




Article

# Scenario Planning for Climate Adaptation in Agricultural Systems

Laura Schmitt Olabisi <sup>1,\*</sup>, Robert Ugochukwu Onyeneke <sup>2</sup>, Onyinye Prince Choko <sup>3</sup>,  
Stella Nwawulu Chiemela <sup>4</sup>, Lenis Saweda O. Liverpool-Tasie <sup>5</sup>, Anthonia Ifeyinwa Achike <sup>4</sup>  
and Adedapo Ayo Aiyeloja <sup>3</sup>

<sup>1</sup> Department of Community Sustainability, Michigan State University, East Lansing, MI 48824, USA

<sup>2</sup> Department of Agriculture (Agricultural Economics and Extension Programme), Alex Ekwueme Federal University Ndufu-Alike, Ebonyi State, Ikwo 482131, Nigeria; robert.onyeneke@funai.edu.ng

<sup>3</sup> Department of Forestry and Wildlife Management, University of Port Harcourt, Port Harcourt 500272, Nigeria; chokonyinye@gmail.com (O.P.C.); aiyeloja@uniport.edu.ng (A.A.A.)

<sup>4</sup> Department of Agricultural Economics, University of Nigeria, Nsukka 410001, Nigeria; stella.chiemela@unn.edu.ng (S.N.C.); anthonia.achike@unn.edu.ng (A.I.A.)

<sup>5</sup> Department of Agricultural, Food and Resource Economics, Michigan State University, East Lansing, MI 48824, USA; lliverp@msu.edu

\* Correspondence: schmi420@msu.edu

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**Abstract:** Effective climate adaptation in sub-Saharan African agriculture will require coordination across multiple scales of governance. Decision-makers from local to national scales will be tasked with planning under conditions of high uncertainty, often with minimal data. Participatory scenario planning is a method for devising adaptation strategies under high uncertainty, and we hypothesized that it could also be used for identifying systemic, inclusive, and transformative adaptation options at the community scale, and for highlighting opportunities for cross-scalar collaboration. We conducted scenario exercises with two communities in southeastern Nigeria that have experienced increasing flooding and other challenges linked to climate variability. Both communities identified drivers of change that intersect with climate, as well as community-scale actions that would improve adaptation to a range of future scenarios. We found evidence that scenario exercises can stimulate communities to develop transformative approaches to climate adaptation that seek to reduce climate risk by creating new systems and processes. We also found that community-identified priorities for strategic action highlight how larger-scale interventions could coordinate with communities to adapt more effectively. Participatory scenario planning is therefore a potentially important tool for adaptation planning in regions in which future conditions are highly uncertain.

**Keywords:** scenarios; climate change; adaptation; community; governance

## 1. Introduction

Agricultural systems in sub-Saharan Africa are expected to be heavily impacted by climate change, but the specific nature of these impacts is highly uncertain due to a lack of data and localized climate modeling [1]. In order to increase the adaptive capacity of local communities to respond to these uncertain conditions, new tools are needed. One such tool that has been used for decision-making in highly uncertain conditions is scenario planning [2]. Scenario planning can take many diverse forms and may be used at different spatial scales [3]. Quantitative climatic and socio-economic modeling tools are used by the Intergovernmental Panel on Climate Change to develop global scenarios for mitigation and adaptation [4]. However, detailed, downscaled quantitative models are frequently

not available for decision-makers at local scales. While some downscaled climate studies have taken place in West Africa (e.g., [5]), these studies are data- and expertise-intensive and time-consuming, and are typically outside of the purview of state and local (and even federal) governments in the region. Moreover, they are conducted primarily by researchers from the United States and Europe, and may not reflect local priorities. Participatory scenario planning in agricultural systems at local scales in Africa may therefore take a more qualitative approach, rooted in local experiential knowledge, when a quantitative downscaling approach is not feasible.

Qualitative scenarios have been used for agricultural planning and development strategies in Tanzania [6], Burkina Faso, Nigeria, and Malawi [7]. They allow for a participatory approach in planning and responding to uncertainty, and for grappling with the best course of action in the context of an uncertain future [2,8,9]. Even without quantitative information about a system, the scenario process itself can help stimulate more systemic and long-term thinking about how a community might respond to climate change and other systemic challenges [10]. Moreover, a scenario approach can facilitate strategic thinking about how decision-makers might respond and adapt to “surprising” events as the future unfolds by acknowledging tipping points and lock-in [11–13].

In order for scenario processes to be maximally effective, they should delineate courses of action at the scale of decision-making relevant to the participants, while also responding to trends and processes beyond the control of the participants—essentially asking the question, “what actions will be beneficial to our community no matter what future we find ourselves in?” [14]. In the context of climate adaptation planning, this may mean a community can take action to improve their agriculture and food systems no matter what climate future comes to pass, or what adaptation actions the federal government takes. Scenario processes may be conducted at any scale [2], and nested scenario processes may be used to downscale national and regional plans to a local context, or to harness local knowledge for input into larger-scale plans [15]. In this project, we are working at a community scale to understand how effective local actions might improve adaptive capacity in the face of larger-scale changes that are out of local control.

The community scale of climate adaptation has been under-represented in this literature with few exceptions [16,17], but communities in West Africa have a history of adapting to climate variability [18]. These adaptation efforts may be classified into absorptive, adaptive, and transformative, where absorptive capacity is the capacity of a community to cope with expected shocks; adaptive capacity is the ability to anticipate shocks that have not yet occurred; and transformative capacity is the capacity to reduce either risk or vulnerability by creating a new type of system [19]. Examples of absorptive capacity might include informal safety nets and crop insurance to deal with the aftermath of adverse climate events. Adaptive capacity could encompass efforts to diversify cropping systems and livelihoods, and build social networks, thereby improving system resilience generally, including to shocks which have not yet manifested [20]. Transformative capacity would be seen in efforts to reform major institutions, such as land tenure, credit markets, or cropping systems themselves, to move the entire system towards greater resilience. Previous studies have found that most community-scale actions to reduce climate vulnerability fall in the absorptive or occasionally the adaptive category [18]. Effective adaptation will undoubtedly require some more transformative efforts as well—for example, a community may have to move from floodplain farming to a different type of farming regime altogether if flooding regimes become too unpredictable. Scenario planning, because it incorporates distant future thinking and imaginative approaches, could potentially help communities to grapple with more transformative approaches [21].

In this study, we developed scenarios with community members in southeastern Nigeria to explore potential climate adaptation actions into the mid-term future. We had previously used targeted interviews in these communities to understand what they are currently doing to adapt to climate variability. The questions posed by this research were: What actions do community members propose to take in light of climate change and intersecting drivers of change that they anticipate in their communities? How do these actions dovetail with larger-scale climate adaptation efforts, and

where do they fall along the absorptive–adaptive–transformative continuum? This study contributes to the literature on community-scale climate adaptation, by introducing a new method for moving communities into more transformative modes of thinking around adaptation and for linking community efforts with adaptation planning at larger scales.

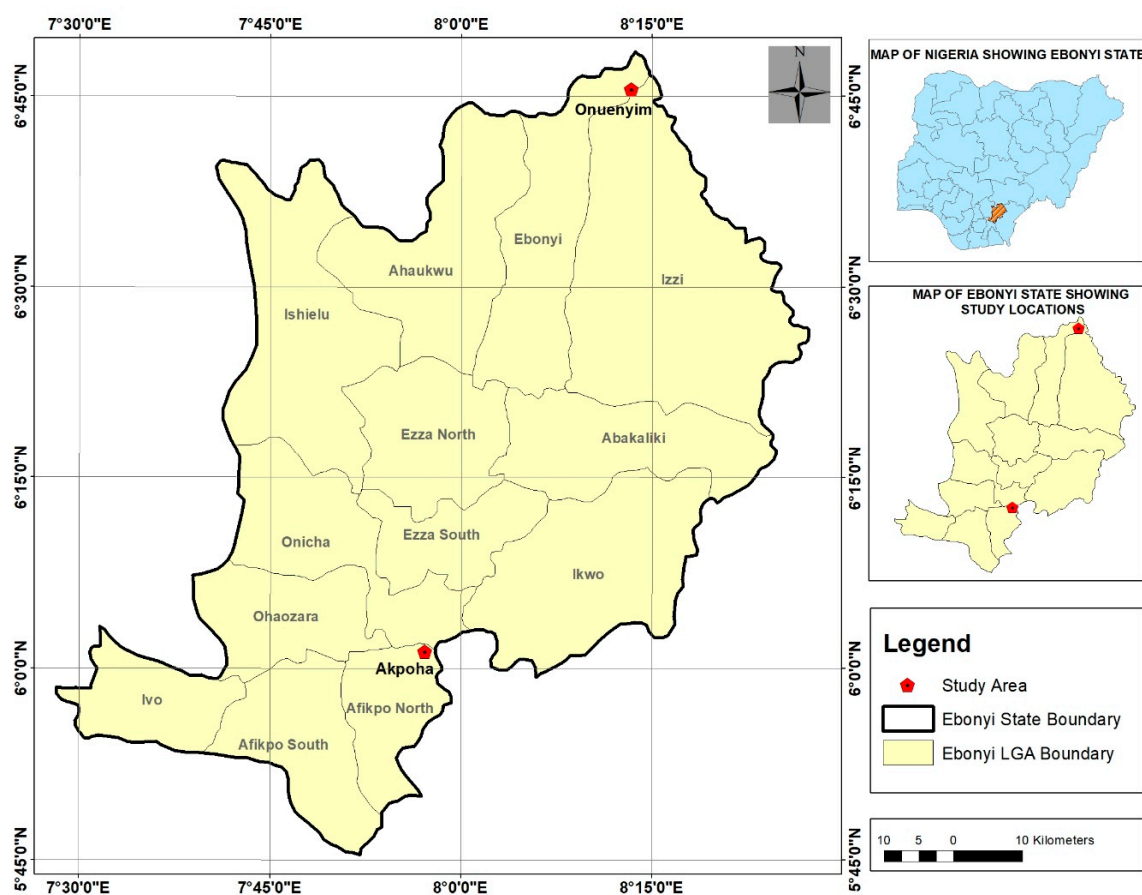
## 2. Materials and Methods

The scenario methodology we used was modified from the process described by Johnson et al. [14]. We deliberately designed the scenario process to consider both climate-related and non-climate-related drivers, in order to understand the potential interactions between the two. Prior to the community-scale scenario workshops, the researchers conducted both a national-scale workshop to scope climate risks in Nigeria and a community-scale data collection exercise in Ebonyi state.

The goal of the national workshop was to identify both direct and indirect sources of climate risk in Nigeria, as well as their dynamics and interactions. The method used was participatory modeling with a diverse group of scientists, policy-makers, and private-sector agricultural experts from around the country as described in [22]. Workshop participants diagrammed the impacts of climate change on the agricultural sector, as well as exacerbating or mitigating factors, such as declining soil fertility. The output from this workshop was used to scope further research in Ebonyi state, a region of the country understood to be particularly sensitive to climate risk. The researchers visited six communities in Ebonyi state to build a catalog of community-defined climate risks as well as community-scale climate resilience strategies, as described in detail in [18]. Two of these communities, Akpoha and Onuenyim, were selected for follow-up scenario exercises to investigate further actions the communities might take in light of multiple drivers of change. Akpoha and Onuenyim were selected because they represent a continuum of peri-urban (Akpoha) to remote and rural (Onuenyim) communities, to highlight the range of climate risk experienced by and climate action taken in Ebonyi state at the community level.

For this study, the authors visited two communities—Akpoha and Onueyim—in Ebonyi state, southeast Nigeria, on 13 and 16 May 2019 respectively (Figure 1). Both communities are rural, although Akpoha is within approximately one hour's drive of Ebonyi's capital city of Abakaliki. Staple crops cultivated in these areas include rice, yam, and cassava; sheep, goat, pig, and poultry are also raised in both communities. Other prevalent economic activities in the area include hunting, tailoring, petty trading, auto mechanics, salons, and civil services.

In each community, a workshop was organized and representatives of different stakeholder groups in the communities were invited (community leadership, women's groups, etc.; see Choko et al. [18] for full list of active community groups). During the workshop, participants were asked to describe community activities embarked upon in order to strengthen the resilience of their community to climate change [18]. Through a translator, the researchers explained that "resilience" entails lessening the impact of climate disturbances on their community (for example, changing planting schedules in response to altered river flooding regimes). Secondly, individuals were required to identify and list the drivers of change in their community, which could either be social, political, economic, cultural, or technological drivers. These drivers were organized into clusters on flip charts, and then each participant was required to vote on the most important drivers by placing a mark beside their top two choices. Participants who were non-literate were able to make their marks after the options were read aloud to them in the local language. Thereafter, the group discussed and selected the top two drivers of change in the community, focusing on the future state of the community in 2040, around which four scenarios were built.



**Figure 1.** Ebonyi State, Nigeria, showing the location of study communities in Akpoha and Onuenyim.

At the same workshop, following the large group discussion and voting exercise, breakout groups allowed the attendees to inhabit the scenarios, imagining that they come to pass in the near future, and what actions will be taken to live with and manage the outcomes of the scenarios. Participants were divided into small groups of 5–7, and each group was assigned a particular scenario to discuss, after which they shared their scenario and the plausible actions that they thought would be effective in managing the outcomes of the scenario. The actions and major points of discussion were recorded by note-takers. All discussions took place in the local language (Igbo in Akpoha and Izhi in Onuenyim). Note-takers fluent in both the local languages and English were appointed for each small group from either the research team or local participants, and were asked to translate into English as they took notes. The notes collected from the workshop were synthesized into details about the scenarios themselves, taken from the inhabitation exercise, and notes on effective adaptation strategies under the different scenarios. These strategies were coded into categories of absorptive, adaptive, and transformative. “Absorptive” actions are those actions responding to events or situations the community has already seen, and which have been tried before in the community, according to prior research [18]. “Adaptive” actions are actions that anticipate greater risk in the future, for example, stronger floods. “Transformative” actions are actions that change established systems or ways of doing things in the community, for example, introducing different cropping regimes. The Institutional Review Board at Michigan State University reviewed the human subjects protocol under the umbrella Nigeria Agricultural Policy Project and declared the study exempt.

### 3. Results

In Akpoha, the two driver axes chosen by community members were flooding and youth empowerment (Table 1), while in Onuenyim they were flooding and infrastructure development.

**Table 1.** Community-generated scenario matrix for Akpoha, Nigeria, depicting four combinations of driver states as different plausible futures. See discussion for detailed explanation of scenario states.

	<b>Low Youth Empowerment</b>	<b>High Youth Empowerment</b>
Low Flooding	Proliferation of social vices Food security Economic meltdown Increase in agricultural yield Improved land utilization	Reduced social vices Increased life expectancy/health Community development Reduced migration Food security
High Flooding	Proliferation of social vices Food insecurity Untimely death Improved farming/agricultural techniques Community displacement	Food insecurity Deforestation Self-employment/job creation Loss of property Economic crisis

These driver axes represent factors influential in determining the future of the community, over which the community has limited control (which is not to say that the community cannot influence them at all, as described below). The driver axes define the scenario space into four distinct scenarios representing plausible futures for the community under different climatic and socio-economic conditions.

Workshop participants in Akpoha proposed actions they could take at the community level that would be beneficial in any scenario, thereby bolstering community-scale resilience (a full list of proposed actions by scenario may be found in the Supplementary Material). These actions included self-employment (transformative), education (adaptive), cooperative social and economic groups (adaptive), training/skill acquisition (transformative), aquaculture (transformative), and better enforcement of social norms (adaptive). Cooperative groups, schools, and mechanisms for enforcing social norms already exist in the community [18], but the development of aquaculture and new forms of employment would be new and potentially transformative developments in community-scale resilience, as they would represent creating new systems and ways of generating income and supporting livelihoods that do not currently exist.

The cultural context in Onuenyim prohibited a full scenario approach that included scenario inhabitation. Residents were very resistant to discussing a future scenario that was “worse” than the present, believing that speaking about a potential future brings it to fruition. Therefore, facilitators were unable to broach a robust discussion about “negative” scenarios in which either flooding or infrastructure development, or both, worsen or fail to improve in the community, and we did not develop a scenario table for Onuenyim similar to Table 1. Nevertheless, several potential consequences of these worsening conditions emerged from the focus groups, including increasing crime and out-migration. The community pointed out that a lack of infrastructure (meaning roads, electricity, and borehole wells) allows crime to proliferate. The total darkness at night provides cover for assaults to take place, and the lack of connectivity with the outside world prevents crimes from being reported and the perpetrators from being arrested. In addition, the absence of a paved road prevents farmers in the community from bringing their crops to market (particularly during the rainy season), and the absence of electricity prohibits many forms of processing. Conversely, reduced flooding and improved infrastructure were seen as contributing to the development of local industries and educational opportunities.

The community in Onuenyim discussed actions that would be beneficial in any scenario (see Supplementary Material for actions divided by scenario). These included local job creation through crafts and handwork (adaptive), tree planting (adaptive), crop rotation (adaptive/transformative), culvert construction (absorptive) and altered planting schedules (transformative) to accommodate changing regimes in river flooding, and enforcement of social norms to reduce crime. Collectively, these actions could allow residents to continue farming productively even if river flooding were to become more unpredictable. This may be seen as transformative, because it would result in a different system of farming compared to what residents have traditionally practiced. Agroforestry, aquaculture,

and different varieties of crops were discussed in this context, although residents expressed the need for external training and materials (for example, improved seed varieties) to be able to transition to this type of agriculture. Alternative income streams, such as handicraft production, are already present in Onuenyim, so training more community members to make these products may be seen as an adaptive response to changing climate and natural resource conditions.

#### 4. Discussion

Flooding is a community concern for Akpoha because of altered rainfall regimes and increasing road and building development, which has led to more impermeable surfaces, and therefore more runoff, on hilly areas of the town. During rain events, roads, housing compounds, and agricultural fields are eroded. In the high flooding future scenarios in which rain events become more destructive, food insecurity, economic insecurity, and displacement result as fields are flooded and houses and businesses are destroyed. Environmental consequences were also mentioned, with deforestation being both a cause and an effect of increased flooding. On the positive side, an increased flooding regime could force farmers in the community to take up improved farming techniques, such as planting cover crops and practicing agroforestry.

Another major concern in Akpoha is lack of employment and educational opportunities for young people, termed “youth empowerment” by the community residents. Akpoha is emblematic of many communities in Nigeria, a country in which 44% of the population is under the age of 14, and youth under-education and unemployment are seen as contributing to a range of social and economic problems, including poverty, religious extremism, and crime [23]. The community recognized that a future characterized by less flooding, but lower youth empowerment, would be stronger agriculturally but less socially and economically developed. Akpoha is close to Abakaliki, the state’s capital and largest city, and without economic opportunities in the community, many young people are likely to migrate there. Residents of Akpoha acknowledged that future scenarios of flooding and youth empowerment are only partly under the control of the community, being also affected by broader global patterns of climate change and economic development.

Onuenyim is located on the banks of the Aloma River, and the residents traditionally grow yams, rice, and vegetables using flood plain agriculture. The river flooding regimes have become more erratic in recent years, a pattern that was attributed by Onuenyim residents to deforestation and changing rainfall patterns, although the growth of the upstream city of Abakaliki and consequent expansion of area covered by impervious surface undoubtedly also contributes. The increasingly unpredictable nature of the river flooding has led to crop losses, as flooding may occur while plants are still in the ground. Residents believed that if farming were no longer viable in the community, many would leave.

In both communities, residents felt they could take significant steps towards climate adaptation even in the absence of external support, but agreed that these steps would be more effective with additional resources and training provided by government, NGOs, or the private sector. For example, establishing aquaculture in both communities would require some training and materials (fish stock, feed, etc.) provided by a third party. Once established, it is likely that the community could become relatively self-sufficient in providing the training and materials internally, so this external intervention may only be necessary once, or periodically every few years. Other proposed actions, such as tree planting, community policing, culvert and ditch construction, and handicraft production, could take place in communities without external intervention, as the skills and materials required for these interventions are already present in the communities. The scenario exercises, by eliciting community priorities for action, were therefore useful in highlighting the external interventions that would potentially be most effective and most welcome from the community perspective. This is important, because effective climate adaptation will require actors from multiple scales of government working together effectively.

The scenario research is clear that, in order to link visioning with action, appropriate decision-makers must be in the room when actions are prioritized through the scenario process [2,11].

That was a weakness of this exercise, which took place at the community level without representatives from state or national decision-making bodies, although the results of the scenario exercise were communicated to these stakeholders. Any proposed actions that would involve the intervention of larger-scale actors were therefore not tied to immediate opportunities for implementation; however, many local leaders responsible for implementing community-scale actions were in attendance. In addition, the scenario exercise was necessarily shortened from a more typical 2–3 day exercise, because of the difficulties in scheduling travel to the field sites. This did not allow for the more in-depth and nuanced conversations around adaptation options and priorities that would be optimal for developing an adaptation plan [16]. Finally, the scenario literature has not yet fully engaged with differing cultural understandings of the future. As evidenced by our experience in Onuenyim, cultural contexts can be influential in shaping the direction of participatory scenario exercises.

## 5. Conclusions

In a previous paper around community-scale climate adaptation in southeastern Nigeria, we hypothesized that a participatory scenario exercise would elicit community-led ideas for transformative adaptation actions. We found evidence that this was the case; proposed actions such as aquaculture development, job training, and new farming regimes may be seen as transformative because they represent the creation of new systems (economic or agricultural) in the community context. Participatory scenario exercises may therefore have utility as a method of moving a community from reacting to climate change towards proactively designing and co-creating more climate-resilient systems.

Given that effective climate adaptation will require coordination across multiple scales of governance [1], processes for eliciting community priorities and perceptions around the impacts of climate change and potential adaptation strategies will be important tools for promoting this coordination. Participatory scenario processes have been shown to generate consensus and to prompt systemic, future-oriented, and adaptive thinking [7,10,24]. Scenarios can serve as a means of communicating priorities and opportunities across scales, such that state and federal governments can intervene and support communities in a targeted, effective manner. It is worth noting that nearly all of the community climate adaptation strategies proposed in both Akpoha and Onuenyim were relatively low-cost and could be rolled out quickly. Adaptation does not always need to be costly or complicated, but it does require coordination, prioritization, and communication between actors. Scenario exercises can help to fill these needs.

Our study also sheds light on the contexts in which participatory scenario exercises may be useful and in which their limitations may be manifested. In some cultural contexts, the types of prompts used for community reflection may need to be altered to accommodate different concepts of the future and how one should talk about it. Ideally, participatory scenario exercises should involve decision-makers with authority to implement solutions from local to national scales. When or if localized data and quantitative modeling become available, communities may return to the scenarios they discussed to focus on those that are consistent with data trends. In the absence of data, the flexible and adaptive approach suggested by qualitative scenarios can offer robust solutions for climate adaptation.

**Supplementary Materials:** The following are available online at <http://www.mdpi.com/2077-0472/10/7/274/s1>, Table S1: The Way Forward under the low flooding scenario, Table S2: The Way Forward under the high youth empowerment scenario, Table S3: The Way Forward under the low youth empowerment scenario, Table S4: The Way Forward under the high flooding scenario, Table S5: High flooding versus high youth empowerment scenario, Table S6: High flooding versus low youth empowerment scenario, Table S7: Low flooding versus low youth empowerment scenario, Table S8: Low flooding versus high youth empowerment scenario, Table S9: The way forward under the same infrastructure, less flooding scenario, Table S10: The way forward under the more infrastructure, less flooding scenario, Table S11: The way forward under the same infrastructure, more flooding scenario, Table S12: The way forward under the more infrastructure, more flooding scenario.

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