

## Article

# A Resilience Approach to Community-Scale Climate Adaptation

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**Abstract:** Climate risk is expected to impact rural communities in West Africa in multiple ways. However, most current research addresses resilience and climate adaptation at either the national or the household scale; very little is known about community-scale interventions. We interviewed 934 community members in six communities in southeastern Nigeria about sources of climate risk and community-based actions for climate change adaptation. We found these communities contained multiple active and engaged groups that have implemented a wide range of interventions to reduce climate risk, most of which are seen as effective by community members. Flooding was the most common form of risk in this region, but drought, windstorms, and irregular rainy seasons are also frequent, implying that effective climate adaptation will have to be sensitive to multiple types of risk. Structural interventions (constructing roads, bridges, etc.) were the most common type of intervention, suggesting that communities are capable of marshalling considerable organizational and human power for adaptation efforts, even in the absence of external assistance. Efforts to boost community resilience and adaptation to climate change would benefit from first understanding what community actions are currently underway, and working with the groups implementing these actions to support and extend them.

**Keywords:** climate change; resilience; community adaptation; Nigeria; flooding

## 1. Introduction

Climate change is expected to bring multiple changes to rural communities in West Africa, as temperatures rise and rainfall regimes shift [1]. These changes are already threatening community livelihoods, which in rural areas are typically dependent on agriculture and natural resources. Crop models indicate that yields of staple crops in the region could decline significantly due to increased evapotranspiration caused by rising temperatures, even with technological improvements, which would have devastating consequences for smallholder farmers in rural areas [2,3]. In addition to declining crop yields, other climate change impacts that are currently affecting rural communities, or could affect them in the future, include droughts and floods [4], climate-induced migration and

resource conflicts [5], and pest and disease outbreaks [6,7]. All of these impacts and potential impacts have been identified by West African stakeholders as risks associated with climate change over the coming half-century [8].

The concept of resilience is useful for understanding how communities might respond to climate change while maintaining and developing critical community functions, for example, ensuring food production and improving wellbeing. Resilience efforts may be divided into absorptive, adaptive, and transformative resilience [9]. Jeans et al. [10] define absorptive capacity as the capacity for a community to take action to cope with expected shocks; adaptive capacity is the ability of a community to anticipate shocks that have not yet occurred and to develop flexibility to deal with these shocks in the future; and transformative capacity is the capacity to stop or reduce either risk or vulnerability by creating a new type of system. In the case of climate change, communities have very limited ability to mitigate climate change and its associated risks, but they do have an ability to reduce their vulnerability to these risks over time. Adaptive, absorptive, and transformative capacities are all arguably needed to address climate risk, because this risk takes place over different time scales and affects communities in multiple direct and indirect ways [11].

Community-scale collective action is necessary for building resilience to changing climatic regimes, but not much is known about how this might take place in sub-Saharan Africa, or how it might be scaled up or supported. Literature on community-based disaster preparedness suggests that communities can play a vital role in responding to climate-induced risk, but care should be taken to avoid disempowering or over-burdening already vulnerable communities [12]. Moreover, much of the literature on community-based efforts focuses on short-term response or preparedness to a particular disaster, not on more systemic changes [13]. Climate change is likely to bring multiple interacting stressors to rural communities. Many community-based analyses do not provide a nuanced look at the different yet complementary roles undertaken by different groups in a community, nor do they actively engage with what communities might already be doing to mitigate risk; the assumption is often that knowledge and capacity to respond to risk must be built from outside [14]. The social complexity of many West African societies suggests that the power to use absorptive, adaptive, or transformative capacities to move a community towards resilience likely lies with multiple types of community groups operating in diverse ways [15]. It is therefore important to understand the roles and responsibilities of these groups when working at a community scale to address climate risk. Because external researchers have limited ability to understand or observe the internal dynamics of community decision-making, this suggests the need for a participatory approach to documenting climate resilience efforts that involves diverse community leaders [16].

We conducted a participatory survey of community-based climate adaptation measures in Ebonyi State, Nigeria. The goal of this research was to learn about community-scale collective action in Nigeria for building absorptive, adaptive, and transformative climate resilience (Frankenberger, 2013), and the potential of these strategies for being adopted elsewhere, scaled up, or supported through targeted interventions. We focused in Ebonyi State, which was especially vulnerable to climate impacts through flooding, unpredictable rainfall, and increasing temperature (Figure 1). We focused on climate resilience in agricultural systems, although other types of climate adaptation measures were allowed to emerge from the research.

Our objectives were:

- (1) To build a catalog of community-scale climate adaptation measures that were being used, or had been used, in the agricultural sector in Ebonyi State;
- (2) To assess the effectiveness of these adaptation measures according to community residents, and the constraints/challenges of adopting them (as well as the benefits of adoption);
- (3) To understand which actions were being undertaken by which type of community groups (womens' groups, farmer organizations, etc.).

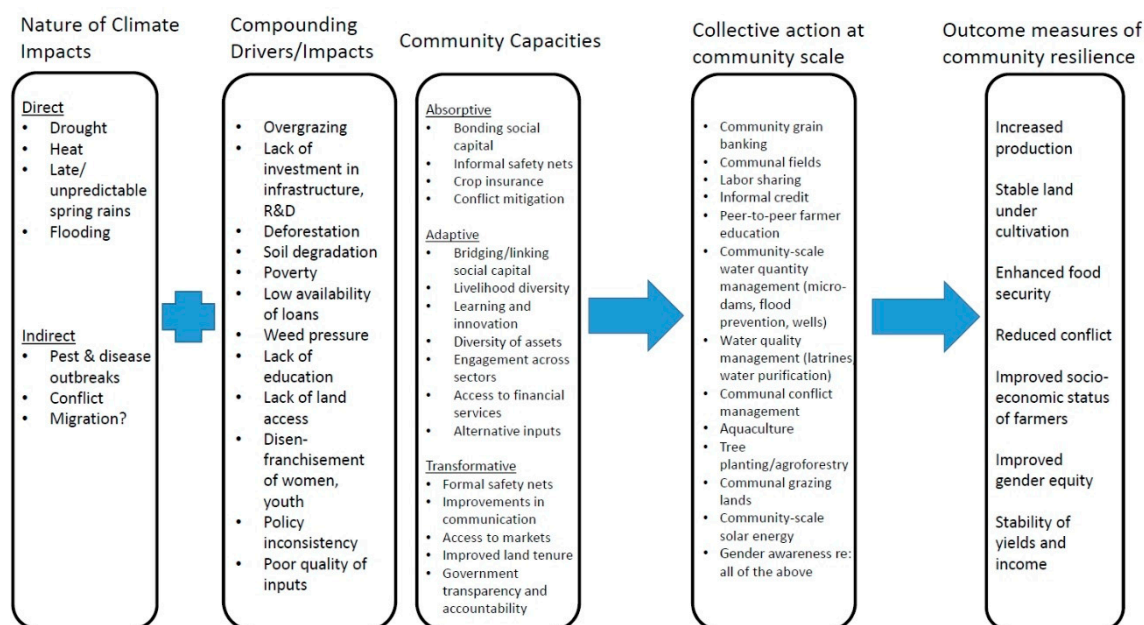


**Figure 1.** Map depicting location of Ebonyi State within Nigeria and study communities.

### 1.1. Conceptual Framework

Our conceptual framework for this study was drawn from [9] and modified using an updated literature review and prior work on assessing climate risk in Nigeria [8] and elsewhere in West Africa [17] (Figure 2). This community resilience framework developed by USAID draws from the vast literature on socio-ecological systems resilience, including Adger and Berkes [18,19]. Communities face climate impacts that are compounded by other drivers and factors that increase risk, but which are

mitigated by community capacity to reduce that risk. Impacts, confounding factors, and community capacity together influence community collective action, which can build resilience. Community capacities may be divided into absorptive, adaptive, and transformative categories. Absorptive capacities are those that allow the community to persist and retain its key structures and functions in the face of disturbance. Adaptive capacities are those that allow the community to make incremental changes that take into account the changing risk environment. Adaptive actions therefore reflect a proactive stance, while absorptive actions reflect a reactive stance. Finally, transformative capacities are those that facilitate systems change at a fundamental level—for example, the relocation of a community or a shift from agrarian livelihoods to manufacturing. The specific activities in the collective action column are drawn from reports and literature on climate adaptation in Nigeria, as well as stakeholder consultations cited in our previous work [20–27]. We hypothesized that communities in Ebonyi, Nigeria would be undertaking some subset of these actions, even in the absence of programs or government interventions promoting them.



**Figure 2.** Conceptual framework for the community resilience study in Ebonyi State, Nigeria, adapted from [9]. Both direct and indirect climate impacts on a community are compounded and exacerbated by other factors. The community capacity to respond may be divided into absorptive, adaptive, and transformative capacities [10]. The community then undertakes collective action to absorb or adapt to the impact, or to transform the community in the face of the impact. This, in turn, affects outcome measures of community resilience over time.

### 1.2. Study Area

The survey was conducted in six selected communities in six Local Government Areas in Ebonyi State, southeast Nigeria (Figure 1). The areas are large, with settlements ranging from rural to peri-urban, and distinguished by notable landmarks like streams/rivers. The areas are endowed with mineral reserves and have a tropical climate. The seasons experienced in the area are rainy and dry season. The list of staple crops cultivated in these areas includes rice, yam, and cassava, while the predominant livestock products are sheep, goat, pigs, and poultry. Other prevalent economic activities in the area include hunting, tailoring, petty trading, auto mechanics, and salon and civil services [28]. The test communities represented the four cardinal points of the state as follows: Onueyim and Ezzamgbo communities were situated in the northeastern and northwestern zones, respectively, Inyimagu community belonged to the eastern zone, Nkomoro community was situated in the western zone, and Akpoha and Nguzu–Edda communities were situated in the southern zone. The major

water bodies found in these zones include the Enyim River, which flows from the north to other parts of the state and into the neighbouring Benue state; the Ebonyi river, which flows through the eastern parts of the state; and the Akpoha River, which traverses the southern parts of the state.

## 2. Materials and Methods

We developed an inventory of past climate shocks in each community using historical records and a background study of the area. Data were available through the state emergency management agency, the Ebonyi State Office of the Nigeria Erosion and Watershed Management Project, and interviews with community leaders. We then identified key informants in each community, including leaders and members of groups involved in climate adaptation in both formal and informal settings, through snowball sampling beginning with community leaders. These groups that were active in climate adaptation included traditional leadership, chiefs, NGOs, religious leaders, age grades (a cultural group comprised of members of the community born within approximately a 5-year window), womens' groups, farmers' groups, extensions, local government leadership, and other community groups.

Ebonyi is one of the Igbo-speaking states in Nigeria. Like other Igbo-speaking states, the area operates a democratic and decentralized system of government. There are many institutions in the area that perform some governance functions—executive, legislative, and judicial functions. These institutions include the traditional ruler/king, council of elders, town union, age grades, women associations, youth association, the family, and village council. The traditional rulers perform virtually all of the governance functions—judicial, legislative, and executive—but do not act alone. The council of elders advises the king, negotiates peace with their neighbors, registers age grades and assigns functions to them, and judges offenders and (where needed) punishes them. The village council settles disputes and helps maintain law and order in the study area. The family headed by an *Okpara* is the basic political unit, and is responsible for settling all family disputes. The town union is another important political institution in the area. The town union works with the king and elders in council in carrying out developmental activities/projects in the community. The age grades mainly perform public services such as clearing the path to the farm, repairing roads, building bridges, cleaning the environment, maintenance of law and order, carrying out developmental projects, etc. The youth and women associations play important roles in community development. They carry out developmental projects such as building bridges, settling disputes among members, and assisting members to start businesses.

For each group, the research team interviewed the leadership, a rank and file member of the group, and members of the community who were not a part of the group, regarding the organization's mission, characteristics, and actions taken in response to climate shocks. The interviews were semi-structured (see Appendix A for a sample interview protocol). Additional focal group discussions designed to construct a community climate event timeline were open to all community members who were able to attend. In these focal groups, attendees were prompted to recall specific climatic shocks based on the inventory and the actions taken by various groups in the communities to manage the shocks. They were also asked about whether, in their view, the actions taken by the organization were effective. The study proposed to interview the same number of groups/participants in each community. However, we could not meet this target because of the disproportionate number of age grades and other groups identified in the different communities.

Interviews were coded using Nvivo software, with nodes developed in consultation among the research team members (Table 2). A total of 934 interviews were conducted across six communities (Table 1). 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.



**Table 1.** Total number of interviewees by community and interview method.

Community	Timeline Participants	FGD Participants	Interview Participants	Total Number of Persons Interviewed
Akpoha	61	20	30	111
Ezzamgbo	68	20	23	111
Onueyim	288	20	32	340
Inyimagu	105	20	30	155
Nguzu–Edda	53	20	37	110
Nkomoro	52	20	35	107
<b>Total</b>	<b>627</b>	<b>120</b>	<b>187</b>	<b>934</b>

### Data Analysis

Data generated from the interviews were uploaded into Nvivo software (version 12), a type of computer-assisted qualitative data analysis software. The contents of the interviews were coded and analyzed following a content analysis approach [29]. A total of ten nodes were created by the research team (Table 2), and relevant themes were identified by the research team and assigned to specific nodes in line with the aims of the study. These themes were compared with one another to check for relationships, and, subsequently, tools of descriptive statistics in the form of frequencies and percentages, were employed in the data analysis. Additionally, inferential analysis in the form of correlation was used to test the significance of these relationships, while several scatter plots revealed the trends between some selected variables. Furthermore, a timeline analysis was carried out that revealed the climate change incidences that had been occurring in the study area for the previous 30 years. Finally, the results of the study were presented in the form of tables, charts, and figures with the aid of Microsoft excel and Nvivo and SAS-JMP software.

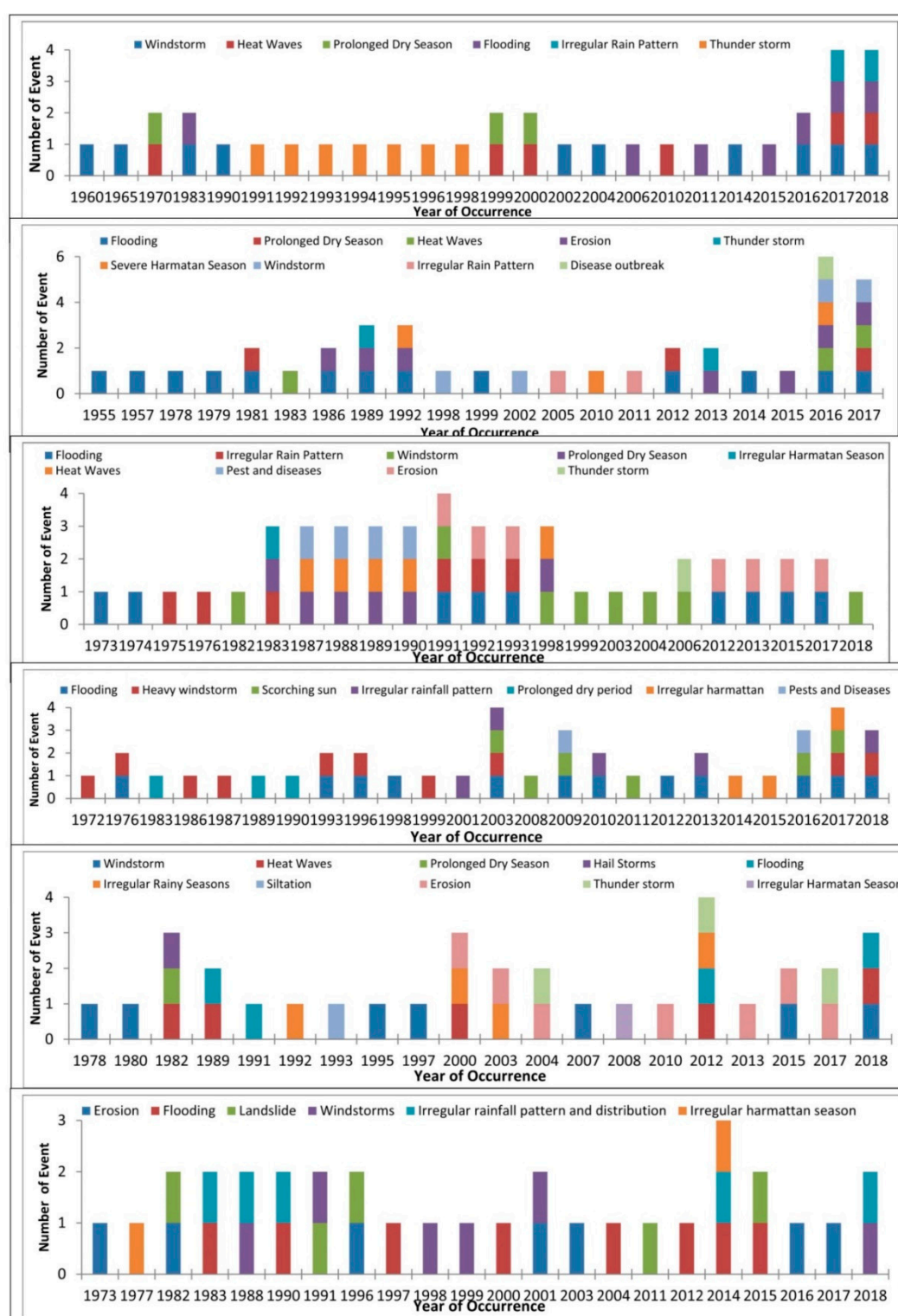
**Table 2.** Interview data coding nodes created in NVivo Software.

Name
Adaptation techniques
Decision to adapt
Duration of organization
Future perception
Gains from adaptation mechanism
History of climate change events
Membership capacity
Quality of mechanism
Status of adaptation mechanism
Type of organization

## 3. Results

### 3.1. Timeline Analysis

Figure 3 depicts the climate change events/incidences that have affected the six communities in specific years over the past 60 years. In Ezzamgbo community, a total of six different climate change events were recorded as follows: windstorm (10 years), flooding (7 years), thunder storm (7 years), heat waves (6 years), prolonged dry season (3 years) and irregular rain fall pattern (2 years). Meanwhile in Onueyim, nine climate change events were recorded as follows: flooding (13 years), erosion (7 years), windstorm (4 years), prolonged dry season (3 years), heat waves (3 years), severe harmattan season (harmattan is a West African weather pattern characterized by dry and dusty northeasterly winds originating from the Sahara; it typically occurs between November and February) (3 years), thunderstorm (2 years), irregular rain pattern (2 years), and disease outbreak (1 year).



**Figure 3.** Type of climatic event for each year from 1955–2018 for all communities in Ebonyi State, as recounted to community residents and state records. No significant patterns were observed by region of the state, so results are aggregated.

In Nkomoro community, a total of nine different climate change events were recorded as follows: flooding (9 years), windstorm (8 years), erosion (7 years), irregular rain pattern (6 years), prolonged dry season (6 years), heat waves (5 years), pest and diseases (4 years), thunderstorm (1 year), and irregular harmattan season (1 year). Meanwhile, in Inyimagu community, seven climate change events

were recorded as follows: flooding (12 years), windstorm (10 years), scorching sun (6 years), irregular rainfall pattern (5 years), prolonged dry season (3 years), irregular harmattan (3 years), and pest and disease outbreak (2 years).

In Akpoha community, a total of seven different climate change events were recorded as follows: flooding (4 years), windstorm (7 years), irregular rain season (4 years), prolonged dry season (1 year), heat waves (5 year), thunder storm (3 years) and hail storm (1 year). Meanwhile, in Nguzu–Edda community, seven climate change events were recorded as follows: flooding (12 years), windstorm (10 years), scorching sun (6 years), irregular rainfall pattern (5 years), prolonged dry season (3 years), irregular harmattan (3 years), and pest and disease outbreak (2 years).

### 3.2. Climate Change Intervention Types

Several adaptation mechanisms were reported by the respondents, and these were grouped into categories including structural, behavioral, economic, social, environmental, legislative, religious, and technological. The structural adaptation category involved setting up physical structures in the form of roads, bridges, drainage systems, and earthen ponds, while the social adaptation involved educating people on how to adapt, getting people to rescue affected community members, and providing relief materials.

The environmental category included planting of trees in open spaces in the community, while the economic adaptation category entailed providing financial resources that would aid victims in recovering from climatic shocks. The behavioral adaptation category entailed moving away from the affected area to better areas as a means of adaptation, while the legislative category entailed enacting laws as a means of adaptation. Finally, the technological adaptation entailed employment of technological advances (for example, providing improved plant varieties).

Results from the community surveys revealed between four (Nguzu–Edda) and eight (Akpoha) types of intervention being practiced (Table 3). The most frequently practiced type of intervention in all communities was structural intervention, followed by social, environmental, economic, and behavioral interventions.

**Table 3.** Climate change interventions by type and community in Ebonyi State, southeastern Nigeria. Total percentages may not add to 100, due to rounding.

Intervention Type	Ezz	Onu	Nko	Iny	Akp	N-E	Pooled
Structural	7 (40%)	11 (36%)	11 (50%)	26 (58%)	19 (40%)	11 (65%)	85 (47%)
Behavioral	3 (17%)	2 (7%)	1 (4%)	2 (4%)	1 (2%)	0 (0%)	9 (5%)
Social	3 (17%)	9 (30%)	5 (22%)	9 (20%)	14 (30%)	2 (12%)	42 (24%)
Economic	2 (11%)	3 (10%)	2 (9%)	4 (9%)	1 (2%)	3 (18%)	15 (8%)
Environ.	1 (5%)	2 (7%)	1 (4%)	4 (9%)	8 (17%)	1 (6%)	17 (10%)
Legislative	1 (5%)	1 (3%)	1 (4%)	0 (0%)	1 (2%)	0 (0%)	4 (2%)
Tech.	1 (5%)	2 (7%)	1 (4%)	0 (0%)	1 (2%)	0 (0%)	5 (3%)
Religious	0	0 (0%)	0 (0%)	0 (0%)	2 (4%)	0 (0%)	2 (1%)
<b>Total</b>	<b>18 (100%)</b>	<b>30 (100%)</b>	<b>22 (100%)</b>	<b>45 (100%)</b>	<b>47 (100%)</b>	<b>17 (100%)</b>	<b>179 (100%)</b>

### 3.3. Climate Change Intervention Types by Group in the Communities

Thirteen different group types involved in climate adaptation were identified in the study area: the age grade, women's group, men's group, youth group, king's cabinet, farmer's group, corporate workers, health workers, NGO, religious group, security group, welfare group, and others (Figure 4). Results indicate that nearly all of the groups practiced structural and social interventions, with the exception of a security group and welfare groups, respectively. Only religious and age grade groups practiced religious interventions (e.g., prayer meetings), while legislative and technological interventions were only practiced by four of the group types.



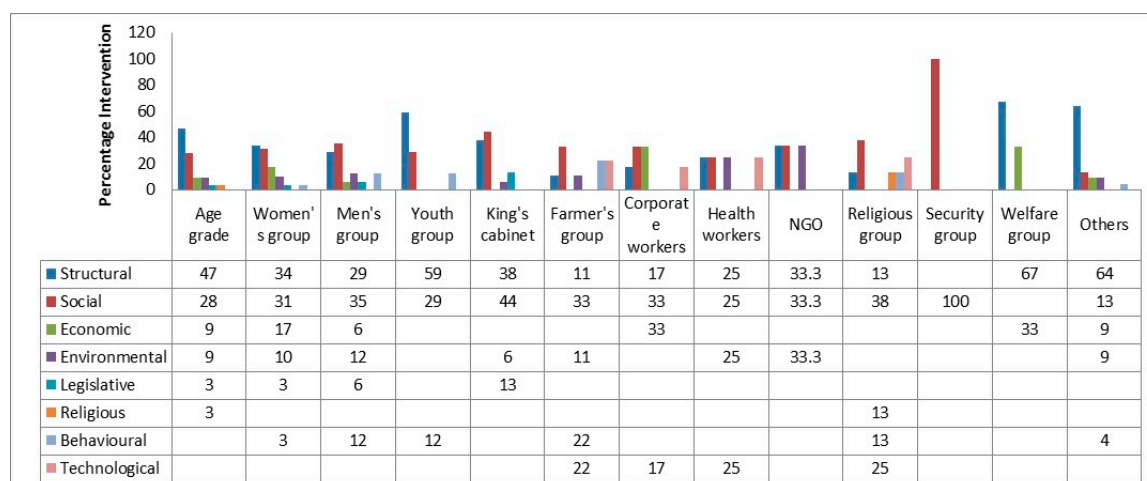


Figure 4. Climate change intervention types by group.

### 3.4. Interviewees' Evaluation of Intervention Mechanism

Table 4 shows the evaluation of the quality of intervention mechanism adopted in the wake of past climate change events for all communities in Ebonyi. The majority of interventions were seen as effective by respondents; however, efforts to control erosion were largely seen as ineffective. Monetary relief from the state government was also seen as ineffective, with respondents complaining that state funds did not reach the most needy residents.

Table 4. Community residents' perceptions of the effectiveness of climate adaptation interventions by risk type, group implementing intervention, and year (E = effective; I = ineffective).

Group	Incidence	Year	Intervention	Quality
King's cabinet	Flooding		Creation of water channels, salvaging of crops in the field during flooding, financial contributions to victims, growing adaptive crops (rice) on flood-prone lands, and road maintenance and bridge repair	E
	Flooding		Advising community members to avoid building and planting in flood-prone area	I
Age grade	Flooding/Prolonged dry season/Windstorm	1970; 1982; 1983; 1989; 1990; 1991; 2017; 2018	Construction of bridges and culverts, road maintenance, built embankments, security patrols, and rehabilitated damaged buildings	E
	erosion/Windstorm	2014	Construction of bridge; filling eroded paths, clearing water ways	I
Others	Erosion/Flooding/Irregular rainy season/Prolonged dry season/windstorm/Pests diseases	1991; 2012; 2015; 2016; 2017; 2018	Rebuilding damaged structures; repairing and maintaining roads, bridges, and culverts; financial and labor contributions and providing relief materials to victims; making courtesy visits to the caretakers of the community; advisory roles; sensitizing people to weather/climate forecasts; discouraging cultivation on lands prone to flooding; group work in farms of flood victims; dry season farming; introduction of early maturing crop varieties	E
Others	Erosion		Communal road repairs, road maintenance, and reclamation	I
Farmer's group	Flooding		Trained members on farming implements, improved faming systems and warning signs; advisory services on climate reports; avoiding farming in flood prone areas; early planting/early maturing varieties; and use of metrological information	E
Youth group	Erosion/Flooding		Clearing of the roads and pathways, construction of bamboo bridges, construction of boats/ferries to help people reach their farm plots and salvage some crops during the flooding, and alternating farmlands for cultivation based on season	I

Table 4. Cont.

Group	Incidence	Year	Intervention	Quality
Womens' group	Erosion/Windstorm/ Flooding		Provision of relief materials; road repairs and maintenance; house repair; and labor and financial contributions towards repairing eroded roads	E
Men's group	Erosion		Repairing and maintaining road and bridge	E
Corporate workers	Flooding/Scorching sun		Provision of monetary relief by the state government	I
Religious group	Flooding		Dry season/irrigation farming	E

### 3.5. Relationship between Size of Group, Duration of Group, and Type of Intervention

A scatter plot analysis of group size in relation to the type of intervention revealed no pattern (Appendix B). From the plot, it is apparent that the type of intervention preferred is not a function of the size of the group. Smaller groups were observed to practice forms of intervention as diverse as larger groups.

Figure 5 shows the scatterplot matrix of the duration of each group (how many years it has been in operation) and the type of intervention employed during climate change events. In the case of the youth group, women's group, religious group, men's group, king's cabinet, farmers, age grade, and others, the longer the duration of the group, the greater the number/type of interventions employed. The reverse was the case for NGO, welfare, health, and corporate workers' groups.

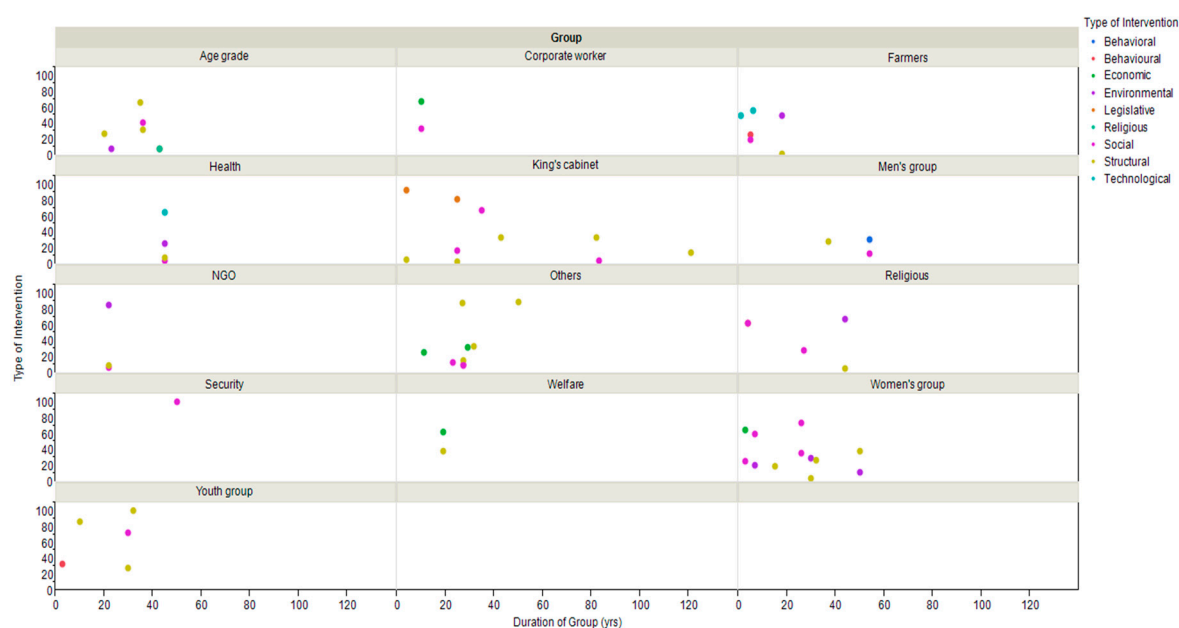


Figure 5. Type of intervention by duration of group (in years) and type of group for all communities in Ebonyi State.

## 4. Discussion

As hypothesized, there is substantial effort in communities in Ebonyi State to adapt and respond to climate impacts such as floods, droughts, and storms. The number and diversity of community groups working on these issues was, however, unexpected. Diverse community groups across six communities were responsible for implementing collective actions that helped their community adapt or respond to climatic events. These included youth groups, 'age grade' groups (cultural organizations that emphasize collective action by villagers within a certain age range), women's' groups, political groups, farmers' groups, health workers, NGOs, religious groups, and others. This considerable

diversity of community stakeholders should complicate any homogenous notions of 'community' held by researchers or external interveners. It also emphasizes that communities are not 'blank slates' waiting for interventions or trainings in order to take action on climate adaptation—they are already very active in this arena [30].

Floods were the most common type of climate risk in Ebonyi, but drought, storms, and erosion were also frequently mentioned by community members (Figure 3). This suggests that interventions to build resilience in Ebonyi would be mistaken to focus on only one type of climate impact, without considering how the intervention might affect system resilience. Activities that reduce overall system risk would therefore be more desirable than actions that respond to only one type of risk.

The most common form of intervention in every community was structural, encompassing repairing roads post-flooding, constructing culverts, etc. This is perhaps surprising given the substantial effort and resources needed to undertake such interventions (compared to educational campaigns, for example), but it serves to further emphasize the community's commitment to addressing climate risk. In four out of the six communities, social interventions were the second most common, consisting of donations of relief materials, educational campaigns, and strengthening social ties. Other interventions (environmental, economic, legislative, and technological) were much less common, suggesting that the community may not have capacity in these areas, or may not see such interventions as valuable. If the former, these areas could provide grounds for capacity building or collaboration with groups external to the community. If the latter, further investigation would be important to determine the reasons behind the community's lack of adoption of these types of interventions.

The majority of the interventions described by community members fall into the absorptive (immediate response to a disaster) or adaptive (anticipating future disasters) space of the resilience framework (Figure 2). The two exceptions include liaising with meteorological professionals to create new communication networks and promoting new methods of farming that are more ecologically sensitive, both examples from Ezzamgbo community. In almost every case, community members reported being satisfied with the effectiveness of the interventions (Table 4). This was true even for community members who were not part of the groups responsible for the interventions. This would imply that, for the time being, absorptive and adaptive responses to risk are working for the communities in Ebonyi. One notable exception was communities' dissatisfaction with efforts to control erosion, implying that assistance with this specific problem may be helpful in Ebonyi. However, even the interventions with which community members are generally satisfied may no longer be sufficient for an altered climatic regime, which will coincide with a number of other changes occurring in Ebonyi (population growth, development, etc.). There may be a role for outside scientists, extension workers, and policy makers to communicate with active community groups around what their community's long-term future could look like given anticipated changes, and what interventions they might take to propel the community towards a desired future and away from unacceptable future risk. Scenario visioning exercises have been used for this type of planning [31–33].

While a scatterplot revealed no pattern of correlation between type of intervention and size of the group (Appendix B), duration of the group was correlated with type of intervention in most cases (Figure 4), indicating that as groups mature and learn better how to work together, they may diversify their adaptation portfolio. Moreover, groups that have been active through several different types of climatic events may have used different types of actions to respond to these events at different times. NGO groups, welfare, health, and corporate workers' groups were exceptions, as they did not demonstrate any pattern when plotted against type of intervention. It is difficult to draw conclusions from these exceptions, since there were relatively fewer of these groups; however, it is possible that these groups are more mission-focused than womens' groups or age grade groups (for example), and so may not undertake actions outside of their purview.

Given that this study took place in a very specific cultural and climate context, the specific findings are likely not broadly generalizable, as all climate adaptation is by necessity localized. Further study is needed to examine the full range of climate adaptation strategies across different types of communities

in West Africa; this type of research effort could support a climate adaptation ‘database’ of strategies for building community resilience.

## 5. Conclusions

We interviewed 934 community members in six communities in southeastern Nigeria about community-based actions for climate change adaptation. We found these communities contained multiple active and engaged groups that have implemented a wide range of interventions over several decades to reduce climate risk, most of which are seen as effective by community members. Communities are by no means ‘blank slates’ waiting for external support to begin adapting to climate risk. In addition, many of the community adaptation strategies in Ebonyi are relevant for other communities across the state, country, and region facing similar climate risks. Government (at various levels) and development practitioners need to be made aware of what communities are doing in response to climate risk. With more interaction with communities, external support can be better designed to work alongside and improve community efforts. The research team is coordinating dialogs at community and state level to discuss the findings of this study with stakeholders and their implications for planning efforts to deal with climate risk in the study state. In addition, the research team is now able to identify specific community needs (e.g., erosion control) that could be met with additional support and expertise, and arrange for consultations between community groups and appropriate scientific and engineering personnel.

While floods were the most common type of climate risk experienced by these communities, drought, storms, and erosion were also mentioned frequently, pointing to the need for climate adaptation that is not risk-specific. The most common type of community intervention was structural (repairing roads, constructing bridges, etc.), indicating that community groups are capable of marshalling substantial resources and human power to implement adaptation efforts. Most community interventions would be classified in the ‘absorptive’ or ‘adaptive’ space of the resilience framework [10]; as climate risk continues to worsen, these communities may benefit from strategic planning to envision more transformative changes to increase resilience and alleviate risk. In sum, this research suggests that efforts to boost community resilience and adaptation to climate change would benefit from first understanding what community actions perceived as effective are currently underway, and working with the groups implementing these actions to support and extend them.

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**Conflicts of Interest:** The authors declare no conflict of interest.

## Appendix A

### Interview Procedure

-Interview key informants (individual)

-Interview leadership and a rank and file member

Interview schedule for leadership:

-What is your organization’s central mission?

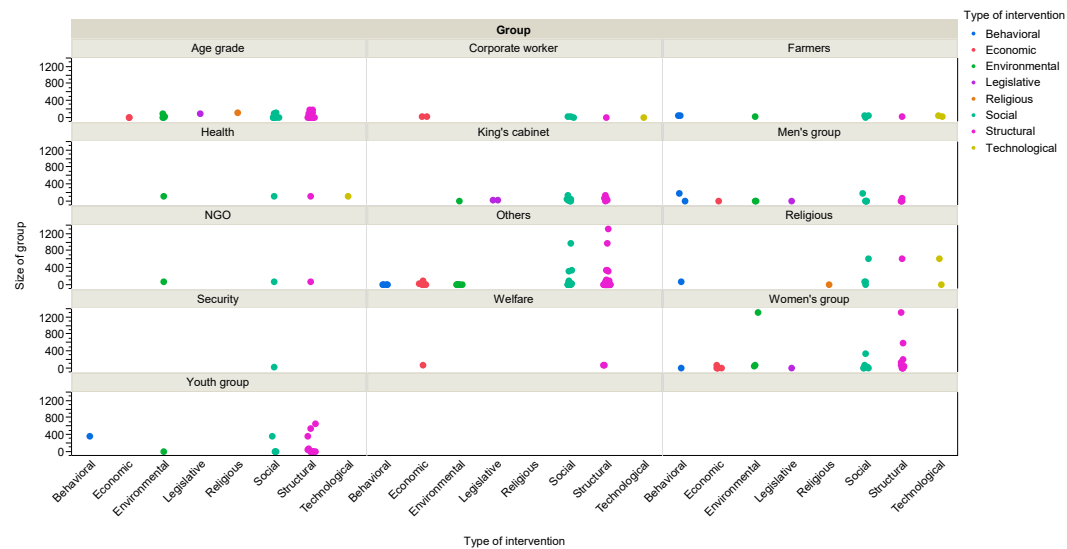
-What is your position in the organization

-What are your organization’s current programs and activities in the communities?

- How long has your organization existed?
- What is the size of your organization?
- Are there requirements to be part of this group? What are they?
- What actions have your organization taken to respond to climate shocks?
- Are these actions still active today?
- Are/were these actions effective?
  - Why or why not?
- Have any of these actions involved partnership with other agencies?
- Prompts based on historical climate inventory
- Ask if they have any shocks to add to the inventory.
- How do you see your community changing in the next thirty years, and how would your organization play a role in adapting to that change?
- Interview schedule for rank and file member:
  - What is your organization's central mission?
  - Why did you join this organization?
  - What were the requirements for you to be a part of this organization?
  - What actions has your organization taken to respond to climate shocks?
- Are these actions still active today?
- Are/were these actions effective?
  - Why or why not?
- Have any of these actions involved partnership with other agencies?
- Prompts based on historical climate inventory
- Ask if they have any shocks to add to the inventory.
- How does your participation in the organization affect your household?
- Interview checks
  - Try to get the register for organizations
  - Interview random community residences
  - Identify systematically vulnerable and poor communities (can vary from community to community)
  - Interview random members of these communities
- Individual interviews focus on past and present resilience measures at the community level
- Interview schedule for individuals
  - What actions have the community taken to respond to climate shocks?
  - Are these actions still active today?
  - Did you participate in these actions?
    - Are these activities inclusive of all community members?
    - How were decisions made to execute these actions?
      - Who was involved in these decision making processes?
  - Why did you participate/not participate?
  - Were/are these actions effective?
    - Why or why not?
  - Prompts based on historical climate inventory
  - How do these actions work in your household?
  - Do you belong to any organizations that organize around these issues



## Appendix B



**Figure A1.** Correlation matrix depicting size of group on type of intervention for all communities in Ebonyi State, Nigeria.

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