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Susannah M. Sallu, Chasca Twyman and Lindsay C. Stringer

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Resilient or vulnerable livelihoods? Assessing livelihood dynamics and trajectories in rural Botswana

Sallu, S.M.[1], Twyman, C.[2] and Stringer, L.C.[1]

[1] Sustainability Research Institute, School of Earth and Environment, University of Leeds, Woodhouse Lane, Leeds, LS2 9JT, UK.
[2] Department of Geography, University of Sheffield, Winter Street, Sheffield S10 2TN, UK.

ABSTRACT

In this paper, we explore the resilience and vulnerability of livelihoods within two different socio-ecological dryland contexts of Botswana over the last 30 years. We draw on primary field data sources, including oral histories, livelihood surveys, ecological surveys, as well as documented evidence of environmental, socio-economic and institutional dynamics, to identify a broad range of activities that combine to create a range of different household livelihood outcomes. We use this information as a starting point to assess the ways in which livelihoods have changed over time, evaluating whether they have become more resilient or more vulnerable and considering the factors that have contributed to these outcomes. In the context of dynamic dryland social-ecological systems, we apply a livelihood trajectory approach to explore the shocks and stresses that affect livelihoods, and to elucidate the characteristics of livelihood strategies that contribute to increased resilience or vulnerability. We use the vulnerability framework proposed by Fraser (2006) as a means of framing discussion about vulnerability and resilience and as a means of identifying broader insights. The research identifies 'accumulator', 'diversifier' and 'dependent' households and the ways in which they move between these categories. More resilient livelihood trajectories can be achieved if the important role of formal and informal institutions is recognised.

Key words: livelihood trajectories, livelihood strategies, resilience, vulnerability, Botswana

INTRODUCTION

Pastoralism is an important component of many rural livelihood strategies within Botswana (Dougill et al., this issue). However, livelihoods also comprise a number of other non-pastoral activities, many of which depend on a variety of different components of the natural resource base (Sallu et al. 2009, Sporton and Thomas 2002, Twyman 2001, Scoones 1996). As such, many of the shocks and stresses that can destroy or damage the natural resource base can also adversely affect livelihood prospects over both the long and short term. In this paper we seek to investigate the resilience and vulnerability of rural livelihoods, and consider their relation to the dynamic natural resource base in two different socio-ecological contexts of Botswana. In doing so, we first outline some of the key concepts relating to livelihoods in terms of livelihood strategies, trajectories, resilience and vulnerability. We next outline the research process and develop a background narrative of the environmental and livelihood systems in our study area, qualitatively determining those factors (environmental and non-environmental) that contribute to the increased vulnerability and/or resilience. We apply

Fraser (2006; see also this issue) vulnerability framework to help us to understand these processes and to inform the direction of future interventions.

Livelihood approaches, resilience and vulnerability

Chambers and Conway (1992) define a livelihood system as comprising the capabilities, assets (including both material and social resources) and activities required for a means of living. The chosen combination of assets and activities, undertaken usually at the household level, is often referred to as the household's '*livelihood strategy*'. A livelihood strategy encompasses not only activities that generate income but many other kinds of elements, including cultural and social choices (Ellis 2000). Livelihoods approaches illustrate how, in different contexts, sustainable livelihoods can be achieved through access to a range of livelihood assets (e.g. natural, social, financial, physical and human capital) which, within the context of personal, institutional and environmental provisions and constraints, are combined in the pursuit of different livelihood strategies. Within the sustainable livelihoods framework (Chambers and Conway 1992; Scoones 1998) context is framed within the 'vulnerability context' which includes issues of 'seasonality', 'trends' and 'shocks'.

Carney (1998: 2) explains that "a livelihood is sustainable when it can cope with and recover from stresses and shocks and maintain or enhance its capabilities and assets both now and in the future, while not undermining the natural resource base". This interpretation of sustainability relates strongly to definitions that consider the 'resilience' of social-ecological systems. Walker et al. (2006: 2) define resilience as "the capacity of a system to experience shocks while retaining essentially the same function, structure, feedbacks, and therefore identity". As Marschke and Berkes suggest (2006: 2): "resilience offers a lens with which to explore stresses and shocks and to understand livelihood dynamics", and is "future oriented, and is used to characterise a system's ability to deal with change". By stresses we mean "enduring shifts" (such as seasonality and trends) and shocks "transient disruption" (cf. Leach et al. 2007). Incorporation of ideas surrounding resilience alongside understandings of vulnerability can contribute an essential temporal dimension to analysis, allowing the combinations of strategies and circumstances that move households towards more resilient outcomes over time to be identified, ultimately enabling them to embrace change as a result of shocks and/or stresses as opportunities for innovation and accumulation (Folke et al. 2002). In this paper a focus on resilience can help us to learn from the past to inform future planning.

Fraser et al's vulnerability framework (this issue) draws on several elements of the livelihoods approach and in the context of this research stimulates the following questions:

- Does the agroecosystem have the resilience to remain productive in a changing vulnerability context?
- Do people have access to livelihood strategies that allow them to survive changes to the vulnerability context?
- Do the institutions have the ability, capacity and willingness to respond to a changing vulnerability context, especially in crisis situations?

In this paper we use this framework to inform discussion of the direction and dynamics of livelihoods over a 30-year time period. Through comparative research we provide a rich

contextual narrative, using this to explore those factors that in isolation and combination push livelihoods along particular '*trajectories'* towards vulnerability or resilience.

Bagchi et al. (1998) use the term '*livelihood trajectories'* to describe and explain the direction and pattern of livelihoods of individuals or groups of people (e.g. households). A livelihood trajectory approach allows the examination of an individual household's "strategic behaviour that is embedded in a historical repertoire, in social differentiation" (de Haan and Zoomers 2005: 43) and in perceptions of risk. Such an approach is sensitive to life histories (an individual's own 'story' of their changing livelihoods). A focus on livelihood trajectories allows a deeper penetration into the beliefs, needs, aspirations and limitations of people's lives, but one that is also contextualised in relation to power and institutions (de Haan and Zoomers 2005). An increasingly important application of the livelihood trajectory approach is in exploring the shocks and stresses that can affect livelihoods, as well as in elucidating the characteristics of the overall livelihood strategy that contribute to increased resilience or vulnerability.

METHODS

Data were collected in 2004 and 2005 when fieldwork was carried out as part of a larger research project that considered environmental, socio-economic and institutional dynamics in two of Botswana's remote rural settlements, Khawa and Kedia settlements in Central and Kgalagadi Districts respectively (Figure 1). These settlements were chosen for comparison as they were of similarly low economic status, classified by the government as 'remote area dweller' (RAD) settlements, yet representative of distinct social-ecological systems, with different environmental contexts, social compositions and histories. Social and environmental characteristics of each settlement are summarised in Table 1. Residents in both settlements had access to surrounding communal lands in order to pursue their livelihoods.

Figure 1
Table 1

A mixed-method approach was taken in collecting the data. Methods used included oral histories and in-depth livelihood trajectory mapping exercises (n = 17), as well as household-level livelihood and resource-use surveys (n = 98). These sought to identify the ways in which households use their environment, how environmental changes (drought, land degradation etc) affect livelihood decisions, and also how environmental factors interact with broader socio-economic and political processes to determine resource use outcomes and impacts on livelihood systems. Repeated vegetation and wild animal surveys were conducted before and after rains and time-series sets of Landsat images and aerial count data records were collected from the Departments of Surveys and Mapping and Wildlife and National Parks. Soil and climate data were collected from the Department of Surveys and Mapping and Department of Meteorological Services respectively (see Sallu (2007) for a more detailed outline of the methodology and data). Environmental change data were then analysed in conjunction with livelihood trajectory results, in order to elucidate the key dynamics of relationships between livelihoods and the natural resource base. The average time span covered by the investigation was limited to the 30 years between 1974 and 2005, primarily due to restrictions on the availability of climate, soil, vegetation and large wild animal data. Consideration of this 30-

year temporal frame nevertheless permitted incorporation of the periods of formal settlement establishment, which proved important in setting the boundaries of the livelihood context.

Data analysis took place throughout the period of information gathering. Initially, this was at a descriptive level in order to note any trends in the data but it progressed to a more detailed level as both qualitative and quantitative social and environmental information was drawn together. Qualitative data were coded through processes of indexing the data under emerging themes. This permitted the identification of the factors that played an important role in the construction of livelihood strategies. Consistent triangulation of the results highlighted any contradictions and similarities in the different data sources. Where contradictions were found, further iterative reflection took place in the form of focus groups in order to ascertain why and how the conflicts in information may have come about. This became a circular process that led to inductive interpretation and explanation, as the ecological information was gradually juxtaposed within the emergent socio-economic context. Quantitative data sets were analysed using multivariate statistics. Livelihood and environmental data were classified using cluster analysis and correlations tested using Principal Components Analysis (PCA). Landsat images were classified using ERDAS Imagine V.9 software and landscape-level changes detected from raster attribute comparison (see Sallu (2007) for a more detailed outline of data analysis procedures). Based on this analysis, we aimed to identify contemporary strategies and the nature of trajectories to which they lead. In doing this we also identified the key changes to the vulnerability context and the combination of factors which have led to more resilient or vulnerable livelihood outcomes. This is discussed in more detail in the next section.

RESULTS - TOWARDS A NARRATIVE OF RESILIENCE

Social-ecological dynamics

The productivity of the natural resource base in dryland Botswana is exceptionally dynamic, with the provision of ecosystem goods and services largely determined by the extreme environmental conditions that affect water, soil and landscape form. These include: large diurnal and seasonal temperature variations, low average annual rainfall (ranging from a minimum of <200 mm in the southwest to a maximum of >800mm in the northeast of the country), frequent and extended periods of drought (caused by cyclical (multidecadal) climate factors (Thomas and Shaw 1991, Batisani and Yarnal in press), sporadic heavy rainfall events (Bhalotra 1987, Goomes and Petrassi 1996, Figures 3 and 4), edaphic (soil related) variation (Ministry of Agriculture 1990) and hydrologic flux (McCarthy et al. 2003, du Plessis and Rowntree 2003, Figure 6). In particular, both natural and human-influenced riverine and lacustrine dynamics affect the ecology of landscapes associated with Okavango and Makgadikgadi systems in northern Botswana. These therefore have important impacts on our Kedia study area (see map in Figure 1). Soils in Khawa and in much of Kedia exhibit low fertility with limited key nutrient contents (N, P, K). Indeed, much of the country's northern, central and southern regions are unsuitable for cultivation (Buckley et al. 1987, Tolsma et al. 1987, Ministry of Agriculture 1990). Despite this, soil heterogeneity can be diverse leading to vegetative diversity equal to that of other savanna areas in Africa (Thomas and Shaw 1991). The resultant human responses to dynamism are manifest in the flexibility of livelihood activities. These are structured in such a way that people are able to take advantage of changing availabilities of and access to natural assets.

In the rural settlements in our study areas, livelihoods are highly dependent on biodiversity (Sallu et al. 2009) and the environmental dynamics outlined above create both opportunities for and threats to the livelihood strategies followed at different times. For example, soil heterogeneity plays a significant role in determining landscape and species diversity. In Kedia these dynamics have led to a diverse ecological landscape that is in stark contrast to Khawa where the landscape is edaphically homogeneous and less species diverse. The situation in Kedia thus offers more natural resource based livelihood opportunities than are found in Khawa, across a similar sized landscape.

In both settlements, livelihood activities are strongly influenced by the spatial and temporal variability of rainfall. In Khawa and in far southwestern parts of Kedia, this results in patches, hot- or cold-spots of abundance, which punctuate the landscape, and create spatially and temporally distributed opportunities for gathering and hunting. Hotspots of water-rich veld fruits such as the wild water melon (*Citrullus lanatus*) and cucumbers (e.g. *Cucumis africanus* and *Acanthosicyos naudinianus*) for example, were witnessed in patches of duneveld beyond 13km from Khawa after heavy rain in 2004 (Figure 2). These particular hotspots provide water and nutrient rich resources for wild animals, livestock and humans during the dry season. If accessible, they provide valuable opportunities in times of inner-settlement food and water scarcity, thus making an important contribution to wider livelihood systems (Figure 3).

Figure 2
Figure 3

Environmental change

The inherent dynamics described above create diversity in otherwise homogeneous and species poor semi-arid landscapes and provide spatially and temporally limited opportunities for different livelihood activities. However, longer-term and larger-scale environmental changes have altered the vulnerability context over the past 30 years and have influenced the livelihood trajectories that households have followed. This section considers five significant environmental changes that have occurred in either one or both of our study settlements over this time period.

1. Mid-1980s drought. Both settlements experienced prolonged drought in the 1980s, beyond the inherent rainfall variability that characterises dryland environments (Figure 4). This led to a significant reduction in the diversity and productivity of vegetation (Sallu 2007), and rapid declines in wild animal populations (Table 2; Williamson and Mbano 1988), limiting both the potential for hunting and the available graze and fodder resources for pastoralism. Whilst the ecology in these dryland systems has evolved to withstand drought, the prolonged nature of this event resulted in changes that exceeded the magnitude and extent of that associated with normal rainfall variability for the area. This drought created a shock within the dynamic system that affected both of our study settlements.

Figure 4
Table 2

2. Late onset of rainfall. Whilst no significant long-term change in average annual rainfall occurred between 1974 and 2004 in either settlement, data obtained from the Department of Meteorological services shows that peak monthly rainfall in Khawa started to fall an average of one month later than usual after 1984. Peaks in mean monthly rainfall between 1985 and 2004 fell in the months of February, March and April compared to January, February and March between 1975 and 1984 (Figure 5). Above average levels of rain fell in the period 2000-2004 (Figure 3) with the largest amounts of rainfall occurring in April. This has important implications for the productivity of vegetative growth (Tadross et al. 2005). If peak rainfall periods occur late in the season, low winter temperatures and frosts (usually in June, July and August) may kill plants before they are fully mature. This has detrimental knock-on effects for the production of human foods such as wild herbs and fruits, wild medicines, plant-based materials used as building products and for crafts, rainfed cultivation, and the availability of graze and browse resources for cattle and wild animals. This was an issue of particular concern in Khawa settlement, where diurnal temperatures were greatest. Whilst it is difficult to conclusively link this stress to global climate change because of the inherent dryland rainfall dynamics described above and limited data with sparse spatial coverage, Tadross et al. (2007) show increasing evidence that there may be links between climate change and the reduced length of rainfall seasons in southern Africa.

Figure 5

3. Increased unpredictability of rainfall. In Kedia, there was a clear trend towards increased annual rainfall variability after 1996, with greatest volatility noted during the most recent time period, between 1996 and 2004 (Figure 4). Increased variability has resulted in increased unpredictability of rainfall-dependent natural capital resulting in years of either boom or bust, with little in between. In particular, this stress on the system has increased the risks associated with rainfed cultivation, resulting in significant impacts on the provision of livelihood opportunities. No such trend was seen in Khawa.

4. Drying of Lake Xau. During the mid-1980s in the context of changes to rainfall patterns and the prolonged drought, Kedia experienced significantly reduced water flows in the Boteti River (Figure 6). Coupled with infrastructural developments in the river channel upstream (Zufferey 1983), this contributed to the complete drying of Lake Xau by 1984 (Cashdan 1985). Although in some years the lake has been known to dry up, to date the waters have not returned. This has resulted in the eradication of a seasonal surface water resource, the extinction of fish and water-dependent species such as hippopotamus (*Hippopotamus amphibus*), crocodile (*Crocodylus niloticus*), reeds ('lethaka') and water lilly (*Nymphaea nouchali*) in the area, significant changes in vegetation composition, structure and functioning and the cessation of flood recession cultivation (Sallu 2007). In turn, this added stress had an important impact on the provision of livelihood opportunities.

Figure 6

5. Land degradation. In both settlements, land degradation (manifest as soil erosion and compaction, salination and vegetation changes at a variety of scales) has also become an emerging environmental constraint through the associated decline in productivity it represents. Data from vegetation surveys illustrated that degradation was most typically

recorded within close proximity of settlements, cattle posts, watering holes (boreholes or wells), and transport routes (roads and tracks) (Sallu 2007). As was seen in Kedia during the mid-1980s, temporary deterioration of the land was also commonplace, particularly in areas seasonally frequented by large numbers of wild herbivores (Sallu 2007). This additional system stress meant that herders had to travel further afield to access water and suitable grasses for their cattle, while opportunities for hunting and arable cultivation as livelihood activities also decreased.

Contemporary livelihood strategies

In the context of these environmental dynamics and livelihood struggles, and despite significant socio-economic and cultural differences within settlements (Table 1), three major groups of households, conducting similar or related livelihood activities, were identified in 2004/5 (Figure 7). These strategy groups were classified using cluster analysis performed on household livelihood survey data. A description of the key characteristics of the households and livelihoods of each cluster group is presented in Table 3. Principal activities determining strategy differentiation determined by PCA can be linked to Fraser et al's vulnerability framework (this issue), and include: 1) ownership of livestock (Fraser et al's 'access to assets'), 2) the cultivation of arable crops (Fraser et al's 'capacity of ecosystem to remain productive'), 3) reliance on government-provided social security benefits[1] (Fraser et al's 'strength of formal and informal institutions'), and 4) permanent and temporary employment (Fraser et al's 'access to assets') (Table 3).

Figure 7
Table 3

A small number of households (13% in Khawa and 7% in Kedia) with a tendency to specialise and thus accumulate large numbers of livestock, described here as 'accumulators', existed in each settlement (Figure 7). In many cases, accumulator households accrued income mainly through permanent and/or temporary employment and livestock (e.g. Case 1 in Table 4). In Kedia investment was also directed to arable cultivation, with money being spent on inputs such as land, seeds and/or labour (e.g. Case 4 in Table 4). As well as occupying financially superior positions within communities, accumulators were often politically powerful; the majority of whom either currently, or in the recent past, had assumed a leadership role (e.g. village chief, village development committee chairman, remote area dweller programme assistant, councillor) in the settlement (e.g. Cases 1 and 4 in Table 4). This sector of society therefore represented a politically as well as economically influential sector of the community, similar to Peters' (1984) 'rural elite'. Ethnic bias was noted too. Elite accumulators were generally composed of dominant Batlharo and Bakalanga descent in Khawa and Kedia respectively (Table 3).

A more varied strategy, undertaken by what we have called 'diversifiers', was followed by 26% of households in Khawa and 25% of households in Kedia (Table 3, Figure 7). These households tended to distribute effort across multiple livelihood activities with lesser tendency towards specialisation (reflected by moderate livestock units (LSUs), Figure 7).

[1] For detailed information about social security benefit provision in Botswana for the period 2004/2005 refer to URL: http://www.ssa.gov/policy/docs/progdesc/ssptw/2004-2005/africa/botswana.html.

Whilst these households were typically composed of a range of ethnic groups, minority groups such as Bakgalagadi in Khawa, and Banajwa and Bakwena in Kedia, were absent.

Finally, a "dependency strategy", undertaken by 'dependents', was followed by the remaining households. Households within this group were characterised as smaller than average in size, with low (e.g. 10) to zero LSUs, and were highly dependent on social security benefits. In Kedia, household members were also frequently employed as herders or labourers for other members of the community, often based outside the settlement (Table 3, Figure 7). This category comprised the majority of households in both settlements (Figure 7) and households were typically composed of a range of ethnic groups. In both settlements this included minority groups, and in Kedia, involved a high proportion of Basarwa (Table 3).

Livelihood trajectory analyses

As a means of teasing out the relative importance of each of the multiple interacting factors that resulted in the contemporary livelihood strategies presented above, detailed investigation of livelihood trajectory data for 17 households across the two settlements was conducted for the 1974-2005 period. Some of the trajectories encountered are illustrated through the narrative cases presented in Table 4. Whilst Table 4 clearly illustrates that trajectories were unique to households, some generic trends were evident. These trends are drawn out below.

Table 4

Khawa settlement

Between 1974 and 2005, trajectories of elite accumulator households in Khawa were primarily aimed at building up asset bases with periodic peaks and troughs, mainly the result of a gain or loss of employment, livestock disease and/or drought (e.g. Case 1, Table 4). Asset accumulation in Khawa focussed on the conversion of employment income into physical assets, primarily the expansion of livestock herds, and investment in improved access to water and transport. It is well known that in some arid and semi-arid environments (in particular those where stock mortality is density independent) that the maximisation of stocking densities helps to ensure long-term survival after drought stock loss (Campbell et al. 2006, Barrow et al. 2007). With only a small number of elite accumulators and an expansive communal rangeland landscape, which is largely functionally intact beyond 4km of the settlement, cattleposts or boreholes, this accumulative strategy led these household livelihoods to become increasingly resilient to environmental changes over time. In addition, investment in improved access to water increased household resilience to drought-induced water stress. Access to transport (in particular a vehicle) improved resilience to degradation as well as drought. The availability of transport improved access to areas that were rainfed and/or most ecologically intact outside the settlement. Transport also facilitated access to external institutions and distant markets for the direct sale or purchase of goods. As socially and politically elite members of the community, members of accumulator households were best placed to predict, monitor and adapt to economic and institutional changes, and therefore most likely able to position themselves to achieve the most resilient trajectories in the face of environmental change.

Over the same time period, many households in Khawa following a dependency strategy had not demonstrated such resilience in their livelihoods (e.g. Case 3, Table 4). These households,

were especially vulnerable to the combined impacts of drought and degradation, particularly over the past 15 to 20 years, with many failing to recover from the prolonged mid-1980s drought. A lack of financial income and limited access to water and transport coupled with a range of institutional and policy-related changes (one of the factors that Fraser et al's vulnerability framework identifies as a key for the successful management of environmental shocks) meant that these households had not been able to overcome drought shock or degradation stress. The most significant institutional and policy changes affecting these households in Khawa have been 1) changes to the hunting-licensing system on hunting-associated livelihoods; 2) settlement-specific trends towards elite-capture of productivity hotspots and water resources in the settlement; 3) a failure in the effective provision of government support and 4) the breakdown of social capital within the community. Both 1) and 2) have reduced non-accumulator households' access to water and ecological diversity, decreasing their options with regard to the livelihood activities they can pursue, and increasing their vulnerability to drought and degradation. Shifts to a new quota-licensing system in Khawa, whilst providing more equitable community-wide access to wild animal (hunting) resources, have preferentially benefitted elite accumulator households, who were previously expected to purchase licences, and negatively affected the less-successful households, who now suffer more limited access and opportunities to generate income and/or food from this resource (e.g. Cases 1, 2 and 3, Table 4). Whilst government support prevented many dependent households from experiencing a total loss of resilience (e.g. a shift from a dependent strategy to a strategy that might be labelled as a 'leaver' – a household that is forced to leave the area and settle elsewhere to gain a new livelihood); the failure to effectively provision destitute (Case 3, Table 4) and disabled community members (Case 2, Table 4) with government support in this community (the reasons for which are unclear) failed to create opportunities for improved livelihoods or trajectory shifts amongst many households. In the context of fluctuating agroecosystem conditions, the ineffective distribution of support from the government, elite capture of natural assets, and the general breakdown of social capital within the community (e.g. breakdown in inter-generational and intra-family support e.g. Case 5, Table 4), several diversifier households also experienced a downward trajectory shift from diversifier to dependent over the study period.

Kedia settlement

Household livelihood trajectory trends in Kedia differed from those of Khawa due to both social and environmental differences between sites. Since the 1970s in Kedia, trajectories of accumulator households, composed entirely of the Bakalanga ethnic group (Table 3), have consistently retained a tendency to specialise in livelihoods built upon pastoralism and arable cultivation. Similar to accumulator households in Khawa, these households have been subject to peaks and troughs in their livelihood activities over time. They have focussed on the accumulation of livestock, access to water and land, through the investment of income generated from salaried employment, as a means to build up asset stocks (e.g. Case 4, Table 4). The trajectories of the accumulators in Kedia however, demonstrated greater vulnerability to climate shocks over the same time period. With less opportunity for elite capture, only one accumulator household studied in Kedia (Case 4, Table 4) was able to re-accumulate livestock to pre-1980s drought levels by 2000, and even though re-accumulation had been possible, it had occurred at a much slower rate than in Khawa. Livestock assets of all accumulator households declined due to drought-induced starvation and/or thirst which was compounded by the drying lake and increased degradation. Restrictions to the area available for grazing

over time, due to the introduction of veterinary fencing dictated by government policy (1988 and 1996) and increased competition from nearby settlements, has increased grazing pressure, reducing the ability of the agroecosystem to remain productive. This has created or increased the likelihood of density dependent livestock mortality. Coupled with the amplified risks associated with cultivation under less predictable rainfall regimes and dry lake conditions, it is not surprising that accumulator household livelihoods have become increasingly vulnerable to climate-induced shocks. For example, since the mid-1980s drought, successful large-scale cultivation in Kedia has only been achieved once, in 2000 (Cases 4 and 7, Table 4).

With regard to the impacts of this vulnerability on livelihood trajectories in Kedia, it has caused some accumulator households to shift to a more diversified strategy (e.g. Case 5, Table 4). In some cases however, reduced human capital (e.g. as a result of within-household sickness, ageing, death or outmigration of household members) and/or reduced social capital (e.g. reduced family support, trust and/or reciprocity), and policy changes have compounded the extent to which a strategy can remain resilient. As such, factors beyond the environment clearly also exacerbate the stress and cause shifts in livelihood trajectories. It is therefore apparent that Fraser et al's (this issue) 'capacity of agro-ecosystems to remain productive', 'capacity for individuals to adapt based on access to assets' and the 'strength of formal and informal institutions', have all proved relevant in determining the direction of these households' trajectories.

Households characterised as following diversified and dependency strategies in Kedia, whilst also following post-1980s downward trajectories, also showed greatest resilience to climate-induced shock and/or stress. These less accumulative and less specialised livelihood strategies, and/or those reliant on the effective functioning of social security mechanisms (either or both government and traditional) had fewer accumulated assets to lose and access to a wider range of livelihood activity or substitution options which facilitated the absorption of shock effects and prevented strategy shifts. Indeed, over the historical period covered by our study, the livelihood strategies of Basarwa in Botswana have seen a long-term shift towards diversification. Since formal settlement establishment in 1978, many Basarwa in Kedia have become increasingly involved in pastoralism and cultivation as well as maintaining their more traditional focus on hunting, gathering and fishing (see Case 7, Table 4). Whilst opportunities for fishing ceased when the lake dried in the mid-1980s, and for hunting, when restrictive permits were introduced, skills in crafts, gathering and in-conspicuous (illegal) forms of hunting, typically common amongst the Basarwa, have provided opportunities for greater livelihood resiliency. In contrast, livelihoods that were solely dependent on more climate-sensitive activities e.g. strategies specialising in cultivation and/or pastoralism, common amongst the Bakalanga, were typically more vulnerable. The practice of a diverse range of activities therefore helped to buffer the stresses and shocks of the 1980s, limiting the overall impact on livelihood trajectories.

The government's effective provisioning of financial, nutritional and educational support to children, destitutes, orphans and the elderly in Kedia, coupled with strong traditional social security mechanisms (which were of particular importance to the livelihoods of Basarwa and Bateti groups – e.g. Case 6 and Case 7, Table 4) led none of the diversifier or dependent households to experience such a radical loss of resilience that pushed them to leave the settlement. Family and friendship sharing networks (cf. Silberbauer 1981, Kent 1995) outside

the settlement, and in many cases beyond the veterinary fences surrounding the settlement (e.g. Case 7, Table 4), buffered the livelihood impacts of agroecosystem stress caused by degradation and drought. Such mechanisms allowed family members or friends to provide support through the sharing of each other's advantage or disadvantage (e.g. a gain or loss of physical, financial or natural assets). This opportunity to access and utilise social networks and thus benefit from high social capital maintained the resiliency of such livelihoods as it allowed risks to be spread over a wider geographical area. It is clear therefore, that in Kedia, formal and informal institutions (cf. Fraser et al's vulnerability framework (this issue)) have played a key role in reducing vulnerability amongst dependents during the time period of study.

DISCUSSION - TOWARDS FUTURE LIVELIHOOD RESILIENCE

In both Kedia and Khawa settlements there were some generic choices which, if taken, increased the likelihood of a livelihood trajectory increasing in resilience between 1974 and 2005. These included:

1) Accumulation of financial assets (through waged- or self-employment, business and/or the sale of natural and/or physical assets)
2) Investment in and accumulation of physical assets (e.g. land and diverse herds of livestock)
3) Opportunistic and strategic diversification of livelihood activities
4) Diversity within livelihood activities (e.g. investment in a range of stock types and planting of a mixture of crop types
5) Investment in improved access to water
6) Investment in transport
7) Access to government support for elders, disabled and destitutes.

Factors precipitating a shift towards increased vulnerability were typically:

1) Loss of livestock
2) Reduced access to natural assets (environmentally or policy determined)
3) Reduced diversity of livelihood activities conducted / loss of livelihood activity/option.

In light of the continued heavy reliance of remote rural households on natural assets, the impacts of current and past dynamics and the potential future impacts of climate change in the Kalahari (Thomas et al. 2005) on these agroecosystems, there is likely to be an increasing role for formal and informal institutions in reducing vulnerability in Botswana. Clearly in the context of these two settlements, ensuring access to a diversity of assets is vital. In the face of increasing climatic uncertainty, the key challenges to maintaining the effective functioning of this social-ecological system include:

1) maintaining agroecosystem health to ensure adequate future supplies of natural resources (most essentially water, plant and wildlife resources);
2) preventing elite capture and accumulation of opportunities; and
3) ensuring opportunities for diversification and the generation of financial capital.

Many of these challenges could be addressed through the improved functioning of formal and informal institutions (cf. Twyman et al 2004). Developments that facilitate: 1) improved

efficiency and accuracy of the distribution of government support; 2) the adaptive management of dryland agroecosystems to ensure accommodation of dynamics rather than the imposition of stability and control; 3) more equitable access to natural resources; and 4) more equitable access to diversification opportunities and the accumulation of financial and physical assets, will assist. As was illustrated in both settlements, collective action within communities is required alongside that of the government. If such developments cannot be achieved, and the predicted impacts of climate change continue, households are likely to increasingly face the need to move in search of better functioning and more resilient social-ecological systems.

CONCLUSION

This paper has drawn on the concepts of livelihood trajectories and resilience to assist in the exploration of vulnerability in the drylands of Botswana. We used a combination of primary and secondary data to examine the inherent social-ecological dynamics in the study area and to categorise households into three different groups according to the ways in which their livelihood strategies exploited these inherent dynamics. Based on this information, we have qualitatively assessed those factors that contributed to the emergence of vulnerability and/or resilience, and elucidated five environmental changes operating independently of the inherent environmental dynamics that in many cases altered the vulnerability context and the overall direction of livelihood trajectories. In returning to the questions outlined earlier in relation to Fraser et al.'s framework (this issue), we have illustrated the combined influence of environmental change and formal and informal institutions in determining a household's access to and use of assets and therefore its ability to create more resilient livelihood outcomes. In some cases the agroecosystem remained productive in a changing vulnerability context and for some people their survival was supported by the combination of livelihood strategies they pursue and the institutional capacity and willingness relating to their particular context. Our paper has nevertheless indicated that the everyday details in each narrative have a profound influence on households' livelihood trajectories and resilience. In view of projected climate changes in this part of southern Africa and their potential impacts, these findings have highlighted the importance of formal and informal institutions in building resilience and the need for increased effort to ensure the most vulnerable households have access to a diversity of assets.

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Figures & Tables

Figure 1 Location of study settlements Khawa and Kedia, Botswana.

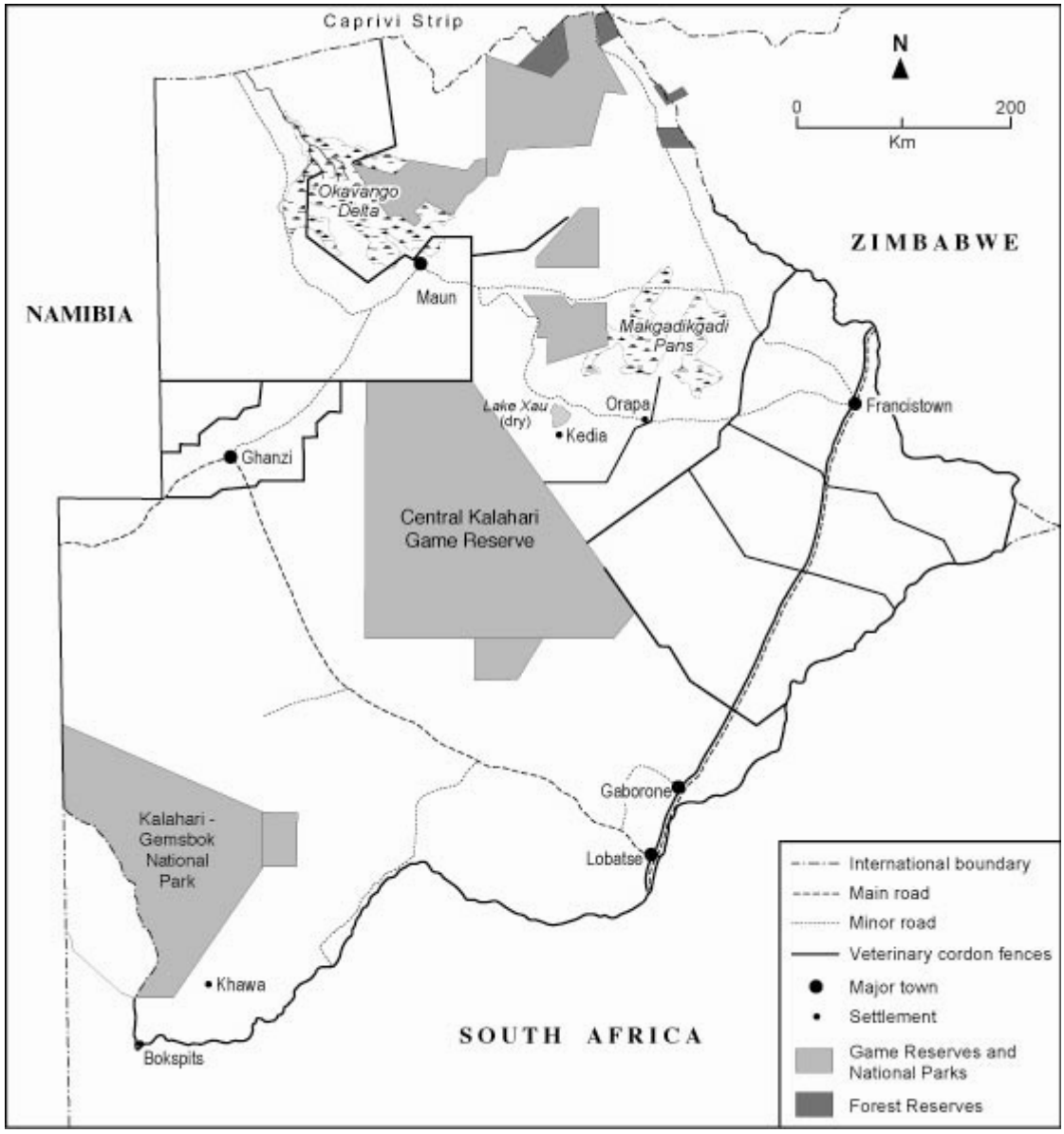

Table 1 Study site descriptions.

Study site	**Khawa settlement**	**Kedia settlement**
Geographical location	21°21'87.6"S 24°43'80.7"E	26°17'01.3"S 21°22'03.7"E
Vegetation (Olson and Dinterstein, 2001)	Desert and Xeric Shrubland	Subtropical Grasslands, Savannas and Shrublands
Diversity of soil types	Low	High
Hydrology (Thomas and Shaw 1991)	-	Lake Xau, Boteti River (Makgadikgadi-Okavango-Zambezi rift depression wetlands complex)
Average annual rainfall between 1995 and 1999 (mm)	129.8mm	386.5mm
History of human settlement	Short – first settled in 1974 when a borehole dug and equipped. Previously ancestral hunting and gathering grounds.	Long – archaeological evidence of settlement dating back to the Middle and Late Stone Age (Cooke and Paterson 1960; Helgren 1984).
Population size (Census, 2001)	510	805
Population size estimated from sampling (2004/5)	683	1033
Average number of people per household (2004/5)	9	6
Number of people interviewed in survey (number of oral history & trajectory mapping exercises)	58 (9)	40 (8)
Ethnic composition (2004/5) (cf Sporton and Thomas 2002)	Dominated by Batlharo (74%)	Dominated by mix of Bakalanga (43%), Basarwa (28%) and Bateti (13%) groups
Primary livelihood options (2004/5)	Pastoralism (goats, cattle, sheep, donkey); hunting (legal and illegal); veld product collection; employment (mostly temporary); small business (alcohol sales, leatherworks).	Pastoralism (cattle, goats); arable cultivation; employment; small business (alcohol sales, chicken/egg sales, baking, crafts); veld product collection, vegetable gardening; illegal hunting.
Primary food sources (2004/5)	Wild meat, wild vegetables, destitute rations, livestock, shop-bought foods.	Cultivated crops (e.g. maize, sorghum, beans, pumpkin, melon), shop-bought foods, livestock, wild vegetables, destitute rations.
Water availability (2004/5)	Drinking water rationed and supplied by bowser. Livestock water available from open-access community borehole and/or private syndicate borehole.	Drinking water available from taps in settlement centre. Livestock water available from private wells and open-access seasonal supplies of surface water.

Table 2 Population change of selected wild animal indicator species between 1970s and 1994 for the southern Kalahari system associated with Khawa (data sources: DHV 1980 and DWNP 1994 a, b; modified from Boggs 2000) and the northern Kalahari system associated with Kedia (data sources: Van Der Maas (1995) and Bonifica (1992). CKGR =Central Kalahari Game Reserve; MPNP = Makgadikgadi Pans National Park;. '-' refers to no data available.

Species	**Population change Southern Kalahari (1978-1994) (%)**	**Population change CKGR (1979-1994) (%)**	**Population change MPNP (1973-1994) (%)**
Zebra - *Equus burchelli*	-79.1	-	-58.5
Red Hartebeest - *Alcelaphus buselaphus*	-84.8	-95.8	-
Blue Wildebeest - *Connonchaetes taurinus*	-94.3	-87.1	-93.1
Springbok - *Antidorcas marsupialis*	-33.2	+375.1	-99.5
Kudu - *Tragelaphus strepsiceros*	+22.1	-	-65.1
Common Ostrich - *Struthio camelus*	-70.0	-66.6	-64.2
Eland - *Taurotragus oryx*	-	-8.2	-
Gemsbok - *Oryx gazella*	-	-0.8	-24.3
Giraffe - *Giraffa camelopardalis*	-	-59.8	-

Figure 2 Dry season hotspot of water-rich veld fruits (Citrullus lanatus dominant), 40km from Khawa settlement, August 2004. Such hotspots are typically positioned in patches that have received repeated localised rainfall events.

Figure 3 Villagers separating Citrullus lanatus flesh and seeds at a temporary camp, 40km from Khawa settlement, August 2004. Flesh is heated to form water and the seeds are pounded into flour for porridge.

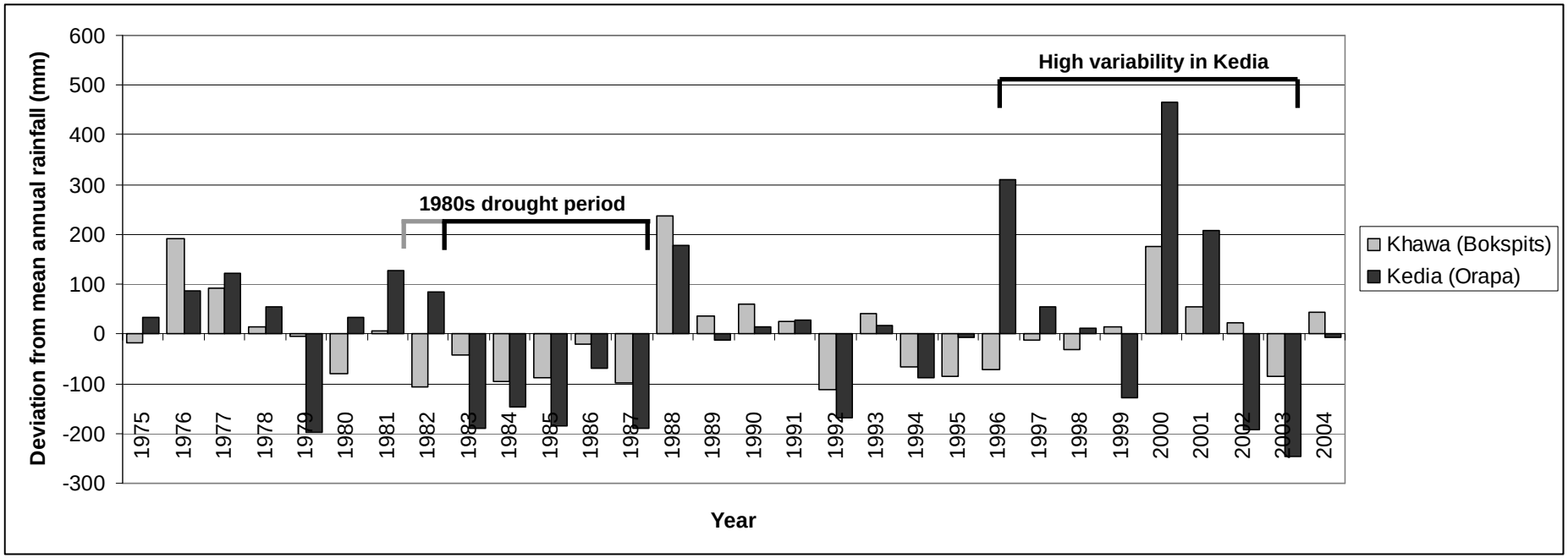

Figure 4 Rainfall variability in Khawa and Kedia between 1975 and 2004 as illustrated by deviations from mean annual rainfall. The 1980s drought period is evident from the recurrent and prolonged period of below average rainfall. Data from nearest weather stations - Bokspits (100km southwest of Khawa) and Orapa (55km east of Kedia) is presented. Data source: Department of Meteorological Services, Gaborone.

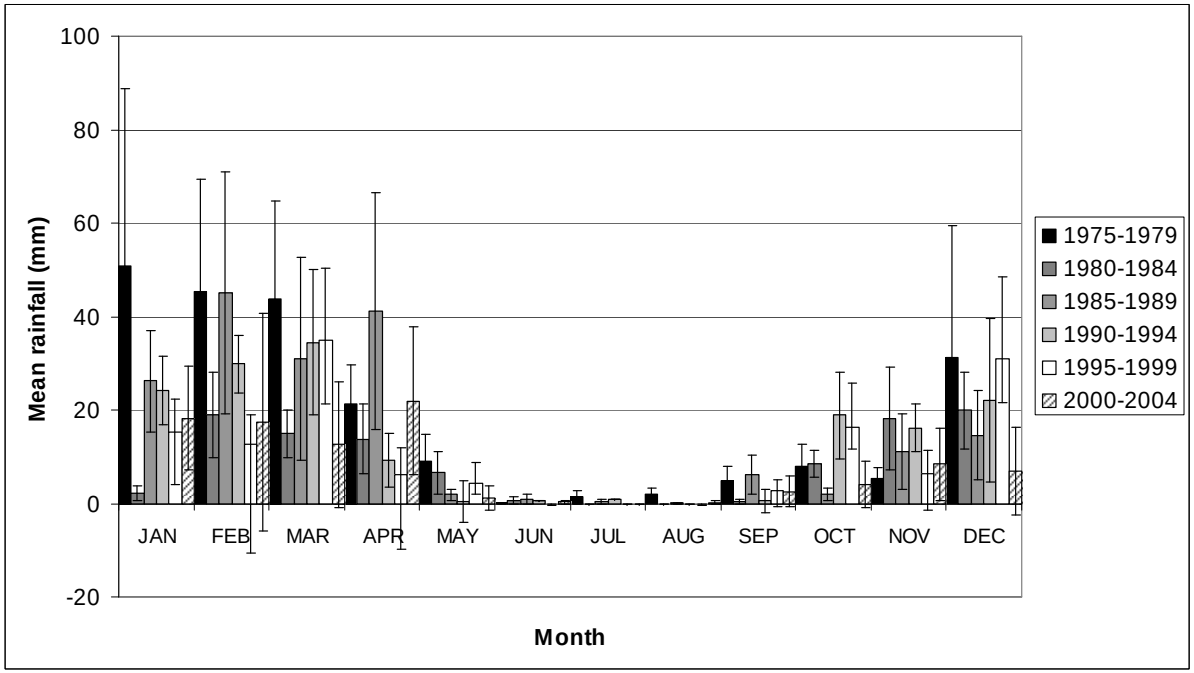

Figure 5 Monthly rainfall patterns for consecutive five year periods in Bokspits (100km southwest of Khawa), 1975-2004. Data source: Department of Meteorological Services, Gaborone.

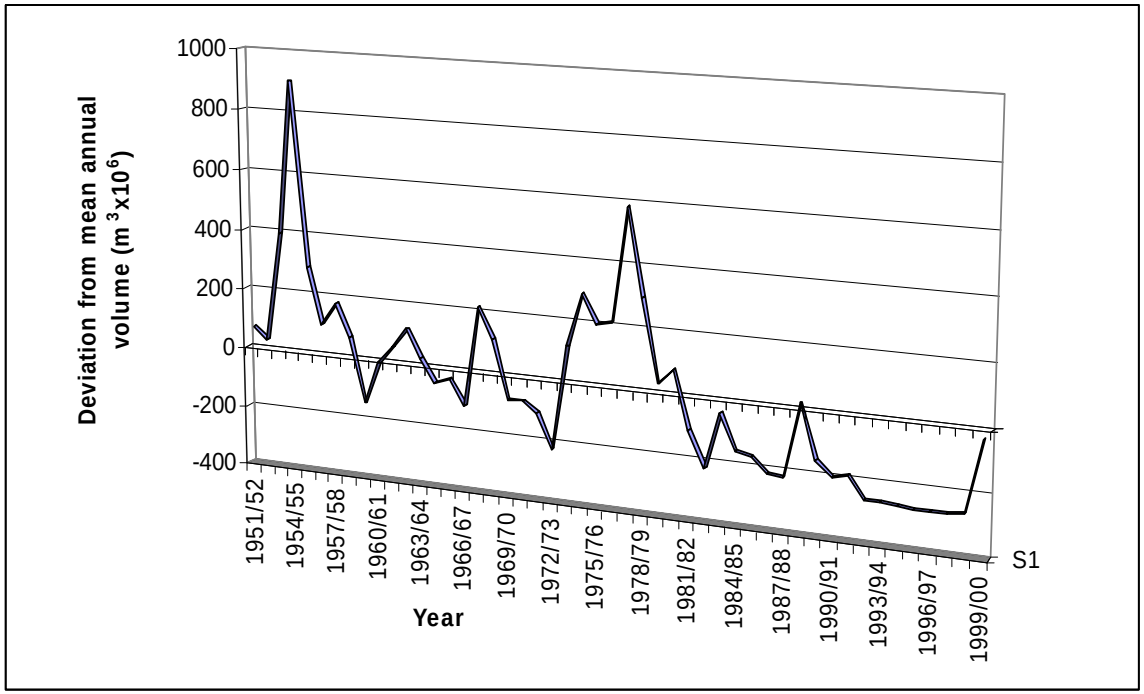

Figure 6 Drying of the River Boteti as illustrated by the deviation from the mean annual volume flow ($271m^3x10^6$) at Maun (1951-2000). Source: Sharing Water Okavango/Kubango Database online http://www.sharing-water.net/ Accessed - August 2006.

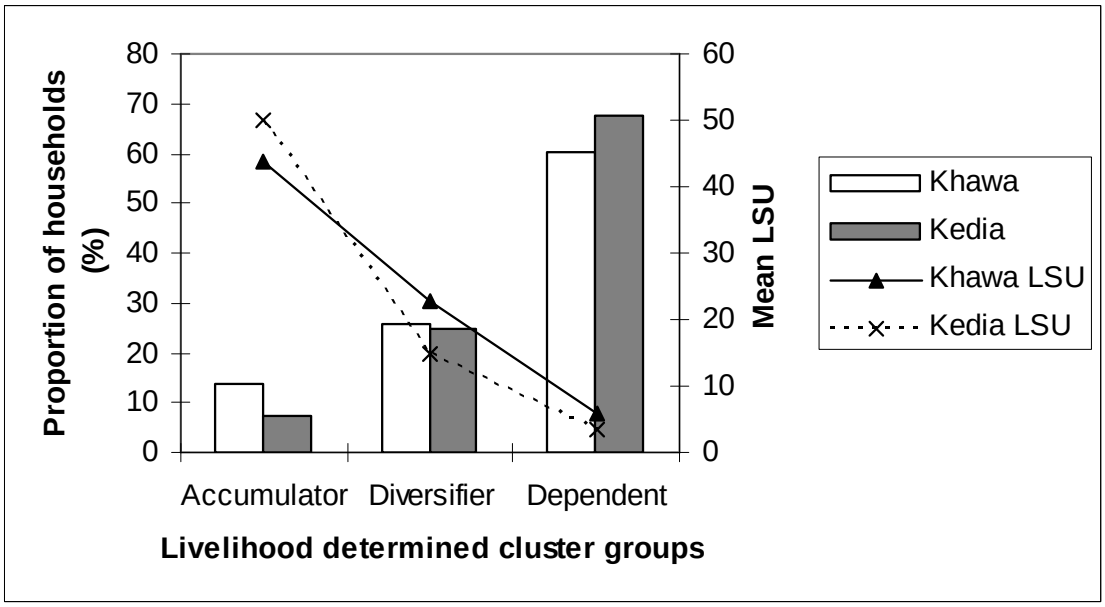

Figure 7 Proportion of households in livelihood-determined cluster groups (strategy groups) and respective mean livestock unit (LSU) values for each group in Khawa and Kedia in 2004 and 2005 respectively. Refer to Table 3 for full description of cluster group livelihoods. Livestock units: 1 cow = 1LSU, 5 goats/sheep = 1LSU (cf. Sallu 2007).

Table 3 Table showing livelihood strategies associated with household cluster groups, and the principal activities determining each strategy for Khawa and Kedia in 2004 and 2005 respectively. Principal activities were identified using principal components analysis. Differentiation of livelihood activities between cluster groups was more significant (clear cut) in Kedia than in Khawa with a greater proportion of the cumulative percentage of total variance explained in Kedia than in Khawa at each level of analysis.

Settlement	**Khawa**			**Kedia**		
Household cluster group	**Accumulator**	**Diversifier**	**Dependent**	**Accumulator**	**Diversifier**	**Dependent**
Livelihood strategy	**Diversified strategy *with tendency to specialise***	**Diversified strategy *with tendency for dependency***	**Dependency strategy**	**Specialised strategy**	**Diversified strategy**	**Dependency strategy**
Principal livelihood activities differentiating clusters (in order of significance)	Livestock specialisation often accompanied with permanent employment and/or commercial business.	Involved in broad range of activities. Greatest dependence of all clusters on child benefits.	Dependent on destitute relief, orphan relief, pensions and drought relief.	Livestock and arable cultivation specialisation.	Employment, commercial business, livestock and/or cultivation.	Dependent on destitute relief, orphan relief, pensions and drought relief, as well as household level income strategies (e.g. alcohol brewing, baking) and labourer activities (e.g. herding/digging wells).
Social Identity	- Pastoralist - Hunter - Employee (mainly working for government) - Syndicate members	- Pastoralist - Hunter-gatherer - Herder - Destitute	- Destitute - Hunter-gatherer	- Agro-pastoralist	- Employee - Agro-pastoralist - Hunter	- Destitute - Labourer

	- Settlement leader					
Ethnic Identity	**Mixed (Bakgalagadi absent)** 50% Batlharo 38% Bakgatla 12% Other	**Mixed (Bakgalagadi absent)** 73% Batlharo 7% Bakgatla 20% Other	**Mixed (Bakgalagadi present)** 77% Batlharo 9% Bakgatla 9% Bakgalagadi 5% Mix	**Bakgalanga** 100% Bakalanga	**Mixed (minority groups absent)** 40% Bakalanga 20% Bakurutse 20% Basarwa 20% Bateti and Bakgalagadi	**Mixed (include a high proportion of Basarwa and all minority groups)** 37% Bakalanga 33% Basarwa 15% Bateti 7% minority groups (Banajwa and Bakwena)
Average household size (average number of adults absent from settlement in 2004/5)	10.5 (1.4)	10.5 (1.4)	9.1 (1.5)	6.3 (1.7)	6.7(1.6)	6.2 (0.9)

Table 4 Livelihood dynamics and trajectories of example case study households.

	Trajectory (through time, T) and factors leading to resilience (R) and vulnerability (V)
Case 1 – Mr Thau, Khawa Batlharo, aged 54, living with his wife, 7 youth and 10 additional children. Thau moved to Khawa in 1985 with his wife and young children. They moved to benefit from the government support available. This included food and schooling for the children in particular. At this time Thau had 25 goats and 2 donkeys and a donkey cart. Once settled in Khawa Thau's family also started collecting veld products, engaging in leather works, and started to brew and sell traditional beer. In 1989 Thau's family stopped their leatherwork activities as an expensive licence was imposed on the sale of products. This did not significantly affect the household as in the same year Thau became Councillor for 5 years. He earned 700 Pula per month. He invested much of this money in livestock. He bought 2 cows in 1990 and then every month he bought a goat. He also invested money in a syndicate run borehole and a car. His wife cared for the livestock when he worked and by 1994 he had 150 goats and 10 cows, despite some losses to wild animals (4 cows killed by lions in 1992 but compensation from Wildlife Department granted). Whilst Thau was working, his wife and children collected veld products to supplement their diet. In 1994 and 1995, rains fell late so no veld products were available. Thau also depended on piece jobs and drought relief work during the 1990s e.g. between 1994 and 2002 Thau was a Member, and later Chairman of the Village Development Committee. In these roles he received cash sitting allowances. He continued to invest his income in livestock and also began paying a monthly fee to have a private water tap in his compound. In 1999 Thau's wife died, but in 2001 he remarried the Health Clinic Cleaner. In 2004 additional household income was achieved when Thau's daughter started working as the Manager of the Co-operative Shop. In 2004, due to low rainfall and degradation around the settlement grazing and water resources were limited. Due to his access to transport in the form of donkey cart and car (which facilitated the transport of water and food for those caring for the livestock), Thau sent his livestock 40km west to access an area of rangeland that had benefitted from rain earlier in the season (Figure 5). This area provided sufficient wild water melons (*Citrullus* sp.) and grazing to sustain his and other household herds for up to 3 months during the dry season. The extra nutrients gained from these resources enabled his goats to reproduce twice in that year leading to rapid growth in numbers.	*Accumulative trajectory – building resilience* T1, 1985 – Limited assets, low capacity of agroecosystem to remain productive, some collective capacity to cope through social security benefits. **R1. Diversification of livelihood activities** ↓ T2, 1990s – rapid accumulation of financial, physical and human assets, moderate capacity of agroecosystem to remain productive (rainfall higher, but degradation increasing), increasing individual and collective capacity to respond to crises as he became Councillor and his children get older, **R2. Salaried employment** **R3. Investment in livestock accumulation** **R4. Investment in transport** **R5. Investment in access to water** ↓ T3, 2000s – continued accumulation of financial, physical and human assets (children gained jobs), decreasing capacity of agroecosystem to remain productive, capacity to respond to agroecosystem decline high due to access to transport and private water source,

Case 2 – Mr. Mpoelang, Khawa Batlharo, aged 74, living with his wife, an adult son and two children (one of whom has Down's syndrome). Mpoelang was one of the first settlers in Khawa in the late 1970s. At this time the rains were so plentiful and appropriately timed that he was able to cultivate melons and beans in close proximity to the settlement. He was also hunting for wild meat and practicing leather works and the household was selling the leathers and dried meat (biltong) across the border into South Africa. At this time Mpoelang had 30 cows, 18 horses and a car. In the mid-1980s trade was no longer allowed across the border and he ceased cultivating altogether due to the drought and inappropriate timing of rainfall. In 1984 he also lost 15 cows and 18 horses to drought. In 1987 his household was not allocated a Special Game Licence and as a consequence they were no longer able to hunt. Despite this, Mpoelang was still able to conduct leatherworks by purchasing skins off those who were hunting and when the licence for selling leatherwork products was introduced, he purchased one. In the early 1990s, Mpoelang's livestock numbers slowly began to recover. There was however a set back in 1993 when 8 of his cows were struck by lightening. Between 2000 and 2003 they lost an additional 11 cows to lion predation. Financial compensation from the Wildlife Department, access to pensions and the sale of horses for cows allowed some recovery of cattle stocks. In 2000 Mr. Mpoelang's household started to benefit from the Quota system, with a small share of meat from the community-allocated hunt available for his household. In 2003 the household cultivated rain-fed melons on a small-scale with success near to the house. In 2004, the household remained with 3 horses and 7 cows. The child with Down's Syndrome was not receiving support from the government.	*Fluctuating trajectory* T1, Late 1970s – high capacity for agroecosystem to remain productive (high and appropriately timed rainfall, low numbers of people and livestock and no degradation), high levels of access to natural assets (horses), moderate to high accumulation of financial or physical assets (car, livestock), moderate capacity to respond (social networks, no trade or resource-associated restrictions, no formal institutions, transport). **R1. Accumulation of livestock in high rainfall years** **R2. Cultivation of crops in years of appropriately timed rainfall** ↓ T2, Mid-1980s – low capacity of agroecosystem to remain productive (prolonged drought, inappropriate timing of rainfall), limited natural assets (drought), some physical and financial asset stores (leatherworks), moderate capacity to respond (reduced from high by permits restricting hunting and border restrictions to trade). **V1. Loss of livestock** **V2. Loss of livelihood activity** ↓ T3, 1990s – moderate capacity of agroecosystem to remain productive, fluctuating financial, physical and natural assets, changing institutional support to assist household's capacity to respond. T4, 2000s – some capacity of agroecosystem to remain productive (ability to cultivate), some financial and physical assets (horses), moderate capacity to cope (trade horses for cows), high capacity to cope (access to pensions, compensation, quota meat and pension). **R4. Diversity of livestock types (spread risks)** **R5. Access to government support mechanisms to supplement livelihood activities in elder years**

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Case 3 – Mr. Bakghotu, Khawa Bakgalagadi, aged 66, living with his wife and no children. Bakghotu first came to Khawa in 1974 with his wife. At this time he was hunting and they were practicing leather works with the skins of *Otocyon megalotis* (bat-eared fox), *Canis mesomelas* (black-backed jackal) and *Pedetes capensis* (springhare). They were making cushions and rugs and selling them to people for money. In addition, they were collecting veld products for food and wild medicines for medicine and sale. Bakghotu was also engaged in woodcrafts. Between 1980 and 1992, as a destitute, they also received a Special Game Licence allowing them to hunt. Also the RAD programme provided his household with food rations, clothing and blankets. Between 1987 and 1988 Bakghotu was also employed for a short time on piece jobs. These combined activities allowed them to purchase a few livestock – goats, donkeys and horses. Bakghotu described himself as making "a very nice living up until the changes in licences". From 1989 Bakghotu was no longer able to sell his leatherworks without a licence and from 1992 when the Quota Hunting Licenses were introduced, he was no longer able to hunt for himself. Even in more recent years, a licence has been introduced to prevent to sale of *Sengaparile* (Devil's Claw - a medicinal plant) and the other veld products he used to collect for food, medicine and for crafts are now located far from the settlement due to increased degradation. These combined restrictions have severely limited the range of activities he is able to practice for his livelihood and with the loss of his livestock due to drought and predation, he is now dependent on the government. He now relies heavily on the old-age pension and destitute rations but complained of shortages in the destitute rations and reductions in the money provided to those in need.	*Degenerative trajectory - vulnerable* T1, 1974 – high capacity for agroecosystem to remain productive, high levels of access to natural assets, moderate accumulation of financial and physical assets (livestock), moderate capacity to respond (asset stock). **R1. Engagement in diverse livelihood activities** ↓ T2, 1980s – low capacity of agroecosystem to remain productive, retained access to some natural assets (hunting permit), limited access to other natural assets (drought), some physical and financial asset stores, moderate capacity to respond (RAD programme support). **V1. Loss of livestock** ↓ T3, 1990s – moderate capacity of agroecosystem to remain productive, loss of financial and physical asset stores, loss of access to natural assets (permit changes), increasing reliance on government support. **V2. Loss of livelihood activity** ↓ T4, 2000s – some capacity of agroecosystem to remain productive, no asset stocks, total reliance on government support. **V3. Sole reliance on government support**

Case 4 – Mr. Mathoa, Kedia Bakalanga, aged 51, widowed and living with 3 youth (2 present and 1 absent at time of survey) and 3 children. Between 1976 and 1979 Mathoa worked in Orapa. At this time he had very few livestock. In 1979 when he finished working he invested the money he had saved into livestock, mainly cattle and goats, the digging of a well and some cultivation. Between 1979 and 1984 the number of livestock units he owned increased from 19 to 57 due to the availability of good grazing, browse and access to water. He also managed to accumulate land. However, between 1984 and 1994, he lost 50% of his livestock to drought and no cultivation was possible. During this time, Mathoa gained employment with the Land Board and married a woman employed as a nurse at the clinic. The financial capital accumulated from both forms of employment allowed reinvestment in livestock and land after 1994. By 2005 he had 15 hectares of land (12 hectares one side of the settlement and 3 the other). The number of livestock units Mathoa accumulated peaked at 72 in 2000 after a particularly good rainfall year. Cultivation of sweet reed, maize, sorghum, watermelon and beans was also possible in this year. Food was generated for both subsistence and sale. During this period, Mathoa finished working with the Land Board and retrained as a welder. He also received small amounts of money at this time in his role as Village Development Committee (VDC) Chairman. The income generated through self-employment as a welder and from the VDC enabled him to maintain his livelihood status despite the death of his wife in 2004 and a drop in livestock units to 53 in 2005 after 2 successive years of below average rainfall. Some years (e.g. 2001) he was unable to harvest due to pest attack on crops.	*Stable trajectory - retained resilience* T1, Late-1970s-early 1980s – high capacity of agroecosystem to remain productive, access to and accumulation of financial and physical assets, moderate capacity to respond to change. **R1. Salaried employment** **R2. Accumulation of livestock** **R3. Improved access to water** **R4. Accumulation of agricultural land** ↓ T2, 1984-1994 – low capacity of agroecosystem to remain productive (prolonged drought and lakeside degradation), loss of some physical assets (livestock), high capacity to respond (employment, powerful social network). **V1. Loss of livestock** ↓ T3, 1994-2005 – moderate capacity of agroecosystem to remain productive (some rainfall but increasing unpredictability of rainfall, degradation), accumulation of financial and physical assets, high capacity to respond (self-employment, retained and expanding social networks) **R5. Salaried employment** **R6. Income generation from self-employment** **R7. Reaccumulation of livestock** **R8. Accumulation of agricultural land** **R9. Cultivation of a range of food crops** **R10. Sale of some of the harvested crop**

Case 5 – Mr. Mmegwa, Kedia Bakalanga, aged 76, married and living with one wife, 4 youth and 5 children. Mr. Mmegwa worked for 6 years in South African mines. Between 1951 and 1975 he lived in Xhumo and Beetsao. He was a healthy man who owned land and small shops. They used to cultivate enough to sell and managed to dig a well from the money this generated. Since their move to Kedia in 1975 they have not experienced a good harvest. Livelihood activities at this time instead specialised in livestock farming and small amounts of hunting around the lake. Livestock units in this household peaked at 163 in 1991. Mr. Mmegwa stopped hunting around this time as he considered himself to be rich. In 1993, however, Mr. Mmegwa's well was stolen and sold by someone else without his knowledge. This resulted in the death and/or loss of all his livestock and reliance on the only other livelihood activity contributing significantly to the household at this time, his wife's brewing and sale of alcohol. This activity protected the household livelihood from collapse, and over time, in combination with the collection and sale of medicinal plants and Mr. Mmegwa's monthly receipt of an old-age pension, has generated enough money to purchase livestock and access water once more. By 2005, the numbers of livestock in the household had reached 11 cows, 16 goats, 6 donkeys, 2 horses and 10 chicken. Despite several of Mmegwa's children being away from the settlement, either working or studying, none of them send remittances.	*Fluctuating trajectory with shift from accumulator-diversifier strategy* T1, 1975-1991 - fluctuating capacity of agroecosystem to remain productive, access to and accumulation of natural assets, high capacity to respond to change (financial and physical capital stores, social network outside settlement). **R1. Accumulation of livestock** ↓ T2, 1993 - moderate capacity of agroecosystem to remain productive (some rainfall but increasingly unpredictable, degradation, lake dry), loss of access to water, moderate capacity to respond (skills and knowledge to diversify activities). **V1. Loss of livestock** **R2. Diversification of livelihood activities** ↓ T3, 2005 – moderate capacity of agroecosystem to remain productive (some rainfall but increasingly unpredictable, degradation, lake dry), moderate access to assets, moderate capacity to respond (diverse skills, access to government support). **R3. Reaccumulation of livestock**

Case 6 Mr. Baitsile, Kedia Basarwa, aged 57, married and living with one wife, 1 other adult, 3 youth and 8 children. During the 1970s, Baitsile's household livelihood was composed of a range of livelihood activities including fishing, hunting, cultivation, livestock farming and veld product collection. Of greatest significance at this time was cultivation and veld product collection. In a good season he was able to cultivate up to ten 50kg bags of maize, ten 50kg bags of sorghum, eight 50kg bags of beans, as well as a plentiful supplies of pumpkin (maputse), green melon (marotse) and water melon (moghapo). Veld products collected after rain included the fruits of *Grewia* species (mogwana, moretlwa/ moseme, motsotsojane) and *Ximenia Americana* (moretologa), as well as the Mophane worm. He was able to sell some of these natural products. He described how in more recent time periods however (1990 onwards) that veld products have become increasingly scarce near to the settlement over time due to the numbers of people collecting such resources. During the mid-1980s, Baitsile was unable to cultivate due to poor rainfall, he was no longer able to fish due to the lake drying, veld products were significantly reduced due to low rainfall and he was no longer able to hunt due to permit changes. His livestock unit reduced from 13 in 1981 to 0 in 1991. In 1991 the only activity keeping the household going was government provided employment in the form of piece jobs laying water pipes. Between 1997 and 1999 Baitsile was employed by the Community Hunting Project. In 2000 after this project had ceased, the government gave Baitsile 15 cows. The number of livestock has remained similar since. In 2005 Baitsile gained employment as a night watchman at the shop.	*Fluctuating trajectory* T1, 1970s-early 1980s – high capacity of agroecosystem to remain productive, access to and accumulation of natural and financial assets, moderate capacity to respond to change. **R1. Accumulation of a variety of natural asset stocks** **R2. Cultivation of range of crops** **R3. Supplementary collection of wild food** ↓ T2, Mid-1980s – low capacity of agroecosystem to remain productive (drought, degradation, dry lake), reduced access to natural assets (permit changes, drought, dry lake), no ability to respond to change (low to no asset stocks). **V1. Loss of livelihood activity(ies)** ↓ T3, 1990s-2005 – moderate capacity of agroecosystem to remain productive (some rainfall but increasingly unpredictable, degradation, lake dry), some access to natural assets, moderate capacity to respond (government support and employment). **R1. Salaried employment** **R2. Reaccumulation of livestock**
Case 7 – Mr. Charlie, Kedia Basarwa, aged 34, married and living with one wife and two young children. Lives adjacent to his sick mother and elderly step father. When Charlie was growing up (late 1970s-early 1980s), their food came from the lake. They used to eat reeds and fish. When the lake dried life changed and as a child he can remember being hungry. Charlie was given 1 cow and 1 goat by relatives when he started his own household and by 2005 there were 5 cows and 4 goats. Some had died that year due to a lack of water. Charlie currently lives approximately 10km outside the centre of the settlement in an area of Mopane woodland. He spends much of his time now (2005) assisting his sick mother to care for her livestock, collecting and preparing medicines and wood-crafts, and illegally hunting for small game. Cultivation has not been possible since 2000 due to the irregular rainfall, and even when it is possible they have only a small amount of land to cultivate. Charlie's household has access to a well. The well is shared resource with other Basarwa families. His children are cared for by the government during school term time. They come home during holiday periods. The elder parents both receive a pension.	*Diversified trajectory – increasing resilience* T1, Late 1970s-early 1980s – high capacity of agroecosystem to remain productive, access to and accumulation of natural assets, low capacity to respond to change. **V1. Use of wild foods (lake products)** ↓ T2, Mid-1980s - low capacity of agroecosystem to remain productive (drought, dry lake), reduced access to natural assets (drought, dry lake), some ability to respond to change (family support, livestock). **V2. Loss of livestock** **V3. Loss of wild lake foods** ↓ T3, Late 1980s-2005 - moderate capacity of agroecosystem to remain productive (some rainfall but increasingly unpredictable, degradation, lake dry), good access to natural assets (living outside settlement), high capacity to respond (diverse skills, family support, access to government support). **R1. Diversification of livelihood activities** **R2. Accumulation of livestock**