Mapping hotspots of risk in the COMESA region

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1. Introduction

The socio-economic condition in most COMESA countries, and the whole of Sub-Saharan Africa for that matter, is characterised by persistent high poverty levels and low food security. This is further compounded by the susceptibility of agriculture to climatic variability and other hazards as well as the vulnerability of impoverished and malnourished households to HIV/AIDS, market shocks and prolonged violent conflict. One of the biggest challenges governments in Africa face, with notably few exceptions, is the lack of sufficient financial and human resources to undertake the required action when disaster arises. This starts from the inability to address the underlying causes of disasters, including recurrent poverty that stifles household resilience (NEPAD, 2007).

In response to these challenges, the African Heads of State and Government have endorsed the Comprehensive Africa Agricultural Development Programme (CAADP) as a framework for the restoration of agricultural growth, food security, and rural development in Africa. Agricultural growth is at the centre of the CAADP agenda. This sustainable growth agenda must at the same time ensure that the marginalized are the ultimate beneficiaries of growth and are not further marginalized by rapid development. It is therefore crucial that the growth agenda includes a special focus on those who may not be the immediate beneficiaries of agricultural growth but whose immediate needs to address hunger and malnutrition require urgent and immediate attention and assistance.

The mapping of hotspots of risk in the COMESA region fits in a research program that aims at a richer understanding of the sources and consequences of vulnerability, how they differ across space and endowments, and the channels by which they stunt individual welfare and community economic development. This study builds on the recently published work of Thornton et al. “Mapping climate vulnerability and poverty in Africa” (ILRI, 2006), but focuses more rigorously on the risk component of the vulnerability framework. Its main result is the mapping and characterisation of risk hotspots in the COMESA region.

The generation of socio-economic profiles of geographical areas and communities, including their risk profile, is very valuable when response measures are considered (NEPAD, 2007). Given the recurrence of certain types of disasters (floods and droughts) it makes even more sense to generate risk maps of the most prevalent shocks and stresses and their potential impact on communities. Maps and risk assessment reports that show the geographical areas and vulnerable population groups most likely to be affected are essential baseline information.

The purpose of this study is therefore twofold. On one hand, it is providing policy makers with a collation of baseline information on risks and vulnerability in the COMESA region (type of shocks and stresses, and population groups and geographical areas most affected by them). Hotspots of risk exposure to different types of risks, as well as compounded risks are mapped. The presented maps, tables and graphs can inform policy discussions and eventually resource allocation. In addition to that, the mapped and characterised hotspots will be used to geographically target future research for increased understanding of the co-evolution of risk profiles, coping strategies and socio-economic development.

2. Conceptual Framework

A wide variety of definitions and frameworks to assess vulnerability of households and ecosystems is used, described and applied throughout the scientific literature. These different approaches each come with their own specific weaknesses, strengths and fields of application. None of them can be seen as superior, nor the most widely accepted. Generally, the definitions and frameworks combine hazard factors with social factors, i.e. they holistically merge external stressors with internal system capacity to resist and/or recover. It is precisely the interaction between these two factors that defines how vulnerable communities are (e.g. Diley et al. 2005, Lim et al. 2004, Thornton et al. 2006, Alwang et al. 2001). These components can be applied in various ways, depending on the stressors and the systems looked at, the level of uncertainty of the stressors, whether the focus is broad or specific and on the direction and emphasis of the approach used. There is however one point on which all authors agree: it is essential to start from a clear conceptual base, i.e. explicitly describe which approach is taken, agree on the exact meaning of the terms used and follow this through throughout the whole study, project or program.

The definition we adopted for this study is the exposure to risk, mitigated by the ability to cope. Vulnerability is thus comprised of a risk (or a chain of risky events) that people confront in pursuit of their livelihoods, the risk response or the options that people have for managing risks and finally the outcomes that describe the loss in well-being. The risk response or available options are in turn determined by livelihood assets, strategies and policy and institutional environments. In this framework, vulnerability has to be seen as a dynamic process that represents the conditions set by the environments they inhabit and the choices of the vulnerable populations themselves. Vulnerability rests in a coupled human-environment system that operates at different spatio-temporal scales.

Vulnerability begins with a notion of *risk*. Risk is characterized by a known or unknown probability distribution of events. All individuals, households, communities or nations face multiple risks from different sources, whether they are natural (e.g., floods, illness) or man-made (e.g., unemployment, environmental degradation, conflict). These risks cannot be prevented, and if they materialize they can negatively impact individuals, households, communities and/or regions in an unpredictable manner (Heitzmann et al., 2002). Risks are either idiosyncratic, with one household's experience weakly, if at all, related to neighbouring households'—or covariate, with households suffering similar shocks. Idiosyncratic shocks commonly arise due to crop yield shocks associated with microclimatic variation or local wildlife damage or pest infestation, illness (especially chronic rather than infectious), and one-off events such as property losses due to fire or theft. Such shocks can, in principle, be managed within a locale. Covariate shocks by contrast, commonly arise due to natural disasters, war, price instability and financial crises which virtually everyone in a community experiences. Such shocks are difficult to insure locally and thus require some coordinated external response (Alderman, 2007).

One can respond to, or manage, risks in several ways. Risk management involves ex ante and ex post actions. Ex ante actions involve preparedness and anticipation before a risky event takes place, and ex post management takes place after its realization and is therefore reactive. Ex ante risk reduction can reduce risk (e.g., eradication of malaria-bearing mosquitoes) or lower exposure to risks (e.g., malaria pills, mosquito nets). It is also possible for a household to take ex ante risk mitigation actions that provide for compensation in the case of loss such as purchase of insurance. Risk mitigation includes formal and informal responses to expected losses such as self- insurance (e.g., precautionary savings), building social net works, and formal insurance based on expansion of the risk pool. Ex post risk coping activities are responses that take place after a risky event is realized and involve activities to deal with realized losses such as selling assets, removing children from school, migration of selected family members, seeking temporary employment. Some governments provide formal safety nets, such as public works programs and food aid, that help households cope with risk. It is clear that different types of risk exposure necessitate different risk management measures and responses, and by different actors, e.g. from households themselves as well as from the policy makers.

3. Data and Methodology

From the literature we identified the main sources of risk and grouped them into four categories: natural disaster risk, disease risk, socio-economic risk and political risk (TzPPA, 2002/2003; Republic of Malawi/World Bank, 2006; Freeman et al., 2007; African Development Bank, 2007). For each of the identified risk criteria spatially disaggregated data was collected and probability surfaces developed. Not all criteria and categories were considered of equal importance to vulnerability. Statistical methods were used to scale down the original list of criteria to an operational, non-redundant set and weights assigned before combining the different variables into one map. The identified hotspots of risk were then further characterised in terms of farming systems, market access, population density, poverty and malnutrition.

3.1. Risk Indicators

Four groups of risk indicators were identified: natural disaster risk, disease risk, socio-economic risk and political risk. For each of the groups different indicators were chosen. They are summarised in table 1. Sections 3.1.1 through to 3.1.4 provide more detail about the choice and meaning of the selected indicators. While some of the indicators are representing actual hazards, shocks or stresses, data constraints forced us to use proxy variables for some of the risks identified. Climate variability for example is a clear stress, influencing the agricultural potential of an environment and therefore people's livelihood strategies. The number of internally displaced people, on the other hand, is not only stressing populations directly, it is mainly a symptom of a system under stress.

Table 1: the risk indicators

	Source	*Resolution*	*Description*	*Some potential effects*
1. Natural Disaster Risk				
Drought	CHRR	4.6 km	Anomaly of the standard precipitation (50% below for a 3-month period)	Loss of crops and livestock, changing terms of trade, less access to water, spreading disease
Floods	CHRR	4.6 km	Counts of extreme flood events	Loss of crops and physical assets, isolating communities, disease
Cyclones	CHRR	4.6 km	Frequency of extreme wind strength	Loss of crops, destroying physical assets, isolating communities
High CV in the Rainfall	Thornton and Jones	18.4 km	Inter-annual coefficient of variation of rainfall	Fluctuation in food production, changing terms of trade
LGP Change 2000 and 2030	Thornton and Jones	18.4 km	Percentage change of length of growing period (in days) between 2000 and 2030	Change in suitability of the environment for the current farming systems and practices
Deforestation	AfDB	Country	Annual change of forest cover: 1990 - 2000 (in %)	Soil degradation, declining agricultural productivity
Water Stress	FAO	1 km	Discretionary water (in mm)	Conflict, reduced productivity, hygiene and disease
2. Disease Risk				
Tsetse	FAO	5.2 km	The maximum suitability for forest, riverine or savannah tsetse (0 to 1).	Loss of Livestock, decreased income and safety nets
ECF	ECFxpert	1:25million	Incidence of ECF	Loss of Livestock
Striga	De Groote	Country	Maize area infected by maize (%)	Loss in agricultural production, supply shift
Malaria	MARA/ARMA	1 km	Suitability for Malaria transmission (0 to 1)	Loss of life, reduced labour force
HIV/AIDS	WR2005	Country	Incidence (%)	Loss of life, reduced labour force, increased cost of health care
3. Socio-Economic Risk				
Population growth	CIESIN	1 km	Population growth between 1990 and 2000 (%)	Increased pressure on the Natural Resources

Inflation	AfDB	Country	Inflation in 2003 (%)	Reduced income, increased expenses
Unemployment	ILO	Country	Unemployment rates (%)	Lack of off-farm income
4. Political Risk				
Refugees	WR2005	Country	% of population fleeing the country and applying for refuge outside the country	Governance, interruption of agricultural production and services, lack of good functioning institutions
Internally Displaced	IDMC	District	Number of conflict-induced internally displaced people	Interruption of production, increased competition over resources

For all the indicators in table 1, spatial data was collected and stored in a Geographical Information System (GIS). The corresponding layers were obtained from different sources and consisted of both raster and vector layers. The layers were all converted to raster and re-sampled to 4.6 km resolution. These raster layers were first of all normalised (by applying log10 and assigning the minimal risk to original zero risk areas) and then standardised in probability surfaces using the simple arithmetic transformation from formula 1.

Formula 1: $V_i = (X_i - X_{i,\,min}) / (X_{i,\,max} - X_{i,\,min})$

With V_i = *standardised indicator i*
X_i = *the indicator before it is transformed*
$X_{i,\,min}$ = *the minimum score of the indicator i before it is transformed*
$X_{i,\,max}$ = *the maximum score of the indicator i before it is transformed*

This transformed all data into a relative score ranging from 0 to 1. For most variables, the higher the value, the higher the probability of this specific type of risk occurring in that area. The only exception in the list of variables is the water stress indicator, where less water means higher pressure. Therefore, the water indicator was further transformed using the formula $1 - X_i$. These values thus no longer provide absolute values. They only provide an 'indication' of much broader and complex social concepts. They are, however, suitable for comparative assessments and therefore also for priority setting and targeting of further research activities and actual interventions.

3.1.1. Natural Disaster Risk

Over 60% of the population in the COMESA region depends on agriculture for their livelihoods and employment (FAOSTAT, 2006); they almost entirely depend on direct utilisation and/or transformation of local natural capital. Disasters have a significant impact on agricultural production and represent a major source of risk for the poor and wipe out development gains and accumulated wealth in developing countries (Diley et al, 2005).

Floods, droughts and ***cyclones*** disrupt productive activities. The result is loss of crops and livestock, changing terms of trade, reduced access to water, spreading disease, destroyed physical assets, isolated communities, etc. The Global Natural Disaster Risk Hotspots Project generated global flood, drought and cyclone data. This data was downloaded and integrated in the Spatial Risk Database.

Climate variability, especially as regards to precipitation, can have substantial impacts. Rainfall variability continues to be the principal source of fluctuations in global food production, particularly in developing countries (Reynolds et al.). The expected long-term climate change may affect food systems in several ways ranging from direct effects on crop production (e.g. changes in rainfall leading to drought or flooding, or warmer or cooler temperatures leading to changes in the length of growing season), to changes in markets, food prices and supply chain infrastructure (Gregory et al., 2005).
The coefficient of variation for rainfall was calculated by Jones and Thornton in the framework of the Mapping Climate Vulnerability and Poverty study (Thornton et al. 2006). The same study also provides data for change in length of growing period (LGP) between the year 2000 and 2030. The

areas where a gain in LGP was projected were set to zero and then the rest of the data was normalised and standardised as described above.

As most rural livelihoods directly depend on natural resources, declining natural resources mean declining returns from livelihood activities. In contrast to the above droughts, floods and cyclones, the ***natural resource degradation*** is not a sudden shock but rather a slow and continuous stress on the livelihoods assets of the poor.
Natural resource degradation takes many forms, soil erosion being one of the most prominent ones. Data limitations, however, drove us to the selection of deforestation as a proxy for natural resource degradation. A high rate of deforestation contributes significantly to soil degradation, making the latter one of the most serious problems facing Africa today (African Development Bank, 2007). The African Development Bank provides country-level figures of forest cover change in the 1980's and 1990s. It is the data for the 1990's that was normalised, standardised and converted to GIS format for further analysis.

The increasing ***scarcity of clean water*** is becoming an issue of serious concern in Africa. There is a fear that future regional conflicts may result from competition over water use. Partly owing to long spells of drought, Africa has less water today than in the 1970s (UNEP/OAU, 1991). Associated with falling water supplies is the issue of water pollution. In rural areas, the population draws water from unprotected sources, such as wells and rivers. Many of these sources have been exposed to serious pollutants from industry, the infiltration of agricultural chemicals and fertilizers, and raw sewage. The African Development bank (2007) estimated that in most of Africa sewage is discharged untreated into surface waters. These are often sources of drinking water for downstream communities, making populations vulnerable to 'environmental' diseases like cholera, typhoid, diarrhea and dysentery. The limited access to health services further compounds the vulnerability of these communities (African Development Bank, 2007).
For water availability, river basin values from the FAO Atlas of Water Resources and Irrigation in Africa were used. The values for Internally Renewable Water Resource (IRWR) and Natural Inflow (NI) were added up and combined into a "Discretionary Surface Water" raster dataset. This dataset was normalised, standardised and used for further analysis.

3.1.2. Disease Risk

Illnesses and injuries in a family simultaneously reduce income due to lost time working and increased curative health treatment expenditures (Alderman, 2008), while crop and livestock diseases and pests directly reduce yields, agricultural productivity and food security. Diseases of crops and livestock are widespread in the COMESA region. In addition, agricultural intensification generally leads to even higher pest pressure (SAKSS, 2007).

While exposed to a wide array of risks related to animal disease, the poor have little capacity to cope. Existing close to the survival threshold, the poor tend to be more risk- averse, and so less likely to 'take a chance' on preventive disease technologies. ***Livestock disease*** is particularly damaging since it threatens one of the few assets that the poor keep on hand for dealing with other shocks (Perry et al., 2002).
According to a study from Perry et al. (2002), *East Coast Fever* (ECF) has the greatest impact on the poor people in the East and Central African region. ECF is indeed a major economic threat, putting at risk the lives of about 25 million cattle in Burundi, Kenya, Malawi, Mozambique, Rwanda, Sudan, Tanzania, Uganda, Zaire, Zambia, and Zimbabwe. The disease has been reported to be the cause of half a million deaths in cattle per year in East Africa. In Kenya alone, it has been estimated that 50-80% of the national cattle population, currently around 10 million animals, are exposed to the tick, and of these animals 1% die of ECF each year. (ECFxpert, 2007).
Another major livestock disease in the COMESA region is *Trypanosomiasis.* Tsetse-transmitted trypanosomiasis occurs in 36 sub-Saharan countries, covering some 10 million square kilometers of

Africa. Animal trypanosomiasis causes the death of about 3 million cattle annually and, each year, African livestock owners administer about 35 million doses of trypanocides to prevent or treat the disease. The annual economic losses resulting from the disease are estimated as being about US$3-5 billion per year (NRI, 2007). The economic loss due to East Coast Fever has been estimated at US4 168 million (Torr et al., 200x).
The areas under threat of Trypanosomosis were sourced from the FAO website (2006). The maximum probability of occurrence of any of the tsetse species was used as a proxy. ECF occurrence was digitized from a map in Perry et al. (1989).

Epidemics of ***crop diseases***, infestations of insect pests and colonization by weeds result in significant losses in agricultural production worldwide. These yield losses occur despite the application of pesticides valued at $30 billion annually and the use of improved varieties with varying levels of resistance to specific pests. As a result of crop improvement programmes to incorporate resistance to pests, devastating epidemics and infestations are now the exception and not the rule; nevertheless, pests continue to exact a heavy toll in terms of yield losses (Oerke E-C, 2005).
The most recent global estimate of yield losses for eight major crops was published by Oerke et al. (1994). According to Oerke's data, developing countries had higher losses than industrial countries. Africa had the highest percentage losses at 49% (equivalent to $13 billion annually). By crop, the highest absolute annual value and percentage loss was reported for rice at $113 billion/51% loss, followed by wheat at $39 billion/37% and maize at $28 billion/38%.
Form these “top 3 crops” maize is the most important staple crop in COMESA. De Groote (2007) estimates that in the whole of SSA 250 to 500 million US$ is lost due to *Striga* infestation. Details about the areas infested in East- and Southern Africa were found in De Groote (2007) and digitized[1].

Human diseases undermine the capacity of those who are ill as well as their caretakers to pursue livelihoods. It significantly reduces labor productivity and often results in the sale of productive assets in order to pay for treatment.
HIV and AIDS are having a devastating effect on agriculture, education and the private sector. Many farmers have died and many others are debilitated by illness, leading to reduced food production. Low food production and accessibility in turn contribute to food and nutrition insecurity. In the short and medium term, the epidemic impoverishes households through:

- loss of labour in agriculture and other livelihood activities;
- increased cost of health care and funerals;
- diminished capacity to care for children and other vulnerable individuals; and
- erosion of the asset base.

In the longer term, HIV and AIDS have impacts on social and economic systems and
institutions in hard-hit countries. AIDS forces children, particularly girls, to withdraw from school in order to work or care for ill parents. It reduces the inter-generational transfer of skills and knowledge of agriculture, and erodes the human resource base of institutions required to address the sectoral and cross-sectoral impacts of the epidemic. HIV and AIDS reduces the availability of labor and knowledge that in turn affect household level access to food (Panagides et al., 2007). Country level HIV/AIDS incidence for the year 2003 was sourced from World Resource 2005[2].
SSA caries the highest per capita burden of disease in the world. Of this *malaria* is the single most important disease, being responsible for nearly one million deaths and 300-500 million clinical cases every year. This situation results both from the particular epidemiological situation in Africa and the nearly total absence of systematic control activities during the past decades. As a result, the burden of the disease on societies and economies is tremendous (MARA/ARMA, 1998). The probability layers developed by MARA/ARMA were added to the spatial database and used in the subsequent analyses.

[1] Missing data was replaced by the average incidence, i.e. 11% of the maize area to be infected with striga.
[2] For the countries without data, the average incidence of the other COMESA countries was taken.

3.1.3 Socio-Economic Risk

Economic shocks reduce revenues just as they necessitate an increase of expenditures (Alderman, 2007).

Africa's population is one of the fastest growing in the world. High ***population growth*** exerts further pressure on the limited land, leading to increasing encroachment on forests and other natural resources, that in turn leads to soil degradation, deforestation and subsequent loss of productivity (African Development Bank, 2007).
CIESIN's spatial population layers for the year 1990 and 2000 were used to calculate the percentage population increase between these two years.

Inflation figures for the year 2003 were obtained from the African Development Bank[3] as a proxy for price fluctuations.

The latest ***unemployment*** figures were obtained from the International Labour Organisation for Egypt, Ethiopia, Madagascar, Mauritius, Uganda, Tanzania, Zambia and Zimbabwe[4].

3.1.4 Political Risk

Conflicts disrupt people's lives and their livelihoods. Proxies used were the number of people fleeing the country and the number of internally displaced people (IDP). The number of refugees was sourced from WRI. While information for IDPs in 9 countries in the COMESA region was downloaded from the Internal Displacement Monitoring Centre (IDMC): Burundi, DRC, Eritrea, Ethiopia, Kenya, Rwanda, Sudan, Uganda and Zimbabwe.

3.2 Principal Components Analysis

In order to distil the 17 indicators from table 1 down to a smaller number of indicators, we subjected the data to a Principal Component Analysis (PCA). PCA was performed per risk category and on all the pixels that had valid data for all indicators in that category. PCA is an example of a factor analysis, a class of statistical methods that attempts to reduce the complexity of multivariate datasets by producing a set of new factors or components that are orthogonal, thereby avoiding the problems of correlation among indicators. The main reasons to transform the data in a principal component analysis are to "compress" data by eliminating redundancy, to emphasize the variance within the grids of a stack, and to make the data more interpretable. The PCA was done with a Varimax orthogonal rotation and new factors were selected that had an eigenvalue greater than unity.
The result of the PCA is a set of uncorrelated principal components, with the first principal component having the greatest variance, the second will show the second most variance not described by the first, and so forth. The normalised and standardised indicators from table 1 were reduced to 4 non-redundant sets of orthogonal factors or principal components (PC), each set representing one of the rsik groups mentioned above. PCA scores were saved for each pixel in the dataset and standardised between 0 and 1. They were then used to derive a vulnerability index and for the identification of hotspots.

3.3 Identification and Characterisation of Hotspots

The sets of principal components per risk category were used to construct a "categorical" risk indicator. This combined index is the weighted sum of the standardised PCA scores for each pixel. Although small in effect, the PCA scores were weighted by the variance explained by each PCA as in Thornton et al (2006). The different categorical risk indices were further classified in 5 quantiles

[3] Again, missing data was replaced by the average for the COMESA region.

[4] The other countries were assigned the average value of these countries.

and mapped. The top quantile was considered to be at very high risk; we further refer to these as hotspots. In addition to the categorical risk maps, a combined map was produced. It indicates to how many high risks a certain area is exposed.

In reality, a risk factor is defined by the hazard, stress or shock in combination with the elements at risk. The set of elements that may be impacted on by a given hazard is often quite large; for example: infrastructure, people and natural resources. This study considers vulnerable communities as the main element at risk. Therefore, the population density and total population numbers were the first characteristics of the hotspots defined and will probably be a major factor in choosing case study sites. Additional characteristics include: types of risk, farming system, area, malnutrition and market access.

4. Results

The results of the PCA in terms of factor loadings and the percentage of variance explained by each component are shown in tables 2 to 5.

Table 2: PCA results for Natural Disaster Risk

	PC1	PC2	PC3
cvrain	.881	.088	-.152
cycloon_int	-.434	.653	-.256
deforest	.382	.567	-.065
drought_int	.225	.663	.312
floods_int	-.145	.019	.916
lgpch	.859	.067	-.001
water	-.798	-.145	.033
% variance	**36.537**	**17.451**	**14.729**

Table 3: PCA results for Disease Risk

	PC1	PC2
ecf	.833	.108
hiv2003	.875	.045
malaria	.405	.671
striga	.325	-.748
tsetse	.175	.625
% variance	**35.171**	**28.285**

Table 4: PCA results for Political Risk

	PC1
idps	.828
refugees	.828
% variance	**68.540**

Table 5: PCA results for Social Risk

	PC1	PC2
inflation	.821	.272
popgro	.012	.968
unemploy	.848	-.220
% variance	**46.396**	**35.308**

The three natural disaster factors are a combination of the 7 natural disaster indicators. Between them these three factors explain almost 69% of the variance of the original dataset. It seems that principal component 1 has to do with the water related variables, i.e. water availability and rainfall variability and changes in length of growing period. PC2 seems dominated by the extreme droughts and cyclones, these extreme events seem to be highly correlated with deforestation. PC3, finally, is completely dominated by the floods.

The five disease indicators were combined into 2 principal components, together explaining 63% of the variance in the original dataset. Their interpretation is not straightforward but it seems that principal component 1 has to do with East Coast Fever and HIV/AIDS, whereas component 2 is heavily loaded on the diseases that are transmitted by flying insects, i.e. malaria and trypanosomiasis. These seem to have a high negative correlation with Striga infestation.

The Political risk factor combines the two indicators, internally displace population and number of refugees, into one component. This component explains 68.5% of the variance in the original dataset.

The three Socio-economic risk indicators were reduced to two factors. The first principal component combines the economic indicators, whereas the second principal component is completely dominated by population growth. Together they explain almost 82% of the total variance.

The quantiles of the resulting composite indices are mapped in figures 1 to 4 in annex 1. The final map, indicating multiple hazard risk is shown in figure 5 of annex 1.

Table 6 summarises per country the total area, total population, major farming system, malnutrition level and average distance to the nearest town with a population of more than 250,000 inhabitants. It should be noted that Comoros, Mauritius and Seychelles are missing in this table, this can be traced back to the quality of the secondary data that was used in the analysis. There was a lot of missing data for these islands, therefore they were not included in the analysis. It would, however, be wrong to assume they don't face any risks. The same remark counts for other than natural disaster risks in Madagascar.

Table 6: Characterisation of the Hotspots

	Area (km2)	*%*	**Population**	*%*	**Major Farming System[5]**	**Travel time to town>250,000 (hours)**	**% children under five stunted**
Burundi							
Natural Disaster Risks	11,181	*41*	2,210,899	*36*	Mixed Rainfed	7.0	56.5
Political Risks	3,372	*13*	754,258	*12*	Mixed Rainfed	8.1	56.8
Socio-Economic Risks	2,005	*7*	447,355	*7*	Mixed Rainfed	8.0	55.6
Multiple Risks	2,838	*11*	572,878	*9*	Mixed Rainfed	7.6	56.1
Total Country	26,945		6,173,796		Mixed Rainfed	6.7	56.5
Djibouti							
Natural Disaster Risks	9,944	*46*	492,352	*84*	Rangelands	9.0	41.2
Socio-Economic Risks	1,025	*5*	5,211	*1*	Rangelands	11.2	No Data
Multiple Risks	816	*4*	4,060	*1*	Rangelands	11.7	0.0
Total Country	21,773		587,566		Rangelands	8.8	No Data
DRC							
Disease Risks	664,000	*29*	15,980,940	*32*	Other	12.0	38.8
Political Risks	90,527	*4*	6,546,746	*13*	Other	13.0	42.6
Socio-Economic Risks	64,393	*3*	621,879	*1*	Other	11.6	39.6
Multiple Risks	104,629	*4*	6,631,389	*13*	Other	12.8	44.0
Total Country	2,327,867		49,709,940		Other	10.9	38.6
Egypt							
Natural Disaster Risks	99,368	*10*	2,883,856	*4*	Rangelands	9.9	16.2
Socio-Economic Risks	29,869	*3*	85,632	*0*	Rangelands	8.2	16.9
Multiple Risks	3,025	*0*	3,954	*0*	Rangeland	12.1	17.3
Total Country	982,379		69,105,550		Rangelands	14.7	17.1
Eritrea							
Natural Disaster Risks	6,784	*6*	66,491	*2*	Rangelands	11.8	41.0
Political Risks	42,664	*36*	1,665,831	*47*	Rangelands	7.2	43.9
Socio-Economic Risks	90,434	*76*	3,114,722	*88*	Rangelands	11.8	40.3
Multiple Risks	41,362	*35*	1,648,527	*47*	Rangeland	7.1	43.4
Total Country	119,694		3,543,846		Rangelands	13.1	40.2
Ethiopia							
Natural Disaster Risks	229,269	*20*	10,767,730	*17*	Rangelands	14.3	48.3
Socio-Economic Risks	906,720	*80*	60,971,360	*97*	Mixed Rainfed	17.9	48.7
Multiple Risks	182,976	*16*	10,398,390	*17*	Rangeland	14.3	49.3
Total Country	1,130,606		62,807,900		Rangelands	18.4	48.0
Kenya							
Disease Risks	143,984	*25*	18,206,150	*61*	Mixed Rainfed	9.2	36.2

[5] *The farming system classification used, is an aggregated version of Kruska et al. (2002). Differentiation was made between Rangelands, Crop-Livestock Mixed Irrigated, Crop-Livestock Mixed Rainfed and Other (including urban, coastal, forestry, etc).*

Natural Disaster Risks	253,360	*44*	5,462,818	*18*	Rangelands	10.3	37.3
Socio-Economic Risks	268,029	*46*	11,785,580	*40*	Rangelands	11.6	35.5
Multiple Risks	189,398	*33*	8,177,041	*28*	Rangeland	10.3	36.2
Total Country	582,261		29,710,780		Rangelands	11.5	36.6
Libya							
Natural Disaster Risks	764,481	*47*	2,226,773	*47*	Rangelands	19.0	15.2
Total Country	1,616,371		4,783,891		Rangelands	18.2	15.1
Madagascar							
Natural Disaster Risks	408	*0*	1,366	*0*	Rangelands	11.2	39.0
Total Country	591,725		15,675,540		Rangelands	12.3	43.6
Malawi							
Natural Disaster Risks	85,792	*73*	9,516,081	*83*	Mixed Rainfed	7.7	47.1
Socio-Economic Risks	4,789	*4*	97,726	*1*	Rangelands	14.1	44.5
Multiple Risks	3,288	*3*	81,579	*1*	Rangeland	12.7	42.5
Total Country	117,944		11,519,020		Mixed Rainfed	7.9	47.0
Rwanda							
Natural Disaster Risks	11,342	*45*	2,594,234	*34*	Mixed Rainfed	5.5	63.8
Political Risks	919	*4*	446,254	*6*	Mixed Rainfed	12.5	57.7
Socio-Economic Risks	107	*0*	4,507	*0*	Mixed Rainfed	6.3	64.9
Multiple Risks	107	*0*	4,507	*0*	Mixed Rainfed	6.3	64.9
Total Country	25,202		7,586,020		Mixed Rainfed	7.0	55.5
Sudan							
Natural Disaster Risks	707,592	*28*	10,654,330	*35*	Rangelands	11.1	32.7
Political Risks	1,387,187	*55*	22,786,290	*76*	Rangelands	9.8	42.9
Socio-Economic Risks	156,405	*6*	3,057,926	*10*	Rangelands	10.4	44.5
Multiple Risks	677,787	*27*	12,907,290	*43*	Rangeland	9.6	44.8
Total Country	2,504,994		30,056,560		Rangelands	13.0	No Data
Swaziland							
Natural Disaster Risks	6,398	*33*	331,523	*19*	Other	10.2	31.2
Socio-Economic Risks	372	*2*	244,004	*14*	Other	9.1	30.9
Multiple Risks	38	*0*	1,036	*0*	Rangelands	9.1	30.9
Total Country	19,457		1,740,256		Other	9.3	16.9
Tanzania							
Natural Disaster Risks	12,574	*1*	325,350	*1*	Mixed Rainfed	9.4	45.9
Socio-Economic Risks	2,283	*0*	19,979	*0*	Rangelands	11.5	54.2
Total Country	933,849		34,039,160		Mixed Rainfed	11.7	44.5
Uganda							
Natural Disaster Risks	534	*0*	73,796	*0*	Mixed Rainfed	9.6	45.3
Political Risks	53,778	*22*	2,799,019	*12*	Mixed Rainfed	9.5	30.2
Total Country	241,129		23,203,030		Mixed Rainfed	8.3	No Data
Zambia							
Disease Risks	267,842	*36*	2,230,605	*22*	Rangelands	16.1	49.4
Natural Disaster Risks	106,144	*14*	857,290	*9*	Rangelands	15.2	46.5
Socio-Economic Risks	381,393	*51*	6,176,394	*62*	Rangelands	11.8	48.1
Multiple Risks	162,559	*22*	1,803,555	*18*	Rangeland	13.6	49.6
Total Country	751,551		9,990,055		Rangelands	14.8	47.4
Zimbabwe							
Disease Risks	55,696	*14*	1,174,777	*9*	Mixed Rainfed	7.5	27.3
Natural Disaster Risks	97,758	*25*	4,544,303	*36*	Rangelands	7.2	28.3
Socio-Economic Risks	258,799	*66*	10,364,900	*82*	Mixed Rainfed	5.9	26.5
Multiple Risks	93,016	*24*	4,590,558	*37*	Mixed Rainfed	7.1	28.0
Total Country	390,717		12,571,130		Mixed Rainfed	6.4	25.4

Table 7: Hotspot summary per farming system

	Area (km2)	***%***	**Population**	***%***	**Travel time to town > 250,000 (hours)**	**% children under five stunted**
Rangelands						

Disease Risks	294,828	*4*	2,538,948	*5*	12.3	43.7
Natural Disaster Risks	1,869,655	*26*	12,876,580	*26*	14.9	29.2
Political Risks	1,036,419	*15*	12,977,050	*26*	11.0	44.9
Socio-Economic Risks	1,140,446	*16*	14,101,100	*28*	12.5	42.0
Multiple Risks	877,072	*12*	12,044,760	*24*	11.0	43.4
Total Land Surface	7,117,486		49,881,080		14.9	31.8
Mixed Irrigated						
Disease Risks	214	*0*	327,214	*0*	5.2	38.3
Natural Disaster Risks	40,829	*38*	4,980,232	*7*	3.0	36.2
Political Risks	34,861	*32*	3,667,299	*6*	2.8	43.2
Socio-Economic Risks	4,853	*5*	594,196	*1*	6.2	43.9
Multiple Risks	32,395	*30*	3,242,960	*5*	3.0	43.5
Total Land Surface	107,650		66,475,120		3.1	29.7
Mixed Rainfed						
Disease Risks	200,371	*8*	18,716,450	*11*	9.2	39.4
Natural Disaster Risks	382,791	*15*	28,896,330	*16*	8.5	45.4
Political Risks	409,289	*16*	12,461,790	*7*	6.9	45.6
Socio-Economic Risks	819,005	*32*	69,197,100	*39*	14.1	45.7
Multiple Risks	387,456	*15*	22,760,910	*13*	9.0	44.1
Total Land Surface	2,553,969		177,113,100		10.8	44.2
Other						
Disease Risks	629,017	*26*	15,507,600	*21*	13.5	41.8
Natural Disaster Risks	88,176	*4*	5,623,529	*8*	16.6	40.0
Political Risks	87,380	*4*	5,623,367	*8*	12.7	43.7
Socio-Economic Risks	195,998	*8*	12,693,570	*17*	16.2	43.1
Multiple Risks	159,551	*7*	8,547,306	*12*	15.0	43.3
Total Land Surface	2,414,313		73,755,540		13.0	41.2
Total						
Disease Risks	**1,131,522**	*9*	**37,592,470**	*10*	**12.4**	**41.9**
Natural Disaster Risks	**2,402,930**	*19*	**53,009,180**	*14*	**13.7**	**32.2**
Political Risks	**1,578,447**	*13*	**34,998,400**	*9*	**9.9**	**45.0**
Socio-Economic Risks	**2,166,621**	*17*	**96,997,180**	*26*	**13.4**	**43.5**
Multiple Risks	**1,461,840**	*12*	**46,824,760**	*13*	**10.7**	**43.6**
Total Countries	**12,386,590**		**373,973,100**		**14.0**	**36.0**

The risk profiles in the different countries are quite varied. In twelve out of the seventeen countries listed there are areas where people face multiple risks. In Sudan, Zimbabwe and Eritrea more than 30% of the population is in that situation. Natural disaster risks are affecting the largest area in COMESA, i.e. almost 20% of the total land surface, while 14% of the population in COMESA is subject to very high natural disaster risk. In some countries, i.e. Djibouti and Malawi, this percentage is even higher than 80%. In terms of population affected, socio-economic risk ranks first, with 26% of the population impinged upon. Not surprisingly, the disease risk hotspots are mainly found in the "other" farming systems. It is for example a well-known fact that livestock keepers are avoiding the tsetse infected areas. The pastoral/agro-pastoral systems, on the other hand, are by far the most important in the natural disaster, political and multiple risk hotspots.

The level of malnutrition in the hotspots is up to 9% higher than the average in the COMESA region. The only exception to this is the natural disaster hotspots. This seems to be mainly due to the low level of stunted children under five in the natural disasters struck rangelands.

5. Discussion

The regional analysis undertaken in this study is limited by issues of scale as well as by the availability and quality of data. Nevertheless, we managed to identify those areas that are e.g. at higher risk of natural disasters than others and which areas are at a high risk of multiple hazards. The data, analysis results and maps produced in the course of this study will enable policy makers to identify major threats encountered in their area of interest. Such information can inform a range of disaster prevention and preparedness measures, including prioritization of resources, targeting of more localized and detailed risk assessments, implementation of risk-based disaster management and emergency response strategies, and development of long-term land-use plans and multihazard risk management strategies.

In order to derive actionable, context-specific policy interventions aimed at reducing vulnerability we still need to zoom in from the aggregated level of the risk maps to access the necessary detail of information needed to identify investment options with the greatest potential impact for vulnerable communities. This exploratory macro work is therefore only a first step towards improved policy making and better targeted interventions. It enables the identification of hotspots of various risks and selection of a range of focused case study sites, in which more in-depth analysis relevant to the identified risks will be conducted.

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Figure 1: the principal components and composite index for Natural Disaster Risk

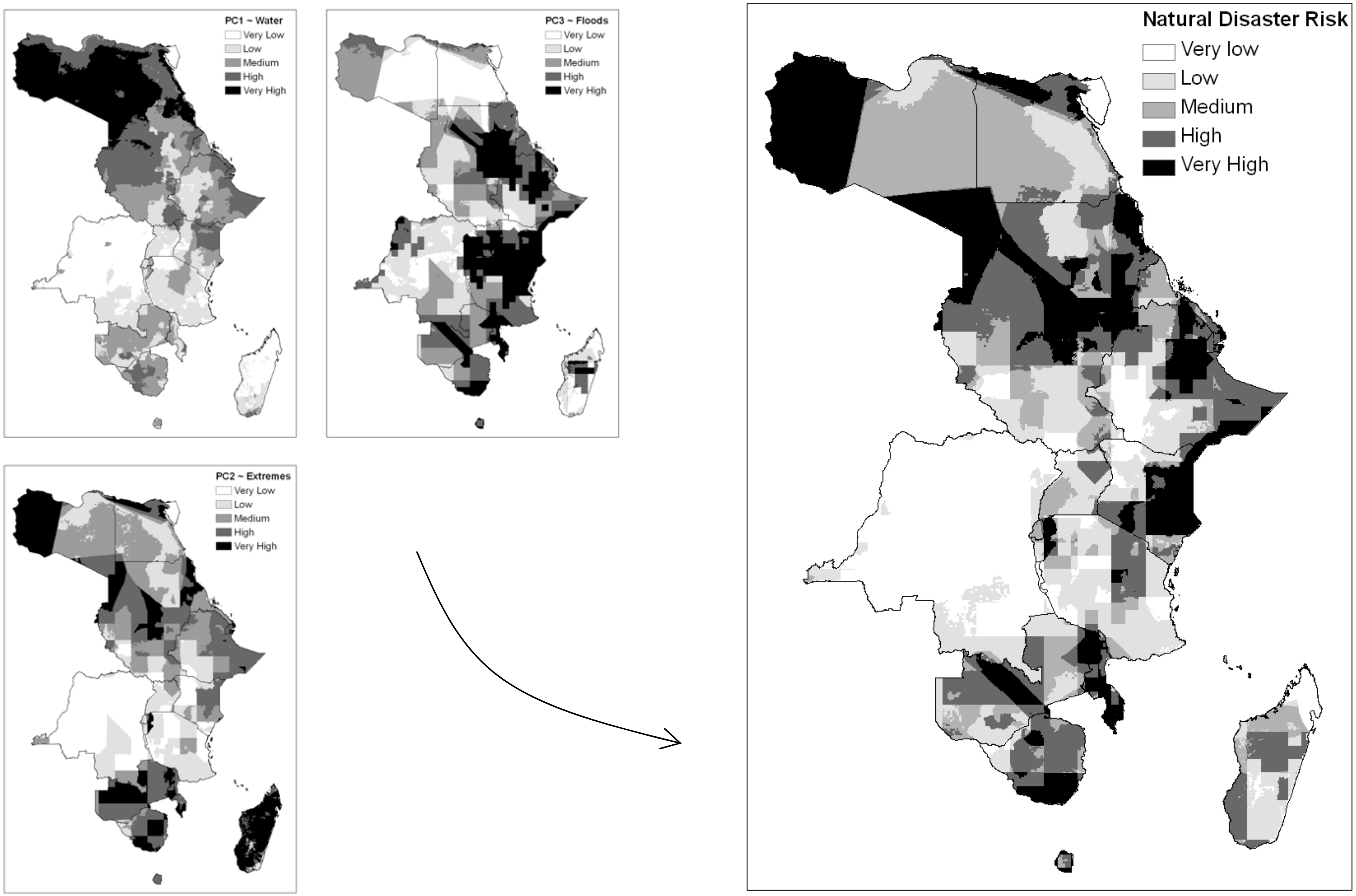

Figure 2: Disease Risk Map

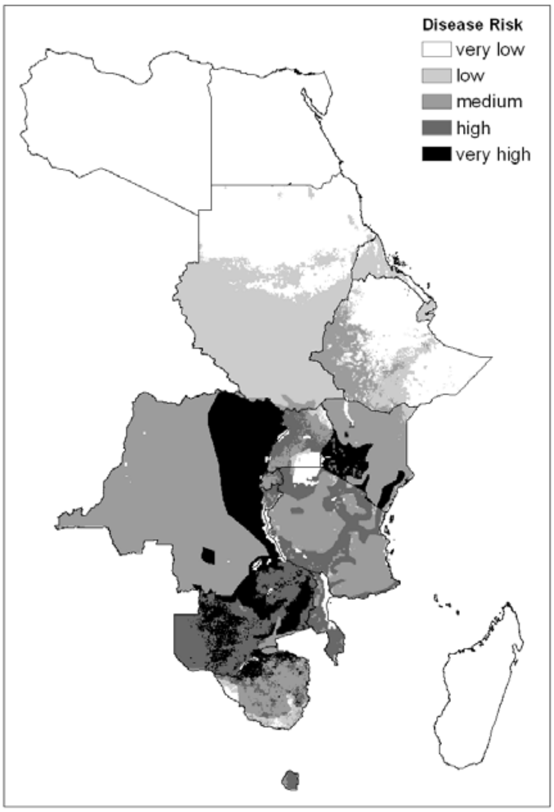

Figure 3: Political Risk Map

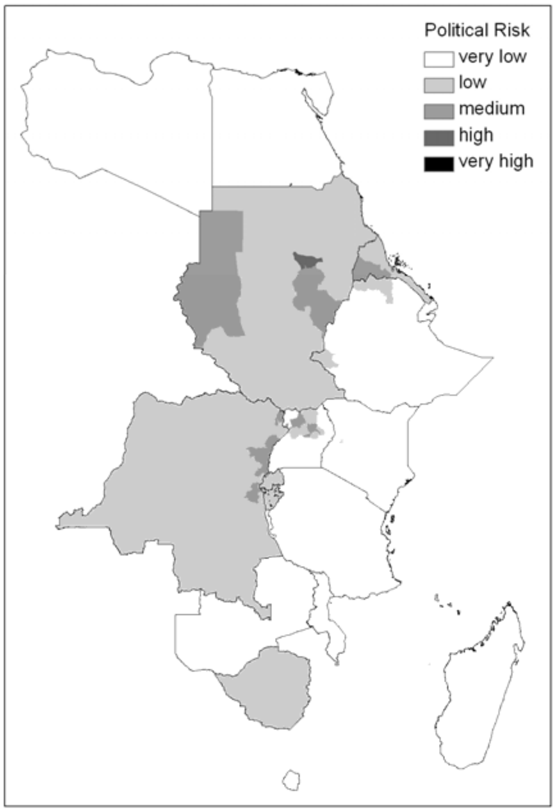

Figure 4: Socio-Economic Risk Map

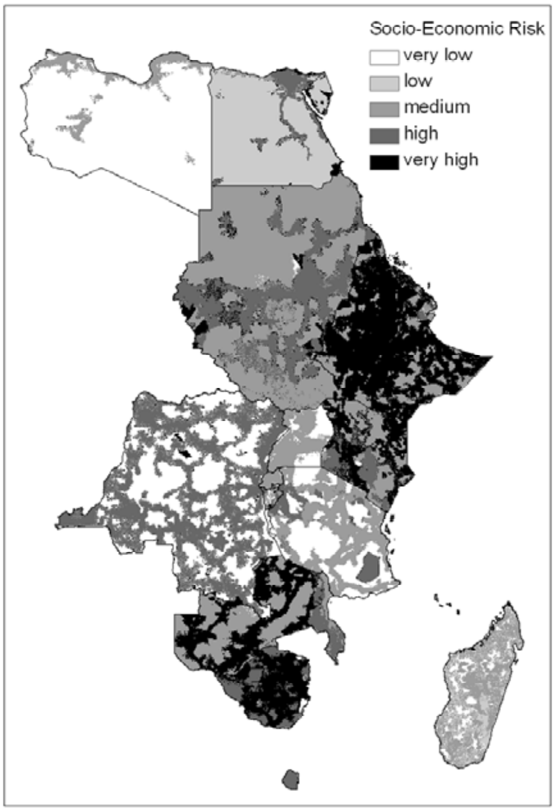

Figure 5: Multiple Risk Map