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Panel 8

Roles of local and indigenous knowledge in addressing climate change

Maria Onyango: Policy Issues in Integrating Indigenous Knowledge in climate risk management to support community based adaptation

Andrew Newsham: Agro-ecological knowledge & climate change adaptation in North Central Namibia

Elder Moonga: Climate change adaptive capacities in the traditional livestock system of southern Africa based on indigenous knowledge

Sibonginkosi Khumalo: The use of agrobiodiversity by indigenous and traditional agricultural communities in adapting to climate change

Panel Summary

The following discussion points and issues were raised in the Q&A following the presentations:

- How we can better integrate indigenous knowledge into climate change adaptation?
- What is the difference between indigenous knowledge, local knowledge and traditional knowledge?
- Indigenous knowledge versus scientific forecasting: Which one is more reliable?
- Intellectual property right of IK e.g. a book is coming out on Nganyi Community of their IK in weather-forecasting, and it will be the property of the community
- What mode of dissemination do communities prefer? Development agents? Local radios?
- Indigenous land unit system helps to cope with climate variability. Local knowledge incorporated within adaptive capacity can reduce vulnerability. For example, use of early maturing variety seeds enhances resilience to climate variability.
- Climate information is often not available and accessible. How do we address observational data scarcity for mitigation and adaptation? What is the strategy? Whose job is it? How do we get downscaled climate information? How do we turn climate information into agricultural extension messages in a more palatable form?
- Biodiversity/ agro-biodiversity including documentation of farming systems could be good for climate change adaption.

Maria Onyango

Policy Issues in Integrating Indigenous Knowledge in Climate Risk Management to support Community Based Adaptation

Many African communities have used indigenous knowledge (IK) as a critical knowledge base and survival tool for adapting to extreme climate events and other natural hazards. IK may be defined as an ancient, communal, holistic and spiritual knowledge that encompasses every aspect of human existence. Local communities through accumulated IK have gained from generation to generation, known patterns of weather; how and when local natural disasters occurred; how to plan to cope with their impacts on the natural environment, livelihoods, and lives. According to research, many African communities have developed techniques and strategies for forecasting, and managing climate variability including coping mechanisms to respond to both normal and harsh conditions of their local environments. They base their forecasting on observation of the natural environment including flora, fauna and stars. This paper discusses the close linkage between sustainability of community livelihoods and lives. Extreme climate variability such as floods and droughts often have far reaching environmental, health and socio-economic impacts in many developing countries. To counter this trend, there is need to have in place efficient and realistic climate risk reduction strategies, including availability of effective integrated early warning systems to enhance the planning efforts. This would reduce the negative impacts; take full advantage of positive impacts and adapt to climate change. Reducing this vulnerability calls for community-based adaptation through empowering local communities to take action on their vulnerability to climate variability and change. From a development point of view, wider access to knowledge and information will help reduce climate risks and inequalities within a community by. Opening up opportunities for vulnerable members (women and youth) to benefit from integrated climate knowledge and strategies for sustainable use, management and conservation of biodiversity will enhance integrating scientific and IK resilience of the communities.

Andrew Newsham

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Agro-ecological knowledge & climate change adaptation in North central Namibia1

1 This paper is adapted from Newsham, A. J. & Thomas, D. S. G. in press. 'Knowing, farming and climate change adaptation in North-Central Namibia'. *Global Environmental Change*, In Press, Corrected Proof,DOI: 10.1016/j.gloenvcha.2010.12.003.

Paper for AfricaAdapt Climate Change Symposium 2011, for Panel 8: Roles of local and indigenous knowledge in addressing climate change

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Abstract

Ovambo farmers in north-central Namibia possess and deploy agro-ecological knowledge which has given them, over hundreds of years of settlements, no small measure of resilience in the face of considerable climate variability – especially inter-annual rainfall variation and its associated impacts. Recent research from Omusati, one of the four regions of north-central Namibia, documents the potential role of knowledge co-production between agro ecological knowledge and agricultural science in strengthening adaptive capacity to future climate change (and not just to current forms of climate variability). However, scope remains for developing a deeper understanding of the conditions under this kind of co-production, which is by no means automatic, is likely to emerge. This paper explains how agro-ecological knowledge constitutes adaptive capacity, and considers how we might better understand the kind of knowledge co-production likely to lead to positive adaptation outcomes.

Introduction

The role of local knowledge(s) and capacities has long been a focus within development studies. This much can be gleaned from even a brief acquaintance with the overlapping literatures on 'farmer first' approaches to agricultural development, livelihoods and participation (Chambers, 1997, Chambers and Conway, 1992, Cooke and Kothari, 2001, Fals-Borda, 1991, Hickey and Mohan, 2004, Richards, 1985).

The profile of local knowledge has since been raised in relation to climate change adaptation. This is partly because of its prominence in the resilience literature (see Berkes and Folke, 2000 for a review), but partly also due to the efforts of initiatives like AfricaAdapt. It was covered by the IPCC's Working Group II in the Fourth Assessment Report (see Boko et al., 2007 for African examples); although some deem this engagement too fleeting (Salick and Ross, 2009). There have since been a number of special issues, for instance in *Ecology & Society* (Folke, 2004), and *Climatic Change* (Green and Raygorodetsky, 2010) which further champion the value of local knowledge for understanding and dealing with climate change.

This paper adds critical mass to this agenda by extending its empirical coverage: it explores the extent to which agro-ecological knowledge held by Ovambo farmers in North Central Namibia constitutes adaptive capacity to climate change impacts. It has **two** core objectives. The first is to leave beyond doubt the imperative need for Namibian climate change adaptation policy to engage with this knowledge system, especially given the uncertainties inherent in the projected impacts of climate change for Namibia. Such are these that the one national climate change assessment, which generated downscaled climate projections for the country, concluded that it remained unclear *what* Namibians would have to adapt to (Dirkx et al., 2008). Conversely, agro-ecological knowledge in North Central Namibia has provided farmers with resilience in the face of a highly variable, and hence uncertain, climate for perhaps hundreds of years. There is a literature on this knowledge in North Central Namibia, but it has little to say, *explicitly,* about the adaptive capacity to climate variability that is built into the knowledge system. We tease this point out of this literature, and add to it results from fieldwork conducted in the Omusati Region of North Central Namibia. In so doing, we show *how* local agro-ecological knowledge has permitted farmers to build enduring resilience to adverse climate impacts. We warn against, however, romanticisation: current farming practice is implicated in land degradation processes in North Central Namibia; although, we argue, to what extent remains unclear (Kreike, 2010, Newsham and Thomas, 2009, Sullivan, 1999).

Our second objective is to document instances of knowledge co-production, in which local agro-ecological knowledge and agricultural science are combined, and in ways that foster the kind of adaptive capacity likely, we argue, to help farmers deal better with future climate change impacts. Berkes (2004) argued that there are few examples of science and local knowledge being fitted together to provide input into resource management. Happily, however, in the case of Southern Africa, there are a number of

examples of instances where this has been attempted, with encouraging results (Reed et al., 2008, Reed et al., 2007, Stringer et al., 2009, Stringer et al., 2007)**.** Here we add a Namibian case study to this exciting body of work.
Another link-up to broader debates arises from our more extensive use of the literature on science and technology studies (STS). This is poorly-represented in debates on local knowledge and climate change adaptation, despite offering many theoretical and empirical resources on which to draw. These open up space for local knowledge by challenging the basis for the privileged truth status scientific knowledge is routinely given, yet without adopting an intrinsically 'anti-science' position (Barnes et al., 1996, Latour and Woolgar, 1979).

The paper is structured as follows. Section two briefly reviews the literature on agro-ecological knowledge in North Central Namibia, and shows how such knowledge can be considered adaptive capacity. It introduces the study area, field sites and outlines the research methodology. This prepares the ground for a core research focus: the extent to which this knowledge system can *also* be taken as a proxy for adaptive capacity to future climate change. This question is explored in section three, which combines the results and discussion. Noting that this research is the start, not the end, of an ethnography on the promise and pitfalls of knowledge co-production for strengthening adaptive capacity, the conclusion charts avenues for further research and flags the work of STS veteran Harry Collins (2004) on 'interactional expertise'. This we present as a useful conceptual resource for delineating the minglings and mismatches of knowledge co-production between farmers and extension workers. However, we end on a note of caution by placing framing within the context of broader changes, both in the climate and in shifts in how people make a living. Diversifying into off-farm, climate-insensitive activities would appear to make intuitive sense as an adaptation strategy; but we caution that it is a double-edged sword.

Background: agro-ecological knowledge, fieldsites and research design

Agro-ecological knowledge, adaptive capacity and resilience in North Central Namibia

An exciting literature has delineated the contours of agro-ecological knowledge of the Ovambo peoples in Northern Namibia (for an overview see Shitundeni and Marsh, 1999, Verlinden and Dayot, 2000). An understanding its contribution to farmers' adaptive capacity to climate variability requires a brief outline of this knowledge system. Researchers such as John McDonagh and Alex Verlinden have documented the classification system which farmers in Northern Namibia employ when making decisions about crops and livestock (Hillyer et al., 2006, Verlinden and Kruger, 2007). Farmers draw upon a sophisticated understanding of the productive potential of their environment, which Hillyer *et al* refer to as an "indigenous land unit framework" (2006:252)2.

2 See Newsham & Thomas 2009 for an explanation of the choice of 'agro-ecological knowledge' as opposed to 'indigenous', 'traditional' etc. But it is as well to be clear that we drop 'indigenous' from the 'indigenous land unit' name Hillyer, Verlinden and others have given this knowledge system because of the confusion this may cause. 'Indigenous' is a term sometimes mobilised by a particular group of people trying to become less marginalised in a particular society, country or economy by claiming rights, i.e. to land, or other forms of recognition. Whilst one may consider the Ovambo people as *indigenous to* Namibia, they do not refer to themselves as an indigenous people. Indeed, they are the majority ethnic group, comprising 50% of the country's population and dominating its political systems. The San of Namibia, in contrast, may sometimes deploy 'indigenous' as a term which designates both their marginality relative to other groups such as the Ovambo and their (generally recognised) claim to have occupied modern-day 'Namibia' prior to the arrival of Bantu-speaking groups (such as, again, the Ovambo but also the Herero, amongst others). Whilst the land unit system is a very laudable attempt to capture in an agro-ecological idiom the consistency and utility of Ovambo farming-environmental knowledge, it unfortunately pays little heed to the politics of identity which infuse other areas of Namibian life and society.

'Land units', or types of land classified according to specific agro-ecological criteria, help farmers decide what type of crop to plant and where, according to the conditions expected for a given growing season. Verlinden and Dayot classify land units according to three broad sets of characteristics: soil, vegetation and landform (2005). For each of these three sets, they identify a number of specific indicators, such as texture or hardpan depth for soil, species and structure for vegetation, and elevation or depression for landform. On this basis, particular land units have come to be associated with particular crops under particular conditions. For instance, *ehenge*, a land unit characterised by depressions in the landscape, is desirable for planting pearl millet in drier growing seasons. In wetter growing seasons, farmers prefer to plant pearl millet in *Omutunda*, a land unit characterised primarily by elevation, and held also to be more fertile. In contrast, other land units such as the sandy, dry and well-drained *Omufitu* tend to be reserved for legumes such as bambara groundnuts, where farmers would expect less from a pearl millet crop (see Hillyer *et al* 2006 for a broader matching of crops to ILUs).

Land units also identify landscape features conducive to cattle grazing. Verlinden and Kruger (2007) documented the ten land units most popular for grazing purposes, finding a preference amongst farmers for *Omutunda*, *Omutuntu* and *Omuthitu*. As with cultivation, the range of land units used by people in the Oshikoto region gave them a flexibility to graze cattle in the face of a range of dynamic environmental states linked to climate variability. As Verlinden and Kruger point out, the search for land units best suited to grazing was another factor influencing settlement decisions. The centrality of agro-ecological knowledge to Ovambo social and economic organisation is difficult, therefore, to overstate.

Strikingly, studies which compared some (though not all) land units to scientific classification systems – derived from detrended correspondence analysis of cropping land units (Verlinden & Dayot 2005), and canonical correspondence analysis of grazing units (Verlinden & Kruger 2007) – found them to capture what, scientifically, we would term key ecological characteristics. Perhaps we might infer from this scientific robustness in the land unit system. There is no reason to presuppose that that this should not be the case, nor *a priori* to privilege scientific knowledge (cf. Barnes and Bloor, 1982, Thomas and Twyman, 2004). Yet it is worth emphasising, if only so as *not* to overlook sources of knowledge.

Agro-ecological knowledge as adaptive capacity

The existing literature on the land unit system has, then, established its prevalence, utility, rigorousness and widespread application. We add to this another insight: such knowledge makes farming in North-Central Namibia more resilient to climate variability and impacts, spanning from recurring droughts to recurring floods. Understanding agro-ecological dynamics allows farmers to adapt cropping and livestocking strategies to the highly variable climatic conditions they encounter from one rainy season to the next. Hillyer *et al* (2006) demonstrate this visually by mapping farms in the village of Oshaala, Omusati Region, onto the landscape. Most farms incorporated a number of land units, as opposed to picking one specifically. This is because different land units are recognised by farmers to perform well under different growing conditions. Flexibility is, then, key to the resilience of the system. Furthermore, the continued presence of settled agriculture in North Central Namibia, stretching back for perhaps 400 years (cf. Williams, 1994), suggests that the system has been enduringly resilient. Whether it can remain so in the face of future climate change is a core focus of the research (laid out in more detail in section 2.4). Before addressing this point, we describe the empirical settings in which the research was conducted.

Study area and field sites

Fieldwork was conducted in 2008 at Outapi, the 'capital' of the Omusati region, and at Omufitugwanauyala and Oshikulufitu, two villages within the Anamulenge constituency, 20-30km from Outapi. As Outapi houses the headquarters of agricultural extension services in the Omusati region, Interviews with extension staff duly were held there. The brunt of the research occurred in Omufitugwanauyala and Oshikulufitu.

All the fieldsites are located in the *oshana* landscape of the wider Ovambo Basin, consisting of a series of southward-flowing, seasonal watercourses that carve gentle undulations across the land, and extending across the Omusati Region. In the rainy season, pools of water form, known in Oshivambo as *oshana*, (hence the landscape's name). Along with the fish they provide, *oshanas*3 support various forms of tree and plant life that can be eaten or used for house-building, basketry or medicinal purposes (Mendelsohn et al., 2000).

3 Strictly speaking *iishana* in the plural, but pluralised in Namibian English as *oshanas* (the convention we follow here).

In Omufitugwanauyala and Oshikulufitu (as in Omusati more broadly), livelihoods and land use are principally characterised by an agro-silvi-pastoral system (Marsh & Seely 1992), combining livestock herding and small-scale cereal production, supplemented by the *oshana* resources. Off-farm diversification was occurring, especially in Outapi, a commercial centre, but less so in our rural fieldsites (see Table 1).

The favoured livestock is cattle, mostly of the Sanga variety (ibid). Donkeys are the only other large livestock, but smaller animals, including goats, pigs and chickens, are increasingly common, in line with a general decline in cattle ownership (Mendelsohn *et al* 2000). Fruit trees – especially *Berchemia Discolor* and Marula – provide widely-consumed wild fruit resources to supplement agricultural produce (Marsh and Seely, 1992).

Crop production in Omufitugwanauyala and Oshikulufitu, as across North-Central Namibia predominantly, is rain-fed, with pearl millet (or *mahangu* in Oshivambo) the staple crop, as well as maize and sorghum grown in smaller quantities (Mendelsohn et al., 2006). These cereals are supplemented by vegetables and legumes. Yields vary from year to year, for which the most significant climate driver is variation in rainfall (Mendelsohn et al. 2000).

The climate in the fieldsites, as in Omusati broadly, is semi-arid. Rainfall is seasonal, falling mostly from November to April (Mendelsohn *et al* 2000:9). Median annual rainfall in Omusati, as measured between 1961 and 1998, followed a south-west to north-east gradient, from 240-300mm in the south-west, increasing to 420-480mm in the north east (Mendelsohn, 1999). In the northwesternmost reaches of Omusati, where the fieldsites were located, median annual rainfall was calculated to be between 360-420mm (ibid). Significantly, the coefficient of variation of annual rainfall in the fieldsite area was calculated as 40-50% (ibid), indicating starkly the magnitude in variability of growing conditions to which farmers have to respond.

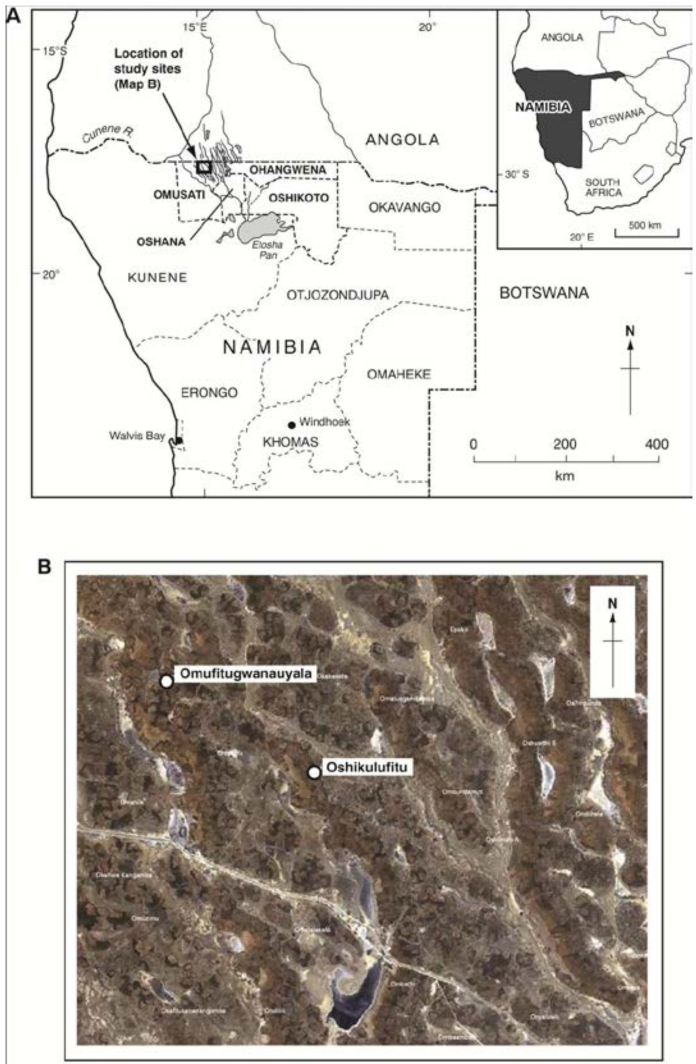

Figure 1: Field sites in North Central Namibia

Agro-ecological knowledge in Omufitugwanauyala and Oshikulufitu was distributed evenly between men and women. More substantial expertise in a given farming activity split along the same gendered lines as the division of farming activities, with men generally tending to livestock and women to cultivation. As such, vulnerability to climate impacts did not appear to be a result of access to agro-ecological knowledge. This is not to say, however, that vulnerability to climate impacts was therefore equally distributed across both genders. For instance, some widows in both villages had been dispossessed of valuable assets such as cattle, which were claimed by the husbands' relatives upon his death. Given the well-documented importance of cattle for food or cash access in North Central Namibia (i.e. Marsh and Seely, 1992, Williams, 1994), losing this resource could not but increase vulnerability to climate impacts.

Similarly, household visits conducted during field work suggested a positive correlation between wealth, farm size and variety of different land units on the farm. Poorer households tended to have smaller farms with fewer land units. New arrivals in the village also struggled to establish farms across more than one land unit, due to increasing competition over recent years to available land. This reduced the flexibility with which they could tailor their growing strategies to fit with the weather conditions of any given growing season.

Table 2 – Land units and crops grown in Omufitugwanauyala and Oshikulufitu Land Unit	**Crop grown**	**Found in**
Omutunda	Pearl millet (mahangu)	Oshikulufitu
Omuhenye	Pearl millet, beans, watermelon, squash	Oshikulufitu and Omufitugwanauyala
Ehenge	Nuts, mahangu, beans	Oshikulufitu and Omufitugwanauyala
Oshindabo	sorghum, watermelon and maize	Oshikulufitu
Ehenene	sorghum, maize, watermelon, matanga, beans	Oshikulufitu and Omufitugwanauyala
Ombode	Mahangu, sorghum, melon	Oshikulufitu and Omufitugwanauyala
Omufitu	mahangu, beans, maize, nuts, pumpkin, watermelon	Oshikulufitu and Omufitugwanauyala

Elder Moonga

Climate Change Adaptive Capacities in the Traditional Livestock System of Southern Africa based on Indigenous Knowledge

Abstract

Improvement of livestock productivity in the Southern Africa region is severely constrained by the prevalence of a wide range of diseases like: Theilerioses (East Coast Fever, Corridor, and January Diseases); Babesiosis; Anaplasmosis; Trypanosomosis; Contagious Bovine Pleuro Pneumonia (CBPP); Foot and Mouth Disease (FMD); Brucellosis; Haemorrhagic Septicaemia; Anthrax; Blackleg; African Swine Fever; Lumpy skin; and Newcastle Disease. In this region, even though the commercial farming sector contributes to the overall livestock production, more than 70% of livestock population is under the rural traditional farming system which is generally characterised by faulty scientific technical know-how and thus not able to meaningfully control and manage these diseases. Equally, the vulnerability of the traditional sector has been worsened by poorly implemented policies that have left most of these areas with inadequate services such as: extension; diagnostic centres; and marketing infrastructures. The other contributing factors have been the prohibitive costs of imported chemo-therapeutic and chemo-prophylactic materials and the respective mismanagement by traditional farmers is not uncommon. The regulations for quality controls on imported substances are also poor in Southern Africa region. As a result, the traditional farming sector has most times accessed ineffective materials from unscrupulous service providers which lead to resistances of vectors and/or pathogens.

Most rural populations in Southern Africa are either partially or entirely dependent of livestock for their food security and poverty alleviation. Livestock, especially cattle and donkeys are the major assets for draft power needed for crop cultivation and transportation. The other values of livestock to these communities include: sources of income (education, health, clothing and farming inputs); nutrition; organic manure for soil fertility; cultural ceremonies (dowry, funerals and initiations) and prestige. When livestock are diseased, they lose the productive efficiency, lose condition and market value, and even die. Additionally, predicted climate change effects of reduced rainfall or increased flooding will lead to serious crop failures immediately and livestock will the available coping mechanism of resilience because the traditional livestock farmers will try to avert short term risks by selling some stock and restocking later when the situation seems to normalise.

A study conducted primarily to build capacity for increased livestock productivity from selected areas of a rural district in Zambia (Mumbwa), through participatory appraisal, determined how the traditional livestock farmers interpret the increased prevalence of livestock diseases and the relevant Indigenous Knowledge (IK) that exists. From that study area, farmers are knowledgeable of the association that exists between the abundance of disease vectors like ticks and the outbreaks of Tick Borne Diseases (TBDs). TBDs are among the economically important livestock diseases in this region and claim huge financial losses through animal mortalities, production losses and respective costs required for diseases control. Similarly, the farmers reported having observed a trend of increasing tick abundance during the last decade. For the Southern Africa region, the climatic change predictions are such that speedy vector developments and probably their spread to new areas will be favoured. Using the available meteorological data from the study area, there is evidence that climate change is a real phenomenon and it correlates well with the observed tick abundance trends. The mean difference in seasonal rainfall for the study district, Mumbwa between the periods 1940 to 1970 and 1971 to 2005 is 104 mm. The rainfall has been reducing to a present (2000 to 2010), mean seasonal rainfall of 714.0 mm. Similarly, the mean annual temperature has been rising steadily at 0.032^{o}C per year (0.32^{o}C per decade) with the mean temperatures of 20.6˚ C during the last decade. During the same period, the Relative Humidity average is 62.7 %. These parameters largely explain the possible life cycle changes the tick vectors have already undergone and are steadily getting suited and adapting to climate change. Similarly, the disease pathogens may have been changing and adapting alongside their vectors. The overall impact of this scenario is altering the diseases epidemiology and new sustainable control strategies have to be developed as a matter of urgency.

The other explanation to increasing tick abundance in the area is as a result of chemical resistance induced by dip mismanagement and by not adhering to best practices due to lack of extension services for the few farmers that try to use acaricides and as a result of using substandard products. Since the study area is warming up, it is likely that the breakdown of chemical compounds in acaricides after their use on animals is much more rapid than before. This effect would equally induce tick resistances and the alternative may require increasing the dipping frequency against the backdrop of prohibitive costs. Also, the study established that the farmers prefer improving their indigenous breeds of livestock by crossing them with exotic breeds that have admirable traits like faster growth rates. Whereas the indigenous breeds are fairly resistant to the local species of tick vectors and pathogens, the cross-bred animals are far less resistant and they instead act as easy hosts for ticks developments which ensures their fast proliferation.

Sustainably exploiting the IK bases that already exist amongst the traditional farmers is one sure method for them to adapt to climate change and upholding the livelihoods of communities. Other studies from Zambia have established the potential of IK and have inventorized the useful indigenous plants that have either medicinal or pesticidal properties. One such plant that has been widely studied in Zambia is *Tephrosia vogelli. Tephrosia* is a leguminous shrub mostly found in the tropical countries and contains rotenone, an important non residue insecticide. The *In vitro* studies carried out validated the efficacy of *T. vogelli* to major tick vectors that have been responsible for the transmission of economically important TBDs like Theilerioses in the Southern Africa region. Based on this validation, the Southern Africa Network of Biosciences (SANBio), through it's Livestock Development Node is undertaking a regional developmental research programme aimed at utilization and preservation of our biodiversity by promoting *T. vogelli* for tick control in the traditional sectors of livestock farming communities. So far, the farmers readily appreciate the cost effectiveness and sustainability of the plant materials. Tephrosia plant has other advantages. Being a legume, is very useful in soil enrichment through nitrogen fixation. It's also effective against a number of crop pests. The values being realised from promotion and utilization *T. vogelli,* are expected to generate additional interests into more applications of IKS for various livestock management practices in relation to creating resilience and adaptation to climate change.

Key words: Livestock, diseases, vectors, climate change, Indigenous Knowledge System.

Sibonginkosi Khumalo

The use of agrobiodiversity by indigenous and traditional agricultural communities in adapting to climate change

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Introduction

The Platform for Agrobiodiversity Research is a multi-stakeholder partnership established in 2006 (PAR, 2006) to bring together researchers and others to share knowledge and experiences that can improve the maintenance and use of agrobiodiversity[5]. Currently hosted by Bioversity International, the Platform's goal is to enhance the sustainable management and use of agrobiodiversity for meeting human needs by improving knowledge of all its different aspects.

One of the Platform's objectives is to explore the different ways in which agrobiodiversity can be used to help meet current global challenges and to identify ways in which its contribution could be improved. Over the past two years, as part of the work to support this objective, the Platform has collected information on the ways in which indigenous peoples and rural communities are using agrobiodiversity to help cope with climate change (PAR 2010).

[5] Agrobiodiversity includes the variety and variability of animals, plants and micro-organisms that are used directly or indirectly for food and agriculture, including crops, livestock, forestry and fisheries at farm, community and landscape scales.

The information collected from over 200 different cases, reports and articles from many different sources, has been analyzed to identify the key characteristics of the adaptation strategies adopted. This analysis and review of the experiences of people around the world (available at http://agrobiodiversityplatform.org/climatechange/) has resulted in the identification of a number of recommendations on how agrobiodiversity can be used to help improve the adaptability and resilience of the farming systems managed by rural communities and indigenous peoples around the world.

Results

The cases analyzed include a wide range of climate adaptation measures and coping strategies of rural and indigenous communities including landscape restoration, changes in cropping systems, cultivation of stress-tolerant crops, organic agriculture, changes in livestock and fisheries management, indigenous beekeeping, biodiversity management, diet diversification, and soil and water management. Often, these strategies are the elements of integrated and site-specific approaches based on the indigenous and local knowledge and innovation. Important elements in response of communities to climate change within agricultural ecosystems include:

- Water and soil management practices such as improved water retention practices in dry environments (Barro, A. et al., 2005) or improved management of mangrove systems in coast areas (http://www.mssrf.org/tsunami/eco_rehab.htm).

- Introduction of new crops, livestock species and new cultivars of existing materials especially the increased use of agroforestry species. This includes the use of varieties and crops with greater stress tolerance (http://www.leisa.info/index.php?url=show-blob-html.tpl&p[o_id]=2x93x8&p[a_id]=2xx&p[a_seq]=2) and a wide range of diversification practices such as the introduction of fish farming or floating gardens in Bangladesh (Practical Action, 2009);

- Changes in cropping systems, timing, rotations and other crop management practices and altered management practices with respect to key production components and ecosystem services such as pollinators (http://www.ddsindia.com/www/enviindia.html);

- Adoption of agricultural management practices believed to increase adaptability and resilience such as organic agriculture and conservation agriculture (http://www.utviklingsfondet.no/filestore/Nicanet.pdf);

- Institution strengthening particularly through the development of mutual support systems such as is occurring among many pastoral communities (http://www.cenesta.org/projects/Pastoralism.htm);

- Diet diversification as a result of changed availability of foodstuffs (http://practicalactionpublishing.org/food-production/ricefishculture)

The results show that maintaining high levels of agrobiodiversity in agro-ecosystems seems to provide adaptability and increase stability and resilience in the face of change. While new crops, varieties and livestock materials are often used to meet changed production conditions, traditional agricultural varieties commonly remain an essential part of adaptation strategies. Thus, both access to new materials and the continuing management and selection of traditional materials are important elements in coping with change.

Indicators of change and of the nature and extent of change are clearly important to rural communities. In addition, often the traditional indicators used for determining sowing, harvesting and other cultural practices have changed characteristics and may not be relevant so new ones need to be identified and tested. There are also more significant changes. Farmers, pastoralists, forest dwellers and fisher folk are adopting alternative livelihood strategies. This involves developing new skills and the need to exchange information and knowledge. Ways of supporting these transitions are important and often involve institution building (e.g. Ensor and Berger, 2009). Finally, combining traditional knowledge with new scientific information is an important part of improving resilience and ensuring adaptability. New information may often be needed but it needs to be placed in the context of a framework of traditional knowledge which itself is dynamic and continually developing.

Conclusions

Three general conclusions can be drawn from this analysis of the different ways in which indigenous and traditional agricultural communities are coping with climate change. Firstly, adapting to climate change has usually involved a range of different actions at all three levels; ecosystem or landscape, farm or agricultural system, and involving both inter- and intra-specific diversity. Secondly, innovation based on both traditional knowledge and new information has been important, and social (e.g. community) cultural and political dimensions have played a key role. Thirdly, use of traditional crop and livestock species and varieties, with new materials where necessary, has been a common feature.

From these general conclusions follow a number of specific considerations that can provide a basis for action to support adaptation to climate change by indigenous and traditional agricultural communities. These include:

- The resilience of local food systems and their adaptation to change can be enhanced through a strategy of diversification;
- Ecosystem protection and restoration can reduce the adverse effects of climate change on local food systems;
- Resilience and adaptability seem to be enhanced by the use of sustainable agricultural practices;
- Maintenance of intra- and inter-species and access to new diversity are essential elements in improving adaptability and resilience;
- The need to adapt to climate change has often led to the revival of traditional practices;
- The continuous process of innovation required involves the use of traditional knowledge combined with access to new knowledge;
- Adaptation solutions are local and often most relevant and effective when undertaken at community level;
- Local agrobiodiversity-based solutions create opportunities for integration of adaptation and protection of indigenous peoples' rights

Challenges ahead and opportunities

The analysis conducted by the Platform allows identification of some research and other activities that can support adaptation to climate change by rural communities and indigenous peoples. These include:

- The development indicators of adaptability and resilience that can be used at different scales by communities, civil society organizations and national agencies;
- Ensuring support for, and maintenance of, local social and cultural institutions and activities which can empower local communities;
- Development of strategies that help improve the maintenance of local agrobiodiversity and access to new diversity (crop varieties, animal breeds and other components that support production) to cope with changing conditions. This will include locally based selection or breeding activities;
- Supporting the maintenance of traditional knowledge combined with access to new information;
- Supporting the development and adoption of locally appropriate improved agronomic practices;

Implementing these actions will require approaches that build on the experience of rural communities and are fully participatory, combining research with implementation at local levels.

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