

Article

Climate Change Adaptation Tools at the Community Level: An Integrated Literature Review

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Abstract: The negative impacts of climate change are experienced at the global, regional and local levels. However, rural communities in sub-Saharan Africa face additional socio-political, cultural and economic challenges in addition to climate change. Decision support tools have been developed and applied to assist rural communities to cope with and adapt to climate change. However, poorly planned participatory processes and the lack of context-specific approaches in these tools are obstacles when aiming at strengthening the resilience of these rural communities. This paper uses an integrated literature review to identify best practices for involving rural communities in climate change adaptation efforts through the application of context-specific and culturally-sensitive climate change adaptation tools. These best practices include the use of a livelihoods approach to engage communities; the explicit acknowledgement of the local cultural do's and don'ts; the recognition of local champions appointed from within the local community; the identification and prioritisation of vulnerable stakeholders; and the implementation of a two-way climate change risk communication instead of a one-sided information sharing approach.

Keywords: climate change adaptation tools; design considerations; rural communities; sub-Saharan Africa

1. Introduction

Climate change-induced natural hazards increase both in magnitude and frequency, thereby threatening the stability and sustainability of social-ecological systems. Society has to adapt its economic, institutional, political and social practices in order to protect the physical environment on which it depends from anthropogenic climate change [1]. Global responses to man-made climate change focus on adaptation and mitigation efforts. Planned adaptation efforts are geared towards minimizing the risk of an already occurring climate change, while taking advantage of associated opportunities [2]. Incidental adaptation [3] is unplanned and its actors might not even be aware of it. Mitigation involves the reduction of anthropogenic greenhouse gas emissions, which has recently gained momentum at the global level thanks to the so-called Paris Agreement [4].

All actors and sectors have to adapt to and mitigate the negative impacts of climate change [1,5]. However, climate actions are fraught with complexities and uncertainties [6] which has led to the emergence of decision support tools (DST) in the fields of environmental management [7], disaster risk reduction [8–10] and impact assessment [7,11–18]. These tools use a transdisciplinary approach

that fosters collaboration between scientists, practitioners and local communities in order to address climate change. Transdisciplinarity (TD) is an approach that involves different disciplines as well as scientific and non-scientific stakeholders collaborating to address socially relevant problems, through joint knowledge integration and mutual learning. The aim is to produce “socially robust knowledge” that is both scientifically valuable and relevant for societal progress [19–23]. However, the uptake of decision support tools by non-scientific stakeholders (local communities) is challenging due to many factors (including prohibitive financial cost, top-down design of the tools, poorly designed participation processes and technical complexity). This explains the low uptake of decision support tools by local communities, especially in developing countries [7,18].

Climate adaptation tools have been developed and applied by bilateral, multilateral and non-governmental development organizations [24,25]. The majority of these tools are developed by European and North American institutions including the United Kingdom Department for International Development (DFID), the United States Agency for International Development (USAID) and international not-for-profit organizations such as the Catholic Relief Services, Red Cross/Crescent and ActionAid [26]. However a nexus of historical, socio-political, cultural and economic factors [7] may hinder the effective use of climate adaptation tools by rural communities in developing countries.

This paper uses an integrated literature review to highlight key contextually-driven and culturally-sensitive factors that should ideally be acknowledged when designing and applying climate change adaptation tools in rural communities in sub-Saharan African.

2. Methodology

First, the contextual factors we report on in this paper were deduced from scientific literature reporting on climate change adaptation at the rural community level in the global South. These literature sources were gathered through an integrative literature review process, which describes and synthesizes knowledge from past empirical and/or theoretical literature sources [27,28]. The objective of this integrated literature review is to target representative literature sources rather than drawing a comprehensive review as is the case in a systematic literature review [27,29].

Second, we identified and accessed climate change adaptation tools ($n = 49$) through online searches using a range of websites of international development organizations (such as the Danish International Development Agency (DANIDA), the German Technical Cooperation Agency (GTZ), United Nations (UN) agencies, the United States Agency for International Development (USAID), the UK Department for International Development (DFID), the World Bank etc.) as well as through Google web browsing. We used the following key search words: “Climate Change Adaptation Tools” (see Appendix A for a full list of considered climate change adaptation tools).

Third, a Boolean search was conducted on Google Scholar between January and October 2017 using these key search words: Local knowledge AND Climate change AND Africa; Livelihoods AND Climate change adaptation AND Africa; Community based adaptation AND climate change; Community adaptation AND Climate change; and Participatory climate change adaptation. This search yielded scientific literature ($n = 70$) reporting on climate adaptation specificities in a rural community context in the global South.

Fourth, the literature was analyzed and synthesized through qualitative content analysis to deduce the contextual factors that should be considered when designing and applying climate adaptation tools in rural communities in the global South. Qualitative content analysis systematically describes the meaning of qualitative data [27]. This method is both systematic, reductionist and flexible. It is systematic in that it follows a step-by-step iterative process. It also reduces large volumes of data by deriving meanings of passages and elevating them to higher levels of abstraction through a coding frame. Its flexibility lies in its ability combine varying portions of concept-driven and data-driven categories within any one coding frame [30]. Hence, this study organized large volumes of qualitative data into themes and sub-themes that form the structure of this paper. The themes are the following:

- Planning, designing and implementing climate change adaptation tools at the rural community level
- Considerations when planning the participation process at the rural community level
 - Context-specificity
 - Socio-economic and Livelihoods context*
 - Socio-political and cultural context*
 - Objectives-clarify and Stakeholder identification and management
 - Clarifying the objectives of the participation process*
 - Identifying stakeholders for the participation process*
- Considerations when designing the participation process at the rural community level
 - Oral narratives
 - PRA, CRA and VCA tools and techniques
 - Participatory mapping
- Considerations when implementing the participation processes at the rural community level
 - Risk communication
 - Information-sharing*
 - Extraction*
 - Participatory modelling and scenarios building at the rural community level
 - Participatory modelling*
 - Scenarios building*
- Assessing the sustainability of climate adaptation action plans

Fifth, a supplementary backward snowballing exercise was conducted, which revealed scientific literature publications by leading authors in Environmental Decision Support Systems (EDSS) and Environmental Decision Support Tools (EDST) including Matthies et al. [31], McIntosh et al. [7] and Sullivan [32]. In addition, articles from leading journals on indigenous knowledge science, including *Climatic Change* and *Indilinga: African Journal of Indigenous Knowledge Systems*, were considered in the analysis.

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Sixth, we selected reports emanating from international development cooperation organizations from the following sources:

- Reports on indigenous knowledge practices: ACIA [33]; IPCC, [5]; IUCN, [34]; UNESCO, [35]; and FAO [36].
- Conference proceedings on environmental modelling: International Congress on Environmental Modelling and Software (iEMS). (URL Link: <http://www.iemss.org/sites/iemss2016/>).

Lastly, we excluded books and articles published outside of the sub-Saharan African context and those that were not published in English.

3. Planning, Designing and Implementing Climate Change Adaptation Tools at the Rural Community Level

Based on the integrative review outlined in Section 2, this section discusses the various factors that should be taken into consideration when planning, designing and implementing climate change adaptation tools in a rural community context in sub-Saharan Africa.

3.1. Considerations When Planning the Participation Process at the Rural Community Level

3.1.1. Context-Specificity

The majority of climate adaptation tools is influenced by Western worldviews [37]. The importance of context is highlighted by empirical studies on climate adaptation in Africa (see [6,38–47]). In the following paragraphs, we discuss the contextual dimensions that influence climate adaptation efforts in sub-Saharan African communities.

Socio-Economic and Livelihoods Context

The majority of sub-Saharan African citizens reside in rural areas and they are directly dependent on agrarian activities including subsistence rain-fed agriculture [38,42,48,49] and livestock rearing [50,51]. Rain-fed agriculture is especially susceptible to climate change [48]. The vulnerability of rural communities is further exacerbated by non-climatic stressors such as poverty [43] and the HIV/AIDS pandemic [47,50]. Hence, climate change and development are interconnected [52]. It is this reality that compels the incorporation of socio-economic and livelihoods considerations in the design and implementation of climate change adaptation tools. This reality has now started to influence the work of development cooperation organizations [6]. Framing climate change adaptation efforts within a socio-economic and livelihoods context has many benefits, including increased acceptability and ownership by rural communities, which is key to overcome public resistance to perceived external interference. Moreover, this inclusive approach ensures that resources are devoted to the socio-economic development of rural communities as climate adaptation does not merely bring challenges but also socio-economic opportunities [2]. Such opportunities are recognized and institutionalized at the national, regional and local levels. For example, the growth and development strategy of South Africa-the National Development Plan 2030-prescribes that the government and its agencies (including those tasks with environmental protection) have to address the triple challenges of inequality, poverty and unemployment [53]. This is a reflection that local communities' priorities mostly revolve around 'everyday problems' and their constant struggle with their maintenance of livelihoods [6].

Socio-Political and Cultural Context

“What people know is influenced by (and influences) their beliefs, lifestyle and behavior. To understand local knowledge one has to understand and account for people’s ways of knowing (i.e. different knowledge types) as much as their practices and beliefs, perceptions and values. Understanding all this is crucial because it can explain why people do things the way they do” [54] (p. 21).

This quote illustrates the importance of local beliefs, customs and traditions, as these are the lenses through which rural communities see the world. These lenses govern the decisions they make on a daily basis. Such decisions include climate adaptation and mitigation actions using information derived from their own local climate monitoring mechanisms. Simply put, local knowledge is defined as institutionalized knowledge that has been accumulated from interactions with the local environment over a long period of time and that has been passed on from one generation to the other by word of mouth” [45] (p. 792). Local knowledge serves as a local framework for decision making in rural and urban communities [43,45,46,55,56]. Despite this, Nyong et al. [45] (p. 794) notes that “development

projects are known to have been created, funded and managed by outside resources and introduced into rural communities with the hopes and promises of impacting lives. These projects did not take into consideration the culture of people and resulted in low participation and success rates”.

The limited success of many climate-centered development cooperation projects does not come as a surprise when decision makers (policy makers, scientist and practitioners) apply adaptation tools that are poorly designed to engage local communities [26]. These decision makers are often ‘out of touch’ with the realities of rural life. Van Aalst et al. [6] found that decision makers are often baffled by the risk and adaptation priorities of local communities which are often shaped by the immediate socio-economic, political and cultural contexts [46,55,56].

Elders are sought after as custodians of local knowledge due to their age and long-term interaction with their local environment [37,39,41,42,45,53–55]. As such, they are seen as experts, gatekeepers and go-between in local decision-making matters. Their position of authority is confirmed by purposive sampling targeting community elders in indigenous knowledge studies conducted by Nkomwa et al. [38]; Ifejika-Speranza et al. [43]. Their communities rely on them to pass on specialist local knowledge on climate monitoring, adaptation and mitigation to the younger generations [54]. As gatekeepers, community elders are the go-to individuals when planning development cooperation work in their local communities. The role of community elders as go-betweens has many aspects including in organizing and leading traditional rituals such as rain making ceremonies. Traditional beliefs are very important to rural life and together with local knowledge, form a traditional institutionalized decision-making framework. For example, Egeru [40]; Mengistu [42]; Ifejika-Speranza [43]; Roncoli et al. [46]; Lemos et al. [54] and Luseno et al. [55] found that traditional beliefs were significant factors affecting the uptake of local and scientific climate forecasts by rural communities. Such beliefs reiterate the importance of acknowledging different worldviews, particularly those that are not shaped by Western knowledge. Such worldviews emerge from the local knowledge of rural communities accumulated overtime and based on interactions with their environment. These alternative worldviews should be acknowledged by development cooperation practitioners designing and implementing climate adaptation tools in rural communities (see [37]).

In this regard, the roles of community elders have to be acknowledged and their participation as local champions and knowledge brokers in the development of decision support tools should be encouraged. A ‘local champion’ is an individual who is trained and appointed from within an organization to maintain user engagement with the decision support tool(s) [43] (p. 279). Similarly, local experts within rural communities can be ‘trained’ and ‘appointed’ to work alongside community members, scientist and practitioners using mediums suitable for a local audience including the local language [43,56].

The institutionalisation of climate change planning and management in eThekweni municipality (City of Durban) was spearheaded by the head of the Environmental Management Department after participating in a semester-long environmental management program at Brown University in Rhodes Island (USA) in 2004. This local champion established the Municipal Climate Protection Program (MPCC) [57] (p. 527) that commissioned assessment studies on the local impacts of climate change on various sectors and actors in the eThekweni municipal area entitled *Climatic Future for Durban*. The outcomes of the impact assessment studies laid a solid foundation for localised adaptation plans highlighted in the *Headline Adaptation Strategy* and later the Municipal Adaptation Plans (MAPs). The MAPs are “sectoral adaptation plans focused on the biodiversity, health, water and disaster management sectors” [58] (pp. 1, 62) resulting in forty-seven (47) discrete adaptation options across these sectors [59]. This example, although set in an urban context, can get us thinking about the lessons we can draw from the involvement of local champions in adaptation endeavours. Empirical studies are still required on the experiences of involving local champions in a rural context.

The case study referred to in the previous paragraph is evidence that involving a local champion can encourage the take up of climate adaptation efforts at the local level.

3.1.2. Objectives-Clarity and Stakeholder Identification and Management

Clarifying the Objectives of the Participation Process

Clarifying the objectives at the beginning of any climate adaptation effort helps with identifying stakeholders and managing their expectations. Local communities have the right to know and understand the purpose of any climate adaptation effort in their community. This will enable them to gauge the level of their involvement and/or commitment. By doing so, local communities can also develop realistic expectations regarding the benefits they can derive out of such adaptation efforts. Benefits do not always entail material gains but can revolve around new knowledge, skills and techniques. We have developed a participation typology that can be useful in guiding the planning, development and implementation of climate adaptation tools. The typology is presented in Table 1 and explained in a subsequent paragraph.

Table 1. Typology for participation in the context of community-based climate change adaptation.

Stages of Participation (i.e., Degree of Participation/Rungs of Arnstein's Ladder)	Main Purpose of Participation (i.e., Objectives of Participation)	Characteristics of the Stage (i.e., Direction of Communication Flows)	Type of Participation (i.e., Theoretical Basis/Pragmatic Participation etc.)
Information-sharing	Information	Information flows in one direction from the practitioners to the local community	Passive participation
Consultation	Extraction	Information flows in one direction from the local community to the practitioners	
Co-decision	Co-development (characterized by reciprocity of actions)	Flow of information is arranged in both directions: from the local community to the practitioners and vice versa- in a process of shared learning	Interactive participation
Decision	Ownership	The local community becomes responsible for the planning, design and implementation of climate adaptation action plans	Active participation/ self-organization/ citizens control

Source: adapted from Nkoana et al. [20].

The typology for public participation can include subject (objective) of participation, communication (information and/or extraction), type (passive, interactive, and/or active) and the stages of participation. The types and objectives of the projects at-hand determine the type and the degree of participation by local communities [60]. This is evidence that the 'one-size-fits-all' approach does not work in participation. It is for this reason that the authors have developed a participation typology for climate adaptation tools. The purpose of participation within this is sharing information (scientific data and local observations) about climate change, consultation to build consensus about the reality of climate change between practitioners and the local community, co-development of climate adaptation action plans and lastly, decision about implementation and ownership of the adaptation action plans by the local community. This typology of community-based climate adaptation is based on all three participation principles namely normative, substantive and instrumental [60,61]. The normativity principle argues that the local communities have the right to participate in climate adaptation efforts in their localities. The substantive principle posits that the quality of the participatory process is improved with the involvement of various players including the local community members. The instrumental principle states that participation improves trust and acceptance of subsequent decisions [56]. The participation typology also covers crucial areas of participation including: stages, purpose, characteristics and type of participation. Practitioners should consult this participation typology when planning, designing and implementing climate adaptation tools with local communities.

Identifying Stakeholders for the Participation Process

Practitioners can move on to classify stakeholders once the objectives of the climate adaptation effort have been established. Stakeholder classification allows to identify groups that are particularly vulnerable to climate change impacts and variability, Nkoana et al. [26] have developed a stakeholder classification typology presented in Table 2. This stakeholder classification typology consists of top-down and bottom-up approaches. The top-down approaches are exclusively initiated by practitioners and the bottom-up approaches are pioneered with the assistance of local communities.

Table 2. Common stakeholder classification typologies.

Classification/Criteria Used (Models/Methods)	
Stakeholder’s levels of interest and influence (Interest & Influence Matrix) [62]	
Competition or cooperation [63,64]	
The strategic and the moral stakeholder [65]	
Stakeholder’s potential powers to threaten or cooperate with the organization (cooperation and threat) [66]	
The primary (with formal relationships) and the secondary (without formal relationships) [67]	Top-down approaches “Analytical Categorization”
Power, legitimacy and urgency (Stakeholder Salience Model) [68]	
Network density and the centrality of the organization focus [69]	
Power of influence, impact on the organization and affinity with organizational objectives [70]	
Power and the level of interest [71]	
Degree stakeholders affect or can be affected by problem or action-with a Rainbow Diagram [72]	
Classical stakeholders, stakewatchers, stakekeepers [73]	
Discourse Analysis-with a Q methodology [74–79]	Bottom-Up “Reconstructive Methods”

Source: Nkoana et al. [20].

Once the stakeholders have been classified using one or a combination of the classification typologies, the next step is to identify stakeholders that should be involved in the climate adaptation effort. Reed et al. [16] summarizes the methods that can be used to identify, differentiate, categorize and investigate relationships between stakeholders (see Table 3).

Table 3. Summary of various top-down and bottom-up methods used to identify, differentiate, categorizes and investigate relationships between stakeholders.

Identify Stakeholders	Differentiate & Categorize Stakeholders	Investigate Relationships between Stakeholders
Self-selection	Top-down Analytical Categorization using:	
Expert Opinion	Interest-Influence matrices	
Focus Groups	Radical Transactiveness	
Semi-structured interviews	Bottom-up Stakeholder-led Stakeholder	Actor-Linkage matrices
Snowball Sampling	Categorization:	Social Network Analysis
Demographic data (age, gender, nationality, residence, occupation etc.)	Card Sorting	Knowledge Mapping
	Discourse Analysis	
	Q Methodology	
	Q sorting	
	Strategic Perspectives Analysis	

Source: Nkoana et al. [20].

3.2. Considerations When Designing the Participation Process at the Rural Community Level

The planning phase is followed by the actual design of the participation process. Local communities have to be involved in all the stages of environmental management initiatives in their localities [35]. Full participation can be realized through the integration of local and scientific knowledge systems through forms and formats that are familiar to the local communities. This approach is crucial when considering the skepticism surrounding 'standalone' local knowledge systems [42,43]. Such skepticism compels practitioners to work alongside local communities to merge these two knowledge systems. However, the process of involving local communities in such efforts obliges us to think critically about the design of these interventions-including on these forms and formats. A few studies exist on the forms and formats for soliciting local knowledge (see [6,80]) because this field of study is still in its embryonic stage. As a consequence, we focus on Oral narratives, Participatory Rural Appraisal (PRA), Community Risk Assessment (CRA) and Vulnerability and Capacity Assessment (VCA) tool and techniques and the use of Visual images to engage local community members in climate adaptation efforts.

3.2.1. Oral Narratives

Narratives are used to solicit local knowledge seen through cosmological and weather observations and changes in the local environment, flora and fauna (see Table 4 below). These changes and observations include, erratic behaviour and irregular migration of animals, variable rainfall, wind direction, moon cycles, encounters with rare and exotic species, increased mosquito numbers and frequent cases of water-borne diseases and malaria outbreaks [38,40–42].

3.2.2. PRA, CRA and VCA Tools and Technique

However, narratives are only a small part of participatory techniques that can be used to involve local communities in climate monitoring, adaptation and mitigation efforts. Dominant participatory forms and formats such as Participatory Rural Appraisal (PRA) [81,82], Community Risk Assessment (CRA) [6] and Vulnerability and Capacity Assessment (VCA) [83] enjoy widespread application in international and regional NGOs sectors doing disaster preparedness work in rural communities in over eighty (80) countries across the world. Van Aalst et al. [6] (p. 166) note this trend that "international NGOs such as Oxfam, ActionAid, Save the Children, Christian Aid, Tearfund; developing country NGOs such as Citizen's Disaster Response Centre (Philippines); Third World networks such as La Red (in Latin America), PeriPeri (in southern Africa), Duryog Nivaran (in south Asia); and other organizations like the Asian Disaster Preparedness Centre, Disaster Reduction Unit, as well as umbrellas like the ProVention Consortium and the UN ISDR (International Strategy for Disaster Reduction)" use grassroots strategies that share elements of CRA, VCA and PRA. These elements involve place-based and bottom-up approaches that increase the resilience of rural communities through disaster preparedness and livelihoods diversification. Most, if not all, of these NGOs and multilateral and bilateral development cooperation organizations use document-based decision support tools-in the form of climate change adaptation and disaster preparedness tools-with PRA leaning methods and tools. Sometimes the tools are not exclusively directed at climate change adaptation and mitigation but also at disaster preparedness.

These methods and tools can include but are not limited to, transect walks, participatory mapping (resource and social maps), geographic maps (topographical maps), concept mapping, Venn diagrams, seasonal calendars, historical timeline and trend-line, problem tree, community hazard and vulnerability scoring and ranking matrices, semi-structured interviews, focus group discussions, mobility diagram, wealth ranking, gender daily calendars and future-backward scenarios analysis [81,84] and so forth.

The use of such participatory methods and tools is resource intensive. However, it is key to apply these tools with a large number of community members, in order to derive meaningful and scalable results [6]. Low-tech methods and tools are crucial for engaging rural communities despite

their resource intensity. In fact, computer-based environmental decision support tools are not cheap either and have been known to intimidate end-users including the educated elite [18].

3.2.3. Participatory Mapping

Participatory mapping is a common technique used in CRA, VCA and PRA exercises with rural communities. Visual images of aspects relevant to the local community are often the end-products of focus group activities using such participatory mapping techniques. However, Bell and Morse [85] warn about the uncritical use of participatory mapping and suggest a ‘Subjective Assessment of Group Analysis’, an assessment framework consisting of indicators to improve the quality of the mapping process and results, which, in turn, increases the credibility of the participation process and method applied (see Table 2 in [85]).

3.3. Considerations When Implementing the Participation Processes at the Rural Community Level

Participation of local communities should take center stage when implementing climate adaptation tools. Participation is important for normativity, substantive and instrumental reasons but also because solutions to wicked problems will require the involvement of those that understand the local context and cultures within which such changes occur. Climate adaptation tools should involve local communities through risk communication, vulnerability and impact assessment, adaptation assessment and sustainability assessment. There are claims that the participation of local communities might lead to high quality and robust decision-making that increases the resilience of social-ecological systems to climate change [61,86]. Nkoana et al. [26] found that climate adaptation tools are poorly designed to involve rural communities in adaptation efforts. We highlight the important considerations that should be heeded when implementing climate adaptation tools in rural communities in sub-Saharan Africa.

3.3.1. Risk Communication

Communication of climate change risk is an important step when implementing adaptation tools [42,87,88], as local communities have to perceive risk before they can act to protect themselves against it. However, climate change is an abstract concept and is often considered to be a remote problem of little personal concern to many individuals [40,87–89], despite the fact that unplanned or incidental adaptation is already occurring in many rural communities [38,40,41,45,90]. Risk communication can bridge the gap between incidental and planned adaptation in rural communities in sub-Saharan Africa. However, careful considerations have to be heeded when designing risk communication messages in a rural context. For example, risk communication efforts have to demonstrate the localized impacts of climate change on rural communities. In doing so, practitioners have to recognize that climate risk communication is a two-ways process characterized by information-sharing and extraction [26]. Information-sharing is when practitioners share scientific data on climate change hazards and impacts with the local communities. Extraction happens when practitioners solicit local knowledge about climate change hazards from rural communities. This two-way dialogue is crucial for building consensus about the reality of climate change hazards and impacts at the local community level. Linking local knowledge to climate change science is a viable way to involve local communities [43]. Additionally, this two-ways process creates a participation platform that is important for instrumental, normativity and substantive reasons [60,61].

Information-Sharing

Mengistu [42] points out that improving access to climate information is an important first step to improving the livelihood of people affected by climate change. Also, climate information is crucial in the context of “low grassroots awareness or campaigning on issues of climate change” [6] (p. 170). However, there are many factors that have to be taken into account when delivering a climate risk information message intended at local communities, especially since climate information

which feed into decision-making is not suitable for most resource poor communities if created for a developed country's context [42]. These factors can include the various media of communication that are accessible to local communities, the participation platforms, and tools and the socio-political and cultural context including the language of the communication that is understood by the local communities. In this regard, practitioners conducting a climate risk information-sharing exercise should link their message with the day-to-day activities of the rural community members. This will make the climate risk message of local and individual relevance. Nicholson-Cole [88] suggests a clear criterion that can be useful in the visual communication of climate change to rural communities. An important message that can be derived from this author's work is that climate risk communication has to resonate with rural communities' experiences and motivate-rather than discourage them-to make adaptation actions, of course, this is also dependent on objective versus subjective (individual and collective) adaptive capacity of the local community members. Some of Nicholson-Cole's criterion including using locally sourced 'emotive' imagery; the careful design of risk communication message that does not "end up triggering defensive psychological responses, leaving the audience desensitized with a sense of 'issue fatigue' or leading to feelings of powerlessness to do anything to reduce the causes of climate change" [88] (p. 260) or anxiety and fatalism [6]; understanding of the local community context including customs and culture that act as socio-psychological lenses through which local communities interpret risk communication messages; and the use of a simple and easy to understand communication language [88]-particularly in rural communities with low literacy levels-a sobering reality for many sub-Saharan African countries. Information-sharing inevitably involves a top-down approach that is triggered and led by outsiders-an oxymoron in a process that is supposedly bottom-up. But Rojas Blanco (quoted in [6]) reassures us that "*Not only do local communities have the right to be informed about the ramifications of climate change but also they are capable of generating solutions likely to work at their level*".

Extraction

Extraction involves exercises in which practitioners solicit information and knowledge about climate change from local community members [26]. Local knowledge is often associated with rural communities, however, urban dwellers can also possess such knowledge as Codjoe et al. [39] found out. In this regard, there is a wealth of evidence on the role of local knowledge in incidental and planned climate adaptation in rural and urban communities all over the world [41]-including those in sub-Saharan Africa [38–40,42,43,45,90–92]. Local knowledge exists in many different forms. However, local ecological knowledge is the popular form that is associated with the natural environment. In this regard, local ecological knowledge refers to common and specialist knowledge that is location and culture-specific, is acquired through long-term interaction and observation of the natural environment (i.e., changes in flora, fauna, sea and weather conditions and astronomy constellations) and is passed down through oral traditions from one generation to another [39–42]. Local ecological knowledge-a form of local knowledge-is concerned with how people manage their natural resources. Just like other forms of local knowledge, local ecological knowledge is passed on from generation to generation through *word of mouth* [39–42]. Appreciating the inter-generational transfer of environmental observations through *narratives* represents an entry point on how climate adaptation tools can engage local communities in planned adaptation efforts [42], a subject we raised in the previous sections. Additionally, local ecological knowledge can be an important source of environmental observations particularly in African regions with limited instrumental records [41]. Such a role is crucial considering that most climate information provision tools are limited to international, regional and country-level spatial resolutions [43] and that Africa cannot wait for such data collation instruments to be availed as climate change is already obliterating its social, cultural and economic systems. It is in this context that local ecological knowledge can provide valuable information for climate adaptation efforts that are cost-effective, participatory, locally-relevant and are sustainable [38,40]. As such, participation

processes (including the methods and platforms) for soliciting such *environmental change narratives* become very important when implementing climate adaptation tools.

3.3.2. Participatory Modelling and Scenarios Building at the Rural Community Level

The risk communication exercise is subsequently followed by participatory modelling and scenarios-building which practitioners and the local community members use to draw up climate adaptation action plans.

Participatory Modelling

Computer-based and document-based modelling are two common types of modelling used by various actors and sectors in development planning and environmental management across the world. Computer-based modelling is used to simulate different scenarios and provide climate change information particularly as they pertain to large spatial and temporal scales (e.g., IPCC Global Circulation Models, weADAPT etc.). Computer-based modelling can be participatory although it mainly requires the input of quantitative data rather than qualitative narratives of the future emanating from the local community itself. The selection of such quantitative data is guided by principles, hypotheses and assumptions derived through a subjective and qualitative process of desirable or undesirable alternative futures defined by the concerned stakeholders [15]. Exercises on computer-modelling with stakeholders have been conducted in large-scale projects such as PHOENIX, VISIONS for a Sustainable Europe (VISIONS project), Urban Lifestyles, Sustainability and Integrated Environmental Assessment (ULYSSES), and Climate Options in the Long-term (COOL) projects [18]. Findings from these projects suggest that stakeholders struggled with computer models and experienced single loop learning only (fact acquisition and consequences of actions) but did not experience triple loop/social learning that foster behavioural change [18] despite the fact that computer-modelling exercises can multiple learning opportunities.

In 2009, Mahmoud and colleagues proposed a framework for scenarios development and application that features full stakeholder participation and iteration throughout. Despite this, calls for simplified but credible model-based approaches continued [61]. These efforts are partly driven by the recognition that computer-models can be intimidating to local communities, including even the educated elite. Others have criticized computer models as been an authoritative form of knowledge that might discourage the participation of local and indigenous people. Critics add that computer models can lead to streamlining of cognitive frames and uniform forms of knowledge [18] which is the direct opposite of local ecological knowledge. Also, the cost of hardware, software and trained personnel is out of reach for many sub-Saharan African countries and more so for rural communities.

Small-scale or narrative scenarios can be developed and applied without the aid of computer models. This has been the trend followed by development cooperation organizations applying document-based climate adaptation tools in rural communities [26]. These paper-based climate adaptation tools use document-based participatory modelling to illicit small-scale (spatial and temporal) scenarios. Small-scale scenarios, at a local community level, use hands-on participatory tools that include, rich pictures, companion modelling, group model building and the future-backward scenarios analysis tool. Critical development and application of such tools is crucial although they are not high-tech. The critical development and application of small-scale scenarios hinges on the ability of practitioners and local communities to reflect on the quality and rigor of such a process. Such due diligence increases the credibility and acceptability of narrative scenarios as a decision-making technique.

Scenario Building

The Intergovernmental Panel on Climate Change [93] defines scenarios as coherent, internally consistent and plausible description of possible future state of the world. It is not a forecast, rather,

each scenario is one alternative image of how the future can unfold. Scenarios can be either exploratory or anticipatory (see Mahmoud et al. [15] for an in-depth definition).

Table 4. Scenarios type.

Scenarios	Exploratory	Future trends	Projective Prospective
	Anticipatory	Policy responsive	Expert judgement Stakeholder defined

Source: Authors' own synthesis.

According to Mahmoud et al. [15] (p. 799) “scenarios are typically used in the context of planning over long time horizons or short-term decision making that has long-term consequences” in fields such as climate change adaptation and mitigation. However, application of scenario planning in the environmental management is a new phenomenon that began in the mid-2000s and case studies of such applications can be found in Baker et al. [94], Santelmann et al. [95], and Steinitz & McDowell [96]. Scenarios are important in environmental management, particularly in climate change adaptation, because they create a platform for decision makers and rural communities to work together and create solutions that are politically acceptable, also, this interaction allows the integration of scientific know how with local ecological knowledge. In this way, scenario planning guides and supports informed decision-making. This process of decision-making can involve exercises that challenge conventional thinking and assumptions leading to social learning [15,26]. Reframing conventional and commonly held assumptions, beliefs and practices is required if we are to change the patterns of consumption and production that are destroying the atmosphere. We hope that such a paradigm shift will redirect humanity towards sustainable development practices.

The majority of climate adaptation tools that were critically assessed by Nkoana et al. [20] are ‘not explicit’ on whether or not they conduct scenarios analysis with community members. The limited application of scenario planning in environmental planning and management is not only due to its novelty but also to the lack of guidance on how to conduct scenario planning process—a hurdle that Mahmoud et al. [15] attempt to overcome by proposing a ‘formal framework for scenarios analysis’. Important lesson on scenarios planning can be drawn from Mahmoud and colleagues’ work by practitioners conducting scenarios planning with local communities in a developing country context.

This framework highlights the fact that narratives or mental images can be used to develop qualitative description of scenarios for small-scale systems such as a rural community. Narratives or storylines are a communication medium used by local communities to pass on knowledge from one generation to another. Using this communication medium will encourage the participation of local communities in scenarios planning in climate adaptation efforts. Small-scale scenarios planning can be a useful collaboration, communication and planning platform for practitioners and local communities engaged in climate adaptation work. This is in direct contrast to computer-based modelling that requires the input of quantitative data and is used to produce alternative scenarios for large-scale systems such as the Global Circulation Models (GCMs) of the IPCC to predict the impact of increasing concentrations of harmful greenhouse gases in the atmosphere by the year 2100 [97].

3.4. Assessing the Sustainability of Climate Adaptation Action Plans

An assessment of the sustainability of climate adaptation plans is a necessary step considering what Mahmoud et al. [15] (p. 799) calls “... *planning over long time horizons or short-term decision making that has long-term consequences*”. Indeed, climate adaptation action plans should be vetted against increasing the maladaptation of the intended beneficiaries of development cooperation efforts. This is crucial due to the over reliance of rural communities in sub-Saharan Africa on climate sensitive natural resources that renders them vulnerable to the negative impacts of climate change. It is this reality that compels development cooperation organizations to implement climate adaptation efforts that

mainly focus on “addressing the drivers of vulnerability” through the diversification of livelihoods, improvements in literacy, advocacy on human rights and HIV/AIDS projects and so forth [26,98]. However, the caveat with this logic of pursuing climate adaptation through socio-economic means might lead to maladaptation, defined by the World Bank [2] as an action or process that increases vulnerability to climate change-related hazards. Maladaptive actions and processes may include planned development initiatives that deliver short-term gains or economic benefits but lead to exacerbated vulnerability in the medium to long-term. Climate adaptation tools should aim to realize win-win adaptation, no-regret adaptation, and/or low regret adaptation [3] in order to minimize maladaptation. With this in mind, climate adaptation tools should incorporate a component of sustainability assessment as a final stage prior to the implementation of adaptation action plans. Hugé et al. [99] discusses the effectiveness of sustainability assessment in improving the quality of development cooperation efforts. Such empirical studies can feed into the incorporation of sustainability concerns in climate adaptation tools—thus improving the quality of collaboration between practitioners and the local communities.

4. Concluding Remarks

Climate change is threatening the livelihoods of rural communities in sub-Saharan Africa. These negative impacts of climate change are superimposed by non-climatic stressors including HIV/AIDS and poverty. Rural people continue to make decisions on a daily basis to secure their livelihoods and to protect their culture. Bilateral, multilateral and non-governmental organizations have developed and applied climate adaptation tools to support decision-making processes within rural communities in the global South. However, these adaptation tools are sometimes underpinned by worldviews which are highly divergent from and not always compatible with, the perspectives of the rural communities they seek to help. This is one of the causes that result in the limited participation of rural communities in climate adaptation efforts.

We conducted an integrative literature review exercise to identify best practices for involving rural communities in climate adaptation efforts initiated by development cooperation practitioners. We subsequently pointed out important considerations when planning, designing and implementing adaptation tools in pursuit of full participation and sustainable climate adaptation—that is, adaptation that minimizes maladaptive practices. Such a process begins with acknowledging the context within which rural communities are embedded. Issues of context can highlight daily struggles to put food on the table. These struggles preoccupy the everyday lives of rural community members on the African continent and should serve as an entry point for discussions about climate adaptation. Practitioners have to involve elders as local experts, leaders and gatekeepers when identifying stakeholders to partake in climate adaptation efforts. These elders might hold the key to the success of any adaptation effort because they are respected by the members of their own community. The training and involvement of a local champion as a part of the steering committee can assist outsiders (practitioners) to make sense of the cultural do’s and don’ts within the rural community. The local champion can assist to communicate the objectives of the adaptation effort to the rural communities in a language they understand. Soliciting their informed consent in this manner will enable the local community who are potential participants to gauge the level of commitment in the adaptation effort and to manage their expectations.

The local knowledge of community members about development and environmental protection is an important aspect of context. It is well documented that rural communities all over the world observe the changes in nature. They use techniques such as climate monitoring to determine cultivation seasons and the culling of livestock and so forth. Their interaction with and knowledge of their surrounding environment shapes the worldview of members of these rural societies. These worldviews constitute the lenses through which members of a society, collectively or individually, experience and interpret the world around them. Unless they come from the same culture, often, practitioners cannot fully understand these local worldviews as they are the lived experiences of rural people but efforts should

be made to solicit such knowledge from these communities. In the same vein, rural communities can benefit from the knowhow of practitioners on climate science. This dialogue between local and scientific knowledge systems is crucial in the context of finding solutions to complex socio-political, economic and environmental problems. Such a dialogue also enables rural communities to fully participate in adaptation action plans and take ownership post the intervention of development cooperation organizations.

The full participation of rural people in adaptation action plans requires careful, reflexive and critical application of climate adaptation tools. Subjective frameworks that improve the quality and acceptability of participation process and outcomes should be considered in a serious light. Equally, practitioners should think critically when applying methods and tools found in the PRA, CRA and VCA family. Critical and reflexive application of such methods and tools is crucial in the context of integrating local and scientific knowledge in local decisions-as it gives the former legitimacy and acceptability-especially considering the skepticism surrounding stand-alone local knowledge systems.

Last, practitioners and local community representatives should conduct a sustainability assessment exercise to assess the resilience of climate adaptation action plans against maladaptive practices that might increase the vulnerability of the intended beneficiaries in the long-term. More empirical research is required to develop participatory and sustainability assessment methods and tools that are accessible to and mainstreams the inclusion of rural communities in sub-Saharan Africa in transdisciplinary endeavors.

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Appendix

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