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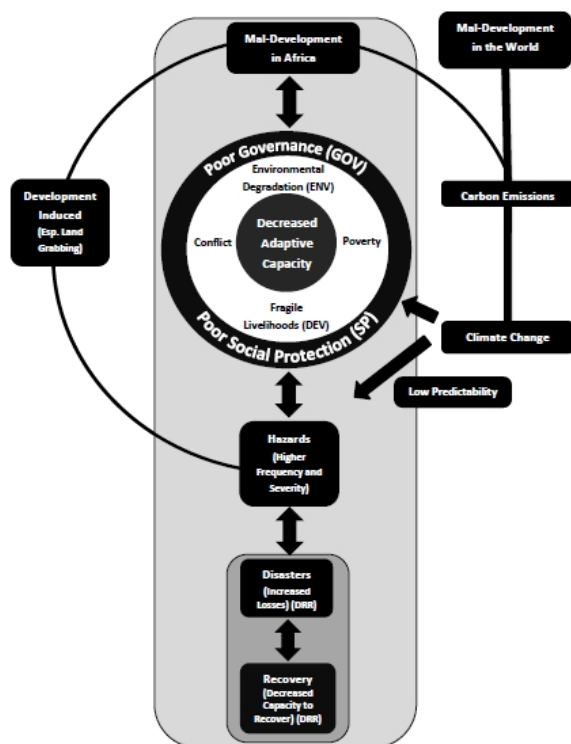
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## NOTE DE L'AUTEUR

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- 1 There is considerable interest in the synergism among sustainable livelihood development (DEV), disaster risk reduction (DRR) and community based climate adaptation (CBA) (*e.g.* Orr *et al.*, 2009; Duryog Nivaran et Practical Action, 2010). Such tightly coupled linkages are apparent at high, medium and low altitude in the North of Tanzania, where a team of researchers from Tanzanian and American institutions has been investigating the interplay of local and outside specialist knowledge in the process of spontaneous adaptation to many changes, including climate change. The relations among these processes are schematised in Figure 1.

Figure 1. Relations among DEV, DRR &amp; CBA

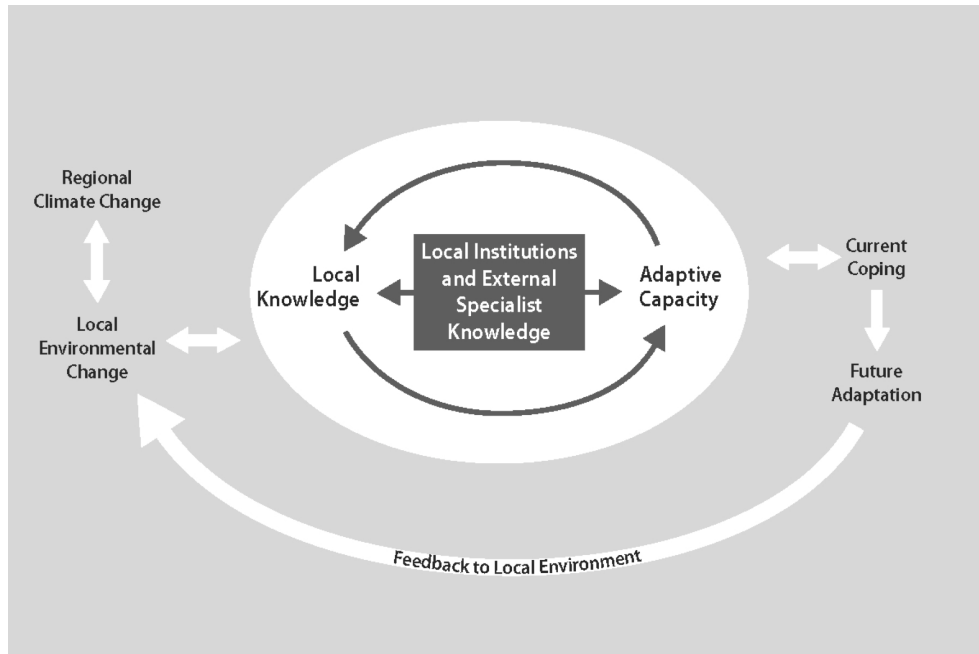


SOURCE: DURYOG NIVARAN AND PRACTICAL ACTION (2010)

- 2 Figure 1 provides an overview of global climate change processes and how they manifest themselves nationally and locally. At the centre of the figure, one sees the interaction among livelihoods, poverty, conflict and environmental degradation and the important reality that adaptive capacity is socially and spatially differentiated. Moving outwards from that core, Figure 1 posits links to poor governance and weak social protection. There are many macro-economic and political reasons for such institutional weakness and failure. At the bottom of the figure, one sees the knock on effect: increased losses from hazards and decreased capacity to recover.
- 3 Our study focuses on the way that farmers and herders understand these multi-scale challenges. We also want to know how much of the whole system portrayed in Figure 1 plays a role in their thinking and behaviour, and how they “fight back”, making claims on the government for public goods and disputing attacks on their land and water rights.
- 4 In Tanzania, hills and mountains run inland from near the Indian Ocean. These are part of the so-called Eastern Arc, a zone of great biodiversity, dense human population and diverse land use. First comes the ancient Usambara massif, then the South and North Pare mountains and finally the geologically different Kilimanjaro Mountain which is more recent and has volcanic origins. The team is working in the parts of this mountain-plains system within Kilimanjaro Region – the inhabited slopes of Africa’s tallest mountain and the Pares, and their surrounding plains as far as the Ruvu-Pangani River to the West and the Kenyan border to the East.
- 5 During this four year long project, the team’s research focuses on the interaction of local knowledge and outside specialist knowledge in defining the range of choice farmers and pastoralists perceive as they negotiate many changes – political and administrative,

economic, infrastructural and environmental – in the course of minimising risks and maximising opportunities. The study's overall aims are set out in Figure 2.

**Figure 2. Overall project theoretical framework**



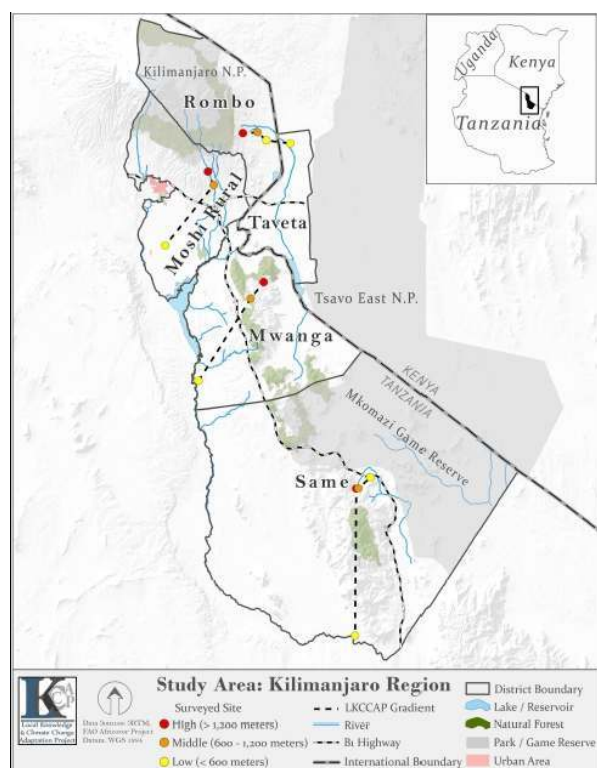
- 6 In order to capture a wide sample of agro-ecological and pastoral conditions, micro-climates, topographical settings and cultural-linguistic situations, we conducted scoping throughout much of Kilimanjaro Region, consulting with regional and district leaders and professionals and holding local focus groups with ward and village level leaders and elders. We chose Kilimanjaro Region since it contains an enormous range of variability in these respects and also because it is adjacent to Simanjiro District, Manyara Region across the Ruvu river and Kadjiado District in Kenya, where some of the study team had been active in other, related research projects.

## Context and methods

- 7 The team eventually chose four gradients, each composed of villages at the top, mid-slope and in plains. Two of these gradients ran from the highest inhabited zone on Mt. Kilimanjaro and down slope in two directions (Figure 3). In Rombo District, one gradient descends toward the Kenyan border. In Moshi Rural District, a second descends toward the rice irrigation schemes in the western plains beyond Moshi Town. One gradient each was also defined in Mwanga and Same Districts. Again, these involved highland villages at the highest inhabited altitudes and descended toward the plains. In the lowland villages one finds a rich diversity of livelihood activities: Maasai in five sampled villages carry out pastoral activities with varying degrees of diversification into agriculture and trade. There is river fishing, dryland farming, irrigation farming and horticulture (mangoes). The highest sites feature banana and taro roots, coffee, ginger and cardamom (these last two recent introductions of high value), fruit (*e.g.* avocado) and vegetable cultivation, and small scale dairying. The middle zone on these gradients is a transition zone that had been farmed seasonally and only permanently settled within the last generation. Staple

bananas give way gradually to maize and cassava and sunflower. These villages are nearer to the main tarmac road that joins Tanga and Dar es Salaam on the Indian Ocean coast to Same Town, Mwanga Town and onwards to Moshi and Arusha as well as to border crossings into Kenya. Commerce is therefore more highly developed as a non-farm livelihood option (see Box 1).

Figure 3. Map of full study area



- 8 A structured questionnaire was administered to 600 randomly chosen adults in 14 villages along these four gradients. Tanzania's highly organised, decentralised system of governance made it possible to obtain lists of village residents and choose respondents at random (with randomly chosen replacements if those chosen were not available).
- 9 Analysis of wealth indicators suggests less socio-economic inequality between altitudinal zones than might be suggested by income-based indicators of poverty. A wealth index was developed by assigning equal weights to four household survey variables reflecting land-based forms of livelihood, rural diversification and local social resources. The index consists of the following four variables: land access, livestock wealth, extent of remittances and involvement in community-based organizations. Percentiles were calculated from grouped data and cross-tabulated to indicate the distribution of households within each wealth percentile group by altitudinal zone. We ran the  $\chi^2$  test for independence in contingency tables and found that altitudinal zone and wealth index are statistically independent ( $\alpha = 0.05$ , 18 df). Thus wealth variation by altitudinal zone – as measured by this index – is not statistically significant. This assessment of the wealth classes by zone suggests less socio-economic stratification by agro-climatic conditions than suggested by previous efforts to map income poverty (URT, 2005) and provides important background to our investigation of capacity and spatial interdependence related to DEV, DDR, and CBA among the study sites (Table 1).

**Table 1. Wealth distribution of households by zone**

Wealth percentile	Altitudinal zones			Total - Number (%)
	Lower (500-700m) - Number (%)	Middle (700-1200m) - Number (%)	Upper (> 1200m) - Number (%)	
10	29 (12.6)	17 (8.4)	9 (5.4)	55 (9.2)
20	22 (9.6)	37 (18.2)	29 (17.5)	88 (14.7)
30	13 (5.7)	12 (5.9)	10 (6.0)	35 (5.8)
40	26 (11.3)	15 (7.4)	7 (4.2)	48 (8.0)
50	31 (13.5)	21 (10.3)	25 (15.1)	77 (12.9)
60	18 (7.8)	16 (7.9)	20 (12.0)	54 (9.0)
70	27 (11.7)	23 (11.3)	19 (11.4)	69 (11.5)
80	25 (10.9)	20 (9.9)	12 (7.4)	57 (9.5)
90	22 (9.6)	19 (9.4)	20 (12.0)	61 (10.2)
100	17 (7.4)	23 (11.3)	15 (9.0)	55 (9.2)
Total	230 (100)	203 (100)	166 (100)	599 (100)

- 10 The people of Kilimanjaro Region have generally been adept at maximizing traditional practices and absorbing new ones. This is best exemplified by the intense garden-like family homestead with banana as a staple, stall fed cattle and coffee as a cash crop introduced over a 100 years ago. By the 1970s improved breeds of dairy cattle brought increased production and surpluses that provided extra income. From this stable base the people invested heavily in education so that there has been diversification away from the core livelihood based on fishing, pastoralism and agriculture. The impact of this can clearly be seen in Table 2. The core livelihoods activities depicted in the first four columns account for only about 40% of the households. If we look at Mwanza District, in 2003, there were more than 10,300 households employed in the government, private sector or NGOs (URT, 2007). The figure is now higher. This means more people buying food, productivity increasing or going into crops that give greater returns. Where equity issues were considered right from the start and an integrated approach taken, as in Lower Moshi, and the rights of people over resources has been assured, paddy yields have more than doubled (Likwelile *et al.*, 2008).

**Table 2. Principal activity of the households from the region of Kilimandjaro**

District	Crops Farming /		Livestock keeping / Herding		Livestock pastoralism		Fishing		Total % 4 columns	Total % 10 unlisted columns
	Numbers	%	Numbers	%	Numbers	%	Numbers	%	%	%
Rombo	99,057	38	1,278	0.5	354	0.1	118	0.0	38.6	61,4
Mwanga	29,060	37	684	0.9	115	0,1	117	0.1	38.1	61,9
Same	58,823	45	3,467	2.7	148	0.1	0	0.0	47.8	52.2
Moshi Rural	119,230	34	4,653	1.3	261	0.1	0	0.0	35.4	64,6
Hai	87,085	43	6,616	3.2	227	0.1	111	0.1	48.4	51.6
<b>Total</b>	<b>393,255</b>	<b>38</b>	<b>18,698</b>	<b>1.8</b>	<b>1,105</b>	<b>0.1</b>	<b>346</b>	<b>0.0</b>	<b>39.9</b>	<b>60.1</b>

Source: URT (2007)

## Hypothesis

- 11 Our hypothesis is based on the following general observations found in previous studies in Africa (*e.g.* Richards, 1986; Wangari *et al.*, 1996; Mascarenhas, 2000, 2010; Sarris and Karfakis, 2006; Mwaura, 2008; Smucker and Wisner, 2008; Wangui, 2008). Rural people on these gradients do not perceive climate change as a unique challenge, but understand it as one of many changes. They seek to minimise risks and maximise opportunities that accompany not only climate change but other changes in the physical and natural environment and economy, politico-administrative and legal changes and changes in infrastructure (transport, markets, communication) and services available. While the residents of these gradients have been living with climate variability for generations, changes over the past 10-20 years present difficulties for the application of traditional decision making criteria such as signs that one should plant.
- 12 Our hypothesis, therefore, is that people will be found to be using a wide range of social contacts and diverse ecosystems across spatially distinct zones to buffer the effects of natural hazard risks, including those that are climate related, as well as a means of adapting to other changes in economic risks and opportunities. We refer to this as socio-geographic adaptation.
- 13 This is only one of the three hypotheses in this on-going research project. Another deals with the nature of the relationship between local/traditional knowledge and outside/specialist knowledge; while a third is focused on possible conflict and conflict resolution arising from growing socio-geographical adaptive capacity. Since this paper is an interim report on the first phase of our work, we only address the first hypothesis.

## Preliminary findings

- 14 Hazards vary by altitude. In the highlands, mid-slopes and internal valleys they include drought, flooding, minor landslides that block roads and occasional deadly ones, as in highland Same District in 2009 when 28 people died, wind damage to crops, insect and animal attack on crops and livestock (the latter including baboons, wild pigs and crocodiles). In the lowlands drought, floods and tick-borne animal disease are also the main hazards. Wind damage to crops is less common and landslides are absent.
- 15 The household survey on all gradients showed a perception that drought, flooding, damaging winds and landslide had increased over the past ten years. In addition, respondents from all agro-climatic zones believed that animal and plant diseases and pest attacks had increased (Table 3)

**Table 3. Perception of natural hazard trends**

Hazard						
Zone - % 'yes'	Drought increasing	Flood increasing	Wind increasing	Landslide increasing	Animal and plant disease increasing	Pest attack increasing
High	51	0	37	16	63	67
Medium	83	10	36	18	67	77
Low	93	24	52	12	81	81

- 16 Whilst increasing drought was reported by half of highland dwellers, it was in the mid-slope zones and lowlands that nearly everyone perceived greater incidence of drought. Since the lowland sites are recipients of seasonal flow from the mountains, often in the form of flash flooding, it is not surprising that increased floods were a concern of farmers and pastoralists in these low altitude sites.
- 17 A specific change in climate identified was variability in the starting time of rains, and, in this bi-modal rainfall regime, the length of the so-called short rains and long rains. Changes in the distribution of rain more than its absolute quantity were said to produce the greatest hardship (Table 4). Such results concerning the perception and understanding of climate characteristics need to be set against current climate science models. According to Agrawala *et al.* (2003), mean annual temperatures in Tanzania are projected to increase by 2.2 °C by 2100. Their work shows seasonal variations in this increase with June, July and August averaging a higher increase of 2.6 °C and December, January, February averaging a 1.9 °C increase. They also report that country level averages show a projected annual precipitation increase of 10% by 2100. Results from the National Science Foundation funded, "East Africa Climate People and Savannah Ecosystems Project" (ECLIPSE) confirm this trend (Moore *et al.*, 2011). There are however seasonal variations in this trend. June, July and August are projected to have a *decline* of 6% while December, January and February show increases of 16.7%.

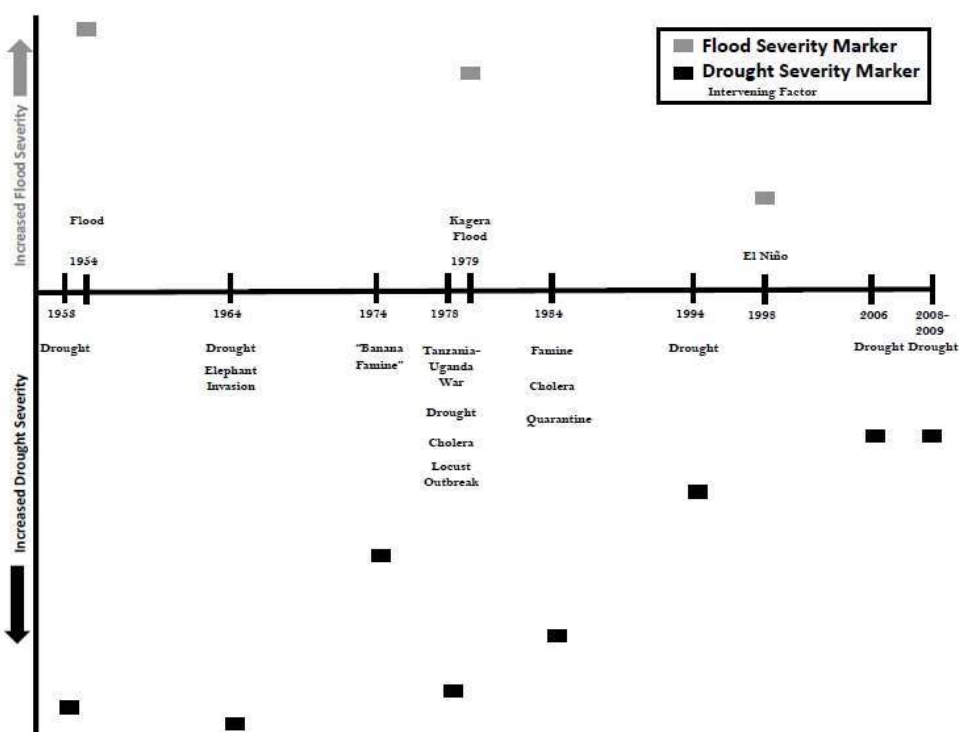


**Table 4. Perception of changes in rainy seasons**

Comments by whole survey across all zones (percentage mentioning short and long rains)	Cooler	Warmer	Shorter	Heavier	More droughts
Short rains	xx	18	26	xx	21
Long rains	26	xx	21	15	xx

- 18 Fifty-eight per cent of all respondents had witnessed a decrease in vegetation over the past ten years, rising to 65% in the lowland sites, where there has been considerable immigration. Decreasing soil fertility was noted by 63% of the household survey. In the high mountain sites where permaculture still prevails, fertility decline was reported by only 51% (while 40% of their neighbours thought fertility had increased). In the middle zone, where slopes can still be steep, but annual cropping, not the traditional polyculture, is practiced, some 70% said fertility had decreased in the last ten years.
- 19 In addition to changes in pests and plant and animal diseases, hazards that may well be climate related, roughly a third of all households across the agroclimatic zones believed invasive weeds had increased; however, opinion differed as about the same percentage thought weeds had decreased and a slight majority overall though they were about the same.
- 20 Other changes widely acknowledged by respondents were improvements in transportation (road density and available public transport) and communications (mobile phones) and increased awareness of the need to diversity livelihoods. As we shall see below, these changes to some extent facilitate an adaptive strategy in the face of climate risks that has so far been reasonably successful.
- 21 All of these changes and hazards were discussed in a holistic way as aspects of life, together with a variety of economic and social risks and opportunities. This was strikingly obvious in the focus groups with elderly women and men that produced time lines of disaster experience. The Swahili word for disaster is *maafa*, and was generally understood to be the outcome of a wide variety of risks. In one time line – the result of several hours of discussion and debate – elders arrayed a series of disastrous events including named droughts, floods, gale force winds, locust plagues to colonial period quarantine of the village due to cholera (Figure 4). The last mentioned did as much harm to livelihoods as some of the extreme natural events because trade and socio-spatial interdependence – already existing then – was cut off. Men were forced to travel secretly at night to seek a few days wage labour in order to purchase and bring home food – all under the threat of capture and imprisonment.

Figure 4. Emangulai "A" time line

**Box 1. One elder spoke as follows during a time line focus group:**

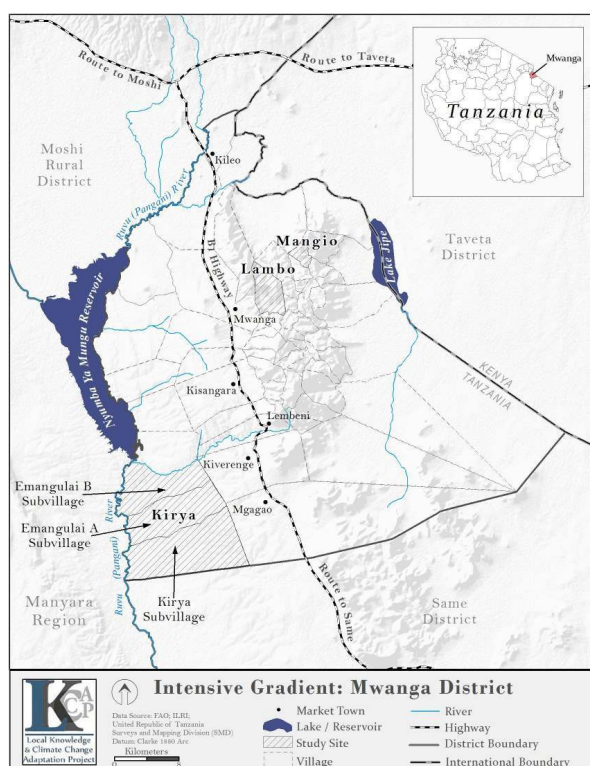
"Comparing 1974 and 1984, 1984 was much worse because many places did not even have transportation. So even the means to take food to people was difficult... '84 had very intense hunger, and then there was also cholera. There was quarantine and all the roads were closed. People were not able to communicate... There was intense hunger because nobody could do anything to help themselves... People had to wait for the government to bring them food here... [I]t was a very bad cholera outbreak. I remember it very well... And the drought made everything worse."

- 22 Compared to the 1940s when severe drought killed people, the elders said that more recent droughts have much lower fatalities. In the past, drought meant that people had to walk down to the plains and trek for several days and then walk back up hill with a head load of about 35 kg of grain. Improved infrastructure has reduced the risk from disastrous food shortages.

## Preliminary test of hypothesis

- 23 The research team chose four sites in the North Pare mountains and associated plains for intensive qualitative study. The gradient descends from 1476 m to 500 m in Mwanga District and takes in a very wide range of topography, climate, soil, water resources as well as livelihood systems (Figure 5).

Figure 5. Map of Mwanga gradient



- 24 Livelihood systems include zero-grazing milk production, banana, maize, taro root, cardamom and coffee production in the highlands and semi-arid, dryland extensive herding and irrigation of rice and vegetables in the lowlands as one approaches the Ruwenzori River. In the mid-slopes and internal valleys one finds a mixture of rainfed agriculture that combines some lowland cultivars such as cassava with highland crops such as bananas and also includes maize and sunflower as well as some small-scale irrigation. Ethnic-linguistic groups include the Pare in the highlands, Pare mixed with Chagga in the mid-slope zone, Maasai herders (and a wide variety of immigrant farmers of diverse backgrounds) in the irrigation zones. Immigrant farmers include Pare whose parents or grandparents originally came from the mountain area.
- 25 The large household survey along all four gradients included 118 randomly chosen households in four village sites along this Mwanga gradient (one highland, one mid-slope and two in the lowlands – one of which was exclusively Maasai). We held follow up focus group discussions with men, women and elders in each of the four sites which suggested that mobility and social interdependence are the key to simultaneous and synergistic livelihood improvement, risk reduction and adaptation to climate change. Many highland and mid-slope dwellers have family members working in the lowlands or in urban areas.
- 26 Ten per cent of all respondents list a spouse or head of household living outside of the homestead; while this combines both those who are farming, herding, fishing or trading elsewhere on the gradient, it also includes those in paid employment and able to remit income, as nine per cent of the sample reports they do. In addition, sons and daughters also migrate and remit income. Forty-two per cent of households interviewed claimed one or more dependents living outside the homestead. In total, 30% of all households received remittances – a considerable component of the livelihood system during

“normal” times, and one that is likely to be more important during an emergency. Sixty-one per cent of the remittance locations (from which children or a spouse sent money) were one of these larger Tanzania cities: Dar es Salaam (30%), Arusha (17%), Moshi (12%) and Tanga (3%).

- 27 Many also have livestock or secondary farms in the lowlands. Lowland farmers have secondary farms in the highland. Thirty-nine per cent of lowland plots were, in fact, cultivated by people whose home is in the middle zone and another 14% cultivated by people whose home is in the upper zone. Of highland plots, 37% are farmed by middle zoners and 9% by lowlander dwellers. The pivotal position of the recently settled middle slopes is apparent. Dispersion of livestock, at least during “normal” rainfall conditions is less than the spread of farms. It is mostly the lowland farmer-herders and pastoralists who have livestock, especially goats and sheep in pasture in a neighbouring village or in a more distant place in the lowland and even a few in the highlands.

**Box 2. A focus group elder spoke about migration along the gradient:**

“1954 is important because before there was a flood, there was a drought. And that is when people moved from the highlands and came down to the lowlands to farm over here. I remember my parents moved here to farm during that time.”

- 28 Most of the Maasai also engage in irrigation farming and trading. Animal fodder, rice and dried river fish are traded up the slope; while bananas and milk products are marketed downhill. From mid-slope farms maize and sunflower oil go in both directions, and fodder goes to highland stall-feeding. Diversity of livelihood activities and income sources, including trade, is definitely an aspect of the combined DEV-CBA-DRR strategy that the team’s early research has revealed. Also from key informants we learned that many new credit sources are available such as informal village banks and loans from religious and social groups. This provides another source of income for livelihood diversification.

**Box 3. Cross border migration as socio-geographic adaptation**

*Maingi Solomon*

Njukini – an informal settlement wedged between the Kenya-Tanzania border and Tsavo West National Park – presents a microcosm of East African dryland communities. The settlement demonstrates two important interrelated aspects: (1) the arid and semi arid areas have both social, economic and ecological diversity; (2) various communities have had different perspectives and responded differently to hazards.

Njukini marks a transitional zone between the pastoral areas of Loitokitok and Kajiado and the crop oriented Taita-Taveta areas to the East in Kenya and Southwest up the slopes of Mt. Kilimanjaro, through the low, medium and upper sites of the Rombo gradient. It is characterised by dryland farming, pastoralism and trade. The presence of water has allowed four irrigation schemes, and this has attracted casual labour.

Before the early 1970s, there were very few people in Njukini because it was a government protected water catchment area. After Kenya’s independence several

people moved from Mkuu on present-day Tanzania's Kilimanjaro slopes to settle in Njukini. They lived outside the protected area next to the border. However, highly politically connected individuals owned land within the protected area and utilised the water for large-scale farming and depended on migrant family labour. In time employers did not allow mature members of the families to live with their parents in the estate. The older children carved out temporary farms outside the estate. Tensions between the members of the East Africa Community (EAC) in the early to mid-1970s contributed to settlement in the area by Kenyans moving back from Tanzania Njukini thus became a host of many Kenyans crossing the border from different parts of Tanzania.

Several factors influence perspectives on resource use and migration. Migration histories demonstrate social networks which facilitate resource access across the border. The proximity to the Kenya/Tanzania border offers a unique opportunity for the residents to diversify livelihoods through trade, social networks, labour and migration.

- 29 *Governance* is important in this strategy. Roads must be maintained especially during the rainy seasons, since mobility and trade is at the core of the strategy. Small non-lethal but obstructive landslides are common during intensive rain storms in the mountains. Land tenure issues, water rights and other issues of access and regulation of land use and resource access are also crucial in the face of growing population density and the constant threat of deforestation. In Tanzania a complex nested system of governance exists at the scale of the sub-village, village, ward, district, region and nation. Each of these play roles in what is often a struggle for access to resources and services, access to and maintenance of infrastructure and the adjudication and allocation of property rights.
- 30 *Ways of coping with drought* also reveal the importance of socio-geographic strategies, diversity of livelihood activities and governance. The household survey covering all four of the gradients included a section that asked about coping activities during the 2008 drought – a serious event in all of the gradient's zones. Twenty-eight per cent of the lowland site dwellers undertook wage labour in order to purchase food, higher than the 17% choosing this option in the upper zone and 15% in the middle zone. Nine per cent in the lower zone sold handicrafts and manure – rare coping measures in the middle and upper zones. Also in the lower zone some 15% reported selling wood as a coping mechanism during the 2008 drought. Others made and sold charcoal – something we observed and spoke about – but since this activity is illegal, it did not emerge clearly in the household survey. Livestock were moved to another place by 45% of the lowland households, 14% of people in the middle zone and 12% at the upper end of the gradient.
- 31 Seventy-four per cent of the sampled households in the lowlands sold livestock during the drought (55% reported doing so in the middle zone and 56% in the upper zone). Such a high level of distress sale of livestock in the lowlands, especially prominent among the Maasai, may have been effective in providing money to feed the family during the 2008 drought, but reducing herd size in this manner also reduces their capacity to respond soon to a subsequent crisis.
- 32 Agronomic adjustment (or coping) was also evident. Half of the whole sample said they planted before the first rains; while 60% planted immediately after them. A third engaged in one kind of irrigation or another – right across the agroclimatic zones. Seventeen per

cent used soil and water conservation measures, and 18% said they cultivated wetlands. Notably, 58% signalled that they had weeded more frequently, and 44% had planted drought-resistant crops. Since drought may affect high, middle as well as lowland sites, one would expect adoption of drought-resistant crops all along the study gradient. However, millet and sorghum are not staple foods for most people in the middle and highland sites, and key informants mentioned that these crops are perceived as “birds’ food” or only for commercial purposes. Thus, peoples’ perception, lack of market for these crops as well as presence of pests like the bird, *quelea quelea*, limit the adoption of this adaptation strategy.

- 33 Concerning agronomic measures, both old and new techniques were apparent in field visits and intensive key informant interviews. While everyone claimed to pray as a drought coping measure, only 31% of the sample consulted a rainmaker. Indeed, in a separate question about the sources of seasonal climate forecasts, radio and the government agricultural extension officer were the two top ranking sources – followed by more traditional natural signs: the moon, first rains and clouds. Lightning and thunder topped the list of “second most reliable” indicators. No more than 7% ever listed the traditional weather forecaster among the three most reliable sources.
- 34 Cultural change and demographic pressure seem also to have affected the ability to source wild plant and animal foods as a coping measure, except in the lowland sites (where there is more undisturbed wild land), and even there no more than 5-6% claim to have hunted or gathered wild plants, respectively. Also, it is notable that a greater proportion says they relied on government food relief (69%) than on their relatives (39%). This is a function of more efficient government relief activities and better transport and is not necessarily a function of a more fragmented and isolated life style, since other coping measures point toward social interdependence. One example is moving livestock to available pasture and water, mentioned earlier. Another is moving in with a relative, something practiced during the 2008 drought by 14% of lowland households. In addition, across the whole sample along the four gradients we found that 20% belonged to faith based groups, 12% to community groups, 8% to some other informal group and 7% to a savings society. All of these provide possible conduits for knowledge to flow as well as a nexus around which cooperative coping and livelihood activities may be organised.

## Discussion and provisional conclusions

- 35 Historically the residents of these gradients have shown considerable flexibility, resilience and adaptability. One suggestion of this is changes that have taken place in the staple food. Among the waPare people in Same District, as among the waSambaa in the Usambara Mountains, dramatic shifts over the last half century have taken place, with bananas giving way to cassava and this, in turn, being displaced by maize and rice. Our household survey data also shows staple food shifts of this kind.
- 36 A number of studies have suggested that farming, herding and fishing as the basis of livelihoods cannot be expected to be guided in a future of climate change exclusively by knowledge developed in the past (Wisner, 2010; Onyongo, 2011; ENDA, n.d.). However, this caution assumes a static, “traditional” body of knowledge. Local knowledge is not a single epistemology and technology but is a bundle of practical knowledge, modified by communities. There are compelling reasons to regard local knowledge as a valuable

national resource (Warren and Rajasekaran, 1993). For example, recent work on rain water harvesting shows the versatility of local knowledge in different parts of Tanzania including in the Pare Mountains (where our Mwanga gradient is located) (Mbilinyi *et al.*, 2005).

- 37 Our study suggests that local knowledge draws from diverse sources – a process accelerated by more interaction up and down the altitude gradients – and that livelihoods are in constant flux. This process of socio-geographic adaptation is at the core of livelihood diversification and differential vulnerability to climate change and environmental change more broadly. The earlier discussion of how people coped during the 2008 drought shows that strategies are flexible and change, even when it comes to something as vital as coping under stress. However, the results also have a dark side. One also notes a shrinking of the available range of coping measures due to constraints on access to common property resources (compare Smucker and Wisner, 2008, writing about Kenya).
- 38 Given such a history of opportunistic strategies in the face of variability and changes of many kinds, what are the chances that socio-geographic adaptation will continue to allow stability or even increased well being in this part of Tanzania?
- 39 There are many imponderables. Climate models simply do not yet provide projections at a spatial resolution appropriate to informing district and community-level adaptation planning. Whatever further climate changes occur, a deciding factor will be access to resources and locations. Even now there is considerable competition over water rights and access to irrigation water. Herder-farmer conflicts exist. More and more people from outside the region, among them, some wealthy and influential individuals, are acquiring land in the lowlands and in the middle zone of the gradient. While neither government nor the people can control the climate, both can do a good deal to anticipate and resolve emerging conflicts of interest surrounding land, water and prime locations along the main roads. The recent Land Act and Villages Act provided a framework of decentralised, popular control of access. Time will tell whether this democratic process will be trumped, not by climate alone, but by economic and political power.

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## RÉSUMÉS

This paper presents a preliminary analysis of work conducted along altitudinal gradients in the mountains and plains of northern Tanzania. We find evidence of a high degree of interdependence among groups of people of different language/cultural groups and socio-economic status interacting along environmental gradients from high to low altitude. We call this “socio-geographical adaptation” to climate change. However, our analysis and discussion adds complexity to any simple notion of “adaptation to climate change” since changes are multiple and adaptation is complex.

## INDEX

**Keywords :** climate change, complexity, governance, interdependence, livelihood

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