR activities. The best practice for deriving accurate impact information from disasters that have already occurred, but may not have been formally surveyed at the time, is to utilize multiple

⁷ However it is good to have data on similar magnitude disasters for both DRR and Non-DRR communities. This allows one to have data points at about the same places along the $I[M]$ curve (impact as a function of disaster magnitude), so that systematic errors in the assumed relationship between magnitude and probability affect the With-DRR and Non-DRR exceedance probability curves in the same way. This will minimize the error in the final result. Alternatively, it is even better to simply have data for a large range of disaster magnitudes for both With-DRR and Non-DRR communities, so that your With-DRR and Non-DRR models for $I[M]$ are high quality.

information gathering methods such as community member surveys, key informant interviews and secondary data research.⁸ Mitigating factors such as political and economic changes, separate from the DRR activities carried out between the two disasters, must also be accounted for in the final CBA results. A challenge with the Before-and-After Approach is the assumption that nothing besides the implementation of DRR has changed in the community between the two disasters, and this is most likely not the case. For example, impacts “before” might be less than “after” due to an exogenous change in people’s livelihoods that is nothing to do with DRR programming. In addition, because one of the main goals of DRR programming is to make a community more aware of the impacts of disasters, there is a recognition that greater awareness of DRR strategies may translate to a more thorough reporting of impacts. On the other hand, there is the possibility that impacts before DRR programming will be less accurate after DRR programming simply because pre-DRR disasters occurred longer ago. Therefore, when implementing the Before-and-

After Approach, it is important to try to control for these potentially confounding variables as best as possible. Further, we recommend that the Hypothetical Approach be implemented in addition to either the Comparative Approach or the Before-and-After Approach to account for changes in perception following DRR training.

Our General Approach

For this study, we are using the backward-looking Hypothetical Approach. This approach was chosen due to the fact that the DRR programming location (the Bisanpur village) was small enough, and the project managers insightful enough, that we could confidently assess what the impact on the community would have been had there not been DRR programming. Furthermore, we wanted to avoid the “information-DRR association problem” mentioned above. Lastly, the quantitative CBA portion of this assessment does not include any of the indirect impacts of the flooding. Here we define indirect impacts as any impacts which occur more than a year after the flood.

⁸Post Disaster Surveys: experience and methodology [http://www.ema.gov.au/www/emaweb/rwpattach.nsf/VAP/\(99292794923AE8E7CBABC6FB71541EE1\)~Post+disaster+surveys.pdf/\\$file/Post+disaster+surveys.pdf](http://www.ema.gov.au/www/emaweb/rwpattach.nsf/VAP/(99292794923AE8E7CBABC6FB71541EE1)~Post+disaster+surveys.pdf/$file/Post+disaster+surveys.pdf)

III. Project Context

The Kailali Disaster Risk Reduction Initiative (KDRRI)

Floods and other weather related disasters are a major factor contributing to endemic poverty in Nepal and this is likely to increase as climate change proceeds. Preparedness requires the ability to forecast when a disaster is likely to occur and people need knowledge of risk, mechanisms of communication to inform about disasters, and equipment to monitor the advent of a disaster. The Nepal Red Cross Society (NRCS) - Kailali District Chapter and Mercy Corps Nepal have implemented two consecutive projects in the Far-Western Development Region of Nepal in order to prepare communities for weather related hazards.

In the first project, the Kailali Disaster Risk Reduction Initiatives was implemented in six communities of the Far-Western Development Region of Nepal between November 2007 and April 2009. The project was supported by the European Commission via its Humanitarian Aid department (DG ECHO) under the DIPECHO Fourth Action Plan for South Asia⁹. The stated aim of the project was to build safer communities through DRR initiatives in collaboration with communities, local governments and other key stakeholders. Project interventions included local capacity building and training, early warning systems, small-scale mitigation, education, and facilitation of coordination. These activities were later expanded to an additional ten communities through KDRRI II under the DIPECHO Fifth Action Plan for South Asia.

Primary problems faced by the communities supported under the KDRRI projects are inundation of settlement areas, erosion of river banks on the receding flood and aggravating the shifting tendencies of the river courses. The

project is multi-sectored and relies on a mix of capacity building, physical and early warning interventions. The KDRRI work focuses heavily on capacity building to drive DRR within the communities. Thus capacity building includes the establishment of Disaster Preparedness Committees (DPC), comprising members elected by the community, as well as smaller groups with specific responsibilities (e.g. a search and rescue, early warning, first aid, construction, nursery management teams). These committees along with youth representatives, student and teachers are trained in community-based DRR, first aid, search and rescue, early warning, community management and leadership. Each community has created an emergency and maintenance fund. Households commit to donating a certain sum¹⁰ of money or amount of grain each month. These savings are deposited in a local bank and supervised by DPC members. The community maintains control over the funds, and uses them for agreed activities, such as relief support for disaster affected households in the community or even in neighboring communities and for

⁹ The principal objective of the DIPECHO Action Plan for South Asia is to increase the awareness and the response capacity of local communities and institutions to potential and recurrent natural disasters and to reduce the effects of these disasters on the most vulnerable by supporting strategies that enable local communities and institutions to better prepare for and mitigate natural disasters by enhancing their capacity to cope, thereby increasing resilience and decreasing vulnerability and by strengthening the level of coordination, information sharing and advocacy at national and regional level.
<http://www.evd.nl/zoeken/showbouwsteen.asp?bstnum=192489&location=>

¹⁰ Monthly contribution for the funds is based on decisions made by the individual communities and differs from five to ten rupees (Euro 0.05-0.10) per house hold.

repair of mitigation measures. The communities have developed their disaster management and contingency plans based on community lead assessments.



Upstream observation

The KDRRI has also piloted community-based early warning systems. The systems involve monitoring upstream points and passing information, and when flood and rainfalls levels make it necessary, warning to downstream communities and

dissemination of warning messages within the communities.

The physical work supported by the project is of smaller scale as time and resources render larger scale river training interventions impractical. However, this has the added benefit of allowing the committees to build their own planning and implementation capacity. Bio-engineering is the essential measure for bank protection work. Bamboo crib walls are used to protect against toe undercutting. The physical work also includes plantation on the river bank, evacuation routes, boats, raised water points, embankment work and spurs. Small scale mitigation work has been designed and implemented based on hazard mapping exercises and community Disaster Management plans to address the mentioned problems. Experience from the project demonstrates that communities are likely to expand these mitigation works after understanding their effectiveness, and that neighboring communities are also likely to observe and replicate mitigation works.

In summary guiding principles for the interventions are community participation, capacity building, low tech, low cost and easy to replicate projects, long term solutions, use of local material and other local resources such as bamboo and shrubs and transparency through participatory decisions,

reviews and social audits. These principles will not only ensure a positive outcome for this project, but can be seen as an investment to secure future community-led interventions.

As reported in case studies¹¹, these activities have had a number of impacts on the communities. Number of lives lost and the number of injuries due to the flooding have decreased as a result of the evacuation routes, boats, search and rescue, and first aid services. The early warning systems ensured timely information on floods, allowing for on-time evacuation of vulnerable community members, livestock and personal belongings. The creation



Dissemination of early warning

of the DPCs has greatly enhanced intra- and inter-community relationships and promoted collective actions. The community members express that they have gained more confidence and a greater sense of control the development of their community. This counts not the least for the women, since they have been actively involved in the various activities. The installation of raised hand pumps has ensured clean water supplies, and villagers report substantial reduction of diarrhoea. Trainings and capacity building activities have strengthened the communities' ability to cope and prepare for floods. Overall community members report that flooding has become less of a problem in their community through the implementation of the DRR programming, and that they feel empowered to deal more effectively with floods when they occur.

Bisanpur as a Case Example

Of the 6 villages where KDRRI was active, Bisanpur was selected for this CBA study because

¹¹ <http://www.mercycorps.org/fordevelopmentprofessionals/communitybaseddisasterriskreduction/15781>

NRCS and Mercy Corps staff felt that it was the most representative of the greater KDRRI. Furthermore, this community did not in any way receive a disproportionately high portion of the funding and staff devoted to the KDRRI project as a whole. If anything, Bisanpur represented one of the most modest financial investments, so the project cost for this community (estimated at one sixth of the total KDRRI budget for the purposes of this CBA) is highly conservative.

The village of Bisanpur is located in the Kailali district of Nepal's far west Tarai region. Bisanpur is comprised of 275 individuals, living within 30 households. All the residents of Bisanpur are members of the Tharu ethnic group. They are primarily subsistence farmers; however, they are currently only able to produce enough food to feed their community for four months out of the year. Low agricultural productivity is due to traditional cultivation practices (communities rely heavily on rain-fed agriculture and lack funds for irrigation systems, fertilizer or high quality seed, etc.), fragmented land holdings, and decreased soil quality from recent flooding and subsequent siltation. The majority of the men in the community must find seasonal manual labor jobs to earn enough money for food for the remaining eight months of the year. In past years these men have generally migrated to India or the Nepali border town of Danghari for such work; however other Mercy Corps projects in the local area (i.e. "Cash for Work"¹²) have recently provided another means to earn this extra income, which also allows them to simultaneously work their own fields, take care of their children, etc. Bisanpur is located immediately next to the Mohana River. When the river floods, water and silt first flood a large swath of agricultural land, and riverbanks are eroded by the floodwater. Bisanpur has a main road which is elevated, and serves to protect the village from the flooding in the agricultural

fields. However, during severe floods, the river proceeds to break through this barrier and flood the low portion of the village. This low portion contains 11 of the village's 30 houses. The 2065 (Nepali calendar)/ 2008 (Gregorian calendar) flood deposited several feet of silt on their agricultural fields and then also broke through the road, flooding these 11 houses. This flood destroyed the entire rice crop for that year (which was nearing the harvest season at the time), and it also prevented that year's wheat harvest because of the inability for the sandy soil to retain enough water for agriculture. Furthermore, according to community members, this land remains at only about 20% of its original productivity, and the people of Bisanpur can no longer use the land for rice and wheat cultivation. Instead, this land is used only for "river bed" crops, such as cucumber and water melon. These crops are highly perishable, so while they could theoretically provide income for the community if sold, the production volumes and available market linkages are not conducive to significant sales. Furthermore, because the river bed crops are low-calorie food items and cannot be stored well, they cannot serve as a significant food source for the community members.



Flooding, September, 2009

¹² Supported by the World Food Programme (WFP) between November 2008 and June 2010.

IV. Methodology

Methodological decisions

Before data collection for a CBA can proceed, the following must be determined:

- The definition of a disaster event within the local context
- The time unit by which disaster risks and impacts are to be assessed
- The resolution of the impact assessment data (e.g., community level, households)
- The spatial scale at which the CBA will be conducted (e.g., single village)
- The forms of capital to be included into cost and benefit calculations (e.g., economic, social, environmental)

In the case of this CBA, because floods are common (there are often multiple floods in a single year), and naturally separated by the dry seasons, disaster events are defined here as flood years, according to the Nepali lunar year. The magnitude of the disaster is defined as the magnitude of the largest flood in that year, and the impacts include the consequences of all floods during that year (however, the subtleties of these definitions were not extremely important in practice, because most flood years are dominated by a single high-magnitude flood.) Data was collected at a detailed level, using surveys to inventory impacts as completely as possible from a large proportion of the community (~40%). It was decided that this fine-grained approach to impact assessment was important in this case, because the initial qualitative assessments indicated that personal asset losses constituted a major portion of the disaster impact. Losses to these forms of capital are impossible to inventory without extensive survey and interview methods. This approach meant that the CBA could not be conducted across all of the communities targeted by the DRR project. Thus, this CBA is a study of the cost effectiveness of the DRR project in the one community of Bisanpur. Nevertheless, to the extent that the DRR programming in Bisanpur is representative of how the program has taken shape in all six communities, these results can be applied to the evaluation of the KDRRI project as a whole.

Impact Assessment

In order to conduct a DRR CBA, the impact (damages) as a function of disaster magnitude needs to be assessed and quantified.

Only some forms of impact can be appropriately incorporated into a CBA. For one thing, they must be quantifiable into monetary values so that the costs and benefits can be compared in the same units. Another consideration is that the forms of capital included in the costs and benefits must be consistent. For example, if the costs associated with time or

labor contributions by locals are not considered into project costs, then the calculation of disaster impacts should, similarly, exclude such labor costs.

Other types of impact are appropriate for conventional CBAs, but not risk-based CBAs. These include impacts which manifest after the occurrence of another disaster. For the purposes of this CBA, because disasters are defined as all the floods occurring in one Nepali lunar year, and because floods have a reasonable chance of occurring annually, impacts that occur after the flood year were not included.

Though unquantifiable and non-additive impacts cannot be incorporated into the quantitative portion of the CBA, they should nevertheless be included in the qualitative benefits to accompany the quantitative CBA results and interpretation.

Lastly, it is important to keep in mind that the modeling approach developed for this CBA requires the specification of a “maximum possible impact” (i.e. the impact caused by an arbitrarily large disaster), and that the same forms of capital must be included in this calculation as in the calculation of impacts from specific floods. For example, if one decides to include “lives lost” into impact calculations, the maximum possible impact must include the value of all possible lives that could be lost.

Forms of capital

In general, there are three types of capital that are impacted (directly and indirectly) from a natural disaster: economic, social, and environmental.

- Economic capital refers to those components of society that are generally thought of as having economic or material worth. Examples of economic capital that are often affected by natural disasters include: household income, infrastructure (roads, electricity), buildings, homes, vehicles, crops, savings, personal belongings, etc.
- Social capital generally refers to social relations and connections that have productive benefits. Examples of social capital that are directly affected by natural disasters include: loss of life, injuries, or cultural/religious items. Examples of social capital often indirectly affected include: disease occurrence (i.e. typhoid, malaria, cholera, etc.), school attendance,

physiological disorders such as stress and depression, and loss of living environments or social contacts and relationships.

- Environmental capital refers to attributes of the natural environment that contribute to the productivity of the community, as well as those that can be considered to have intrinsic value. Examples of environmental capital that can be impacted by natural disasters include water quality, soil productivity, air quality, biodiversity, natural habitats, etc.

Data Sources for With-DRR Impact Assessment

Given time constraints and methodological complexities, it is not possible to address all possible components of each form of capital in a DRR CBA. The number of components is further reduced when working at the community level in remote villages such as Bisanpur. Thus, it is important to establish the scope of the data collection that is: What data can be accurately and realistically collected?

To date, most DRR CBAs measure the impact on economic, social, and environmental capital using data compiled by government organizations (local, regional, and national), industries, NGOs, and disaster management authorities. In the Kailali district of Nepal, however, statistical data is sparse, and at the village level it is virtually non-existent¹³. Despite these challenges, we assess impact at the focal level of the village for the purposes of this CBA. Given the limitations of any single data collection method, it is important to corroborate data from multiple sources and stakeholders. In the case of the Kailali DRR CBA, impact data collection was primarily targeted at (1) village members through the

¹³ After the majority of the analysis was complete, we discovered that detailed impact data was collected by Mercy Corps at the village level for one of the flood years. This data was not incorporated into this assessment primarily because it was only available for a single flood year, however, this type of data would be ideal for future CBAs. We therefore strongly encourage the continued collection of the same data in the future.

disaster preparedness committee (DPC) Survey¹⁴, (2) project managers and community leaders through the Project Manager (PM) Survey¹⁵, (3) available data through Mercy Corps, Red Cross, and government statistics, and (4) qualitative assessments and site visits conducted by the research team to corroborate survey data and to fill data gaps.

1. Disaster Preparedness Committee (DPC) survey

A survey consisting of 16 questions was used to collect data on the impact of both the 2065/2008 and 2066/2009 floods in Bisanpur.¹⁶ Interviewees were restricted to members of the Bisanpur DPC and were asked to answer questions from a household perspective (i.e., “what belongings did your household lose” as opposed to “what belongings did you lose?”). Questions were directed at determining specifics on household’s annual crop production and other income, worth of assets, belongings lost or damaged during the floods, replacement costs of damaged items, and any health and education costs that resulted from the floods. English and Nepali versions of the survey are available from Mercy Corps Nepal upon request.

The design of the survey was challenging. The CBA model requires specific numbers and details that can be difficult for community members to recall or estimate. Much of the community is illiterate and poorly educated, and many concepts (such as annual income) are foreign. Thus, it was

critical that the survey be reviewed, edited, and translated by several people familiar with Bisanpur and fluent in Nepali. Further, it was determined that the actual surveying be conducted by one of the Mercy Corps field coordinators who routinely works in, and is familiar with, the local community. It was critical that such a person administer the survey as cultural and language barriers would have made the survey impossible to administer by the research team or through a translator. 12 of the 13 DPC members were interviewed (representing 12 households and thus 40% of the community).

2. PM survey and interview

The design of the project manager survey was directed at any “experts” who would know how the community was affected during the flood years. Due to the lack of a government resource, only Mercy Corps and Red Cross project managers were interviewed. The survey consisted of 32 questions, but the interview was mainly an open discussion with the questions providing the structure. Questions were designed to understand the impacts that fell outside of individual households (i.e., community impacts), to corroborate data with the DPC survey, to get a general understanding of how Bisanpur is affected by floods, and to understand how Bisanpur would have been affected by the floods had DRR programming not been implemented. Nepali and English versions of this survey are available from Mercy Corps Nepal upon request.

¹⁴ A central component of Mercy Corps DRR programming is the establishment of disaster preparedness committees (DPCs) and sub-committees within each community that it operates. Members of these committees have clearly defined roles and responsibilities, and are relied upon to promote DRR related activities and to mobilize local people to reduce risks. Selection of DPC members follow a participatory approach with key involvement of community leaders and are purposely made to be gender and socially inclusive so to be as representative of the greater community as possible. The community survey was only administered to DPC members as they were viewed as the most knowledgeable about the impact from flooding, are familiar with surveys, and as a group we representative of the greater community.

¹⁵ The PM survey was initially developed to be administered to local government officials or community leaders under the assumption that they would be most knowledgeable about community wide impacts of the flooding. However, it was later determined that Mercy Corps and Red Cross project managers were most knowledgeable about such impacts considering their intimate relationship with, and constant evaluation of, the project sites.

¹⁶ See “Risk Assessment” section for detailed explanation of the flood events and their probability.

3. Available Data

Some impact data was previously collected by Nepal Red Cross Society and Mercy Corps Nepal for Bisanpur. This data, however, was not complete or fine-grained enough to be sufficient for inclusion in the CBA. Nevertheless it was used to corroborate information gathered through the DPC and PM surveys.

impact could not accurately be assessed, a conservative assumption was made for the “No-DRR” impact: we assumed it would have been the same as the scenario with DRR. Using Google Earth satellite photos and GPS coordinates of houses and other landmarks in the village, it was possible to determine the number of houses that would have been flooded without the river bank and erosion protection, as well as the amount of

Table I. Types of data collected and corresponding sources, and collection methods

Capital	Component	Data Sources	Data Collection Methods
Economic			
Household	Method of income generation, belongings, savings,	DPC members	DPC survey, site visits
Community	Infrastructure, savings	DPC members, project managers, NGO and government data	DPC survey, PM survey, review of available data; site visits
Social			
Household	Deaths, injury, health, education	DPC members	DPC survey, site visits
Community	Deaths, injuries, health, education	DPC members, project managers, NGO and government data	DPC surveys, PM survey, site visits
Environmental			
Household	Soil productivity, water quality	DPC members, project managers, researchers assessment	DPC survey, PM manager survey; qualitative assessment
Community	Soil productivity, water quality	DPC members, project managers, researchers assessment	DPC survey; PM survey; qualitative assessment

agricultural land that was saved by this intervention. It was also possible to collect very reliable information from the interviews and surveys of DPC members and project

4. Qualitative Assessment and Site Visits

Subsequent to the DPC survey being administered and analyzed, the research team visited Bisanpur to meet with the DPC members and the village leader. This visit was important to help interpret survey results, to understand the particularities of how floods impact Bisanpur, to assess the relative magnitude of the recent floods and their respective probabilities, and to assess the impact of these floods in the hypothetical case of these floods occurring in this community had there not been any DRR programming.

Data Sources for No-DRR Impact Assessment

With the above methods, we determined how the DRR project reduced the impact of the floods, and approximated the hypothetical impact had there not been DRR. In cases where the hypothetical

managers about exactly how many assets were saved through the implementation of the Early Warning System. Project managers also provided specific information about how the DRR project changed the behavior of community members and the availability of clean drinking water, allowing us to approximate the number of individuals that would have been exposed to contaminated water had there not been DRR programming prior to these floods.

Risk Assessment

The magnitude of the floods in the dataset must be assessed, and then the annual probabilities for flood years exceeding any particular magnitude must be assessed. Because rainfall data had only been collected for 12 years in this area, and because it is unclear how up-stream rainfall determines flood magnitude (due to the absence of flood forecast models), and because the flooding in this region is due to recent environmental shifts

(massive up-stream deforestation), we did not rely on probabilistic statistics on the likelihood of causal weather events. Instead, a risk assessment was carried out using local knowledge about flood probability and advice from experts about the causation of the floods. As an index of flood magnitude, the water height from the river bottom (in meters) is normalized so that it ranges from 0 at 100% probability, to 10 at ~0%. The authors normalized this number simply by subtracting 4. We then verified that this system for assigning magnitude roughly aligned with local knowledge of flood probabilities. For example, this system assigns a probability of 60% to a 5 meter water height, which is approximately the water height at which flooding begins in Bisanpur. This is clearly a very conservative estimate, since the village essentially floods every year. Further, the water height for the 2065/2008 flood was 7.2 meters, and for the 2065/2008 flood year, it was 6.0 meters. The approximate magnitudes of the 2065/2008 and 2066/2009 floods are therefore 3 and 2, respectively. This implies that the 2065/2008 flood is a “5-year-flood”, and the 2066/2009 flood is a “3-year-flood”. Again, these were confirmed to be reasonable approximations through discussions with locals and development workers who have knowledge of the flood history in the area. For future CBAs, the equations used in our analysis can all stay the same if one simply defines magnitude such that it conforms to the probability distribution shown in Figure 2 and Table II:

Table II. Defining disaster magnitude via annual probability

Magnitude	Annual probability
0	1
1	0.607
2	0.368
3	0.223
4	0.135
5	0.082
6	0.0498
7	0.0302
8	0.0183
9	0.0111
10	0.00674

This distribution assumes an exponential decline in the probability for a disaster as magnitude increases. We believe this assumption is conservative - that is, it likely underestimates the contribution by high magnitude disasters to average annual impacts, because this distribution assigns such disasters very low probabilities.

The Community-based Sigmoid Exponential Disaster Risk (CSEDR) CBA Model

The general methodology for a risk-based CBA requires that quantified impacts be mapped to disaster magnitudes so that the impacts of each possible disaster can be appropriately weighted, according to the probability of that event, in the calculation of a final B:C ratio. Here we use an explicit mathematic model for mapping impacts to magnitudes, and another to assign probabilities to all possible magnitudes. We therefore rely on mathematical software to solve for the final results. Further, we designed a user-friendly computer program expressly for the purpose of carrying out the analysis of a risk-based CBA undertaken at the community level. This program, which we call the Community-based Sigmoid Exponential Disaster Risk (CSEDR) computer program, is available from the authors upon request (Rorick MM & White BA, 2010). Below we provide a basic description of the DRR CBA process that the CSEDR CBA program implements. Some of the underlying assumptions of the model are also discussed.

The basic methodology of CSEDR CBA

1. The CSEDR program assumes a sigmoid (s-shaped) function describes how disaster magnitude “M” determines impact “I” (i.e., the model specifies I[M] as a sigmoid function of M). The form of this function is the same for both the With-DRR and Non-DRR situation:

$$I = \frac{ce^{\frac{am}{h}} v}{1 - c + ce^{\frac{am}{h}}} \quad (\text{Equation 1})$$

where “a”, “c”, and “v” are constants, “e” is Euler’s number (~2.71828), “M” is magnitude, and “I” is impact¹⁷.

- The program then finds appropriate parameters for this model by determining the best fit “a” parameter, using impact data from disasters of known magnitude, and the maximum possible amount of capital that can be lost given an arbitrarily large disaster. The “a” parameter determines the steepness of the s-curve. This fitting will be done separately for the With-DRR and Non-DRR data, so the curves will differ. The “c” and “v” parameters are the same for both the With-DRR and Non-DRR situations, and determined by other means¹⁸.

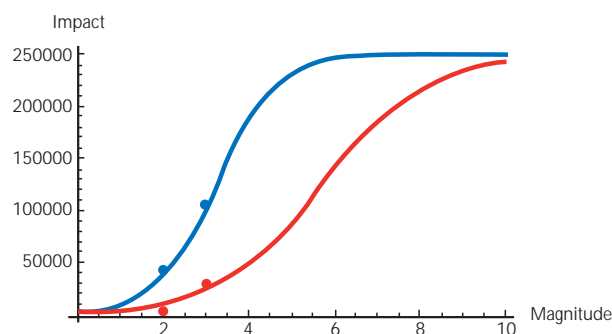


Figure 1. The impact of a disaster at a given magnitude, for both Non-DRR (blue) and With-DRR (red) situations. These functions are generated by finding the best-fit sigmoid, and a priori specification of $I[M=0]$ and $I[M=M_{\max}]$.

- Determines the annual probability of all possible flood magnitudes, and fits an appropriate model. Here we use an exponential decline function¹⁹:

$$\text{Prob}[M] = e^{-0.5M} \quad (\text{Equation 2})$$

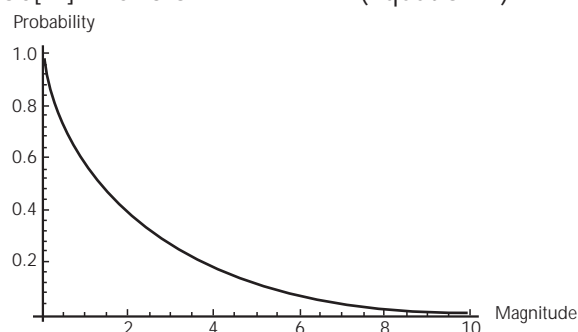


Figure 2. The probability that a disaster at, or exceeding, a given magnitude will occur in any given year, as a function of disaster magnitude. We assume an exponential decline in probability as disaster magnitude increases.

¹⁷ We make assumptions when we use a sigmoid curve (described in Equation 1) to model impact as a function of magnitude. The primary assumption is that as flood magnitude initially increases, impacts increase at an accelerating rate, but that at some point, once flood magnitude reaches a certain level, the rate at which impacts increase starts to slow, to a point where increasing flood magnitude makes no more difference on impact, because all capital in the community has been lost.

¹⁸ We assume that the maximum impact of a flood is the same in both the With-DRR and Non-DRR communities. We set v equal to this maximum impact in Equation 1, which describes how impact (I) is a function of flood magnitude (M), and this specifies that this curve should plateau at this maximum impact. Also, we set $c=.01$ in Equation 1, which assumes that both communities experience an impact of 1/100th of this maximum impact when the flood magnitude is 0 (due to the structure of the function, the impact at $M=0$ must be greater than 0).

¹⁹ We make an assumption when we use the exponential curve (described by Equation 2) to model magnitude as a function of probability. The assumption underlying this decision is that the probability of a flood decreases exponentially with increasing flood magnitude. Since different indices for magnitude (e.g. water level, water speed, annual rain-fall, etc.) may not have linear relationships with one another, whether this assumption is true or not depends on one’s magnitude index. Thus, given one’s choice of magnitude index (which will probably be determined by considerations of the causal factors of the disasters along with considerations of the indices for which there is available risk data), it is important that this assumption is more or less correct.

4. Knowing impact as a function of magnitude (Figure 1), and probability as a function of magnitude (Figure 2), solves for impact as a function of probability to obtain the “exceedance curve” (Figure 3).

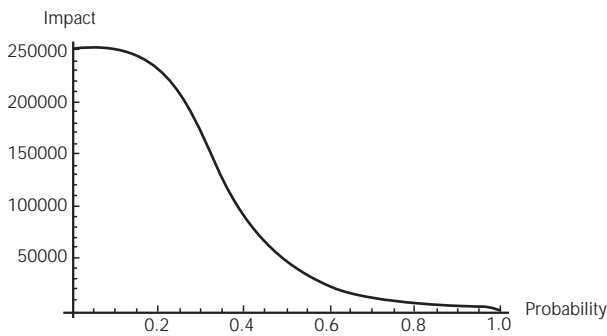


Figure 3. The annual impact due to disasters, as a function of annual probability. This is also known as the “exceedance curve”. This curve is obtained by solving for $I[M]$ as a function of $P[M]$.

5. The With-DRR and Non-DRR data produce two exceedance curves, which differ by their “a” parameter. We then take the difference between the areas under these curves, which is simply the difference between the discrete integrals of these curves, between 0 to 1. This difference in area represents the average annual benefits accrued through DRR interventions.

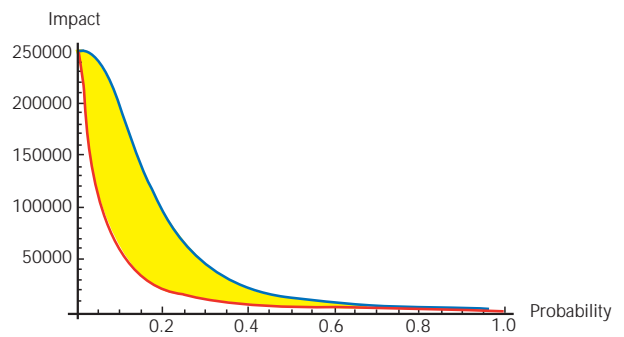


Figure 4. The area (yellow) between the Non-DRR (blue) and With-DRR (red) exceedance curves represents the average annual benefits accrued through the DRR program.

6. Considering project lifetime, discount rates, potential error in cost and benefit estimates, etc., we now determine the overall B:C ratio for the DRR project as a whole. This number gives the factor by which the benefits are greater than the costs. If this ratio is over 1, the benefits are greater than the costs and it can be concluded that the DRR project is economically viable. If this ratio is below 1, the costs are greater than the benefits (unless the CBA has significantly underestimated the benefits or overestimated the costs), so the economic viability of the project should be questioned.

VI. Results and Interpretation

The “impact” data used for this analysis is diverse—in terms of the ability to quantify it, the collection method, our confidence in its accuracy, etc. Ultimately, we decided that it is only appropriate to include direct impacts into the CBA (defined here as impacts which occur in the same year as the flood). Further, there were some impacts which were difficult to quantify. To deal with this, we analyze the data in two stages. First, we analyzed the results without including any hard-to-quantify impacts. Second, we analyze the results including health impacts due to disasters. There are, of course, many other significant impacts of disasters which we did not include in either part of the quantitative analysis, either because we were not able to meaningfully quantify them, or because they were indirect (and therefore non-additive). Some of these are discussed in the “qualitative results” section further below. Also, there are some beneficial outcomes of DRR programming which are not consequences of reducing disaster impacts. Although these things cannot be included in the quantitative CBA, they are discussed in the “qualitative results” section.

Table III shows the raw data, which we analyzed using the CSEDR CBA Model, to provide B:C ratios for the KDRRI project.

Table III. Raw data on impacts and magnitude.

Impact Table		2065/2008 Flood		2066/2009 Flood	
		Non	With	Non	With
		DRR	DRR	DRR	DRR
Economic Capital	# of Houses flooded	21	11	12	1
	% grain-storage lost in flooded homes (quintals)	100%	71%	100%	71%
	% assets lost in flooded homes *not including crops, land, or grain storage	100%	0%	100%	0%
	% total annual crop lost	100%	100%	15%	15%
	% of land permanently lost due to erosion	15%	5%	5%	0%
	Value of Infrastructure lost	4452 €	4452 €	N/A	N/A
Social Capital	Number of individuals exposed to contaminated drinking water	193	0	110	0
Risk Assmt.	Flood Magnitude	3	3	2	2

Reducing impacts to economic capital

If impacts are assumed to only include direct losses of personal assets (including the annual crop, grain storage, livestock, belongings, etc.), and to community infrastructure, we find considerably different exceedance probability curves for No-DRR versus With-DRR scenarios (Figure 5). From these curves, we can infer that the average annual benefit of DRR is €23,550 (before accounting for

Table IV. Other necessary data

Other Necessary Data	
Number of households	30
Average household size (people)	9.2
Total Project Cost (€)	304,422 (50,737 per community)
Number of communities project targets	6
Expected Benefit Duration (Years)	4-10
Average Annual Household Crop Production and Other Income (€)	1,046
Average Value of Household Assets (€) *including one annual crop and not value of land	3,386
Average Household Annual Crop Value (€)	694
Average Household Owned Land Value (€)	2,529

the discount rate). To calculate a B:C ratio, we assume that the benefit duration is 4 years (our conservative estimate), and that there is a 12% annual discount rate, which takes effect after the first year (to account for the fact that future benefits are worth less than present benefits). We assume that the project cost for the village of Bisampur is 1/6 of the total program cost, and incurred only

during the first year (i.e., no costs are discounted). These costs and benefits correspond to a B:C ratio of 1.72, and assuming a 20% reduction in our estimate of average annual benefits, a B:C ratio of 1.38. We also determined B:C ratios under the assumption of optimistic benefit duration and for other discount rates (Table V).

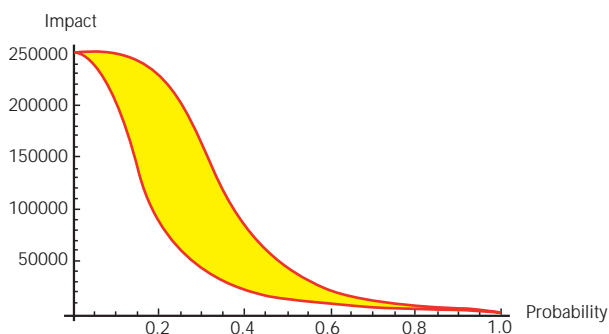


Figure 5. Exceedance probability curves for No-DRR (blue) and With-DRR (red) scenarios. Impacts are in Euro, and include only those which directly affect household assets.

Table V. B:C ratios with economic impacts

Assumptions	Benefit Duration					
	4 years			10 years		
	Discount Rate			Discount Rate		
	0%	5%	12%	0%	5%	12%
Assuming best estimates for costs and benefits	1.86	1.72	1.55	4.46	3.75	2.79
Assuming 20% reduction in benefits	1.49	1.38	1.24	3.71	2.98	2.23

Reducing impacts to social and economic capital

Second, we consider the impact of floods on human health, as well as the direct impacts of floods on economic capital. The health impacts we are considering are those due to contamination of the water supply. By providing the community with elevated water pumps which do not become contaminated during a flood, and through education of the community about avoiding contaminated water sources after the flood, the DRR programming may reduce some of these health-related impacts of floods. When the health impacts of flooding are considered,

the maximum possible impact is greater. The No-DRR versus With-DRR scenarios again leads to considerably different exceedance probability curves (Figure 6). In this case, the average annual benefit of DRR is €29,487. Assuming benefit duration of 4 years and a 12% annual discount rate, the B:C ratio is 2.16. With a 20% reduction in the average annual benefits, the B:C ratio is 1.72. We also calculate the B:C ratios under the assumption of optimistic benefit duration and for other discount rates (Table VI).

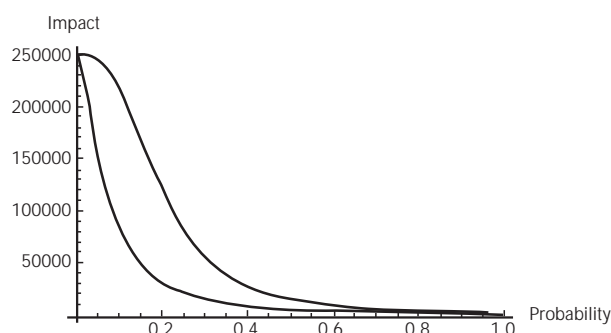


Figure 6. Exceedance probability curves for No-DRR (blue) and With-DRR (red) scenarios. Impacts are in Euro, and include impacts to economic capital and social capital.

Table VI. B:C ratios with impacts to social and economic capital

Assumptions	Benefit Duration					
	4 years			10 years		
	Discount Rate			Discount Rate		
	0%	5%	12%	0%	5%	12%
Assuming best estimates for costs and benefits	2.32	2.16	1.94	5.81	4.66	3.49
Assuming 20% reduction in benefits	1.86	1.72	1.55	4.65	3.73	2.80

These above results suggest that, even with the most conservative estimates for flood damage, discount rate, and project impact duration, the benefits of KDRRI programming exceed its costs. Further, these results only consider impacts to economic capital and a small component of social capital. Had it been possible to more fully quantify the impact of social capital and environmental capital, we expect the B:C ratios would have been significantly higher.

It is our belief that the B:C ratio of 3.49, which was determined assuming a 10 year benefit duration²⁰, a 12% discount rate²¹, best estimates for costs and benefits²², and the inclusion of some social benefits, is the most accurate assessment of the KDRRI project. A B:C ratio of 3.49 indicates that for every Euro spent on DRR, we expect that 3.49 Euros will be saved by the community or the aid organization responding to the community's post-disaster needs. Though this is significant by itself, it should be stressed that the 3.49 B:C ratio still represents a considerable underestimate of benefits given the methodological problems with including all benefits associated KDRRI programming. Thus, the 3.49 B:C ratio should be thought of as the best conservative estimate. The additional, non-quantified benefits of KDRRI programming are discussed in the following section.

Additional Social and Economic impact

The CSEDR Model was only able to capture the direct economic benefits from DRR programming in Bisanpur. However, several other benefits from DRR programming that could not be quantified clearly have monetary, social, and spiritual benefits. These include:

Human: The study did not attempt to quantify, or estimate, how many lost lives or injuries were avoided due to DRR programming in Bisanpur. However, Bisanpur villagers told stories of how the early warning system helped alert them to the approaching flood and gave them ample time to secure their belongings and

move to higher ground. Further, the search and rescue team was estimated to have saved over 300 people in neighboring villages (including the local police force) by taking them to safer ground.

Livestock: During the 2065/2008 dozens of livestock, including water buffalo and goats, from a neighboring community were rescued using KDRRI research and rescue techniques and equipment. The economic capital of neighboring communities that was saved through the DRR programming in Bisanpur was not considered in our economic analysis.

Community Empowerment: During the site visits and discussions with Bisanpur residents it was clear that DRR programming significantly empowered Bisanpur as a community. For instance, the community now feels more confident to meet with, and request help from, government officials; they have become proactive about preparation and planning of new structures in the community, and no longer feel completely helpless in the face of floods.

Indirect loss of crop production and other income: The CSEDR Model does not account for future (beyond 1 year) losses in crop production and other income that resulted from the floods. For example, while the model includes impacts on crop production and other income for the first year following the loss of an agricultural implement such as a plow, it does not consider the economic impact of the plow's absence 2 or 3 years later.

²⁰ We believe 10 year benefit duration is more appropriate for the KDRRI project than a 4 year benefit duration for several reasons. Much of the programming that was done in KDRRI will last well beyond the completion of the project. For instance, there were several permanent structures built to protect the communities, resources/tools used by the search and rescue groups have a slow depreciation rate, by most accounts the early warning system has become a permanent component of the communities, and the education/capacity building/training that was conducted can be expected to last well beyond the 2 year implementation phase.

²¹ A 12% discount rate was chosen because it is the most common rate used for CBAs in India by the Asian Development Bank. See: http://www.adb.org/Documents/ERD/Working_Papers/WP094.pdf

²² The 20% reduction in benefits used as a sensitivity analysis was not used for our best estimate as we feel confident in the accuracy of calculated economic impacts. Further, had social and environmental impacts been quantifiable the B:C ratio would have been significantly higher.

Social Cohesion: Before DRR programming in Bisanpur the village men routinely left for India or the trade town of Dhangari to work as day laborers. However, in recent years Cash-For-Work programs established alongside KDRRI have allowed many of them to stay in their village despite the particularly poor agricultural yields. This has the benefit of allowing the men to continue to work their own land and be with their family, while also earning the extra money they require to support their livelihood. Further, after the 2065/2008 flood year 3 families who lost their homes moved to another village. It is possible that more households would have uprooted and left the community had there not been DRR programming.

Education: During the 2065/2008 flood several school books were lost in the flooding, and Bisanpur children missed several days of class. Our quantitative analysis does not account for how this loss in education affects the community or how many books were saved due to the early warning system.

Environmental: Loss of top soil and decreased soil productivity from the 2065/2008 flood was extensive. Roughly 2 feet of sand and silt was deposited during the flood. The CSEDR Model captures the immediate impact, which was the loss of 2 harvests. However, through the site visit and conversations with Bisanpur residents it was estimated that the soil productivity remains roughly 20% of what it was before the flood, and is only increasingly marginally from year to year. The CSEDR Model does not account for the future loss of crop production and other income resulting from this loss in soil productivity.

CBA is a tool specifically designed to consider costs and benefits that can be quantified into monetary units. Unfortunately, the quantification of the above benefits was simply beyond the scope of this project. Our qualitative assessment suggests that, had it been possible for us to more comprehensively quantify disaster impacts on social and environmental capital, we would have found much greater benefits of KDRRI programming, and thus, much higher B:C ratios.

VIII. Conclusions

Using conservative estimates for the benefits measured in this study, we find B:C ratios greater than 1 for this particular disaster risk reduction project. Therefore, we conclude that investments in similar DRR activities in similarly hazard prone areas are likely to return in benefits at least 3.49 times the original cost of the investment.

Furthermore, it is important to note that we find B:C ratios greater than 1 under a broad range of circumstances— even when we use a highly restricted set of flood impacts and even under great reductions in the benefits. Our best estimate B:C ratio for the KDRRI project is 3.49, which suggests that for every Euro spent on DRR, the expectation is that 3.49 Euros will be saved by the community or the aid organizations responding to the community's post-disaster needs. Further, this estimate represents a very conservative B:C ratio, as it only considers economic impact and limited variables of social impact. There are many impacts which we did not include in our quantitative

assessment, either because they were indirect or difficult to quantify. Through our qualitative assessment in the field, and through our in-depth discussions with villagers, community leaders and local development workers, we believe that the qualitative impacts of floods are in fact those most significantly modified by the KDRRI programming. Thus, we believe that a complete assessment of this disaster risk reduction project must also consider its many significant qualitative benefits. Had it been possible to more thoroughly quantify the full scope of the benefits accrued through KDRRI programming, we are confident that our final B:C ratios would be significantly higher.

Works cited

Queensland Government, Counter Disaster and Rescue Services (2002). Disaster Loss Assessment: Guidelines

Asian Development Bank (2007). Theory and Practice in the Choice of Social Discount Rate for Cost-benefit Analysis: A Survey.

http://www.adb.org/Documents/ERD/Working_Papers/WP094.pdf

Post Disaster Surveys: experience and methodology

[http://www.ema.gov.au/www/emaweb/rwpattach.nsf/VAP/\(99292794923AE8E7CBABC6FB71541EE1\)~Post+disaster+surveys.pdf/\\$file/Post+disaster+surveys.pdf](http://www.ema.gov.au/www/emaweb/rwpattach.nsf/VAP/(99292794923AE8E7CBABC6FB71541EE1)~Post+disaster+surveys.pdf/$file/Post+disaster+surveys.pdf)

World Bank Earthquake Vulnerability Reduction Program in Colombia - A Probabilistic Cost-benefit Analysis, World Bank (2006)

<http://www.proventionconsortium.org/?pageid=26#projects>

Buildings and Infrastructure Project: A Case Study of Caribbean Infrastructure Projects that have Failed Due to the Effects of Natural Hazards, OAS (1998)

<http://www.proventionconsortium.org/?pageid=26#projects>

Description of Fourth DIPECHO Plan for South Asia.

<http://www.evd.nl/zoeken/showbouwsteen.asp?bstnum=192489&location=>

Rorick MM, White BA (2010) The CSEDR CBA Model, Mercy Corps Nepal



DIPECHO is the Disaster Preparedness Programme of the European Commission's Humanitarian Aid department, the largest single humanitarian donor in the world. The DIPECHO programme funds pilot projects intended to demonstrate that simple, inexpensive preparatory measures, particularly those implemented by communities themselves, can limit damage and increase resilience and save lives.

Mercy Corps is an international non-governmental humanitarian relief and development organization with headquarters in the USA and UK that focuses on providing support to countries in transition. Mercy Corps exists to alleviate suffering; poverty and oppression by helping people build secure, productive and just communities. Mercy Corps is primarily focusing on emergency relief; economic development; and, initiatives that strengthen civil society. The goal of Mercy Corps Nepal is to alleviate poverty by increasing resilience to shocks, expanding economic opportunity, and fostering social inclusion.

Mercy Corps Nepal
P.O.Box 24374
Sanepa Chowk, Lalitpur, Nepal
Telephone: +977 1 555 5532
Fax: +977 1 555 4370
E-mail: info@np.mercycorps.org

Mercy Corps European Headquarters
40 Sciennes, Edinburgh, EH9 1NJ, UK
Telephone: +44 (0)131 662 5160
Fax: +44 (0)131 662 6648
www.mercycorps.org

