

Farmers' Knowledge and Climate Change Adaptation: Insights from Policy Processes in Kenya and Namibia

Overview

One major policy challenge for the agricultural sector is to make sure that lessons from farmers' knowledge and experience are informing emerging climate change policy processes. This briefing paper reports on lessons from recent studies in two areas: first on seasonal forecasting and indigenous knowledge in Kenya (Guthiga and Newsham, 2011), and second, agro-ecological knowledge and science in Namibia (Newsham and Thomas, 2011). The paper draws insights from the studies on processes of knowledge co-production between actors using different knowledge systems. We make two basic arguments. First, advocates of local knowledge playing a role in adaptation policy and practice need a clearer understanding of how policy processes really work, in order to be more effective in making it happen. Second, efforts to link local to national are subject to broader processes of global change. We tease out the implications from two especially pertinent trends: first, recent projections suggesting accelerated and more dangerous climate impacts by the 2060s; and

second, deagrarianisation (a long-term shift away from farming livelihoods in rural areas).

Background: Local knowledge, agricultural development and climate change

The role of local knowledge(s) and capacities has long been a focus within development, not least in 'farmer first' approaches to agricultural development, livelihoods and participation (Chambers and Conway, 1992; Fals-Borda, 1991; Richards, 1985; Scoones and Thompson, 1994; Scoones and Thompson, 2009). Although the insights from this work are only unevenly drawn upon in practice, the relevance of local knowledge to dealing with the challenge of climate change has been increasingly recognised (see Boko et al., 2007 for African examples, for other regions Folke, 2004; Ford and Furgal, 2009; Green and Raygorodetsky, 2010; Salick and Ross, 2009). Taking a more practical tack, web-based initiatives such as AfricaAdapt and weAdapt have sought to share climate change adaptation knowledge, and to bring together different actors who might usefully talk to each other.

Donors and international organisations, such as Canada's International Development Research Centre (IDRC) and the UK's Department for International Development (DfID), have also been keen to fund work relating to local knowledge and climate change.

These are important contributions, and in documenting how local knowledge in Kenya and Namibia can help build adaptive capacity to climate impacts, our briefing paper resonates strongly with them. We seek to add to this agenda by arguing for the need to situate the debate about local knowledge and climate change within broader contexts and processes. Therefore, we set local knowledge in Kenya and Namibia within the ambit of national policy processes, with a view to gauging its prospects of making a significant mark in climate change policy and practice.

We then consider the implications for local knowledge of deagrarianisation, itself just one facet of wider changes ongoing in our increasingly globalised world. Deagrarianisation refers to a long-term shift away from agriculture-based livelihoods in rural areas (Bryceson and Jamal, 1997; Bryceson, 2004). It is significantly altering the role played by smallholder farming in rural livelihoods across many parts of Africa and further afield, and will have profound implications for adaptation pathways.

We argue that without linking local knowledge to these 'big picture' factors, it is not possible to determine what role local knowledge should or is likely to play in climate change adaptation policy and practice.

Kenya: The meetings of rainmakers and meteorologists

A who's who of Kenyan forecasters

A recent collaborative effort in Kenya has brought together elders of the Nganyi clan of the Banyore people of the Western Province with

meteorologists from the Kenya Meteorological Department (KMD). In essence, the aim was to explore possibilities for using both Nganyi and meteorological knowledge, as a way to produce more intelligible, robust and locally useful seasonal forecasts.

The KMD routinely releases seasonal forecasts which are broadcast on local radio, with a view to helping farmers make appropriate cropping decisions. Yet concerns had arisen that the technical language used, as well as the relatively wide geographical area covered, was inhibiting the uptake of the forecasts. Because the forecasts were not sufficiently locally specific, some farmers had come to question their usefulness and even to doubt their credibility. At the same time, the salience and credibility of local knowledge in Kenya has of late been in the ascendency, to the point that the Great Lakes University of Kenya has developed local knowledge curricula among its academic programmes.

The Nganyi are held by many in Kenya not only to have the capacity to predict the onset of the rains, but also to be able to *make* rain fall. The act of rain making is performed mainly at shrines established on the graves of deceased 'rain makers', with a pot resting on, and partly submerged in the surface above their head (see photo 1). In the pot, a rain maker will mix various ingredients, such as herbs, soil and river water, whilst chanting, in a bid to commune with his predecessor.

Aside from their imputed ability to hasten the onset of the rains, there are practical reasons why rain makers are valued locally. For a start, their seasonal forecasts are much easier to understand than are their meteorological counterparts. Additionally, their predictions are given at the village level. In contrast, meteorological forecasts can only give information across a wider geographical area, and hence their results are much harder to extrapolate (accurately) for any given village within that area. In other words,



Photo 1: Thomas Osore Omulako, an Nganyi rain maker, demonstrates one element in the act of making rain.

both culturally and spatially, it is hard to match the local appeal of a rain maker.

In the context of a changing climate, the availability of reliable, useful forecasts – be they Nganyi or meteorological in origin can, of course, be a central part of adaptation strategies. Was there a way to bring these two knowledge traditions together, with a view to producing forecasts that were better than those produced in parallel? This was the question driving a participatory action research (PAR) project that sought to narrow the gap between rain makers and meteorologists. Led by the *IGAD Climate Prediction and Applications Centre* (ICPAC), the PAR project created a space in which rain makers and scientists at the Kenya Meteorological Department were able to interact with each other and learn something of their respective arts.

Difficulties and convergences

Attractive though this encounter was in theory, making it happen in practice did not prove

straightforward. One meteorologist recalls, *“I had my doubts on the veracity of some of the claims the rain-makers made. But I was also aware that for an art or community based activity to survive it must be serving the community well”*. Whilst the scepticism held by KMD officers was not, then, insurmountable, the trust and cooperation of the rain makers was harder to secure. This has much to do with the privileged position of rain makers within Nganyi society: only a few individuals can be chosen to inherit this sacred role. Only a few, therefore, have the ability to make the forecasts. It could be argued that the sharing of their knowledge would threaten the status quo, and that this explains the rain makers’ reluctance. One rain maker offered a different explanation: *“We had a problem in sharing knowledge with project partners as it was inherited... and it would be a sign of betrayal for the community if it was shared”*.

Whatever the motivations of the rain makers, a number of factors seem to have helped in generating sufficient trust. First, rain makers have not been asked to reveal how to make rain,

thereby assuaging concerns that their sacred knowledge would be stolen¹. The project has instead focussed on their forecasts, not on their 'methods'. Second, through their meetings with the meteorologists, rain makers came to understand better how meteorologists generated their forecasts, and gained greater respect for them. Third – and also crucial to the credibility of the rainmakers in the eyes of the meteorologists – there has been a high and repeated level of convergence between the results of the forecasts.

As a result, rain makers and meteorologists meet once a year to produce a joint forecast. In the words of the lead researchers on the project, *“By merging modern scientific and indigenous forecasting styles, we hope to better manage climate risks and reduce poverty, and provide communities with new tools for coping with extreme weather events.”* (Onyango et al., 2010). To help achieve this aim, the KMD has agreed to set up a community-operated radio and internet station, as well as a resource centre that can help preserve and promote Nganyi rain-making knowledge.

Local origins and national concerns

This collaboration has reached a broader, national audience, and has become an increasingly popular example of the value of drawing on different knowledge traditions. In many ways, it illustrates what is required for relatively marginalised perspectives – such as local or indigenous ones – to find their way into national policy arenas. These may be dominated by a range of actors attached to influential narratives serving particular interests, and characterised by the politics of competing agendas. Key in getting Nganyi into the national spotlight were

the close links the IGAD Climate Predictions and Applications Centre (ICPAC) had to the Kenya Meteorological Department (KMD). In ICPAC's director, Laban Ogallo, the Nganyi had a policy champion that was able to lobby KMD to consider seriously the prospect of working with the rain makers. Also key was the change of direction in KMD, which broadened out from a focus on forecasting products for industries such as aviation. The Hon. John Michuki, Minister of Environment and Mineral Resources, was instrumental in moving the KMD from the Ministry of Transport (in which he had served as minister previously). The increasing importance of weather information, especially due to the devastating impacts of weather disasters (droughts and floods), has led to KMD occupying a more prominent role in climate debates. In essence, the changing political climate under which KMD is operating provided a policy space for KMD to work with other partners in the PAR project (Guthiga and Newsham, 2011).

However, whilst the Ministry of Environment may have made more space to engage with the rainmakers and bring them into some areas of climate policy, it is less clear that the same will happen with the Ministry of Agriculture. Other work has shown that perhaps the predominant focus in agriculture and climate change policy and intervention in Kenya is on the use of drought-tolerant maize through formal distribution systems (Brooks et al., 2009). Whilst there is clearly a case to be made for such approaches, the concern is that little space is left over for considering the informal seed varieties and distribution systems that farmers currently use, and which may in themselves have a significant contribution to make to adaptation pathways (ibid). This lack of attention to local circumstances does not bode well for the uptake of local knowledge such as that held by the Nganyi.

¹ Rain makers believe that if the secrets of their rituals are revealed to people who have not been 'chosen' to become a rain maker, the power to make rain will be lost.

Namibia: Agro-ecological knowledge and agricultural science

'Indigenous land units'

In North-Central Namibia, Ovambo farmers have a sophisticated understanding of the productive potential of their environment, known in the literature as the "indigenous land unit framework" (Hillyer et al., 2006:252). 'Indigenous land units' (ILUs) are essentially categories of land which classify features of the environment according to their agricultural utility. Farmers use the land unit framework to decide what crops to plant and where, according to the

conditions expected for a given growing season. Verlinden and Dayot (2005) classify indigenous land units according to three broad sets of characteristics: soil, vegetation and landform. 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

Table 1: Types of indigenous land units (ILUs) and importance of specific indicators to their classification (1= highest importance).

ILUs classified primarily by soil-related indicators					
Name	Hardness	Colour	Texture	Salinity	Hardpan
Ehenene	-	3	-	2	1
Etathapya	2	1	3	-	4
Oluma	2	4	3	-	1
ILUs classified primarily by vegetation indicators					
Name	Structure	Species			
Ombonde	1	2			
Ongoya	1	3			
Ehengethitu	1	2			
ILUs classified primarily by landform indicators					
Name	Elevation	Depression	Pan		
Omutunda-Ekango	1	-	2		
Ombuwa-Ekango	1	-	2		
Elonzi		2	1		

Source: Adapted and simplified from Verlinden & Dayot's study of ILUs in North Central Namibia (2005:152-3). The study identifies 38 land units, but only 9 are selected here for illustrative purposes.

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 little from a pearl millet crop (see Hillyer et al 2006 for a broader matching of crops to ILUs). Table 1 shows what crops were grown in the available land units in two villages in the Omusati Region of North-Central Namibia, from research conducted by Newsham and Thomas (Newsham and Thomas, 2011). 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 is another factor influencing settlement decisions. The centrality of agro-ecological knowledge to Ovambo social and economic organisation is difficult, therefore, to overstate.

Agro-ecological knowledge as adaptive capacity

This knowledge system has endowed farming in North-Central Namibia with substantial resilience to climate variability and impacts, spanning from recurring droughts to recurring floods. Understanding agro-ecological dynamics allows farmers to adapt cropping and livestock strategies to the highly variable climatic conditions they encounter from one rainy season to the next. As Hillyer *et al* (2006) have demonstrated visually, farmers tend to try to establish farms across a number of different 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 – in particular, drier and wetter rainy seasons. 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 endured.

However, this does not guarantee that agro-ecological knowledge will prove resilient to *future* climate change impacts. What appears to hold some promise of maintaining resilience – at least in the short-to-medium term – are instances of knowledge co-production, in which farmers' agro-ecological knowledge and specific features of agricultural science have mixed well. One example of this is the use of early-maturing varieties of pearl millet (the staple crop) instead of traditional varieties (Newsham and Thomas 2011). This incremental adjustment has strengthened resilience to impacts associated with drier conditions, and increased harvesting options in wetter years. It is, then, a fruitful co-production of knowledge between farmers and extension workers, a technology which slotted well into the existing land unit system. However, there are plenty of instances of practices being suggested by agricultural extension workers which are not taken up (i.e. Hillyer et al., 2006; Verlinden and Dayot, 2005). This is largely because of a failure to engage with the land unit framework, which leaves extension workers without an understanding of how useful people will find their suggestions. There is, then, nothing automatic about knowledge co-production for strengthening resilience.

Local perspectives and national visions

Thus, the potential contribution of local knowledge in North-Central Namibia to climate change adaptation policy and practice is significant. And

it would be unfair not to recognise the many instances of policy and practice in Namibia which engage strongly with local perspectives and capacities, such as its communal areas conservancy programme. Yet there are two reasons for wondering how much space can be made at the national level for incorporating farmers' knowledge.

First, concerns have been voiced about a perceived change of direction within the Ministry of Agriculture, Water & Forestry. One former senior extension officer was a keen student and advocate of the 'Farmer First' approaches that have been so instrumental in establishing the validity of local farming knowledge for agricultural development (e.g. Richards, 1985; Scoones and Thompson, 2009). He felt that recent policy changes in the Ministry would replace the "bottom-up" extension with a "top-down" approach that pushed for rapid modernisation of subsistence agriculture. The result of such changes for farmers, he argued, was that "[agricultural] technicians now have to serve farmers food that the ministry cooked for you". This change would appear not to bode well for engagement with agro-ecological knowledge in North-Central Namibia.

Second, farming practice in North-Central Namibia is routinely linked to land degradation: Namibia's State of the Environment Report (Nangolo et al., 2006) is just one high-profile example. If local farming practice is so heavily implicated in degradation, then is it misplaced or misguided to attach so much importance to the agro-ecological knowledge on which it is based, or to present it as a source of adaptive capacity? There is currently no definitive answer to this question. But there is a concern that degradation may be serving as a narrative of environmental crisis (Leach and Mearns, 1996; Roe, 1994), in spite of significant gaps in the evidence base on which such claims are made (Kreike, 2009; Newsham and Thomas, 2009; Newsham and Thomas, 2011; Rohde, 1997;

Sullivan, 1999). Further research is required to help settle this question, but current thinking on degradation does not cast local knowledge in the North-Central regions in the most favourable light in dominant narratives in the country.

Discussion: Relating local knowledge to broader processes of change

Thinking about local knowledge in the context of climate change adaptation requires us to consider questions of timescale. It also means setting climate-specific adaptation in the broader context of changes that people are making in the ways in which they make a living. In that regard we flag two important issues: the seemingly worsening climate change impacts outlook; and the extent to which diversification into off-farm livelihoods activities – deagrarianisation – is already occurring in Kenya and Namibia.

By 2009, carbon emissions had increased 40% on 1990 levels, with little discernible prospect of abatement in the near future (Jackson, 2009). As a result of global inaction on emissions, Anderson & Bows (2011; 2008) argue that avoiding 'dangerous' climate change is now next to impossible. Even if we stuck to 'politically and economically acceptable' reductions of 3% per year suggested by Stern (2009) – and we are not even close to this rate – then there is an 88% chance of exceeding 2°C.

As if this were not sufficiently bad news, the task is further complicated by a shift in the goalposts on the threshold for dangerous climate change. 2°C may now be not the 'safety line' so much as the difference between 'dangerous' and 'extremely dangerous' climate change (Mann, 2009; Smith et al., 2009). Responding to *extreme* climate change therefore becomes the adaptation challenge (New et al., 2009). All the while, however, the chances of reaching a 4°C or 5°C rise even as early as 2060 (Betts et al., 2011) are

increasing. To put that in context, at +5°C in Africa, a decrease in precipitation is projected to result in more than a 20% decrease in the length of the average growing season, especially in the Sahel and most of Southern Africa. Of perhaps particular concern is a projected increase in rain-fed crop failures to a frequency of every two years across Southern Africa (Thornton et al., 2011). For this reason, recommending farming as a continued livelihood activity is certainly appropriate in the short-to-medium term, given its importance to current livelihood strategies across Kenya and Namibia. And as part of that, bringing in local knowledge to adaptation policy and practice is a key short-medium term policy objective. However, over the longer term a precautionary approach would suggest that livelihoods diversification into climate *insensitive* activities, mostly off-farm, is an adaptation pathway that requires serious consideration, given the evidence to suggest that neither in Kenya (Eriksen et al., 2008; Freeman et al., 2002) nor Namibia (Newsham and Thomas 2009) is farming the preeminent livelihood strategy it is often assumed to be.

Deagrarianisation is a form of economic transformation. Literature on economic transformation in general argues that as an economy becomes more developed, the relative contribution of the agricultural or primary sector to the GDP declines. In essence agriculture becomes less important in relative terms. This process of transformation is primarily triggered by an increase in productivity in the agricultural sector itself. Other sectors such as manufacturing gain prominence and absorb labour from the agriculture sector. Many African countries are currently undergoing a major transformation in economic structure and location of economic activity, from rural agriculture-based economies to more diversified economies with much larger urban industrial and service sectors. This transition tends to go hand in hand with economic

development. However, there is a growing controversy over how rapid urbanization should be managed: many of those living in informal urban settlements are vulnerable both to chronic poverty and climate change impacts. Clearly, the sheer scale of urban slums across the world shows that we cannot assume that urbanisation always brings about poverty reduction.

Furthermore, there is a worrying trend in some countries, where the relative contribution of agriculture is declining but there is no corresponding shifting of labour away from the agriculture sector. This is mainly attributable to the ballooning of the service sector, which has little capacity to absorb labour from agriculture. In other words, people may want to or actually leave agriculture, but find they do not, in employment terms have anywhere else to go. Certainly, the literature on deagrarianisation has suggested that, whilst this phenomenon is widespread, it by no means automatically leads to poverty reduction. On the contrary, it can lead to the *reproduction* of poverty (Bryceson, 2002; Rigg, 2006). Moreover, where diversification into other parts of the non-farm rural economy does lead to poverty reduction, it seems to depend upon a buoyant agricultural sector. Where the agricultural sector is stagnant, diversification away from farming is less likely to bring about poverty reduction (Haggblade et al., 2010).

The process of economic transformation faces an additional and more grievous threat from climate change. The impacts of climate change on agriculture could forestall the process of economic transformation by making it difficult to increase agricultural productivity, thereby making the livelihoods of poor people in the agriculture sector worse off. If it is harder to create or maintain a buoyant agriculture sector, it may make it harder for people to experience the kinds of livelihood diversification that do lead to poverty reduction.

Therefore, whilst there can be merit in diversified livelihoods as a longer term adaptation goal, diversification away from farming is at best a double edged sword. This may be especially the case in countries with a highly inequitable distribution of national wealth – such as Namibia and also Kenya, though to a lesser extent – which typically experience lower rates of poverty reduction than do countries with more equitable distributions (Cornia, 2010; Donaldson, 2008).

Conclusion and key policy lessons

The Kenya and Namibia cases have shown how discussions over the role of local knowledge for adaptation to climate change must be situated in broader, cross-sectoral policy processes. In both countries, recent government changes have led both to opening and possible closing of policy spaces for the application of local knowledge.

Thus, while the contribution that can be made by local knowledge to climate change adaptation is clear, the local must be linked to the national and the global. If not, our perspective is likely to remain partial at best. It is for this reason that the concept of co-producing knowledge and outcomes for climate change adaptation becomes so important. This partly relates to the gains that can be made from combining different forms of knowledge to make a 'hybrid' that is more useful than what we might generate from one knowledge tradition alone. And in part, it addresses questions of legitimacy, as it offers more scope for involving the people whose development is at stake in the very definition of what that development should be. Even if people are going to modify or leave their farming livelihoods and the knowledge systems attached to them, they should still be the starting point for questions about what sorts of change are desirable and how best to bring them about.

Lessons for policy

Adaptation is all about timescales. In keeping with this insight, our policy recommendations are grouped accordingly.

In the short-to-medium term:

- Engaging with local knowledge can clearly enrich and guide climate change adaptation policy and practice. Commitment to such engagement needs to be more than rhetorical.
- Advocates of bringing local knowledge need to be keenly aware of the policy spaces and processes which will determine how local knowledge is or is not brought in

In the medium-to-longer term:

- The forms of economic transformation that seem to be occurring in many parts of Africa do not hold much promise of delivering alternative, poverty-reducing livelihoods. Therefore, there may be a need to intensify adaptation measures to ensure that agricultural productivity is increased even in the presence of climate change.
- However, with climate change impacts only likely to make agriculture even more difficult in the future for many African farmers, livelihoods diversification as a form of climate change adaptation is clearly worth contemplating, recognising that it is a double-edged sword.
- Yet diversification away from agriculture into other *climate insensitive* activities is already happening and is likely to increase, not decrease. Therefore, for it to make sense as a development strategy as much as it does an adaptation, we need to find ways for deagrarianisation to move people out of poverty, rather than into other forms of entrenched poverty.

References:

- Anderson, K. & Bows, A. 2008. Reframing the climate change challenge in light of post-2000 emission trends. *Philosophical Transactions of the Royal Society A*, 366, 3863-3882 <http://rsta.royalsocietypublishing.org/content/366/1882/3863.abstract>.
- Anderson, K. & Bows, A. 2011. Beyond 'dangerous' climate change: emission scenarios for a new world. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences*, 369, 20-44, 10.1098/rsta.2010.0290 <http://rsta.royalsocietypublishing.org/content/369/1934/20.abstract>.
- Betts, R. A., Collins, M., Hemming, D. L., Jones, C. D., Lowe, J. A. & Sanderson, M. G. 2011. When could global warming reach 4°C? *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences*, 369, 67-84, 10.1098/rsta.2010.0292 <http://rsta.royalsocietypublishing.org/content/369/1934/67.abstract>.
- Boko, M., Niang, I., Nyong, A., Vogel, C., Githeko, A., Medany, M., Osman-Elasha, B., Tabo, R. & Yanda, P. 2007. Africa. In: PARRY, M. L., CANZIANI, O. F., PALUTIKOF, J. P., VAN DER LINDEN, P. J. & HANSON, C. E. (eds.) *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge, UK: Cambridge University Press.
- Brooks, S., Thompson, J., Odame, H., Kibaara, B., Nderitu, S., Karin, K. & Millstone, E. 2009. Environmental Change and Maize Innovation in Kenya: Exploring Pathways In and Out of Maize. Brighton: STEPS Centre, IDS.
- Bryceson, D. & Jamal, V. 1997. *Farewell to farms: de-agrarianisation and employment in Africa*, Aldershot, Ashgate.
- Bryceson, D. F. 2002. The Scramble in Africa: Reorienting Rural Livelihoods. *World Development*, 30, 725-739 <http://www.sciencedirect.com/science/article/B6VC6-4538GYG-6/2/56e4b418db23130cbe4f0bc8746ce587>.
- Bryceson, D. F. 2004. Agrarian Vista or Vortex: African rural livelihood policies. *Review of African Political Economy*, 31, 617-617 <http://www.informaworld.com/10.1080/0305624042000327831>.
- Chambers, R. & Conway, G. 1992. Sustainable rural livelihoods: practical concepts for the 21st century. *IDS Discussion Paper*. Brighton: Institute of Development Studies, University of Sussex.
- Cornia, G. A. 2010. Income Distribution under Latin America's New Left Regimes. *Journal of Human Development and Capabilities*, 11, 85-114, 10.1080/19452820903481483 <http://dx.doi.org/10.1080/19452820903481483>.
- Donaldson, J. A. 2008. Growth is Good for Whom, When, How? Economic Growth and Poverty Reduction in Exceptional Cases. *World Development*, 36, 2127-2143, 10.1016/j.worlddev.2007.10.020 <Go to ISI>://WOS:000261117100002.
- Eriksen, S. H., O'Brien, K. & Rosentrater, L. 2008. Climate Change in Eastern and Southern Africa: Impacts, Vulnerability and Adaptation. *GECHS Reports* Oslo: Global Environmental Change and Human Security Institute (GECHS)
- Fals-Borda, O. M. A. R. 1991. *Action and Knowledge: Breaking the Monopoly with Participatory Action Research*, London, IT Publications.
- Folke, C. 2004. Traditional knowledge in social-ecological systems. *Ecology and Society*, 9, 7
- Ford, J. D. & Furgal, C. 2009. Foreword to the special issue: climate change impacts, adaptation and vulnerability in the Arctic. *Polar Research*, 28, 1-9, DOI 10.1111/j.1751-8369.2009.00103.x <Go to ISI>://000264242100001.
- Freeman, H. A., Ellis, F. & Allison, E. 2002. Livelihoods and Rural Poverty Reduction in Kenya. *LADDER Working papers* Norwich University of East Anglia.
- Green, D. & Raygorodetsky, G. 2010. Indigenous knowledge of a changing climate. *Climatic Change*, 100, 239-242, DOI 10.1007/s10584-010-9804-y <Go to ISI>://000277958200001.
- Guthiga, P. & Newsham, A. 2011. Meteorologists Meeting Rainmakers: Indigenous Knowledge and Climate Policy Processes in Kenya. *IDS Bulletin*, 42, 104-109, 10.1111/j.1759-5436.2011.00228.x <http://dx.doi.org/10.1111/j.1759-5436.2011.00228.x>.
- Haggblade, S., Hazell, P. & Reardon, T. 2010. The Rural Non-farm Economy: Prospects for Growth and Poverty Reduction. *World Development*, 38, 1429-1441, 10.1016/j.worlddev.2009.06.008 <Go to ISI>://WOS:0002834030 00008.
- Hillyer, A. E. M., McDonagh, J. & Verlinden, A. 2006. Land-use and legumes in northern Namibia - The value of a local classification system. *Agriculture Ecosystems & Environment*, 117, 251-265
- Jackson, T. 2009. *Prosperity without growth: economics for a finite planet*, London, Earthscan.
- Kreike, E. 2009. De-Globalisation and Deforestation in Colonial Africa: Closed Markets, the Cattle Complex, and Environmental Change in North-Central Namibia, 1890-1990. *Journal of Southern African Studies*, 35, 81-98, Doi 10.1080/03057070802685585Pii 910044980 <Go to ISI>://000264750500006.
- Leach, M. & Mearns, R. 1996. *The lie of the land: challenging received wisdom on the African environment*, Oxford, The International African Institute in association with James

Currey.

Mann, M. E. 2009. Defining dangerous anthropogenic interference. *Proceedings of the National Academy of Sciences of the United States of America*, 106, 4065-4066, 10.1073/pnas.0901303106 <Go to ISI>://WOS:000264278800003.

Nangolo, E. N., Willems, N. & Muya, S. 2006. Vital Signs of Namibia 2004: An Integrated State of the Environment Report. Windhoek, Namibia: Ministry of Environment & Tourism.

New, M., Liverman, D. & Anderson, K. 2009. Mind the gap. *Nature*, 143-144 <http://dx.doi.org/10.1038/climate.2009.126>.

Newsham, A. J. & Thomas, D. S. G. 2009. Agricultural adaptation, local knowledge and livelihoods diversification in North-Central Namibia. *Tyndall Working paper No 140*. Oxford: Tyndall Centre for Climate Change Research/ University of Oxford.

Newsham, A. J. & Thomas, D. S. G. 2011. Knowing, farming and climate change adaptation in North-Central Namibia. *Global Environmental Change*, 21, 761-770

Onyango, M., Ouma, G. & Ogallo, L. 2010. Science of the elders: famous for their rainmaking skills, Kenya's Nganyani are working with scientists to forecast the weather. *Alternatives Journal* 36 http://web.idrc.ca/en/ev-157064-201-1-DO_TOPIC.html.

Richards, P. 1985. *Indigenous agricultural revolution: ecology and food production in West Africa*, London, Hutchinson.

Rigg, J. 2006. Land, farming, livelihoods, and poverty: Rethinking the links in the Rural South. *World Development*, 34, 180-202 <http://www.sciencedirect.com/science/article/B6VC6-4HGM7JG-2/2/243257cad7955bf0f2df9d19698d94b5>.

Roe, E. 1994. *Narrative policy analysis : theory and practice*, Durham, N.C ; London, Duke University Press.

Rohde, R. F. 1997. Looking into the past: interpretations of vegetation change in Western Namibia based on matched photography. *Dinteria*, 24, 121-149

Salick, J. & Ross, N. 2009. Special Issue: Traditional peoples and climate change. *Global Environmental Change*, 19, 137-190

Scoones, I. & Thompson, J. 1994. *Beyond farmer first : rural people's knowledge, agricultural research and extension practice*, London, Intermediate Technology Publications.

Scoones, I. & Thompson, J. 2009. *Farmer first revisited : innovation for agricultural research and development*, Rugby, Practical Action Pub.

Smith, J. B., Schneider, S. H., Oppenheimer, M., Yohe, G. W., Hare, W., Mastrandrea, M. D., Patwardhan, A., Burton, I., Corfee-Morlot, J., Magadza, C. H. D., Fuessel, H. M., Pittcock, A. B., Rahman, A., Suarez, A. & van Ypersele, J. P. 2009. Assessing dangerous climate change through an update of the Intergovernmental Panel on Climate Change (IPCC) "reasons for concern". *Proceedings of the National Academy of Sciences of the United States of America*, 106, 4133-4137, 10.1073/pnas.0812355106 <Go to ISI>://WOS:000264278800017.

Stern, N. 2009. *Blueprint for a Safer Planet: How to Manage Climate Change and Create a New Era of Progress and Prosperity*, The Bodley Head Ltd.

Sullivan, S. 1999. The Impacts of People and Livestock on Topographically Diverse Open Wood- and Shrub-Lands in Arid North-West Namibia. *Global Ecology and Biogeography*, 8, 257-277 <http://www.jstor.org/stable/2997887>.

Thornton, P. K., Jones, P. G., Ericksen, P. J. & Challinor, A. J. 2011. Agriculture and food systems in sub-Saharan Africa in a 4°C+ world. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences*, 369, 117-136, 10.1098/rsta.2010.0246 <http://rsta.royalsocietypublishing.org/content/369/1934/117.abstract>.

Verlinden, A. & Dayot, B. 2005. A comparison between indigenous environmental knowledge and a conventional vegetation analysis in north central Namibia. *Journal of Arid Environments*, 62, 143-175

Verlinden, A. & Kruger, A. S. 2007. Changing grazing systems in central north Namibia. *Land Degradation & Development*, 18, 179-197 <http://dx.doi.org/10.1002/ldr.769>.

Williams, F.-N. 1994. *Precolonial communities of Southwestern Africa: A history of Owambo Kingdoms 1600-1920*, Windhoek, Namibia, National Archives of Namibia.

Acknowledgements:

This Policy Brief was written by **Andrew Newsham, Lars Otto Naess** and **Paul Guthiga** of the **Future Agricultures Consortium**. The series editors are **Beatrice Ouma** and **Elaine Mercer**. Further information about this series of Policy Briefs at: **www.future-agricultures.org**

The Future Agricultures Consortium aims to encourage critical debate and policy dialogue on the future of agriculture in Africa. The Consortium is a partnership between research-based organisations across Africa and in the UK. Future Agricultures Consortium Secretariat at the University of Sussex, Brighton BN1 9RE UK **T** +44 (0) 1273 915670 **E** info@future-agricultures.org

Readers are encouraged to quote or reproduce material from Future Agricultures Briefings in their own publications. In return, the Future Agricultures Consortium requests due acknowledgement and a copy of the publication.

FAC appreciates the support of the
UK Department for International Development (DfID)

