The Economics of Early Response and Resilience:
Lessons from Mozambique

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Acronyms

ARC	Africa Risk Capacity Facility
CC	Climate Change
DFID	Department for International Development
DRR	Disaster Risk Reduction
EWS	Early Warning Systems
FTS	Financial Tracking Service
GDP	Gross Domestic Product
GFDRR	Global Facility for Disaster Reduction and Recovery
GHA	Global Humanitarian Assistance
HEA	Household Economy Analysis
HFA	Hyogo Framework for Action
MAM	Moderate Acute Malnutrition
MT	Metric Tonne
NGO	Non-Governmental Organisation
OECD DAC	The Organisation for Economic Cooperation and Development, Development Assistance Committee
SAM	Severe Acute Malnutrition
SWC	Soil and Water Conservation
U2	Children Under Age 2
UNDP	United Nations Development Programme
USD	United States Dollars
WFP	World Food Programme

1 Introduction

The impacts of natural disasters and complex emergencies have been increasing over recent decades, putting the humanitarian system under considerable pressure. The costs of humanitarian crises are also growing – not only do disasters and complex emergencies result in significant economic losses, but they also require mobilization of large amounts of humanitarian aid from the international community.

It is widely held that, broadly speaking, investment in early response and/or building the resilience of communities to cope with risk in disaster prone regions is more cost-effective than the ever-mounting humanitarian response. Yet little solid data exists to support this claim, and there is a clear need for a greater evidence base to support reform.

The UK Government commissioned an independent study to contribute to filling these evidence gaps. This report presents the findings from the country study on Mozambique, and sits within a suite of reports within the Economics of Early Response and Resilience (TEERR) Series (Table 1). The study relies heavily on the Household Economy Approach (HEA) to model impacts of crises. More detail and data used to build the findings presented here can be found in the "TEERR HEA report" as well as the Mozambique "Country Supporting Document".

1.1 Structure of this Report

This report analyzes available data for Mozambique, along with HEA modelled data, to compare the cost of three scenarios:

- Storyline A: Late humanitarian response;
- Storyline B: Early annual humanitarian response;
- Storyline C: Investment in resilience.

Both droughts and flood are considered.

The report is structured as follows:

- **Section 2** provides a very brief overview of the country context.
- **Section 3** assesses the comparative costs from a bottom-up perspective – using disaggregated project and sector level estimates to compare the cost of response. This is considered separately for drought and floods.
- **Section 4** assesses the comparative costs from a top-down perspective – using aggregate level costs and losses for the country as a whole.
- **Section 5** draws conclusions from the findings.
- **Annex A** contains data provided by WFP for this analysis.
- **Annex B** contains detailed calculations that support the analysis.

Table 1: Reports in the Economics of Early Response and Resilience (TEERR) Series

Report Title	**Report Content**
TEERR Synthesis of Findings:	Summarizes the key findings
TEERR Introduction and Methodology:	This report includes the introduction to the study objectives, and the detailed methodology as well as limitations to the analysis.
TEERR Country Reports: • Ethiopia • Kenya • Bangladesh • Mozambique • Niger	The country reports contain a very brief introduction, description of the country/study context, the detailed findings from the analysis, and conclusions/recommendations. These draw together the data presented in the country supporting documents (see below) as well as the HEA report, to model outcomes.
TEERR HEA report:	Contains details of the HEA modelling, assumptions and parameters, as well as modelling output.
Country Supporting Documents	Each country is supported by a report that contains country level detail and data.

2 Country Context

Mozambique ranks third amongst the African countries most exposed to risks from multiple weather-related hazards, such as floods, cyclones and droughts and related epidemics. Worldwide, Mozambique ranks 43 out of 173 countries for disaster risk.[1] As much as 25% of the population is at risk from droughts, floods and cyclones.[2]

Floods occur every two to three years along major river basins, low coastal plains, and areas with drainage problems. The risk is highest in the central and southern region. Cyclones affect the entire coast, but with highest wind impact along the northern area, from October to April, with frequencies of one to two cyclones every four years. Droughts occur primarily in the central and southern region of the country, with a frequency of seven in ten years. In some areas in the southern part of the country, they are a chronic problem. Droughts can last for one or two years or for a much longer period and result from a combination of low levels of precipitation, its spatial and temporal distribution and the overgrazing and overuse of agricultural lands.[3] Epidemics, especially water-borne diseases and malaria, are widely spread and outbreaks peak during and after floods and cyclones.[4]

The high dependence on subsistence farming contributes to high vulnerability; more than 80% depend economically on agriculture.[5] The loss of harvest or income caused by cyclones, droughts or floods can easily push a household below the poverty line. Most of the population are smallholder farmers (cultivating no more than three hectares) and suffer from low productivity. Apart from weather-related hazards, several other factors contribute to the stagnant production and in general low productivity: less fertile soils, low yielding traditional varieties, use of untreated seeds, unsophisticated tools, limited use and lack of access to fertilizers, herbicides and pesticides. Furthermore, lack of public sector rural extension services and poor agricultural infrastructure connecting farmers to suppliers of inputs and product markets are also responsible for low agricultural productivity. Most of the farmers have little or no access to formal markets for inputs as a result of poor transportation infrastructure and consequent high costs. Finally, access to credit is a major challenge in the purchase of inputs, equipment and other farming requirements in Mozambique.[6]

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[1] UN University & Bündnis Entwicklung Hilft (2012): World Risk Report.
[2] INGC (2009): Synthesis report. Study on the impact of climate change on disaster risk in Mozambique. [van Logchem B and Brito R (ed.)]. INGC, Mozambique.
[3] Ministry for the Coordination of Environmental Affairs (MICOA) (2007): National Adaptation Programme for Action (NAPA).
[4] Ibid.
[5] https://www.cia.gov/library/publications/the-world-factbook/geos/mz.html
[6] Mozambique P4P Country Profile 2010: http://documents.wfp.org/stellent/groups/procuweb_content/documents/reports/wfp2267

Crop failure increases food insecurity and can lead to malnutrition. According to the World Food Programme (WFP), around 25% of the population suffers from acute food insecurity at some point in the year and approximately 34% remains chronically food-insecure and lacks an adequate diet. The majority of food-insecure households are located in the arid and flood-prone areas of the south and centre. Food insecurity is higher in rural (47.2%) than in urban areas (34.8%). Chronic malnutrition in children under 5 remains alarmingly high at 44%, one of the highest in Africa.[7]

The people who live along the Limpopo river in Gaza Province and the Zambezi river are largely subsistence farmers who rely on rain-fed agriculture. Irregular weather patterns challenge their ability to produce food and generate income. They are regularly affected by floods and drought.

Gaza Province has a long dry season and its population, with 62.5% below the poverty line, is the second poorest in the country.[8] The main problems are access to water, heavy reliance on subsistence farming, limited livelihood opportunities, high temperatures, droughts, floods and cyclones. The nutritional and health status of communities is fragile and HIV prevalence is around 25%, the highest in the country.

In total, more than 930,000 people live in the Zambezi Valley. There has always been drought and flooding in this area, but in the last 10 years weather patterns have become more unpredictable. Rainfall is erratic and there have been more frequent floods and droughts. There are several livelihood zones in the Zambezi River Valley. At the coast, fishing is the main income source, while rain-fed agriculture is the basis of the local rural economy upstream. In the semi-arid areas (Manica and Tete Provinces), livestock provides a substantial source of income as does the trade in natural resources, especially local timber. Flood recession cropping supplements rain-fed agriculture and provides the basis of the economy. Fishing is not done by all households, but wild foods are an important source of food and income throughout the year.

80.pdf ; and Nkala, Peter (2012): Assessing the impacts of conservation agriculture on farmer livelihoods in three selected communities in central Mozambique, Doctoral Thesis, University of Natural Resources and Life Sciences, Vienna, Austria

[7] WFP (2010): Comprehensive Food Security and Vulnerability Assessment; see also SETSAN (2009): Relatório da Monitoria da Situação de Segurança Alimentar e Nutricional em Moçambique;

[8] Government of Mozambique 2010: Report on the Millenium Development Goals; FAO (2012);

3 Bottom-up Assessment

The HEA modelling was only done for drought, and this is where the majority of this analysis is focused, though some analysis is done for floods using World Bank data.

3.1 Drought

The HEA modelling estimates the food deficit for drought in the Zambezi Valley and the Limpopo Basin. Modelling was conducted for 16 livelihood zones engaged in agricultural livelihoods, with a total modelled population of 2.6m people (out of an approximate total population of 24m people).

The modelling conducted for this analysis uses historic data to identify high, medium and low magnitude droughts, their characteristics, and their return period. These were then introduced into a 20-year HEA model (see "TEERR HEA Report" for more detail) that assumes the following drought recurrence:

- High magnitude drought: once every 18 to 20 years.
- Medium magnitude drought: once every 6 to 7 years.
- Low magnitude drought: once every 2.5 to 3 years.

Each year of the model feeds into the next, with each drought event affecting levels of need in subsequent years. The model provides an estimate of the number of people with a food deficit, as well as the total magnitude of that deficit, for each of the 20 years. These are then valued using data on the cost of response.

The timing of droughts of different magnitude in the model has minimal impact on the total need estimated by the HEA. In other words, whether a high magnitude drought happens in the first year, or the 10th year, the total impact on the estimated food deficit will alter only slightly as a result of herd dynamics – the majority of the impact on food deficit will not change. However, the modelled cost of response will vary in this regard with respect to discount rates – in other words, a loss today is valued more highly than a loss in a year. As a result, if a high magnitude drought is accounted for in the middle of the 20 year model, the losses will be understated in comparison with a high magnitude drought in year one (which is the scenario used in the model presented here). Lowering the discount rate can control for this, and this is done in the sensitivity testing. This has no impact on the comparison between scenarios, however; because the timing of the high magnitude drought is the same in all of the modelled storylines, they are comparing like with like.

It should be noted that the aim of the study is to test a methodology for evaluating the *economics* of building resilience, particularly as compared with humanitarian response. Economic analysis is only one facet of the analysis – social, moral, political and institutional factors all have a bearing on prioritization. As a result, ***this study is not trying to provide a list of interventions that should be prioritized for reducing the impact of crises – rather it is providing insight into the economics of various choices, to contribute to a much wider decision-making framework.*** Along similar lines, this study is not looking to evaluate what types of interventions deliver impact at scale – this is dependent on a whole host of factors that are outside the scope of this analysis. Rather, it is attempting to assess the level of impact that could occur if things are done differently, using specific measures as proxies.

3.1.1 Late Humanitarian Response

Unit costs of late humanitarian response

According to WFP (see Annex A), food aid under late humanitarian response costs $895 per Metric Tonne (MT) (or $90 per beneficiary). This is combined with the total deficit measured in MT for each of the 20 years in the HEA modelling (see caseloads below). The Mozambique supporting document contains a detailed breakdown of estimated costs for late humanitarian response. The estimated cost of non-food aid – specifically water and sanitation (including non-food items), is $9-19 per person for droughts, which is applied to the total number of beneficiaries in each year of the model. In addition, WFP estimates that 25% of the population would have to be treated for Moderate Acute Malnutrition (MAM) at a cost of $31 per person (no data was available for treatment of Severe Acute Malnutrition (SAM), due to its relatively small prevalence in the country compared to chronic malnutrition, and as a result the costs presented are lower than would be expected).

Caseloads

The HEA model assumes that late humanitarian response occurs after the onset of medium- to high-risk coping strategies have been undertaken, including the sale of productive assets (as well as sale of excess livestock that threaten the viability of medium- to long-term herd viability; excess labour migration; sending children away to live with other families, etc), and after significant livestock deaths have occurred. The model output includes caseloads in each year, both in terms of number of people who have a food deficit, as well as the total magnitude of that deficit (measured in MT). Caseloads differ in each year, depending on the magnitude of the drought and what has preceded it. Annex B has a full screen shot of the modelling.

Losses

A cost benefit analysis of the Africa Risk Capacity Facility[9] estimated that late response (i.e. 6 months +) costs an additional $1,294 per household. This estimate includes reduced income potential of children under age 2 (U2) who receive reduced

[9] Clarke D and R. Vargas Hill (2012). "Cost-Benefit Analysis of the African Risk Capacity Facility."

nutrition, reduced household growth due to reduced consumption and increased distress sales, plus direct losses from livestock deaths.[10] This estimate was made for six African countries, including Mozambique. However, the results are generalized across all six countries (they are not specific to Mozambique), and as a result they must be viewed with some caution. These losses are multiplied by the total number of people facing a deficit each year.

<u>Total cost of late humanitarian response</u>
The model was run over 20 years, using a discount rate of 10%.[11] It was run twice, once for estimated humanitarian costs only, and the second including estimated losses. Results are presented in Table 2.

Table 2: Late Humanitarian Response to Drought

	Value (US$)
Humanitarian Costs only	$452m
Costs and Losses	$2,111m

3.1.2 Early Humanitarian Response

<u>Unit Costs of Humanitarian response</u>
WFP Mozambique estimates that food aid procured early costs $698 per MT (or $39 per person). The cost of early humanitarian response is estimated in the Mozambique supporting document, and assumes that water and sanitation supplies are the same as those used in humanitarian response (i.e. water trucking, containers, water purification, etc), but with a reduced cost due to early procurement, resulting in a cost per person of $4-8.

<u>Caseloads</u>
An early response has been defined in the HEA modelling as a response at the time of early warning of the drought – before the onset of high-risk coping strategies uptake (including sale of productive assets) and before significant livestock deaths.

When these parameters are inputted to the HEA model, the model predicts that, in a high magnitude drought, caseloads are 69% of those in a late response. The variation across types of events is substantial, with caseloads dropping to between 47% and 59% of the total in a medium magnitude event, approximately 21% of the total in a low magnitude event, and with almost no change in non-drought years (because there is no event to cope with, the model does not predict any change in caseloads).

[10] These figures are estimated based on a review of empirical evidence documented in the literature. Please see the paper referenced for the detailed calculations.
[11] See the "TEERR: Approach and Methodology" report for a full description of assumptions underlying the methodology.

Along similar lines, WFP independently estimates that caseloads under early response drop to 66% of the total under late response.

Losses

ARC estimates that early response (i.e. 4-6 months after first failed rain) costs an additional $49 per household – this is the cost of reduced nutrition for U2s losing 14% of lifetime earnings.

Total cost of early humanitarian response

These costs were modelled over 20 years. Table 3 summarizes the findings.

Table 3: Early Humanitarian Response to Drought

	Value (US$)
Humanitarian Costs only	$122m
Costs and Losses	$152m

Box 1: Multi-year Humanitarian Funding

Multi-year humanitarian funding can bring several other benefits beyond early response, including decreased staff costs, prepositioning, and the ability to make better/long term investments.

As an example, Save the Children in Mozambique estimated that they spend $50k per crisis in proposal writing. If this is expanded across the full range of agencies writing proposals, the figure could become quite significant. Donor agencies would also need to expand resources to appraise and process these proposals. If we assume that this would cost another 50% of the total figure, and assuming that there are 10 lead Non-Governmental Organizations (NGOs) writing proposals, this cost would equate to $500k per crisis. Clearly there could be economies of scale, but this gives a sense of the magnitude of cost. The total cost could not be averted with multi-year funding, but certainly a large portion would be averted.

WFP estimates that investment in disaster risk reduction and longer-term interventions could reduce caseloads by another 30% from early response (or approximately 47% as compared with late response). This estimate is based on practical experience, but not supported by empirical evidence.

Specific data on reduced costs of multi-year funding was not available, and so this is not included in the cost comparison below. However, it is noted that multi-year humanitarian funding is highly likely to result in further gains.

3.1.3 Resilience

Building resilience will require a suite of interventions, and may differ depending on the specific context. However, for the purposes of this analysis, a simple soil and water conservation (SWC) intervention has been chosen to represent a resilience intervention that a) is appropriate for a wide range of types of livelihood zones in Mozambique; and b) has enough documented impacts in rural communities in Mozambique to allow for modelling.

The resilience scenario models an increase in maize yields, based on literature that shows a minimum of a doubling in maize yields under SWC conditions.[12] This estimate is very conservative, and is based on extensive evidence in the literature – most studies estimate that yields could be much higher. Marginal costs that households incur in their uptake of such measures are also included – including increases in expenditure on labour, maintenance, improved seed, and fertilizer. It is assumed that these measures are implemented effectively.

Unit Costs of Resilience

The "Coping with Drought and Climate Change" programme from the United Nations Development Programme (UNDP) runs for five years (2009 to 2014) and covers seven communities (4,267 households, hence about 25,000 people) in Guija District, Gaza Province.[13] The project's objective is to develop and pilot a range of coping mechanisms for reducing the vulnerability of farmers and pastoralists to future climate shocks. Project activities include improving water supply, training the communities to grow drought-resistant crops, diversification of income opportunities, improving communication lines to make weather forecast and climate information available to communities, water harvesting and storing systems, etc. The project budget is USD 1.9 million, **equivalent to approximately US$76 per person, or $15 per person annually for five years**. It is not known definitively whether this sum is sufficient to build resilience. However, it does provide an indication of the level of funds that are believed to be required.

Within this, agriculture and livestock interventions are assumed to cost between **$21 (agriculture only) and $36 per farmer** (see Mozambique supporting document). $21 is used in the model, as this is most relevant to the improvements included. These

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[12] Cabral, L., A. Shrivastava, C. Muendane (2007). "Formulating and Implementing Sector-wide Approaches in Agriculture and Rural Development: The National Programme of Agrarian Development (PROAGRI) – Mozambique" Global Donor Platform for Rural Development.
GIZ/INGC (n.d.) "Redução de Vulnerabilidade à seca nas zonas semi-áridas: Técnicas de captação e conservação de água de chuva para produção agrícola".
INGC/GTZ (n.d.). Projecto da Institucionalização da Gestão de Risco de Calamidades em Moçambique PRO-GRC: COMPONENTE 1: DIVULGAÇÃO DE INSTRUMENTOS COMPROVADOS PARA A REDUÇÃO DA VULNERABILIDADE ÀS SECAS RELATÓRIO FINAL
[13] UNDP (2010). "Coping with Drought and Climate Change, Mozambique Case Study."

costs are applied to the total number of people requiring aid under the early response scenario in a high magnitude drought. These costs are assumed for 10 years (while the impacts of these investments run through the full 20 years of the HEA modelling).

Caseloads

The results of the HEA modelling estimate the total number of people with a food deficit under the resilience scenario as described above. The number of beneficiaries decreases to 35% of the total number of beneficiaries under late response in a high magnitude drought (this figure drops to 10-13% of the number of beneficiaries in late response under low and medium magnitude droughts, while reductions in non drought years are closer to 50% because there is no crisis to cope with in the model and therefore the impacts are not as great).

Losses

It is assumed that losses are minimal under a resilience scenario – they are not accounted for in the model. However, it is assumed that there is some residual risk – i.e. that humanitarian needs are not completely avoided. The HEA model accounts for ongoing food deficits (as described in the preceding section on caseloads) and these are included as a cost in the model, using early response cost estimates.

Benefits of Resilience

The analysis is run twice:

1. Storyline C: Direct benefits from SWC practices as it relates to improved yields. The analysis above relied on empirical evidence on the impact of a specific intervention – SWC practices – and the effect that improved yields have on the household economy.
2. Storyline C – with benefits. Activities to build resilience, in this case SWC, will result in numerous other benefits. For instance, SWC can facilitate greater diversity of crops grown, and hence contribute to increased incomes (for higher value crops than maize), improved nutritional outcomes, decreased health costs and improvements in education. These have been shown in the literature to deliver returns that are quite substantial. However, because it is not known the degree to which SWC will contribute to wider gains, a very conservative assumption of benefits of $1.1 for every $1 spent are assumed in the model, in addition to the decreased caseloads as a result of increased yields.

3.1.4 Mozambique - Comparison of Costs for the Limpopo and Zambezi

Table 4 summarizes the findings from the model parameters discussed above. It presents a comparison for the cost of aid alone, and then a second model that incorporates potential losses as well (though this must be viewed with some caution as it is not based on Mozambique-specific data). The findings are specifically for the livelihood zones modelled within the Zambezi Valley and the Limpopo Basin, with an estimated population of 2.6m people (approximately 10% of the total population of Mozambique).

Table 4: Cost Comparison of Response for Storylines (USD million) – Mozambique, Zambezi Valley and Limpopo Basin

	Storyline A	Storyline B	Storyline C	Storyline C – with benefits
	Late Hum. Response	Early Response	Resilience	Resilience with benefits
Aid Alone: Total Net Cost over 20 years, discounted at 10%	$452m	$122m	$77m	$19m
Aid + Losses: Total Net Cost over 10 years, discounted at 10%	$2,111m	$152m	$77m	$19m
Sensitivity: Aid alone: 0 discount rate	$768m	$186m	$115m	($9.5m)

Early response is significantly less expensive than late response, saving between $330m and $1,959m over 20 years, depending on the model. Resilience saves even more money still. On a pure cost comparison, SWC practices could save between $375m and $2,034m over 20 years, and if benefits are incorporated, between $433m and $2,092m are saved.

When the discount rate is reduced to 0, to account for the fact that each magnitude drought could occur at any point in the model, the costs associated with late humanitarian response are much greater, while the benefits associated with resilience are also greater, strengthening the case for resilience.

These factors are combined to model the "value for money" of investing in resilience. The costs of building resilience are offset against the benefits – the reduced aid cost, as well as a very conservative assumption around the additional benefits that would accrue from investments in resilience that deliver significant health, education and other gains. **When the costs of building resilience are offset against the benefits, the benefit to cost ratio is 12.4 : 1. In other words, for every**

$1 spent on resilience, $12.4 of benefits are gained. If the avoided losses are incorporated to this analysis, the benefit to cost ratio rises to 55.9:1.

3.2 Floods

A full HEA analysis was not conducted for floods, as it was for drought. However, data had been compiled on the impact of the 2000 floods and the 2013 floods. The January 2013 floods appear to have been similar in spatial extent to those of 2000, but of very different dynamic and characteristics. Based on available information, the preliminary analysis suggests that flood levels and peak flows upstream in the Limpopo River were higher (1.5m higher) than those in 2000, but lower in Chokwe (-3 m) and Xai-Xai (-4.5m). The volume of the 2013 flood was smaller and recession of the flood waters faster than those experienced in 2000. The 2013 floods show a very steep rise and a relatively short duration. In contrast, the 2000 floods experienced a series of successive peaks that resulted in the accumulation of a larger volume of water, which then took more than six weeks to recede. By contrast, in 2013 the peak was sharp, passed relatively quickly and receded more rapidly.[14]

Clearly, no two events will be the same. Nonetheless, the lower impacts of the 2013 floods were believed to reflect improvements from lessons learnt from the experience in 2000, including improved flood forecasting and early warning systems, and transboundary cooperation. The following sections document the evidence of the impacts of each event, and while they cannot be compared like for like, they are a useful benchmark for the types of reduction in impacts that seem to have occurred.

3.2.1 Late response: 2000 Floods

The impacts of the 2000 floods were as follows:

- 700 people lost their lives.
- Damage/losses were estimated at 5.5% of Gross Domestic Product (GDP).
- Half a million people displaced. The cost of response is estimated at $109-140 per person in the Mozambique supporting document (including food aid, WASH, shelter and evacuation).

Table 5: Impact of 2000 Floods (presented in 2013 $)

Impacts	Assumptions	Estimated Impact
700 people lost their lives	Value of lost life[15] = US$15,935	$11.2m

[14] World Bank (2013). “Limpopo Floods 2013: Assessment and Response Mission.”

[15] The value of lost life is estimated using the World Health Organization guidance and formula. It estimates the years of lost life, based on life expectancy in Mozambique, life expectancy at death (assumed to be average), and GNI per capita. http://www.who.int/quantifying_ehimpacts/publications/9241546204/en/

Damage/losses were estimated on the order of 5.5% of Gross Domestic Product (GDP)	According to UNData, GDP in 2000 was US$4,310m (current USD). GDP in 2009 (the latest figure on UNData) was $9,579m[16]. GDP losses equate to US$237m in 2000. However, in 2013 this would have been equivalent to US$527m.	$527m
500k people displaced	500,000*[$109/$140]	$54.5m-$70m
TOTAL		**$593m-$608m**

GFDRR estimated damages and losses in the 2000 floods at **$663m**, roughly in line with the estimates above.[17]

3.2.2 Early response: 2013 Floods

- 113 people lost their lives
- Damages are estimated in excess of US$250 million. While the absolute figure is roughly on par with the 2000 damages, GDP in 2009 (the latest figure on UNData) was $9,579m and hence damages represent a much smaller proportion of total GDP.
- 172,600 were evacuated – the cost of response is estimated at $83-106 per person in the Mozambique supporting document (including food aid, WASH, shelter and evacuation).

Table 6: Impact of 2013 Floods (presented in 2013 $)

Impacts	**Assumptions**	**Estimated Losses**
113 fatalities	Value of lost life = $15,935	$1.8m
Damages are estimated at $250 million		$250m
172,600 people displaced	172,600*[$83/$106]	$14m-$18m
TOTAL		**$266m-$270m**

The amount of investment required to achieve this reduction is unknown, and indeed, given that no two events are the same, it is not clear how much of this reduction is attributable to investment in risk reduction. However, the majority of stakeholders felt that there was a clear decrease in impacts evident in the two events, and the figures above help to give some sense of the magnitude of that decrease.

[16] http://data.un.org/CountryProfile.aspx?crName=Mozambique

[17] Kellet, J and D Sparks, (2012). "Disaster Risk Reduction: Spending where it should count." Global Humanitarian Assistance, UK.

4 Top-down Assessment

The top down assessment uses national level estimates on humanitarian costs, and efforts to build resilience, to make an assessment from an aggregate level.

4.1.1 Late Humanitarian Response

The cost of humanitarian response is estimated using two components:

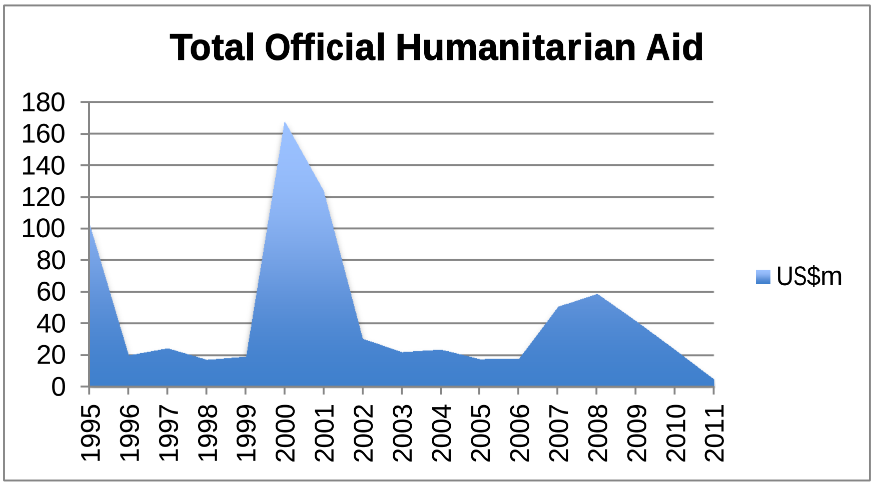
- The cost of food aid and non-food aid; and
- Estimated losses.

Estimating the cost of food and non-food aid:
A number of sources report on humanitarian aid flows – two of these are recorded here, the Financial Tracking Service (FTS) and Global Humanitarian Assistance (GHA) (see the Mozambique supporting study for more detail).

The FTS reports humanitarian aid; however, registration of commitments is voluntary, and therefore not necessarily systematic. Under the FTS, average aid flows between 2000 and 2012 have averaged $33m per year.

GHA attempts to combine numerous sources of data on humanitarian aid flows, to provide a more complete estimate. Under the GHA, average aid flows between 1995 and 2011 have averaged $45m per year (Table 7).

Table 7: Humanitarian Aid Data, GHA, 1995 to 2011



Using data on historic modelled food security needs, the ARC study estimates **the average annual modelled response cost to drought (1983-2011) at US$128m,** or US$5.5 per person. The maximum historical modelled response cost is US$538m. These costs specifically pertain to the humanitarian response costs that would be required for food security needs in response to drought.[18]

Unfortunately, there is no similar assessment to the ARC assessment for floods. The ARC assessment suggests that FTS/GHA data is significantly underreporting humanitarian aid costs, as both are reporting on actual monies spent (as opposed to needs).

Estimating Losses

A report by the Global Facility for Disaster Reduction and Recovery (GFDRR) estimates losses associated with drought and flood in Mozambique.[19] Their findings include the following:

- Agricultural losses: The sector contributes around a third of Gross Domestic Product (GDP) and employs 80% of the workforce. A 2009 study estimated average annual losses of 9 percent of the maize crop and 7 percent of the sorghum crop arising from drought and flood, with losses of around 20 percent anticipated once every ten years. This equated to an annual average loss of over US$60 million from maize and sorghum losses from these two perils, with flood accounting for over 80 percent of these losses (approximately US$50m) and drought contributing the remainder (approximately US$10m).
- Damage to infrastructure: On average, 100km of roads and 33,000 households are impacted by flooding every year resulting in estimated direct losses of US$700,000 and US$17.5 million respectively.

A recent World Bank Flood Assessment quotes that flooding costs Mozambique an average of 1.1% of GDP per year. Using the previously cited 2009 GDP of US$ 9,579m, this equates to average annual losses of $105m.

Climate change (CC) is expected to increase these damages. The World Bank has estimated the cost of inaction to climate change in Mozambique at just over US$400m per year (average discounted value through to 2050). The majority of these damages are as a result of crop yields, impacts on the transportation system, and hydropower. Clearly, this estimate extends well beyond floods and droughts, but these will nonetheless represent a significant portion of this estimate given that they are expected to be heavily impacted by climate change.[20]

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[18] Clarke, D. and R. Vargas Hill (2012). "Cost Benefit Analysis of the African Risk Capacity Facility". Commissioned by the WFP in cooperation with and on behalf of the African Union Commission to contribute to the evidence base for the African Risk Capacity (ARC) facility.

[19] GFDRR (2012).

[20] World Bank (2010). "Economics of Adaptation to Climate Change: Mozambique". The World Bank Group, Washington, DC.

The recently established Climate Vulnerability Monitor[21] estimates more specific increases in damages as a result of drought and flood:

- Drought: additional economic costs due to climate change are estimated at US$1m in 2010, and US$10m in 2030.
- Floods: additional economic costs due to climate change are estimated at US$10m in 2010 and US$85m in 2030. Additional mortality due to climate change and floods is estimated at 1 death in 2010 and 5 deaths in 2030. The additional affected population is 20k in 2010 and 30k in 2030.

Total cost of late humanitarian response

Table 8 summarizes the costs and losses described above that are inputted to the model. Three scenarios are set out, representing lower, middle and upper bound estimates of the potential cost of humanitarian aid, given the figures above.

Table 8: Summary Table of Cost of Humanitarian Aid and Losses

	Amount (USD, millions)
Average Annualized Response Costs - Estimate 1: GHA Estimate 2: ARC, drought only	 $45m $128m
Average Annualized Losses/Damages: Drought Flood	 $10.0m $105.4m
Climate change – additional losses (2030): Drought Flood	 $10m $85m
Scenario 1: GHA+Losses	***$160.4m***
Scenario 2: ARC+Losses	***$243.4m***
Scenario 3: ARC+Losses+CC losses	***$338.4m***

The combined impact of the average cost of humanitarian aid year on year, with losses inflated by 5% every five years to reflect increasing caseloads due to erosion of assets, results in a total economic cost discounted over 20 years as follows:

- **Scenario 1: $1,575m**
- **Scenario 2: $2,389m**
- **Scenario 3: $4,578m**

This is an underestimate for the following reasons:

- The annualized losses/damages associated with drought are estimated for maize and sorghum losses. While these are major areas of impact, other

[21] http://daraint.org/climate-vulnerability-monitor/climate-vulnerability-monitor-2012/

damages are not included that would add to this estimate, such as other crops, loss of life and livelihoods, business interruption, etc.

- The ARC estimate of annualized costs is for drought only, and clearly would be significantly higher if floods and other events were also included.

4.1.2 Early Humanitarian Response

Estimating the cost of food and non-food aid:
Based on WFP data, the cost of food aid procured early is 81% of food aid procured late in a rapid onset event, and 78% of food aid procured late in a slow onset event. This is due in part to smaller rations under Food for Work (widely used as an early response measure), as compared with general food distributions; and in part due to cost savings on food purchase prices (cereals are 30% cheaper, pulses are 9% cheaper, and oils are 10% cheaper). Transportation costs for food are estimated to be the same under both scenarios. Given that food aid is the bulk of humanitarian spend, and given that these reductions in cost are likely to be similar for non food items (which can also benefit from savings due to early procurement), these figures are applied to the total cost of humanitarian aid under each of the scenarios presented above.

Cash transfer approaches have the ability to bring these costs down even further. However, the cash market in Mozambique was in its nascent stages and hence good data was not available on this. Given good market functionality in most parts of Mozambique, cash rather than procuring and transporting food is likely to be much more cost effective, and the establishment of social protection systems merits further attention.

Estimating caseloads
Not only will costs decrease under early response, but caseloads will also decrease.

- Caseloads from flood – WFP estimates that caseloads in early response are between 47% and 66% of late response.
- Caseloads from drought – according to HEA, caseloads from early response to a high magnitude drought are 70% of caseloads under late response. Further to this, the WFP estimates that caseloads in early response are 66% of late response.

Estimated total decrease in aid cost
The Mozambique supporting document, combined with the estimated caseloads in the 2000 and 2013 flood events, suggests that early response cost is 46% of late response cost for floods.

The HEA modelling for drought suggests that early humanitarian response is 38% of the total cost (aid and caseloads) of late humanitarian response in a high magnitude drought.

These reductions are applied to the total aid figures in the model to estimate the early response costs. It is not known how much of the total humanitarian response estimated above is targeted towards flood, and how much is targeted towards drought. For the sake of this analysis, it is assumed to be a 50/50 split. The percentage reductions in cost are not that different between the two disasters, and therefore any changes to this assumption are unlikely to make a significant difference to the model.

Estimated losses

The World Bank comparison on the 2000 and 2013 flood events suggests that losses, as a percentage of GDP, were decreased by 53% of the total (from $527m to $250m).

The ARC data suggests that losses in a drought can be decreased significantly, with losses in early response equivalent to only 4% of losses in late response. The significant reduction comes about because the ARC modelling was able to incorporate losses in lifetime earnings and household consumption that account for a range of direct and indirect losses.

To be conservative, it is assumed that early response and preparedness can reduce losses by 53%.

The total cost of early response, discounted over 20 years ranges between $738m and $2.2 billion across the three scenarios.

4.1.3 Resilience

Evidence on the cost of building resilience varies significantly, as evidenced in the Mozambique supporting document.

- Estimated spend on disaster risk reduction (DRR) as estimated by GHA based on OECD DAC[22] data is $46.7m between 2000 and 2009. According to reporting to the Hyogo Framework for Action (HFA), planned DRR expenditure is much higher (though this also covers many more categories of spending), at $197m per year.
- A study commissioned by the National Disater Management Institute (INGC) on climate change estimates the cost of climate change adaptation at $435m

[22] The Organisation for Economic Cooperation and Development, Development Assistance Committee

for five years, or approximately $87m per year.[23] A recently developed government strategy on climate change, the "National Climate Change and Adaptation Strategy, 2013-2025" has a budget of $142 million for 2013 to 2014 ($64m in 2013, and $78m in 2014).[24]

- The Mozambique supporting document reports on two comprehensive programmes that incorporate a range of activities that would build resilience. The UNDP and UNJP budgets for resilience programming are estimated at US$36 per person for 4 years, and US$76 per person for 5 years, respectively. As a very crude estimate, these costs can be multiplied by the total poverty headcount in Mozambique. The World Bank estimates a poverty headcount ratio of 54.7% of a total population of 24m (2011 figures)[25], equating to a poverty headcount of 13m. This would imply a spend of between US$117m and US$198m per year. The upper estimate is considered to be a significant overestimate, because it is unlikely that a full suite of resilience building measures would be required for half of the country.

As one would expect, given the potential scope of resilience building, these estimates are wide ranging. For the purpose of this analysis, an upper estimate of US$198m per year is used to be conservative (using the maximum estimate for resilience will return the minimum savings that can be achieved by using a resilience approach). Because the estimate is so high, the model is also tested using the average of the estimated spend for climate change adaptation, which would support many of the same measures as disaster resilience, at $76m per year.

The model assumes a cost of $76m/$198m per year for 10 years (extending beyond the five years cited above to account for ongoing needs), at which point it is assumed that beneficiaries will be able to cope on their own with crises. Residual risk is assumed to be total aid costs (under late humanitarian response) discounted to 13% of total aid under late response to reflect aid requirements in line with the HEA modelling. These are further expected to decline by 10% each year, stabilizing at 10% to reflect that there is likely to always be some degree of risk that requires humanitarian aid. **Discounted over 20 years, the total cost of resilience is estimated at between $609m and $1,616m.**

4.1.4 Mozambique - Comparison of National Level Costs

[23] INGC 2012b

[24] REPÚBLICA DE MOÇAMBIQUE, MINISTÉRIO PARA A COORDENAÇÃO DA ACÇÃO AMBIENTAL, Estratégia Nacional de Adaptação e Mitigação de Mudanças Climáticas, 2013-2025

[25] http://data.worldbank.org/country/mozambique

The modelling suggests that, at a minimum, early response could reduce humanitarian spend and losses by $837m over a 20 year period. The upper estimate, which includes potential additional losses under climate change, suggests a saving of $2,432m over 20 years.

Table 9: Summary of National Level Cost Estimates over 20 years (discounted) - Mozambique

	Humanitarian	Early Response	Resilience – low/high estimates	Resilience – With benefits
Scenario 1	$1,575m	$738m	$609m/ $1,434m	($174m) / ($606m)
Scenario 2	$2,389m	$1,080m	$658m/ $1,483m	($124m) / ($557m)
Scenario 3	$4,578m	$2,146m	$791m/ $1,616m	$8m / ($424m)

All six resilience estimates result in figures that are less than the cost of humanitarian aid. The lower bound estimates of the cost of resilience are less than the cost of early response in all three scenarios, while the higher bound estimates are less than the cost of early response in one of three scenarios. However, the resilience estimates represent costs only. Resilience interventions, such as agriculture and food security, and WASH interventions, have been shown to have benefits that far outweigh the costs. For instance, we know that investments in SWC practices will double crop yields at a minimum, bringing increased income and better nutrition. WASH interventions can reduce travel time to fetch water, reduced incidence of water borne disease, and increased income and attendance at school. Using a very conservative estimate, assuming a return of $1.1 for every dollar spent on resilience, which is assumed to persist for the full 20 years of the model, **the resilience scenario results in a *benefit* in five out of six scenarios, between $124 and $606m.**

These factors are combined to model the "value for money" of investing in resilience. The costs of building resilience are offset against the benefits – the reduced aid cost, as well as a very conservative assumption around the additional benefits that would accrue from investments in resilience that deliver significant health, education and other gains. **When the costs of building resilience are offset against the benefits, the benefit to cost ratio ranges between 2.6 and 4.7:1. In other words, for every $1 spent on resilience, between $2.6 and $4.7 of benefits are gained.** These ratios are for the higher cost of resilience – a similar analysis with the lower estimate of resilience would yield even higher ratios.

5 Conclusions and Recommendations

5.1 Conclusions

The evidence above clearly points to three conclusions:

Early response is far more cost effective than late humanitarian response. The assumptions used in this analysis were conservative, and the findings nonetheless indicate that early response can decrease costs and losses substantially, with very high benefit to cost ratios indicating tremendous potential to improve value for money. Modelling of household level data for 2.6m people in the Zambezi Valley and Limpopo Basin suggests that early response could save between $330m and $2b over 20 years. When this is modelled on a national scale, the savings range between $837m and $2.4b over 20 years. A perceived risk in responding early is that humanitarian funds will be released incorrectly to situations that turn out not to be a disaster. However, these figures suggest that donors could mistakenly release funds six times in Mozambique before the cost is even equivalent to the cost of humanitarian aid in one event.

Resilience saves even more money still. On a pure cost comparison, SWC practices alone would decrease aid costs from $452m to $77m over a 20 year period. This represents a lower bound estimate, as it does not account for the significant indirect benefits that can occur (more sustainable livelihoods lead to ongoing economic, social and community benefits), and is only a test of a single measure. At a national scale, resilience is consistently less expensive than humanitarian response.

Early response and resilience building measures should be the overwhelming priority response. These two categories of response are not mutually exclusive. The findings in this study fully support an economic imperative for a shift to greater early response and resilience building.

Annex A: WFP Data

The following information was provided by WFP in Mozambique, in support of this study. The tables estimate costs and caseloads associated with the response scenarios for slow onset crises, rapid onset crises, and treatment of Moderate Acute Malnutrition (MAM).

Slow onset disaster (Limpopo basin)

Late humanitarian assistance

Assumptions

People affected by slow onset disaster (drought) 200,000

Late response forces the affected people to resort to food sharing. Solidarity mechanisms among affected people contribute to deplete a larger portion of the affected population who are now in dire needs of assistance

Estimation (based on experience) of population to be assisted		75%
Beneficiaries of food assistance		150,000
Requirements for food assistance during	6	months
	GFD ration	
cereals (MT)	480	12,960
pulses (MT)	60	1,620
oil (MT)	20	540
Total	560	15,120
Food purchase at peak of lean season	rate	
cereals (USD)	370	4,795,200
pulses (USD)	629	1,018,980
oil (USD)	2136	1,153,440
Total (USD)		6,967,620
Logistics costs	194.1	2,934,792
Other Operational costs	72.32	1,093,478
Total DOC		10,995,890
Direct support Costs	15%	1,649,384
Total Direct Costs		12,645,274
Indirect support costs	7%	885,169
Total costs		13,530,443
USD /MT		**894.87**
USD/pers assisted		**90.20**
USD/pers affected		**67.65**

Early humanitarian assistance

Assumptions

People affected by slow onset disaster (drought) 200,000

Timely assistance to most vulnerable allows to prevent assets depletion of the less affected. Food assistance is properly planned and provided through the most adequate type of intervention (Food for Work, Cash For Work or Vouchers), contributing therefore to further enhance communities resilience.

Estimation (based on experience) of population to be assisted		50%
Beneficiaries of food assistance		100,000
Requirements for food assistance during	6	months
	FFW ration	
cereals (MT)	267	4,806
pulses (MT)	40	720
oil (MT)	0	0
Total	307	5,526
Food purchase at harvest time	rate	
cereals (USD)	260	1,249,560
pulses (USD)	575	414,000
oil (USD)	2069	0
Total (USD)		1,663,560
Logistics costs	194.1	1,072,597
Other Operational costs	72.32	399,640
Total DOC		3,135,797
Direct support Costs	15%	470,370
Total Direct Costs		3,606,166
Indirect support costs	7%	252,432
Total costs		3,858,598
USD /MT		**698.26**
USD/pers assisted		**38.59**
USD/pers affected		**19.29**

Multi-year humanitarian assistance

Assumptions

People affected by slow onset disaster (drought) 200,000

DRR activities can be undertaken prior to disaster and consequently limit number of people in needs of food assistance once a shock hits as they do increase resilience. Food assistance is properly planned and provided through the most adequate type of intervention (Food for Work, Cash For Work or Vouchers), contributing therefore to further enhance communities resilience.

Estimation (based on experience) of population to be assisted		35%
Beneficiaries of food assistance		70,000
Requirements for food assistance during	6	months
	FFW ration	
cereals (MT)	267	3,364
pulses (MT)	40	504
oil (MT)	0	0
Total	307	3,868
Food purchase at harvest time	rate	
cereals (USD)	260	874,692
pulses (USD)	575	289,800
oil (USD)	2069	0
Total (USD)		1,164,492
Logistics costs	194.1	750,818
Other Operational costs	72.32	279,748
Total DOC		2,195,058
Direct support Costs	15%	329,259
Total Direct Costs		2,524,317
Indirect support costs	7%	176,702
Total costs		2,701,019
USD /MT		**698.26**
USD/pers assisted		**38.59**
USD/pers affected		**13.51**

Rapid onset disaster (Zambezia and Nampula coastal districts)

Late humanitarian assistance

Assumptions		
People affected by rapid onset disaster (flood, cyclone)		200,000
Late response forces the affected people to resort to food sharing. Solidarity mechanisms among affected people contribute to deplete a larger portion of the affected population who are now in dire needs of assistance		
Estimation (based on experience) of population to be assisted		75%
Beneficiaries of food assistance		150,000
Requirements for food assistance during	3	months
	GFD ration	
cereals (MT)	480	6,480
pulses (MT)	60	810
oil (MT)	20	270
Total	560	7,560
Food purchase at peak of lean season	rate	
cereals (USD)	370	2,397,600
pulses (USD)	629	509,490
oil (USD)	2136	576,720
Total (USD)		3,483,810
Transport to hard-to-reach areas (boat/airlift transport)		
Logistics costs	290	2,192,400
Other Operational costs	72.32	546,739
Total DOC		6,222,949
Direct support Costs	15%	933,442
Total Direct Costs		7,156,392
Indirect support costs	7%	500,947
Total costs		7,657,339
USD /MT		**1012.88**
USD/pers assisted		**51.05**
USD/pers affected		**38.29**

Early humanitarian assistance

Assumptions		
People affected by rapid onset disaster (flood, cyclone)		200,000
Timely assistance to most vulnerable allows to prevent assets depletion of the less affected.		
Estimation (based on experience) of population to be assisted		50%
Beneficiaries of food assistance		100,000
Requirements for food assistance during	3	months
	GFD ration	
cereals (MT)	480	4,320
pulses (MT)	60	540
oil (MT)	20	180
Total	560	5,040
Food purchase at harvest time	rate	
cereals (USD)	260	1,123,200
pulses (USD)	575	310,500
oil (USD)	2069	372,420
Total (USD)		1,806,120
Prepositionning by road, water transport required in response		
Logistics costs	235	1,184,400
Other Operational costs	72.32	364,493
Total DOC		3,355,013
Direct support Costs	15%	503,252
Total Direct Costs		3,858,265
Indirect support costs	7%	270,079
Total costs		4,128,343
USD /MT		**819.12**
USD/pers assisted		**41.28**
USD/pers affected		**20.64**

Multi-year humanitarian assistance

Assumptions		
People affected by rapid onset disaster (flood, cyclone)		200,000
DRR activities can be undertaken prior to disaster and consequently limit number of people in needs of food assistance once a shock hits as they do increase resilience		
Estimation (based on experience) of population to be assisted		35%
Beneficiaries of food assistance		70,000
Requirements for food assistance during	3	months
	GFD ration	
cereals (MT)	480	3,024
pulses (MT)	60	378
oil (MT)	20	126
Total	560	3,528
Food purchase at harvest time	rate	
cereals (USD)	260	786,240
pulses (USD)	575	217,350
oil (USD)	2069	260,694
Total (USD)		1,264,284
Prepositionning by road, water transport required in response		
Logistics costs	235	829,080
Other Operational costs	72.32	255,145
Total DOC		2,348,509
Direct support Costs	15%	352,276
Total Direct Costs		2,700,785
Indirect support costs	7%	189,055
Total costs		2,889,840
USD /MT		**819.12**
USD/pers assisted		**41.28**
USD/pers affected		**14.45**

MAM Treatment

Late humanitarian assistance

Assumptions		
Overall population affected		200,000
Nutritional rehabilitation activities		
Population targeted for MAM treatment (children under 5 and pregnant and lactation women)	25%	50,000
Latck of prevention and timely response leads to an increase of Moderate and Severe Acute Malnutrition. As a consequence, mortality rate increases also.		
Estimation (based on experience) of population to be assisted		15%
Beneficiaries of nutritional assistance		7,500
Tonnages required for 3 months of nutritional rehabilitation	MAM ration	
CSB (MT)	200	135
oil (MT)	20	14
Total	220	149
Food purchase at peak of lean season	rate	
CSB (USD)	720	97,200
oil (USD)	2136	28,836
Total (USD)		126,036
Logistics costs	189.74	28,176
Other Operational costs	135.24	20,083
Total DOC		174,296
Direct support Costs	26%	45,317
Total Direct Costs		219,612
Indirect support costs	7%	15,373
Total costs		234,985
USD /MT		**1582.39**
USD/pers assisted		**31.33**
USD/pers affected		**4.70**

Early humanitarian assistance

Assumptions		
Overall population affected		200,000
Nutritional rehabilitation activities		
Population targeted for MAM treatment (children under 5 and pregnant and lactation women)	25%	50,000
Timely assistance to most vulnerable allows to prevent the deterioration of health status. Food distribution contributes to reduce mortality and addresses already existing cases of MAM avoiding increments.		
Estimation (based on experience) of population to be assisted		10%
Beneficiaries of nutritional assistance		5,000
Tonnages required for 3 months of nutritional rehabilitation	MAM ration	
CSB (MT)	200	90
oil (MT)	20	9
Total	220	99
Food purchase at harvest time	rate	
CSB (USD)	720	64,800
oil (USD)	2069	18,621
Total (USD)		83,421
Logistics costs	189.74	18,784
Other Operational costs	135.24	13,389
Total DOC		115,594
Direct support Costs	26%	30,054
Total Direct Costs		145,648
Indirect support costs	7%	10,195
Total costs		155,844
USD /MT		**1574.18**
USD/pers assisted		**31.17**
USD/pers affected		**3.12**

Multi-year humanitarian assistance

Assumptions		
Overall population affected		200,000
Nutritional rehabilitation activities		
Population targeted for MAM treatment (children under 5 and pregnant and lactation women)	25%	50,000
Preventative measures can be undertaken prior to nutritional crisis and limit number of people in need of MAM treatment. Interventions include: conditional cash interventions to improve nutritional status; and strong nutrition communication/IYCF-E support for management of MAM.		
Estimation (based on experience) of population to be assisted		5%
Beneficiaries of nutritional assistance		2,500
Tonnages required for 3 months of nutritional rehabilitation	MAM ration	
CSB (MT)	200	45
oil (MT)	20	5
Total	220	50
Food purchase at harvest time	rate	
CSB (USD)	720	32,400
oil (USD)	2069	9,311
Total (USD)		41,711
Logistics costs	189.74	9,392
Other Operational costs	135.24	6,694
Total DOC		57,797
Direct support Costs	26%	15,027
Total Direct Costs		72,824
Indirect support costs	7%	5,098
Total costs		77,922
USD /MT		**1574.18**
USD/pers assisted		**31.17**
USD/pers affected		**1.56**

Annex B: Model Calculations

The following screenshots show the results of the modeling for the cost comparison.

Bottom-up

MODEL 1: Aid costs only													
USD													
YEAR	Humanitarian Cost		Early Response COSTS		Resilience				Resilience with Benefits				
	aid	PRESENT VALUE	aid	PRESENT VALUE	Cost per farmer	Ongoing aid	Total Cost	PRESENT VALUE	Cost per farmer	Ongoing aid	Potential benefits	Total Cost	PRESENT VALUE
0	177,193,751	177,193,751	68,052,022	68,052,022	5,641,923	22,968,750	28,610,673	28,610,673	5,641,923	22,968,750	(6,206,115)	22,404,557	22,404,557
1	39,616,230	36,014,755	5,235,162	4,759,238	5,641,923	2,458,302	8,100,225	7,363,841	5,641,923	2,458,302	(6,206,115)	1,894,109	1,721,918
2	1,147,267	948,154	844,992	698,340	5,641,923	454,758	6,096,681	5,038,579	5,641,923	454,758	(6,206,115)	(109,435)	(90,442)
3	118,016,856	88,667,811	25,010,120	18,790,473	5,641,923	4,546,684	10,188,607	7,654,851	5,641,923	4,546,684	(6,206,115)	3,982,492	2,992,105
4	1,149,002	784,783	845,072	577,195	5,641,923	448,544	6,090,467	4,159,871	5,641,923	448,544	(6,206,115)	(115,649)	(78,990)
5	33,358,201	20,712,818	5,256,155	3,263,659	5,641,923	2,476,231	8,118,154	5,040,735	5,641,923	2,476,231	(6,206,115)	1,912,038	1,187,225
6	1,148,715	648,419	845,281	477,139	5,641,923	453,848	6,095,771	3,440,904	5,641,923	453,848	(6,206,115)	(110,344)	(62,286)
7	33,140,941	17,006,543	5,231,740	2,684,710	5,641,923	2,484,658	8,126,581	4,170,221	5,641,923	2,484,658	(6,206,115)	1,920,466	985,503
8	1,147,899	535,503	844,656	394,038	5,641,923	463,535	6,105,458	2,848,241	5,641,923	463,535	(6,206,115)	(100,657)	(46,957)
9	114,868,211	48,715,334	24,669,587	10,462,313	5,641,923	4,558,322	10,200,245	4,325,900	5,641,923	4,558,322	(6,206,115)	3,994,130	1,693,901
10	1,147,801	442,527	844,933	325,758		459,058	459,058	176,987		459,058	(6,206,115)	(5,747,057)	(2,215,739)
11	32,943,460	11,546,482	5,210,394	1,826,211		2,492,129	2,492,129	873,476		2,492,129	(6,206,115)	(3,713,986)	(1,301,729)
12	1,147,648	365,676	844,515	269,089		464,386	464,386	147,968		464,386	(6,206,115)	(5,741,729)	(1,829,492)
13	32,710,707	9,475,127	5,186,959	1,502,477		2,500,533	2,500,533	724,315		2,500,533	(6,206,115)	(3,705,582)	(1,073,375)
14	1,146,171	301,823	843,932	222,234		470,717	470,717	123,955		470,717	(6,206,115)	(5,735,398)	(1,510,310)
15	111,358,337	26,658,301	24,412,355	5,844,124		4,562,012	4,562,012	1,092,109		4,562,012	(6,206,115)	(1,644,104)	(393,585)
16	1,146,851	249,588	844,409	183,768		465,202	465,202	101,241		465,202	(6,206,115)	(5,740,914)	(1,249,390)
17	32,500,293	6,430,010	5,184,599	1,025,745		2,501,760	2,501,760	494,960		2,501,760	(6,206,115)	(3,704,355)	(732,887)
18	1,146,387	206,188	843,681	151,743		468,781	468,781	84,314		468,781	(6,206,115)	(5,737,335)	(1,031,910)
19	32,097,300	5,248,165	5,184,366	847,685		2,517,264	2,517,264	411,593		2,517,264	(6,206,115)	(3,688,852)	(603,157)
Total	768,132,025	**452,151,758**	186,234,929	**122,357,962**	56,419,230	58,215,472	114,634,702	**76,884,733**	56,419,230	58,215,472		(9,487,604)	**18,764,959**

BCR

BCR	12.36				
COSTS		BENEFITS			
Cost per farmer	PRESENT VALUE	Avoided Aid	Potential Addl benefits	Total Benefit	PRESENT VALUE
5,641,923	5,641,923	154,225,002	6,206,115	160,431,117	160,431,117
5,641,923	5,129,021	37,157,928	6,206,115	43,364,044	39,421,858
5,641,923	4,662,746	692,509	6,206,115	6,898,625	5,701,343
5,641,923	4,238,860	113,470,172	6,206,115	119,676,288	89,914,566
5,641,923	3,853,509	700,458	6,206,115	6,906,573	4,717,282
5,641,923	3,503,190	30,881,970	6,206,115	37,088,085	23,028,783
5,641,923	3,184,718	694,867	6,206,115	6,900,982	3,895,424
5,641,923	2,895,199	30,656,283	6,206,115	36,862,398	18,916,239
5,641,923	2,631,999	684,364	6,206,115	6,890,479	3,214,459
5,641,923	2,392,726	110,309,889	6,206,115	116,516,004	49,414,160
0	0	688,742	6,206,115	6,894,858	2,658,266
0	0	30,451,331	6,206,115	36,657,446	12,848,211
0	0	683,262	6,206,115	6,889,377	2,195,168
0	0	30,210,174	6,206,115	36,416,289	10,548,502
0	0	675,454	6,206,115	6,881,569	1,812,132
0	0	106,796,326	6,206,115	113,002,441	27,051,886
0	0	681,649	6,206,115	6,887,765	1,498,978
0	0	29,998,533	6,206,115	36,204,648	7,162,897
0	0	677,606	6,206,115	6,883,721	1,238,098
0	0	29,580,037	6,206,115	35,786,152	5,851,322
56,419,230	38,133,892	709,916,553	124,122,306	834,038,859	471,520,690

MODEL 2: Aid+Losses													
USD													
YEAR	Humanitarian Cost		Early Response COSTS		Resilience				Resilence with Benefits				
	aid	PRESENT VALUE	aid	PRESENT VALUE	Cost per farmer	Ongoing aid	Total Cost	PRESENT VALUE	Cost per farmer	Ongoing aid	Potential benefits	Total Cost	PRESENT VALUE
0	682,516,926	682,516,926	81,216,509	81,216,509	5,641,923	22,968,750	28,610,673	28,610,673	5,641,923	22,968,750	(6,206,115)	22,404,557	22,404,557
1	250,740,957	227,946,324	6,766,845	6,151,677	5,641,923	2,458,302	8,100,225	7,363,841	5,641,923	2,458,302	(6,206,115)	1,894,109	1,721,918
2	9,062,449	7,489,627	1,134,419	937,536	5,641,923	454,758	6,096,681	5,038,579	5,641,923	454,758	(6,206,115)	(109,435)	(90,442)
3	452,312,051	339,828,739	32,514,241	24,428,431	5,641,923	4,546,684	10,188,607	7,654,851	5,641,923	4,546,684	(6,206,115)	3,982,492	2,992,105
4	9,098,044	6,214,086	1,136,009	775,910	5,641,923	448,544	6,090,467	4,159,871	5,641,923	448,544	(6,206,115)	(115,649)	(78,990)
5	224,867,181	139,624,828	6,793,212	4,218,050	5,641,923	2,476,231	8,118,154	5,040,735	5,641,923	2,476,231	(6,206,115)	1,912,038	1,187,225
6	9,071,014	5,120,351	1,135,394	640,900	5,641,923	453,848	6,095,771	3,440,904	5,641,923	453,848	(6,206,115)	(110,344)	(62,286)
7	223,362,176	114,620,114	6,762,500	3,470,232	5,641,923	2,484,658	8,126,581	4,170,221	5,641,923	2,484,658	(6,206,115)	1,920,466	985,503
8	9,025,124	4,210,287	1,133,364	528,723	5,641,923	463,535	6,105,458	2,848,241	5,641,923	463,535	(6,206,115)	(100,657)	(46,957)
9	532,525,258	225,842,694	32,045,696	13,590,503	5,641,923	4,558,322	10,200,245	4,325,900	5,641,923	4,558,322	(6,206,115)	3,994,130	1,693,901
10	9,046,808	3,487,936	1,134,319	437,329		459,058	459,058	176,987		459,058	(6,206,115)	(5,747,057)	(2,215,739)
11	221,924,181	77,783,071	6,735,535	2,360,764		2,492,129	2,492,129	873,476		2,492,129	(6,206,115)	(3,713,986)	(1,301,729)
12	9,021,638	2,874,572	1,133,125	361,049		464,386	464,386	147,968		464,386	(6,206,115)	(5,741,729)	(1,829,492)
13	220,204,190	63,785,310	6,706,000	1,942,489		2,500,533	2,500,533	724,315		2,500,533	(6,206,115)	(3,705,582)	(1,073,375)
14	8,978,106	2,364,216	1,131,652	297,999		470,717	470,717	123,955		470,717	(6,206,115)	(5,735,398)	(1,510,310)
15	521,540,594	124,852,672	31,690,210	7,586,384		4,562,012	4,562,012	1,092,109		4,562,012	(6,206,115)	(1,644,104)	(393,585)
16	8,999,058	1,958,457	1,132,946	246,562		465,202	465,202	101,241		465,202	(6,206,115)	(5,740,914)	(1,249,390)
17	218,644,349	43,257,619	6,702,970	1,326,147		2,501,760	2,501,760	494,960		2,501,760	(6,206,115)	(3,704,355)	(732,887)
18	8,958,049	1,611,184	1,131,711	203,548		468,781	468,781	84,314		468,781	(6,206,115)	(5,737,335)	(1,031,910)
19	215,668,453	35,263,515	6,705,971	1,096,480		2,517,264	2,517,264	411,593		2,517,264	(6,206,115)	(3,688,852)	(603,157)
Total	3,845,566,606	**2,110,652,528**	153,626,119	**151,817,221**	56,419,230	58,215,472	114,634,702	**76,884,733**	56,419,230	58,215,472		(9,487,604)	**18,764,959**

BCR

BCR	**55.86**				
COSTS		BENEFITS			
Cost per farmer	PRESENT VALUE	Avoided Aid	Potential Addl benefits	Total Benefit	PRESENT VALUE
5,641,923	5,641,923	659,548,177	6,206,115	665,754,292	665,754,292
5,641,923	5,129,021	248,282,655	6,206,115	254,488,770	231,353,427
5,641,923	4,662,746	8,607,692	6,206,115	14,813,807	12,242,816
5,641,923	4,238,860	447,765,367	6,206,115	453,971,483	341,075,494
5,641,923	3,853,509	8,649,500	6,206,115	14,855,615	10,146,585
5,641,923	3,503,190	222,390,950	6,206,115	228,597,066	141,940,792
5,641,923	3,184,718	8,617,166	6,206,115	14,823,281	8,367,356
5,641,923	2,895,199	220,877,518	6,206,115	227,083,633	116,529,810
5,641,923	2,631,999	8,561,589	6,206,115	14,767,704	6,889,243
5,641,923	2,392,726	527,966,936	6,206,115	534,173,051	226,541,519
0	0	8,587,750	6,206,115	14,793,865	5,703,675
0	0	219,432,051	6,206,115	225,638,167	79,084,801
0	0	8,557,252	6,206,115	14,763,367	4,704,064
0	0	217,703,657	6,206,115	223,909,772	64,858,685
0	0	8,507,389	6,206,115	14,713,504	3,874,526
0	0	516,978,582	6,206,115	523,184,697	125,246,257
0	0	8,533,857	6,206,115	14,739,972	3,207,847
0	0	216,142,589	6,206,115	222,348,704	43,990,506
0	0	8,489,268	6,206,115	14,695,384	2,643,094
0	0	213,151,190	6,206,115	219,357,305	35,866,672
56,419,230	38,133,892	3,787,351,133	124,122,306	3,911,473,439	2,130,021,461

Top-down

Scenario 1

USD MILLIONS										
YEAR	Late Humanitarian Response				Early response		Resilience			
	Aid (needs)	Losses	Total	Present Value	Aid+losses	Present Value		Residual		
							Total	Risk	Benefits	Present Value
0	45	115	160	160	73	73	198	21	(218)	1
1	45	115	160	146	73	66	198	19	(218)	(1)
2	45	115	160	133	73	60	198	17	(218)	(3)
3	45	115	160	121	73	55	198	15	(218)	(4)
4	45	115	160	110	73	50	198	13	(218)	(5)
5	47	121	168	105	80	50	198	11	(218)	(5)
6	47	121	168	95	80	45	198	9	(218)	(6)
7	47	121	168	86	80	41	198	7	(218)	(7)
8	47	121	168	79	80	38	198	4	(218)	(7)
9	47	121	168	71	80	34	198	2	(218)	(7)
10	50	127	177	68	84	33		2	(218)	(83)
11	50	127	177	62	84	30		2	(218)	(76)
12	50	127	177	56	84	27		2	(218)	(69)
13	50	127	177	51	84	24		2	(218)	(62)
14	50	127	177	47	84	22		2	(218)	(57)
15	52	134	186	44	89	21		2	(218)	(52)
16	52	134	186	40	89	19		2	(218)	(47)
17	52	134	186	37	89	18		2	(218)	(43)
18	52	134	186	33	89	16		2	(218)	(39)
19	52	134	186	30	89	14		2	(218)	(35)
Total	970	2,487	3,457	**1,575**	1,633	**738**	1,980	140	(4,356)	**(606)**

BCR

BCR	**2.63**				
COSTS		BENEFITS			
Cost	PRESENT VALUE	Avoided Aid and Losses	Potential Addl benefits	Total Benefit	PRESENT VALUE
198	198	140	218	357	357
198	180	142	218	359	327
198	164	144	218	362	299
198	149	146	218	364	273
198	135	148	218	366	250
198	123	157	218	375	233
198	112	160	218	377	213
198	102	162	218	380	195
198	92	164	218	382	178
198	84	166	218	384	163
0	0	175	218	392	151
0	0	175	218	392	138
0	0	175	218	392	125
0	0	175	218	392	114
0	0	175	218	392	103
0	0	183	218	401	96
0	0	183	218	401	87
0	0	183	218	401	79
0	0	183	218	401	72
0	0	183	218	401	66
1,980	1,338	3,317	4,356	7,673	3,519

Scenario 2

USD MILLIONS										
YEAR	Late Humanitarian Response				Early response		Resilience			
	Aid (needs)	Losses	Total	Present Value	Aid+losses	Present Value	Total	Residual Risk	Benefits	Present Value
0	128	115	243	243	108	108	198	32	(218)	12
1	128	115	243	221	108	98	198	28	(218)	8
2	128	115	243	201	108	89	198	25	(218)	5
3	128	115	243	183	108	81	198	22	(218)	2
4	128	115	243	166	108	74	198	19	(218)	(1)
5	134	121	256	159	117	73	198	17	(218)	(2)
6	134	121	256	144	117	66	198	13	(218)	(4)
7	134	121	256	131	117	60	198	10	(218)	(5)
8	134	121	256	119	117	55	198	7	(218)	(6)
9	134	121	256	108	117	50	198	3	(218)	(7)
10	141	127	268	103	123	47		3	(218)	(83)
11	141	127	268	94	123	43		3	(218)	(75)
12	141	127	268	86	123	39		3	(218)	(68)
13	141	127	268	78	123	36		3	(218)	(62)
14	141	127	268	71	123	32		3	(218)	(56)
15	148	134	282	67	129	31		4	(218)	(51)
16	148	134	282	61	129	28		4	(218)	(47)
17	148	134	282	56	129	26		4	(218)	(42)
18	148	134	282	51	129	23		4	(218)	(39)
19	148	134	282	46	129	21		4	(218)	(35)
Total	2,758	2,487	5,245	**2,389**	2,385	**1,080**	1,980	212	(4,356)	**(557)**

BCR

BCR	**3.20**				
COSTS		BENEFITS			
Cost	PRESENT VALUE	Avoided Aid and Losses	Potential Addl benefits	Total Benefit	PRESENT VALUE
198	198	212	218	430	430
198	180	215	218	433	393
198	164	218	218	436	360
198	149	221	218	439	330
198	135	224	218	442	302
198	123	239	218	457	284
198	112	242	218	460	260
198	102	246	218	463	238
198	92	249	218	467	218
198	84	252	218	470	199
0	0	265	218	483	186
0	0	265	218	483	169
0	0	265	218	483	154
0	0	265	218	483	140
0	0	265	218	483	127
0	0	278	218	496	119
0	0	278	218	496	108
0	0	278	218	496	98
0	0	278	218	496	89
0	0	278	218	496	81
1,980	1,338	5,033	4,356	9,389	4,284

Scenario 3

USD MILLIONS										
YEAR	Late Humanitarian Response				Early response		Resilience			
	Aid (needs)	Losses	Total	Present Value	Aid+losses	Present Value	Total	Residual Risk	Benefits	Present Value
0	128	338	466	466	213	213	198	61	(218)	41
1	128	338	466	424	213	193	198	55	(218)	32
2	128	338	466	385	213	176	198	49	(218)	24
3	128	338	466	350	213	160	198	42	(218)	17
4	128	338	466	319	213	145	198	36	(218)	11
5	134	355	490	304	234	145	198	32	(218)	7
6	134	355	490	276	234	132	198	25	(218)	3
7	134	355	490	251	234	120	198	19	(218)	(0)
8	134	355	490	228	234	109	198	13	(218)	(3)
9	134	355	490	208	234	99	198	6	(218)	(6)
10	141	373	514	198	246	95		7	(218)	(81)
11	141	373	514	180	246	86		7	(218)	(74)
12	141	373	514	164	246	78		7	(218)	(67)
13	141	373	514	149	246	71		7	(218)	(61)
14	141	373	514	135	246	65		7	(218)	(56)
15	148	392	540	129	258	62		7	(218)	(50)
16	148	392	540	118	258	56		7	(218)	(46)
17	148	392	540	107	258	51		7	(218)	(42)
18	148	392	540	97	258	46		7	(218)	(38)
19	148	392	540	88	258	42		7	(218)	(34)
Total	2,758	7,293	10,051	**4,578**	4,754	**2,146**	1,980	407	(4,356)	**(424)**

BCR

BCR	4.74				
COSTS		BENEFITS			
Cost	PRESENT VALUE	Avoided Aid and Losses	Potential Addl benefits	Total Benefit	PRESENT VALUE
198	198	406	218	624	624
198	180	412	218	630	572
198	164	418	218	636	525
198	149	424	218	642	482
198	135	430	218	648	442
198	123	458	218	676	420
198	112	464	218	682	385
198	102	471	218	688	353
198	92	477	218	695	324
198	84	483	218	701	297
0	0	508	218	725	280
0	0	508	218	725	254
0	0	508	218	725	231
0	0	508	218	725	210
0	0	508	218	725	191
0	0	533	218	751	180
0	0	533	218	751	163
0	0	533	218	751	149
0	0	533	218	751	135
0	0	533	218	751	123
1,980	1,338	9,645	4,356	14,001	6,341