

**Title of Presentation:**

Local vulnerability of the human-biodiversity interface to drought in South Africa

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## Summary

The majority of rural households and communities of the communal areas of South Africa's former homelands are experiencing varying degrees of stresses within the coupled human-environment system. These areas are known to be mostly associated with extreme events such as drought and water stresses, limited access to the formal economy and arable land, and food deficits. These issues have respective links to global environmental change (GEC) and the human political economy. The case of livelihoods (household production and consumption) and natural resource use in response to drought stress in the village of Thorndale in the Bushbuckridge district of South Africa is presented. The goal of the paper is to analyse the multi-layered premises on which households are vulnerable to GEC (i.e. drought) and mitigating the effects and impacts. Severe drought is experienced in approximately every 10-year cycle with the most prolonged between 2002 and 2005 in the Bushbuckridge district.

The three livelihood categories identified in Thorndale were (i) land-based (NTFPs, livestock, crops – direct use and sales), (ii) cultural (kinship ties), and (iii) monetary (formal and informal wages, pensions, government welfare grants). For the 26 reasons why the villagers embarked on these activities, the pointers were mostly to make food available to the households than any other objectives. The NTFPs involved the direct use of wild edible herbs and fruits as substitutes for the more costly domesticated leafy vegetables and fruits, respectively. Households identified 28 food crops on which they depended, including wild varieties and landraces. More households depended on crops followed by NTFPs during normal periods. The reverse holds true when there was not much farm activity.

Nine major stressful events emerged in this study, leading to four typologies of stresses based on their outcomes. They are (i) chronic stresses (those that the people live with daily, i.e. joblessness, illness, death and resettlement), (ii) acute (i.e. rain floods), (iii) recurring stress (i.e. drought and livestock losses) and (iv) intermittent stress (often sporadic and not lasting for long time periods, e.g. veld / forest fires and family problems). More households cited drought as the most important stress and because Thorndale is characterised by rain-fed agriculture, livelihoods (especially food production) easily crumbles under severe drought. Poor and weak households were the most vulnerable, suffering from food shortages, hunger and malnutrition.

It was observed that the vulnerability of households and the community to the effects and impacts of drought depends on its magnitude, intensity and the types and number of livelihood portfolios of households. Households with least livelihood portfolios were mostly affected by drought than the ones with more. Additionally, not a single livelihood portfolio could help fight drought and households combining land-based livelihoods with formal income will have better capacity to cope and adapt. The response strategies of the households were myriad with the majority targeting the natural environment, putting some plant diversity under pressure and at risk of overutilization. Mitigating outcomes of drought and associated food deficits need to first account for all livelihoods. Three response groups were generally identified as those responding to (i) only the effects of drought, (ii) impacts only and (iii) combined effects and impacts. The responses underlie the “vulnerability identity” of households and communities, defining the shifts in boundaries and heterogeneity of vulnerability, requiring understanding for effective mitigation. Vulnerability of a unit of analysis is therefore a function of (i) resource production systems, (ii) consumption (dependence) systems, (iii) resource accessibility and distribution, (iv) options and (v) resilience, among other variables (e.g. markets, pricing and safety nets).

## **1. INTRODUCTION**

### **1.1. The coupled human environment system**

The understanding of the human-biodiversity interface that shapes the biophysical and socio-political dimensions of global environmental change (GEC) has strongly emerged in recent times (Koziell, 2001; Kumar and Ram, 2005; Millennium Ecosystem Assessment, 2005). The interpretations of how these systems interact within the frameworks of different political, environmental, historical, and socio-economic contexts will lead to our understanding of resource use changes in tandem with human security. The vulnerability of humans and biodiversity to the effects and impacts of such changes constitute core challenges for science and management. The assessment of the vulnerability of a system to perturbation has been carried out in research and practice situated in risk and response analyses frameworks (Holzmann and Jorgensen, 1999). The emphasis of the analysis of the vulnerability of a system to perturbation has been on risk, hazards, and climate impacts (Ansell and Wharton, 1992; Canon, 1994; Blaikie et al., 1994; Smithers and Smit, 1997; Kelly and Adger, 2000). From these has emerged recent frameworks, one of which focuses on assessing vulnerability of the coupled human – environment systems (Kasperson and Kasperson, 2001; Turner II et al., 2003). In this framework, the exposures of ecosystems and human communities to climate variability and land cover change are known to be linked to the resilience and sustainability of ecosystem and society. The framework is important because of the strong cases that are being made for the link between climate change, agricultural production, food security, livelihoods and biodiversity (Turner II et al., 2003; O'Brien and Vogel, 2003). In this paper, the vulnerability of households to the effects and impacts of drought is examined for a rural communal area of South Africa.

### **1.2. Drought and land-based livelihoods in South Africa**

The result of the high climate variability in South Africa's dry ecosystems with important rainfall deficits is the occurrence of drought in most parts of the country (Fauchereau et al., 2003). Yet drought and dry spells are considered by a number of households especially in the communal areas, as part of their normal lives. In every three to six years, South Africa is affected by intermittent droughts. Prolonged and extreme drought periods are however experienced in a 10 – year cycle. Examples are 1982/83, 1991/92 and most recently 2002/03 that led to drastic losses of livestock and crops (Dovie et al., 2005). These droughts generally stressed the food production systems of rural people, exposing weak and vulnerable households to the outcomes of food shortages and the scarcity of natural resources. These may often lead to hunger, poverty, migration, disease and at times death (Schulze et al., 2001; O'Brien and Vogel, 2003). The findings of a study in Thorndale in the Limpopo province, South Africa are visited.

Thorndale is located in the savanna, and within the Bushbuckridge district that experiences extreme drought events. Mean annual rainfall is approximately 550 mm to 600 mm and mean annual temperature around 22°C. The district was part of the former apartheid government's policy of the relocation of the majority of black people to mostly 'unproductive' land, the communal areas within the former homelands with restricted access to resources. As a result, inhabitants were unable to implement adequate water supply initiatives, and rain-fed agriculture became the order of the day and livelihoods crumbled in times of drought. Thorndale exhibits the typical characteristics of the majority of communal areas of South Africa in terms of access to land, development, governance, resource availability and use.

## 2. LIVELIHOODS AND STRESSES

### 2.1. Typology of natural resource and socio-economic livelihoods

The three broad identifiable typologies of livelihoods based on the findings of this study are, (i) land-based (non-timber forest products ‘NTFPs’, livestock, crops), (ii) cultural (kinship ties), and (iii) monetary (formal and informal wages, pensions, government welfare grants).

The land-based sources of households’ livelihoods (cash and kind) dominated the top five sources of livelihood portfolios of the local people (Figure 1). More households depended on food crops ( $78.5 \pm 5\%$ ), followed by NTFPs ( $38.5 \pm 6\%$ ) and government support grants (Figure 1). Fewer households had few members involved in formal employment, as well as the dependence on kinship ties or social networks (Figure 1). Several reasons were given by households why they embarked on such livelihood activities (Box 1).

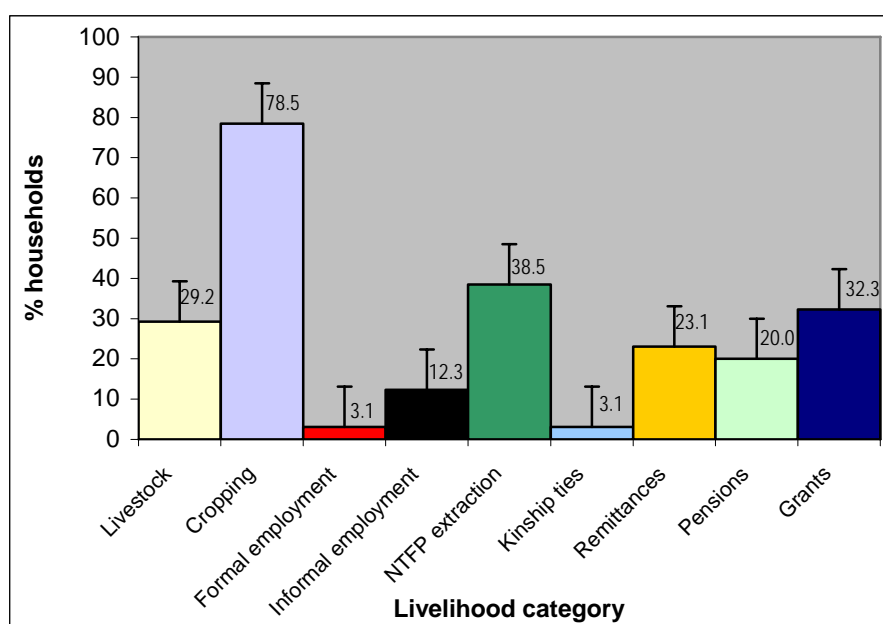


Figure 1. The proportion of households involved in specific livelihood activities in Thorndale in 2004/5.

#### Box 1. Overall reasons for embarking on livelihood activities

1. Income insecurity
2. Role of household head to provide
3. Good farming environment
4. To foster other family members after death of the major breadwinner
5. Supplementing food income
6. Livestock is an investment
7. Having pensioner parents
8. Woodland resource is the only option for survival
9. Good income opportunity
10. Cultural value for keeping livestock
11. Farming is a cultural activity
12. To enhance financial savings
13. No source of cash income
14. Lack of parental support
15. Big family size
16. Over-dependence on family members
17. Collapse of family business
18. Migrant husband
19. Few employment opportunities
20. Young / teenager household head
21. Temporary and casual jobs
22. Nursing the sick
23. Working for other people for food
24. Societal pressure to support other family members
25. Unemployed and looking after the rest of family
26. Inadequate support grants inadequate

The extreme dependence on the land-based livelihoods is a product of the forcible relocations during apartheid that shaped household access to sustainable livelihoods (De Wet, 1995). To maximise agricultural development within the “communal areas”, land was divided into arable, residential and common grazing areas and the remaining left as vegetation cover (De Wet, 1995). The forced relocations rendered households vulnerable to the effects of poverty and socio-cultural or economic instability from the lack of skill development and access to the formal economic sector. In response, households developed various easily and readily available coping strategies involving new patterns of land use, some of which became permanent. The overall result was increased land use such as overstocking of grazing lands, and the clearing of woody vegetation for fuelwood, construction materials and for additional arable land.

## 2.2. Typology of stressful events

Every household in Thorndale experienced at least one form of stress be it social, economic, or environmental. More households ( $61.5 \pm 6\%$ ) cited drought as the most important stress, followed by rain floods ( $41.5 \pm 6\%$ ), and death of a family member ( $29.2 \pm 5\%$ ), relatively accounting for 36.7%, 24.8% and 17.4%, respectively, of all stresses combined (Figure 2). Excessive rainfall in the form of floods, illness of a family member especially due to HIV/AIDS, and joblessness were other frequently mentioned stresses (Figure 2). More households (58%) experienced double stresses at a time, 36% experienced triple and 6% single. The important stressful events to households can be described as chronic, acute, recurring and intermittent.

- a) Chronic stresses are those that the people live with daily and considered part of their normal lives, probably because they are able to quickly cope or adapt to the situation. Joblessness, illness, death and resettlement (Figure 2) form part of the chronic stresses.
- b) Rain floods may be classified as acute, whilst
- c) Drought and livestock losses are recurring stresses.
- d) The intermittent stress is often sporadic and not lasting for longer time periods. Veld / savanna fires and marital problems will constitute this category of stresses.

The responses of households to stressful events were very much variable and involved the direct use of some environmental resources because of the poor nature of households (Table 1). The impacts of these stressful events for households and the biophysical environmental were also highly variable and depending on large amounts of plant resources for immediate response and long-term adaptation especially because money was not required (Table 1). The response or reaction of households to stresses may differ from year to year and from one stressful event to the other depending on the intensity and magnitude of the event.

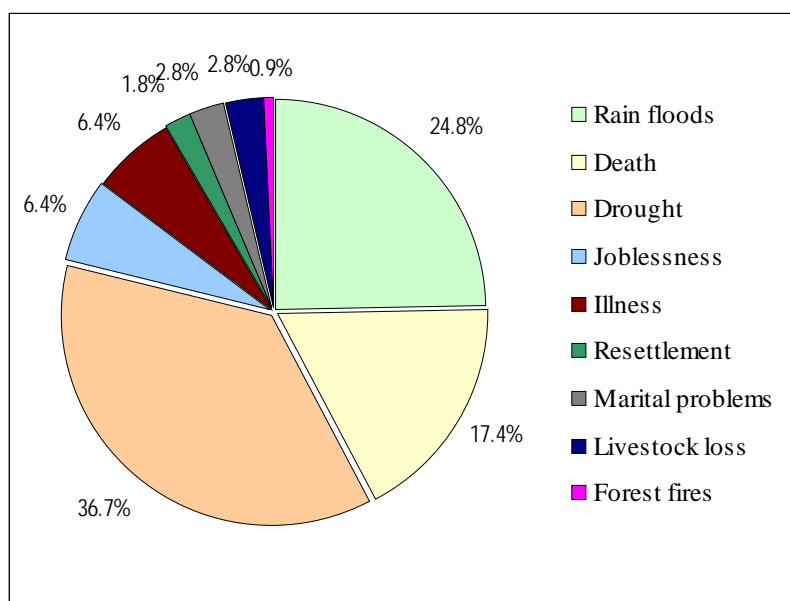


Figure 2. The relative proportion of households that cited the various stressful events.

### 2.3. Interrelationships between livelihood options and most important stressful events

Kinship ties between households were stronger along the axis of death stress (Figure 3). Joblessness correlated with support grants, extraction of NTFPs and crop production. Drought was most likely to be the stress that will influence household behaviour in terms of livestock production, formal employment and remittances hence households with these potentials will be favoured to better mitigate the outcomes of drought (Figure 3). Informal employment was much affected by illness of a household member. Although all the stresses constitute a nodal network of risks and hazards underlying the total vulnerability of households to extreme events, drought is emphasised as the focus of this paper in the following paragraphs / sections.

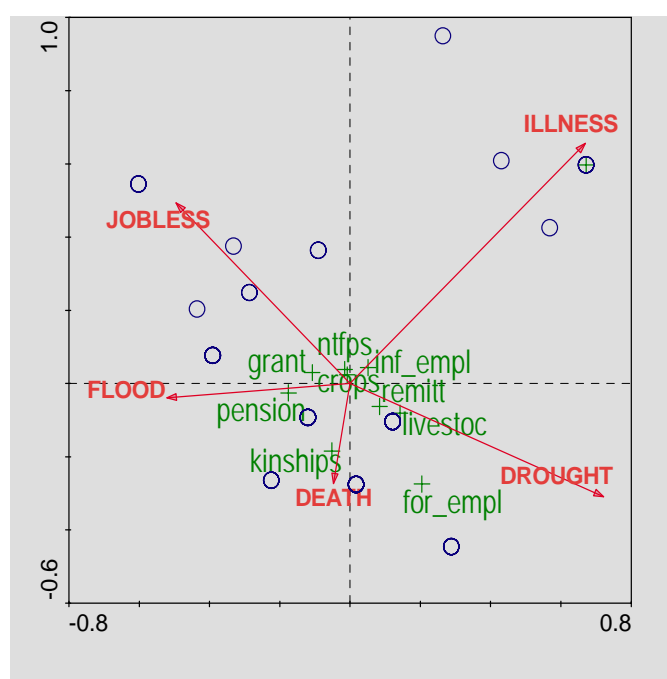


Figure 3. The canonical correspondence analysis (CCA) of the extent of the influence of the most important stressful events on households' livelihood options in Thorndale.

### 3. DROUGHT

#### 3.1. Drought and livelihood portfolios of households

Drought, the most commonly cited stress was found to occur in every ten year interval characterised by the breakdown in the traditional food production and supply systems of poor rural people. The effects and impacts are mostly felt in the area of crop production, to the extent that households through their biocultural diversity complemented food crops with intense dependence on wild plant varieties. Of the 28 food crops on which households in Thorndale depended, six were wild and their usage frequently cited by majority of households, indicating the scale of usage. The wild varieties qualify as NTFPs and important safety nets to food-stressed and insecure households and as a result reducing their vulnerability to the collapse of food security systems due to environmental or socio-economic change. Strategies to respond to and adapt to droughts are highly variable yet these strategies do not seem to help households, which may only be coping. It therefore follows that severe droughts are able to break the resilience of households and communities, exposing them to other forms of stresses such as illness and social problems (e.g. marital) as was observed in the Thorndale study. Increasing incidence of drought for example has been noted to reduce agricultural yields significantly in South Africa (O'Brien and Vogel, 2003). The impacts of this reduction in agricultural yield can be severe in the light of the total decoupling of livelihood strategies and social networks. The common response strategies have been the use of intensive home gardening, migration, selling of woody plant products and the reliance on stored products from previous years' harvests.

It was observed that households with formal sources of cash income only (i.e. remittances, formal and informal jobs) did not escape drought and could therefore be vulnerable to the effects or impacts of drought (Figure 4a). Fewer households dependent on land based resources (i.e. crops, NTFP, livestock) experienced drought compared to the formal cash earning households. Few households dependent on social grants, and kinship ties experienced drought but those households were generally small in number and influencing the results. This implies that in the rural setting of Thorndale, not a single source of livelihood or income can enable a household to cope with or develop resilience to extreme events such drought.

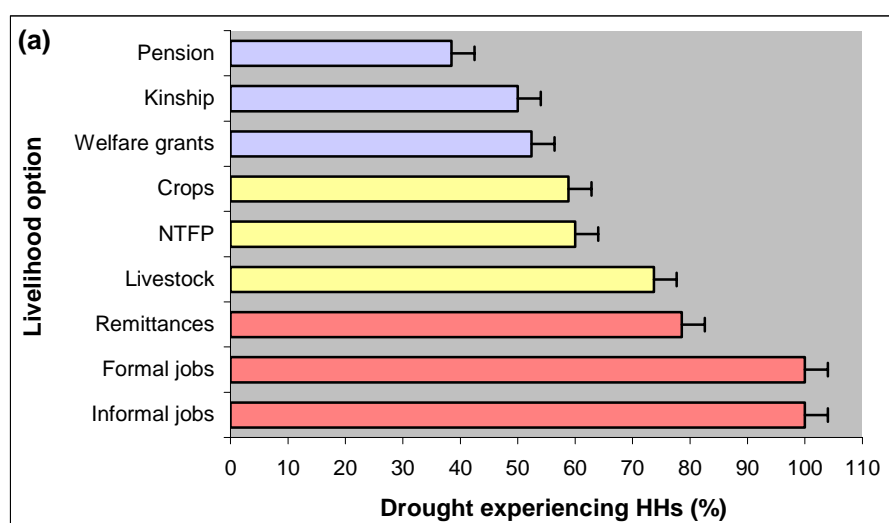


Figure 4a. The drought experiencing households (HHs) relative to the types of single livelihood profiles of households.

It was possible that households with multiple sources of livelihoods or highly diversified livelihood portfolios may be experiencing less severe impacts of drought compared to those with single or limited options (Figure 4b). However even if a household has more but poorly managed livelihood options, it will not make any difference in times of drought. This management will have to involve the preparedness for drought. Even the resource poor and livelihood limited households could have better capacities for preparing towards drought but may not be strong enough. In studying the responses of households to the effects of drought and other extreme events therefore, it is important to build into the methodology and processes, variables that will enable one to determine whether or not a household will be prepared for an extreme event. In addition, having several sources of livelihoods will not necessarily guarantee households' coping mechanism to drought as it will depend on the types of livelihoods. In Thorndale, it was observed that households with fewer livelihood portfolios had the highest proportion of households that experienced drought. Although there was an outlier involving a single household having the highest livelihoods yet experienced drought (Figure 4b).

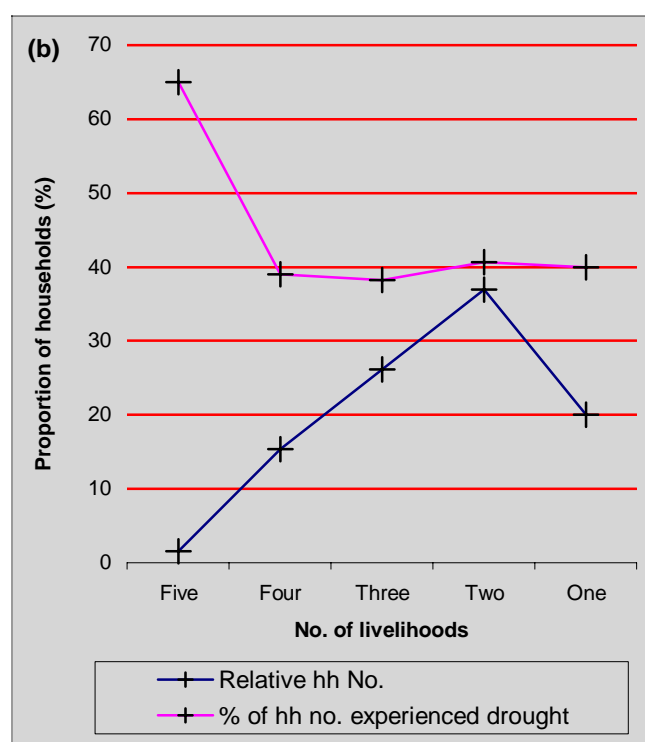


Figure 4b. The number of livelihood portfolios of households (hh) in relation to the proportion of those households that experienced drought in Thorndale, South Africa from 2002-05.

### 3.2. Households' responses to drought and biodiversity

It was observed that the common means of households to respond to drought in Thorndale either by coping or adapting was to depend largely on the natural vegetation. This response, having natural vegetation as the focus can be categorised into three:

- a) The selling of dead wood as fuelwood and stems for housing and fencing poles to raise funds to buy food in the short term, and towards savings and capital items for long term use once the drought subsided. As a result, households cited the "felling of tree" as the most important cause of land cover change in Thorndale (Figure 5).
- b) The second broad category was the clearing of vegetation to expand cropping fields in readiness for the rains and often towards the long-term response to drought. This may

however not be significant according to the opinion of the local people (Figure 5) although in terms of plant diversity it is a major source of disturbance.

c) Excessive livestock grazing, as those who managed to keep some animals, ensured that they optimised benefits from any available grass.

In addition to all the human-centred activities that could change the face of biodiversity, it is known that in South African savannas, intense drought may result in excessive heat and sparking natural fires that tend to destroy biodiversity. Deliberate burning to prepare land for farming once the rains come, has also been noted to result in the fires. Additionally, drought itself had direct desiccation effect on vegetation and disrupting growth and reproduction patterns such as the fruit setting of many species. Because drought is a direct source of disturbance, less resilient species may be eliminated whilst juveniles and least drought-adapted species may be killed. All these factors have a long-term impact on the regeneration and recruitment of species, and putting many species at risk of extinction because for some of them, their reproduction times will possibly coincide with drought. As a result, the villagers had every good reason to specify drought and fire among the top three causes of vegetation loss and hence land cover transformation in Thorndale (Figure 5).

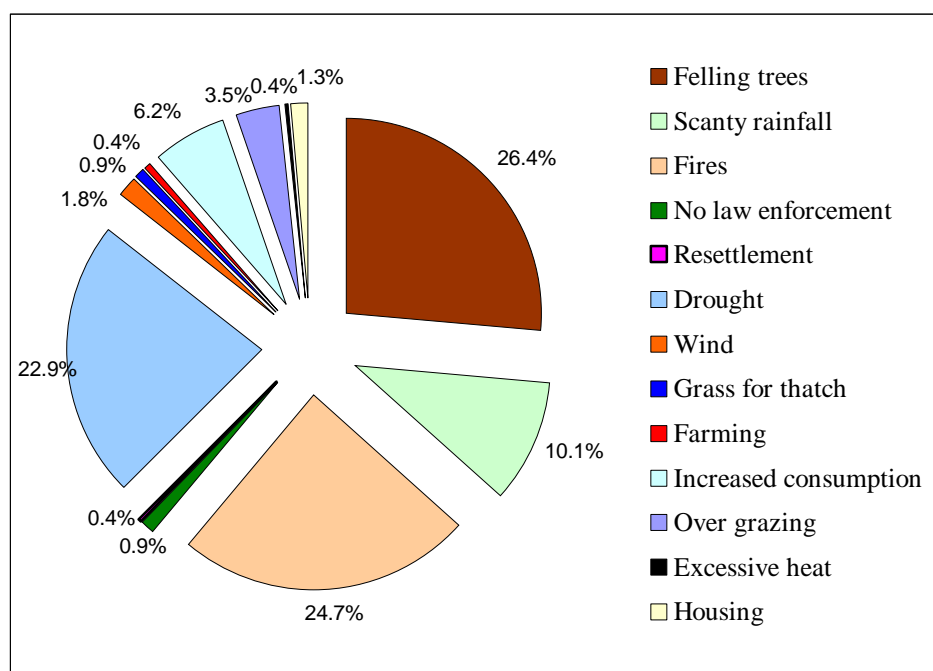


Figure 5. The relative proportion of households that cited various causes of land cover change based on their experiences in Thorndale.

## 4. ASSESSING VULNERABILITY TO GEC: OPTIONS AND CRITERIA

### 4.1. Background

Among the varied measurements of the vulnerability of a system to external perturbations is the notional poverty line and related cash income flows (e.g. Ravallion, 1998; Dercon and Krishnan, 1999; Pritchett et al., 2000). This has been the emphasis of the economics literature, using money as a metric for measuring and comparing the outcomes of vulnerability. Monetizing vulnerability outcomes is a relevant and convenient indicator but often failed to capture the value of social networks, and where less-resource endowed households possess highly diversified and short-term fluid portfolios that are not tangible to price. Valuable economic activities of the poor do not always require the use of money, sometimes rendering it

less important (Dovie, 2003). The lack of proper valuation of such activities often classified as ‘free’ (Dovie, 2003), undermines the monetary assessment of vulnerability. Monetizing vulnerability to global environmental change therefore has limited capacity to measure certain gains and losses, often too general, aggregating and failing to recognise societal heterogeneity. The inabilities of the measures to quantify and value changes associated with production, household and community supplies including food is a source of concern.

The sustainable livelihood approaches (e.g. USAID/FEWS, 1999; Downing, 2004), compared to the economics – based techniques to measure vulnerability relatively portrays a continuous process, considering both risks and responses and the involvement of appropriate stakeholders (Carney et al., 1999; Downing, 2004). This will also imply the inclusion of monetary or cash income dimensions because financial capital is an important part of sustainable livelihoods. Vulnerability therefore represents to a greater extent a continuous event rather than static. The context of the livelihood analysis framework to understand vulnerability is pursued here (a divergence from aggregate analysis of components and indicators of vulnerability).

#### **4.2. Defining “vulnerability” based on the findings of this study**

The study shows that the key measures of households’ vulnerability to the effects and impacts of drought can be based on (i) the stage at which households respond to the effects or impacts (time), (ii) the nature of the response and whether or not they are responding to the effects only, impacts only or both (Figure 6). The two stages therefore define the “vulnerability identity” of the typology of the household responding to the effects or impacts of drought. “Vulnerability identity” defines the different characteristics of the response groups and the accompanying response strategies. It can be assessed and built into strategies that help mitigate the effects and impacts of GEC. It also implies that a “vulnerability identity” will clearly define and isolate heterogeneous actors including the socio-economic identity of the different group. In Figure 6, the assessment of vulnerability has been based only on the effects of drought on the biophysical environment of which the outcomes include crop and livestock loss, and the responses by households. There emerges three response or affected groups (Figure 6) as,

- a) Response Group I: This group responds directly to the outcomes of the effects of drought. Its members may be involved in the direct production from the biophysical environment through farming, livestock production, the harvesting of plant resources, etc. They can be referred to as primary / proximate producers or suppliers of resources.
- b) Response Group II: The members of this group will more often depend on the activities of the first group and are therefore secondary to the effects of the drought (consumers only). However, they are the primary recipients of the impacts ensuing from the outcomes of the effects of drought. Members of this group may therefore not pursue direct remedy for the effects, provided they can use other means to control the outcome of the impacts.
- c) Response Group III: The members of this third group shared in the attributes of the first and second groups, experiencing the outcomes of the effects of drought and the impacts due to the outcomes of the effects. This is because they may either not be having the necessary resources to deal with the effects or impacts concurrently, or they want to optimise benefits.

The three groups will possibly interact at different scales with drought that needs to be understood. The failure to separate the different scales at which the groups may be operating will undermine any help to them to cope or adapt to the situation. Hence the reason why several

actions to assist communities to cope or adapt to or build resilience towards drought only results in only a few members of the community being successful with the majority failing. The response groups will also be affected by other internal and external factors that will define their resource security or insecurity (e.g. food availability). Such factors will include (i) the production system, (ii) consumption or dependence system, (iii) resource accessibility and distribution, (iv) options, and (v) resilience, among factors of market and price mechanisms.

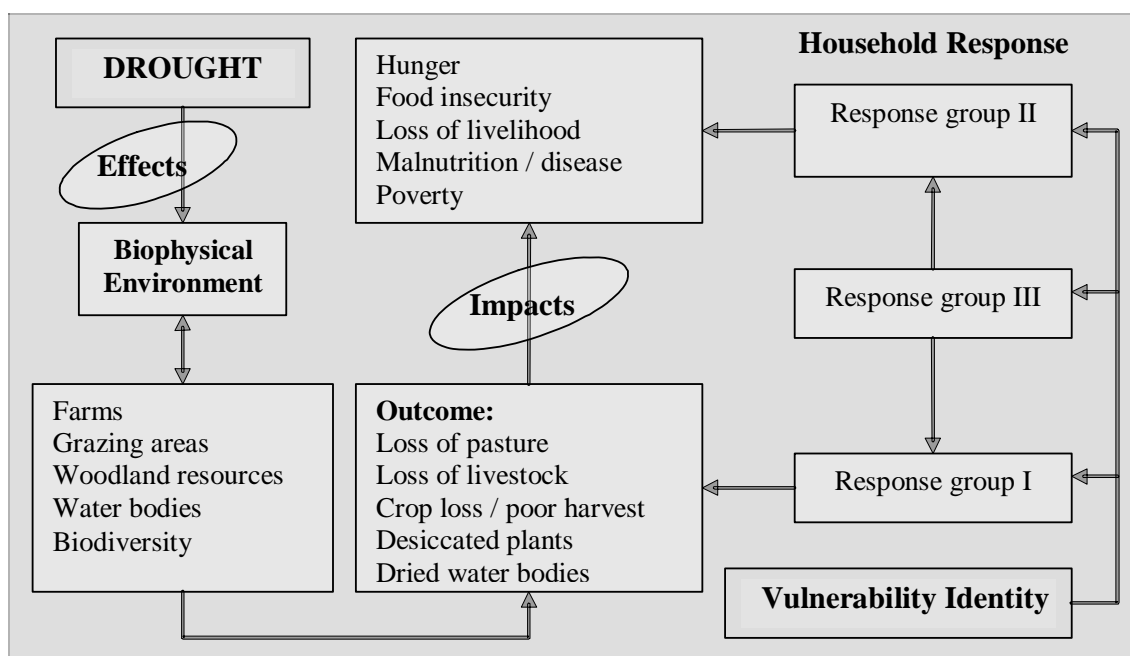


Figure 6. Tracing the vulnerability identity of rural households affected by drought based on the biophysical environment as the exposure unit in Thorndale, South Africa.

#### 4.3. Factors of resource security and assessment of vulnerability

(i) The production system

$$= \int [\text{abundance (quantity), supply, diversity}]$$

(ii) The consumption (dependence) system

$$= \int [\text{socio-economic and financial value, availability, extent of use, knowledge and skill}]$$

(iii) Resource accessibility and distribution

$$= \int [\text{demand, wealth status, marketing, transport, technical services}]$$

(iv) Options

$$= \int [\text{production, consumption, accessibility, opportunity cost}]$$

(v) Resilience

$$= \int [\text{options, response and adaptation}]$$

## 5. CONCLUSIONS

Within the confines of this study, the vulnerability of an exposure unit or a resource to global environmental change may be defined as a function of resilience, safety net and the identity of the particular response group, assuming that all the variables defined (section 4.3 above) hold. The continuous shift in the boundaries of those variables will imply that vulnerability to global environmental change will be dynamic for the different response groups. There is therefore the need to properly identify and define the limits and boundaries (vulnerability identity) of the three identifiable response or affected groups before any sustainable mitigation strategy can be pursued. The study reveals that households with very limited livelihood portfolios are most likely to be severely affected by the outcomes of drought than those with highly diversified portfolios. There was a conflict in resource use in times of drought and households frequently shifted to the natural environment for monetary benefits that will enable them to buy food because of the disruption in crop production, accessibility and distribution systems. The implication thereof is that food security issues in the rural communal areas of South Africa cannot be treated in isolation of the natural environment especially biological diversity. As a result any measurement of vulnerability towards the assessment of food security situations should account for the households' dependence on the natural environment. Additionally, the use of home / backyard gardens for subsistence food supply to fight drought needs to be fully captured and accounted for in the assessments of vulnerability. It is therefore argued that indices for measuring vulnerability need to be disaggregated to capture differences in the levels and processes of impoverishment and responses (coping and adaptation).

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Table 1. Response and adaptation to the effects and impacts of drought stresses in Thorndale, South Africa from 2002-2005.

Effects	Household response	Impacts		Household response to impacts	
		Households	Biophysical	Short-term	Long-term/adaptation
Loss of grazing areas	<ul style="list-style-type: none"> <li>livestock off-take by selling and slaughtering</li> <li>grass from other villages</li> <li>buying fodder</li> </ul>	<ul style="list-style-type: none"> <li>loss of income</li> <li>poverty</li> <li>school drop-out</li> </ul>	<ul style="list-style-type: none"> <li>land degradation</li> <li>erosion</li> <li>dead trees</li> </ul>	<ul style="list-style-type: none"> <li>selling wood and poles</li> <li>cooperatives</li> <li>relocation of livestock</li> </ul>	<ul style="list-style-type: none"> <li>expansion of livelihood portfolios</li> <li>community gardening and cropping</li> </ul>
Livestock loss	<ul style="list-style-type: none"> <li>relocation of livestock</li> <li>dependence on pension</li> <li>selling wood</li> <li>sold small animals</li> <li>support from neighbours</li> <li>used stored maize</li> <li>trade in used clothes</li> </ul>	<ul style="list-style-type: none"> <li>school drop-out</li> <li>loss of business capital</li> <li>poverty</li> <li>food insecurity</li> <li>high illiteracy rate</li> <li>family migration</li> <li>resource use conflicts</li> </ul>	<ul style="list-style-type: none"> <li>plant regeneration</li> <li>pollution by carcasses</li> </ul>	<ul style="list-style-type: none"> <li>sold cattle to buy food</li> <li>wood barter for cattle feed</li> <li>relocation to other villages</li> <li>destocking livestock</li> <li>cattle fed on anything green</li> </ul>	<ul style="list-style-type: none"> <li>having a manageable livestock</li> <li>diversifying livelihood options</li> <li>livestock restocking</li> <li>increased bank savings</li> </ul>
Food shortages/ poor harvest	<ul style="list-style-type: none"> <li>family lived on pension</li> <li>borrowing money</li> <li>sold wild fruits/carvings</li> <li>food parcels</li> <li>social networking</li> <li>stored maize</li> <li>worked for food/sold some cattle</li> <li>relocating to other villages</li> </ul>	<ul style="list-style-type: none"> <li>malnutrition</li> <li>disrupted household responsibilities</li> <li>big family to support</li> </ul>	—	—	<ul style="list-style-type: none"> <li>maize storage facility</li> <li>expansion of fields for cropping</li> <li>diversifying livelihood options</li> </ul>
Water shortage	<ul style="list-style-type: none"> <li>water from far villages</li> <li>digging springs in dried streams and around dams</li> </ul>	<ul style="list-style-type: none"> <li>no water for household use</li> </ul>	<ul style="list-style-type: none"> <li>plants and animals died</li> </ul>	—	—