Drought Cycle Management in arid and semi-arid Kenya:

A relevant disaster risk reduction model?

An empirical study of Garissa, Marsabit, Samburu and Wajir

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Foreword

The underlying study of the impact of disaster risk reduction in Kenya is part of the "*Drought Risk Reduction Programme*" (agreement ECHO/-HF/BUD/2008/01013) between the European Commission Humanitarian Aid Department (ECHO) and Catholic Organisation for Development and Emergency Aid (CORDAID).

The aims and scope of this study are described in the programme proposal under result 3 "*Harmonization, improved programme quality, coordination of drought preparedness and response*", activity 3.4 "*Study on the impact of CMDRR compared with alternative approaches*".

This report is intended for decision makers, to support the process of policy-making and strategy development related to disaster risk reduction.

CORDAID carried out the research in close co-operation with the Development Research Institute (IVO) associated with Tilburg University, the Netherlands.

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Summary

This study seeks to evaluate the relevance of the Drought Cycle Management model as a Disaster Risk Reduction strategy, through examining its application in Kenya. The Drought Cycle Management model aims to increase the resilience and to strengthen the coping capacity of communities and households so as to reduce their vulnerability to the risks of disaster.

Given the assumption that vulnerability and hazard are exogenous factors to households, the risk of a hazard translating into a disaster is highly dependent on the type of coping strategies that households apply. The Drought Cycle Management framework has been used to stimulate various household coping capacities and their impact on households' ability to them successfully and sustainably withstand the impact of drought. Hence, the Drought Cycle Management Model can be considered as a viable and relevant Disaster Risk Reduction strategy in the context of Kenya.

The Drought Cycle Management model was used to stimulate different types of coping capacity and their effects in influencing the risk of drought-induced disaster within at the household level. It identified four types of coping capacity that were strongly associated with reduced risk of disaster. These are:

- Establishing a livestock management structure
- Diversifying household income
- Taking measures to conserve water
- Availability of credit facilities at the community level

In addition, household ownership of land proved to be a coping capacity that is associated with decreased disaster risk for households.

The study also finds that some types of coping capacity had no statistically significant relationship with household disaster risk. Somewhat surprisingly these included:

- the level of education of the household head
- having access to reserve grazing in times of drought
- the main type of livelihood, being (agro)pastoralist or not.

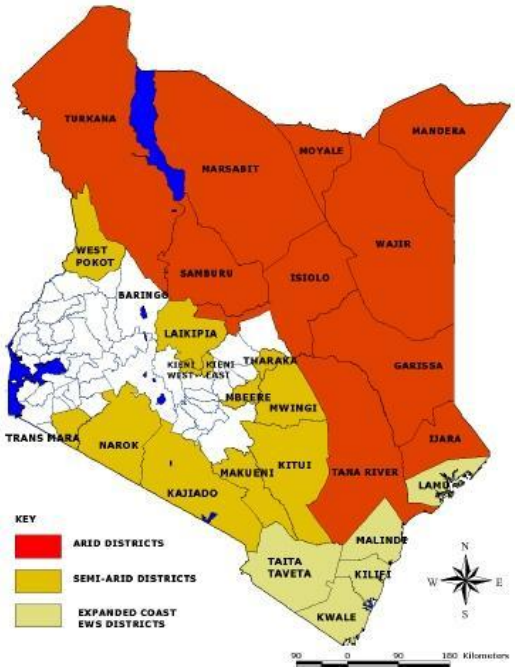
Based upon the statistical analysis and defined proxies the study shows that three out of four indicators of household disaster risk decrease when households have coping capacities as stimulated and reinforced by the DCM model. This conclusion provides sufficient statistical evidence to argue that the DCM model is a relevant approach for mitigating household disaster risk in the ASALs of Kenya.

1. Preface

1.1 Disaster risk in Kenya

Eighty percent of Kenya's territory is arid and semi-arid lands; or ASALs. About 20 percent of Kenya's population (3 million people) live in these ASALs. The red areas on the map[1] show the arid areas, while the semi-arid areas are indicated in brown. Over the last 35 years at least nine severe droughts have taken place in Kenya, affecting an increasing number of people. The 1975 drought affected a total of 16,000 people, while the droughts of 1999/2001 and 2004/2006 affected 4.4 and 3.5 million people respectively throughout Kenya, including those living outside the pastoralist areas.

Figure 1.1: Arid and semi arid areas in Kenya



Although droughts have always occurred at five or six year intervals, in recent decades they have happened more frequently and are more intensive[2].

Since droughts are common in ASALs, pastoralists have developed coping mechanisms to deal with them. It is widely acknowledged that the traditional coping capacity of pastoralists can be sufficient to overcome individual years of drought, as the period between droughts gives them time to recover. However, as droughts become more frequent, the recovery periods become too short.

Another growing problem is the ongoing reduction of grazing land due to the expansion of agriculture on the more productive ground, increasing levels of tourism, and insecurity created by conflicts. Migration between grazing land to another – traditionally the most important coping strategy – is becoming more and more limited.

Both these developments are pushing the pastoralists into a downward cycle. In the past large-scale food distribution programmes have been launched during drought periods to save lives and avert catastrophe. While these interventions met their aims, the reverse side was that they created donor dependency among pastoralists, eroding their coping capacity and mechanisms and stimulated them to become sedentary even in normal situations.[3]

To counter the adverse effects of frequent, large scale food hand-outs, responses to droughts have shifted to a strategy that seeks to provide a balanced mix of mitigation and relief within a model of drought management. Kenya's current strategy against drought in ASALs is enacted through seven main programmes:

- General development related to good governance, emergency response including the World Food Programme (WFP) interventions,), sustainable livelihoods, enhanced

[1] Source: Government of Kenya: "Arid Lands Resource Management Project II" , http://www.aridland.go.ke/mod.php?topic=96

[2] Gerhard van 't Land and Mike Wekesa: "Functional analysis of drought management at the district level", 2008

[3] Jeremy Swift, David Barton and John Morton: "Drought management for pastoral livelihoods – policy guidelines for Kenya", 2002, page 3

environmental management and response to climate change within the UN Development Assistance Framework 2009-2013;
- Emergency relief in drought areas and refugee camps under the “Emergency Humanitarian
- Response Plan” (EHRP) in 2009 implemented by the Inter-Agency Standing Committee (IASC);
- Long term social protection through cash transfers to the poorest and most vulnerable households through the “Hunger Safety Net Programme” (HSNP) funded by DFID for ten years;
- The “Arid Lands Resource Management Project” (ALRMP II) focussing on community based drought-management aiming at enhancing food security funded by the World Bank;
- Reinforcement of effective and efficient drought management covered in the “Drought Management Initiative (DMI) funded by the EU;
- Drought management including emergency aid in response to recurrent droughts in the affected areas of the Greater Horn of Africa countries funded by ECHO through the Regional Drought Decision (RDD)
- Linking relief and development in pastoralist areas through “Regional Enhanced Livelihoods in Pastoral Areas” (RELPA) funded by the Famine Prevention Fund (USAID).

1.2 Problem analysis and research methodology

Drought management strategies try to stimulate household behaviour that is more resilient to the negative effects of droughts (impact level) by increasing resilience at the community level and strengthening coping capacities (outcome level).

While the results of drought management interventions have been frequently evaluated this has usually been within a relatively short term timeframe, mostly to analyse the output (activities) and outcomes of specific projects, rather than measuring the overall long term impact.

The intrinsic value of drought management as a strategy, rather than as an operation, remains relatively unexplored. This study seeks fill some of these gaps and contribute to the understanding of the risk inflicted by drought in four districts of Kenya and the critical factors underlying (agro) pastoralist’s coping strategies. It sets out to test the hypothesis that increasing resilience and strengthening coping capacity will positively influence sustainable household behaviour aimed at mitigation of negative effects droughts. If the hypothesis turns to be correct, drought management strategies may be considered to be proven relevant.

The study also aims to provide information that can be used in the design of interventions targeted at those households most in need of assistance before, during, or after a drought. The study starts from existing theories that seek to explain disaster risk. Based on these theories a number of variable proxies are drawn out to test the hypothesis. These proxies are then valued by testing them against primary and secondary data (see following section). An econometric model (PROBIT model) is used to estimate the maximum likelihood of relationships between the variables. The model assumes that hazard and vulnerability are exogenous to households, and that households equipped with strong coping capacity are more likely to withstand the negative impacts of drought.

1.3 Data collection

For the research CORDAID undertook primary and secondary data collection in four different districts, of Kenya: Garissa, Marsabit, Samburu and Wajir. All four districts lie within ASALs and suffer from droughts, but have different levels of vulnerability. A team of independent consultants was hired to develop a questionnaire and to conduct a survey among 215 agro-pastoralist and pastoralist households in the four districts[4].

[4] The numbers of interviews in each distract was as follows: Garissa (57), Samburu (53), Marsabit (53) and Wajir (52).

The survey data falls within four broad themes. The first section provides data on the characteristics of households across the four districts. This data includes age, education, household size, whether household members are economically active or not, marital status, household composition, housing type and household assets.

The second theme concerns households' socio-economic characteristics. Here the data collected included (but was not limited to), type of agricultural activity, sources of and constraints to household livelihoods, livelihood assets and constraints, sources and stability of water supply, management and use of water sources, changes in livestock, the effects of disease and drought on livestock, land tenure, farm land and irrigated land. Through analysis of this data it was possible to draw an image of an average household within the four districts and to draw a comparative picture between districts.

The third set of data concerns households' understanding of drought and its effects on their livelihoods. This was considered to be relevant as it can be expected that households with a better understanding of drought will take more effective measures to counteract its effects. The information collected included household's understanding of the causes of drought and its effects on their livelihood, access to drought information, household's ability to forecast the weather and to respond to these predictions.

The last section collected data on households' drought coping mechanisms (*ex-ante* and *ex-post*). A short list of the possible *ex-ante* coping mechanisms includes spatial and livestock diversification, livestock management (including strategic sales of livestock), income diversification, livestock insurance, water storing, and pasture preservation. Information was also collected on the coping mechanisms applied during and after drought, including reducing the size of herds and household food consumption, changing use of natural resources (pasture, water and forests), the use of household assets during drought and any support received.

The questionnaire of the household survey is attached as ANNEX 2.

1.4 Deviation from initial objective

The initial research proposal stated

> *"The objective of the study is to quantify the impact of disaster risk reduction interventions in Kenya and to determine the cost-effectiveness of long term DRR compared to short term emergency relief and rehabilitation. Moreover, the study will be a starting point of a future study on the qualitative long term impact of DRR intervention and to determine future direction."*

While carrying out the research, part of the methodology described in the original proposal had to be changed. The original intention was to construct a reduced accounting framework for four districts. This would increase the coherence of the individual data (especially those related to production and money flows resulting from external donor interventions) and was intended to permit an analysis of the cost-effectiveness of DRR interventions.

However, the scarcity of reliable data at the district level hindered this approach, particularly given the available resources and the time schedule. As a result the objective of the study was adjusted, and the focus shifted away from cost-effectiveness to the relevance of drought strategies applied in Kenya.

The alternative research method uses district level data to construct indicators, which are less precise, but easier and faster to construct, and easier to include in the model used for policy simulations.

1.5 Structure of the report

The remainder of the report consists of four main chapters, each addressing a different topic:

Topic 1, contained in chapter 2 ("*Concepts of disaster risk reduction*") provides an overview of various theories of disaster risk.

Topic 2 contained in chapter 3 ("*Putting the theoretical framework into practice*") translates concepts such as hazards, vulnerability, coping capacity and disaster risk into practical proxies that are fit for statistical testing.

Topic 3 contained in chapter 4 ("*Quantitative analysis*") outlines the statistical estimations and results.

Topic 4 contained in chapter 5 ("*Interpretation of the statistical estimations and conclusions*") presents the conclusions of this report.

2. Concepts of disaster risk reduction

2.1 Introduction

Two complementary theories in the literature explore disaster risk and vulnerability. The first theory is the "Disaster pressure and release" model and the second one is the "Access model". From these theories the relationships between disaster risk, vulnerability, hazard and coping capacity can be derived. These have led to the evolution of the "Drought cycle management" model, which is a translation of the theories into a practical working tool.

These theories were used to derive the proxies that formed the basis for the statistical estimations.

2.2 The "Disaster pressure and release" model

The "Disaster pressure and release" model, or the PAR model, was developed by Blaikie et al. and explains disaster risks from a **macro perspective**. The PAR model argues that disasters occur at the tangent between two opposing forces, those of natural hazards and the processes that generate vulnerability. It is when these two forces coincide that a disaster happens.

Vulnerability is defined as the

> *"… characteristic of a person or group and their situation that influence their capacity to anticipate, cope with, resist and recover form the impact of a natural hazard."*
> "At risk, second edition: natural hazards, people's vulnerability, and disasters", Wisner et al., 2003, page 11

The model identifies a *progression of vulnerability*, in which *root causes* are shaped by a series of *dynamic pressures* and can give rise to *unsafe conditions.* These three forces are defined as follows[5]

- *root causes* (or underlying causes) are a set of well-established, widespread economic, demographic and political processes within a society and the world economy that give rise to vulnerability (and reproduce vulnerability over time) and affect the allocation and distribution of resources between different groups of people;
- *dynamic pressures* are the processes and activities that transform the effects of the *root causes* into vulnerability and channel the *root causes* into particular forms of insecurity related to hazards such as population growth, rapid urbanization, deforestation and a decline in soil productivity. These might include a lack of training, appropriate skills and local conditions of markets and policies;
- *unsafe conditions* are the specific forms in which the vulnerability of a population manifest itself in time and space in conjunction with the hazard. This may occur through such processes as fragile local economic conditions, lack of disaster planning and preparedness and a fragile environment.

The model is explained in more detail in ANNEX 1.

2.3 The Access model

The Access model (Wisner, Blaikie, Cannon and Davis, 2003) explains how unsafe conditions at a **household level** emerge as a result of processes that allocate resources. A household's level of access to resources strongly influences its capacity to respond to the impact of hazards. Resources

[5] Piers Blaikie et al.: "At risk: natural hazards, people's vulnerability, and disasters", 1994, page 24-25

can be economic (e.g. income, loans, employment), related to health or infrastructure (including communications) or be information-based..

The access model

> *"… considers how the relationship between households' access to various resources and the choices made within a set of structural constraints impacts on their ability to withstand shocks."*
> "Disaster risk assessment in South Africa: some current challenges", Gideon van Riet, 2008, page 4

Access to resources is the key to households improving their livelihoods, making them sustainable, increasing their resilience against shocks and having the capacity to restore their livelihoods after a disaster occurs.

For further discussion of the model, the reader is referred to ANNEX 1.

2.4 Definition of coping capacities

While the PAR and ACCESS models consider vulnerability at various levels, they do not address the issue of coping capacities. So, how does the role of coping capacities fit with these two theories?

Coping capacities can be classified under three broad headings:

- *ex ante* disaster coping capacity aimed at reducing vulnerability;
- *ex ante* disaster coping capacity aimed at strengthening resilience;
- *ex post* disaster coping capacity aimed at survival and recovery.

Within the PAR model *ex ante* disaster coping capacity aimed at vulnerability reduction can be considered as a *dynamic release* (as opposed to the *dynamic pressures*) that results in improved (safer) conditions. This reduces vulnerability. Development of *ex ante* disaster coping capacity aimed at strengthening resilience leads to increased access to resources as argued by the ACCESS-model.

2.6 Drought cycle management

Drought cycle management (DCM) is an approach based upon the DRR principles that have been developed to battle the negative effects of drought in the Greater Horn of Africa.

> *"Drought cycle management, …, realizes that droughts are a normal, inevitable part of the climate of the drylands. It recognizes that a drought will occur sooner of later – the question is not if, but when. Drought cycle management uses the periods between droughts to prepare for the next one, to minimize its impact when it hits."*
> "Drought cycle management: a toolkit for the drylands of the Greater Horn", CORDAID, 2004, page 4

The DCM model stresses the need for continuity between activities aimed at development, relief and rehabilitation in ASALs. It is a model that fits well within the DRR framework, since it explicitly seeks to reinforce *ex-ante* and *ex-post* coping capacity and thereby reduce vulnerability.

DCM strategies typically focus on trying to strengthen livelihoods through *ex-ante* measures, such as improving water conservation, improving livestock management (access to veterinary services, improvement of trade systems, etc), creating "insurance" systems at the community level. They also seek to ensure that food stocks are in place when droughts are expected (during the alert state), to provide emergency aid when a drought hits and support the reconstruction of livelihoods after drought periods.

3. Putting the theoretical framework into practice

3.1 Base for proxies

The theories and models presented in the previous chapter form the basis for testing the various relationships that exist between hazards, vulnerability, coping capacity and disaster risk. These relationships are estimated using an econometric model, in which the proxies developed represent dependent and independent variables. A proxy for drought (hazard) was defined on the basis of rainfall. The PAR model was used to derive the proxies for vulnerability. The ACCESS and DCM models provided the proxies for coping capacity. Finally, disaster risk was approximated using data from the household survey.

3.2 Hazard

Continuous drought is a hydro-meteorological hazard that can be approximated by the long term annual or monthly rainfall average which, when low enough, causes land to become arid or semi-arid. An area with an average monthly rainfall of less then 42 mm (or approximately 500 mm per annum) is considered to be arid. One with an average monthly rainfall of between 42 mm and 67 mm (circa 800 mm pa)[6] is considered to be semi-arid.[7] We analysed the rainfall data for the four districts between 1985 and 2008 (see table 3.1). With an average monthly rainfall of 31.2 mm and 27.9 mm, two of the study districts (Garissa and Wajir) can be considered arid and the other two (Marsabit and Samburu), with an average rainfall of 59.3 mm and 46.8 mm respectively, can be considered semi-arid. As all four districts are categorised as (semi)arid areas the assumption was made that the drought hazard was identical for all four districts.

Table 3.1: Analysis of rainfall data for Garissa, Marsabit, Samburu and Wajir (1985-2008)

district	monthly rainfall in mm per year (period 1985-2008)			
	average	max	min	std dev
Garissa	31.2	79.2	11.1	16.6
Marsabit	59.3	120.3	8.3	24.1
Saburu	46.8	99.1	27.3	18.3
Wajir	27.9	92.6	6.7	17.8

source: Kenya Meteorological Department

3.3 Vulnerability

Vulnerability is a multidimensional factor, embodying the combined effects of unsafe conditions. It can be approximated by a set of variables derived from the PAR model. To do this we derived proxies from the four elements of the PAR model relating to: the physical environment, the local economy, social relations and public actions. Taken together this allowed us to derive a dichotomous

[6] These definitions are based on Gordon Wayumba: "A review of special land tenure issues in Kenya", 2004, and the African Development Fund: "Kenya, ASAL-based livestock and rural livelihoods support project: appraisal report", 2003

[7] Philip Woodhouse, Henry Bernstein & David Hulme: "African enclosures? The social dynamics of wetlands and drylands", 2001, page 77

comparative vulnerability indicator. Vulnerability was approximated at the district level and represents the variables over which individual households have no control.

3.3.1 The physical environment

Periodical rainfall deficit is defined as the ratio of rainfall within any given period to the long-term average (LTA) rainfall. Monthly rainfall data are used to calculate the intensity of the deficit. Drought is considered to occur in any particular year when the rainfall is less than 80% of the LTA. The intensity of drought is defined as moderate (MD), severe (SD), or calamitous (CD). A drought is considered to be moderate if rainfall in any particular year is 70–80% of the LTA; severe if rainfall is in the range of 50–70% of the LTA, and calamitous if rainfall is less than 50% of the LTA. In addition, drought declarations made by local and national governments can also be used to identify drought years. These years are also highlighted in table 3.2.

Table 3.2: Overview of droughts in Garissa, Marsabit, Samburu and Wajir (1985-2008)

year	drought decl	Garissa	Marsabit	Samburu	Wajir
1985		CD			SD
1986			MD		SD
1987		CD			CD
1991	X		SD		SD
1992	X			MD	
1993				MD	
1994			MD		SD
1995				MD	
1996	X	CD	CD		
1997	X				
1999	X	MD	CD		SD
2000	X	CD	CD	SD	CD
2001	X	SD			
2004	X	CD		SD	
2005	X	CD			CD
2006	X				
2007			SD		MD
2008		MD			

note: the time series for Samburu runs only from 1990 to 2005

Vulnerability to the physical environment can be approximated by the frequency of droughts, weighted by their intensity. This analysis is shown in table 3.3. The data show that Marsabit and Samburu are less vulnerable to drought than Garissa and Wajir.

Table 3.3: Number and frequencies of droughts for Garissa, Marsabit, Samburu and Wajir (period 1985-2008)

district	no of droughts per type			drought frequency	weighted frequency
	MD	SD	CD		
Garissa	2	1	6	0,38	0,92
Marsabit	2	2	3	0,29	0,63
Samburu	3	2	-	0,36	0,50
Wajir	1	5	3	0,38	0,83

note: weights for MD, SD and CD are respectively 1, 2 and 3

3.3.2 Local economy

The PAR theory regards income as an indicator of the strength of a local economy. In line with this view, the present study employs the human poverty index (HPI) as a proxy for the strength of the different local economies. Table 3.4 presents the HPIs for the four districts and the national average.

Table 3.4: HPI for Garissa, Marsabit, Samburu, Wajir and Kenya (1999, 2004 & 2005)

year	Human Poverty Index				
	Garissa	Marsabit	Samburu	Wajir	Kenya
1999	44.9	40.2	59.6	55.3	34.5
2004	39.1	44.8	55.2	48.5	36.7
2005	36.6	64.7	44.9	54.6	36.2

source: Kenya National Development Report 2001, 2003, 2005 & 2006

On the basis of this analysis the districts can be divided into two groups; three districts (Marsabit, Samburu and Wajir) have a HPI that is higher than the national average, with Garissa having an HPI that is on par with the national average. Based upon this proxy Garissa can be classified as less vulnerable than the other three districts.

3.3.3 Social relations

Social relations generally come under pressure at times of substantial population growth (which impacts on security). Therefore population growth was taken as an indicator of increasing vulnerability in this domain.

Table 3.5: Population growth per district (1995-1999 through 2009)

period	annual population growth (percentage)				
	Garissa	Marsabit	Samburu	Wajir	Kenya
1990 ~ 1999	13,5	(0,6)	2,8	10,0	3,0
2000 ~ 2009	2,7	2,0	2,1	6,4	2,2
1990 ~ 2009	8,1	0,7	2,4	8,2	2,6

source: CBS Kenya

The population growth figures show clearly two different growth patterns. Garissa and Wajir both have much higher levels of population growth than Marsabit and Wajir (and the national average). This can

be explained by the huge influx of Somali refugees into these two districts. As a result the populations of Garissa and Wajir are considered to be more vulnerable in this respect than the inhabitants of Marsabit and Samburu.

3.3.4 Public actions and institutions

Public actions and institutions can be measured with development indicators. In this study these indicators are approximated with two indicators: 'access to health services' and 'overall school enrolment'. The following tables show the results for both indicators.

Table 3.6: Access to health services for Garissa, Marsabit, Samburu, Wajir and Kenya (1999, 2004 & 2005)

year	access to health services (percentage of population)				
	Garissa	Marsabit	Samburu	Wajir	Kenya
1999	11.0	24.9	25.0	11.0	49.0
2004	13.0	24.9	25.0	15.0	40.8
2005	11.0	25.0	25.0	11.0	35.0

source: Kenya National Development Report 2001, 2003, 2005 & 2006

Table 3.7: Access to education for Garissa, Marsabit, Samburu, Wajir and Kenya (1999, 2004 & 2005)

year	overall school enrollment (percentage of population)				
	Garissa	Marsabit	Samburu	Wajir	Kenya
1999	11.2	27.2	50.0	5.4	50.7
2004	14.3	29.3	53.0	14.6	62.9
2005	17.2	38.7	53.2	17.4	72.9

source: Kenya National Development Report 2001, 2003, 2005 & 2006

Both indicators show a similar pattern with Garissa and Wajir districts having a far lower level of access to health services and school enrolment rates than the other two districts. In this respect these first two districts are more vulnerable than Marsabit and Samburu.

3.3.5 Comparative vulnerability

Together these indicators were used to derive a dichotomous comparative vulnerability index. The results are summarised in table 3.8 below, which gives a vulnerability ranking for each of the four districts. The five indicators are indexed against the average of their real values. The overall vulnerability index for each district is an average of the indexed indicators. All the indicators were given the same weight to avoid disputes over weighting the indicators.

table 3.8: Dichotomous comparative vulnerability indicator per district

vulnerability indicator	comparative vulnerability index (average = 100)			
	Garissa	**Marsabit**	**Samburu**	**Wajir**
physical environment				
• *weighted drought frequency*	*138*	*94*	*44*	*125*
local economy				
• *human poverty index*	*82*	*102*	*109*	*108*
social relations				
• *population growth*	*167*	*14*	*49*	*169*
public actions and institutions				
• *access to health*	*108*	*92*	*92*	*108*
• *overall school enrollment*	*119*	*94*	*66*	*121*
overall	***123***	***79***	***72***	***126***

3.4 Coping capacity

This study adopts a working definition of coping capacity as the ability of pastoralist households to withstand the negative impact of droughts. Coping capacity can be either certain household characteristics or specific systems in place. Coping capacity is approximated by in total 27 variables presented in ANNEX 5.

3.5 Coping strategy

Traditionally the coping strategies adopted in response to decreased purchasing power include changing consumption patterns (such as reducing the quantity or quality of food intake), timely livestock adjustments, applying for social protection (e.g. food support from relatives and communities), seeking credit from food traders and, finally, humanitarian aid.[15]

The survey results showed that when households are confronted with a food deficit, the most common coping strategies are adjustments in food consumption and the liquidation (sale or slaughter) of productive assets (livestock). Table 3.9 presents an overview of all the coping strategies, ordered by the relative prevalence in which these strategies are adopted. (These strategies are not mutually exclusive, some can be adopted simultaneously).

Table 3.9: Coping strategies and their relative prevalence (percentage)

coping strategy	distribution coping strategies (percentage)				
	Garissa	Marsabit	Samburu	Wajir	overall
household food consumption adjustments	28	30	68	22	36
liquidate productive asset	26	16	18	39	24
deplete food & cash savings	12	24	3	-	11
borrow credit	9	9	5	1	7
rely on charity	6	7	-	12	7
use social network	-	10	2	7	5
earn more wage income	6	1	-	6	3
liquidate other assets	7	-	-	-	2
publicly sponsored relief	-	1	2	3	1
household expenditure adjustments	1	1	-	1	1
migrate families out of pastoralist area	1	-	-	3	1
do nothing	3	-	2	4	2

3.6 Household disaster risk

The household-level food consumption deficit represents an ideal dependent variable. However, it is extreme difficult to measure this deficit as it requires knowledge of a reference “long term average” food consumption within individual households. However the data from the household survey did provide four proxies that could be used to measure this from different angles. These are:

- liquidation of productive assets (livestock)
- food consumption adjustments (lower quality of food and less meals per day)
- calling on community level facilities (credits, charity, support from village level institutions or networks)
- reliance on emergency relief (food distributions)

These *ex-post* coping mechanisms have different impacts in terms of the risk they create for the household.

If a household chooses to liquidate its productive assets to cover its food deficit this can be taken as implying that its food deficit will be large. Opting for liquidation implies that that household has no other response to its severe deficit in food consumption. The liquidation of productive assets is likely to have a devastating effect on a family’s prospects of maintaining a sustainable livelihood and increasing their risk factor. Hence, this coping mechanism is a good proxy for a high disaster risk.

Although food consumption adjustments tend to be of a short term nature, this coping mechanism may lead to severe malnutrition and increase the risk of infant mortality. Therefore, this strategy must also be regarded as a proxy for a high disaster risk.

A household’s ability to call on aid from community organisations or networks suggests that it has an informal safety net which it can fall back on in difficult times, avoiding the need to take radical measures to meet its food deficit. If a household can call on community level networks, it can solve its food shortage without the negative impacts of the previous two coping strategies. Thus this coping strategy should be classified as proxy for low risk.

Households with access to aid from Government and NGOs might be seen as having a formal safety net. Despite this, reliance on emergency relief should be considered as an indicator of high risk, as this type of coping is dependent on uncontrollable, outside factors that may or may not materialise.

Furthermore reliance on this strategy can possibly influence the coping mechanisms of households or their communities, by inducing dependency.

It should be noted that these four strategies are not mutually exclusive. For example a household that decides to liquidate its assets may also receive aid from the community or from formal sources.

4. Quantitative analysis

4.1 Four models to explain household's disaster risk

Household disaster risk is approximated by the four coping strategies described in the previous section: liquidation of productive assets, household food consumption adjustments, calling on community level facilities and reliance on emergency relief. It is important to keep in mind that these coping strategies are applied when households are faced with food shortages during droughts, and should not be confused with *ex-ante* strategies aimed at strengthening household resilience.

A different model was developed for each coping strategy (see ANNEX 3). The models estimate the significance and impact of 27 proxies[8] of coping capacity and household characteristics on the implemented strategy, which are indicators for household disaster risk.

The first model is related to the liquidation of productive assets. The major component of this strategy is selling, trading or slaughtering livestock. But it may also include the disposal of land or farm land, if applicable. Reducing household food consumption is captured in the second model. The adjustment includes changes in the number of meals as well as the quality of food.

Thirdly, the strategy related to calling on community level facilities was modelled. This strategy contains four elements: taking credits or borrowing, receiving charity and falling back on social networks or village institutions. The final model is to rely on emergency relief from either government, national or international non-governmental agencies, or other organisations.

4.2 Significant forms of coping capacity or characteristics in relation to household disaster risk

Of the 27 proxies for coping capacity (or household characteristics) a total of 15 have a statistical significant correlation with the household coping strategy.

Table 4.1 shows the cross-tabulation of the four coping strategies and the respective, significantly correlated coping capacities. The data represent the marginal effects of coping capacity on each coping strategy. This means that when a specific coping capacity changes by one unit, the likelihood that the associated coping strategy is chosen by a household changes by the marginal effect[9]. For example the coping capacity [06] 'individually owned land' has a marginal effect of -0.5238 on the coping strategy 'liquidation of productive assets'. This means that the likelihood that households will apply this strategy will decrease by 52 percent when the first coping capacity increases by one unit.

Liquidation of productive assets as coping strategy against a food deficit during droughts is taken as a proxy for household disaster risk. The following forms of household coping capacity or characteristics reduce household disaster risk when measured with this proxy:

- land owned by households (marginal effect 52 percent)
- sustainable livestock management systems in place (marginal effect 50 percent)
- water conservation measures applied (marginal effect 49 percent)
- total assets currently owned (marginal effect 19 percent)

[8] An overview of the independent proxies can be found in ANNEX 5.

[9] See ANNEX 4 for technical details

Table 4.1: Marginal effect of coping capacity on coping strategies at the household level

coping capacity socio-economic household charisteristics	household coping strategies			
	liquidation of productive assets	food consumption adjustments	call on community level facilities	rely on public relief
01 district vulnerability index			0.3465	-0.4626
02 age head of household		0.3999		
03 sex head of household		-0.0058	0.2404	
04 proportion of non-active household members	0.2377	-0.2223		
05 total number children at school			0.0514	
06 individually owned land	-0.5238	-0.2355		
07 number of animals owned during last five years	-0.0010	0.0008		0.0004
08 total assets owned currently	-0.1915		0.1223	0.1154
09 ex-ante livestock and income management	-0.4966	0.1959	0.2574	
10 total animals lost last year due to disease	0.0014			
11 water conservation applied	-0.4872	-0.3849		
12 response to weather forecasts				0.2088
13 income from employment or business	-0.0003			
14 borrowed money last year		-0.8650	0.3713	-1.0988
15 migration of families outside pastoralist areas	0.3128	-0.2420		

The proportion of economically inactive household members enlarges household risk, having a marginal effect of almost 24 percent. There is also a significant relationship between migration of families outside the pastoralist areas and the liquidation of productive assets. It should be noted that here the causality is reversed. It is more likely that increased disaster risk results in a higher migration outside the pastoralists' area rather than the other way around.

When household disaster risk is approximated by a coping strategy which involves adjusting food consumption, it is lowered when

- households have access to credit facilities (marginal effect 87 percent)
- water conservation measures are applied (marginal effect 40 percent)
- when entire families migrate outside the pastoralist areas (marginal effect 24 percent)
- when the household owns land (marginal effect 24 percent)
- when the proportion of economically inactive household members is higher (marginal effect 22 percent)

The last of these factors might be explained by the unwillingness of households to economise on food for children and the elderly.

On the other hand there are characteristics that increase household disaster risk as measured by reduced food consumption. These are the age of the head of household (marginal effect 40 percent) and, unexpectedly, when sustainable livestock management systems are in place (marginal effect 20 percent). The model's estimations were not able to explain this (significant) correlation, and further statistical analysis would be needed to understand the underlying relationship.

The third coping strategy, calling on community level facilities and social networks, is different from the other three, as it may be regarded as a safety net for those households at risk. Here, the interpretation of the marginal effects is inverted: increased utilisation of this capacity leads to a reduced disaster risk.

There are four types of coping capacity or characteristics that serve to reduce household disaster risk:

- access to credit facilities (marginal effect 37 percent)
- sustainable livestock management systems in place (marginal effect 26 percent)
- the head of household is male (marginal effect 24 percent)
- total assets currently owned (marginal effect 12 percent)

In addition the level vulnerability of the district also affects this type of coping strategy (marginal effect 35 percent). This may be because households in more vulnerable districts tend to seek and find support at community level or other social networks more frequently.

The reliance on emergency relief, which is also a proxy for high levels of disaster risk, is explained by two coping capacities. These are, having access (and responding) to weather forecasts (marginal effect 21 percent), and possessing assets (marginal effect 11 percent)

Lower levels of reliance on emergency relief as a coping strategy are associated with

- access to credit facilities (marginal effect 110 percent)
- district vulnerability index (marginal effect 46 percent)

The latter means that in districts that are more vulnerable, households tend not to rely on emergency relief as coping strategy. This is an unexpected relationship, but could be explained by the fact that it is often more difficult, for logistical reasons, to get aid to the most vulnerable districts. If emergency aid is less available, households will seek alternative coping strategies to handle food shortages.

4.2 Insignificant forms of coping capacity or characteristics in relation to household disaster risk

In total 10 types of coping capacity or household characteristics proved to be statistically insignificant in relation to disaster risk at the household level. Three of the insignificant indicators were unexpected:

- the level of education of the household head
- having access to drought reserve grazing
- the main type of livelihood - being (agro)pastoralist or not

This result that the educational level of the household head has little or no effect on a household's capacity for dealing with food deficits is perhaps counterintuitive to expectations. The finding that having access to reserve grazing has no proven impact on a households disaster risk is also striking, as one would expect that households with such grazing would be able to feed their herds for a longer period, maybe long enough to withstand the drought period. It might be reasoned that back-up feeding for livestock is important when there is not yet a food deficit, but at the time a shortage does appear, animal feeding does not play an important role with respect to the choice of coping strategy.

Finally the main type of livelihood also had no significant correlation with the proxies for household disaster risk. It should be noted that this indicator is not a measure for income diversification, but reflects the main source of livelihood. In other words, families that are primarily reliant on (agro)pastoralism, small scale business or employment are all equally vulnerable when drought occurs. Their main form of income does not influence their level of disaster risk. This might be explained by strong interdependencies that exist between households in such communities.

5. Interpretation of the statistical estimations and conclusions

5.1 Introduction

This study seeks to value the relevance of the Drought Cycle Management (DCM) model within the Disaster Risk Reduction (DRR) strategy being applied in Kenya. The DCM model aims at increasing the resilience and coping capacity of communities and households so as to reduce the risk of household disaster. The results show that the level of disaster risk is related to the types of coping mechanisms that households apply.

To investigate the relevance of coping strategies the study examined the relationship between the coping strategies that households and their capacity to cope with drought, measured in terms of household disaster risk. If a positive, statistical significant relationship can be demonstrated then the Drought Cycle Management Model can lay claim to being a relevant intervention strategy. In addition, the study seeks to identify the most important determinants of household coping strategies, information which can be used for further policy development and intervention formulation.

5.2 The Drought Cycle Management model: a relevant approach to household disaster risk

Liquidation of productive assets as coping strategy to deal with food deficits during droughts is regarded as a severe household disaster risk. The statistical analysis indicates that wealth of households reduces the likelihood of this coping strategy. Measures to avoid – typically promoted by the Drought Cycle Management Model – related to sustainable livestock management, income diversification and water conservation have significant, decrease the effects on household disaster risk.

Food consumption adjustments typically take place when households have no options to borrow money to cover food shortages, have no or little own land and do not migrate outside the pastoral areas. However, this coping mechanism is negatively correlated with households taking *ex-ante* water conservation measures. This means that – taking food consumption adjustment as an indicator for disaster risk – there is a reverse relation between ex-ante water management as promoted by the Drought Cycle Management Model and household disaster risk. This relation is statistically significant, and shows that water conservation have a positive effect on the nutrition pattern of households, and reduce their disaster risk.

Reinforcement of community coping capacity is a part of the Drought Cycle Management Model. If households can turn to community mechanisms to cover their food shortages, without applying the previous two coping strategies, this reduces their disaster risk. The statistical estimates show that having one's own assets, access to credit, management of livestock, income diversification and water management are all positively and significantly associated with this coping strategy. The last three coping capacities fit particularly well with the approach of the DCM model, demonstrating the mitigating that DCM seeks to have on increasing household's coping capacity and reducing their risk of disaster.

In contrast to the previous coping mechanism, relying on emergency relief has no specific relationship with coping capacity within the DCM model. This coping mechanism is widely applied when households have access and respond to weather forecasts and have limited opportunities to obtain credit from within their own communities.

Based upon the statistical analysis and defined proxies it is concluded given that three out of four indicators of household disaster risk decrease when households have coping capacities as stimulated and reinforced by the DCM model. This conclusion provides sufficient statistical evidence to state that the DCM model is a relevant approach for mitigating household disaster risk in the ASALs of Kenya.

5.3 Significant and insignificant factors of the DCM model

For policy development and intervention formulation it is important to know which coping capacities are indicative of successful mitigation of household disaster risk, and those that are not successful.

Based upon the statistical estimations, DCM interventions will be most successful they focus on:

- sustainable livestock management systems
- income diversification
- water conservation
- community level credit facilities and other community level safety net structures

Reinforcing *ex-ante* livestock management, income diversification and water conservation measures will specifically reduce the likelihood of households liquidating productive assets and will stabilise food consumption. Moreover, strengthened livestock management systems also will have a positive impact on community level coping mechanisms. Increased access to credit facilities is significantly beneficial for stabilising food consumption in times of drought and also has a positive effect on the mechanism of community level coping.

DCM often advocates access to drought reserve grazing as a beneficial coping capacity, but this analysis found that this capacity was insignificant in influencing household's choice of coping strategy. Hence, the effect of this coping capacity on household disaster risk is not proven.

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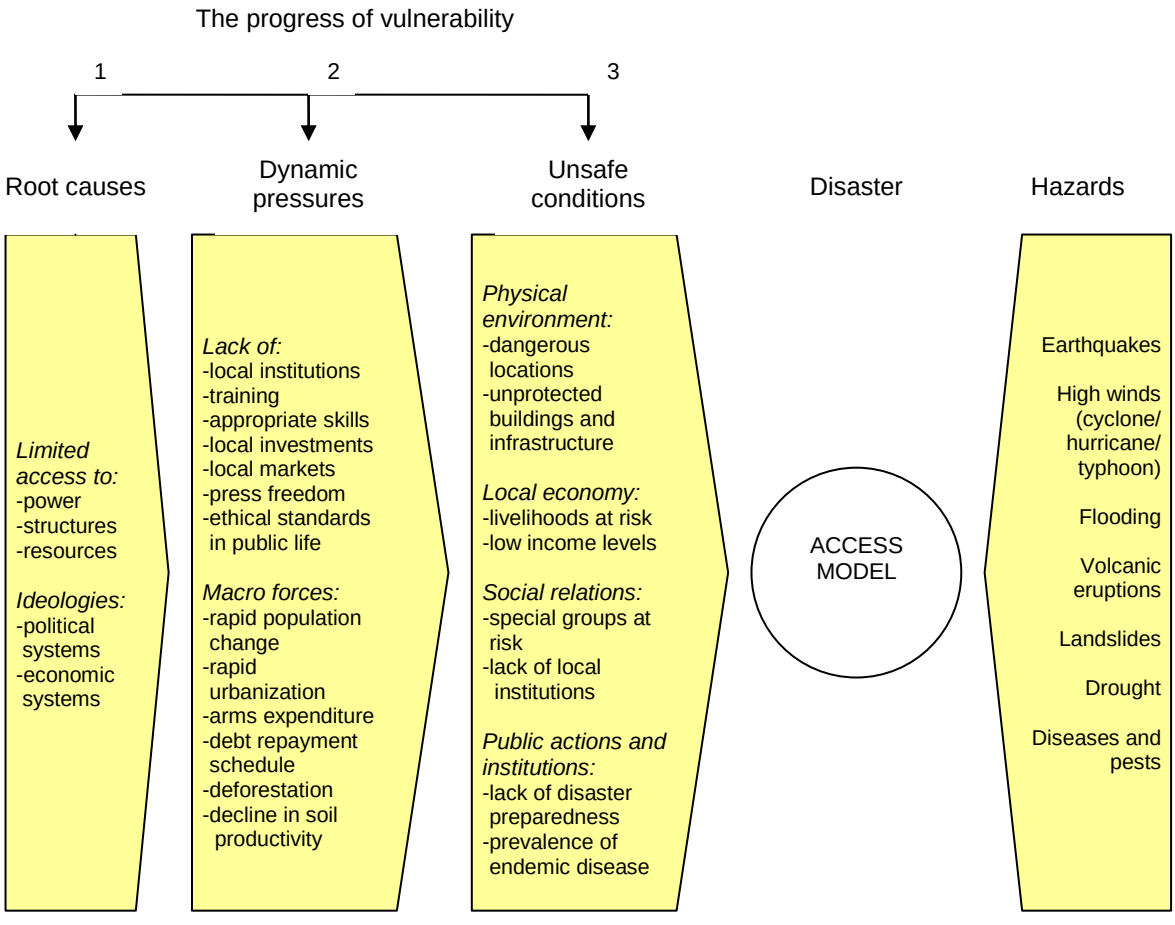
ANNEX 1: Theories on disaster risk

A1.1 Disaster release and pressure model

The PAR model explains vulnerability as a process that starts from what it calls *root causes*. These root causes, such as political or economical systems, establish a distribution of power within a society, which determines access to resources. Through a series of processes, called *dynamic pressures*, these root causes can be channelled and transformed into *unsafe conditions*. The entire process from root causes, through dynamic pressures into unsafe conditions is called the *progress of vulnerability*. Disasters occur when unsafe conditions are combined with physical exposure to hazards. Figure A1.1 summarises this model).

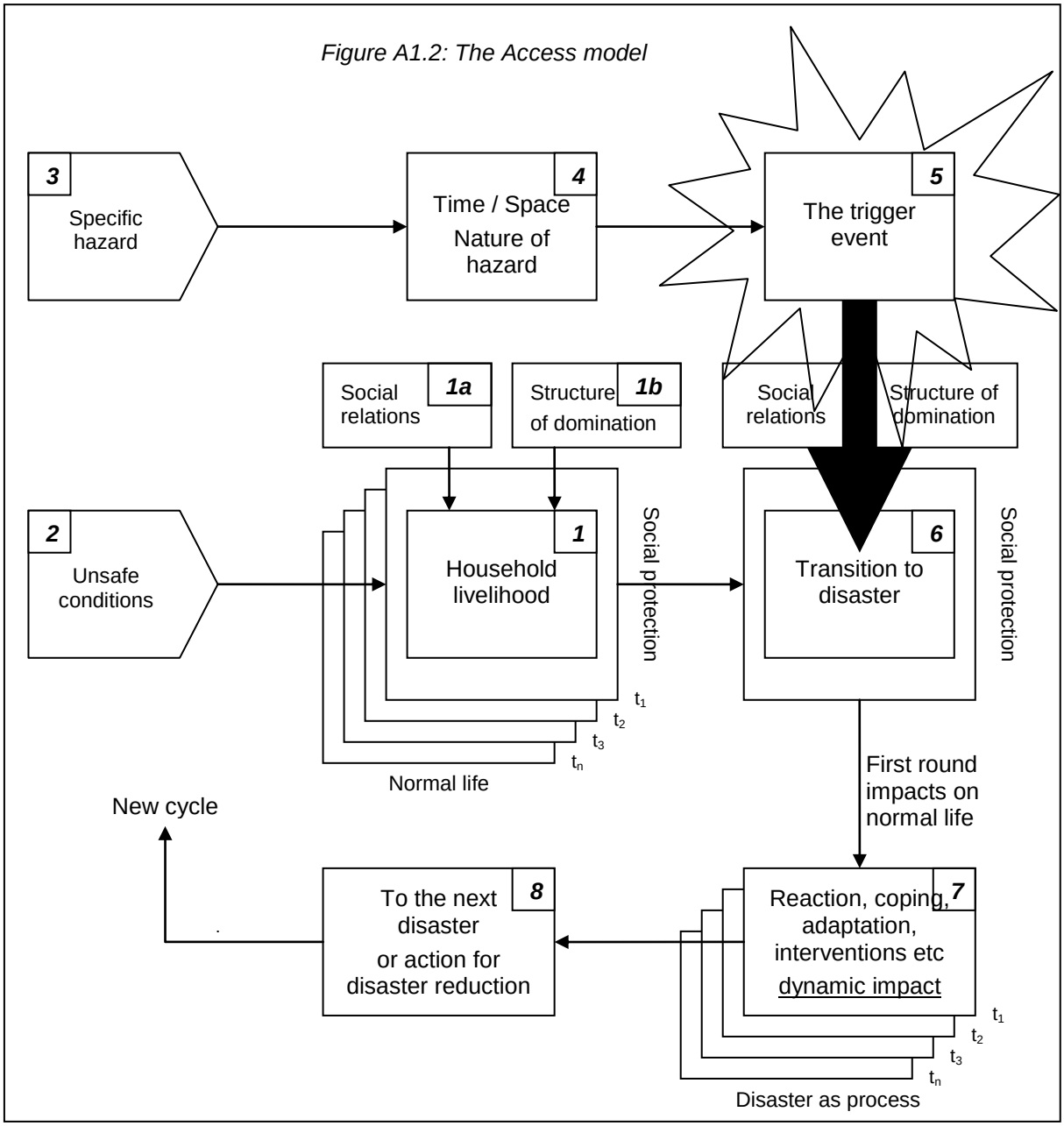
Figure A1.1: The disaster pressure and release model (PAR-model)



A1.2 The Access model

The Access model analyses how differences in access to political or economic resources influence households' capacities to cope with disasters. The model is summarised in figure A1.2.

Figure A1.2: The Access model



Box 1 shows the normal life of households, whose choice of a specific livelihood is limited by the unsafe conditions (box 2) and influenced by the household's social relations (box 1a) and surrounding structures of domination (box 1b). During normal times households create a form of defence structure, referred to here as *social protection* to save their livelihoods from disruptions. Social protection manifests itself as an individual repeating process (expressed as t_1, t_2, t_3 and t_n); but it can also be collective or operate at public level and can be expressed as "*the presence (or absence) of hazard precautions and preparedness that is provided by the state or local collective action*"[10].

Hazards (box 3) have both spatial and temporal dimensions (box 4) that can often hinge around a *trigger event* (box 5). Hazards may occur with little warning, as with an earthquake, or slowly as in the case of a drought. In box 6 the event hits the households, having different effects depending on their level of *social protection.* If this is low the event can turn into a disaster. The impacts of the disaster impacts and the household's responses to them are iterative for a period of time (box 7). After this period the households have the choice of either passively waiting for the next disaster or to strengthen

[10] Wisner. B et al.: "At risk, second edition: natural hazards, people's vulnerability and disasters", 2003, page 90

their capacities and social protection in preparation (box 8). Changed vulnerability, social relations and domination structures all play a potentially significant role in this process.

Improved access to resources is the key mechanism through which households can improve their livelihoods, make them sustainable, increase their resilience against shocks and the capacity to restore their livelihoods after a disaster.

A1.3 The Drought Cycle Management model

The Drought Cycle Management model (DCM model) is a practical refinement of the more general disaster risk theories.

> *"Drought Cycle Management attempts to reduce communities' vulnerability to drought, in order to strengthen their livelihoods – rather that merely responding to disasters after they occur."*
> Source: "Drought cycle management: a toolkit for the drylands of the Greater Horn", CORDAID, 2004, page 4

The DCM model stresses the need for a continuum between development, relief and rehabilitation activities in ASALs. The model recognises four stages in the drought cycle as depicted in figure A1.3.

Figure A1.3: The DCM model

The **normal stage** is a period in which sufficient rain falls. During this stage mitigation activities, such as community development, contingency planning, capacity building and infrastructural development, take place.

The second stage is the **alert and alarm stage**. This is stage when the first signs of a forthcoming drought become visible. During this period activities will be focused on preparing for the drought. These might include building up food strategic stocks, water conservation measures, preparing human health and veterinary services and supplementary feeding of livestock.

In the **relief stage** the drought is at its peak causing food and water shortages and resulting in hunger and possibly deaths among people and livestock. Emergency relief is delivered in order to save lives.

Finally, after the emergency, **the recovery stage** involves reconstruction. Typical measures include the restocking of herds, rehabilitation of dams, capacity building, infrastructural development and natural resource management interventions.

ANNEX 2: Questionnaire from the household survey

Part I	***Household Characteristics***			
Q1.1	Area of residence	Garissa	1	
		Wajir	2	
		Samburu	3	
		Marsabit	4	
Q1.2	Geographical location	Division		
		Location		
		Sub-location		
		Village (Ola)		
Q1.3	Sex of respondent	Male	1	
		Female	2	
Q1.4	Are you the head of household (nuclear family)?	Yes	1	
		No	2	
Q1.5	If not the head, what is your relation with the head of the household?	Spouse	1	
		Son	2	
		Daughter	3	
		Relative	4	
		Other	5	
Q1.6	Marital status	Single	1	
		Married-Monogamous	2	
		Married-Polygamous	3	
		Divorced/separated	4	
		Widowed	5	
Q1.7	Age in years	Age of respondent		
		household head		
Q1.8	Ethnicity	Tribe		
		Clan		
		Sub-clan		
Q1.9	Level of education of household head	None	1	
		Primary school	2	
		Secondary school	3	
		Post secondary	4	
1.10	Household size		Male	Female
		0 - 5 years		
		6 - 18 years		
		18-55 years		
		> 55 years		
Q1.11	Number of children in schooling		Boys	Girls
		Primary (Std 1-8)		
		Secondary		
		Post secondary		
Q1.12	Number of economically active members living in household		Male	Female
		Unpaid family worker		

		Self-employed/small-scale business		
		Wage Employment		
		Other (specify)		
Q1.13	Number of economically inactive members living in the household		Male	Female
		Too young		
		Too old		
		Sick		
		Disabled		
		Other (specify)		
Q1.14	Number of members living outside sub-location (migrated, working etc)		Male	Female
		Within the district		
		Within the Province		
		Elsewhere in Kenya		
		Outside Kenya		
Q1.15	Type of house	Semi-permanent (mud wall/tin roof)	1	
		Semi-permanent (mud wall/grass roof)	2	
		Temporary (grass wall and roof)	3	
Q1.16	Household assets (more than one answer allowed)	Radio	1	
		Television	2	
		Bicycle	3	
		Mobile phone	4	
		Water tanks	5	
		Donkey cart	6	

Part II	***Socio-economic characteristics***		
Q2.1	What is the key source of livelihood for the household? (only one answer allowed)	Pastoralism	1
		Agropastoralism	2
		Small scale business	3
		Wage employment	4
Q2.2	What are the major constraints to your family well-being?	Drought/famine	1
		Floods	2
		Human diseases	3
		Livestock diseases	4
		Conflicts/insecurity	5
		Poverty	6
		Other (specify)	7
Q2.3	What types of livestock do you keep? On average (over the past 5 years), what is the size of your stock?		Number
		Cattle – Bulls	
		Cows	
		Sheep	
		Goats	
		Camels	
		Donkeys	
		Poultry	
Q2.4	What problems do you usually encounter with regard to livestock keeping? Tick where appropriate	Livestock diseases	
		Water and pasture shortages	
		Lack of market	

		Livestock rustling		
		Conflicts/insecurity		
Q2.5	What measures have you put in place to address the above mentioned problems? Tick where appropriate	Migration in search of pasture and water		
		Restocking through traditional systems		
		Use of traditional herbal treatment		
		Accessing livestock veterinary services		
		Sale of animals during drought		
Q2.6	What is the main source of water for the livestock? Tick where appropriate	River/spring/stream		
		Water pans or dams		
		Wells/Boreholes		
		Rock catchment		
		Piped water		
Q2.7	Is the water source constant or seasonal?	Constant supply (1) Seasonal (2)		
Q2.8	Who manages the water source? Tick where appropriate	No management		
		Individually owned		
		community		
		Other (specify)		
Q2.9	How do you contribute to the maintenance of the water source? Tick where appropriate	Does not contribute anything		
		Contributes set fee		
		Contributes in case of a break down		
		Contributes manual labour when required		
		Contributes local materials when required		
Q2.10	How many animals have you sold in the last year?		Number	
		Cattle – Bulls		
		Cows		
		Sheep		
		Goats		
		Camels		
		Donkeys		
		Poultry		
Q2.11	Why did you sell the animals?	Income generation		
		Sale during drought		
		Restocking		
Q2.12	How many animals did you receive/give as gifts last year?		Receive	Give
		Cattle – Bulls		
		Cows		
		Sheep		
		Goats		
		Camels		
		Donkeys		
		Poultry		
Q2.13	How many animals did you loose due to disease last year?		Number	
		Cattle – Bulls		

		Cows		
		Sheep		
		Goats		
		Camels		
		Donkeys		
		Poultry		
Q2.14	How many animals did you lose due to drought last year?		Number	
		Cattle – Bulls		
		Cows		
		Sheep		
		Goats		
		Camels		
		Donkeys		
		Poultry		
Q2.15	If an agro-pastoralist, what type of crops do you grow? What was the maximum yield over the past 5 years assuming normal rains? How much did you sell, if any?		Yield (90 kg bags)	Sales over last one year
		Maize		
		Sorghum		
		Beans		
		Other (specify)		
Q2.16	Looking at the same types of crops, how much would you be able to harvest with limited rainfall?		Yield (90 kg bags)	
		Maize		
		Sorghum		
		Beans		
		Other (specify)		
Q2.17	Farming land area in acres	None	1	
		< 1 acre	2	
		1-5 acres	3	
		> 5 acres	4	
	Ownership of farming land	Individually owned	1	
		Communally owned	2	
		Rented	3	
		Temporary loan	4	
		Other (specify)	5	
Q2.18	Is the land under irrigation? If no, indicate source of water?	Yes	1	
		No	2	
Q2.19	If employed or running a business, on average, how much income do you get in a month?			

Part III	***Perception of drought***		
Q3.1	What is your understanding of drought?		
Q3.2	What causes droughts? Tick where appropriate	Amount of rainfall	
		Seasonality of rainfall	
		Duration of rainfall	

		Change in soil type	
		Change in vegetation (e.g. deforestation)	
Q3.3	What are the effects of drought? Tick where appropriate	Drying of water sources	
		Famine	
		Crop failures	
		Loss of livestock	
		Poor health of humans	
		Poor health of animals	
		Increase in food prices	
		Decline in livestock prices	
Q3.4	How does drought impact on your livelihood?		
Q3.5	How do you get the information on weather forecasts?	Radio/TV	1
		Extension agent	2
		Word of mouth	3
		Traditional sources	4
		Other (specify)	5
Q3.6	How do you form your own weather forecast?		
Q3.7	How do you respond to weather forecasts?		

Part IV	***Household Coping Mechanisms***		
Q4.1	What measures do you put in place to safeguard yourself against a coming drought?	spatial diversification of fields	1
		livestock diversification	2
		livestock management adjustments (changes in feed, water, grazing land use)	3
		access to extension services for knowledge of livestock farming during droughts	4
		income diversification	5
		livestock insurance	6
		use of savings	7
Q4.2	Considering the source of livelihood in 2.1, do you seek additional sources of income when anticipating drought? Yes (1) No (2)		
	If yes, which are these additional sources of income?	Sale of assets	1
		Seeking employment	2
		Starting a business	3
Q4.3	Do you reserve water for use during the drought? Yes (1) No (2)		
Q4.4	Do you reserve pasture for use during the drought? Yes (1) No (2)		
Q4.5	What is the main source of water and	Relief supplies	1

	pasture/hay for the household during the drought season? (more than one answer allowed)	Use reserve	2
		Buy hay from suppliers	3
		Take livestock to rented grazing land	4
		Migrate livestock within district	5
		Migrate livestock outside district	6
		Other (specify)	7
Q4.6	In case of drought, which animals would you rather have?		Yes (1) /No (2)
		Cattle - Bulls	
		Cows	
		Sheep	
		Goats	
		Camels	
		Donkeys	
		Poultry	
Q4.7	During drought, what adjustments do you make in terms of food consumption? How do you cope with food shortages?	Depleting food and cash savings	1
		Earning more wage income	2
		Credit/ Borrowing	3
		Liquidating productive assets (livestock, land, farm tools and building)	4
		Liquidating other assets (gold, ornaments, and jewellery)	5
		Household food consumption adjustments	6
		Relying on charity	7
		Use of social network	8
		Permanent or seasonal migration	9
		Village-level institutions	10
		Off-farm employment	11
		Household expenditure adjustments (clothes, education and health)	12
		Relying on publicly sponsored relief programs	13
Q4.8	What are the practises for using and conserving natural resources such as pasture, forests, water etc?	Having drought reserve grazing	1
		Protection of specific plant species or areas	2
		Having individual or communal user rights for water/grazing points	3
		Other (specify)	4
Q4.9	If the drought was severe, would you migrate your family out of the pastoral livelihood? Yes (1) No (2)		
Q4.10	What livelihood options do you have, apart from pastoralism?	Farming	1
		Wage employment	2
		Small scale business	3

Q4.11	Did you sell any other household assets?		Yes (1) /No (2)	If yes, how much?
		Radio		
		Television		
		Bicycle		
		Mobile phone		
		Water tanks		
		Donkey cart		
		Jewellery		
		Farm implement		
		Other (specify)		
	What was the main reason for selling the assets?	Buying food	1	
		Buying clothing	2	
		Paying for healthcare	3	
		Paying for the farm	4	
		Transport expenses	5	
		To fund cultural ceremonies e.g. marriages	6	
		Other (specify)	7	
Q4.12	Did you borrow any money in the last one year? If so, how much?		Yes (1) /No (2)	How much?
		Bank		
		Co-operative/SACCO		
		Family/friends		
		Other (specify)		
Q4.13	What was the major reason for borrowing the money?	Buying food	1	
		Buying clothing	2	
		Paying for healthcare	3	
		Paying for the farm	4	
		Transport expenses	5	
		To fund cultural ceremonies e.g. marriages	6	
		Other (specify)	7	
Q4.14	What type of support do you get from the following: (Circle where appropriate)	Government agencies	(1) Information (2) Provision of social services (3) Emergency aid (4) Development aid (5) Financial assistance i.e. loans and grants (6) Advocacy assistance	

		NGOs	(1) Information (2) Provision of social services (3) Emergency aid (4) Development aid (5) Financial assistance i.e. loans and grants (6) Advocacy assistance
		Religious organizations	(1) Information (2) Provision of social services (3) Emergency aid (4) Development aid (5) Financial assistance i.e. loans and grants (6) Advocacy assistance

ANNEX 3: Modelling disaster risk

A3.1 Relation between hazard, vulnerability, coping capacity and risk

The relations between disaster risk and various types of hazard impact can be summarised in a set of equations:

$$(E.1) \quad D \equiv I_H$$

$$(E.2) \quad I_H = I_{Hsoc} + I_{Hecon} + I_{Hdem} + I_{Henviron}$$

$$(E.3) \quad R = P(I_H)$$

where,

D	=	disaster
I_H	=	total impact of hazard
I_{Hdem}	=	impact of hazard on demography
I_{Hecon}	=	impact of hazard on economy
$I_{Henviron}$	=	impact of hazard on environment
I_{Hsoc}	=	impact of hazard on social structures
R	=	disaster risk

The following definitions are applied:

risk[11]	The probability of harmful consequences, or expected loss (of lives, people injured, property, livelihoods, economic activity disrupted or environment damaged) resulting from interactions between natural and/or human induced hazards and vulnerable/capable conditions.
hazard[12]	A potentially damaging physical event, phenomenon or human activity that may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation.
disaster[7]	A serious disruption of the functioning of a community or a society causing widespread human, material, economic or environmental losses which exceed the ability of the affected community or society to cope using its own resources.

Equation *E.1* represents the identity between a disaster (D) and the negative impact of a hazard (I_H). The negative impact (equation *E.*2) consists of four components: the social (I_{Hsoc}), economic (I_{Hecon}), demographic (I_{Hdem}) and environmental ($I_{Henviron}$) impacts. The negative impact of a hazard is also influenced by the hazard itself (H), the vulnerability (V) of the population and their coping capacity (C). Disaster risk (R) is defined in equation *E.3* as the probability of a hazard leading to serious disruption.

While the definitions given above are all widely accepted there is, however, no uniform definition of vulnerability. The extensive literature on this subject approaches the issue of vulnerability in various ways. Vallagrán de León[13] argues that the vulnerability theories can be classified in two groups, depending on the definition of coping.

Coping can be considered as an *ex post* disaster activity which implies that coping capacities do not effect vulnerability. For this point of view the equation for disaster risk can be defined as in *E.4a.*

[11] UNISDR : "Living with risk", 2002, page 41

[12] UNISDR (http://www.unisdr.org/eng/library/lib-terminology-eng percent20home.htm)

[13] Juan Carlos Villagrán De León: "Vulnerability: a conceptual and methodological review", 2006, page 49/50

(*E*.4*a*) $R = f\left\{H, V, \frac{1}{C_{EP}}\right\}$

(*E*.5) $V = f\{F_{GV}, F_{EV}\}$

where

C_{EP} = *ex-post* disaster coping capacity of affected population
F_{GV} = factors generating vulnerability
F_{EV} = factors enhancing vulnerability
H = (magnitude of the) hazard
R = total impact hazard
V = vulnerability of the affected population

Other parts of the literature argue that coping is related to both *ex ante* and *ex post* disaster action. Two types of *ex ante* disaster coping capacities can be distinguished: [1] coping capacities that reduce vulnerability, and [2] coping capacities aimed at containing the possible impacts of a hazard. This definition leads to a redefinition of impact of a hazard, as shown in equation *E.4b* and *E.5*.

(*E*.4*b*) $R = f\left\{H, V, \frac{1}{C_{EA}{}^{C}}, \frac{1}{C_{EP}}\right\}$

(*E*.5) $V = f\left\{F_{GV}, F_{EV}, \frac{1}{C_{EA}{}^{V}}\right\}$

where

$C_{EA}{}^{C}$ = *ex ante* disaster coping capacity aimed at containment
$C_{EA}{}^{V}$ = *ex ante* disaster coping capacity aimed at vulnerability reduction
C_{EP} = *ex post* disaster coping capacity of the affected population
F_{GV} = factors generating vulnerability
F_{EV} = factors enhancing vulnerability
H = (magnitude of the) hazard
I_H = total impact hazard
V = vulnerability of the affected population

A3.2 The PROBIT model

Based upon the proxies defined in chapter 3, an econometric model (PROBIT) was developed and estimated. The model tested was derived from set of equations (*E.1*, *E.2*, *E.3*, *E.4a* and *E.5*) presented in the previous section.

The impact of drought of household-level food consumption I_H^h , represents the dependent variable. This variable was approximated by the four coping strategies, discussed in chapter 3.

The *ex-post* coping capacity of households, C_{EP}^h , is an independent variable which can be approximated by such household characteristics, Y^h , such as asset ownership (in terms of size of herd, arable, irrigated or pasture land, access to water, access to loans and income), the proportion of economically active members, the household size, the proportion of females or dependent members (i.e., dependency ratio), the education of the economically active members or the household head or children, the gender and age of the household head.

Households may also take actions, Z^h , to prepare themselves against the adverse impacts of an expected hazard. These can include income diversification, crop or livestock diversification and

household-level drought preparedness (this can be measured by assessing households' water reserve capacity, water use patterns and their attitudes towards using common pastures and water reserves). These actions strengthen *ex-ante* household coping capacity, C_{EA}^{h} , which represents a second independent variable. It should be noted that the set of *ex-ante* coping mechanisms available to a household can also affect the *ex-post* coping mechanisms. In the estimation of the model we took additional care to control the effects of any possible relationship between *ex-ante* and *ex-post* coping mechanisms on the impact of a hazard, since the existence of such a relationship would violate one of the assumptions underlying the econometric estimation.

Vulnerability is a multiple compound factor that is a combination of the effects of resource availability, and the social, economic and institutional development of the affected district. Drought and vulnerability (defined at district level) are exogenous variables to households.

Given the assumptions and definitions, the full model can be defined as:

$$(E.6) \quad I_H^h = h(C_{EP}^h, C_{EA}^h; V^d, H^d)$$

$$(E.7a) \quad C_{EP}^h = c(Y^h)$$

$$(E.7b) \quad C_{EA}^h = c(Z^h)$$

$$(E.7c) \quad V^d = v(X^d)$$

So, the full model to be estimated is then:

$$(E.8) \quad I_H^h = h(c(Y^h), c(Z^h); v(X^d), H^d) + e^h$$

where

$\ldots^h$	=	household level
$\ldots^d$	=	district level
$c(Y^h)$	=	proxy for *ex ante* household level coping capacity
$c(Z^h)$	=	proxy for *ex post* household level coping capacity
$v(X^d)$	=	proxy for district level vulnerability
e^h	=	independently and identically distributed disturbance term

As explained in chapter 3, we used 4 different dependent variables and estimate the PROBIT model separately for each variable. The first dependent variable is an indicator variable, with a value of 1 if a household opts for liquidating its productive assets and 0 otherwise. The second dependent variable has a value of 1 if a household opts to reduce its food consumption and 0 otherwise. The third dependent variable has a value of 1 if a household calls on community level facilities and 0 otherwise. Finally, the fourth dependent variable has a value of 1 if a household relies on aid from the government and/or NGOs and 0 otherwise.

A3.3 Stages of model estimations

In the first stage, the following PROBIT model was estimated:

$$(E.9) \quad I_H^h = h(Y^h, Z^h) + \varepsilon^h$$

where the dependent variable, I_H^h , is a dichotomous indicator variable, with a value of 1 or 0. The estimation identifies the critical socio-economic and demographic determinants of household coping capacity, Y^h and Z^h ,. The estimated dependent variable $P(I_H^h)$ represents a household-specific probability (or risk) of a food consumption deficit: $R_i^h = P_i(I_H^h)$ where i = {1, 2, 3, 4}, implies the

existence of 4 different risk levels, depending on the model estimated, i.e., $R_1^h, R_2^h, R_3^h, R_4^h$. These risk levels can be ordered to identify the most and the least risky strategy for household h[14].

In the second stage, the households are categorized into four groups depending on their individual risk (R_1^h): minimal risk group = [R_1^h <0.25], moderate risk group = [0.25< R_1^h <0.5], high risk group = [0.50< R_1^h <0.75] and severe risk group = [0.75 < R_1^h <1]. A tabular analysis was used to compare the household and socio-economic characteristics of each group, their perceptions of drought, and coping mechanisms.

Cross-tabulation cannot identify causality between the variables, but can be used as input for refining the model, and improving our understanding of the factors determining household coping strategies. These issues lay outside the scope of the study, but could profitably be the subject of further research. The results of the tabular analysis are available upon request.

[14] *For further explanation see ANNEX 2*

ANNEX 4: Understanding the PROBIT model

A4.1 PROBIT estimations

The household questionnaire provided information on households' strategies for coping with their food consumption deficit during drought. Out of 13 identified strategies, one specific strategy (option 4 in Q4.7 of the household survey) involved a household liquidating its productive assets when faced with a serious food shortage. This strategy was taken as the dependent, dichotomous, variable for the PROBIT model. It is given a value of 1 if a household opts for this strategy and 0 otherwise. It should be noted that a household can adopt more than one strategy.

The potential for simultaneously adopting multiple strategies led to some complications in the construction of dependent variables. To clarify this we use an illustration to explain how they were constructed. Question 4.7 in the household questionnaire asked what adjustments households make in terms of food consumption during a drought, or how they cope with food shortages. The answers provided information on 13 strategies, with one (strategy 4) involving a household selling its productive assets when faced with food shortage. An alternative dependent variable was constructed using strategies 3, 7, 8 and 10. This alternative will take on 1 if a household opts for any of the four strategies (3, 7, 8 and 10) and 0 otherwise. Another alternative would be to assign 1 if a household opts for strategy 6 and 0 otherwise. A further other alternative may be to assign 1 if a household opts for strategy 13 and 0 otherwise. Each one of these dichotomous dependent variables stresses the importance of different household coping strategies. The first dependent variable stresses the severity of food deficit; the second, the role of community services; the third, households' food consumption adjustment; and the fourth, the role of government and NGOs.

So far, we have not mentioned the complications arising from the multiplicity of strategies that might be implemented. A household is free to implement as many strategies as possible from the 13 identified. The survey showed that some households implement up to three strategies, but give priority to one or more of these. For example, a household may first implement strategy 4 when faced with food deficit, then may implement strategy 13 and then strategy 6. In this case these three variables can be constructed ranked in importance. The first variable would include the most important strategy implemented; the second variable would represent the second degree strategy implemented; and the third would represent the third degree strategy implemented. It is possible to construct four different dichotomous dependent variables by weighting the importance of each of these variables. However we have based our PROBIT estimations by taking the most important strategy variable, that is, the first strategy adopted by the household.

For further clarity, consider the data in table A2.1. The second column in table A2.1 shows the first degree coping strategy that a household says it implemented when faced with a food shortage. The third column constructs a dichotomous dependent variable using it: 1 if a household chooses strategy 4 and 0 otherwise. The fifth column constructs another dichotomous dependent variable using the 2nd degree coping strategies given in column 4: 1 if a household chooses strategy 4 and 0 otherwise. It should be stressed that a household's choice of coping strategy is given in the order of importance. Namely, in the second column of table A2.1 households declare only their 1st degree strategies; and in the fourth column they declare only their 2nd degree strategies. The PROBIT estimations performed in this report only employ the dependent variable based on the first degree strategies. Estimations have also been made using the 2nd degree coping strategies and the results are available upon request.

table A4.1: Creation of dichotomous dependent variables using option 4 in question 4.7

household	first degree strategy opted for	dependent variable first strategy	second degree strategy opted for	dependent variable second strategy
01	4	1	13	0
02	6	0	13	0
03	8	0	8	0
04	4	1	4	1
05	13	0	4	1
06	7	0	13	0
07	8	0	13	0
08	13	0	4	1
09	4	1	8	0
10	4	1	4	1

A4.2 Estimations and interpretation of the PROBIT model coefficients

A PROBIT model estimates four values:

- $\hat{\beta}$ = estimated PROBIT coefficient
- $\hat{\sigma}$ = standard deviation
- Z = z-scores
- P(Z>z) = the probability levels of significance

As mentioned in paragraph A3.3 the following model will be tested:

(*E*.9) $I_H^h = h(Y^h, Z^h) + \varepsilon^h$

In this model *h* is the estimated PROBIT coefficient ($\hat{\beta}$).

The PROBIT model estimates the probability of the model successfully identifying the dependent variable to be true when an independent variable changes. This is called the "probability of success".

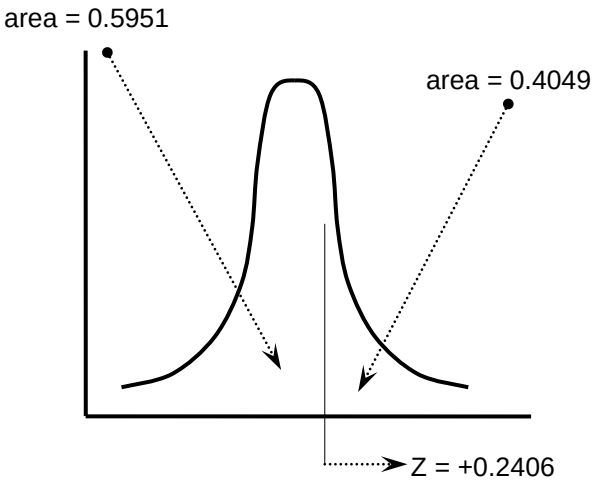
Example: the dependent variable is "liquidation of productive assets" as a household coping strategy and an independent variable "*ex-ante* livestock management measures" has a $\hat{\beta}$ of -1.24. This implies that when the independent variable "ex-ante livestock management measures" changes by 1, the "probability of success" decreases by 1.24. The "probability of success" refers to the likelihood of the PROBIT model successfully identifying "liquidation of productive assets" as a household coping strategy.

All the other coefficients should be interpreted in a similar fashion, although careful attention needs to be paid to the "Units of Measure" of these explanatory variables. Using the full PROBIT model given in table A3.1 (ANNEX 3), one can predict the probability of success as follows:

PROBIT (or Z-score) = 4.7 (constant) + 0.35 (sex head of household) – 0.50 (education head of household) – 0.48 (total assets owned) – 1.31 (individually land owned) + 0.59 (proportion non-active in household) – 0.002 (total animals owned last five year) – 0.0007 (income from employment or business) – 1.24 (ex-ante livestock / income management) – 0.27 (respond to weather forecast) + 0.78 (migration out of pastoralist areas) + 0.004 (animals died of disease last year) – 1.22 (water conservation)

When this PROBIT is evaluated at the mean values of each one of these explanatory variables, we will obtain an estimated probability, called the "Z-score". For illustrative purposes, suppose the Z-score

= +0.2406. This will then lead to dividing a standard normal curve into two parts corresponding to 0.5951 and 0.4049 as follows.



Given 215 households (215)*(0.5951) = 128, so the coping capacity of 128 households is expected to be classified correctly

One can also calculate Z-scores associated with individual explanatory variables. For example, in Table 2, the Z-score for "the *sex* of the *head of household*" is 1.38. This Z-score would divide the corresponding standard normal curve into two parts (as above) and can be used in the same manner as above to estimate the probability of success based on only (for example) "*sex head of household*". A Z-score of 1.38 implies that the area on the right hand side of the above curve would be 0.16853. The last column in Table 2 gives the significance levels. We assume that a variable is statistically significant if its associated P(Z>z) value is less than or equal to 0.1 or 0.05.

A4.3 Measurement and interpretation of marginal effects of explanatory variables

Having identified the significant variables, the next step is to calculate marginal effects of the explanatory variables in the PROBIT model. It should be stated from the outset that the estimated PROBIT coefficients, $\hat{\beta}$, do not represent marginal effects, which are nonlinear functions of the parameter estimates and the levels of the explanatory variables. As a result the marginal effects cannot generally be inferred directly from $\hat{\beta}$. Hence, it is necessary to adjust $\hat{\beta}$ to yield the true estimates of the marginal effects, that is, the change in predicted probability (risk) associated with changes in the explanatory variables. Measures of the marginal effects are calculated as:

$$(E.10) \quad ME_j = \frac{\delta P(y_i = 1)}{\delta \chi_{ji}} = \frac{\delta F(\beta_1 + \beta_2 \chi_{2i} + \beta_3 \chi_{3i} + \beta_k \chi_{ki})}{\delta \chi_{ji}}$$

where *F* is the CDF (Cumulative Distribution Function) of a standard normal random variable:

$$(E.11) \quad F = F'(\beta_1 + \beta_2 \chi_{2i} + \beta_3 \chi_{3i} + \cdots + \beta_k \chi_{ki})\beta_j$$

ME_j represents the effect of one unit change in the explanatory variable $\delta \chi_{ji}$ on the predicted probability $P(y_i = 1)$ where $P(y_i = 1)$ $y_i =$ a specific household coping strategy. $F(c)$ is an assumed cumulative distribution of a standard normal random variable. $f(c) = F'(c)$ defines the probability density function of a standard normal random variable. Hence, $ME_j = f(c)\beta_j$ where β_j is the j[th] estimated coefficient in the PROBIT model and $c \equiv \beta_1 + \beta_2 x_{2i} + ... + \beta_k x_{ki}$.

The estimated coefficients in the tables of ANNEX 3 are multiplied by 0.399 to calculate the desired marginal effects at means and their standard deviations[15]. The results are presented in the last two columns of the tables in ANNEX 3.

Referring to the example in paragraph A2.2, the marginal effect of the coping capacity "*ex-ante* livestock management" is equal to -0.50. This means that the probability of a household liquidating its productive assets as a coping strategy in order to meet its food shortage during a drought decreases by 50 percent when this coping capacity increases with one unit, when all else is held constant.

[15] *For the derivation of the adjustment coefficient 0.399, see S. Anderson and G.R. Novell, "Simplified marginal effects in discrete choice models" in Economics Letters 81, 2003, page 321-326.*

ANNEX 5: Independent variables of the PROBIT model

Table A5.1: Types of coping capacity significantly correlated with one of coping strategies

agehhd	age of household head
animals	total number of animals owned during last 5 yrs
assetso	individually owned assets
borrow	borrowed money last year: 1=yes, 0=no
childschool	total number of children in school
disease	total number of animals lost from disease last year
dvi	district vulnerability index
income	income from iemplyment or business
landown	create a binary variable "landown": 1=individually owned, 0=not owned
migration	migrate if drought is severe: 1=yes, 0=no
propNonact	nonact/hhsize; proportion of Non-active HH members
respond	how do you respond to whether forecast: 1=no response, 2=sell weak stock, 3=migrate in search of water/pasture, 4=slaughter weak animals, 5=reserve water, 6=seek veterinary services create a dichotomous variable "respond to drought": 0=no response (option 1)", 1=response (options 2-6)
safegd	ex-ante measures taken against an expected drought: 1=spatial diversification, 2=livestock diversification, 3=livestock mngt adjust, 4=access to extension services, 5=income diversification, 6=livestock insurance, 7=use of savings, 8=do nothing, 999=not available "safegd" is transformed into a dichotomous variable: 1 if diversification takes place (options 1, 2,
sex	sex of the respondent: 1=male, 2=female
waterconv	sources of water and pasture during drought: 1=Relief supplies, 2=Use reserve, 3=Buy hay, 4=move to hired ranches,district, 5=migrate livestock within district, 6=migrate livestock outside district, 999=Not available water conservation: 1=yes, 0=no

Table A5.1: Types of coping capacity insignificantly correlated with one of coping strategies

borrowsource	source of borrowing: 1=bank, 2=cooperatives, 3=friends, 999=did not borrow
contwatermngt	create a binary variable "contwatermngt": 0=no contribution, 1=some contribution. original variable "CONTRBTN" is 1=no contribution, 2=fixed fee, 3 through 5 = when needed
drought	total number of animals lost during drought last year
education	create a binary variable "education of the HH head": 0=no education, 1=some education
hhsize	total number of household members
livelihood	create a binary variable "livelihood": 1=pastoralist or agro-pastoralist, 0=non-pastoralist. original variable "LIVELHD" is 1=pastoralist, 2=agropastoralist, 3=small scale business, 4=wage employment, 5=Fishing
livelihoodoptions	livelihood options: 1=farming, 2=wage, 3=small business, 4=none
pasture	pasture land reservation: 1=yes, 0=no
practices	a dichotomous variable "practices": 1=having drought reserve grazing, 0=otherwise
sale	total number of the liquidated animals last year
watermngt	who manages water supply: 1=Nobody, 2=Individually, 3=Community, 999=Not available
watersupply	what is the main source of water: 1=river/spring/stream, 2=water pans/dams, 3=wells/boreholes, 4=rock catchment, 5=piped water, 06=water relief, 999=not available is water seasonal or constant: 1=constant, 2=seasonal

ANNEX 6: PROBIT estimations

All simulations for each per model are presented in the tables below. Where

- $\hat{\beta}$ = estimated PROBIT coefficient
- $\hat{\sigma}$ = standard deviation
- Z = z-scores
- P(Z>z) = the probability levels of significance
- dF/dx = marginal effect
- $\hat{\sigma}_a$ = adjusted standard deviation

All models are statistically significant implied by the Likelihood Ratio Statistic and Pseudo Chi Square of the four models.

Table A6.1: Model 1 – liquidation of productive assets as the dependent variable

independent variable	$\hat{\beta}$	$\hat{\sigma}$	z	P([Z] > [z])	dF/dx	$\hat{\sigma}_a$
constant	4.6611	1.7667	2.6384	0.0083	1.8640	0.7049
sex head of household	0.3546	0.2575	1.3769	0.1685	0.1418	0.1027
education head of household	-0.5045	0.3609	-1.3977	0.1622	-0.2017	0.1440
total assets owned	-0.4789	0.1528	-3.1336	0.0017	-0.1915	0.0610
individually land owned	-1.3099	0.7337	-1.7854	0.0742	-0.5238	0.2927
proportion non-active in household	0.5943	0.3031	1.9606	0.0499	0.2377	0.1210
total animals owned last five year	-0.0024	0.0008	-2.9160	0.0035	-0.0010	0.0003
income from emploment or business	-0.0007	0.0003	-2.6994	0.0069	-0.0003	0.0001
ex-ante livestock / income management	-1.2418	0.3222	-3.8542	0.0001	-0.4966	0.1286
respond to weather forecast	-0.2711	0.2413	-1.1234	0.2613	-0.1084	0.0963
migration out of pastoralist areas	0.7822	0.2479	3.1551	0.0016	0.3128	0.0989
animals died of desease last year	0.0036	0.0019	1.8556	0.0635	0.0014	0.0008
water reservation	-1.2182	0.4957	-2.4575	0.0140	-0.4872	0.1978

PearsonChiSquare	*185.5530*
LikelihoodRatioIndex	*0.4014*
LikelihoodRatioStatistic	*119.6430*
LogLikelihood	*-89.2054*
AIC	*204.4110*
BIC	*248.2290*

Table A6.2: Model 2 – food consumption adjustment as the dependent variable

independent variable	$\hat{\beta}$	$\hat{\sigma}$	z	P([Z] > [z])	dF/dx	$\hat{\sigma}_\alpha$
constant	-0.6374	1.5742	-0.4049	0.6855	-0.2549	0.6281
sex head of household	-0.2850	0.2434	-1.1709	0.2416	-0.1140	0.0971
age head of household	-0.0144	0.0074	-1.9472	0.0515	-0.0058	0.0030
total assets owned	0.1777	0.1255	1.4164	0.1567	0.0711	0.0501
size of farm land in acres	-0.5890	0.2491	-2.3643	0.0181	-0.2355	0.0994
individually land owned	-1.2383	0.8497	-1.4573	0.1450	-0.4952	0.3390
proportion non-active in household	-0.5559	0.2918	-1.9053	0.0567	-0.2223	0.1164
total animals owned last five year	0.0020	0.0006	3.2437	0.0012	0.0008	0.0002
income from emploment or business	0.0001	0.0000	2.5001	0.0124	0.0000	0.0000
ex-ante livestock / income management	0.4899	0.2521	1.9437	0.0519	0.1959	0.1006
respond to weather forecast	0.5422	0.2216	2.4472	0.0144	0.2168	0.0884
migration out of pastoralist areas	-0.6051	0.2297	-2.6341	0.0084	-0.2420	0.0917
water reservation	-0.9624	0.4961	-1.9401	0.0524	-0.3849	0.1979
borrowed money last year	-0.6183	0.3147	-1.9646	0.0495	-0.8650	0.4403

PearsonChiSquare	*201.2100*
LikelihoodRatioIndex	*0.3052*
LikelihoodRatioStatistic	*90.9581*
LogLikelihood	*-103.5480*
AIC	*235.0950*
BIC	*282.2840*

Table A6.3: Model 3 – calling on community level facilities as the dependent variable

independent variable	$\hat{\beta}$	$\hat{\sigma}$	z	P([Z] > [z])	dF/dx	$\hat{\sigma}_\alpha$
constant	-6.5804	2.2709	-2.8977	0.0038	-2.6315	0.9061
district vulnerability index	0.8665	0.3357	2.5809	0.0099	0.3465	0.1340
sex head of household	0.6012	0.2970	2.0242	0.0429	0.2404	0.1185
education head of household	0.5936	0.3631	1.6351	0.1020	0.2374	0.1449
total assets owned	0.3057	0.1857	1.6459	0.0998	0.1223	0.0741
ex-ante livestock / income management	0.6436	0.3115	2.0662	0.0388	0.2574	0.1243
respond to weather forecast	-0.3000	0.3005	-0.9984	0.3181	-0.1200	0.1199
total children going to school	0.1285	0.0575	2.2371	0.0253	0.0514	0.0229
seasonal or constant water	-0.2612	0.2554	-1.0225	0.3065	-0.1044	0.1019
borrowed money last year	0.9286	0.3435	2.7035	0.0069	0.3713	0.1370

PearsonChiSquare	*146.9530*
LikelihoodRatioIndex	*0.6732*
LikelihoodRatioStatistic	*200.6400*
LogLikelihood	*-48.7068*
AIC	*117.4140*
BIC	*151.1200*

Table A6.4: Model 4 – reliance on emergency relief as the dependent variable

independent variable	$\hat{\beta}$	$\hat{\sigma}$	z	P([Z] > [z])	dF/dx	$\hat{\sigma}_{\alpha}$
constant	-3.4980	1.6281	-2.1485	0.0317	-1.3988	0.6496
district vulnerability index	-1.1567	0.2649	-4.3657	0.0000	-0.4626	0.1057
education head of household	0.4847	0.2926	1.6563	0.0977	0.1938	0.1168
total assets owned	0.2885	0.1292	2.2328	0.0256	0.1154	0.0516
size of farm land in acres	0.2471	0.1883	1.3123	0.1894	0.0988	0.0751
individually land owned	-0.4660	0.5025	-0.9274	0.3537	-0.1864	0.2005
proportion non-active in household	-0.3118	0.2879	-1.0830	0.2788	-0.1247	0.1149
total animals owned last five year	0.0011	0.0006	1.8519	0.0640	0.0004	0.0002
income from emploment or business	0.0000	0.0000	1.3063	0.1915	0.0000	0.0000
ex-ante livestock / income management	0.1582	0.2423	0.6529	0.5138	0.0633	0.0967
respond to weather forecast	0.5222	0.2165	2.4114	0.0159	0.2088	0.0864
migration out of pastoralist areas	-0.2207	0.2331	-0.9469	0.3437	-0.0883	0.0930
contribution to water management	0.2512	0.2355	1.0667	0.2861	0.1005	0.0940
borrowed money last year	-0.7854	0.2876	-2.7312	0.0063	-1.0988	0.4023

PearsonChiSquare	*223.8200*
LikelihoodRatioIndex	*0.2676*
LikelihoodRatioStatistic	*79.7600*
LogLikelihood	*-109.1470*
AIC	*246.2930*
BIC	*293.4820*