Learning and envisioning under climatic uncertainty: An African experience

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Accepted with Environment and Planning A

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Abstract. Learning about and embracing change and uncertainty are essential for responding to climate change. Creativity, critical reflection, and co-generative inquiry can enhance adaptive capacity, or the ability to anticipate, prepare for, and respond to adverse future impacts. However, how precisely learning about change and its driving forces occurs and how experiences are combined with envisioned yet indefinite prospects of the future are poorly understood. We present two linked methodological tools – an assessment of drivers of change and participatory scenario building – used in a climate change adaptation project in Ghana and Tanzania (ALCCAR). We discuss opportunities and challenges of such iterative learning. Our findings suggest that joint exploration, diverse storylines, and deliberation help to expand community-based adaptation repertoires and strike a balance between hopelessness and a tendency to idealize potential future realities.

Keywords: scenario building; drivers of change; co-production of knowledge; possible futures.

1. Introduction

Learning about and embracing change have become increasingly important in the fields of resilience management (Carpenter et al, 2011) and climate change adaptation (e.g., Fazey et al, 2010; Kuruppu and Liverman, 2011). Embracing change includes the capacity for innovation (Folke, 2006), the ability to learn from mistakes (Adger et al, 2003), and experiences in dealing with change (Berkes et al, 2003). Learning about change and managing its drivers allow for transformative experiments and exploration of cross-scalar change processes (Folke et al, 2010) as well as anticipating and preparing for the worst (Tschakert and Dietrich, 2010). Walker and

colleagues (2006) stress that the interaction of slow- and fast-changing variables across multiple scales, system dynamics, critical thresholds, and feedback loops is vital for apprehending change in coupled social-ecological systems. By acknowledging the unknown in change, its inherent unpredictability, and inevitable but uncertain outcomes, scientific inquiry reveals its own limitations and becomes more amendable to and legitimizes the co-production of knowledge with non-scientific inquiry, including indigenous knowledge (Cote and Nightingale, 2012). This recognition plays an important role in participatory vulnerability and adaptation assessments that attempt to enhance agency, or "the culturally constrained capacity to act" (Ahearn, 2001: 54), while appreciating context-specific values, cultural preferences, and other normative factors.

How precisely this engagement with change occurs is less well understood. Despite insights into discovery from sustainability and resilience management (e.g., Gunderson and Holling, 2002), constructivist learning (e.g., Wenger, 1998), democratic knowledge production (e.g., Horton and Freire, 1990), and participatory research (e.g., Kindon et al, 2007), the specific dynamics of engaging with change have remained largely underexplored in the field of climate change adaptation. Only a handful of compelling examples demonstrates how lay knowledge and collaborative problem solving can heighten awareness about complex change processes and their multiple drivers, particularly in contexts of high vulnerability to environmental changes. Fazey and colleagues (2010), in a joint assessment and planning effort in the Solomon Islands, view community members, researchers, and non-governmental organizations (NGOs) as "co-learners" who negotiate understandings of drivers and trajectories of change. Such co-learning enables a practice of reflective thinking, local capacity for dialogue and problem solving, the generation of socially robust data, and local ownership and responsibility over identified solutions. In Kiribati, the combination of practical local rainfall monitoring and cognitive and cultural understandings

of change has proven effective for enhancing adaptive capacity (Kuruppu and Liverman, 2011). Efforts to explore change trajectories, encourage anticipatory learning, and enable adaptation planning under climatic uncertainty have been foregrounded as explicit goals of community-based scenario building (Enfors et al, 2009; Frittaion et al, 2010; Sheppard et al, 2011).

However, because participants' lived experiences are seldom homogeneous, co-generative inquiry about environmental change needs to be attentive to the partiality of knowledge and uneven power dynamics. Community change narratives embody situated understandings, often favoring the views of elites, men, and elders, all of whom tend to be overrepresented in participatory projects, silencing other knowledge claims along gender, age, or ethnic lines (Smucker et al, 2007). Moreover, an overemphasis on local manifestations of global environmental dynamics, including climate change, may obscure the political drivers of these dynamics and undermine the contestation of social and environmental relations that perpetuate differential impacts (e.g., Chatterton et al, 2013; Featherstone, 2013; Swyngedouw, 2013).

This article explores environmental and socio-economic changes at multiple spatial and temporal scales, by combining embodied experiences with envisioning the future as essential components of anticipatory learning in rural communities in Ghana and Tanzania. We discuss an assessment of drivers of change and participatory scenario building as two distinct methods employed in a four-year climate change adaptation project. Specifically, we explore how community members, together with NGO practitioners and researchers, comprehend the driving forces behind the changes they experience and create their own possible futures, against the backdrop of interacting climatic and other changes, stressors, and opportunities.

2. Understanding change in space and time

This section highlights three elements that we consider crucial for exploring driving forces of change: scale, variables, and envisioning. We emphasize local-scale understandings of change and reference to cross-scalar dynamics, pace, control, and uncertainty.

2.1. Scale

Scale and cross-scale interactions, highlighted since early work in political ecology (e.g., Blaikie, 1985), are key to understanding change and its driving forces. A driver of change is "any natural- or human-induced factor that directly or indirectly brings about change in a […] system" (Hazell and Wood, 2008: 501). Typically, and predominantly so in environmental change scholarship, drivers of change are differentiated by their hierarchical spatial occurrence: global (e.g., globalization, climate change), country (e.g., urbanization, public policies), and local (e.g., land tenure, market access). Drivers have also been described by their nature – political, economic, social, and biophysical – and the distinct scales at which they operate (e.g., Walker et al, 2002). Identities, power, and agency are also important drivers of change and are foregrounded in examining vertical and horizontal webs of connections (Rocheleau, 2008). In the context of climate change adaptation, Osbahr and colleagues (2008), for instance, examine agency and reciprocity between actors and land use systems that drives adaptation to environmental change by making visible webbed connections across social institutions.

For the purpose of remembering, learning, and anticipating climate change and its multifaceted and simultaneous social, economic, atmospheric, political, and institutional causes, we argue that a comprehensive understanding of the multiple drivers of change and their distinct scalar interactions is not only impossible but also unwarranted. Although a certain appreciation

of local (proximate) and global (remote) determinants is essential for situating adaptation options within complex spatial interactions, a rigid distinction between the local and global seems rather futile. In fact, an initial emphasis on those drivers and their levels or scales that local actors can shape and control is recommended (Biggs et al, 2007; Hazell and Wood, 2008). An inclusive treatment of possible drivers of change may not only be overwhelming and time-consuming; it also risks undermining community-level engagement and adaptive decision making. More beneficial, we contend, is to use discussions of local issues to help participants appreciate webbed connections and interdependencies between lived realities and broader dynamics. We find particularly useful the notion of open and changeable places, as proposed by Massey et al (2009), recognizing that climate change (or any other external driver) can unseat what is often assumed as the boundedness of the local and, thereby, unsettle its neatly delineated and nested position in space and time.

2.2. Variables

The resilience literature posits that only a few key variables, operating at slower or faster rates (temporal scale) and smaller or larger extents (spatial scale), tend to control change. Slow variables (slow rate or low frequency of change) are often overlooked, yet are essential for understanding system changes (Walker et al, 2006). Relevant for climate change adaptation are slowly changing social variables such as identity, cultural values, and worldviews (Folke et al, 2010), and power relations and institutional dynamics (Cote and Nightingale, 2012).

Equally important is the degree of control actors have over these changing variables (Walker et al, 2002). Climate change as an atmospheric-oceanic phenomenon is beyond the control of community or district-level actors, although responses to climate change, including

policies, funding, adaptation and mitigation, and the broader structural dynamics behind a changing climate, are contested (Featherstone, 2013; Chatterton et al, 2013). System ambiguities and uncertainties that may be difficult or impossible to quantify or regulate deserve particular attention. Uncertainties refer to the direction and magnitude of change, for instance, regarding new policies, cultural continuity, or rainfall levels during the major cropping season. Consideration for these uncertainties can foster critical reflection, enhance agency over change, and demystify the unknowable future. Appreciating the difference between what is controllable and what is not, and what is intrinsically uncertain (unpredictable) and what we simply do not know (yet) is crucial for envisioning the future and embracing it.

2.3. Envisioning

The ability to envision and think about the future is shaped by the capacity to attend to forces that drive change (Wollenberg et al, 2000). Envisioning allows for extrapolating observed trends into the future while considering new occurrences; it offers a lens for systematically and creatively exploring complex yet possible futures (e.g., Enfors et al, 2008). Envisioning as a methodological tool is most useful in situations of high uncertainty that require multifaceted responses (Peterson et al, 2003). By evoking diverse knowledges, people can more easily embrace new conceptions of the future in locally meaningful ways, despite incomplete information (Shaw et al, 2009; Sheppard et al, 2011). Envisioning is a lens through which to connect grounded, embodied experiences of change with shifting environmental and social trends, uncertainties about the future, and surprise.

Scenario building, an increasingly popular tool for envisioning, offers an iterative way to grapple with incomplete information and uncertainties (Wollenberg et al, 2000). Scenarios,

quantitative and qualitative, constitute narratives of the future that retain perceptions and empirical knowledge while enabling people to imagine plausible futures beyond everyday experiences (Frittaion et al, 2010). Scenario building can enhance participants' capacity to embrace change by exploring a range of possible futures, stretching past and present insights and imaginations, and jointly weighing possible responses.

In scenario building for adaptation, external science information such as climate data or concepts may be added to elicit perspectives beyond embodied experiences. Despite the uncertainties inherent in climate science, the incorporation of external knowledge in a locally relevant manner has been recommended for participatory future thinking (e.g., Ziervogel and Zermoglio, 2009). Scenario building provides a space for participants to distill science information and complex feedbacks across scales and between the social and the natural for local relevance. Moreover, examining the spatial configurations of what may be considered "common" (the air and other collectively owned resources, and social connectedness to other people) can evoke political imaginaries that contest top-down climate decision making by practicing and performing what actors define as a desirable future (Chatterton et al, 2013).

Despite these epistemological advantages, scenario building as co-production of knowledge can be challenging. Participants may have difficulty absorbing foreign concepts such as computer-generated climate projections (Marx et al, 2007) or unequal geographies of power that shape local vulnerabilities (Featherstone, 2013). They may also resist long time frames, such as 25 years into the future as in a community-based scenario building activity in Tanzania (Enfors et al, 2008) or 90 years in British Columbia (Sheppard et al, 2011).To overcome analytical barriers, researchers have suggested employing visuals and narratives, practical experiments, and multiple iterations of learning to deconstruct, digest, and re-configure complex

information into new knowledge frames (Biggs et al, 2007; Shaw et al, 2009; Tschakert and Dietrich, 2010).

3. Project, site description, and methods

3.1. The ALCCAR project

Our interdisciplinary research project, Anticipatory Learning for Climate Change Adaptation and Resilience (ALCCAR) in Ghana and Tanzania, 2009-2012, employed innovative methods to explore drivers of change and scenario building and foster co-learning between local actors, external academics, and NGO practitioners. The project's aim was to reveal understandings of the past, monitor the present, and enhance the ability to anticipate and prepare for a future ripe with uncertainties and imperfect knowledge (Tschakert and Dietrich, 2010).

Conceptually, ALCCAR builds upon a notion of iterative adaptive learning to initiate planning for the future. This type of learning is recognized to respond flexibly to disturbances, uncertainties, and surprise (Walker et al, 2002; Folke, 2006) and is fundamental for informing the process of adaptation. We aimed to stimulate learning through a series of activities that arose from and enabled collective creativity, reflection, experimentation, and deliberation, embedded in co-production of knowledge and information exchange. Our objective was to create spaces in which co-learners gain new insights from combining experiences from places of everyday life with exogenous climate change science and anticipatory views of their future. Rather than viewing learning as an ultimate outcome, we understand it as co-constituent of the adaptation process. Hence, we explicitly talk about learning processes, congruent with progressive research on adaptation.

In conjunction with affiliates from the University of Ghana and the University of Dar-es-Salaam as well as practitioners from the Afram Plains Development Organization (APDO) and the Tanzania Red Cross Society, ALCCAR worked with eight rural communities representing two districts each in Ghana (Akyeamfour, Odomase, and Xedzodzoekope in Afram Plains District; Bowiri Anyinase in Biakoye District) and in Tanzania (Makurunge and Mlingotini in Bagamoyo District; Chekereni and Rau in Kilimanjaro District). The communities, dependent on rain-fed agriculture and some on fishing, were selected by our partners due to differences in governance, geographic location, and anticipated climatic trends.

Downscaled climate projections for the mid-21st century indicate further unpredictability in rainy seasons, higher temperatures, and increased frequency and severity of extreme events in both countries. The downscaling methodology is based on Hewitson and Crane (2006). Self-Organizing Maps (SOMs) are used to characterize the larger-scale atmospheric state using 2.5^{o} gridded daily reanalysis data from the U.S. National Center for Environmental Prediction (NCEP) for the period 1979-2007. The NCEP data are remapped to a nominal 2^{o} lat/long hexagonal grid. The SOM uses 19 grid cells centered on each downscaling (meteorological station) location. For each grid-cell, we use seven variables (*u*- and *v*- components of the wind at 10 m and 700 hPa, relative humidity at 850 hPa, air temperature anomaly at 2 m, and the lapse rate of temperature from 850 hPa to 500 hPa) to train the SOM. The SOM identifies days that are similar to each other in the multi-dimensional data space and the output, in this case, is analogous to a non-linear fuzzy clustering algorithm. Each day is then mapped to the trained SOM. We take all of the days mapped to a particular node and extract the daily precipitation from the meteorological station to produce a precipitation frequency distribution associated with the atmospheric state represented by that node. To obtain the downscaled Global Circulation

Model (GCM) data, we re-map the GCM data to the hexagonal grid for each downscaling location, map the daily GCM data (present day and future) to the SOM and, for each day, randomly select a precipitation value from the appropriate SOM node. This approach provides a realistic daily time series and also captures the extremes of the distribution. For this application, we use GCM data from 1961 to 2000 and 2046-2065 (using the A2 emissions scenario) from the World Climate Research Programme (WCRP) Coupled Model Intercomparison Project phase 3 (CMIP3), for nine different models: CCCMA_CGCM3_1, CNRM_CM3, CSIRO_MK3_0, GFDL_CM2_0, GISS_MODEL_E_R, IPSL_CM4, MIUB_ECHO_G, MPI_ECHAM5, and MRI_CGCM2_3_2A. Five key features for each country were extracted from the downscaled projections for informing the scenario building process (see Table 2).

Individuals and groups participated in 15 research and learning activities over 3.5 years (Figure 1). In this analysis, we focus only on learning regarding drivers of change and participatory scenario building. We first ask how an understanding of observed socio-economic and environmental changes shapes visions of the future. We then examine to what extent climate change becomes incorporated in the envisioning process. Subsequent activities that further explored trade-offs, planning, and decision making are not addressed here.

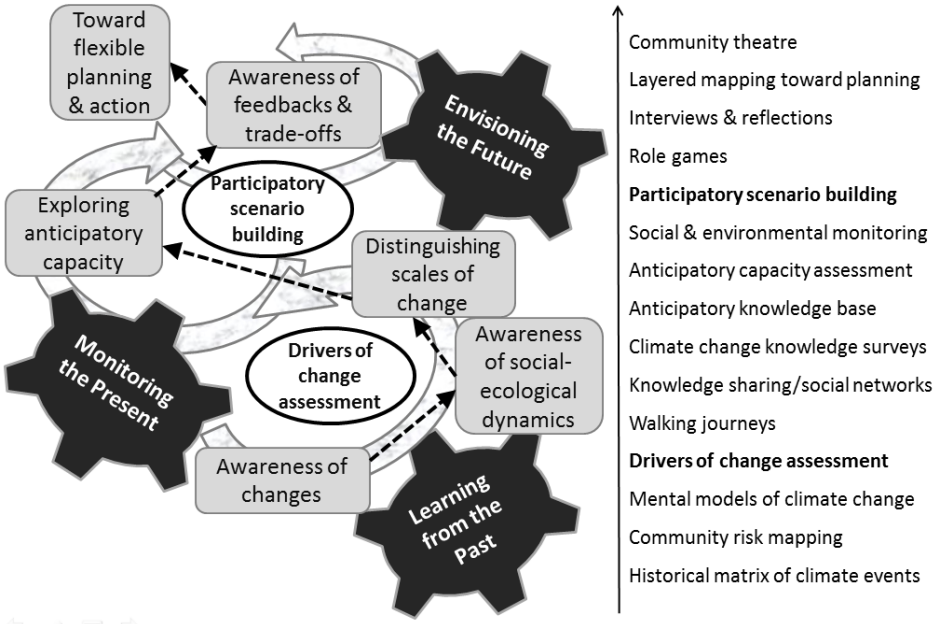

Figure 1: Iterative design of ALCCAR research and learning steps and activities (drivers of change assessment and participatory scenario building in bold)

3.1. Methods

We describe two specific methods: an assessment of drivers of change and participatory scenario building. They involved small group activities, discussions, and reflections that extended over one year (Figure 2).

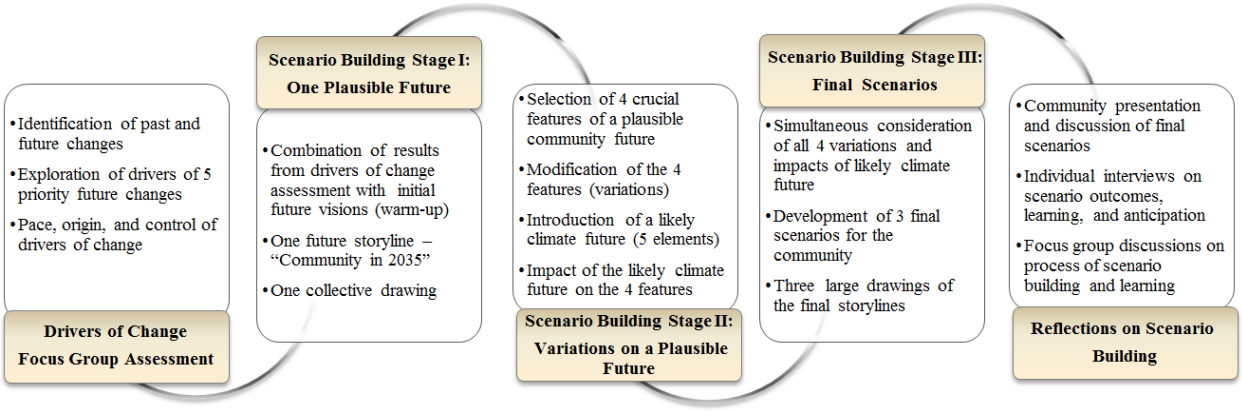

Figure 2: Sequence of methods in the drivers of change assessment and scenario building

3.1.1. Assessing drivers of change

We first asked members of the eight communities, selected due to their long residence time, to identify the main changes that had affected their community in the past, possible future changes, and the drivers of those changes. Men and women worked separately in small groups of seven to 12, invited by a local contact person, often a community leader or government official. Groups were sex-segregated to encourage women to share perspectives that they might otherwise withhold in a larger, mixed-sex group. In Ghana, we also interviewed eight individuals at the district-level (e.g., an NGO director). In each case, the activity lasted two to three hours.

The first part of the method examined changes over the past 30 years, those expected to continue over the next 30 years, and likely new changes. Each change was recorded on a card; the past changes were placed at the top of a large paper and the anticipated future changes at the bottom, in different colors. Then, participants used pebbles to vote for five possible future changes that they believed would most affect their community over the next generation.

In the second part, participants were asked to describe drivers they thought would trigger these future changes, listed on sticky notes. They explored each driver in as much detail as possible based upon three characteristics (Figure 3): *origin* (inside or outside the community), *pace* (slow, fast, or abrupt), and the community's *degree of control* over the driver of change (control, no control, some control). While constructing this mental map, participants discussed the dynamics of change. Finally, participants identified three most worrisome or important changes or drivers of changes that would warrant further deliberations.

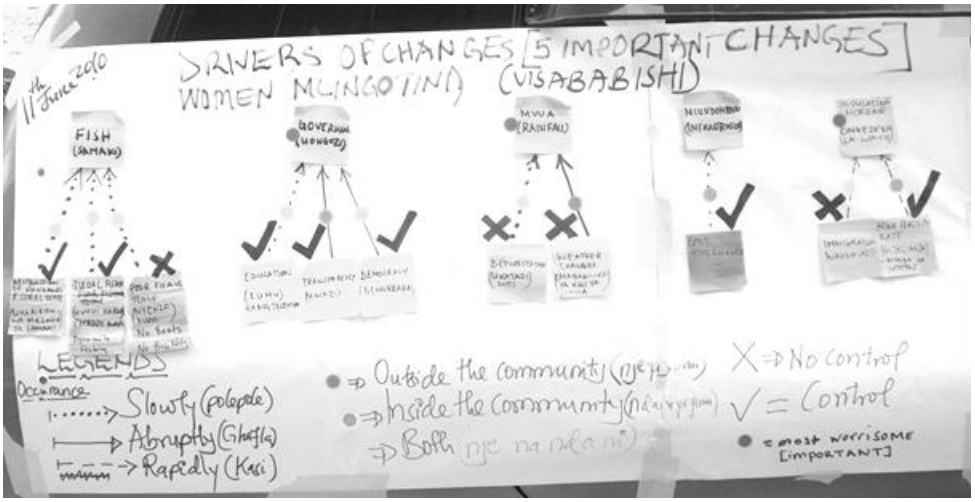

Figure 3: Assessing drivers of change, second part (women's group Mlingotini, Tanzania)

3.1.2. Participatory scenario building

In the following activity, the goal was to integrate the anticipated changes and their drivers into envisioning each community's future. Our approach was innovative in that it built on pace, origin, and control of key drivers of change, as identified by local stakeholders. Moreover, it introduced downscaled climate projections (e.g., increased temperatures, see Table 2) into scenario discussions. The participants created their own scenario narratives based on predictable trends extrapolated from the past (e.g., continuous bush fires), emerging trends (e.g., crime), and unpredictable events or surprises (e.g., extreme flooding). This combination of predictability and unpredictability is crucial for imagining future realities that are likely to exceed experiential knowledge. In three stages, participants deliberated for two to three hours, including time for drawings. Stage I was open to the whole community, split by gender only for warm-up brainstorming. In stages II and III, volunteers formed small groups of five to seven people to investigate and elaborate on details of possible futures.

In stage I, participants created a community storyline 25 years in the future. The only condition was that the storyline be plausible, meaning possible and credible, but outside of past or current experiences. After a recap of elicited drivers of change, men and women, separately, identified the characteristics of this plausible future from extrapolated and conceivable trends, which they reported to all attendants. A few participants spontaneously took charge of integrating overlapping elements and resolving contradictions, merging them into one cohesive future narrative. Local artists captured this narrative in a large drawing while other participants provided corrections and suggestions for fine-tuning. Lastly, the group identified four themes they judged important to explore in greater depth (Table 1).

Table 1: Themes identified for in-depth discussion in stage II

Ghana	**Akyeamfour**	**Bowiri Anyinase**	**Odomase**	**Xedzodzoekope**
	Afforestation	Erosion	Afforestation	Education
	Crime	Family planning	Education	Fish farming
	Hunger	Poverty	Employment	Mechanized farming
	Roads	Savannaization	Outmigration	Unity
Tanzania	**Chekereni**	**Makurunge**	**Rau**	**Mlingotini**
	Economy	Education	Disease	Education
	Education	Infrastructure	Economy	Environmental degradation
	Health	Good leadership	Education	Good leadership
	Water	Technology	Water	Population increase

In stage II, groups of three to six volunteers, both women and men, developed variations of their plausible future narrative by creating rich descriptions of a specific theme. They explored the theme's likely direction, pace, and predictability, until they could discern a clear influence on other elements of the future narrative. For instance, by asking at what point rising land scarcity would disrupt community life, participants were able to identify positive and negative feedbacks between narrative components and pinpoint possible breaking points.

In the next, vital step, facilitators asked how climate change would affect each variation. Instead of assessing a number of impacts from future climate conditions, participants were encouraged to explore how five distinct future climate characteristics, derived from down-scaled projections (Table 2), may alter their storylines about the future. We asked what the community would do differently, taking such possible climatic realities into account. Given the limited understanding of the causes and manifestations of climate change encountered in several communities, the facilitators offered a brief explanation on consumption, emissions, and global atmospheric circulation patterns that clarified why these changes in the global climate occur and how scientists project them into the future. This explanation provided an opportunity for practicing the co-production of knowledge; instead of focusing on locating impacts from an expert-generated climate future, the emerging conversation allowed participants to reflect on global dynamics beyond community control and complement local beliefs that attribute changes in the climate almost exclusively to mismanagement of community resources, particularly deforestation and bush fires.

Table 2: Key features of a possible climate future, from downscaled projections (2040-60)

Ghana	**Tanzania (Bagamoyo)**	**Tanzania (Kilimanjaro)**
Higher temperatures (both maxima and minima)	Increase in temperature (especially June - August)	Higher temperatures (both minima and maxima)
Rains will become even more unpredictable	Rains will become even more unpredictable (long rains will start and end earlier)	Longer dry season (starts earlier and ends later)
Fewer rain days (from approximately 145 to 115)	Dry season starts earlier and ends later	A little more rain in January
More heavy rainfall events (and more flooding)	More rains in November and December	Long rains (*masika*) start and end earlier
More heavy rainfall events, particularly in July	More extremely dry years and extremely wet years	More rain per year, but not as much as in the past (1960-1980)

Stage III integrated the variations plus possible climate future into final scenarios depicting the community under climate change in 2035. To avoid treating key drivers of change

in isolation, the same participants, now working across the initial groups, developed three final integrative storylines, also on large paper. They envisioned how these drivers could act simultaneously, what feedbacks they would generate, and concrete community actions. The facilitators clarified when needed, but withheld directing the groups into specific narratives. This last stage took two hours, though individuals continued deliberations for several more days. Finally, each group was asked to label its ultimate storyline to capture the essence of the scenario and denote authorship over ideas (Figure 4).

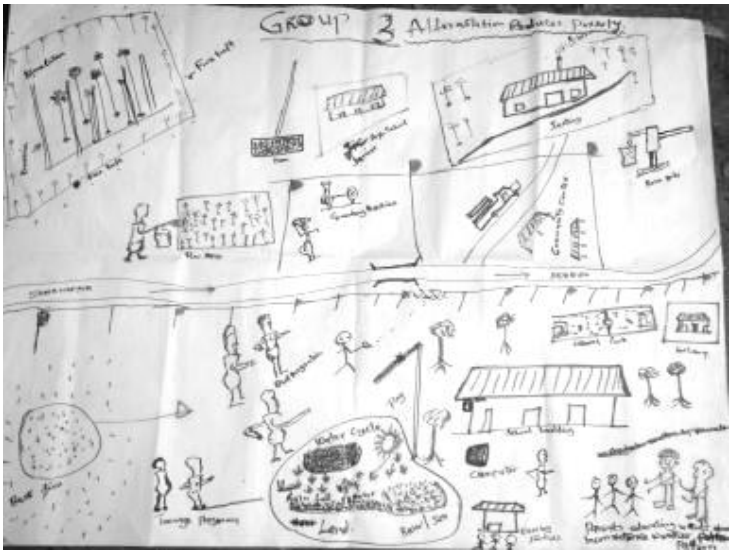

Figure 4: Final scenario drawing, Odomase, Ghana

The three groups presented their final scenario storylines to the community to discuss conceivable aspects, identify missing elements, and assess implications and trade-offs. In subsequent focus groups, the scenario participants reflected on received responses and the utility of envisioning as a step toward forward-looking planning. In a total of 180 individual interviews, the same participants and attendees of the presentation further pondered the future narratives, possible climate realities, and the community's current anticipatory capacity.

Activities were conducted in English, complemented with Swahili in Tanzania and Twi or Ewe in Ghana. Key terms were translated in consultation with African team members. During data collection, they also translated to non-native speakers. All field workers took extensive notes. Data analysis for both methods consisted of binary and categorical coding in Microsoft Excel to identify patterns and graphical representations. For drivers of change, tables indicated the absence or presence of particular changes or drivers, as well as origin, pace, and control, by gender, and individual experts and community members. Basic descriptive statistics (ANOVA) were calculated when appropriate. For the scenario building, narratives were broken into distinct elements classified into eleven categories (e.g., agriculture, education) derived from discursive analysis of storylines. We coded each element's direction as increasing or decreasing, improving or deteriorating, and considered desirable or undesirable. The analysis also noted the elements' connections to the five climate characteristics, and positive or negative consequences.

4. Results

4.1. Drivers of change

4.1.1. Past and future changes

The eight communities elicited >50 changes experienced in the past and anticipated for the future. The majority were related to agriculture, land use or cover change, infrastructure, and population. Several invoked the notion of climate change, typically expressed as decrease or unpredictability of rainfall, droughts, winds, and, in the case of the coastal communities in Tanzania, sea level rise. Figure depicts the ten most often cited local changes across all communities, for the past and future 30 years. Deforestation denotes an actual occurrence and a deeply entrenched environmental discourse, the latter more pronounced in Ghana than in

Tanzania, reflecting the desertification narrative from the 1970s and 1980s (Moseley and Laris, 2008). Population increase in the Tanzanian communities mirrors a steady growth rate of 2.5-3% since 1960 (World Bank, 2012). Between-group differences in each country (n=8) were not statistically significant.

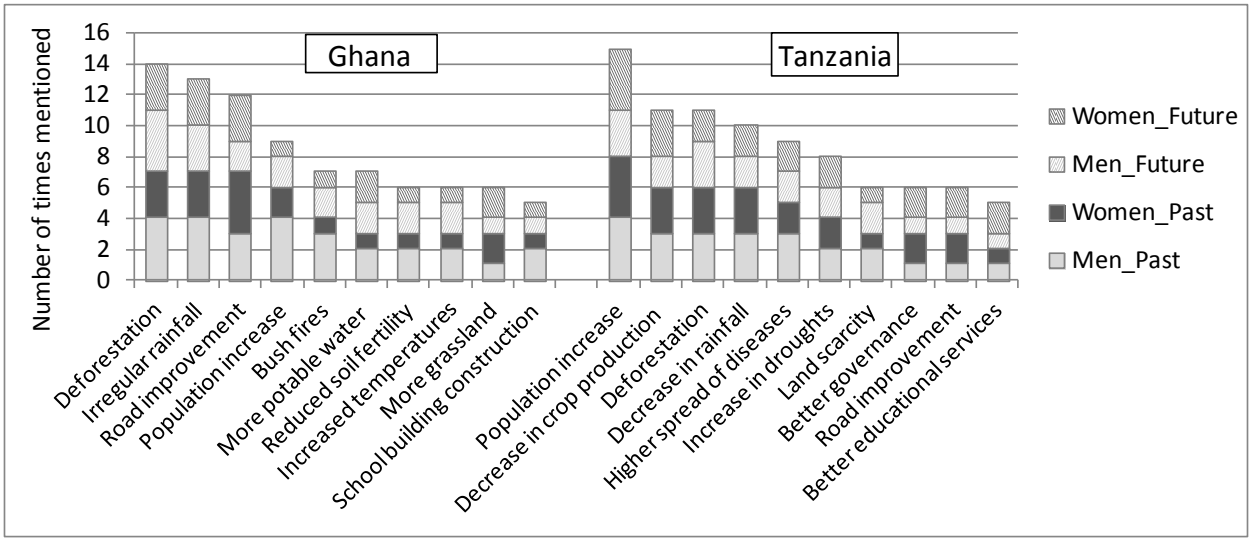

Figure 5: Most often cited observed (past) and anticipated (future) changes.

Overall, the most worrisome future changes elicited in the Ghanaian communities were more irregular rainfall and continued deforestation. In Tanzania, irregular rainfall and land scarcity received the highest scores, followed by population increase. Yet, district-level experts (only tested in Ghana) countered these worrisome expectations with projected improvements in road and water infrastructure and education ($p<0.05$, $n=16$). Ghanaian men scored highest better education, followed by future road construction. Women stressed better access to education for girls, forest conversion into grasslands, and increased teenage pregnancy. In Tanzania, men anticipated more land scarcity and population increase, whereas women foregrounded more irregular rainfall and improved roads.

4.1.2. Drivers of change

Pinpointing the specific drivers that would shape these anticipated changes proved more challenging. Not only are there feedbacks between individual drivers and changes, but what drives change in one place can be a major change in itself in another. For instance, half of the communities in Tanzania cited population increase as the most detrimental driver of future changes, while the other half viewed population increase as the key stressor. Community awareness, good leadership, transparency, and environmental education scored highest on the positive spectrum. In Ghana, bushfires, deforestation, population growth, and charcoal burning were the most often cited negative drivers. The top positive drivers were health and educational policies, NGO and donor involvement, good leadership, and citizen awareness of environmental protection. The strong emphasis on persistent environmental degradation seen in Ghana, reinforced mainly by women's concerns about continuous cropping and forest conversion into grassland, was not evident in Tanzania.

4.1.3. Origin, pace, and control of drivers of change

A better understanding of the manageability of drivers may enhance agency to accept change, demystifying the unknowable and reducing uncertainties that otherwise could lead to fatalism. The good news from this assessment is that none of the top drivers of future change were considered abrupt, hence entirely unpredictable. However, distinct constellations of origin, pace, and control of drivers of change shape place-based contexts. For instance, the often cited bushfires in Ghana can be slow to emerge, indigenous, and controllable, or rapid, triggered by non-residents, and hence much harder to master. Similarly, Tanzanian participants found poverty easier to control when it emerged slowly compared to rapid onset poverty, for instance after a

disaster. Such details are crucial for community adaptation planning. Table 3 depicts different characteristics of drivers and implications for manageability. The drivers perceived as most difficult to handle were abrupt, exogenous, and beyond community control.

Table 3: Typology of drivers of future change

Driver characteristics	Drivers of future change, Ghana	Drivers of future change, Tanzania
Easiest to handle	felling of trees, land fertility, unity, morals, hygiene, good nutrition	community awareness, good governance
Most difficult to handle	bushfires, cattle encroachment, release of land, alcohol consumption, get-rich syndrome, hunters, herders	unpredictable rainfall, poverty, crop diseases
Fast paced	bushfires, irregular rains, use of weedicides/pesticides	deforestation, urbanization, awareness
Exogenous origin	bushfires, governmental policies, qualified health personnel, lack of parental care	decrease and unpredictability in rainfall, crop diseases, agricultural inputs, investment policies, private investors, technology development
No control	bushfires, climate change, governmental support	poor investment policies, private investors, poor enforcement of by laws, poor leadership

4.2. Scenario building

4.2.1. Stage I: One plausible future

The base storyline for each community's future in 2035 showed key elements such as food insecurity, mechanized farming, and health infrastructure. In Tanzania, most elements were social, including poverty, crime, democracy, loss of traditions, community awareness of environmental changes, and technology. The Ghanaian groups focused on infrastructure and social issues, but also agriculture (e.g., irrigation projects), land scarcity, and erosion, wind, and deforestation.

Figure 6 shows the elements anticipated as positive or desirable, negative or undesirable, both positive and negative, or neutral. Improved infrastructure such as roads, police stations, or electricity, as well as employment in factories or individual business scored highest on the positive front. In contrast, the future environment was viewed as adverse, with increased erosion and bushfires and declining wild animals and access to natural resources. Desirable elements dominated (~60%) across all storylines, with the exception of Mlingotini in Tanzania. Specific themes, concerns, and aspirations largely matched the drivers of future change assessment, although slightly skewed to more desirable trends.

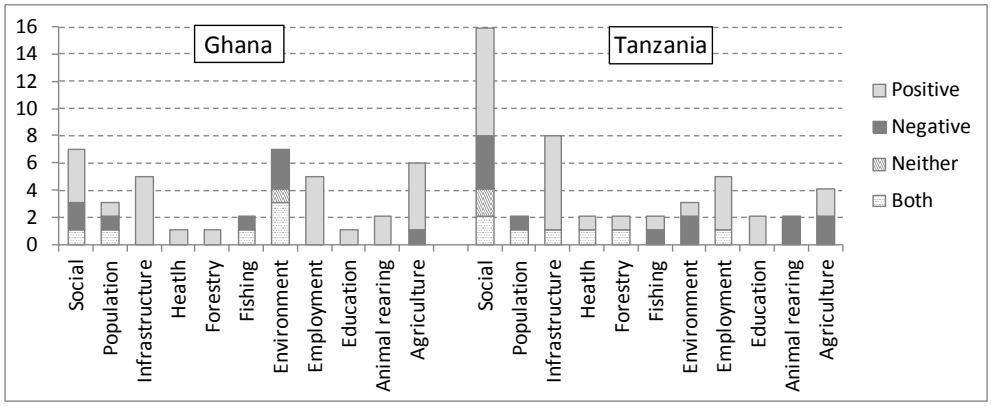

Figure 6: Number of elements, stage I of scenario building

4.2.2. Stage II: Variations on a plausible future

The degree to which elements from climate projections were incorporated into variations of a plausible future varied significantly, with a range of 23-88% in Tanzania and 39-77% in Ghana. In Mlingotini and Makurunge (>80%), technology and leadership were viewed as important for managing the consequences of a likely climate future while education was regarded as negatively affected by diseases, lack of income and food, and destruction of infrastructure. Adverse climate impacts on education in Ghana were anticipated to undermine agricultural production and the ability to feed students or pay school fees, particularly in Xedzodzoekope and Odomase (>75%).

We were particularly interested in how the participants absorbed the possible climate futures into their understanding of complex impacts explored under the specific themes. More than half of all climate references in Tanzania revealed expected harm. In contrast, the Ghanaian communities foregrounded positive climate outcomes under each theme, swiftly evoking viable adaptations to new climate realities, without dwelling on potentially damaging impacts (e.g., irrigation projects, intercropping, and drought-resistant crops to simultaneously fight climate change, hunger, crime, and deforestation). Participants saw themselves benefiting from improved agricultural extension and technology transfer, embellishing their projections from the drivers of change assessment. Their localized optimism contrasted with dire future imaginaries in Tanzania that coupled harmful climate impacts with gloomy trends of population growth and land scarcity.

4.2.3. Stage III: Final scenarios

The final scenarios, highlighting infrastructural improvements, population increase, and cutting and planting of trees, further accentuated the difference in future envisioning between the two sets of communities (Figure 7). Some scenarios in Tanzania became even gloomier (e.g., Mlingotini) while those in Ghana kept their positive spin, with Xedzodzoekope presenting an utterly rosy future. We hypothesize that these divergent perceptions reflect the respective country's policies and political evolution, rather than marked values or worldviews. Tanzania has suffered a decline in government services, including agricultural extension, resulting in pragmatic self-reliance. Rural areas in Ghana, particularly in the Afram Plains, have been enjoying more than 30 years of investment in infrastructure, education, and government services.

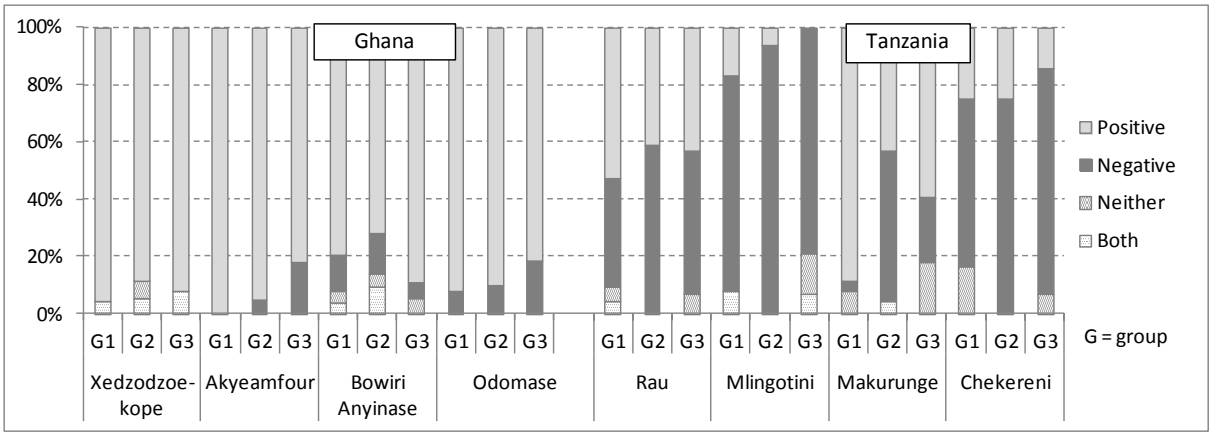

Figure 7: Percent positive and negative elements of scenarios per group

We also assessed how the downscaled climate characteristics were integrated into the final scenarios. Table 4 differentiates positive consequences (e.g., better water availability), negative consequences (e.g., declining water level in springs), or adaptive responses (e.g., planting drought-resistant crops). The predominance of negative future climate impacts in Tanzania reflects expectations of extremely dry and wet years, with reduced access to water, food insecurity, and disease. The Ghanaian scenarios, including fewer climatic elements, portrayed an easily manageable future, for instance, with irrigation in times of high temperatures and irregular rainfall. This distinctively buoyant outlook defied the possibility of undesirable surprises, outside forces beyond people's control, and difficult trade-offs in human-environment interactions.

Table 4: Number of final scenario elements linked to components of a projected climate future

Country	Community	Positive consequence	Negative consequence	Adaptive response	Total
Ghana	Akyeamfour	0	0	7	7
	Bowiri Anyinase	0	2	2	4
	Odomase	0	1	4	5
	Xedzodzoekope	1	0	5	6
Tanzania	Mlingotini	3	15	1	19
	Makurunge	1	2	4	8
	Chekereni	0	9	0	9
	Rau	4	10	4	18

Finally, in subsequent focus groups and interviews, participants reflected on their outlooks. The community partners in Tanzania amended their initial pessimism by conjuring growing adaptive capacity: "We think our community is able to adapt to climatic challenges in a better fashion than [now]; so in 25 years to come we will learn more [through meteorological data and climate training], how to adapt to challenges with a planned technique." Participants in Ghana, also invoking climate information and local climate monitoring and planning tools, maintained their optimistic stance: "With the knowledge of the climatic elements, we have prepared adequately for the future and this is reflected in the scenarios that we have produced."

5. Discussion

Our African case study demonstrates opportunities and challenges when embracing change in the adaptation process. By foregrounding the co-production of knowledge, the project created a space in which community members, researchers, and NGO practitioners could benefit from each other's insights. Such co-learning merged understandings of every day landscapes with processes beyond empirical awareness and local control. Through iterative dialogue and deliberation, participants and facilitators jointly navigated past and potential future change processes, both social and environmental, including feedbacks and trade-offs.

5.1. Reflections on ingredients for exploring driving forces of change

Returning to our initial three parameters for learning to deal with change, we recognize the value of *incremental scalar broadening* for exploring complex social-ecological processes. In the rural, disadvantaged settings in Ghana and Tanzania, it emerged as essential to a) start with socially embodied drivers at scales that community actors could shape and control, and b) subsequently

strive for a locally meaningful balance between empirical knowledge and external and scientific information that captured higher-level climatic and socio-institutional and political dynamics.

In the Ghana sites, the majority of future changes and associated drivers were strongly place-based (e.g., bushfires propelling environmental change, irregular rainfall triggered by local resource mismanagement, citizen awareness shaping future decision making). State-level policies and national or international donors were elicited early on in discussions with district- and regional-level experts, but were shelved in community discussions until later scenario stages. In Tanzania, community understandings of external drivers of change were more evident, including pervasive poverty, investment policies, private investors, technology development, urbanization, HIV/AIDS infection rates, and sea level rise.

We find that a spatial appreciation of interactions between place-based, regional, and global drivers of change beyond the local level enhances the recognition of interdependencies between environmental, socio-economic, and governance processes. Yet, recognizing interconnections and interdependencies requires practice, paired with access to information through newspapers, radio, NGOs, researchers, agricultural or social movements, and the like. The Ghanaian participants saw the natural and the social spheres as rather distinct, whereas those in Tanzania readily volunteered connections between the social and the ecological. Concerning the openness and changeability of a place (Massey et al, 2009), the Tanzanian groups realized this openness, as vulnerability to external political factors. They saw these political factors unsettling their place-based dynamics, more so than climate change, without having control over either. At the same time, recognizing the inherent changeability of their place may allow the Tanzanian partners to judge their adaptive potential more realistically, aware of opportunities, constraints, and potential limits. The strong rooting in localized dynamics and confidence in self-

made solutions, as observed among the partners in Ghana, sidelined notions of global commons. This may explain their distinctly positive, self-contained outlook toward the future.

As for *key variables of change*, our findings confirm the multiplicity and complexity of constellations through which change unfolds. Some vast socio-economic changes, such as the rising demands on land due to urban expansion along the coast of Bagamoyo or the incorporation of Chekereni into the suburbs of Moshi, trumped likely climate change impacts in the Tanzania discussions. In Ghana, expectations of continuous governmental support for infrastructure development made climate change appear like a minor inconvenience. Fast-changing variables described as emblematic in the literature (Walker et al, 2006), such as bushfires, crop diseases, and unpredictable rainfall, received the bulk of attention, while values, beliefs, and power relations were barely considered.

Although the increase in complexity throughout the two methods (features of a possible climate future on top of anticipated local change variables) was a challenge to community participants, it nourished awareness of the simultaneity of change processes and linked uncertainties. For instance, good leadership, identified in the drivers of change assessment and then dropped, was re-injected into final narratives and subsequent group reflections, illustrating participants' recognition of their own agency to navigate undesirable and uncertain changes. Our comprehensive treatment of social and environmental change and drivers characterized by pace, origin, and control is in stark contrast to what Swyngedouw (2010) critiques as reductionist and externalizing mobilization of CO_2 in global climate debates.

The *envisioning process* demonstrated an opening of novel spatial forms for practicing the commons (Chatterton et al, 2013) and alternative trajectories for a different socio-ecological order with new possibilities and assemblages (Swyngedouw, 2013) that go beyond adapting to

climate change. The scenario building purposefully created spaces to grapple with possibly harmful climate futures, embedded in local meaning making; it neither imposed "apocalyptic imaginaries" or "ecologies of fear" nor reinforced nature-society dichotomies (Swyngedouw, 2010). The envisioning enacted iterations of learning in marginalized rural settings where governmental support for adaptation and livelihood resilience is absent, to support a systematic yet fluid and critical engagement with possible futures.

Moreover, this iterative process encouraged participants to consider science projections and likely impacts more than 30 years into the future. It requires skill to translate, deconstruct, and apply such unfamiliar climate information in an exploratory, non-threatening way that allows for the grounding of long-term climate change and extreme events in people's lives, and that of their children. While the downscaled projections provided external knowledge about possible climate futures, they did not define the boundaries of what may be plausible or realistic. In fact, participants evoked other anticipated climatic changes, such as increased wind storms and more extreme flooding, to define what they envisioned as conceivable, desirable, and worrisome. We underscore the significance of participatory narratives and trajectories not as a prediction of the future, but an injection of liveliness and place-based meaning into science predictions that are often considered value-free.

5.2 Challenges

Experiential grounding under climatic uncertainty is no smooth sailing. We highlight four challenges that warrant critical reflections. First, it can be difficult for disadvantaged populations to embrace the future. We witnessed initial skepticism about envisioning the future, rooted in religious belief systems that assign a community's fate to God or Allah. Also, why waste time

talking about a period 25 years out when most of the villagers "would no longer be around"? Another challenge emerged when groups were asked to propose labels or embodied signifiers for their final scenarios. We found that a grounded approach to climate change adaptation tied to relations not only with familiar places and landscapes but also between people's children and future generations enabled most participants to overcome this hurdle of ownership. Grounding anticipatory learning in daily reality motivated participants to recognize and take seriously the responsibility bound to their ability and willingness to conceptualize time and space beyond the here and now.

Second, building shared knowledge of the climate system is easier said than done. Although theory on iterative learning tells us that the experiential and analytical processing of a possible future climate, with all its uncertainties, requires time for unpacking and re-configuring (Marx et al, 2007), we as researchers find ourselves impatient if not all information on future climate characteristics, creatively packaged and retold, is swiftly integrated into visions and scenarios. Such complex information, with a host of possible implications and trade-offs, needs to sink in. As shown by Kuruppu and Liverman (2011), there is no real need for people who manage and adapt localities to fully understand the climate science as long as possible impacts and responses can be envisioned. Thus, we argue that learning activities that distinguish between dynamics that are more or less controllable open a door for vital, albeit incomplete agency that needs to be nourished. What allows participants to embrace change in this learning process is to carefully co-construct a tangible meaning of climate change and its multiple drivers that is "good enough," recognizing the inevitable partiality of knowledge and the cognitive and epistemological differences in how each stakeholder group and each local culture conceive a problem and its solutions. We see this sympathetic navigating as essential to cyclical learning, by

amending or complementing partial knowledge, by stimulating imaginativeness, and by making space for informed deliberation, experimentation, and mistakes.

Third, overconfidence in adaptive capacity, just as well as hopelessness and fatalism, can impede realistic planning and meaningful action. Although knowledge, agency, and the eagerness to plan ahead are all part of anticipatory capacity, idealistic adaptive thinking is likely to misjudge the seriousness and harmful impacts of climatic events outside people's embodied experiences, a danger we saw emerging in some Ghanaian partners. The psychology literature explains the dichotomy between being overwhelmed by the complexity of a challenge and feeling equipped to tackle what seem like manageable sub-components (Lorenzoni et al, 2007; Gifford, 2011). Yet, the dominant discourse in adaptation, especially in contexts of poverty and marginalization, relegates this contradiction to "lack of knowledge." Iterative learning provides the necessary space for people to work out these contradictions for themselves, on both the rosy and gloomy ends of the spectrum.

Fourth, there is a significant gap between envisioning possible futures and democratic deliberation of what changes are desirable, necessary, and for whom. Recent attention has been devoted to contestations in climate debates, ranging from Swyngedouw's (2010, 2013) critique of a post-political consensus to diverse, non-state manifestations of antagonism, translocal solidarity, and climate justice (Featherstone, 2013; Chatterton et al, 2013). Our case study in rural communities in Ghana and Tanzania did not reveal any climate justice movements or attempts to politicize dominant climate responses. Except for cursory critiques of northern polluters and unjust impacts ("You all need to be arrested," as jokingly expressed by one group discussant in Bowiri Anyinase, Ghana), the contestations we found were targeted toward inadequate local leadership and the "getting-rich syndrome" (Ghana) as well as scrupulous

private investors and state-led urban policies that disregard the well-being of marginalized rural communities (Tanzania). Local requests focused largely on access to climate information and monitoring tools, hence foregrounding the technical and managerial rather than power or inequalities in climate adaptation. However, subsequent project activities that explored flexible planning toward uncertain futures prompted more in-depth reflection on leadership, representation of diverse voices, value judgments, trade-offs, decision making, and accountability between the local, the district, and the regional level. We interpret it as incremental development of critical consciousness (Pelling and Manuel-Navarrete, 2011), to challenge both local and larger, structural drivers of change. Contestation, it seems, is likely to be stifled in situations where place is seen as strongly bounded, with limited connections between socionature components and across scales. We argue that the ability to understand change as linked to processes beyond the bounded local also holds the seed for more profound transformations, rather than mere adjustment at the community level.

6. Conclusion

Despite accomplishments and some challenges in embracing change under climatic uncertainty, we end on a cautionary note. Our approach is unique because it attempts to enhance anticipatory and adaptive capacity among partner institutions and communities. Yet, we are fully aware that much can still go wrong. Co-learning and capacity building take time and commitment. The field of adaptation urgently needs ways to scale up such learning environments and find convincing alternatives to mainstream – and often disempowering – vulnerability assessments. We advocate for an explicit focus on flexible, collaborative, yet critical planning toward alternative future trajectories, drawing from the best of exogenous and endogenous knowledges and information

conduits and building upon continued practice of how to deal with surprises, from the local to the national. At the same time, we must acknowledge limits to autonomous adaptation and hold governments and the global community accountable for their responsibility to protect and renew.

Acknowledgements

We thank Yaw Boafo, Anselm Silayo, Umar Nuhu, Winfred Oteng, Neema Masomo, Lucy Swai, Maureen Biermann, Timothy Obideabah, and Paulina Apaadey for their outstanding work in the field. We are grateful to Robert Crane and Bruce Hewitson for help with the downscaled projections and Elias Asiama, Awudu Modoc, Grace Achisah, Julius Kejo, and Chris Hoadley for suggestions on methodological fine-tuning. Finally, we acknowledge financial support of the ALCCAR project from the United States National Science Foundation, DRU #0826941.

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