Building Nigeria's Response to Climate Change: Pilot projects for community-based adaptation in Nigeria with a focus on alternative livelihoods

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Abstract. Throughout history, human societies have had to effectively devise ways and means to adapt to climate variability by altering their lifestyles, agriculture, settlements and other critical aspects of their economies and livelihoods. The capacity to adapt enables societies to deal with a range of uncertainties. Coping and adaptation is a way of life in Nigeria, where climate variability is the norm and where planting cycles in a largely rain-fed agricultural system are affected by reoccurring droughts, floods and other extreme weather events. Climate change scenarios for Nigeria suggest a warmer climate with more extreme heat events as well as more aridity in the north and wetter in the south along the coast. Resource-dependent people, such as farmers, hunters and fishers, who depend directly on the productivity of natural resources around them for their livelihoods, are the first to be impacted by these changes in local environmental conditions.

The Government of Nigeria is a signatory to the UNFCCC and there is an initiative underway to develop a national strategy for community- based climate change adaptation. Since 2007, the Nigerian Environmental Study/Action Team (NEST) is an NGO has been implementing the project *Building Nigeria's Response to Climate Change* (BNRCC). Pilot Projects are one component of BNRCC, and are designed to test adaptation options on a small scale in order to strengthen the resilience of communities to climate change, increase their adaptive capacity and provide recommendations based on lessons learned from community-based adaptation projects to the national strategy. The projects involve seven partner organizations who are working directly with 15 vulnerable communities spanning Nigeria from the Sahel in the north east to the Coastal/Rainforest in the south east. The projects include but are not restricted to: increasing food security by introducing improved crop varieties; testing alternative livelihood options such as aquaculture in order to provide a means of income and decrease reliance on dwindling forest resources; providing fuel efficient wood stoves; improving access to water sources to deal with water scarcity; and tree planting for ecosystem rehabilitation.

Key words: community-based adaptation, vulnerability, livelihoods, improved varieties, water scarcity

Introduction

Nigeria, the most populous country in Africa, with over 140 million people, of which 70% depend on small holder rain-fed agriculture (IFAD 2009), is highly vulnerable to the impacts of climate change. The average life expectancy is 48 years and Nigeria ranked 158 out of 182 in the Human Development Index (UNDP 2006). Nigeria has historically experienced major drought episodes causing massive famine in some northern Nigerian states in 1882-86, 1913-16, 1942-45, 1971-73, 1983-84, 1987-88 and 1997-98 (Tarhule and Woo 1998). The most severe drought years (1973, 1983, 1987, and 1997-98) coincided with El Niño years (NIMET, 2006).

Nigeria's First National Communication (FNC) (2003) identified the nation's natural ecosystems, agricultural ecosystems and water resources including coastal and marine ecosystems, as highly susceptible to climate change impacts, including:

i. Over 850sq km^2 coastal line which harbors highly diverse flora and fauna and important spawning grounds; and

ii. Northern Nigeria, which is experiencing increasing drought leading to accelerated desertification and water scarcity.

The report also noted a lack of political will, the policies and financial resources to support adaptation measures as well as a lack of and access to requisite technology to reverse the current trend of degradation exacerbated by climate change and increasing population growth.

Building Nigeria's Response to Climate Change (BNRCC) is a four year project (2007-2011), funded by the Canadian International Development Agency (CIDA), administered by Marbek Resources in Ottawa, Canada and implemented by the NGO, Nigerian Environmental Study/Action Team (NEST) in Ibadan, Nigeria. The BNRCC project has four components: Pilot Projects, Research Projects, Policy Development and Communications. This paper presents information on the pilot project component, which was designed to provide community-based climate change adaptation information for Nigeria's proposed National Adaptation Strategy and Plan of Action (NASPA). As a precursor to the NASPA, a Climate Change Adaptation Strategy Technical Report (CCASTR) was written as the policy component of BNRCC. The CCASTR is based on literature reviews by a team authors, as well as recommendations from the research and the pilot projects.

Climate Change Scenarios

In a research partnership between the Climate System Analysis Group (CSAG), University of Cape Town, South Africa and the Institute of Ecology and Environmental Studies, Obafemi Awolowo University (OAU), in Nigeria, simulations of nine global climate models (GCM) were downscaled to over 40 stations in Nigeria. Two scenarios, A2 and B1[1], were used to predict climate change impacts over two future time periods. Both scenarios suggest a warmer climate in the future for Nigeria. The A2 scenario projects a temperature increase of 0.04^{o}C per decade until 2050 and 0.08^{o}C until 2100. The coastal regions are predicted to warm less than the interior regions, due to the cooling effect of the Atlantic Ocean. The greatest temperature increase is predicted to occur in the northeast, in the Sahel. Extreme heat events, which are defined as days with temperatures of 38^{o}C or more, will increase in the Sahel by 82 days in the 2046-2065 time period, increasing to 151 days in the second time period, 2081 to 2100 (A2 scenario). Both A2 and B1 scenarios suggest a wetter climate in the south along the coast, but a drier climate in the northeast. This is consistent with the increase in temperature resulting in more ocean evaporation to produce more rainfall over the coastal region. The warmer climate in the arid northeast would decrease the atmospheric humidity, and thereby reduce the chance of cloud formation and rainfall. Over the coastal, rainforest and Guinea savanna zones, both scenarios project earlier rainfall onset dates and later cessation dates, hence the increase in the rainy season could be up to two weeks. On the other hand the models predict a shorter rainfall season over the Sudan savanna, suggesting a decrease of more than one week.

Water is one of the most critical resources that determine the severity of climate change impacts in the Sahel region. The erratic short duration rainfall comes in heavy downpours and then drains off into the natural depressions infiltrating into the sandy soil while the remaining water quickly

[1] Scenarios are storylines that describe potential futures with their own emissions pathways, which are based on either change in the climate system, socio-economic circumstances or other potential future changes. The A storyline is based more on economic changes and the B gives more weight to environmental changes. The 1 is a global scenario and the 2 is regional. For this particular study, only A2 and B1 were used since datasets for the GCM were only available for these. The A2 scenario is considered to be the less conservative of the two.

evaporates in the dry air, leaving little for human and livestock consumption. In the south, increased rainfall intensity leads to flooding. Variability in the rainy season has made it more difficult to predict the best planting dates for crops and this has also contributed to country-wide crop failure. The effects of heat stress and extreme weather events are also widely reported by communities themselves.
This paper provides an overview of the pilot projects to date, presents lessons learned from the tested adaptation options, with a focus on alternative livelihood options, and key recommendations for policy.

Methods

Description of the study area
Pilot projects were implemented in 15 communities in Nigeria (Figure 1), ranging from the Sahel in Yobe State in northeastern Nigeria to the coastal zone in Cross River State in the southeast.

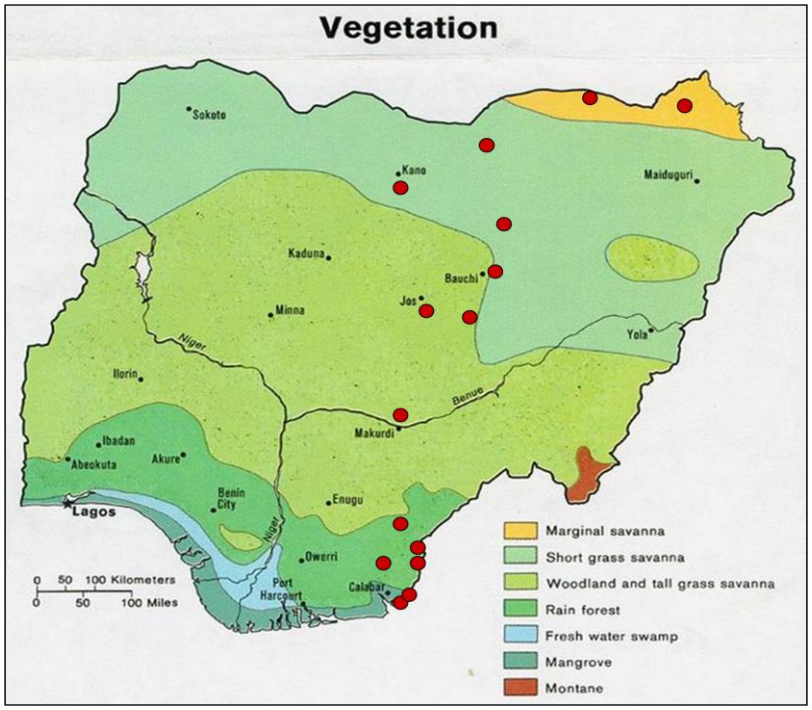

Figure 1. Vegetation map of Nigeria with approximate locations of 15 pilot project communities (shown by red circles). (Note, the naming of vegetation zones on the map as they correspond to the text are: *Marginal Savanna* = Sahel; *Short grass savanna* = Sudan savanna; *Woodland and tall grass savanna* = Guinea savanna; *Rainforest* = Rainforest; *Fresh water swamp and Mangrove* = Coastal).

Research Approach
At the inception of the BNRCC project, seven partner organizations were selected to be funded and to work with NEST, based on a country-wide bid for proposals. Each partner organization then chose two communities to work with (with the exception of one partner that works with three communities), for a total of 15 pilot project communities, with a broad geographical representation in Nigeria. Communities were chosen generally on the basis of need: for

example, those that were facing the most critical water shortages, the greatest amounts of deforestation, or significant loss of livelihoods, or those communities that were neglected in that they had no prior government assistance. Partner organizations facilitated the entire project cycle and were the liaison between BNRCC staff at NEST and the communities. The partners made frequent and regular visits with the communities in order to work with the communities to implement the community-identified adaptation projects. Partners provided resources such as expertise, encouragement, finances and access to other resources such as seed sources. Social Analysis Systems (SAS) tools (Chevalier and Buckles 2008) were applied in each community to ensure full community participation in selecting the adaptation options that addressed their most immediate needs due to perceived climate change impacts. The tools provided the means to elicit community natural resource use maps, an assessment of key stakeholders and their level of influence in the community and the impact of the proposed project on them. The tools raised awareness of who in the community is not heard and the need for equality in project management and in who benefits. To increase the adaptive capacity of communities, climate change awareness workshops were organized by the partners and held in each of the communities at the beginning of the projects. The inclusion of local and traditional knowledge into climate change policies were also encouraged as it has shown to lead to effective adaptation strategies that are cost-effective, participatory, sustainable and empowering for local communities (Robinson and Herbert, 2001, as cited in Boko et al. 2007). The role of institutions was also considered important in the pilot projects, as the capacity to adapt is dependent on the roles of both traditional and newly formed institutions. Research suggests that the role of institutions has been diminished by socioeconomic changes and government policies. As community members become further alienated from decisions about their local resources, dependence on government interventions tends to increase and poverty alleviation becomes more difficult (AIACC 2007). Partners were required to submit quarterly reports and further monitoring was done by site visits to each community by BNRCC/NEST staff who facilitated focus group discussions and conducted fact finding visits to each of the specific projects.

The projects were generally of 18 months duration. Close to the end of the project the partners were required to submit relevant information on vulnerability, impacts and adaptation options for the purposes of the technical report (CCASTR). One of the key components of the pilot projects was to build in sustainability by ensuring the development of sustainable institutions. Project Implementation Committees (PICs) made up of both men and women in management and decision making roles, were formed as a precursor to the eventual Community Based Organizations (CBOs). The CBOs, organized towards the end of the project cycle, are to oversee the existing project, to procure more funding arrangements and to liaise with local and state governments on expanding the project and developing policy on community-based adaptation.

Results and Discussion

The accounts of the pilot projects illustrate the efforts of rural communities to implement the most suitable and feasible adaptation options as identified by them. They also attest to communities' ability to fundraise, provide labour, land and other resources to ensure that the projects succeed and that the knowledge derived from them is shared with others, both policy makers and other communities. The focus of the pilot projects is on empowering communities to take action on climate change impacts, based on their own decision-making processes thus increasing their adaptive capacity. These bottom-up community-based initiatives, discussed in this paper contrast to the many 'top-down', energy-based interventions, which commonly

dominate climate negotiations (Mitchell and Tanner 2006). The key adaption options implemented by the BNRCC pilot projects, from which recommendations were made to the CCASTR, are projects that promote meeting basic needs such as access to quality food and water, alternative livelihoods and ecosystem rehabilitation. Some case studies, drawn from the 15 communities, are described below and grouped by ecozone. Discussion is framed by the adaptation options the communities are testing, with an emphasis on alternative livelihood options, and the lessons learned to inform policy on community-based adaptation.

Sahel

Improving livelihoods and stabilizing sand dunes in two communities in the Sahel in north eastern Nigeria

Since December 2009, a team at the University of Maiduguri (UNIMAID) has been working with two communities, Tosha (pop. 5,000) and Sansan (pop. 400), in the Sahel in northeastern Nigeria. The pilot projects aim primarily to improve the livelihoods of people most impacted by increasing aridity by reviving dry oases; to stabilize mobile sand dunes which are encroaching on farmland and houses; and to improve crop yield by introducing improved varieties.

The low annual rainfall in north eastern Nigeria, which varies from 250 mm annually in the extreme north to 750 mm in the south, makes this already arid region in Nigeria particularly vulnerable to climatic change and further ecological degradation. The aridity, together with the over cultivation, over grazing, over cutting of trees, along with more variable rainfall due to climate change, is causing desertification processes to escalate. The increasing aridity in this region has caused many of the local oases around the community of Tosha to become completely dry: of the 13 once thriving oases, now only six have water at the surface. Originally the oases had rich fertile soils and the seasonal fluctuations of rain and evaporation meant that commercially valuable potash could be harvested. There were fertile uplands with forests and luxuriant grasslands, which supported abundant wildlife. These resources provided the early inhabitants in the region with enough resources for good livelihoods. Conditions started to decline after the 1972 Sahel drought and by 1980, environmental degradation was evident by the appearance of prominent sand dunes close to the village. These invading mobile sand dunes are now encroaching on farmland and grazing lands in both communities of Tosha and Sansan. In Tosha, the dunes have started to push into the community and destroy dwellings, with one death already reported from shifting sands crushing a home. Farmers in Sansan report that farm yields have decreased over the last 40 years as sand dunes have encroached on arable land used in the wet season. The dunes at Sansan are also partly the result of intensive farming activities near a natural water-holding depression. The presence of water in the depression attracts livestock to the area, thus triggering the process of dune formation, which is then exacerbated by aridity and severe weather (drought and sandstorms).

The Project

The project has started to re-establish oasis farming and livestock rearing through the use of shallow boreholes for irrigation and introduced improved crop varieties. The project is also reforesting sand dunes to stabilize the dunes and to provide sources of fuel, food and fodder. Early results show that the boreholes are reliable and dry season crops were successfully grown in the 2010 season, something which hasn't happened for years. The wells were also a water source for domestic purposes and for livestock. Over 800 head of cattle used the borehole every day at one oasis during the peak of the dry season. Improved varieties of cowpea, sorghum, millet groundnut, maize and rice were introduced. They are early maturing, drought resistant,

high yielding, resistant to pests and diseases and, so far, acceptable to the communities. Yields were good this year, as reported by all farmers who tested them. Farmers are learning to record planting times, harvest times and yield, so that by next growing season, the yield of the introduced and the local varieties can be compared. Farmers are also being encouraged to grow resilient wild food tree species of high traditional value both on farm and in home compounds. Sand dune stabilization was initiated in July 2010 with the planting of 15,000 seedlings, by community members, of the early colonizing, fast growing *Prosopis juliflora* on dunes that are threatening the communities and farmlands. *Prosopis* was chosen by the communities as the most acceptable species to provide wood, food and livestock feed. Two months after planting, there was a 90% survival rate of the seedlings. Time will tell how the seedlings will survive the upcoming dry season in 2011 and if there is any danger of this non native species becoming invasive in this arid region.

Sudan and Guinea Savanna

Strengthening community- based adaption to climate change by increasing food security in the Sudan and Guinea savanna regions

Since September 2009, a team at Abubakar Tafawa Balewa University (ATBU) in Bauchi State has been working with three rural communities, located in the Sudan savanna (Gorori, pop. 5000) and the Guinea savanna (Bursali pop. 6000 and Billeri pop. 3000) to increase food security and reduce dependency on fuel wood. Rainfall data from the Bauchi meteorological station show that there is a sustained reduction in rainfall and year to year variability has been increasing since the 1970s. This adds uncertainty and risk to crop planting. Many farmers have to plant more than once, and when the first planting fails there is the risk of depleting the seed stock for that season, in addition to the increased labour of planting more than once. Overall, crop productivity is declining. For example, the women in Gorori observed that only ten years ago they could harvest ten bags of cowpea, but now they harvest very little or sometimes nothing at all. Women in Billeri say that they are getting only one quarter of the cowpea yield that they used to get.

The Project

Projects were designed to increase food security and improve livelihoods by introducing and testing improved varieties of the main crops of sorghum, millet, and cowpea; to assist in weather forecasting so planting times are more accurate and timed to consistent rainfall; and to reduce the demand for fuel wood by introducing and training women on the use and fabrication of fuel efficient stoves.

Food security and improved livelihoods

Five women in each community were selected to receive improved seeds of cowpea and men were selected for improved seeds of millet and sorghum. These early maturing varieties have higher nutrient requirements, necessitating the use of fertilizers, inputs which are difficult to sustain year after year. Many farmers realize the benefits of organic fertilizers and their use is encouraged by the project. Yields of all three crops were above average in the 2010 growing season and all matured earlier, shortening the period of hunger that occurs before harvest each year. Some refinement in crop management is needed, however. The early maturing millet was subject to attack by birds, since it was the first available grain to mature in the area. The cowpea was subject to severe aphid infestation, more than the local, traditional variety, necessitating the regular application of pesticides. The women are in the position of having to decide whether to plant the local variety of cow pea the next growing season or the improved variety. If the higher

yield of the improved variety is to be realized, then there is a need for an aphid-resistant variety of cow pea.

Risk management: Weather Forecasting

Weather forecasters were given to four groups of five male farmers - making 20 direct beneficiaries - in each of the three communities. These small, easy to use hand-held devices, help predict rainfall patterns, and were supplemented by Drought Decision Support Tools (DDSTs). This is a software program used at ATBU to predict the best time for planting specific crop varieties, based on 30 years of local rainfall data and crop requirements. Used together, these tools ensured that farmers planted when rains were consistent enough to ensure germination and sustained growth. The farmers who used these tools did not have to replant this year as they have had to in the past when germination failed. Figure 2 shows the best time to plant the improved variety of millet at Billeri for the 2010 season based on the DDST software. Maximum yield of about 2675kg/Ha will be obtained when planted ten days after the predicted rainfall onset date of 22 May 2010, which is 2 June 2010. To ensure maximum yield, 70:30:30 kg/ha NPK must be given at a planting density of 53,000plants/ha. It is also clear from the graph that if a farmer were to plant the millet 15 days before the predicted onset date, then the crop would be lost. This was corroborated by many of the farmers interviewed around Billeri who indicated that they had already planted when the early rains came but the crop was lost due to insufficient rain after planting.

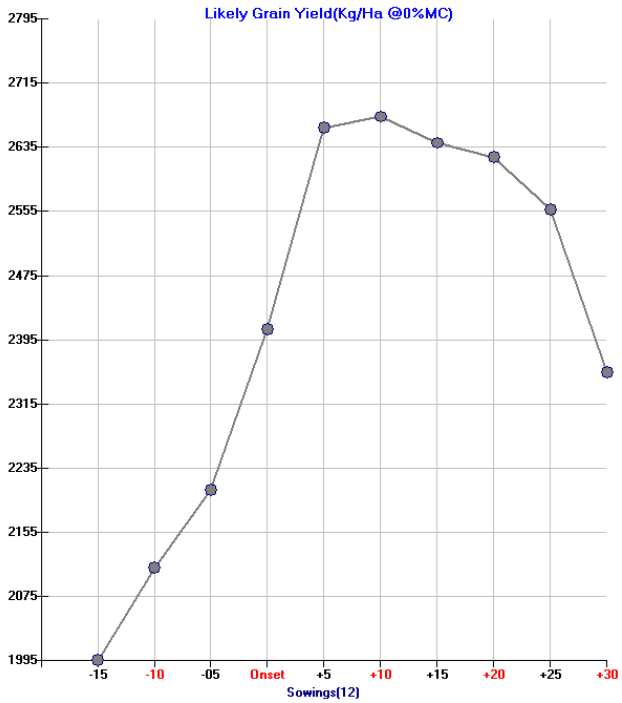

Figure 2. Simulated predicted yield of millet (Sosat 88) in Billeri for the 2010 season

Energy solutions: Fuel efficient wood stoves

The reliance on the dwindling supply of trees for fuel wood is further reducing scarse forest cover in Nigeria. To reduce the demand for fuel wood and to reduce women's labour, fuel efficient wood stoves, built by a local fabricator, were introduced to 20 women in each community. After 2 months of testing the stoves, the women were unanimous in stating that,

while the stoves consumed less wood and the amount of smoke was reduced, they needed modification to meet their specific needs. In order to handle large pots of thick stew made of maize, called *tuwo*, the stove needs to be larger and more stable for them to want to use it over the traditional three stone stoves.

Coastal Rainforest

Alternative livelihood options to promote adaption to climate change in the Rainforest/Coastal ecozones of Cross River State

Since September 2009, the NGOs Coastal Life Initiative (COLIN) and Development in Nigeria (DIN), both based in Calabar, Cross River State, have been working with four rural communities to reduce vulnerability by increasing awareness of resource over-use and climate change impacts, to increase food security and reduce dependency on wild fisheries, mangroves and the rainforest. The coast in this state is characterized by a large expanse of mangroves, which forms an important buffer to the direct impact from storm surges, erosion from severe weather, as well providing habitat for diverse aquatic species. Mangroves are threatened by overuse, sea level rise and by the invasive species, Nipa palm, which has taken over much of the coastline in Cross River State. There is concern in the coastal communities that not enough is being done to save the mangroves from the impacts of Nipa palm. The pilot project did not have enough funding to carry out a long term mangrove restoration project. This state is also home to some of the last remaining stands of rainforest in Nigeria and the vast majority of the rainforest and derived savanna communities in Cross River State still rely on local forests for non timber forest products (NTFPs), including bush meat, and medicine. Many forest animals, such as chimpanzees and gorillas, are now threatened or locally extinct.

In the two coastal communities, fishing supplements agriculture as the main livelihood activities. In the two rainforest communities, the collection of NTFPs and agriculture are the main livelihoods.

Fishing is traditionally men's activity and occurs in both the river estuaries and the open sea. The women then market the catch. Fishers in these communities are now reporting low fish stocks, the cause of which is not necessarily due to climate change, but other factors, including competition with fishers from outside the community and competition from those with bigger engines who are able to get to more areas quickly. There is also an increase in the number of people fishing, the destructive use of chemicals to catch fish and the use of small mesh nets that catch all sizes of fish, even young fish fry that are needed to replenish stocks. The loss of fishing as a key livelihood means that coastal communities are more vulnerable to additional stresses that may be caused by current or eventual climate change impacts - such as sea level rise and possible salt water intrusion onto farm lands.

In all four communities, agriculture is a key livelihood, the main crops being cassava (*Manihot* sp), yam (*Dioscorea* sp) and cocoa yam (*Colocasia* sp). . The communities have reported some reduction in crop yield, due to the unpredictability of rains during the growing season, but it is not as significant as in the crop decline reported in the savanna and sahel communities. The changes in livelihoods are causing many men and youth to leave the communities in search of other means of income, leaving the remaining women and children burdened with additional labour.

The Project

The projects focus mainly on increasing food security and reducing deforestation by testing alternative livelihoods, including aquaculture in the two coastal communities and testing cassava

processing and snail production in the two rainforest communities. The projects have also introduced fuel efficient wood stoves to select households in order to reduce labour for women and to conserve local mangrove and rainforest ecosystems.

Food security and alternative livelihoods

Aquaculture was the adaptation option chosen by the two fishing communities, in order to maintain the essence of their traditional livelihoods, to reduce pressure on the wild fishery and to provide income generating opportunities for both men and women. Two 10m x 30m ponds were completed in April 2010 and were each stocked with 1000 tilapia and 2000 catfish three months later in July. Training on fish farming was also conducted and COLIN produced a manual on aquaculture to address the most important concepts including sustainability, maintenance and harvesting. While still in the early stages, before the first fish harvest, there are some challenges that the community is has had to address. One is how to ensure that there is an equitable distribution of fish and income from marketing to all community members. The other issue is security for the pond, as the community wants to ensure there is no poaching of the fish so that stocks are sustainable and equitably used. Committees have been set up to deal with these two challenges.

In the two rainforest communities, alternative livelihood strategies include cassava (gari) processing and snail farming. Gari production provides income to both men and women. The snail farming, which is still in its early stages, is meant to be a readily available source of protein to replace bush meat, as well as a source of income. Both are intended to reduce the pressure on local forest resources. Income from gari can potentially replace the income that some men make from selling bush meat. One night of hunting can bring 10,000-12,000 naira (about 150 naira = 1 Dollar) and one day of processing gari can bring N8,000 to 9,000. In addition to replacing bush meat, the snail farming is intended to reduce the number of destructive bush fires which are regularly set during the hunt for bush meat.

Energy Solutions: Fuel efficient wood stoves

Reliance on the dwindling supply of trees for fuel wood has greatly impacted the mangroves and rainforests in Cross River State. Fuel efficient wood stoves were introduced and beneficiaries were trained on construction and use. A manual on how to construct, maintain and repair the stoves was also provided. The stoves have not been adopted on a wide scale as the materials to fabricate them are considered too expensive by the women and so they continue with the traditional stoves, despite the fact that they spend more money on fuel wood.

Conclusions, lessons learned and recommendations

In all 15 pilot project communities, there is reported variability in rainfall, decline in crop yields and loss of biodiversity in local ecosystems. Livelihoods are impacted in all communities and in some, more than others, basic needs are not being met, such as clean drinking water and enough food. Some pilot projects aim to increase adaptive capacity by establishing alternative livelihood options, while some projects tackle the climate change impacts directly, by introducing drought resistant crop varieties and setting up water supply options.

There are lessons learned from the pilot projects after 18 months of implementation. One of the overarching lessons learned is the importance of time – essential in any community-based project. While pilot projects are, by their nature, small in scale, they ultimately require time in order to measure impacts. Only the most immediate outcomes can be assessed.

It is fair to say that, at this juncture, the projects were largely successful: the severe hunger that often occurs in the months of August and September in the central and northern communities

was averted for beneficiaries this year by the early maturing varieties of millet, bean and maize; there were also higher yields seen in the improved crops varieties this year in all communities; access to water was greatly improved for 3 of the 4 communities where water supply projects were undertaken; fuel efficient stoves, introduced in all but two communities, were well received, but results are mixed. Also, efforts to test aquaculture and snail farming have progressed well and there is much community enthusiasm for these endeavors. Efforts to stabilize dunes, restore vegetation along watercourses and conserve valuable trees on farms are also well underway. Even ideology is changing: many women, who were initially reluctant to participate, have become more involved in some projects; the youth in one community and farmers in general are more committed to protecting trees, and there is less indiscriminate burning in the two rainforest communities because of increased awareness. Institutions are on the rise: it is anticipated that the newly formed CBOs will oversee the sustainability of the projects and they will approach local governments for assistance; peer education programs will expand the knowledge of CBA and the workshops will sow the seeds for knowledge transfer between communities and policy makers. The pilot project communities must now sustain the project themselves without the continued support of the BNRCC partners and it is only after some time that the project impacts and sustainability will be measured. At this point in the project cycle some of the key lessons learned are:

i) Factors that contribute to vulnerability of communities are complex. The projects illustrate that multiple interacting stressors underpin vulnerability to climate change, but there is a tendency among communities to attribute all negative impacts to climate change. It is essential to understand the range of factors that underlie vulnerability in order to identify solutions and it is important to understand the range of human impact on the environment that sustains us. For example, declining fishing stocks in coastal communities are due, in part, to overharvesting and unsustainable fishing methods; poor crop yields are due in part to declining soil fertility from overuse, and increasing deforestation and overhunting forest species all point to the need to break the "poverty cycle".
Recommendation: Efforts to increase adaptive capacity must include complimentary efforts to increase awareness within communities of the importance of local ecological functions for sustaining human life and livelihoods. In order to break the poverty cycle, increased awareness of human impacts together with community ingenuity can work in tandem with projects that build adaptive capacity by ensuring food security and sustainable livelihoods.

ii) Communities in the sahel and savanna ecozones are more vulnerable with regard to natural capital than communities in the south due to greater water scarcity and fewer natural resources, such as forests, which act as a buffer to crop failure. Climate change impacts are also predicted to be greater in these arid northern regions of Nigeria.
Recommendation: due to the direct impacts of climate change on more vulnerable ecosystems in the north, priority should be given to efforts to reduce the vulnerability of these communities where basic needs are not being met by increasing access to water and improving food security.

iii) The use of improved crop varieties to avert hunger and improve yields is not without a price. The emphasis on the use of inorganic fertilizers and pesticides may not be sustainable, as these inputs need to be purchased year after year to ensure optimal performance of the crop and their continued use compromises soil structure and fertility.

Recommendation: More extension activities are needed to build capacity so that farmers are encouraged to use organic fertilizers to reduce the dependency on purchased ones, and to ensure good soil structure and fertility in the long term.

iv) The adoption of fuel efficient wood stoves in the communities has met with challenges, pointing to the importance of careful monitoring so the project can quickly respond to results from initial trials. The stoves have been shown to reduce the amount of fuel wood used in all cases and, as a result, women spend less time and money procuring wood, and there is less pressure on local forests. Women beneficiaries also report that food cooks faster and less smoke is produced, causing fewer respiratory problems. Despite the advantages, the adoption of the stoves is not immediate and widespread. The reasons are that the stoves are too costly and difficult to fabricate, in some cases they were given to men, and that they do not meet the specific cooking needs of the women who use them.

Recommendation: Women in rural communities, in their multiple roles as caregivers, educators and often farmers need to be included on all technical aspects of project interventions and provisions made so that they can give feedback on the products that they are the beneficiaries of.

v) The weather forecasting tools tested in the three communities in the arid central and northern regions were successful, in that the farmers who used them planted only once. Other farmers who did not have access to them had to plant twice, the first time being unsuccessful to due to lack of rain and germination failure. In this first season of testing, the handheld forecasters used in the field by the farmers supported by the drought decision support (DDS) software used by the partner organization, helped farmers to have successful yields this year, while minimizing wasted seed and lost labour.

Recommendation: Based on the early success of the handheld weather forecasters and DDS tools, there should be greater efforts to forecast weather for and by farmers by any and all means possible, including extension activities, radio programs and awareness, especially for those in the Sudan savanna and the Sahel, where planting times are most critical within a short and increasingly erratic rainy season.

vi) Livelihood activities that are the emphasis in most of the pilot projects need to have an assured market for products: an increased supply of fish from aquaculture projects, gari from the processing of cassava, snail meat from household snail farms, for example, need to have market outlets in order for the livelihoods to meet the objectives for increased and reliable income.

Recommendation: Training and research in market chain analysis should be provided through extension activities to back up the introduction of new and alternative livelihood projects to ensure that there is enough demand for the increased supply of these products on the market.

vii) The development of community institutions and peer to peer education have so far shown to be empowering for community members and effective for increasing awareness within and between communities and to policy makers at local and state governments.

Recommendation: Community institutions should be encouraged and strengthened in order to ensure project sustainability, to liaise with policy makers to bring in new project support and to build community awareness of climate change impacts and adaptation options.

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