Briefing Report: Analysis of Projected Climate Change and Livelihoods

— A Pilot Study —
in the Botswana Open Access Livestock and the Mozambique Coastal Zambezia livelihood zones

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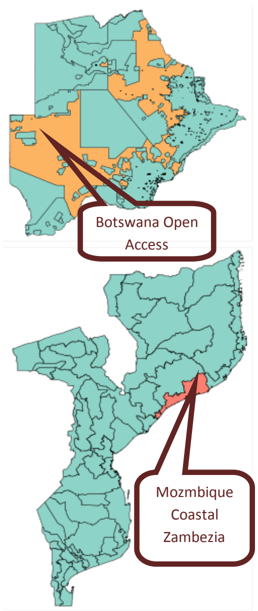
1. Executive Summary - Analysis of projected climate change and livelihoods

1. ***Study rationale***. The Regional Vulnerability Assessment and Analysis (RVAA) Programme has gradually developed a livelihoods-based vulnerability assessment system, with a number of member states undertaking baseline profiles and analyses of livelihoods that project outcomes for a single year. However, they do not necessarily allow for a projection over a long period, such as twenty or more years, which is needed for studying the livelihood impacts of climate change. Climate change, as an added stressor on livelihood systems, is understood to be more unpredictable with extreme occurrences of hazards (such as droughts and floods).

The SADC RVAA Programme has initiated a pilot study intended to test hypotheses of being able to analyse livelihood impacts based on a selection of projected climate scenarios into the future. This pilot study aimed at testing out a process of combining long-term downscaled climate projections with livelihoods data. This facilitated an analysis on whether changes in climate and climate variability will lead to periodic losses that households are unable to recover from in time for the next climate hazard—leading to impoverishment and heightened vulnerability. The pilot undertook to create a measure of the sensitivity of livelihood systems to climate change.

2. ***Livelihoods***. The livelihoods system used in this analysis works by establishing a quantified baseline of how households can transform their assets into income—both cash and in kind, but which is expressed either in currency or in calorie terms—and how that income is used to meet their needs. These needs are ranked as survival, livelihoods protection or discretionary. Livelihoods are grouped geographically into Livelihood Zones[1] and the two areas selected for this study are the Botswana Open Access Livestock and the Mozambique Coastal Zambezia livelihood zones.

Figure 1: Livelihood Zones Locations



3. ***Issues***. This work is a pilot and the aim is to see if the modelling and analysis is possible and then, if it is, to discover the key issues and concerns with it making it more reliable. This analysis is seen as useful to enhancing future contingency and mitigation planning. The weakest link in the analysis in this pilot is in many ways the climate-production relationships. With livestock, there needs to be a reliable rainfall, temperature and carbon simulator for the pasture found in the central Kalahari of Botswana. This can to be used to estimate reliable holding capacities and that needs to be integrated with the herd dynamic models. With crops, better use needs to be made of CliCrop or a simulator such as APSIM to predict yields based on monthly climate projections, so that water logging and dry spells can also be factored in. These models need to be extended to a greater variety of crops, including rice, coconut, millet and various legumes. More work needs to be done with modern population data sets, to explore the limits for expansion of the extent of farming, both in Mozambique and in Botswana. For example, ground water may present a constraint on human settlement in Botswana, limiting grazing land expansion, while arable land may also be limited in Mozambique. Population factors may be a greater factor in livelihood failure than climate (although climate variations could still act as trigger events for disaster). To some extent, economic shocks (such as staple price rises) are possible to predict for a given climate and large-scale (national or regional) production scenario—this would require some economic expertise and analysis.

[1] Livelihood zones are geographical areas where people share similar patterns of livelihood

4. ***Conclusion***. The study found that in the Open Access Livestock livelihood zone in Botswana, which has a fragile ecology and is already water-stressed, climate change will impact enormously on productive potential and livelihoods. A net rainfall decrease will slash cattle production and income (and most likely force a switch to some other means of livelihood), while a net increase will substantially boost income. In the Coastal Zambezia livelihood zone in Mozambique, changes in rainfall, temperature and carbon-dioxide will produce limited changes to household income. This is because of their reliance on fishing as well as their inability—due to poverty—to take advantage of the possible increases in rainfall that this area could experience as a result of climate change. Factors such as increased flooding from rivers or from storm surges, damage from cyclones and saline intrusion are other threats from the changing climate in this part of Mozambique.

The analysis resulting from this pilot is evidence that livelihood and climate information can be combined using the methods developed in this study. However, this is dependent on data availability. Livelihood baselines are essential and climate projections can be validated if there is at least one weather station with good data records in the area of study. The linking of climate and livelihoods analysis hinges on reliable models of productions systems (such as climate/livestock or climate/crop production systems). It is crucial that rigorous models of the relationships between the livelihood asset being analyzed and the components of climate (i.e. rainfall, temperature, etc.) are established. The outputs produced by these models must also be tested and validated as a means of verifying their robustness. This is aided by access to a set of multi-disciplinary expertise that can be consulted to interpret the results produced by the models, checking the accuracy, representativeness and completeness.

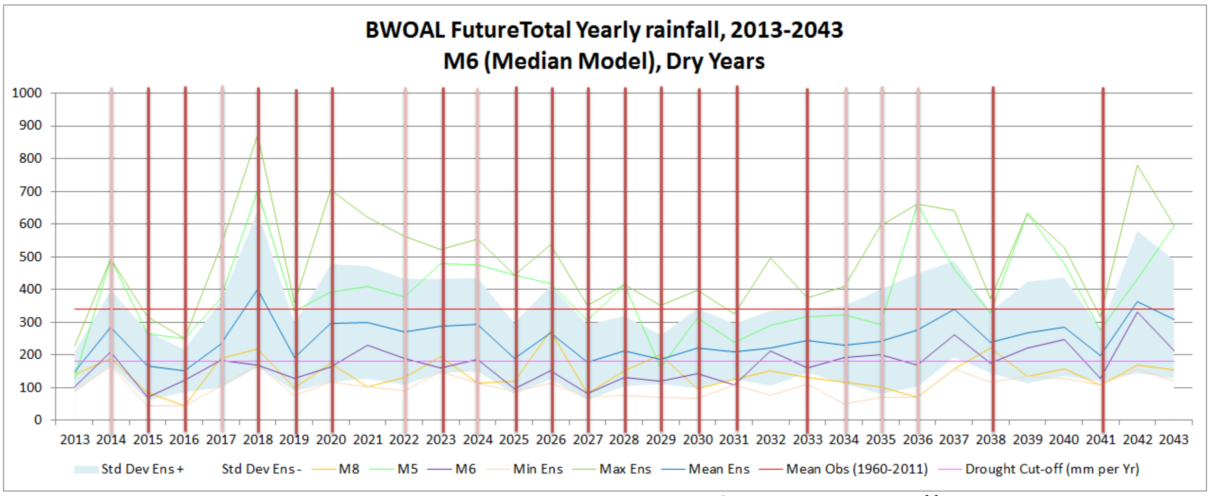
The phenomenon and impacts of climate change are wide-ranging and highly complex. Further value can be added by including analysis on such factors as economic consequences (what are future potential relative price trends resulting from climate stress?), population growth and dynamics (are resources bounded by population pressure rather than climate stress?) and access to services.

2. Summary of Results an Outcomes - Analysis of projected climate change and livelihoods

1. ***Climate scenarios***. The approach taken was one of using a number of climate scenarios based on Global Circulation Models (GCMs), attempting to investigate the long-term consequences of these different scenario's on households' income and assets. Within the database used, there is a total of eleven Global Circulation Models. The four scenarios selected for this analysis included the second wettest model, the second driest model and the median model for each livelihood zone as well as an averaged combination of all eleven of the Global Circulation Models (referred to as a GCM Ensemble). Figure 1 below graphs the models used against a Drought Cut-off (shown by the straight pink line) and a line representing the mean observed total annual rainfall in the Botswana Open Access Livestock livelihood zone (shown by the straight red line, estimated using historical rainfall for this particular area).

In the Botswana livelihood zone, a drought year is characterised as having a total annual rainfall less than 180mm. The graph below provides an analysis whereby dry (or drought) years are identified in the Botswana Open Access Livestock livelihood zone under a scenario where the total annual rainfall for the median model (the jagged purple line – M6) falls below the Drought Cut-off line. Darker shaded vertical red bars depict drought years. These years are classified as drought years as the line for the median model [M6] for this specific area in Botswana is below the drought cut-off line. The lighter shaded vertical red bars depict years where there is a relatively dry year experienced (in terms of the projected total annual rainfall) but where the level of total annual rainfall (of the model being analysed) does not per se fall below the drought cut-off rainfall limit.

Figure 2: Botswana DryYears, Median Model

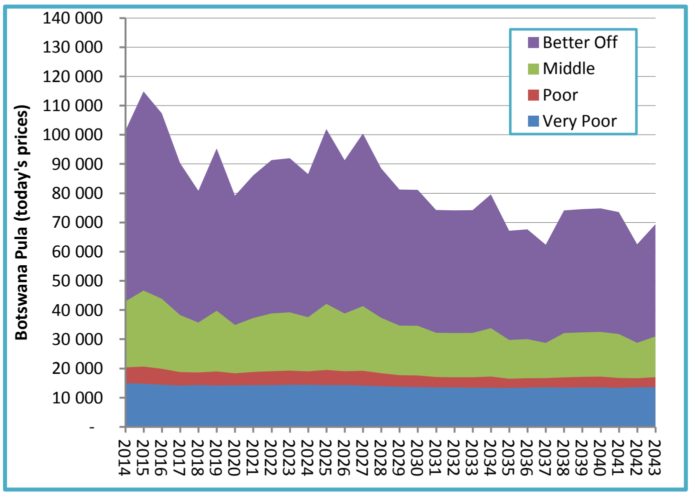


Source: Data Source: From Tshane weather station, accessed via CSAG Climate Information Portal, http://cip.csag.uct.ac.za

As can be seen in the figure above, it is crucial to have observed weather data that is accessed from historical data records. A central finding from the pilot is that the methods for combining climate and livelihoods information is highly dependent of being able to access data for observed weather as well as for projected climate for a particular site. Observed weather figures (rainfall, temperature, etc.) provide benchmarks that allow for a comparison against projected climate data. By creating these benchmarks or cut-offs, one is able to get a sense of potentially how different climate may be in the future in comparison to averages of what has been observed in the past. Thus the feasibility of a particular site is reliant on the presence of a weather station with observed weather and projected climate data, as well as having a livelihoods baseline.

2. ***Climate to livelihoods***. The study investigated the relationships between climate and productive components in each livelihood system. With livestock as the main productive activity in Botswana, the complexity of the key relationship between climate and livestock productivity was analysed based on herd dynamics and livestock productivity against rainfall (for forage and water for animals). The team found that death rates and overall herd numbers correlated somewhat with rainfall but not birth rates. The team were unable to find useful literature on the effects of temperature, although it is understood that it will impact on both pasture and animal condition directly. The rainfall outcomes from the climate models were then applied to the livestock herd dynamics models. In the cropping area in Mozambique, rainfall to yield, temperature to yield and carbon dioxide to yield models were applied on a yearly basis to determine the potential outcome for households. In all analyses it was assumed that there is sufficient land to accommodate expanding populations or additional population growth

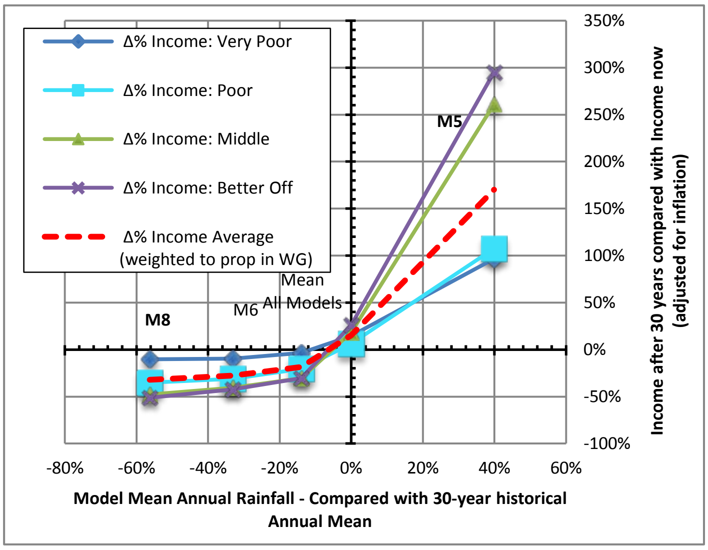
Figure 3: Time series of income for the mean of all climate models in Botswana Open Access Livestock livelihood zone



would be absorbed outside of the livelihood zone, meaning that population would not necessarily be a significant constraint. Further, it was assumed that prudent economic and policy management would enable the continuation of existing government social protection programmes, without severe price shocks or loss of employment opportunities or market access. In reality, it is rare for a country to go thirty years without some sort of economic shock and this could undermine households' livelihoods more substantially than just climate factors.

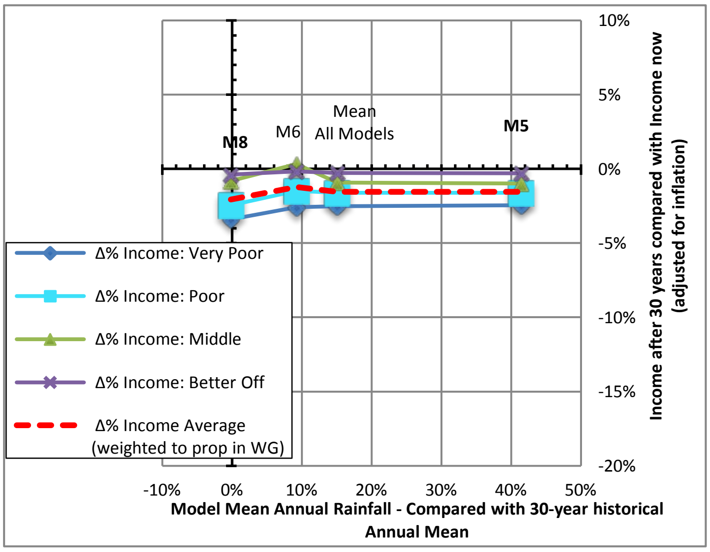
3. ***Livelihood Outcomes***. The study found that in Botswana, for climate scenarios that range from the driest to the median in rainfall, livestock production collapsed for the drier climate models and scenarios, resulting in substantially lower incomes that taper off (less than 50% of baseline) in the last decade. In these climate scenarios households will be forced to move away from cattle husbandry as their primary activity, perhaps switching to more resilient livestock species. When using the mean of all climate scenarios the annual household income oscillates, with a steady decline, as shown in Figure 3. However, for the second-wettest scenario, the average income increases substantially over the period, by 170%.

Figure 4: Livelihood to climate sensitivity for Botswana Open Access Livestock livelihood zone



In the Coastal Zambezia livelihood zone of Mozambique the climate models are more generous in their rainfall projections. However, since the livelihoods here depend on fishing and capital expenditure, with low productivity of crop farming, the impact of the extra rainfall is limited. Using better climate to crop performance models such as CliCrop and APSIM can help determine a wider range of risks (especially risks in distribution of rainfall—as opposed to just the total—like waterlogging).

Figure 5: Livelihood to climate sensitivity for Mozambique Coastal Zambezia livelihood zone



As can be seen by the curves in Figure 4 and Figure 5, Botswana Open Access Livestock liveliood zone has a high sensitivity to climate change, while the flat shape of the lines for Mozambique show that sensitivity of Mozambique is lower (income unchanged across the scenarios). However, there are a number of other climate-related factors that could affect this part of Mozambique, such as rising sea levels, coastal surges from increased cyclone frequency and intensity and increased flooding. These could lead to other impacts such as saline intrusion on the farmland.