Number 49
November 2004

Humanitarian Practice Network
HPN
Managed by
Humanitarian Policy Group

Network Paper

Disaster preparedness programmes in India
A cost benefit analysis

Commissioned and published by the Humanitarian Practice Network at ODI

Courtenay Cabot Venton and Paul Venton

In brief

- This Network Paper presents a cost benefit analysis of two disaster mitigation and preparedness (DMP) interventions in India. Its objective is to analyse the net benefits resulting from DMP to assess the cost-effectiveness of such interventions.

- First, it aims to provide evidence-based research to confirm that investment in DMP initiatives is money well spent from an economic point of view.

- Second, it intends to show how cost benefit analysis can be used as an analytical tool to choose between different types of DMP intervention.

- Third, it aims to provide evidence of the potential for using DMP as a significant element in both humanitarian relief and development programming. Such evidence can also be used to advocate for increasing the resources allocated to specific DMP interventions.

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Printed and bound in the UK

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Acknowledgements

The authors would like to thank the staff of Tearfund partners in India, EFICOR and Discipleship Centre, who worked alongside us in gathering the data and were an invaluable source of information and logistical support. In particular, thanks are due to Mr. David Chandran, Mr. Roy K. Alex and Mr. Harshan K. Y. of EFICOR, and Mr. John Samuel, Mr. Alex Joseph and Mr. Gabriel Das of Discipleship Centre. Guidance and advice have been provided from within Tearfund by Marcus Oxley, Bob Hansford and Alison Fernandes. We would also like to thank Charlotte Benson, Ian Davis, Dominic Moran, Dominic Waughray and Alex Cox for their feedback and comments.

ISBN: 0 85003 735 2
Price per copy: £4.00 (excluding postage and packing).

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More effective prevention strategies would not only save tens of billions of dollars, but tens of thousands of lives. Funds currently spent on intervention and relief could be devoted to enhancing equitable and sustainable development instead, which would further reduce the risk of war and disaster. Building a culture of prevention is not easy. While the costs of prevention have to be paid in the present, their benefits lie in a distant future. Moreover, the benefits are not tangible; they are the disasters that did not happen.

Kofi Annan,
Annual Report on the Work of the Organisation of the United Nations,
1999

Chapter 1
Introduction

This study presents a cost benefit analysis of two disaster mitigation and preparedness (DMP) interventions in India. The objective of the study is to analyse the net benefits resulting from DMP to assess the cost-effectiveness of such interventions. Tearfund, a UK-based NGO, commissioned the study in response to a call from the international community for greater evidence of the impacts and effectiveness of DMP.

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Monsoon flooding in north-east India

Background to the project

Historically, the response to disasters has focused on relief, with governments, donors and NGOs providing post-disaster resources and aid. Whilst this work is essential to respond to people in need, the focus of disaster response has been shifting to encompass the wider issue of disaster preparedness, engaging NGOs and other stakeholders in preparing for the impacts of hazards, through measures such as early-warning systems, evacuation planning and the protection of safe drinking water supplies. The most recent thinking has taken further steps towards a risk reduction approach, in which community risk is assessed and community-level initiatives attempt to reduce the negative impacts of a hazard, through reducing vulnerabilities and building on capacities.

It is also increasingly recognised that local-level efforts alone will not break the cycle of vulnerability. The root causes of vulnerability, which may include cultural contexts, ineffective governance and international influences such as the globalisation of trade, all need to be incorporated into risk reduction if vulnerability is to be effectively reduced. Furthermore, there is a growing awareness that disaster risk reduction work needs to be integrated into development activities in order to ensure that the benefits of development are not lost and risk is not inadvertently created.

Despite these shifts in thinking, the incorporation of DMP into humanitarian and development work has been relatively slow, with the priority remaining on relief responses. A lack of evidence of the effectiveness of DMP, combined with the historic separation of humanitarian relief and development activities, has contributed to this.

This study is intended to inform the growing discussion on risk reduction in a number of ways. First, it aims to provide evidence-based research to confirm that investment in DMP initiatives is money well spent from an economic point of view. Second, it intends to show how cost benefit analysis can be used as an analytical tool to choose between different types of DMP intervention. Third, it aims to provide evidence of the potential for using DMP as a significant element in both humanitarian relief and development programming. Such evidence can also be used to advocate for increasing the resources allocated to specific DMP interventions.

The study is relevant to a wide audience, cutting across issues such as water and sanitation, infrastructure, poverty reduction, gender and health. DMP is of interest to governments, donors, NGOs and the private sector. For the public sector, DMP has important implications for achievement of the Millennium Development Goals (MDGs), as integration of DMP into development will have a significant impact on the success of initiatives to meet the MDGs in disaster-prone areas. For the private sector, disaster risk poses a threat to the financial and operational viability of projects such as infrastructure development.

What is cost benefit analysis?

Cost benefit analysis is an important economic tool for valuing investments, and is used in many sectors and with many applications. It can be used both pre-investment, to choose between different project options, or post-investment, to assess the economic value of a project.

Most projects are typically evaluated using cost-effectiveness analysis, in which an objective is set, and cost comparisons are made between different options for meeting those objectives. Although cost-effectiveness analysis is commonly used in evaluations, it does not account for the wider economic impacts of a project. Cost benefit analysis, on the other hand, allows for a comparison between benefits and costs (a benefit being defined as anything that increases human wellbeing).

Cost benefit analysis has its limitations, and it is important to highlight a number of these, particularly in the context of disasters. First, it requires assigning monetary values to, in this case, loss, including loss of life. Assigning a value to a lost life is a rightly contentious issue. How does one decide the value of that loss to the family, or to society? Economics commonly uses gross domestic product (GDP)/capita, or wage rates, to assign a monetary value to lost life. This approach can be criticised because it relies on a person's earnings potential for their value, which in the case of the poor will be lower, thereby implying that the poor are worth less than the rich. Another measure – known as Willingness to Pay (WTP) – uses a survey to ask people about the value that they place on a human life. This helps to incorporate an emotional and social perspective. WTP commonly reveals much higher values than wage rates (up to six times higher). Whilst WTP analysis is beyond the scope of this paper, it should be noted that the incorporation of WTP could significantly increase the cost/benefit ratio of DMP projects.

Second, some of the impacts that DMP interventions have on the community are difficult to quantify. For example, confidence and coherence in the community are enhanced, women's self-help groups are empowered, relationships with external bodies are strengthened and the mental stresses of dealing with disasters are reduced. All of these impacts are extremely important, and will contribute to further development and progress within the community. However, they are all difficult to quantify. This report therefore relies on a qualitative description of all impacts of DMP, but is only able to include some of these in the quantitative cost benefit model. It is important that both the qualitative and quantitative sections are taken as a whole and given weight when assessing the results.

Third, cost benefit analysis relies on best available information, and depends on a number of assumptions. Sensitivity analysis can be used to test some of these assumptions, but others are more open to debate and can significantly affect the results. There is a risk that cost benefit analysis will be used as a stand-alone tool for making investment decisions. However, it is not intended to be the sole criterion for investment, but rather provides important evidence to be used as part of the decision-making process.

Despite these limitations, cost benefit analysis is nonetheless an important tool to demonstrate the investment potential of DMP activities, as well as assisting in decision-making between alternative programme options. It can also be used to highlight the importance of integrating DMP both into a humanitarian context, and into development projects.

The HPN Good Practice Review *Disaster Risk Reduction: Mitigation and Preparedness in Development and Emergency Programming* by John Twigg includes a discussion of the advantages and disadvantages of measuring impacts from DMP using cost benefit analysis. It also cites the lack of such published analysis in this sector. This research aims to provide concrete case material in support of this discussion.

The structure of the report

This Network Paper presents cost benefit analyses of DMP interventions in two villages in India, the first in Dharbanga district, Bihar, and the second in Khammam district, Andhra Pradesh. Chapter 2 describes the methodology used for the analysis. The paper then splits the analysis by case study area, first reporting on Bihar (in Chapter 3), and then on Andhra Pradesh (in Chapter 4).

Each of the case studies includes the following:

- A description of the case study area, highlighting key characteristics, prevalent disasters in the area and their impact on the community.
- A description of the DMP programme.
- A *qualitative* analysis of the benefits of the DMP programme.
- A *quantitative* analysis of the costs and benefits of the DMP programme.
- A description of the results of the cost benefit analysis.

This is followed by a concluding section for both study areas.

Chapter 2
Methodology

This chapter describes the methodology used to conduct the cost benefit analysis in the two study areas. Broadly, the study involved the following steps:

1. Selection of study areas.
2. Definition of the project scenario.
3. Identifying project impacts.
4. Data collection.
5. Cost benefit analysis.

Selection of study areas

India was chosen for this study because it is highly disaster-prone, and because there is already an awareness of, and capacity for, DMP activities. Because the aim was to conduct a cost benefit analysis of disaster mitigation and preparedness activities at the community level, disaster-prone villages with existing DMP initiatives were chosen.

The two areas (Dharbanga district in Bihar and Khammam district in Andhra Pradesh) were selected because Tearfund partner organisations (two indigenous NGOs – the Discipleship Centre and EFICOR) were undertaking DMP activities in these locations. Strong relationships with these two partners made it possible to work alongside them with the communities. It was important to build on existing rapport and relationships between the partner staff and the villagers, ensuring that community members felt comfortable and confident enough to provide accurate and helpful answers.

Definition of the project scenario

As a second step, it was necessary to define the project scenario to be assessed. In order to analyse the costs and benefits of DMP activities, the situation without DMP needs to be compared with the situation with DMP:

- *Without DMP:* What would have been the impact of the hazard on the community before the DMP intervention had taken place?
- *With DMP:* What is the impact of the hazard on the community now that DMP has taken place?

The study specifically compares these two scenarios to determine the impact of DMP on the community, calculating the net benefits and costs that accrue from the DMP initiative.

Identifying project impacts

It is important to distinguish between the types of impact that can and cannot be assessed when comparing project scenarios in a cost benefit analysis:

- *Macro and micro level impacts (also referred to as external and internal).* Micro level impacts are defined as those that occur within the scope of the project itself, and have an impact on the community being assessed. Macro level impacts are those that affect the wider economy. For example, a project may prevent crop destruction, which results in a micro level impact (rescued income for the farmer). A macro level impact could be the effect on the market price of the crop through increased supply. This study does not include macro level impacts.
- *Primary and secondary impacts.* Primary impacts are those caused directly by the project, whereas secondary impacts are the knock-on impacts of project activities. For example, a direct loss due to flooding could be deaths from drowning, whereas a secondary impact would be increased stress due to these deaths. The aim of this study was to identify all relevant and quantifiable impacts of the DMP projects, whether primary or secondary.

Data collection

Once the project scenarios and the scope of analysis were defined, it was possible to begin collecting data. Data was gathered on both the costs of the programmes, as well as the benefits to the community. A number of techniques were used.

First, focus groups were conducted in the villages, and questions were asked concerning the impacts of flooding (based on Tearfund's Participatory Disaster Risk Assessment methodology), and how these had changed with the DMP intervention. The groups were also asked to provide estimates of the extent of losses both without and with DMP, as well as the value of these losses. Where there was a range in either the amount or the value, this was recorded. In Bihar, focus groups were conducted with five villages – three that had had DMP interventions (Kothiya Balwahi, Lavatola and Godihari), and two that had not (Narvidarya Paswan Tola and Narvidarya Sahani Tola). In Andhra Pradesh, focus groups were conducted with three villages – two that had had DMP interventions (Mal Kasinagaram and Polipaka), and one (Jeeduguppa) that had not. By working with villages both with and without DMP programmes, it was possible to gather data for both scenarios.

In each case, the researchers were introduced as students doing research to learn from the community about the impact of DMP work. The intention was to reduce bias by emphasising that the researchers were not present to provide aid or supplies, but rather to learn from the communities' experiences.

This data was then triangulated using a number of sources. First, village records of disaster impacts were reviewed (these were created with the help of the local NGOs). Second, local NGOs were a key source of data on both the benefits and costs of the DMP interventions. Because the NGOs had been working in these communities for several years, they had a comprehensive view of the impacts of disasters with and without DMP, as well as associated commodity values, and were an important source of information with which to triangulate the data collected in the field. Baseline data collected by the NGOs was also used to verify impacts in the 'without DMP' scenario. Additionally, the NGOs provided all cost data for their programmes, including fixed and variable costs. By corroborating data from a number of sources it was possible to create a robust data bank for the two scenarios.

The cost benefit analysis

The data collected was used to build a cost benefit model to analyse the costs and benefits over the lifetime of the project. This was calculated for all villages in the study area (rather than on a village, household or per capita basis) in order to demonstrate the overall impact of the DMP programme in the areas in which they are working. This involved a number of steps. First, qualitative impacts of the programme were assessed. The scenario without DMP was compared to the scenario with DMP to describe all changes that had taken place as a result of DMP. To provide a framework for the analysis, impacts were analysed in five categories – natural, physical, human, social and economic.

Qualitative impacts were assessed in light of two important concepts – additionality and displacement. Additionality refers to the net impacts of the project – any benefits should be measured net of benefits that occurred without the project. Displacement refers to any negative impacts that may occur as a result of a positive project impact. For example, introducing a technology that brings greater efficiencies in farming may reduce the need for farm labourers, whose wages decline as a result.

Second, a quantitative analysis of costs and benefits was undertaken. Data on programme costs were verified and grouped according to one-off (fixed) costs, and variable costs that occur on a regular basis. Benefits were assessed for those that were quantifiable. For each quantifiable benefit, the change in impact was calculated. For example, a reduction in losses of farming tools during a hazard period as a result of DMP was multiplied by the unit value of farming tools to determine the benefit to the household or community. In all cases, the approach was conservative, and lower-bound estimates of values were used.

Third, in order to calculate the cost benefit ratio, a project lifetime and discount rate were determined. The project lifetime is normally taken to be the operating life of the longest-lived major asset of the project, and establishes the timeframe for discounting the cost and benefit streams. In the case of the two study areas, the anticipated lifetime of the installed water pumps was used. For each year of the project lifetime, expected costs were subtracted from expected benefits to determine the net benefit for each year. These values were then discounted using the discount rate to calculate their present value (PV). The formula for calculating PV is as follows:

$$PV = \frac{A_t}{(1 + r)^t}$$

Where A = Net Benefit at year (t)
r = discount rate
t = year

A discount rate is used because a Rupee today is more valuable than a Rupee tomorrow (it can be used immediately for gain). Therefore, those costs and benefits that occur in the future need to be adjusted to today's value to reflect the time preferences or opportunity cost of capital.

Two calculations are presented in this study. The first is the cost benefit ratio. This figure divides the present value of all benefits by the present value of all costs. The ratio gives an estimate of the benefits that will accrue for each Rupee spent on the project. Costs are estimated for each year of the lifetime of the project, and each of these is discounted using the formula above. The sum of these discounted values for all years of the project gives the present value of costs. The same is done for the benefits, providing a present value of benefits. The ratio of these two figures is presented as the cost benefit ratio. The second calculation is the net present value. This takes the net benefit (the differences between costs and benefits) each year and discounts it to its present-day value. If the result is greater than zero, this indicates that the benefits outweigh the costs. The higher the value, the stronger the argument for going ahead.

Fourth, sensitivity analyses are used to demonstrate any variation that may occur in the values presented. In this instance, one of the key uncertainties is the duration and intensity of the hazard. In the two study areas, the prevalent hazards are flooding and drought, which occur regularly. Villages provided evidence on the duration and intensity of the hazards, and this was triangulated with information from the local NGOs, as well as other local organisations. Unfortunately, local time series data on the magnitude of hazards was not available to further verify the history of disasters. Despite the regularity and consistent impact of the hazards, it is important to test the cost benefit analysis model for hazards of different magnitudes, and this was done in the sensitivity analysis.

Sensitivity analyses involve varying individual values (typically holding others constant) to test how different factors affect the model. In this study, sensitivity analyses were used to test the upper and lower bounds of the model. In the first instance, the cost benefit analysis was rerun to generate a lower estimate, minimising the benefits accruing from the DMP programme and the magnitude of the hazard. The second, the upper estimate, reruns the analysis maximising all benefits and the magnitude of the hazard. This provides a top and bottom range to the potential values resulting from the cost benefit analysis.

Chapter 3
Dharbanga District, Bihar

Bihar is one of the poorest states in India. It has a population of approximately 86 million, the vast majority of whom live in rural areas (it has the highest rural population in India, as well as the lowest rural incomes in the country). Over 50% of the population live below the poverty line. Bihar is also one of the most flood-prone states in India. According to recent estimates by the World Commission on Dams, 56.5% of India's flood-affected people are based in Bihar. Three-quarters of them live in North Bihar.


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Traditional mud and bamboo housing in Bihar

North Bihar contains eight major river basins, all of which drain into the Ganga (Ganges) River. During the monsoon season (approximately June to August), these tributaries inundate large tracts of land. This flooding happens regularly every year. The intensity and duration of flooding can vary, but large numbers of villages are consistently inundated and their populations forced to evacuate to higher ground.

Dharbanga district is typical of much of North Bihar. Villages are characterised by yearly floods, high levels of poverty due to a lack of employment opportunities, very limited infrastructure (poor communication channels, no public transport, limited schooling), a strong caste structure and a feudal-like system whereby the majority of lower-caste villagers live on land belonging to landowners, in return for working in their fields.

Flooding in rural areas increased significantly following the building in 1974–75 of an embankment to protect Dharbanga town from the floods. The severity of flooding increased again when the embankment height was increased in 1987. Additionally, flood waters in Nepal are sometimes released from dams without prior warning, contributing to more rapid-onset flood surges. As a result, even if rains are lighter in Bihar, there is still flooding. Finally, the development of raised roads without adequate culverts has had the effect of trapping floodwaters and preventing run-off, creating stagnant pools that waterlog the area.

Ironically, when the floods arrive villages have to evacuate to the embankments, often suffering loss of life, livestock and possessions. Village 'kutcha' homes (bamboo and mud walls with thatched or tiled roofs) are destroyed, and families live in bamboo and tarpaulin shelters on the embankment for the two to four months of flooding. Disease is common, particularly boils on the feet due to constant exposure to water. There is no cooking fuel, and employment is scarce. Women are particularly vulnerable as they have no sanitation facilities on the embankment, and are often left with the children as the men travel to find work. Children are unable to attend school whilst on the embankment, and the state government often closes schools during the flood period, resulting in state-wide losses. Whilst the government provides assistance, this is inadequate. Emergency supplies are limited and not always usable – for example, rice is provided, but villagers have no cooking fuel. When villagers return, they often find that low-lying water pumps have become blocked by silt and debris and require repair.

Discipleship Centre (DC), a Delhi-based Indian NGO, has been implementing development programmes in Dharbanga district for over ten years. In response to the devastating effects of flooding in 2002, DC began relief work in five villages. Recognising the need for vulnerability reduction in these areas, it began a DMP programme in October 2002 to reduce the impact of flooding and address the causes of vulnerability.

The DMP programme

The DMP programme relies on a mix of physical interventions and capacity-building. From a physical perspective, DC helped with the construction of an escape road, the provision of boats for evacuation, and the installation of raised hand pumps. Capacity-building included the establishment of a Village Development Committee (VDC), comprising members elected by the community, as well as smaller groups with specific responsibilities (e.g. a Village Rescue and Evacuation Team, a Village Vigilant Team, and a Flood Evacuation Centre Management Group). Each village has also established a women's self-help group.

Each community has created a village development fund, with the help of DC. Households commit to donating a certain sum of money each month, and these savings are deposited in a local bank and supervised by VDC members. The community maintains control over the funds, and uses them for agreed activities, such as paying for medical treatment and boat repairs. By May 2004, the five communities had saved a total of Rs21,000 (approximately £250).

Qualitative impacts of the DMP programme

This section explores the qualitative impacts of the DMP programme. These have been grouped into five categories – natural, physical, human, social and economic.

Natural resources

The area is fairly rich in natural resources – groundwater, forests, fertile soil. The DMP programme built on these existing resources by planting trees to increase stability and absorb floodwaters. However, during the flooding the soil is rendered useless and all crops are destroyed. (Rice may survive short periods of inundation, depending upon the stage of growth and water depth.)

Physical assets

Physical assets are limited, and what little the villagers have, including houses and tools, is typically washed away in the flood. DC's programme has had a significant positive impact in preserving moveable assets. Whilst the programme has not been able to reduce the vulnerability of villages stemming from lost shelter, the community fund may in the longer term help to build more permanent 'pucca' structures or raised platforms that can safely house possessions during flood periods.

Perhaps the most significant physical impact has been the installation of raised hand pumps that stay above flood levels, and therefore are still functioning after the flooding recedes, ensuring safe water supplies.

Human impacts

In all cases, villages reported that the number of lives lost and the number of injuries due to the flooding had decreased as a result of the escape routes and boats, and because of the community organisation achieved through the Volunteer Rescue Groups. Additionally, identification of the most vulnerable people has helped to ensure that they are effectively evacuated.

Social impacts

A number of social issues are at play in the communities, perhaps most importantly the caste system, which causes substantial discrimination and lack of development within the villages. DC has made significant steps to reduce social vulnerability, at a number of levels. At the government level, DC has maintained regular contact with Panchayats (groups of villages with an elected council) and with appointed Block Development Officers to gain support for development activities within the villages. There have also been noticeable improvements in relations between landowners and villagers. Villagers note that landowners have become more sympathetic and helpful, despite caste differences, since the DC intervention. Finally, at the local level, villagers reported that the creation of the VDC has greatly enhanced community relationships, as well as cooperation with neighbouring villages. There is a strong feeling amongst the villagers that they have gained more confidence and have a greater sense of control over their development path. The women's group has had a similar effect, as has women's participation as committee members of the VDC, and the training they have received under the DC programme. There is a marked improvement in the role of women in the community, and their increased self-confidence is evident.

Economic impacts

Communities in this area are very vulnerable economically, due to their reliance on landowners, the lack of land ownership and employment opportunities, and lost education time during the flooding. The key impact of the

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Members of a Women's Self Help Group and other community members, Bihar, March 2004

Table 1: DMP programme costs

Item	Fixed costs	Yearly variable costs	Other costs included in CBA model
Materials and supplies			
Installation of 5 hand pumps @ Rs12,000 each	Rs60,000		Hand pumps have a lifetime of approximately 20 years. They require Rs2–3,000 approximately every 3 years for maintenance work
Purchase of 5 boats @ Rs20,000 each	Rs100,000	Rs2,500	Boats last approximately 7–10 years. They require painting every year which costs Rs500 (x 5 boats), and replacement at years 8 and 16
Purchase of motorbike for staff transport	Rs45,000	Rs12,000	Variable costs for vehicle maintenance and fuel
Construction of evacuation road*		Rs100,000	Maintenance of the road requires approx. Rs10,000 every 2 years
Community training		Rs45,000	
Personnel support costs			No other costs: all personnel support costs occur for 3-year duration of project
Rent for field office		Rs24,000	
Travel/lodging		Rs24,000	
Stationary/printing		Rs12,000	
Communication		Rs12,000	
Miscellaneous		Rs12,000	
Personnel costs			No other costs: all personnel costs occur for 3-year duration of project
Project supervisor		Rs54,000	
Admin Assistant		Rs30,000	
Staff training	Rs15,000		
Exposure visit	Rs25,000		
Consultancy charges	Rs30,000		
Total	**Rs375,000**	**Rs227,500**	

Notes: * Includes estimate for community labour contributions.

DC programme has been the establishment of the village development fund. Communities were previously reliant on moneylenders, with interest rates of 10% a month. The funds established by DC can be borrowed at 3% interest a month, allowing the community access to goods and services they otherwise could not afford.

Adverse impacts

It is also important to note any potentially adverse impacts of the DMP programme. Villagers said that the escape road, whilst providing benefits through improved evacuation, also allowed landowners to drive trucks onto their land to facilitate the movement of crops to market. There is a risk that this could reduce the number of days that villagers are employed, as labour is replaced by machinery. On the other hand, better access to markets could also bring benefits to villagers by giving landowners the opportunity to increase production, plant new crops that are perhaps harder to transport without trucks, or diversify into new forms of livelihood that are less affected by the hazard.

Quantitative analysis of costs and benefits

The previous section provides a qualitative description of DC's DMP programme in Bihar, and its impacts on the community. In order to analyse the net value of this programme, its costs need to be calculated, and the qualitative impacts need to be assessed for their quantitative impact.

Costs of the DMP programme

The first step is to identify the specific costs of the DMP programme. This includes both fixed and variable costs. The DMP programmes in each village end after three years, and the majority of costs dissipate after this time. However, it is important to include a number of costs that continue into the future. These include repairs to hand pumps, the maintenance and replacement of boats, maintenance of the evacuation road and on-going training for communities. All costs are reported at present-day values.

Table 2: Identifying benefits

Type of impact	'Without'	'With'	Inclusion in model
Natural	Destruction of crops and soil from waterlogging	Planting of trees to increase soil stability	
Physical	'Kutcha' houses destroyed (where villages have a school it is normally 'pukka'. Other buildings are non-existent)	Houses still destroyed but village development fund has potential to provide loans in the future for rebuilding at lower rates than moneylenders	
	Government hand pumps submerged and often rendered unusable	Raised hand pumps ensure clean water supply	✓
	Loss of household possessions	Minimal/no loss due to effective evacuation	✓
	Loss of tools	Minimal/no loss due to effective evacuation	✓
	Loss of livestock *	Minimal/no loss due to effective evacuation	✓
Human	Drownings due to flooding	Reduced loss of life due to effective evacuation procedures/boats	✓
	Injuries during evacuation	Reduced injuries due to effective evacuation procedures/boats	✓
	Skin diseases prevalent on embankment	First-aid training helps in treatment of skin diseases, but no reduction in level of disease/illness	
Social	Breakdown of relationships – survival focus High stress for all groups	VDC helps ensure that community works together Greater confidence for evacuation reduces stress levels Women's self-help group helps build confidence	
Economic	Loss of work on the embankment (no cropping, minimal alternatives)	No impact	
	Spending on boat rental	Provision of boat means community does not have to rent	✓
	Loss of education	No impact	
Notes: * No other livelihood assets were reported to be lost.			

Benefits of the DMP programme

In order to quantify the benefits, it was necessary as a first step to identify those qualitative impacts that could be valued quantitatively for inclusion in the model. Table 2 summarises the impacts identified in the previous section, describing the 'without' and 'with' DMP impact, and indicates those included in the quantitative model. It should be noted that some activities, such as the creation of a women's self-help group, could also be undertaken as part of normal development programming. These activities are included here because they were directly chosen to reduce vulnerability to disasters. The impacts on all five villages were very similar, given their comparable hazard and socio-economic profiles.

It is necessary to provide a brief explanation of those impacts that are not included in the quantitative model:

- Planting trees to increase soil stability. Whilst it is likely that this will have a positive effect on the land, it is not possible, particularly within the short time frame of the interventions, to quantitatively assess what this impact will be.
- Establishing the village development fund. Whilst the fund may be able to provide low-interest loans for rebuilding houses, thus avoiding the high rates of the moneylenders, the funds have not yet raised sufficient capital for this level of loan. The potential impact of loans at lower interest rates is modelled in the results section below.
- Social impacts. The programme has had a clear positive, significant impact on the communities in terms of confidence and the management of stress. However, these types of impacts are difficult to quantify, and are therefore confined to the qualitative assessment.
- Communities are increasingly renting out their boats to other villages during the non-flood season. Villages earn approximately Rs500–600 for renting out the

boats, and this money is deposited in the village development fund. Whilst this form of income generation could bring significant benefits, it is not included in this analysis because it is still in the early stages, and income generation is irregular.

Quantitative analysis of benefits

For each of the qualitative impacts included in the model, it was then necessary to assign values, comparing the relative impact without DMP to the improved situation with DMP. The study identified the magnitude of each impact as well as its unit value, in order to derive a total impact. Table 3 describes these benefits on a yearly basis.

As a first step, it is important to note the following facts about the villages included in the cost benefit analysis:

- Five villages are included.
- These five villages comprise 540 households, and 2,401 people.
- They have 30 government-installed hand pumps in total.

Table 3: Quantifying benefits

Impact	Magnitude 'without'	Magnitude 'with'	Value	Total yearly benefit (avoided cost)
Raised hand pumps	20% of villages have to repair government hand pumps, others are able to clear through pumping	No villages have to repair DC pumps	Rs6,500 repair costs per government hand pump	Rs39,000
Reduced loss of household possessions	All villages affected. 40% of households within each village lose house-hold goods	No household possessions lost	Rs600 per household	Rs129,600
Reduced loss of tools	Approx 50% of the villages own their own tools, and about 40% of HH lose their tools in the flood*	No tools lost	Rs100 per household	Rs10,800
Reduced loss of livestock	Approx 75% of house-holds have at least one goat, and 20% have a buffalo. About 5% is lost in the flood (drowning)**	No livestock lost	Rs400 – goat Rs7,000 – buffalo (replacement values)	Rs45,900
Reduced loss of life	10 people on average across all 5 villages	1 person across all 5 villages	Daily average wage rate – Rs35	Rs329,249
Reduced injuries	10% of all people suffer injury†	No one suffers injury	Rs25 per injury requiring bandage and injection, Rs10 bandage only. Assume 50/50 split.	Rs4,202
Boat rental	Approx 80% of villages have to rent boat for evacuation	Boat provided by DC	Boat rental Rs2,500 per month	Rs30,000
Total				**Rs588,751**

Notes: * It is understood that tools are replaced quickly and, if delayed, landlords normally lend tools for a short period. Therefore no loss in income is incurred.
** Livestock are typically replaced within the year.
† Severe injuries rarely lead to lost work due to a lack of employment opportunities at this time of year, and therefore no losses to income are incurred.

As a final note, it is helpful to understand the scale of these losses in relation to annual income. Households consist of five family members on average, and all adult family members are engaged in work for approximately 110 days a year, with children also contributing to income-generating activities. The vast majority of employment comes from agricultural work in the landowners' fields (from preparing the fields for planting through to harvesting and preparing crops for market). Other forms of employment include brick making and rickshaw driving. Wages from this work average approximately Rs30–40 per day. Men report occasionally going to cities to get work, where they can earn up to Rs75 a day. Thus, each family member earns roughly Rs4,000 per year, equating to an annual household income of approximately Rs20,000, depending on the number of family members working.

Cost benefit analysis: results

A cost benefit analysis was created using these values to calculate the cost and benefit streams, and their resulting net present value. Whilst the flooding varies in duration and level each year, it returns every year and the duration and height are always sufficient to cause the levels of impact discussed here (hand pumps are always blocked, crops are always destroyed). Thus, the cost benefit analysis calculations are more straightforward because the impacts are present each year. Where the impacts do vary, due to changes in height and duration, the sensitivity analysis accounts for potential differences.

A number of key assumptions were made:

- The project lifetime is 20 years. This is based on the average lifespan of the hand pumps used in Bihar.
- The discount rate is 10%. This is based on local lending rates from moneylenders and local banks.
- The duration of flooding is three months. Communities unanimously reported that the flooding lasts between two and four months, and therefore the average was taken (and this variation is tested in the sensitivity analysis).
- The cost benefit analysis assumes no external changes to the scenario for the duration of the project.
- Because the flooding comes every year (and has done so for over 20 years), it is assumed that the benefits will accrue every year over the project lifetime.

Baseline scenario

Using the baseline scenario, the cost benefit ratio as well as the net present value of the DMP intervention was calculated for these five villages. The cost benefit ratio was calculated by discounting the benefits and costs in each of the 20 years of the project lifetime. The ratio of these two figures is presented below. The net present value was calculated by discounting the net benefit of the project in each year of the project lifetime, and taking the sum of these values. These figures were derived using the PV formula described in Chapter 2.

$$\frac{\text{Benefit}}{\text{Cost}} = \frac{5{,}012{,}365}{1{,}332{,}863} = 3.76$$

In other words, for every Rupee invested in these DMP activities, there is a return of 3.76 Rupees in benefits.

Net present value = Rs 3,679,502 (£45,994)

This indicates that the project provides greater benefits than costs, and therefore the project has a positive return on investment. These estimates are based on conservative values and assumptions, and do not include social impacts, for example. If all benefits could be quantified, the result could be significantly higher. In particular, as discussed in Chapter 1, the value used for lost life is very conservative.

Sensitivity analysis

Impacts are often not black and white, and reasonable assumptions need to be made about what might happen in an average year. Sensitivity analysis shows what happens when these assumptions change. In this study, it is used to calculate upper and lower estimates for the cost benefit analysis. The lower estimate minimises the benefits accruing from the DMP programme, and the upper estimate maximises them. One of the key variables tested is the discount rate.

In the lower estimate, the following assumptions were used:

- The discount rate was assumed to be 15%.
- The duration of the flooding was two months.
- The lower value for the costs of repairing hand pumps and renting boats was used.

This resulted in the following cost benefit ratio and net present value:

$$\frac{\text{Benefit}}{\text{Cost}} = \frac{3{,}578{,}776}{1{,}128{,}934} = 3.17$$

Net present value = Rs 2,449,842 (£30,623)

In the upper estimate, the following assumptions were used:

- The discount rate was assumed to be 5%.
- The duration of the flooding was four months.
- The upper value for the costs of repairing hand pumps and renting boats was used.

This resulted in the following cost benefit ratio and net present value:

$$\frac{\text{Benefit}}{\text{Cost}} = \frac{7{,}598{,}839}{1{,}659{,}919} = 4.58$$

Net present value = Rs 5,938,920 (£74,237)

Raised hand pumps: integrating DMP into development

In addition to a cost benefit analysis for the project as a whole, an analysis was done specifically to see if the benefits of installing raised hand pumps outweighed the costs.

In the 'without' scenario, the government hand pumps are blocked each year by the silt and debris carried by the flood water, and the pumped groundwater is contaminated. We assume that approximately 20% of the 30 government-installed hand pumps have to be repaired, at a cost of Rs6,500. It is assumed that the others can be cleared by continuous pumping. In the 'with' scenario, DC has installed a raised hand pump in each of the five villages. These do not get blocked, but are assumed to have regular maintenance work every three years, at a cost of Rs2,500 per pump. Thus the benefit in the project scenario is the avoided cost of repairing 20% of the water pumps each year.

Assuming a 20-year lifetime and a 10% discount rate:

$$\frac{\text{Benefit}}{\text{Cost}} = \frac{332{,}029}{103{,}699} = 3.20$$

Or, in other words, every Rupee spent on raised hand pumps yields Rs3.20 of benefit.

Net present value = Rs 228,330 (£2,854)

These calculations do not include the cost of installing the government hand pumps, as this data was not available. If it was included, the benefit to cost ratio would be even higher.

Modelling potential future initiatives

Modelling potential initiatives can be a useful tool for assessing and prioritising future activities. This study therefore looked at a number of potential interventions, and applied cost benefit analysis principles to assess the relative cost-effectiveness of different options.

In Dharbanga, the DC programme has been able to address the immediate needs of the population, and to lay the foundations for further development. The cost benefit analysis demonstrates the cost-effectiveness of their interventions. However, because villagers are forced to move to the embankment each year, they still face illness, loss of work, loss of education and loss of their homes.

Although each of the five villages is in a floodplain, villagers cannot move to higher ground because they do not own any land, and do not have the economic resources to buy new land. Each year, the floods destroy their houses, and the next year they have to borrow to rebuild the same houses, which will be washed away again. Whilst a local DMP programme cannot directly address the land ownership issues that are at the root of this vulnerability, it can mitigate the impact of this recurrent destruction. One option is to build houses on stilts, a practice used in other parts of India, particularly in the north-east. Whilst villagers do not own the land on which their homes are built, they are interested in investing in more permanent housing. Their families have been on the land for generations, and they view it as a permanent home.

A simple model was developed to assess the cost-effectiveness of a programme to provide concrete and brick pillars to act as raised platforms for houses (cheaper options such as bamboo are not available in North Bihar). The model assumes a 10% discount rate and a 20-year project lifetime. It is estimated that a house on a brick and cement platform would cost Rs45,000 to build, though this figure does not include costs related to training and other programmes that would be included in such a large development project. The average cost to rebuild 'kutcha' houses each year is Rs3,000. It is assumed that an average of 67% of houses are washed away in the flood.

The model shows the following:

$$\frac{\text{Benefit}}{\text{Cost}} = \frac{9{,}240{,}622}{14{,}800{,}909} = 0.62$$

Net present value = Rs –5,560,287 (£–69,504)

The results clearly demonstrate that the high cost of building houses on permanent platforms outweighs the benefit of avoiding the cost of rebuilding each year. Therefore, from a purely financial perspective, investing in houses on stilts under these circumstances is not the wisest use of money.

Low-interest loans

One measure that has already been initiated is the use of low-interest loans through the village development fund. Villagers borrow funds for replacing livestock, building houses, medical costs and marriages. Whilst it is difficult to estimate amounts, households may borrow Rs5–6,000 in a year. Interest rates are 3% a month, compared with moneylenders' rates of 10%.

As an alternative to houses on stilts, a cost benefit analysis was done to assess the benefits of lower-rate interest loans to help households with the cost of rebuilding their kutcha houses each year. As before, a 10% discount rate and a 20-year lifetime were used. It was assumed that the households would pay off the loan within a month. The 'without DMP' scenario assumed a 10% interest rate, and the 'with DMP' scenario assumed a 3% rate. The cost of rebuilding a kutcha house is estimated at Rs3,000, and (as above) 67% of houses are on average assumed to be destroyed in the flooding. The cost of running the fund is minimal, as it is managed by the communities themselves, though there is an opportunity cost. We assume one month of field staff time per year to help in establishing the fund, and in the administration of the loans, for the three years of the DMP programme.

Under this scenario, households borrowing from the moneylender are required to repay Rs300 per month on a Rs3,000 loan. Households borrowing from the fund are required to pay Rs90 on the same loan. Comparing the benefits with the costs for all five villages shows the following results:

$$\frac{\text{Benefit}}{\text{Cost}} = \frac{646{,}844}{11{,}191} = 57.80$$

Net present value = Rs 635,653 (£7,946)

This clearly demonstrates the positive impact that alternative lending schemes, such as microfinance, can have on communities.

Chapter 4
Khammam District, Andhra Pradesh

Andhra Pradesh (AP) is in the south of India, bordering the Bay of Bengal. It is well-endowed with natural resources, and 40% of the land is used for agriculture. The state has a population of approximately 76 million, making it the fifth most populous in India. AP is also a centre for technical and scientific excellence, with a high number of research and training institutions. Nonetheless, approximately 30% of the population lives below the poverty line. The state is prone to many types of hazard, including flooding, cyclones and drought.

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A chilli crop in Andhra Pradesh, April 2004

Khammam district, the location of the study, has a population of approximately 2.6 million. Villages in this region are poor, and inhabited primarily by tribal peoples. They are mostly reliant on agriculture for their livelihoods. However, they do have considerable natural resources, and some own plots of land. Poorer people work for the landowners in their fields, whilst others sharecrop or use their own land for agriculture. Whilst infrastructure is minimal, these villages have electricity, and roads to the villages are good. Water is supplied via government-installed hand pumps in each village. The majority of houses are made of mud with thatched roofs. Most households own some livestock, and have a few minor implements such as cooking equipment and tools.

The two most prominent hazards facing Khammam district are flooding and drought. Flooding is a prevalent problem along the major rivers, and affects the area most years during the rainy season (June to August). Normal floods last three to four days, but the most severe recorded flood, in 1986, lasted for 20 days. Villagers have adapted their crops and cropping patterns to reduce the impact of flooding. For example, the village of Bhandarigudem historically harvested chillies from June to September, but because of the flooding has shifted this crop to September to April. Whilst flooding can cause displacement and destruction, it also brings many benefits; fishing increases, teak wood carried by the flood waters is collected and sold or used in the village, and fields receive important nutrients from the flood waters.

Drought during the summer (April–June, when temperatures can reach 50 degrees Celsius) poses a serious threat to communities in Khammam. For the last four years the region has suffered from drought, with below-average rainfall and record high temperatures. Drought affects rain-fed agriculture the most; few of the villages have irrigation, and only fields next to rivers can be watered.

Both flooding and drought have important consequences for health. Whilst lives lost tend to be minimal in both cases, illness is a significant problem. During flooding, water-borne illnesses, such as skin conditions, diarrhoea and cholera, are significant problems. Standing water creates good breeding conditions for mosquitoes, and malaria increases. During the drought season, heat stroke is a common problem.

The DMP programme

Within Khammam district, EFICOR, a Delhi-based NGO, has targeted ten vulnerable villages with a disaster management programme. EFICOR's work relies heavily on capacity-building to drive development within these communities, supplemented by specific physical measures. In each of the ten villages, EFICOR has established a Disaster Management Committee (DMC), and has trained 20 young people as an emergency response task force, responsible for rescue and evacuation. Vulnerability assessment and contingency planning have been conducted in each village, and women's self-help groups and farmers' groups have been established.

EFICOR has also initiated a number of physical measures. It has installed raised hand pumps in seven of the villages, and made provision for repairs by training mechanics and issuing toolkits. EFICOR has also been involved in testing alternative cropping in the villages to help with food security. Each village selected two farmers, who have received hybrid seeds that are stronger varieties and more resistant to pests (which are more common during flood periods and heavy rains). They have also provided diesel-powered irrigation pumps to two villages, benefiting approximately 35 farmers. These are intended to extend the duration of the cultivation period. EFICOR has also facilitated tree planting.

Qualitative impacts of the DMP programme

These activities have had a number of impacts on the community. These impacts are organised into the same five categories used above: natural, physical, human, social and economic.

Natural resources

Khammam District is rich in natural resources and soils are fertile. Flooding and drought primarily affect crops, and EFICOR has responded with its programme of hybrid seeds. Whilst it is difficult to measure the impact of this initiative based on a single year's results, it is an important step in the long-term mitigation of the effects of these hazards on natural resources and food security.

Physical assets

EFICOR's primary impact in reducing vulnerability has been the installation of raised hand pumps, which ensure a clean water supply during both drought and flooding. Previously, many villagers had to walk up to 2km to get drinking water during droughts, because government-installed hand pumps dried up. During flood periods, these wells become blocked and contaminated. Because the flooding is relatively brief, and there is nearby high ground, villagers do not report effects on other assets, such as livestock and household goods.

Human impacts

Illness is the primary human impact of both the drought and the flooding. The installation of raised hand pumps has ensured clean water supplies, and villagers report substantial reductions in diarrhoea. EFICOR's training and capacity-building activities have strengthened the community's ability to cope with illness. Whilst the number of cases of illness during droughts and floods has not necessarily decreased, first-aid training has helped villagers to feel more confident about dealing with minor illnesses and injuries, and identifying and referring problems that require medical attention. New skills have also been imparted through the hand pump caretaker training programme and the technical support for growing alternative seed varieties.

Social impacts

As a result of the capacity-building and training inputs, villagers are better able to organise themselves and feel more confident. Young people are trained to work in teams in rescue and evacuation techniques, and show pride and strength in demonstrating their new skills. Villagers frequently mention that flooding has become less of a problem in their community, not because the levels or duration of the floods have changed, but because they feel empowered through their training to deal effectively with the flood when it comes. The establishment of farmers' groups has helped to facilitate the exchange of information and knowledge of new cropping systems. EFICOR has also been instrumental in establishing women's self-help groups, which have empowered women and given them a community voice. Women are also part of the DMC.

Economic impacts

EFICOR's pilot cropping programme is helping villagers to experiment with alternative seeds and cropping patterns that are suited to flood and drought conditions, thereby reducing crop losses. Diesel-powered water pumps help to irrigate agricultural land with river water.

Adverse impacts

A potentially significant negative impact of the programme is the depletion of groundwater reserves through the use of deeper tubewells with the raised hand pumps. Whilst there are clear benefits to the community in the short term, the long-term implications of depleted water reserves could see more costs than benefits. This question is outside the scope of this study, and is not included in the analysis.

Quantitative analysis of costs and benefits

Not all of the impacts of EFICOR's DMP programme can be assigned a value. Many of the interventions are based on capacity-building and training, so the impacts from this work are not clearly quantifiable. Because the programme has only been in operation for a year, and many of the initiatives are long term, it is not yet possible to robustly identify all of the benefits of the project. The key intervention is the pilot alternative cropping programme, and in one year, due to the multitude of factors that affect cropping, it is not possible to definitively assign benefits. This is also true of the provision of water pumps for irrigation. Similarly, while the villagers who had first-aid training felt better able to cope with illness, they did not report a reduction in the number of cases of illness/medical costs, and therefore no direct impact could be modelled.

Villagers have reported that they have been able to use the toolkits provided by EFICOR not only to fix their own hand pumps, but also to repair pumps in other villages. Whilst this activity was still informal and had only just been initiated, villagers reported receiving Rs300 each time they fixed a hand pump, so this could represent a significant future source of income. However, the magnitude of the impact is not clear, and it is not included in the analysis presented here.

Table 4: DMP programme costs

Item	Fixed cost	Variable cost	Notes
Installation of 7 hand pumps in 7 villages @ Rs23,000 each, plus provision of toolkit for repairs @ 3,500 each	Rs185,500	Rs700 (every 3 years)	Hand pumps have a lifetime of approximately 15–20 years. They require Rs100 approximately every 3 years to undertake maintenance work
Total	**Rs185,500**	**Rs700**	

Costs of the DMP programme

Because it was not possible to quantify many of the benefits of the DMP intervention, this cost benefit analysis includes only the costs and benefits of the raised hand pumps.

Benefits of the DMP programme

As in the Bihar case study, it is necessary first to identify those qualitative impacts that can be valued quantitatively. Table 5 summarises all of the impacts identified in the previous section, describing the 'without' and 'with' scenarios, and indicates those included in the quantitative model. Again, activities like the women's self-help group are included because these were directly linked to the DMP programme.

Quantitative analysis of benefits

The primary quantifiable impact in the community is the addition of raised hand pumps, which brings time savings and health benefits, and avoids the costs of repairing government pumps. Table 6 describes the magnitude and value of each of the impacts of raised hand pumps.

Table 5: Identifying benefits

Type of impact	'Without'	'With'	Inclusion in model
Natural	Destruction of crops and soil in severe floods/drought	Training in food security and sustainable agriculture	
Physical	'Kutcha' houses destroyed in severe floods, lightly damaged in normal years	No change	
	Government hand pumps dry up in drought, and villagers have to walk to river to fetch water (up to 2km). Reliance on flood water creates health problems	Raised hand pumps ensure water supply in times of drought; reduced health problems.	✓
	Floodwaters block low lying pumps with silt and debris.	Raised hand pumps ensure water supply once floodwaters recede (no blockage)	✓
Human	During flooding, water-borne illnesses in normal floods, and more serious diseases (such as cholera) in severe floods During drought, heat stroke	Level of illness still the same, but greater capacity of villagers to cope due to first-aid training	
Social	Breakdown of relationships – survival focus High stress for all groups	VDC helps ensure that community works together Greater confidence for evacuation/coping with disaster reduces stress levels Women's self-help group builds confidence	
Economic	Loss of work during drought due to water collection issues	Provision of hand pumps allows for easier water access, allowing more time for livelihood activities (mainly agricultural work at this time of year)	✓
	Loss of cash crops (source of income) and food crops during severe floods and droughts	Alternative cropping with hybrid seeds/food security training should mitigate against this loss and help protect crops Provision of water pumps for a number of households allows easier irrigation of fields	

Table 6: Quantifying benefits

Impact	Magnitude 'without'	Magnitude 'with'	Value	Total benefit (savings)
Raised hand pumps – time savings during drought	Villagers have to walk between 700m and 2km (assume average 1km), 10 times a day	Villagers do not have to walk to get water	Villagers lose approx Rs24 per day from collecting water*	Rs681,372
Raised hand pumps – health benefits during drought	60–65% are ill from river water, and 10–15% of these make the trip to town to get treatment	Drinking water is clean and therefore no ill-health	Rs134–164, depending on amount of medicine required	Rs21,620
Blockage of hand pumps during flooding	Assume 20% of hand pumps are blocked	No villages have to repair pumps	Rs800 to repair blocked hand pumps	Rs6,400
Total				**Rs709,392**

Note: * An average household requires ten pots (each pot contains ten litres) of water per day, and women normally carry one pot (on their head) whereas men carry two pots (hung from a yolk resting across their shoulders). For the purposes of this analysis, it was assumed that the average distance walked is 1km each way, taking approximately one hour round trip. Men are assumed to make two trips (four pots) and women six trips (six pots). During this time of year, most people (both women and men) are working, and they typically work 20 days a month for eight hours a day. However, rather than assuming that all time spent gathering water is lost income, half of the time needed to gather water is conducted outside of working hours, and the other half displaces work. Therefore, men typically lose one hour a day and women three hours a day collecting water. The average wage rate for women was cited as Rs45 a day (Rs5.6 per hour), and for men Rs60 a day (Rs7.5 per hour). Therefore lost wages from collecting water per household are Rs24.3 per day.

Cost benefit analysis: results

The cost benefit analysis used these values to calculate the cost and benefit streams, and their resulting net present value. A number of key assumptions were made:

- Given that the drought has lasted for four years, it is assumed that the drought will last for another four years (in other words, the analysis is estimating the impact on the community if this project happened to coincide with the start of the drought four years ago).
- Given that the flooding has been consistent for decades, it is assumed that it will continue to occur every year.
- Project lifetime was set at 15 years, based on the average lifetime of the hand pumps used in AP.
- The discount rate was assumed to be 10%. This is based on local lending rates from moneylenders and local banks.
- The duration of the drought was taken as two months, and four days for flooding.

Water-carrying, Andhra Pradesh, April 2004

Baseline scenario

Using the baseline scenario described above, the cost benefit ratio as well as the net present value of the DMP intervention were calculated for the seven Khammam villages.

$$\frac{\text{Benefit}}{\text{Cost}} = \frac{2,277,068}{170,245} = 13.38$$

Thus, for every Rupee invested, Rs13 are realised as benefits.

Net present value = Rs 2,106,823 (£26,335)

It should be noted that, as in the other case study, these estimates rely on conservative assumptions, and therefore there is a strong possibility that the results could be higher than reported.

Sensitivity analysis

As with the Bihar case study, sensitivity analysis was used to calculate upper and lower estimates for the cost benefit analysis.

The probability of future drought is the most uncertain factor. The drought has consistently arrived each year for the past four, so a drought lifetime of two to six years was used. The length of each individual drought was also varied. To estimate the lower-bound cost benefit, the following assumptions were changed:

- The drought continues for only the next two years, after which the only benefits to accrue are from the avoided cost of repairing the hand pumps due to flooding blockages.
- The duration of the drought is assumed to be one month, and therefore lost days' work were adjusted to 20 (out of 30) instead of 40 (out of 60).
- The discount rate is assumed to be 15%.

This resulted in the following cost benefit ratio and net present value:

$$\frac{\text{Benefit}}{\text{Cost}} = \frac{600,698}{162,483} = 3.70$$

Net present value = Rs 438,215 (£5,478)

For the upper estimate, the following assumptions were changed:

- The drought continues for the next six years. Clearly, it is possible that it could continue for much longer, but a more conservative approach is used.
- The duration of the drought remains unchanged at two months.
- The discount rate is assumed to be 5%.

This resulted in the following cost benefit ratio and net present value:

$$\frac{\text{Benefit}}{\text{Cost}} = \frac{3,588,928}{178,971} = 20.05$$

Net present value = Rs 3,409,957 (£42,624)

These results demonstrate the effect that variability can have on the outcome of the analysis. Nonetheless, even at the lower end the investment still provides a good return in terms of quantifiable benefits.

Chapter 5
Conclusions

The two case studies presented in this paper clearly show that cost benefit analysis can provide a useful, evidence-based tool for analysing the benefits of DMP, and can make an important contribution to debates on the value of integrating DMP into humanitarian and development activities. Specifically, a number of key conclusions can be drawn.

First, in the case of the study areas investigated, the analysis demonstrated a clear economic argument for DMP. Whilst cost benefit work should not be taken in isolation, it can be a powerful contributor to the debate on DMP initiatives. The case for DMP is even stronger in light of the fact that the estimates used in this report are conservative. Willingness to pay figures for lost lives, for example, could substantially increase overall cost-effectiveness. It is difficult to compare these results to other work, as there is a lack of similar studies. However, any benefit/cost ratio greater than one indicates a positive return on investment, so the results present a clear argument for investment in DMP.

Whilst the numbers are convincing, the impact of DMP is even more impressive when all the impacts are viewed as a whole. It is very difficult to quantify some impacts, and so not all the impacts are included in the analysis. For example, the local communities in both studies consistently reported that they felt empowered, that they were able to use their local committees to organise themselves, and that they now had the confidence to make changes within their village. Whilst this is difficult to quantify, this will undoubtedly contribute to development within the village.

Second, cost benefit analysis is an important tool for monitoring ex-post impacts, and for informing choices between potential future initiatives. This can help NGOs in their planning, to develop measures that make the greatest impact on the community in question (both quantified and qualified), and to demonstrate to potential donors the cost-effectiveness of their proposed activities. In the Bihar example, cost benefit analysis was used to calculate the possible benefits of improved housing on stilts, and microfinance initiatives.

Third, development must integrate DMP if it is to be effective in hazard-prone areas. The examples of the hand pumps in both Bihar and Andhra Pradesh clearly demonstrate that investment in development could be rendered useless if it does not accurately take account of local conditions and integrate DMP. The results have clear policy implications for government development plans. For example, the cost benefit analysis shows that government investment in low-lying hand pumps in Bihar and AP did not have the desired effect because it did not account for the impact of disasters on the pumps. This evidence could be used to advocate for more effective development spending, and decision-making which incorporates disaster risk. A similar logic could be used to promote the integration of DMP into development in other hazard-prone areas, perhaps to the point where cost benefit analysis should be recommended as part of the project appraisal process.

Next steps

The work conducted for this report points to several areas that would benefit from further research.

- One of the drawbacks of cost benefit analysis is that the local capacity to implement it is not always available. A toolkit for analysis at the local level could be of great benefit to NGOs operating in these areas. This could help them not only make internal assessments about which activities to undertake, but could also be used with potential donors to demonstrate the viability of projects for funding.
- Minimal cost benefit analysis work has been done for DMP initiatives. It would be useful to replicate this study in other areas, possibly in Africa and Central America, to compare results across regions and to highlight differences in impact. This could be expanded to develop a study on optimising DMP interventions (e.g., at what point does the benefit of installing a hand pump begin to decline, and therefore how can DMP programmes be set up to maximise benefits?).
- It would also be useful to replicate this work in the two study areas after a number of years. Both DC and EFICOR have conducted detailed disaster losses surveys for each of the villages where they operate, before initiating their programmes. Because the programmes have only been running for a short time, these surveys could be replicated in a number of years' time, to gather more detailed data to conduct a revised cost benefit analysis.
- One of the key issues, highlighted in particular in the Bihar case study, is the importance of linking community 'bottom-up' initiatives with 'top-down' change to address the root causes of vulnerability. This linkage is critical to reducing the risk faced by vulnerable populations. It would be very helpful to develop a demonstration project in which local community-level work is integrated with government-based initiatives to specifically target the root causes of vulnerability.
- Mainstreaming DMP into development planning is applicable for all stakeholders – donors, governments, the private sector and NGOs. Any development initiatives in disaster-prone areas need to take account

of the risk from hazards. Ways of mainstreaming DMP into risk analysis as part of development planning need to be investigated and actively promoted to policy-makers. A study to critically assess the ways in which DMP can be effectively integrated, and case study material on successful attempts to integrate DMP into planning, should be undertaken.

- Perhaps the greatest challenge is the development of a strategy for replicating and expanding risk-reduction initiatives, based upon proven economic benefits. A research report to identify barriers to adequate resourcing of risk-reduction initiatives, and means of expanding these initiatives, could be undertaken. This could build on the Tearfund research report *Natural Disaster Risk Reduction – The Policy and Practice of Selected Institutional Donors* (Paul Venton and Sarah LaTrobe, 2003). It could include an analysis of high-risk regions, identify initiatives that already exist in these regions, and provide recommendations for how to expand on these.

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Network Papers 1995–2004

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