



Climate Resilience Index: Gender Resilience Analysis of Climate Change Induced-Shocks in Redd+ Piloted Site, Cross River State, Nigeria

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ABSTRACT

Climate change is real all over the world, and hence the vulnerability and resilience capacity for gender in relation to REDD+ Cancun Safeguard “d” must be assessed. This study assessed genders’ resilience to climate change-induced shocks in REDD+ piloted site, Cross River, Nigeria. Data were collected through quantitative (200 questionnaires) using Cochran allocation formula and qualitative (Focus Group Discussion and Key informant interview) approaches. The respondents were classified as Male and Female. The Climate Resilience Index (CRI) and Livelihood Resilience Index (LRI) based on the three-resilience capacities absorptive, adaptive and transformative, were used to measure genders’ resilience to climate change impacts. Findings indicate that the CRI and the resilience capacities scores of major components clearly differentiated genders along role, responsibilities and forest usage. Unambiguously, LRI score showed that transformative capacity (0.458) leads the contributing factor to resilience for male followed by adaptive (0.431) for female and absorptive (0.240) for male capacities. Similarly, male was relatively more resilient with a mean index value of 0.376. The study also shows that access to and ownership and use of livelihood resources were major elements of genders’ resilience in the study area. In general, low resilience recorded by Female might be due to exposure to recurrent shocks, poor access to infrastructure, poor livelihood diversification practices, limited adaptive capacities, e.t.c. Gender resilience capacity was minimal with a mean score of 0.353. Thus, in addition to short-term buffering strategies, intervention priority focusing on both adaptive and transformative capacities in REDD+ community particularly for Female/women should be strengthened.

Keywords: Climate change-induced shock, climate resilience index, gender, REDD+, Resilience index

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RÉSUMÉ

Le changement climatique est bien réel partout dans le monde, la vulnérabilité et la capacité de résilience en ce qui concerne le Safeguard "d" de Cancun de REDD+ doivent être évaluées pour les décideurs politiques. Cette étude a évalué la résilience des sexes aux chocs induits par le changement climatique dans un site pilote de REDD+ dans l'État de Cross River, au Nigeria. Les données ont été collectées à l'aide d'approches quantitatives (200 questionnaires utilisant la formule d'allocation de Cochran) et qualitatives (discussions de groupe et entretiens avec des informateurs clés). Les répondants ont été classés comme hommes et femmes. L'Indice de Résilience au Climat (CRI) et l'Indice de Résilience des Moyens de Subsistance (LRI) basés sur les trois capacités de résilience - absorptive, adaptative et transformative - ont été utilisés pour mesurer la résilience des sexes aux impacts du changement climatique. Les résultats indiquent que le CRI et les scores des capacités de résilience des composantes principales différencient clairement les sexes en fonction de leur rôle, de leurs responsabilités et de leur utilisation de la forêt. De manière non équivoque, le score LRI a montré que la capacité transformative (0,458) était le facteur contribuant le plus à la résilience des hommes, suivie de la capacité adaptative (0,431) pour les femmes et de la capacité absorptive (0,240) pour les hommes. De même, les hommes étaient relativement plus résilients avec une valeur moyenne de l'indice de 0,376. L'étude montre également que l'accès à la propriété et à l'utilisation des ressources de subsistance étaient des éléments majeurs de la résilience des sexes dans la zone d'étude. En général, la faible résilience enregistrée par les femmes pourrait être due à l'exposition à des chocs récurrents, à un faible accès à l'infrastructure, à de mauvaises pratiques de diversification des moyens de subsistance, à des capacités adaptatives limitées, etc. La capacité de résilience des sexes était minimale, avec un score moyen de 0,353. Ainsi, en plus des stratégies tampons à court terme, la priorité d'intervention axée sur les capacités adaptatives et transformantes de la communauté REDD+, en particulier pour les femmes, devrait être renforcée.

Mots-clés: Chocs induits par le changement climatique, indice de résilience au climat, genre, REDD+, Indice de résilience

INTRODUCTION

Climate change-related shocks are some of humanities most serious livelihood challenges, with detrimental impacts disproportionately affecting developing countries (Green *et al.*, 2009). Africa is more vulnerable to climate change impacts as a result of high levels of poverty and over-reliance on rainfed agriculture (IPCC, 2001, 2007; Challinor *et al.*, 2007). Consequently, the climate resilience of any system either man or biophysical would differ greatly across the countries (Balk *et al.*, 2009), and can be disaggregated down to subnational and local level (See Beauchamp *et*

al., 2019). At the local level, plight of some social and vulnerable groups e.g. women and elderly people whose exposure to climate change is high, and also climate-related stress will accentuate due to their limited mobility even in the climate extreme event. According to the Intergovernmental Panel on Climate Change (IPCC), the frequency and intensity of climate-related shocks such as heat waves, droughts, floods, and other natural disasters are increasing around the world (IPCC, 2014). Extreme weather occurrences would place additional strain on human health, food security, and water resources, all of which are

particularly vulnerable and negatively impacted among the rural poor (IPCC, 2001, IPCC, 2014). According to the IPCC report, disaster risk management programs should focus on lowering exposure and vulnerability while increasing shock resistance (IPCC, 2014).

The word 'resilience' was coined from the Latin word '*resilire*,' which means 'to bounce back' or 'recoil' (Alexander, 2013). The term was first used in mechanics in 1858 to describe a material's ability to resist (rigidity) as well as absorb (deformation) a force; it was then employed in psychology in the 1950s, system ecology in 1973, and social-ecological systems in the 1990s (Alexander, 2013). The deepening of two major societal processes, climate change and globalization, which intensify multidimensional and non-directional impacts, has led to the recognition of resilience across a wide range of disciplines around the world (Darnhofer, 2014). Its application has gradually expanded into social-ecological system and is defined as the potential of a social-ecological system to sustain basic structures and continue functioning following shock events (Walker *et al.*, 2002; Walker *et al.*, 2004). Its application has gradually expanded into disaster risk reduction, climate change adaptation, vulnerability, social protection, and so on (Béné *et al.*, 2012). Because it is a multidisciplinary expression, it has been used in a variety of ways, but they all have one thing in common: 'the ability to adjust to changes, particularly unprecedented ones' (Darnhofer, 2014). A social-ecological system's ability to respond to major shock occurrences includes a variety of abilities such as "shock absorbing," "buffering," "bouncing back," and "transforming" (Walker *et al.*, 2002). Its application in various disciplines has broadened its understanding from its original narrowed engineering resilience-'the ability of a system to bounce back after disturbance'- to a more comprehensive concept-'the ability not

only to bounce back but also to adapt to and even transform into a new system' (Béné *et al.*, 2012).

Furthermore, socio-ecological resilience is viewed as a process rather than a static condition, and long-term resilience requires the acquisition and maintenance of three basic resilience capacities: absorptive, adaptive, and transformative (Cutters *et al.*, 2008; Béné *et al.*, 2012). Because the three major structural elements of absorptive, adaptive, and transformative capacities are considered the best to capture resilience (Béné *et al.*, 2012), this study used the Three-Capacity (Absorptive, Adaptive, and Transformative capacities) frame to investigate genders' resilience to climate change-induced shocks. Depending on the severity of the shock, the three fundamental responses or resilience capacities can be linked. As a result, it is natural for the system to block or resist the shock when it occurs intermittently (Béné *et al.*, 2012). As a result, internal resistance is recognized as a normal quality of a system that is manifested on a daily basis and where resources could block the shock, allowing the system to continue operating highly comparable to the human immune system (Norris *et al.*, 2008). Absorptive capacity is particularly important for buffering short-term disruptions as well as during the early stages of dealing with massive shocks (Darnhofer, 2014).

If the shock exceeds the absorptive capacity, the next adaptive resilience requiring system alteration to maintain system functioning will be used (Cutters *et al.*, 2008). "The ability of a system to alter itself to maintain system functioning," according to adaptive capacity (Folke *et al.*, 2010). These habits of incremental modification, as well as learning through failure and achievement, contribute to adaptability (Glover, 2012). "Resourcefulness-the ability to identify difficulties, set priorities, mobilize resources, integrate experience and

knowledge during crises, and plan for forthcoming shock impacts" is part of this capability (Darnhofer, 2014). Diversifying livelihoods, establishing market networks, empowering storage facilities, developing community pooling, introducing shock-resistant varieties, new farming practices, strengthening social networks, and other multi-level (individuals, households, communities) and incremental adjustment mechanisms for farming communities could be used (Béné *et al.*, 2012). It may be challenging to maintain system functioning through adaptive resilience, which involves transformational resilience, in the case of high-intensity and repetitive shocks. It is frequently linked to system-level changes in elements such as infrastructure (for example, roads, communication, credit access, health facilities, and so on), governance, and formal safety nets, all of which contribute to long-term resilience (Frankenberger, 2013). For example, transforming rural livelihoods into resource extraction economies, modifying resource management practices through ecotourism, and so on. Institutional reforms, behavioral adjustments, and technical advances may be required for a transformative reaction (O'Brien, 2011). The performance of transformative resilience may be limited by factors such as socioeconomic policies, land-use policies, resource management trends, institutions, and technology (O'Brien, 2011). Genders' capacities to successfully adapt to the rapidly expanding shock events must be reinforced in the face of environmental uncertainty (Darnhofer, 2014) in order for smallholder farmers to better resist the forthcoming shock consequences (Tambo and Wünscher, 2017). Because resilient households are more active in anticipating, resisting, coping with, and recovering from shock impacts (Fan *et al.*, 2014), as well as maintaining or improving their standard of living in the face of environmental changes, they are more resilient (Fan *et al.*, 2014).

REDD+ is one approach for implementing

the Paris Agreement to mitigate climate through the land use sector. Primary goal of REDD+ initiative is to maintain and enhance forest carbon stocks. According to UNFCCC Cancun Safeguard (e) Refers to social benefits, and under the Warsaw Framework, countries will be required to have a national social and environmental safeguard information system in place, and regularly report on impacts, to be eligible for results-based payments (UNFCCC, 2014). The knowledge is critical in allowing the vulnerable/social group to create adaptive capacity/measures and gender disaggregated study that will throw more light on the degrees of vulnerability and coping methods of various social groups. The findings should be fed into the climate-negotiation process, allowing decision-makers to have a greater knowledge of how diverse groups of people are affected, as well as what adaptive capability and assistance are required in holistic methods to combat the threat of climate change.

There is therefore an urgent need to recognize and make provision for effective mechanism for analyzing resilience and adaptive capacity of REDD+ adaptation programme site, group of people dwelling and relying on forest goods and services for survival. The groups could be potentially affected positively/negatively by the impact of adaptation programme such as REDD+. It is imperative to analyze gender resilience and degree based on disaggregated data in order to bridge existing information gap. By identifying adaptation constraints in the REDD+ piloted site, Cross River, Nigeria, the study's findings will aid in prioritizing intervention approaches for livelihood resilience particularly, the vulnerable categories. The objective of this study was therefore to analyze the resilience of disaggregated gender level in the context of climate change and variability in REDD+ piloted site, Cross River state, South-South, Nigeria.

MATERIALS AND METHODS

Study Area. Geographically, Cross River State (CRS) is situated in the South-Southern part of Nigeria, and bound by Latitudes 4° 27' to 5° 32'N and Longitudes 7° 50' to 9° 28'E with an approximate landmass area of 20,156 square kilometres respectively (Figure 1). For this study, three key sites (known as REDD piloted sites) were selected. The cluster used in this study formed part of the piloted sites for the on-going United Nation REDD+ programme (Reducing Emissions from Deforestation and Forest Degradation) currently on-going in CRS, Nigeria. The sites of interest include: Afi-Mbe, Ekuri-Iko and Mangrove forest cluster from which

communities was selected accordingly (Figure 1). The sites Afi-Mbe and Ekuri-Ukpon clusters are made up of community forests and forest reserves, jointly managed by local communities, government (Cross River Forestry Commission) and conservation Society). In the Afi-Mbe cluster, the existing protected areas include the Afi Mountain Wildlife Sanctuary, Afi River Forest Reserve, Mbe Mountains and a community forest south of the Cross River National Park. The Ekuri-Iko cluster is made of the Ukpon River Forest Reserve, Ekuri Community Forest, parts of the Oban Block Forest Reserve and the Cross River South Forest River (Onoghejugo *et al.*, 2016)

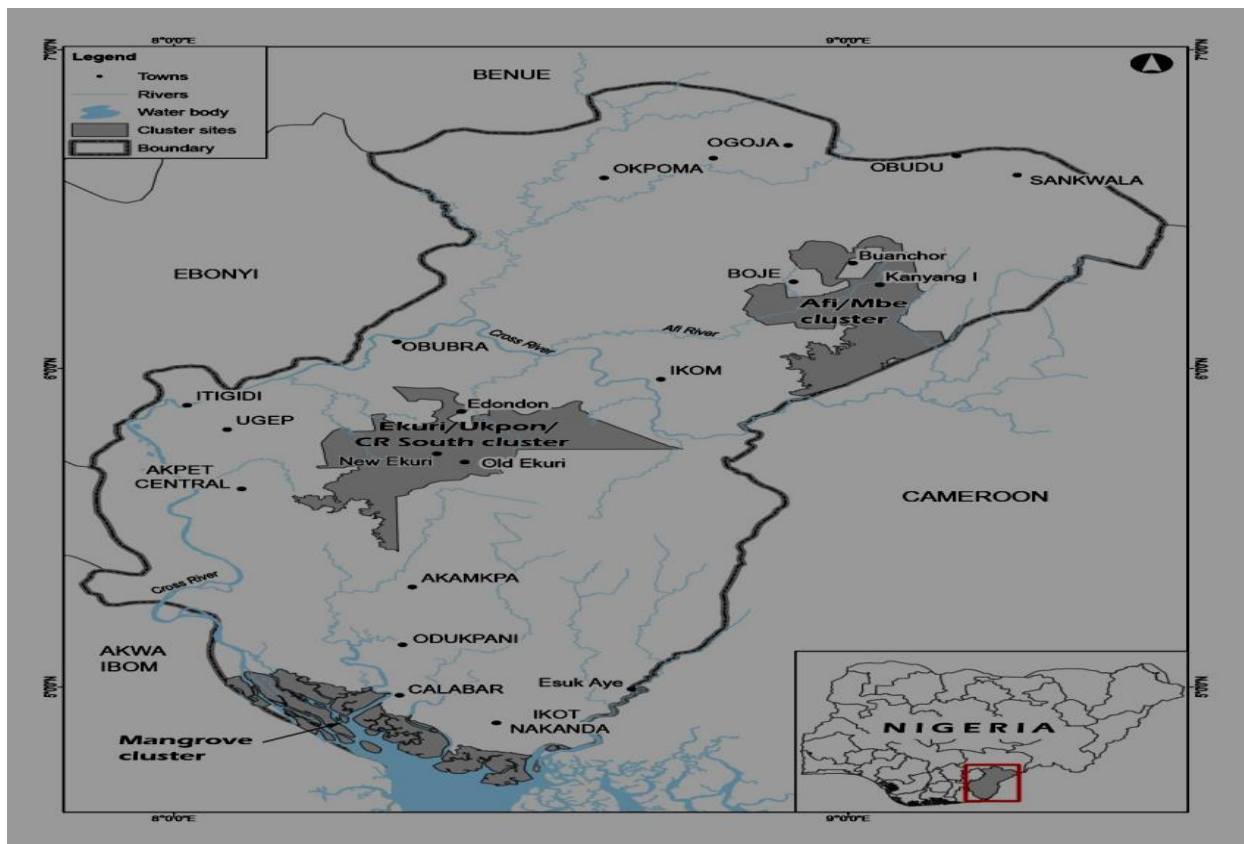


Figure 1: Map of Cross River State showing the Three Cluster Sites and an Insert Map of Nigeria (Culled from Onoghejugo *et al.*, 2016)

Study design. Both quantitative and qualitative approaches were adopted for this study. Qualitative approaches such as in-depth interview, focus group discussion and life histories were being adopted first in identifying important factors that can help us to interpret and give better understanding of the complex reality of the research study and the implication of quantitative data.

Study population. The population for this research study consisted of some selected villages adjacent to where climate change adaptation initiatives such as REDD+ is being piloted. This was purposefully selected based on UN-REDD+ on-going project recommended site.

Sampling design

Six villages adjacent to the REDD+ piloted site were selected purposively for the study (Two from Afi-Mbe, Ekuri-Iko and Mangrove villages respectively). After the purposeful selection of the study population from the sample frame collected from Cross River State Ministry of Forestry, multi-stage sampling was used to determine the respondents for the survey. In each village, respondents were classified as gender categories along age line into both male and female (youth, men and elderly); 3 strata for each gender which was later collapsed into two main categories (Male and Female) based on sex and gender role and responsibility. Within each stratum, simple random sampling was applied to select respondents in each category through picking numbers randomly and assigned it to represent the people within the stratum (Basiru *et al.*, 2018)

Determination of sample size. According to Cochran (1977), using the formulae below was paramount because the total population was available which give the right to assign the proportion according to the variability of population in each community. *This was*

projected to be:
$$n = \frac{N}{1+N(e)^2}$$

$$n = \frac{N}{z^2 + \alpha^2 N} \quad \text{lim} = \frac{1}{\alpha^2} \quad \text{Where } n \rightarrow \infty$$

(For finite population) (For Infinite population)

Where:

n= Sample size

N=Total Population

e=is desired level of precision,

A= acceptable margin of error for proportion) =0.05

Confidence level of 95%

α=Alpha

p=0.05

Data collection. The research study employed questionnaires, Focus Group Discussion, Review of Literature and observation schedule as tools/instrument for data collection. The main strength of quantitative measurement instrument in this study is that the researcher has control over the topics and the format of the interview. On the other hand, qualitative measurement strength is its ability to provide complex textual descriptions of how people experience a given research issue. It provides information about the human side of an issue that is often contradictory behaviours, beliefs, opinions, emotions and relationships of individuals. Qualitative measurements are also effective in identifying intangible factors, such as social norms, socioeconomic status, gender roles, ethnicity and religion, whose role in the research issue may not be readily apparent. Therefore, using qualitative alongside quantitative methods has a major advantage over being used solely because qualitative approach will help us to interpret and better understand the complex reality of a given situation and the implications of quantitative data. Moreover, these tools were utilized based on their established nature, prominence, popularity/acceptance, adaptability and the potential they offered in helping to obtain the data required for this type of study. A total

number of 200 questionnaires (based on result from Chocran size formula) were administered for all the selected villages. The method of administration was done in selection of the respondents from the households in the village until the required respondents are selected to avoid possible bias and achieve actual representation of the entire village.

Questionnaire contains both structured questions with rated response answer and open-ended questions requiring short answers were developed through informal survey to the study site before an effective formal survey. An informal survey using semi-structured interviews and discussion with the residents, key informants survey, and participant observation in the selected piloted villages were formed an important part to develop and understanding how to formulate the outcome variables needed for the research was done. Rather than handing the questionnaires to the respondents to fill themselves, interviewers were used to fill the forms for better collection of data given that level of education is expected to be low.

Validation and reliability of multi-item measures. Construction of instrument validity is necessary as recommended by literatures on methods of using questionnaires to collect data. This was done after carefully selection of contents of the interview schedule and passed through a series of critical examinations to certify its content and face validities. The instrument was subjected to critical scrutiny and consequent modification by other researchers to guarantee its content validity.

Pre-testing of data collection tools. After the pre-testing of the structured interview schedule, the instrument were implemented to collect the data required for this study. The data were collected by a team; made Forest Officer from Cross River State Ministry of Forestry, data collection personnel that was also consisted of instructor from Cross River

State Ministry of Forestry. All the enumerators that were recruited from the community/villages were someone that can speak and interpret English and local dialect which are prominent indigenous language in the study area. In addition to their lingual capabilities, these enumerators was trained before the field pre-test and actual data collection exercises. As part of the training, the enumerators were taken through the nuances of the interview process to reduce the bias that might arise from conformity and social desirability. The study instrument was translated and back-translated and the measure was explained to them in order to enhance their capacity to interpret the questions and administer the instrument competently.

To meet the requirement for informed consent, informal approval of the respondents were sought before being interviewed. Also, the study respondents were enlightened on the purpose of the study in the introductory statement of the interview schedule. In addition, they were also informed of the potential benefits of the study to their community and to the society at large. Moreover, they were also be briefed on what their participation entails and the estimated length of time required to complete the survey. Following this, they were assured of their anonymity and complete confidentiality of any information they will be provided, after which their passive/implicit consent to participate were finally sought. Depending on the literacy level of the respondents, this information was transmitted to him/or her in English or native language. The structured and open-ended questions was designed in a way to make data management and analysis easy through numerical coding of responses. After coding the various responses, data were entered into MS Excel, removing non-meaningful responses and then analyzed with SPSS version 20 using descriptive and inferential statistics such as: means, ranges, standard deviation, percentages and spider diagram.

Data analysis

Climate Resilience Index (CRI) calculation.

As resilience is a complex concept, its quantification remains debatable. Currently, however, substitute indicators through composite index frame has been used to measure resilience in wide range of literature (Tambo 2016; FAO 2010). The climate resilience index (CRI) development followed the prescription by Tambo (2016). Accordingly, a tool developed by FAO (2010) to measure food insecurity was customized to assess genders’ and individual resilience to climate change impacts and shocks. The tool consists of nine major components and a gender with higher in average values of each component were hypothesized to be resilient to climate change-impacts/shocks. Stakeholders’ consultation (extension workers, development agents, experts and elders) and review literature (Tambo, 2016, Cutters *et al.*, 2008;

$$I_a = \frac{S_q - S_{min}}{S_{max} - S_{min}} \dots\dots\dots \text{Equation (1)}$$

Whereas indicators expected to have inversely related to resilience, such as gender food insecurity and access score (GFIA), illness score, shock events, etc. were standardized using equation (2):

$$I_a = \frac{S_{max} - S_r}{S_{max} - S_{min}} M_r = \frac{\sum I_{ai}}{N} \dots\dots\dots \text{equation (2)}$$

Where I_a is the standardized value for the indicator a , S_r was an observed (average) value of the indicator for gender categories r , min and max were the minimum and maximum values of the indicator across all the gender categories, respectively. Once each indicator has been standardized, the average value of each major component were computed using equation 3

$$M_r = \frac{\sum I_{ai}}{N} \dots\dots\dots \text{Equation (3)}$$

Where M_r is one of the nine major components for livelihood/socioeconomic r , I_{ai} is the indicator indexed by i , that make up each major component, N is the number of indicator in

FAO, 2010) were used to select relevant indicator and the details were presented accordingly. The CRI uses a balanced weighted technique (Sullivan *et al.*, 2002) where each sub-component (indicator) contributed equally to the index. Using an individual data on these indicators, a Climate Resilience Index (CRI) was developed forest resources and socio-economic unit of analysis. As each major component was composed of different number of indicators measured on different scales, the standardization considered the functional relationship between indicators and resilience (Tambo, 2016). In effect, two methods of standardization was employed. Indicators that are expected to have direct relationship with resilience, such as income and food access, diversity of income sources, coping strategies, etc. was standardized using equation (1) as:

each major component. After values for each of the ten major components for each gender categories were calculated, the CRI was obtained from the weighted average of the nine components as:

$$CRI_r = \frac{\sum_{p=1}^9 W M_i M_{ri}}{\sum_{p=1}^9 W M_{ri}} \dots\dots\dots \text{Equation (4)}$$

$$CRI_r = \frac{W_{ndcv}NDCV_r + W_{sn}SN_r + W_{ifa}IFA_r + W_{lvs}LVS_r + W_{wh}WH_r + W_{ww}WW_r + W_{sdps}SDP_r + W_{abs}ABS_r + W_{aas}AAS_r}{W_{ndcv} + W_{sn} + W_{ifa} + W_{lvs} + W_{wh} + W_{ww} + W_{sdps} + W_{abs} + W_{aas}}$$

...Equation (5)

Where CRI_r is the Climate Resilience Index for each gender category, M_{ri} = the number of indicators of the major component, $W M_i$ = weight of major component i , $NDCV$ =natural disaster and climate variability, SN = Social networks, IFA =Income and food access, LVS =livelihood strategy, H =health, W =water, SDP =sociodemographic profile, ABS =access to basic services, A =assets. In order to better understand resilience, the Climate Resilience Index (CRI) frame indicators was aggregated into the three resilience capacities (3Ds) viz:

absorptive, adaptive and transformative capacities (Bènè *et al.*, 2012; Weldegebriel and Amphune, 2017; Cutters *et al.*, 2008, Darnhofer 2014;) absorptive capacity is the ability of a socio-ecological system to prepare for, mitigate with or prevent negative impacts through coping strategies in order to preserve and restore basic structures and functions (Bènè *et al.*, 2012). The index was computed based on the perceived ability of gender to climate change-induced shocks and impacts, access to early warning system, preparedness, stability and social capital like sharing of resource and membership to community-based organizations (Bènè *et al.*, 2012). Adaptive capacity is the ability of a system to adjust impacts to moderate potential damage, to take advantage of opportunity, so that it continues functioning without significant change in system structures (IPCC 2001). Examples include, planting drought resistant seed varieties and livelihood diversification. In effect, livelihood diversification strategies, asset and income and food access etc. were placed under adaptive capacity (Cutters *et al.*, 2008, Tesso 2012). Transformative capacity is the ability to create an enabling new system in

times of crises (Walker *et al.*, 2004). It is often associated to system-level changes in factors like infrastructure (example: road, communication, credit access, health facilities, etc.), governance, formal safety nets which substantially strengthen long-term resilience. As a result, access to basic services, social capital like conflict management mechanisms and vertical linkages was captured under transformative capacity (Cutters *et al.*, 2008, Tesso 2012). Therefore, indicators presented in equation (4) will be aggregated into respective resilience capacities to generate the livelihood resilience index (LRI) as follows:

$$CRir = \frac{WabcABCr + WadcADCr + WtcTCr}{ABCr + ADCr + TCr}$$

.....Equation (6)

Where LR_i is the resilience index for gender *r*; W_{abc}, w_{adc} and w_{tc} are the weight of absorptive, adaptive and transformative capacities, respectively; ABC_r, ADC_r and TC_r are the number of indicators in absorptive, adaptive and transformative capacities for each gender categories respectively.

Table 1. Resilience capacities, major components, sub-components and hypothesized relationship

Resilience capacities	Major component	Indicators	Hypothesized relationship: relatively resilient if:
Absorptive capacity	Natural disaster, climate change and variability	Access to early warning system, Ability to perceive climate change induced shock, preparedness for the climate disaster	The gender/household has an access to early warning system, prepared for both climate disaster and climate change induced shock and capability to withstand the induced-shock
		Perception to climate change and variability impacts, preparedness for the shock, capability to withstand climate change induced-shock	
	Social network	Sharing of resources, membership of community-based organisation or NGO	There exist experiences of resources sharing, belong to community-based organisation or NGO

Adaptive capacity	Source of income and food access	Farming, NTFP gathering, raising crops, food security	Gender that doesn't involve in climate sensitive occupation like farming, NTFP gathering and raising crops
	Livelihood strategies	Livelihood diversification, planting of drought tolerant crops, saving for future, engagement in menial job, migration for greener pasture, venture into another business, social networking	Livelihood diversification, planting drought tolerant crop species and social relationship in form of help is observed
	Health	Malaria Exposure, climate related disaster lead to death, chronic illness, health facilities, inactiveness due to natural disaster occurrence	Death score, chronic illness, health facilities and inactiveness occurrences for both climate related disaster and malaria exposure is low
	Water	Access to improved water, water sufficiency and water conflicts	The HH and gender has access to improved drinking water that can be collected within 10 minutes' walk from home (round trip), water sufficiency during last 12 months, no conflicts due to water
	Socio-demographic status	Sex of the household head, dependency and education	Male-headed households with lower dependency ratio and literate
Transformative capacity	Social network	Conflict management, bottom-up involvement in governance	Participate in elderly institutions, REDD+ management, community governance, sustainability of peace and security
	Access to basic services or infrastructure	Access to basic public services in such as market, health services, primary school, health services, road, credit and electricity	Gender who access to basic public services in <5m or 1<hour walking distance from home and also has an access to credit facilities

Table 2. Resilience categories and factors influencing genders’ resilience to climate change impact and shocks in REDD+ piloted site, Cross River State.

Factors	Resilience category		
	Poor resilience or likely high vulnerable	Moderate resilience	Highly resilience or likely less vulnerable
Saving NTFP and crops	Not able to save NTFP and crops in more than 12 months	Save NTFP and crops within 6months in a year	Save NTFP and crops throughout the year(12months)
Farm plot size	≤one acre	One-two acres	≥ two acres
Livestock holding	≤one	One-two	>two
Social protection (resources sharing, labour, borrowing and lending, group and NGO)	Poor social protection	Moderate social protection	Strong social protection
Diversity of income sources	Solely reliance on rainfed crop farming	Combination of crop farming and NTFP gathering	Combination of crop farming, gathering of NTFP and other business activities
Crop diversity	Planting only crop	A minimum of 2-3 crops	Many crops
NTFP/Forest resources gathering diversity	Only type of NTFP	Minimum of 2-3 NTFPS	Many NTFPS
Water	Average water usage is ≤150 litres per day	Average water usage is >150 and < than 250 litres per day	Average water usage is >150 litres per day
Infrastructure e.g. school, health centre etc.	Access to major public services in ≥2-hour walk	Access to major public services in 1-2hour walk	Access to major public services in ≤1-hour walk

Resilience indicators for gender in REDD+ piloted site, South-South, Nigeria

Based on this study, gender perceived resilience as a state of recovery against climate change impacts without interference and aid from external system. As a result, the impacts of climate change, variability and climate related disaster couple with rate of bouncing back were not uniformed among the analysed gender category. In this regards, gender resilience were classified into three (3) categories: 1. poor resilient, 2. moderately resilient; and 3. resilient. This classification

was done based on the recovery time to climate change, variability and climate related disaster impacts. These classification was also reported by Weldegebriel and Amphune (2017) and Mengistu *et al.* (2018) in Northwestern part of Ethiopia. Both key resilience determinant and other major features of each resilience categories were well presented in Table 2.

Respondents indicated that saving both crops and NTFP as key determinants of individual livelihood and resilience to climate change vulnerability. They stressed that availability of crops and NTFP has been a major adaptation

Table 3. Indexed major components, core capacities and overall Livelihood Resilience Index of Gender in REDD+ piloted site, Cross River, Nigeria

Resilience capacities	Major component	Component value	Gender		Resilience score
			Male Resilience score	Female Component value	
Absorptive capacity	Natural disaster, climate change and variability	0.119	0.240	0.089	0.185
	Social network	0.485		0.377	
Adaptive capacity	Income and food access	0.589	0.429	0.584	0.431
	Livelihood strategies	0.488		0.414	
	Health	0.233		0.354	
	Water	0.508		0.490	
	Socio-demographic status	0.337		0.354	
Transformative capacity	Social network	0.408	0.458	0.252	0.378
	Access to basic services	0.495		0.479	
	Assets	0.452		0.356	

strategies to cushion the effect of climate shocks. Accordingly, they noted that ability to save one of crops or NTFPS will go a long way in solving food scarcity in case of unseen occurrence. In another vein, the respondents (gender) also noted that access to and size of farmland is also a main determinant of livelihood and resilience. This can be better explained that for the farming on a particular land to be a continuous and a longer year, long-time planning and decision on soil fertility and management options must be a major consideration. In other hand, peradventure, the issue of land ownership was not well taken care of, deforestation will set in which will eventually amplify environmental degradation

through overexploitation of natural resources and ecosystem. Therefore, individuals with large expanse of farmland/size that has settled the issue land ownership are more likely to invest more on land, productive soil fertility management, source of income diversification (agroforestry, crop-livestock integration, apiculture, horticulture, polyculture e.t.c) and also more likely to have higher resilience quickly against climate impacts. This study agrees with Weldegebriel and Amphune (2017), that land degradation and resilience erosion were caused by landlessness and small landowners. Also, Tesso *et al.* (2012) buttress the previous author by reiterating that determination of natural resource management

practices by farm size among others has been described as the best adaptation strategies for rural communities in the enhancement of resilience to shock.

Though the livestock holding may not arguably signify wealth and cultural observation in the study area, but the respondent disclosed that, being a livestock owner has been characterised as a determinant for individual livelihood and sustainability enhancement. Having domestic animals are more likely to enhance and diversify income sources. However, the economic returns would be determined by the numbers and diversity of animals they are keeping/rearing. Accordingly, rearing of goats and chicken is a priority for majority of the respondents mainly for source of income and meat production. This was done in complimenting the scarcity of cow meat due to long-distance far away from the northern part of the country. The subsequent priority reported was to have livestock production of its kind that will be easily reared and free from diseases. Raising of livestock such as goats and fowls purposefully towards the festive periods such as Easter, Christmas, and traditional festivals markedly supporting livelihood options, asset accumulation, and higher resilience in case of climatic shocks. Consequently, gender that are more livestock diversity reared, (Goats, fowls, dogs and chicken) are more likely to be resilient to climate change-induced shocks. In line with this study, a study in the Northern part of Nigeria state that asset holding such as land and livestock is a determinant to diversify income sources, income improvement and resilience to food security (Oyinbo and Olaleye, 2016) Respondents also disclosed that adaptation to and quick recovery from climate shocks and impacts, sharing of resources and management of disputes and conflicts was their engagement in social networking. (Cutters

et al., 2008). In terms of crop diversity, the respondents also disclosed that, individual planted different crops including drought tolerant species are better positioned for high productivity and relatively resilient to shock impacts than their counterpart that planted only a crop. Moreover, diversity in NTFPs gathering were also identified as a determinant factors affecting an individual food security. In effect, gender who gathers many varieties of forest resources are less likely to be impacted by climate change impact particularly food shortage/scarcity and nutritional deficiency. Thus, likely vulnerable individual are those gathered only type of NTFPs by which exhausting might exacerbating the scarcity problem in case of climate shock. This study is in agreement with Akinnifesi (2007) that both crop and forest resources diversity are the determinant of food security. Accordingly, availability of food in term of crop and forest resources can serve as food bank, nutritional deficiency correction and a buffer for climate shock or impacts. (Akinnifesi, 2007). On diversification of income sources, the respondents and key informants reported that improved standard of living, and more assets possession was synonymous with individual with multiple livelihood options. In this aspects, female discussants stated that combination of selling crops, forest resources gathering and petty business are all essential in supporting the income generating of women and female youth in the community.

Three female informants in Edik-Idim sites disclosed that packaging and re-branding of forest resources such as Afang, Hot leafs and mushrooms to the supermarkets has substantially contributed to the improvement of their standard of living, particularly children's demand such as clothes, school fees and health benefits. At large, gender disaggregated data with diversity of income

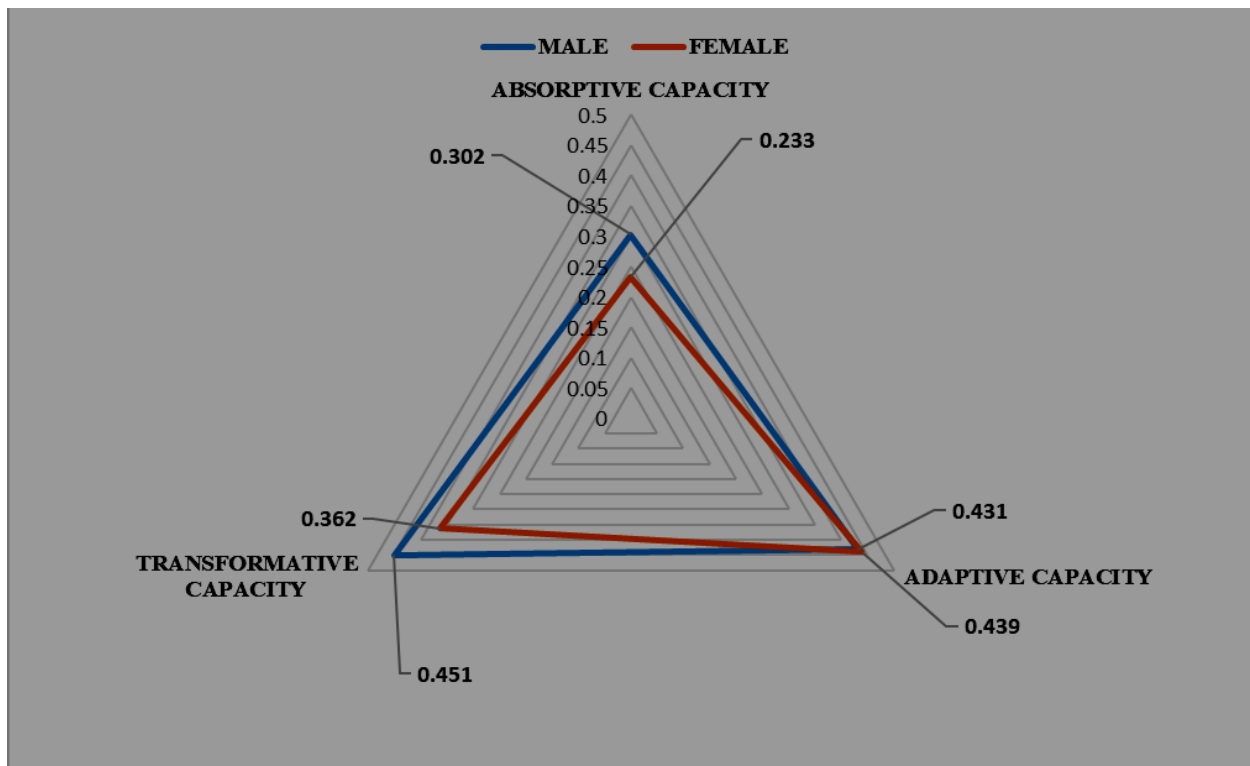


Figure 2. The resilience capacities mean index for the gender in REDD+ piloted site in South-South, Nigeria

sources are likely to be less vulnerable; instead they are more likely to recover quickly against climate-induced shock than who solely depend on a single source of income. The result of this study corroborate the study of Mengistu *et al.* (2018), which stated that income diversification is a strategy to improve income-generating ability of women in rural households. As a result, means of livelihood development in conducive economic setting and coping strategy to risks in time of hazards events are all factored by livelihood diversification measures. (Niehof, 2004).

Access to basic infrastructure: Key informants noted basically that road, school and markets are fundamental for societal developments. As a result access to basic infrastructure were nothing to write home about, because the percentage of gender (male 58%, female 65%) can access schools and

health facilities with average of 30 minutes respectively, creating unnecessarily gap that can make using of basic amenities unattractive and abandoned. In agreement with this finding, (Maryati *et al.*, 2020) state that closeness of infrastructure particularly road to the community will bring out its maximum benefits and potential for the wellbeing of the people. Hence, the people that experience shortage of access to basic infrastructures due to long distance will experience untold hardship related information enjoyment that can be an instrument of developments and opportunities to their respective lives. Also, Alinovi *et al.* (2010) argued that access to basic infrastructure is a major factor that promotes resilience to shocks through assets enhancements. Access to credit facilities such as loan was also minimal for female (45%) compare to male (76%). This also is in line with Gerlitz *et al.* (2014) which

states that socio-economic marginalization experienced was a result of insufficient physical structures that have greatly limits access to basic services such as health and credit facilities. In effect, lack of access to cash needs during crises is a major factor limiting system's resilience to climate change-induced shocks (Tesso *et al.*, 2012) Genders' resilience as measured by Climate Resilience Index and Resilience Capacities Gender analysis of livelihood resilience was done using three-capacities and Climate Resilience Index. Accordingly, the results were relatively comparable where male is better off in exposure to natural disaster and climate change, social network, income and food access, livelihood strategies, water, access to basic services and assets respectively. Female performed well only in health and socio-demographic profile (Table 3) the livelihood resilience analysis through resilience capacities more clearly differentiated the gender (male and female) in terms of their absorptive, adaptive and transformative capacities. In effect, the leading contributing factor to the resilience of gender to climate change impacts was observed to be transformative capacity with a mean index of 0.451 followed by Adaptive capacity with mean index value of 0.431 while the least is Absorptive capacity (0.302) for male category. In other vein, the leading contributing factor to the resilience of female was Adaptive capacity with mean index value of 0.439, when both Transformative and Absorptive capacities were 0.362 and 0.233, respectively (Table 3)

Relatively higher score of transformative capacity for male category is evident by the fact that larger percentage of this category has a proximity and access to schools, hospital score coupled with higher social capacity score and accumulation of assets with good provision of electricity might have contributed to higher transformative capacity among this category. In

compliment, male claimed more inclusion in elderly institutions, REDD+ management, and community governance, sustainability of peace and security of the community than their female counterpart. Consequently, management of conflicts using traditional institution might have contributed significantly to the build-up and sustenance of people both at intra-household and community level at large. In agreement with this study, studies have shown that men are knowledgeable in conflict resolution, and participation of community members in decision options facilitates information dissemination, access to basic assets during crises and enhancement of transformative capacity through institutional reforms (Frankenberger *et al.*, 2013). Also the results shows that non-inclusion of women in decision making might have infringe on their fundamental rights and encouraging gender equality. This was also ascertained by Ise and Mariaty (2018), the disparity in participation and decision making exist among gender both at intra-household and community level. Furthermore, though, conflicts resolution and management through customary law has been recognized as an acceptable options to sustain social capital among African setting (Tobkio, 2013), but neglected gender virtue might be the cog in the wheel of any community development, contrary to Frankenberger *et al.* (2013) that posted that the conflict management institutions are participatory, easily accessible and sustainable in keeping peace that eventually lead to resilience.

Relatively higher score of absorptive capacity associated with male category is evident that they have an access to early warning system, exposure to the recurrent climate shock which eventually prepared them for both climate disaster and climate change induced shock and capability to withstand the future induced-shocks. Also, ownership of large farm and

livestock, migration and social capital such as sharing of resources and belonging to Community Based Organization (CBO) as well as coping strategies might have empowered the male category to better absorb shocks compare to female category.

In line with this study, Alston (2014) disclose that men often have a quick access to climate change information and early warning system contributing to their improved preparedness compare to other vulnerable group particularly women. Other studies argue that possession of large farm and livestock enable to spread risks through diversification of income and asset accumulation opportunities (Kebede *et al.*, 2016). But care must be taken when considering the vulnerable, their enhancement in both absorptive and adaptive capacity in responding properly to changing condition as suggested by Frankenberger *et al.* (2013) using diversification of five capitals (human, financial, social, physical and economic) must be balance so as to avoid inequality as reflected in this study. On the other hand, both the resilience and sub-components mean indexed score in term of adaptive capacity was higher for female gender category than their male counterpart. It might be due to the fact that improved livelihood diversification and practices such as NTFP gathering and home garden business. Others include: planting of drought tolerant crops, saving for future, engagement in menial job, migration for greener pasture, venture into another business and social networking (CBO, Cooperative, e.t.c.). Furthermore, low Malaria Exposure and few occurrence of climate related disaster coupled with better health provision might have enabled the female to better adapt to climate change induced shocks or impact in the study location. Moreover, access to improved water, their availability with knowledge to resolve water related conflicts among female might

have also be a significant factor in enabling them to adapt quickly to any climate related shocks. In agreement with this findings, the study state that female livelihood diversification capability has been described as major factor in enhancement of gender adaptive capacity to climate related shocks particularly income diversity and livelihood capitals (Choden *et al.*, 2020). Also, according to Demuzere (2014), provision and better access to health facilities to take care of ailments such as malaria will allow the individual to have capacity and agility to respond to climate change unseen calls. Furthermore, the graphical representation of gender resilience capacity was presented in four quadrant chart using Anderson and Cardona (2013) and Weldegebriel and Amphune (2017). The graph was established based on the gender individual income per capita and the mean LRI value drawn on both X and Y axes respectively. Based on the overall mean LRI value (0.354), gender category that falls above the mean would be classified as “poor but resilient, resilient and extremely resilient”, while categories that were below the mean threshold would be classified as “rich but not resilient, vulnerable and extremely vulnerable” Likewise, based on the mean monthly income (47,520 per month or 3.96 USD per day), gender category falling to the right of the mean include rich but not resilient, resilient and extremely resilient. Whereas, gender who were poor but resilient, vulnerable and extremely vulnerable were presented in the left corner of the mean (Figure 2). Compared to daily income of 1 USD, the average daily income in this study is far above the poverty line of Sub-Saharan, Africa, indicating the collection of gender categories in the study communities were not poor. Moreover, based on this benchmark, over 70% of both male and female category were above poverty line (Figure 2). Factors such as high livelihood diversification, improved

infrastructure and capital (human, physical, social, financial and economic) might have encouraged their adaptive capacities, thereby reducing their vulnerability.

In this study, according to Focus Group Discussion (FGD) conversion to quantitative percentage, considerable proportion (53.24%) of female gender category own less than one hectare of land, while the case is different from male category (75.7%). Their also an indication that over 60% of either category in the study communities have or own more than two livestock with different varieties and the overall infrastructure has improved. Unanimously, majority of gender from both category (87.89%) agreed that multiple income dominated livelihood option and adaptation strategy has make them less vulnerable to climate change induce and vulnerability. In agreement with this finding, the other studies disclose that both land and livestock are two most relevant and known financial asset in Southwestern Nigeria, and this has been determinant of their wealth status from ages (Dillon and Quiñones, 2011). By contrast, female are more with less land and livestock on aggregate due to land tenure and ownership tussle enmeshed African setting, this might have a very negative influence on their capability to adjust to the effect of climate change and variability (Umaru Baba and Van der Horst, 2018). In light of this, natural, physical, human, social and economic capital of the gender should be a priority in any climate change adaptation plan particularly female/women due to their strong affinity with forest, constructed role and responsibility and their vulnerable status. (Basiru *et al.*, 2018). Finally, if vulnerable can be equipped with access to communication, infrastructure and support systems in form credit facilities (Dirimie and Van-Zyl, 2005), the issue of climate vulnerability would be kept to its

minimum threshold, which can eventually increase source of income and livelihood enhancement

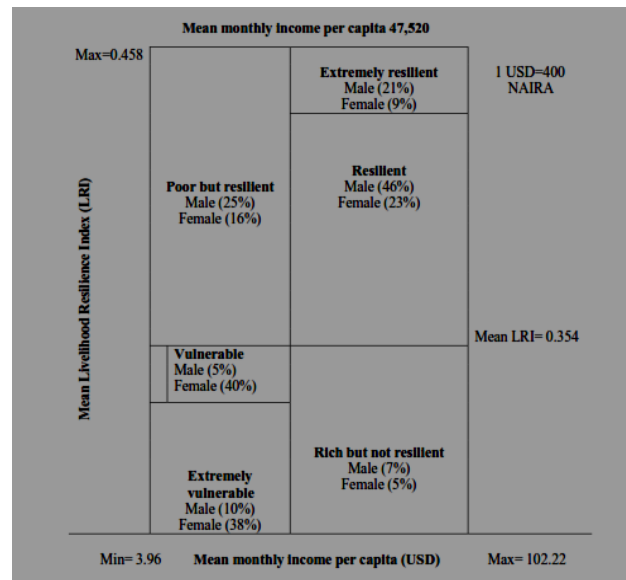


Figure 2. Resilience typologies by Genders' monthly income Conclusion In this study, Climate Resilience Index (CRI) and the resilience capacities (3Ds) framework were used to measure genders' resilience to climate change impacts, induced shocks, and vulnerability. Factors that contributed to genders' resilience to shock and climate-related impacts were well detailed and described by the adopted method. Likewise, access to and size of farmland, land ownership, livelihood diversification, infrastructure and social capital were identified to influence gender resilience to climate change induced-shock and impacts. Analysis of the above contributing factors also indicates that Males are more in possession of these attributes than Females, this makes it easy for them to adjust quickly to climate related impacts than their Female counterpart. However, the gap that exist between climate related experiences due to different exposure to re-current capital, poor access to infrastructure and basic amenities, limited livelihood diversification strategies among others have

made a sharp distinction between Males and Females in the study community. Consequently, the mean resilience score of the study community is minimal but more Females were with lower scores. Similarly, though, adaptive capacity of the Female category in form of improved access to health facilities and socio-demographic profile was slightly better, the Male category did well in other capacities assessed (Transformative and Absorptive). They were well equipped in the early warning system, social protection, climate change information, decision-making inclusion e.t.c. This contributes to their preparation, anticipate and cope with shock impacts than their Female counterparts. Furthermore, the efficacy and beauty of this study lies in the fact that the gender level was disaggregated to an individual level so as to bring out uniqueness that can be a determinant of any adaptation action plan project such as REDD+ compared to Hahn *et al.*, (2009) and Balikoowa *et al.*, (2019) where district and households-head were used. Finally, it is also imperative to strengthen all 3D's: Adaptive (Adjustment strategies), Absorptive (Buffer short term disturbances), and Transformative (System-level change) capacities to ensure long term resilience in the REDD+ community particularly Female, because of their vulnerability status and socio-economic implications.

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