How Bioenergy Can Help Local Communities Adapt to Climate Change: Lessons from Nyanza Province, Kenya

Working Paper

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Main image: Mango seedlings in Wakesi village
All images: Kate Symons, unless otherwise stated

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Executive Summary

Adaptation to climate change is one of the most important issues facing Kenya today. Rural Kenyans' livelihoods are already affected by a changing climate, with increasingly unpredictable rainfall patterns, a 1°C average temperature rise, and increasing intensity of floods to coastal and inland regions recorded since 1970 (FEWSNET).

Adaptation to climate change is considered an essential component of poverty reduction and sustainable livelihoods. Adaptation does not just involve large dams and infrastructure; it also means small-scale initiatives that benefit people's livelihoods as well as address local environmental issues. This report demonstrates how small-scale biofuel innovations can directly contribute to livelihood-based climate change adaptation by improving communities' resilience though flood-proof, clean, and sustainable fuel. Small-scale bioenergy can also provide sources of clean development for communities, improving their livelihoods through clean development. This increases their resilience to climate change. This report informs policy makers at a national government level about the effects of climate change on the livelihoods of rural Kenyans, and recommends a new focus on adaptation as a multi-faceted, cross-cutting livelihood issue.

Kenya is currently developing climate change policies, governance and strategies which recognise that reducing poor people's vulnerability to climate change is an essential component of successful and equitable adaptation. This report makes wider recommendations about mainstreaming adaptation into local and national institutions and policy. Although the recommendations are targeted at the Government of Kenya, other developing country governments can also benefit from creating a more supportive framework for small-scale biofuel initiatives and developing a cross-cutting institutional and policy framework for adaptation at a livelihood level.

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Background: Kenya and Climate Change

Climate change is already a significant problem for developing countries, and is set to grow in importance. In sub-Saharan Africa, there has been a reduction in the length of growing seasons due to warmer and drier conditions. In Kenya, significant changes in rainfall patterns, a 1°C average temperature rise, and increasing intensity of floods in coastal and inland regions, have been recorded (FEWSNET). Though mitigation of climate change has been a priority for the international community under the United Nations Framework Convention on Climate Change and the Kyoto Protocol, GHG reduction targets have not been met and in some cases GHG emissions have risen (IPCC 2007). Even if urgent action is undertaken to slow the pace of climate change, the scientific evidence shows that sufficient GHGs have been emitted to bring about significant climate change in Africa over the coming decades. This means that some degree of climate change is unavoidable, and adaptation is necessary and urgent.

Africa is considered to be more exposed to the risks of climate change (IPCC 2007). Under conservative estimates the cost of climate change in Africa could be as high as 7-10 per cent of GDP by 2100. The 1999 and 2000 droughts in Kenya alone caused damage equivalent to 2.4 per cent of national GDP (GoK, 2010). This means that recent gains in Kenya's development, such as progress towards the Millennium Development Goals and achieving middle-income country status, are considered to be at risk (IPCC 2007, GoK 2010).

Adaptation is therefore increasingly being viewed as an important component of development (NCCRS 2010). There is a two way relationship between adaptation and development: improving Kenya's adaptive capacity increases its capacity to grow its economy, educate and feed its people and promote good healthcare (Vision 2030), and improving livelihood security means that people are less at risk from the negative impacts of climate change (Adger et al 2003). This means that adaptation should be considered a multi-faceted development issue, encompassing multiple interventions and particularly aimed at helping poor communities to become more resilient.

If adaptation is understood in this holistic and community-focussed way, it becomes clear how small-scale bioenergy projects can play a key role in adaptation. Innovations like household bioethanol stoves can provide clean, sustainable and affordable fuel from renewable sources, as well as a source of household income and rural employment. By reducing deforestation, this promotes development while benefitting the environment.

This policy report makes specific policy recommendations under the following categories:

- Production and promotion of small-scale bioenergy for clean household fuel, thereby reducing energy poverty, supporting livelihoods and reducing vulnerability to climate change
- Understanding and supporting adaptation through clean development as part of improving livelihoods
- Promoting climate change adaptation as a crosscutting issue and mainstreaming into policy making

Box One - What is Bioenergy?

Bioenergy is a term for renewable energy from organic sources. This can include bioresources (natural resources which have not been cultivated or processed such as forests), bioresidues (by-products from industry or agriculture such as sawdust, food waste or manure), and biofuels (liquid fuels such as biodiesel and bioethanol from purpose-grown energy crops such as maize, sugarcane or soybeans). Bioenergy has been used for fuel in developing countries for millennia, mainly in the form of firewood and charcoal. International interest in liquid biofuels as a global source of renewable energy has reached a peak very recently due to concerns over climate change and energy security. Research into biofuels is increasing, and new advanced technologies such as cellulosic bioethanol (ethanol from non-food parts of a plant) may provide future commercially viable sources of renewable energy.

This paper focuses on established 'first generation' biofuels, particularly bioethanol from sugarcane and biodiesel from sources such as jatropha and croton nuts (croton megalocarpus). These fuels are currently produced commercially by large-scale operations in order to meet international demands. The land-use changes required by large-scale operations, and the fact that many biofuel crops are edible, have led to accusations that biofuels reduce food security for the poor and damage the environment in developing countries. However, this paper is concerned with the social and political aspects of small-scale biofuels which, if the policy conditions are right, can provide community benefits without damaging the environment (FAO 2008, Muok 2009, Clancy 2011). An important feature of many biofuel crops, especially sugarcane, jatropha and croton megalocarpus is that they are relatively hardy, and provide new opportunities for agriculture in a changing climate.

How is Adaptation Related to Development?

Adaptation is defined as in line with the IPCC as "an adjustment in ecological, social or economic systems in response to observed or expected changes in climatic stimuli and their effects in order to alleviate adverse impacts of climate change or to take advantage of new opportunities" (Adger et al 2005:78). Adaptation is frequently viewed as projects which help people cope with the direct effects of climate change such as transport schemes and flood protection, or public services such as early warning systems and climate change information systems. While these measures certainly play an important role in responding to disasters and proactively improving national adaptation capacity, it is also important for policy makers to consider adaptation from a livelihoods perspective at a community level. This encompasses a range of factors (institutional, economic, environmental, or livelihood-based) which affect people's ability to adapt to climate change. This is known as adaptive capacity.

Communities have varying levels of adaptive capacity to climate change depending on their existing capacities, such as resource access, political and economic power, education, social capital, employment opportunities, exposure to conflict and quality of social structures (Sen 1991, Smit & Wandel 2006, Eriksen et al 2007, Agrawal

2008). It is acknowledged that poor people are highly dependent on environmental assets such as forests, clean water and land (OECD April 2006, IPCC 2007). This is one reason why adaptation is such an important part of development: poor people are highly vulnerable to changes in their environment. Research shows that when confronted with a flood, the poorest citizens of Mombasa suffered more deaths and destruction of livelihoods than other socio-economic categories, as well as having a very limited ability to recover (Awuor et al, 2008). This is understood as vulnerability to climate change. So while the poor and marginalised suffer disproportionately from the effects of climate change, vulnerability can be reduced by lowering poverty and improving livelihoods.

Adaptation, if it is not specifically targeted at poorer communities risks reinforcing existing inequality. On the other hand, adaptation which focuses on the poor "can 'level the playing field'"(Adger et al 2005:83) Under this view, adaptation includes small-scale projects based on local practises, aimed at helping people proactively improve their livelihoods and thereby their resilience to climate change. Successful adaptation rests on individuals having capacities and resilience at a livelihoods level to cope with possible crises associated with climate change, and to be able to adopt clean development options which also add to their livelihoods. In short, by improving communities' livelihoods, their vulnerability to climate change is reduced and their adaptative capacity increased.

What does this approach mean for governments? In this view, the role of government is to support communities', and particularly poorer communities', capacity to adapt by building livelihoods in a proactive manner rather than simply aimed at preventing disasters. Adaptive strategies take place at multiple levels, and could include improving local institutions, supporting local practises through capacity building, knowledge sharing and financial support. For example, case studies in Endau, Kitui District in eastern Kenya and in Turkana in northern Kenya show that local practises have helped communities hit by drought and political conflict to improve their capacity to adapt to climate change (Eriksen and Lind 2009). This local approach complements large projects aimed at improving livelihood security - securing water supply, improving public transport and addressing fuel poverty. A multi-faceted strategy creates a positive circle of improved livelihoods and improved adaptive capacity. Bioenergy can play a major role in this process.

Figure 1: Rural Adaptation Cycle

TEXT BOX TWO – The Technology

PISCES is researching and developing a range of bioenergy technologies. This research concerns the following:

Fuel-efficient jiko stoves – a small, ceramic-lined portable stove modified to increase its fuel efficiency. Jiko have been donated by PISCES to trial in villages throughout Nyanza province, Kenya (and in several other locations throughout Africa).

Bioethanol stoves – portable household cooking stoves which run on bioethanol. Fifty households in Nyallenda, Nyanza Province took part in a three month trial of these stoves in place of their regular cooking methods. The bioethanol for the stoves was produced from Kenyan sugarcane. It comes from molasses, a by-product of sugar processing. Although sugarcane requires lots of water, it has a relatively low carbon footprint compared to food crops such as maize (Canney-Davidson 2011). Currently, bioethanol is produced commercially by companies in Kenya and sold as high-grade bioethanol to a variety of customers including the medical industry. The stoves were imported from overseas, though there is potential, with the right governmental support, for the development of local production rights and therefore a Kenyan-based manufacturing industry.

Biodiesel processing – biodiesel can be produced from a variety of crops (including croton, soya, jatropha, palm and rapeseed oils), and at a variety of scales, from community production to large-scale industrial production. Technologies for local production include simple presses, which produce combustible oil for domestic use.

What Role Does Bioenergy Play in Adaptation?

This section details how using bioenergy technology at a community level can improve adaptation and reduce vulnerability. This can be done directly, for example by enabling people to cook on transportable, flood-proof stoves. It can be done indirectly: by improving communities' livelihoods (through improving health, income, providing a clean environment and reducing poverty), their vulnerability to climate change is reduced. By providing opportunities to develop in an altered climate and in a sustainable way, bioenergy also increases their adaptive capacity. This moves beyond the idea of merely coping with climate change, since bioenergy provides opportunities both to reduce vulnerability, and also for improved and resilient livelihoods. This is a core principle underlying the NCCRS. In short, reduced poverty and increased adaptation form a positive cycle. Community-level bioenergy technology has great potential to contribute to this positive cycle in the following ways.

Improves health

Clean household biofuels can reduce energy poverty, benefit rural livelihoods and give health benefits (Gathui & Ngugi 2010). Up to 90 per cent of rural African communities rely on firewood, charcoal, animal and agricultural waste for their household energy requirements, equating to 47 per cent of sub-Saharan Africa's total energy use (World Health Organisation 2002). This results in a heavy time and health burden for women and children for women who must gather and then cook with the dirty fuels (Canney-Davidson 2011). Pilot studies are being conducted which show that clean bioethanol dramatically reduces these negative effects, and results in a significant health improvement for women and children.

Villagers using the technology

Provides household fuel and a source of income

Energy is considered an essential pre-requisite for development and economic progress (Maesa & Verbist 2012), and biofuels can help by providing a clean, healthy and reliable cooking fuel. Additionally, producing and selling biofuel as a community enterprise can provide an additional source of household income. There is potential for community industry along the lines of pilot studies developed in Mali, where small-scale jatropha schemes by small-holder farmers produce jatropha across 3,600 hectares, involving 2,500 members including 500 women. The scheme supports 12 producer co-operatives.

Reduces deforestation by providing sustainable household energy

In Kenya, 68 per cent of the total primary energy used is from wood-fuel (Muok et al 2010), which has led to the continued clearance of forests. This results in topsoil degradation and increased flooding. This is also of major international environmental concern because these forests act as a carbon sink and as important sources of biodiversity (Wakhungu 2010). There is therefore a direct link between household energy use, and environmental degradation and climate change. Producing household fuel locally in small-scale operations (which do not involve major land clearances) reduce the requirement for wood fuel and hence protect forests. In addition, fuel-efficient stoves result in less charcoal and firewood being used for fuel.

Contributes towards clean development

In common with many developing countries, Kenya is not a net producer of GHG emissions. However, Kenya's carbon emissions are rising swiftly, while those of a number of developed countries are slowly falling. Between 1992 and 2010, Kenya's total carbon emissions rose by 87 per cent (US Energy Information Administration, International Energy Statistics June 2012). It is essential that developing countries adopt clean development pathways which allow economic growth, but use low-carbon energy such as bioenergy. By producing fuel through renewable sources at a community level, bioenergy contributes to livelihoods and development without creating high levels of GHGs.

Provides a source of development funding from carbon finance

By reducing deforestation and providing development benefits, household biofuels schemes can be registered under the Clean Development Mechanism (CDM). The CDM is a carbon finance scheme under the Kyoto Protocol which rewards projects that contribute to reducing GHGs. CDM projects are approved by NEMA, and biofuels may be registered as CDM compliant (NCCRS 2010). However, despite comprising 20 per cent of total projects approved or under consideration in Kenya, there are no active bioenergy projects. This suggests that Kenya is not fully exploiting the potential for bioenergy projects to register under the CDM. There are also a growing number of voluntary carbon markets, which work by calculating the total saved emissions and selling these carbon units internationally, with proceeds reinvested for community development. Both of these are valid options for further developing domestic biofuels under clean development pathways.

Summary: table of benefits and their relation to climate change adaptation

Initiative	Benefits	Relationship to climate change adaptation
Using bioethanol or biodiesel for household fuel	• Improved health due to clean fuel • Elimination of firewood and charcoal leads to a reduction in deforestation	• Reduces vulnerability to by improved health • Provides environmental resilience
Producing bioethanol or biodiesel in a community-based industry to sell locally	• Crops can replace climate-sensitive traditional crops • Provides a source of household income • Provides potential for local industry • Reduces deforestation	• Adapts agriculture to changed conditions • Improves resilience by reducing poverty and providing employment opportunities • Provides environmental resilience
Using portable fuel efficient jiko stoves	• Reduction in charcoal burning provides health benefits • Can be used in flood conditions • Reduces deforestation	• Reduces vulnerability by improving health • A direct adaptation to changing conditions • Provides environmental resilience
Using portable biodiesel/ bioethanol stoves	• Can be used in flood conditions • Additional benefits as above	• A direct adaptation to changing conditions
Scaling up community biofuel schemes for registration under carbon finance schemes	• Provides centralised development funding through NGOs • Benefits as above	• Provides poverty reduction finance to Kenya through sustainable and clean agricultural development

Case Study One – Wakesi Village: Improving Livelihoods for Community Adaptation

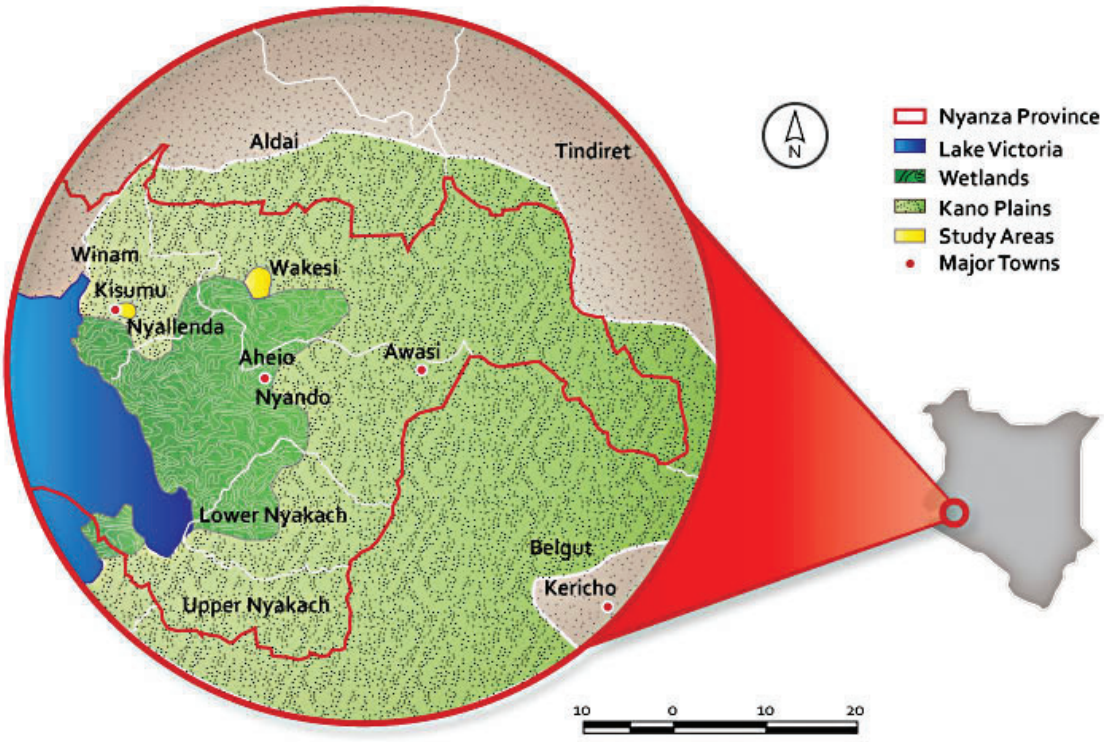

Figure 2: Map of Study Sites

Wakesi village is located approximately 10 kilometres from Kisumu in the Kano Plains in Nyanza Province, Kenya. The province is the poorest in the country, with poverty levels of 65 per cent (GoK and World Bank 2005). The village is in Kenya's 'sugar and rice belt' and close to the major town of Kisumu. Livelihood strategies include seasonal labour in the sugar and rice industries and occasional urban work, though subsistence agriculture dominates.

Challenges posed by climate change

The effects of climate change are most notably drought, with one good harvest reported every three years, and a higher risk to crops from flooding. Data on the villagers' community-level adaptation strategies were gathered between May and June 2012 using field observation, detailed interviews and group discussions. The community has begun to adapt to changing conditions by using drought-tolerant traditional crops and livestock. It has also started to focus increasingly on subsistence farming rather than cash crops, indicating that food for consumption is becoming a priority.

Recently, the community has been growing adaptation crops such as cassava, sweet potatoes, sorghum and short-term maize, and indigenous vegetables such as black nightshade and gynadropsis which provided Wakesi with much-needed income when floods ruined the region's traditional crops in 2011. The villagers have developed particular local knowledge on what type of crop works better with local conditions. However, this strategy can still be be impacted by severe climate-related events such as floods, which means that climate change gravely threatens the livelihoods and food security of these subsistence farmers.

Clean and affordable fuel is becoming scarcer, and the community still relies on traditional cooking stoves. These are neither climate-resilient nor fuel efficient. PISCES has donated fuel-efficient, ceramic-lined jiko stoves. These have multiple benefits, including reducing the amount of charcoal required to cook, saving money, and reducing harmful cooking emissions, potentially improving health. Some members of the village have been trialling croton megalocarpus which grows alongside food crops and produces large nut-like seeds that can be processed into oil. With further PISCES help, this will be developed into a cottage industry to provide income and local opportunities.

"The jiko stoves mean that we spend less money on fuel, and burn less charcoal"

(Interview with housewife, Wakesi Village, May 2012)

Participants felt confident that demand for local clean household energy is high, and therefore can be used to support their livelihoods as well as being a sustainable and clean source of energy. However, the community needs to strike a balance between investing in biofuel and adaptation crops which will benefit them in two-to-four years, and growing crops that provide 'here and now' benefits.

Wakesi farmers have demonstrated willingness to innovate and an attitude of empowerment and responsibility for their own livelihoods. They have clear views on the variety of interventions that would assist with adaptation. These include:

- education and an opportunity to knowledge-share through village meetings, radio, TV and local posters
- government investment in local roads to integrate them with the region's market
- further support to develop improved crop varieties and climate-resilient livestock breeds
- capacity-building to enable the village to write successful proposals for adaptation funding under existing funding channels
- assistance to purchase fuel-efficient cooking stoves; and investment in biofuel processing equipment (such as oil presses) which would kick-start a community-based industry.

Wakesi illustrates the diverse nature of the climate change challenge, and the broad and context-specific range of adaptation strategies necessary to improve the resilience of rural peoples' livelihoods.

"After our traditional crops were ruined by floods, we are growing new varieties, including croton to turn into biofuel. We are willing to try new things so appreciate our partnership with organisations which can teach us new ways of adapting to climate change."

(Interview with farmer, Wakesi, May 2012)

TEXT BOX THREE – Elite Capture

Research shows that the benefits of community development projects are not necessarily spread evenly (Agrawal 1999, Cleaver 1999, Kumar and Corbridge, 2002 Mosse 1994). Benefits may be captured by powerful and influential members of a local community, resulting in the poorest and most vulnerable missing out on the intended gains. This is referred to as 'elite capture', and is a significant issue even in very small communities. This is not always noted at 'head office' level, as it often seems as if the community is benefitting fairly.

The issue is complex, but in simple terms it can be combatted by two main methods. The first is by taking steps to ensure empowerment of all members of the community, not just the most vocal or those who are in official positions, for example by including identification of, and outreach to the most marginalised as an explicit part of the project goals.

The second is by deliberately creating, or identifying existing, local institutions which promote equitable sharing of benefits, and using these as part of the project. This may include women's groups or other collectives. This enables multiple members within a community to have rights to the benefits of the project, and ensures their voices are heard.

Fairness and a perception of equity is particularly important in adaptation projects, since adaptation interventions may fail or be locally unpopular if they do not have the support of a community majority (Thomas &Twyman 2005).

Case Study Two: Using Household Bioethanol to Cope with Flooding in Nyallenda

The Nyallenda informal settlement in Kisumu, one of the largest 'slums' in Kenya, exemplifies the challenges of living in poverty. The suburb has a particularly bad case of fuel poverty, relying almost completely on charcoal, gathered woodfuel and burning of debris and waste (including waste plastics). The continued use of firewood and charcoal places huge pressure on local forests, with estimates of 200-300 trees required each year for one household's domestic energy consumption in the region (Muok et al 2010). However, it is difficult for Nyallenda residents seek alternatives. The poorest are excluded from the first rung of the 'fuel ladder' and continue to depend on direct burning of woodfuel which is bad for their health and bad for the environment.

The community reports that flooding has worsened over the past five years, with several householders noting increases in frequency and intensity. Women report that they are unable to use traditional stoves in the flood season because their cooking areas become inundated with water that does not subside for periods of up to several weeks. In addition, they report that they are unable to access affordable charcoal or firewood since prices can rise by approximately 30 per cent in the flood season.

A trial of clean ethanol as a cooking fuel has been conducted in Nyallenda by PISCES from April 2012. Data on the how clean fuel can contribute to adaptation were gathered between May and June 2012 using field observation and detailed interviews with trial participants. The participants reported that since the stoves are highly portable, they can simply be moved when areas become too waterlogged for traditional cooking methods. In addition, the bioethanol is stored in bottles which are not affected by water, as opposed to charcoal, wood or gathered debris which can become too wet to burn. The price of bioethanol would not change during the flood season, making it a more predictable household expenditure. These simple features mean that the stoves can help households adapt to a changing and unpredictable climate. However, households say that the fuel, at around 280 KSH (Kenyan Shilling) per litre, and the stoves which retail at around 8,000 KSH, are too expensive. Yet, with 1,600 households in Nyallenda informal settlement alone, a large and ready market exists for bioethanol as a household fuel if an affordable price can be established.

Wider benefits include the replacement of charcoal and firewood with bioethanol derived from sugar cane. If used on a wider scale, this has the potential to significantly reduce deforestation. The bioethanol can be produced from molasses. As this is a by-product from Kenya's sugar cane processing industry, this is very environmentally sustainable. There is further potential for bioethanol schemes to quantify the amount of deforestation they have prevented, and use this information to register under the Clean Development Mechanism or under voluntary carbon trading markets. This is an ongoing research area for PISCES.

"When it floods in my house I can't cook because I can't use my traditional stove. If is often hard to get firewood or charcoal, and these fuels get very expensive during rains. The ethanol stove means I can cook for my family."

(Interview with householder in Nyallenda Informal Settlement, May 2012)

A householder in Nyallenda indicates regular flood levels

(Source: Author photograph May 2012)

Adaptation Policy in Kenya

Kenya is a signatory to the 1997 Kyoto Protocol which, along with setting binding targets for climate change mitigation, encourages low-carbon futures through adaptation and clean development pathways such as the CDM. It sets out funds to assist developing countries for adaptation plans which are identified as part of National Adaptation Plans of Action (NAPA).The Government of Kenya (GoK) acknowledges that Kenya must adopt strong climate change adaptation measures, under the Vision 2030 and the NCCRS. These responses include capacity building at a local level, along with maximising technological opportunities and technology transfer (NCCRS, July 2010). The NCCRS links deforestation and growth in consumption of forest products to climate change and environmental damage, while at the same time acknowledging that as a developing economy Kenya urgently requires large amounts of cheap, clean and quality energy. In addition, NEMA states that effective and urgent mitigation and adaptation are both necessary to ensure Kenya's Vision 2030 targets are achieved, as well as acknowledging the uneven effects of climate change according to livelihood vulnerability (NEMA, 2010). The NCCRS acknowledges that Kenya is unlikely to meet its Millennium Development Goals on poverty and sustainability without successful and equitable adaptation. Kenya's NAPA is also currently under development, guided by policy principles in the NCCRS.

Why is the Current Policy Approach Inadequate?

Though the Kenyan Government has been proactive in addressing climate change there are three issues with the status quo which this paper addresses: bioenergy policy gaps, adaptation policy gaps, and institutional issues.

Bioenergy Policy Gaps

Despite the creation of a biofuels strategy and dedicated biofuels committee, Kenya's current policy framework hampers a thriving domestic biofuel industry. This has negative effects on Kenya's forests, on its poorest citizens' livelihoods and their ability to adapt to climate change, and it misses an opportunity to fully exploit funding mechanisms such as the CDM. NEMA's State of the Environment Report (NEMA, 2010) mentions several clean energy options such as solar and wind. However, NEMA does not link adaptation to bioenergy. The relationship between small-scale bioenergy, livelihoods and adaptation provides a way of making this link. Specific policy gaps related to the regulation of bioethanol for use as fuel have been detailed in prior ACTS publications (see Muok et al 2008). In brief, these gaps include lack of implementation of blending regulations for bioethanol under the Kenyan Bureau of Standards, and the lack of specific tax tariff for bioethanol that is used as a fuel rather than alcohol for consumption or industrial/medicinal use. Although there is also a National Biofuels Strategy (2008) and a draft National Biofuels Policy (2010), these have not been implemented. Widespread and profitable small-scale biofuels production for a local market depends on proper management of the industry by governments and other key stakeholders. The failure of government to facilitate the use of ethanol as a household fuel is a demonstration of how political decision-making can restrict the adaptive capacity of livelihoods.

Adaptation Policy Gaps

Kenya's original Poverty Reduction Strategy Paper (June 2000, updated 2004) does not mention climate change as a risk factor. The current PRSP implementation document, 'First Medium Term Plan (2008 - 2012)' represents a welcome step forwards as it mentions the impact of climate change on poverty, especially in the context of water resources, irrigation, land use, tourism and wildlife. However, this strategy makes only one explicit mention of adaptation, which it understands as disaster preparedness rather than a livelihood issue that impacts disproportionately on vulnerable groups. Further amendments to the PRSP would benefit from consideration of socio-economic inequalities and adaptation, as well as planning for adaptation as a livelihood issue. 75 per cent of Kenya's population is employed in the agricultural sector and is thus directly dependent on natural resources for their livelihoods (World Bank Adaptation Profile, Kenya). 25 percent of these are pastoralists, and a failure to adapt to what is likely to be significant changes to this resource base will hinder delivery of poverty reduction targets.

Institutional Gaps

Adaptation is not currently integrated into livelihood policy making, nor is it adequately reflected as a mainstream cross-cutting issue across Kenya's government institutions. There is significant scope to improve communication and collaboration between national, regional and local institutions, and between official and civil society stakeholders, to produce a genuinely cross-cutting, multi -scale adaptation strategy. Kenya's sectors at risk of climate change include agriculture, tourism, infrastructure, health, natural resources, energy, transport, and wildlife (Watkiss et al 2009, NCCRS 2010). Adaptation is therefore a key issue for all the Ministries that have remits in these areas. However, there is no cross-cutting committee or office which brings together these Ministries to coordinate policy on adaptation (at the time of writing, the National Climate Change Steering Committee recommended by the NCCRS has not been established). The current process of developing Kenya's NAPA provides further opportunity to address adaptation as a cross-cutting issue.

Scale

Local institutions are key to successful adaptation because they govern how a community accesses resources, build bridges between local and national policy-making on adaptation, and shape local vulnerabilities and capacities (Agrawal2008). They have a crucial role to play in directing adaptation funds, technology and knowledge from the national to the local level. This means that ministries concerned with regional affairs and ministries concerned with national infrastructure provision have a key role in adaptation policy. Attention should be given to the key role of provincial and county-level government in structuring adaptation responses. This 'middle level' institution has an important role to play in building a bridge between local projects and national policy-making. However, there is a weakness in co-ordination between the local, regional and national level on adaptation policy.

Policy Recommendations

Understanding and supporting climate change adaptation as part of improving livelihoods

Further Research: The first step is ensuring that the effects and risks of climate change on local livelihoods are understood. Vision 2030 and Kenya's National Climate Change Response Strategy (April 2011) recommend that more work needs to be done on enhancing Kenya's understanding of the global climate change regime. This should be complemented by a greater understanding of local adaptation in the context of livelihoods and capacities. This entails a need for further detailed local research on the effects of climate change on livelihoods and what are the area-specific requirements for adaptation.

Building capacity: Capacity building at a community level for adaptation is essential. The government should support an education programme aimed at promoting clean household fuels such as briquettes, fuel-efficient charcoal stoves, pressed-oil biofuel and bioethanol. Support measures include: providing loans or tax relief for start-up essentials such as seeds, machinery, oil presses or briquette equipment; sensitisation to adaptation issues; as well as advice on how to write successful proposals for adaptation funding under existing funding channels. This will increase the ability of local people to use their own local adaptive practises.

Knowledge sharing: Communities are often highly aware of climate change impacts, and the more experienced a subsistence farmer is, the more likely he/she is to perceive the effects of climate change (Maddison 2007). There is a great deal of work being undertaken by various agencies such as the Kenyan Agricultural Research Institute (KARI) into adaptations such as development of drought-resilient seeds. Bringing together this knowledge is key to improving adaptation capacity. Provincial governments need to make further investment in adaptation education initiatives such as seed fairs. Farmers are eager to learn more about adaptation, are prepared to innovate, and are willing to take on risks in order to improve their livelihoods and adaptation capacity. They also already have significant knowledge about agriculture and climate, and are keen to know more. Knowledge sharing would build on this innovative attitude.

Community consultation on adaptation: Climate change affects communities differently according to local environments and existing community capacity. Community consultation should take place as part of the preparation of the NAPA and the NCCRS implementation strategy to ensure adaptation is efficient and context-specific.

Production and promotion of clean household fuel

Bioenergy can assist with both mitigation and adaptation by providing a sustainable source of fuel that can be produced locally. It can support adaptation by improving livelihoods and enabling cooking to take place even in flood conditions. It can provide an alternative to charcoal thus reducing deforestation. For bioenergy to successfully benefit livelihoods, the policy and institutional framework must be pro-poor (Clancy 2011). A supportive policy environment would include:

- A reduced tariff on bioethanol
- Education about the use of bioethanol as a household fuel
- Incentives for the sugar industry to produce bioethanol, including support for millers

to improve the production
- Support for local manufacture of ethanol stoves
- Tax reduction or household incentives to purchase an ethanol stove
- Support for community-based biodiesel production

Changing the tariff on bioethanol for fuel to support a domestic market: For the poorest households to consider using it, the cost of ethanol should fall somewhere between 50-80 KSH per litre. However, the cost is actually around 280 KSH per litre, a large proportion of which is GoK tariff. It is possible to produce and market fuel-grade bioethanol locally for approximately 70 KSH per litre. This means that GoK tariffs are preventing the establishment of a bioethanol market for household use amongst poor households. A change in designation of bioethanol for fuel use to reduce the government tariff is essential to the promotion of its use as a clean domestic fuel.

Supporting bioethanol processing and production for domestic use: Kenya's purpose-built ethanol factory, which was constructed in 1977, has since failed to develop a market for fuel ethanol due to a lack of policy framework and correct pricing (Canney-Davidson, 2011). However, Kenya has the potential to produce up to 413 megalitres per year of bioethanol from molasses, a by-product of the sugar industry (Jumbe et al 2009). Kenya is currently failing to meet its production capacity. Promotion of a local market for bioethanol processing and use would ensure that clean bioethanol can be accessed and used by communities and would provide the incentive for an increase in production. Additional measures include: explicit promotion of bioethanol in existing biofuels and adaptation strategies; favourable lending and other financial support for the industry; knowledge sharing and building relationships with other successful bioethanol producers internationally.

Production of ethanol stoves: There is a requirement for specific policies to enable and promote local production of clean cooking stoves for at-risk areas include the provision of government support for local production of the stoves. Currently, the stoves are manufactured overseas; knowledge transfer to local artisans must be supported, including training, capacity building and start-up funding. This should be done in such a way that the stoves can be produced and sold at an affordable price for poorer communities. Affordability of the stoves could be additionally supported by tax breaks or incentives for poorer users and those in flood-prone areas.

Support for community production of biodiesel: There is great potential for Kenya to learn from Mali's success in piloting biodiesel co-operatives. A supportive environment includes: recognition of small-scale biodiesel within Kenya's existing biofuels strategy; funding for Kenyan pilot schemes to determine feasibility, knowledge-building amongst potential participants; financial support (including priority lending from the financial sector) for the co-operatives; and the creation of a supportive institution (for example a producers' union) to drive the cop-operative.

Promotion of bioenergy under CDM: Despite comprising 20 per cent of total projects approved or under consideration by NEMA, there are no active bioenergy projects registered under the CDM in Kenya. This is one option for further developing the bioethanol market under clean development, especially as its use as a household fuel has been linked to a reduction in deforestation (ACTS July 2010b). Further education and promotion of bioenergy and its links to carbon reduction, and addressing the challenges of small schemes registering under the CDM, are required to increase the number of bioenergy CDM projects.

Promoting climate change adaptation as a mainstream and cross-cutting issue

Mainstreaming adaptation into national institutions: A committee should be established comprising members of the Ministry of Agriculture, the Ministry of Energy, the Ministry of Fisheries Development, the Ministry of Forestry and Wildlife, the Ministry of Public Health and Sanitation, the Ministry of Transport, the Ministry of Tourism, and the Ministry of Water and Irrigation, and offices including the Disaster and Emergency Response Co-ordination unit. The committee would have responsibility for ensuring adaptation efforts are coordinated across the affected ministries, and would mainstream adaptation into poverty alleviation, economic growth, infrastructure, heath and natural resources policy-making.

Integrating local, regional and national institutions: It is necessary to improve communication between local, intermediate and national-scale government institutions. This will ensure thecontext-specific local and regional requirements for adaptation understood and fed into large-scale national and international concerns. Bridge-building activities should include the involvement of local stakeholder and institutions in NAPA development. There is also a key role for local representatives such as District Development Officers in communicating adaptation issues from local to national level. In addition, local NGOS often have a good record of advocacy on adaptation, and can provide local knowledge on patterns of inequality and resource access. They should be involved in adaptation strategy and policy where appropriate.

Including adaptation in poverty reduction strategies: Kenya's original PRSP makes little mention of climate change as a poverty issue, though this has been partially addressed by the 2008-2012 update. The next PRSP update is due sometime after 2012.

This update should mainstream adaptation as a livelihood issue by ensuring poor communities and marginalised groups are consulted on adaptation specifically as part of the PRSP review and evaluation process, and including community consultation as part of poverty reduction projects to ensure livelihood concerns are integrated into the projects.

Conclusions

Some degree of climate change is unavoidable, and the degree to which Kenya successfully builds its adaptation capacity will dictate its future development. It is necessary to build on Kenya's existing national climate change adaptation strategies with a focus on the livelihoods level, especially amongst marginalised communities. Social research has argued that communities which are already vulnerable are particularly ill-equipped to cope with the impacts of climate change (Adger et al 2003, Adger et al 2005, Thomas &Twyman 2005, Awuor et al 2008). This means that adaptation is an economic, health and development issue as well as being an environmental one. Adaptation strategies must form part of poverty reduction, health policy and economic policymaking. This cross-cutting approach should feed into the development of Kenya's forthcoming NAPA and NCCRS implementation. A cross-departmental committee, comprising representatives from the seven Ministries affected by adaptation issues, should be established in order to ensure adaptation is integrated into water, agriculture, energy, transport, tourism, wildlife, and health policy. Bridge-building on adaptation should take place between local, regional and national government and local civil society, to ensure a genuinely multi-scale, cross-cutting approach to adaptation. In addition, environmental policy makers should also ensure they are cognisant of social inequalities as well as environmental issues when considering adaptation policy. Now is an ideal time to begin mainstreaming adaptation as Kenya's NAPA preparation is underway, as is consultation on the NCCRS implementation.

Clean development initiatives must take place at a community level to ensure sustainability and equitable benefits. Bioenergy can contribute to adaptation by providing clean household fuel and a potential source of income if the policy conditions are right. In addition, adaptation and mitigation strategies can complement each other. Drawing on two case studies of adaptation and clean energy, it is seen how bioenergy provides an opportunity to add to livelihoods through the use and production of clean household fuel, while contributing to local empowerment, adaptation and clean development. ACTS recommends that the GoK lift the tariff on bioethanol to promote it as a clean household fuel, provide assistance to stimulate and support a bioethanol market and introduce policies to support local manufacture of clean stoves. Adaptation can be supported by the provision of education and capacity building at a livelihood level. In addition, further support is required to enable bioenergy initiatives to exploit clean development pathways such as the CDM.

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Through action research, the PISCES project is contributing to innovation and providing new policy-relevant knowledge on bioenergy – leading to better practices and widening energy access to the rural poor in East Africa and South Asia. It is the energy Research Programme Consortium funded by the UK's DFID, whose members include ACTS (lead), Kenya; PAC-UK, Eastern Africa, and Sri Lanka; the University of Dar es Salaam, Tanzania; M.S. Swaminathan Research Foundation, India; and the University of Edinburgh, UK.

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The University of Edinburgh works with PISCES through two of its research institutes: the Institute for Energy Systems (IES), and the Centre of African Studies (CAS). IES has a long involvement with energy and environment related projects in developing countries. It has active awards in renewable energy research totalling £17m+; co-hosts the UK Energy Research Centre; and conducts road-mapping on R&D requirements for future energy technologies. CAS is an internationally recognised centre of excellence in research on Africa, and has a history of working with DFID.

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