

Measuring Social Vulnerability to Climate Change in Ghana

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Introduction

1.1 Global Effects of Climate Change

Climate change is arguably the most pressing environmental concern of the modern era. The various predicted impacts will not be evenly distributed across the globe, so certain areas may experience high rates of extreme weather events, droughts, temperature change, and so on (IPCC, 2014). This uneven spatial distribution poses a unique challenge in terms of climate change adaptation because each locale will be responding to a unique set of environmental changes. The impacts of climate change are interconnected with other global forces and according to the Intergovernmental Panel on Climate Change they will further threaten global food security, increase human displacement, slow economic growth and exacerbate poverty (IPCC, 2014). These alarming implications highlight the pertinence of climate change adaptation to policymakers and nongovernmental organizations (NGOs). Decision makers at the international, national, and community level must all work within resource constraints to effectively address climate change adaptation. This raises questions about how these resources should be allocated to target those disproportionately impacted by climate change.

The effects of climate change are said to be disproportionate not only because of the unequal spatial distribution but also because nations that have contributed high greenhouse gas emissions are not the ones that will be most severely impacted. For example the land temperature in Africa is predicted to rise more than the global average, especially in arid regions (Niang et al., 2014). The countries with highest emissions from fossil fuels are predominantly those in the Global North, with the exception of China's

transitioning economy, but the negative impacts are concentrated in the Global South (EPA, 2017). Some argue that climate change is therefore reflective of skewed global power dynamics and the exploitive relationship between developed and developing nations. This stems from World Systems Theory, proposed by Immanuel Wallerstein, that classified countries as core, semiperiphery, and periphery based on their relation to other nations. Natural resources are extracted from periphery nations and make their way to the core nations that hold more power. This is analogous to the burdens of climate change being forced on countries in the Global South that do not have sufficient international power to hold Global North countries accountable for their emissions.

1.2 Social Vulnerability

The concept of social vulnerability is not exclusive to climate change studies, and has been previously employed throughout the social and physical sciences. Definitions of social vulnerability are nuanced to highlight certain aspects or fields of study, but it is generally accepted to mean “susceptibility to be harmed” (Adger, 2006) and focuses on the “political, social, economic, and institutional factors [that] lead some population groups to disproportionately suffer” (Tate, 2012). According to this widely-accepted model social vulnerability is a function of exposure, sensitivity, and adaptive capacity (Smit and Wandel, 2006). Therefore, a social system with greater adaptive capacity will generally have lower vulnerability even though the two are not inversely proportional. Social vulnerability exists at numerous scales, such as on an individual, household, community, or national level. This

thesis untangles the assumptions built into social vulnerability by exploring how it is conceptualized and measured by various actors.

Social vulnerability includes individual vulnerability and the collective vulnerability of a group or an entire nation. The two are distinguishable because individual vulnerability relies on that person's resource access, income and social standing, while collective vulnerability is the result of larger "institutional and market structures" (Dumenu and Obeng, 2016). The difference between these two layers of social vulnerability become important later when I examine the ways that various groups choose to measure and respond to social vulnerability, and one question will be the implications of focusing on either individual or collective vulnerability.

A theoretical framework necessary to understanding social vulnerability is the disaster resilience of place model (DROP) that describes the inherent vulnerability of a community as the "product of place-specific multiscale processes," (Cutter et al., 2008). The DROP framework has been used as a basis to measure vulnerability to hazards and is important to climate vulnerability indices because it accounts for the dynamic nature of social vulnerability. There are numerous assumptions built into any vulnerability assessment so it is beneficial to fully understand the conceptualization of vulnerability that each researcher uses. Though these theoretical frameworks do not prescribe a specific way of measuring social vulnerability, they influence the creation of indices.

Vulnerability indices fall under the umbrella of climate adaptation analyses, which also includes climate change impact assessments and evaluations of various adaptation methods (Smit and Wandel, 2006). Vulnerability indices are distinct from these other

types of adaptation analyses because they assign scores based on inherent conditions and do not explicitly recommend coping mechanisms. Reducing the complexity of social vulnerability to a single score is both useful and problematic. An improperly created vulnerability index will essentialize those it studies. Social vulnerability scores may lead people to make broad brush generalizations, such as labeling an entire country 'vulnerable' based on the criteria selected by outside researchers. Another critique of vulnerability indices is that they further the narrative of helpless poor countries relying on outside intervention from those in the Global North (Bankoff, 2001). There is impetus to target funding and projects at those who need them the most, but this requires an accurate method of identifying those populations.

Social vulnerability indices are used on a variety of scales to classify nations, regions, communities, and even households. This raises questions about scalar mismatch between the vulnerability assessment that is conducted and the resulting intervention. At what scales are vulnerability indices appropriate? This thesis seeks to answer that question by comparing indices used within Ghana at different scales to show the details and local variation that can be overlooked by employing the wrong scale of analysis. The individual scale is particularly difficult to measure because it requires resource-intensive methods such as going door-to-door with surveys. Even though the individual scale "is often overlooked in the development of regional policies, [it] is necessary to complement research and adaptation planning at broader scales" (Marshall 2014). Other researchers have similar critiques about both assessments and interventions following a standard model instead of accounting for local variations. One such study measured the vulnerability

of rural communities and compared them to the adaptation methods that the communities used. The results overwhelmingly showed that local scale adaptation was most commonly used, such as families expanding their farms, migrating, or diversifying their income (Dumenu and Obeng, 2016). The authors argue that the findings show the “importance of local-level climate change vulnerability assessment and demonstrate the need for local area-specific actions/policies to reducing vulnerability and enhancing adaptation in rural communities” (Dumenu and Obeng, 2016). An important nuance in these arguments against broad-scale indices is whether the researchers argue that broad-scale assessments cover up local factors or whether they believe there can be a complementary relationship between the two. There is a school of thought that labeling an entire country or region vulnerable is not a good use of resources while many others believe it is a productive first step to then tailoring smaller-scale indices.

1.3 Decisions and Interventions

The most tangible goal of vulnerability indices is to identify the most vulnerable communities so interventions can be effectively targeted. Vulnerability relies on the interactions between biophysical and social processes and is therefore incredibly dynamic and hard to measure (Adger, 2006). Despite these concerns social vulnerability measurements continue to be employed by researchers, national governments, and aid organizations. Climate adaptation policies are often based on the “average” citizen’s situation. “However, this assumption does not reflect the full range of diversity among resource-users within a region, thereby risking plans that will be irrelevant and ineffective

for some. Understanding social heterogeneity within populations of resource-users is important for effective natural resource management and climate adaptation planning” (Marshall, 2014).

The National Adaptation Plans of Actions (NAPAs) of developing countries are an example of adaptation and vulnerability being discussed on the national scale. These are national plans submitted by Least Developed Countries to the United Nations that identify areas of vulnerability within the country and propose concrete projects to address them. Though the documents are geared more towards building adaptive capacity than measuring social vulnerability, they demonstrate how in practice the two concepts are difficult to separate.

Climate vulnerability is often addressed through projects directed at individual communities, and the chosen interventions can be anything ranging from irrigation infrastructure to gaining access to bank credit. Both researchers and aid organizations have identified interventions to build adaptive capacity and therefore brace communities against the impacts of climate change. Common recommendations include income diversification, strengthening local institutions, utilizing agricultural extension services, among others (Nti Acheampong et al., 2014). In general any projects that improve households’ socioeconomic standing will also indirectly reduce their vulnerability to climate change; this leads to a strong overlap between poverty reduction interventions and climate resilience projects. Where recommendations diverge is usually around the relationship between development and climate change vulnerability. Some researchers argue that the current model of international development is not “attuned to existing and

imminent impacts of climate change and variability” (Nti Acheampong et al., 2014). There is also tension caused by the fact that many previous development projects have encouraged countries in the Global South towards more carbon-intensive economies. For example, past development initiatives have encouraged export-gearred agriculture and intensive farming methods such as pesticide use that have negative implications for climate change vulnerability today.

The list of organizations involved in reducing climate change vulnerability is synonymous with the major players in international development. The World Bank, various branches of the United Nations, USAID, and national governments are all heavily invested in assessing and tackling climate change vulnerability. The monetary investments are just as impressive as the organizations involved. One funding mechanism, Climate Investment Funds, is backed by The World Bank, the Asian Development Bank, and the Inter-American Development Bank. To date they have approved \$969 million for climate resilience projects while another \$2 billion is expected to be co-financed by partner institutions (World Bank Group, 2017). An additional prominent funding mechanism is the Adaptation Fund, which was set up by the UNFCCC under the Kyoto Protocol. The Adaptation Fund has provided \$375 million to projects geared at building resilience and helping the most vulnerable adapt to climate change. There are numerous other funding mechanisms and the key idea is that climate change vulnerability and resilience have garnered the attention of powerful global institutions.

Situated Context

Focusing in on social vulnerability within Ghana allows insights into both local nuances as well as global themes regarding the challenges of measuring vulnerability. Ghana, a nation in West Africa, fits many of the most commonly used criteria for climate vulnerability. According to the United Nations Development Programme, 28.6 percent of the population lives on less than \$1.25 a day and the Gross National Income per capita was \$3852 in 2014 (UNDP, 2017). Life expectancy at birth is around 61 years and like many other African nations, Ghana continues to face challenges in combatting malaria deaths and a high maternal mortality rate. Despite these concerns Ghana continues to be a regional leader and has made laudable progress in reducing poverty rates. For example, Ghana is one of only four countries in the region that is not classified as a Least Developed Country by the United Nations (Stanturf et al., 2011). This illustrates the heterogeneity within peripheral nations and even the West African region, as well as the dangers of making broad-brush generalizations. For these reasons, examining Ghana as a case study helps ground the nebulous topic of social vulnerability while illuminating the many paradoxes of measuring vulnerability.

The dimensions of Ghana's vulnerability to climate change can be put in context by understanding the predicted physical impacts of climate change. Ghana's climate already fluctuates widely, especially with El Niño Southern Oscillation (ENSO). Climate models vary and but show that each ecological zone will be impacted differently. Overall, the average temperature during dry seasons is expected to increase anywhere from 1.5°C to 3°C by

2080 (Stanturf et al., 2011). Predicted changes in precipitation vary across the country due to the differing ecological zones. Modeling these changes in precipitation is also more difficult and there are some contradictions between various climate models. However, it appears that under both conservative and extreme emissions scenarios the percent change in precipitation will be greater during the dry seasons than the wet seasons. This has extreme implications for the more arid regions that have higher sensitivity to changes in rainfall. All regions are expected to see decreases precipitation by 2020, 2050, and 2080; the Coastal Savannah zone in the South of the country is expected to see the greatest percent change in rainfall while the regions with lots of rain forests are expected to have the greatest absolute change in total precipitation. Modeling climate change on the scale of ecological zones is based on meteorological data collected within those regions and remains impossible to verify because it depends so heavily on future temperature changes. What these projections do serve to show is that even within Ghana climatic factors such as temperature and rainfall will not be affected evenly, and climate change will contribute to the extreme variability that occurs both seasonally and spatially between the ecological zones.

These predicted physical impacts of climate change combine with social factors to create Ghana's unique climate vulnerability. Factors such as poverty, high resource dependency, resource depletion, and average education levels have all been used to make inferences about the effects that climate change will have on communities' health and livelihoods. In general, the poorer and more arid regions in the North are expected to suffer most disproportionately from climate change (Antwi-Agyei, 2012).

A key component of Ghana's climate vulnerability is the high dependence on natural resources. 41.5 percent of total employment is in the agricultural sector, and extractive industries such as gold mining are also central to the economy (UNHDP). There is a consensus within the current literature that livelihoods relying on natural resources will be more abruptly impacted by physical changes, and Ghana's economy is no exception (Marshall, 2014). Agricultural practices are incredibly varied throughout the country and range from traditional forms of intercropping to modernized large-scale farming (Stanturf et al., 2011). Agricultural productivity is already influenced by soil degradation and land use changes, and the effects of climate change will interact with these preexisting stressors.

Past disasters, particularly those linked to climate, shed valuable light on the adaptive capacity of different communities within Ghana. Ghana has a history of both droughts and floods that have directly led to food insecurity for thousands of people (Acheampong et al., 2014). In 2007 the sparsely populated Northern region lost crops due to flooding and drought, which prompted the national government to call on international donors for emergency assistance. The impacts of this crop failure were exacerbated because they hit some of poorest regions within Ghana and then made them more vulnerable to future food insecurity and malnutrition (IRIN, 2007). Aid workers were especially concerned over vulnerable populations such as children and pregnant women, which mirrors the emphasis on bracing these same groups to the effects of climate change. In addition the observed coping strategies, such as selling livestock, were noted by aid workers and are concrete predictions of how people will respond to climate change (IRIN, 2007). As previously noted, the field of climate change vulnerability builds extensively on

hazard vulnerability, and the case studies of flooding in Ghana is a perfect example. Social vulnerability also stems from larger economic and political pressures coming from outside Ghana.

Ghana's role in the international aid community is inextricable from its perceived vulnerability. Ghana has been a focus of development aid projects and climate researchers have taken advantage of that accessibility by using those networks to facilitate climate change research. Many of the organizations creating social vulnerability indices within Ghana have a long history of development work there. In 2015 alone The World Bank sent \$323 million in funding to what it calls the "West African hub," ("Ghana Projects and Programs," 2017). The prominent presence of outside organizations not only shapes Ghana's economy but also impacts infrastructure levels and social conditions that then get measured in vulnerability assessments. The implication is that the historical and global forces acting on Ghana are not considered in social vulnerability assessments even though their symptoms are.

Indices Within Ghana

3.1 Methodology

A variety of actors within Ghana have created social vulnerability indices at various scales. My methods explored the use of indices at different scales by honing in on three specific indices and examining the impression of need that each portrays. These indices can be broadly categorized based on whether they are created by climate researchers or

international aid organizations. These three indices are all created with their own purpose and I set out to see whether the scale matched the intended purpose.

To tackle these questions I used ArcGIS mapping to visualize the scores produced by each vulnerability index. Visual representations, usually done with a color gradient, are one of the most common ways that vulnerability scores are presented to the public because they are much easier to process than a table with specific scores. If well designed, these maps are an effective way of relaying vulnerability information and showing spatial trends. Therefore, I wanted to see how the impression of vulnerability within Ghana compared when each of these three scales are used.

The second section of my methods was much more qualitative and included analysing the construction and intended uses of these indices. Vulnerability scores do not exist within a vacuum, and it was therefore necessary to consider the index in relation to the ways it will be used to influence funding decisions.

There were numerous indices I could have selected to study, so decisions had to be weighed. The discussion section of articles proved to be especially helpful in showing where researchers disagreed over the most appropriate scales to measure vulnerability at. A common argument is that the smallest scale possible will always be the most nuanced and provide the best understanding of local factors. Therefore, I found it important to include a nation-scale index in my analysis to show that indices are in fact created and used on large scales by prominent organizations. On the other end of the spectrum, it was necessary to have a community-scale index to serve as a contrast. In order to highlight the

variety of scholarly viewpoints within the field, I selected a community-scale index from a paper that found issues with conventional assessment methods.

Authors	University of Notre Dame Global Adaptation Initiative	W. Dumenu and E. Obeng of the Forestry Institute of Ghana	P. Antwi-Agyei et al., of the University of Leeds and the Kwame Nkrumah University of Science and Technology
Scale	Country	Ecological Zone	Community
Purpose	"Help businesses and the public sector better prioritize investments for a more efficient response to the immediate global challenges ahead"	Help policymakers in developing countries by emphasizing ways to build local resilience.	"Explore the socioeconomic, environmental and community characteristics associated with resilient and vulnerable households and communities."
Collected new data?	No	Yes, 196 household surveys between 14 study communities.	Yes, 270 household surveys between 6 study communities.
Stakeholder input	None	Focus groups and interviews, scholarly input on indicator selection	Focus groups and interviews

Figure 1 summarizes the three indices examined

Index 1: Nation Level

The first social vulnerability index I examined is a country-level assessment called the Notre Dame-Global Adaptation Index (ND-GAIN) that creates one score to encompass both vulnerability and resilience. This index is unique because it provides two separate scores, one for 'readiness' and one for 'vulnerability.' The readiness score is meant to indicate how well a country will be able to leverage investments to adapt to climate change. The readiness score included characteristics of resilient social systems that decrease social vulnerability, so I used the combined ND-GAIN score as the best representation of a country's vulnerability. This index included exposure within vulnerability, such as by including feet above sea level as an indicator. This score therefore cannot be compared

directly to other vulnerability measurements because the working definition of vulnerability is vastly different. It is important to note that the stated intended audience of the ND-GAIN index is business leaders and policymakers so they can better guide investment.

Index 2: Ecological Zone

The second index was created by William Dumenu and Elizabeth Obeng and captures the social vulnerability of Ghana's four ecological zones. In general it is uncommon to find social vulnerability indices at the scale of ecological zones. Presumably this is because governments collect data for administrative boundaries. The authors of this article do say that they tried to choose both indicators and assessment methods that could be applied to other scales.

A preliminary stage of their methods involved getting expert opinion on their chosen indicators. The authors started with a large pool of potential indicators, and then sent a questionnaire to experts to at the CSIR-Forestry Institute of Ghana asking them which they thought were best. This step in the methodology helps bridge the gap between the theorists and those interacting with the physical impacts of climate change in their work. In addition, it brings more diversity of opinions into the process and amplifies the role of local scientists.

This article explicitly states that social networks are intimately tied to both economic and social well-being in response to climate change. "Economic status and forms of livelihoods influence the kind of social network that one may belong to" (Dumenu and

Obeng, 2016). In this case the authors use access to climate change information and dependence on forest resources as indicators representing the social dimension of vulnerability. While these two indicators are well justified, there are many other elements of social networks that they fail to capture. This illustrates that even when using a place-specific index it is difficult to measure social capital.

Index 3: Community-Scale

The third index is the result of a partnership between researchers at the University of Leeds in the United Kingdom and the Kwame Nkrumah University of Science and Technology in Ghana. This uses household level information to score communities, and the authors assert that it “builds on national- and regional-level vulnerability assessments,” (Antwi-Agyei et al., 2013). The index specifically highlighted vulnerability to drought as climate change increases water variability, unlike the previous two indices that examined vulnerability to climate change overall. This index was the most nuanced and included aspects specifically tailored to Ghana, such as whether the family received remittances and whether they owned any irrigation equipment. The obvious limitation of these specialized indices is that they can not be scaled up or effectively reproduced in other locales. In addition, there were more interviews and focus groups involved, showing that issues with lack of participation by stakeholders may be more easily overcome at a smaller scale.

The next section of this paper bridges the gap between the construction of indices and the ways the scores are used in funding decisions. This is a crucial element of analysis because

an assessment can only be deemed appropriate if it meets its intended purpose, which is often to direct resources at the most vulnerable people.

Case Studies

I grounded this analysis of social vulnerability indices by examining two case studies of specific climate vulnerability interventions within Ghana. Many critiques of social vulnerability assessments can be highly abstract and theoretical, so I tried to ameliorate this by connecting them to concrete examples. These case studies also bridge the gap between the construction of social vulnerability indices and how the final vulnerability scores are used.

4.1 Case Study 1

The first case study comes from a report titled “Ghana Climate Change Vulnerability and Adaptation Assessment,” which was prepared in by the international branch of the USDA Forest Service for the United States Agency for International Development (USAID). This assessment identifies ways that existing USAID programs can address climate vulnerability, and the Feed the Future program is emphasized. Researchers for this report created their own vulnerability assessment for the districts within Ghana and emphasized the vulnerability of agricultural systems.

To create the index, researchers reviewed existing climate change literature and selected socioeconomic indicators that could be measured within Ghana. The eleven indicators used in this index were: perceived ability to survive crisis, agricultural employment, dependent populations, distance from drinking water, distance from food

market, female-headed households, illiteracy, percent of malnourished children, self-reported poverty, road accessibility, and drinking water source. These are common indicators of climate vulnerability and the assessment could be recreated in almost any developing country. Perhaps one interesting feature is that two of the indicators, both of which use data from previous surveys, rely entirely on people's own perceptions of their situation. This is obviously highly subjective and connects to larger issues with using indices for social sciences.

There are several key issues with the methodology used to construct this vulnerability index. Eleven is also a relatively small number of indicators to use when measuring something as far-reaching as social vulnerability. Perhaps the key issue with the methodology is that the indicators are not weighted, so they factor equally into the final vulnerability score for each district. The justification given for this is that the authors found no evidence in current literature that any of the indicators are more important than the others. This dismissive claim would be challenged by many climate change researchers. Trying to weight different indicators is a contentious and value-laden step in the methodology but it should not be ignored altogether. As is, the index implies that distance from a food market is just as important as childhood malnutrition or dependence on agriculture, even though both research and common sense indicate otherwise. The authors of this vulnerability assessment relied on data that had already been collected through nation-wide surveys and the government census. This creates an additional constraint on the indicators that can realistically be used because there may have been ones the authors thought were important but the data for them did not exist.

This social vulnerability index addressed issues of scale by using the smallest scale possible with readily available data. The results are presented for each district but also summarized for regions to make it easier to read quickly. This is effective because the averages vulnerability score is given for each region along with the range of district scores within that region; this avoids the false implication of homogeneity within regions. This report is open about the scalar limitations it faced and does not purport to capture other scales of vulnerability such as household and individual.

Traditional forms of owning land and trees in Ghana are determined to 'pose a threat' to policy interventions. Undefined land rights and high costs of buying land mean that many subsistence farmers are neglected if projects are only designed to help landowners. The discussion of this vulnerability assessment does a commendable job of acknowledging how ill-conceived interventions could further this cycle. International development agencies have historically had a heavy hand in Ghana's agricultural policies so this assessment walks a fine line by criticising the commercialization of land without discussing the role that the author organizations have historically had in privatizing Ghana's farmland. Unclear land tenure rights are presented from an economic standpoint as unequivocally harmful to small-scale farmers. Community-based land use may have benefits that this assessments is not able to capture, such as building social capital. This illustrates the tension that theorists have identified between imposing top-down solutions and respecting local practices. It is ironic that this report calls for empowering communities to "identify their own vulnerabilities" (Stanturf et al., 2011) but then assesses vulnerability from a markedly Western, pro-capitalist viewpoint.

The recommended interventions focus on food security because it is ‘in line with USAID’s planned investments’ (Stanturf et al., 2011). This represents a pragmatic application of the social vulnerability index because the authors discuss regions where investments are already focused and stay within the adaptation framework that USAID already uses. Instead of measuring social vulnerability in order to select target areas and choose an intervention, the authors incorporate their index into projects that are already started so they can be made more effective. This opens the methods up to both critique and praise. On one hand there is a clear bias because the chosen indicators emphasize the role of food security in climate vulnerability. Child malnutrition and distance from food markets account for two of the eleven indicators, so addressing them will measurably improve a district’s vulnerability score. The danger here is emblematic of the self-serving nature of many aid institutions. Projects will have the most measurable results if they address what indices measure, so organizations are never challenged to reevaluate their goals.

4.2 Case Study 2

The second case study is an ongoing water management project that was approved in 2015 and has a total budget of \$8,293,972. The project’s full title is “Increased Resilience to Climate Change in Northern Ghana through the Management Water Resources and Diversification of Livelihoods,” and it addresses the variability of water associated with climate change.

This project falls under the Adaptation Fund but the actors involved include a complex web of donors, governments, and administrative bodies. The Adaptation Fund was

established by the UNFCCC to target vulnerable communities in developing countries, and the financial services for the fund are managed by The World Bank. This specific project is implemented by the United Nations Development Programme (UNDP) as well as a branch of the Ghanaian government. The wide range of powerful players and large investment in this project means that lots of interests have to be balanced; it makes sense that nothing would critique development projects being implemented by any of the funding organizations. UNDP also collects a management fee of \$649,758, which illustrates how profitable these projects can be.

“In both rural and urban Ghana, the poor are indeed highly vulnerable to environmental disasters and environment-related conflicts and it is believed that the depth of vulnerability is correlated with the pace of environmental degradation exacerbating climate change impacts.” This explanation of ‘vulnerability’ prioritizes the role of poverty, and implies that vulnerability is a condition that grows from poverty. Of all the definitions of vulnerability I examined, this is the only one that incorporates the rate of environmental degradation as a cause. Slowing down the impacts of climate change is something that usually stays within the field of climate change mitigation, which is distinct from climate change adaptation. Connecting the rate of environmental degradation to vulnerability therefore bridges the usual policy separation between mitigation and adaptation. It also can be read as an implication that environmental action to curb climate change is a key component of addressing vulnerability.

This project used social vulnerability indices to decide where to site specific interventions but did not create its own indices. Instead the project proposal cited previous

assessments carried out by researchers and the government of Ghana. The government of Ghana has identified the Northern regions, composed of the Upper East, Upper West, and Northern region, as the most vulnerable to climate change and said they need to be prioritized. This agrees with the findings of other researchers as well as the index discussed in the previous case study; these three regions had the highest average vulnerability scores according to the USAID index. After the Northern regions were identified as most vulnerable ten specific districts were then selected to be the project target areas.

Selecting specific districts was a convoluted process because it both referenced a previous index and haphazardly added in some additional indicators. The authors were focusing on vulnerability to drought and flood, but no district-scale index existed. This highlights the previous theme that vulnerability must be framed in terms of *who* is vulnerable to *what*, because in this case a generic social vulnerability assessment would have been inadequate and misleading. The assessment of vulnerability to drought comes from work done by Philip Antwi-Agyei and colleagues in 2012. The referenced Antwi-Agyei et al. paper provides a more robust framework for assessing vulnerability and adopts a multiscale approach. Referencing indices that are already made and peer-reviewed may eliminate areas of bias because the indicators are not chosen to reinforce the goals of the aid organization. Because no index existed for vulnerability to flood, the authors assigned scores based on the past impacts of major flood events in each district. This part of the methodology was admittedly less comprehensive and highlights the limitations faced by the authors. Overall, this project built on work done by researchers, aid organizations, and

the national government when deciding which ten regions to situate the interventions in. Creating a social vulnerability index from scratch is time and resource intensive, so many project proposals adopt this approach and reference assessments that have already been done.

The Feed the Future case study and this one highlight different aspects of vulnerability because they have different goals. The vulnerability index created by USAID emphasized rural vulnerability by including distance to markets, roads, and water sources as indicators. This project proposal takes a very different stance and almost downplays the significance of rural vs. urban settings for vulnerability. As discussed, this project proposal implies that poverty is much more of a unifying factor among vulnerable communities than their proximity to resources.

Discussion

The specific indices I examined within Ghana highlight larger limitations of making funding decisions based on vulnerability scores. The key challenge is that certain aspects of vulnerability are dynamic and highly subjective, which makes them difficult to capture in an index. The assessment prepared for USAID by Stanturf et al. admitted that social networks and political involvement greatly decrease social vulnerability but were not captured by their indicators.

None of the indices I examined were able to capture the temporal aspect of social vulnerability. The rapid population growth rate in Africa has been paired with unsustainable resource consumption and is a root cause of many other vulnerability

indicators, but cannot be captured through conventional methodologies. Perhaps the best way that researchers overcome this gap in knowledge is by comparing vulnerability scores for the same spatial area over time. This is only possible if data is collected through constant methods over that time period, which may be unlikely. For example both of the case studies conducted assessments at a single point in time, with no concrete plans to repeat the assessment later. If an assessment is designed to pick a location for a project, the goal is met after one set of vulnerability scores is created so there is little onus to look at a longer time frame. Another way vulnerability indices fail to capture the changes over time is by failing to account for migration.

Social vulnerability indices are created in a way that assumes people's conditions are static. As an example, none of the indices I examined asked respondents if they had moved within the past year. Rural-urban migration, usually for seasonal work, is one of the most common ways that people in vulnerable nations have been responding to climatic stressors (Raleigh and Jordan, 2010). This is true within Ghana, and one study found it to be the second most commonly reported adaptation measure within the study communities (Dumenu and Obeng, 2016). Sending a family member to an urban center reduces a household's social vulnerability by enhancing the scope of their social networks and increasing their capital through remittances. Therefore, social vulnerability indices should be better tailored to account for the important role of migration and other population dynamics. The current model of vulnerability assessment collects information on people within a certain area (e.g. district, region, community) and cannot measure movement between those areas. If members of a family are spread between different districts they will

be assigned a vulnerability score based on where they live, even though their vulnerability is actually closely related to those of their family members they rely on. My case studies showed that failure to capture movement of people, social networks, and capital is something that limits both small and large scale indices.

A prominent finding from the selected indices is the importance of using the appropriate scale of measurement. Dumenu and Obeng's index was the only one that focused on ecological zones, and this is a scale that may not be given enough credit by governments and aid agencies. This scale may be best suited when measuring vulnerability to a specific physical impact of climate change. An intervention aimed at communities in the Coastal Savannah zone is more appropriate than an intervention aimed at an administrative district if it focuses on livelihoods specific to the coastal zone.

The creation of the index should be appropriate for the type of decision it is guiding. The ND-GAIN index is created for private investors who expect a return and understand things in purely economic terms. Joyce Coffee, the managing director of ND-GAIN, says that favorable index scores are necessary to attract private investors who "want to see impact, and value for money" (Anyadike, 2016). Therefore, the researchers making the index have to choose indicators that are meaningful to investors and emphasize economic solutions. Coffee argues for private and public investments to work in conjunction by allowing public investment, such as the Green Climate Fund, to fill gaps that private investors do not prioritize (Anyadike, 2016). There are obvious arguments against letting private investors guide climate change adaptation, especially since unsustainable business decisions have contributed to climate change. Dumenu and Obeng's study finds that 'local-level climate

change adaptation tends to be reactive,” (Dumenu and Obeng, 2016). This could be expanded on to argue that fixating on the local level will only address issues that people already notice in their everyday lives. Larger invisible forces that drive vulnerability may be better analyzed over larger temporal and spatial scales.

Once indices are completed, those interpreting and presenting the data also have considerable power. For the sake of simplicity, countries are often categorized as into broad groups such as ‘highly vulnerable’ or ‘least vulnerable.’ These distinctions are sometimes delineated in a way that seems slightly arbitrary. For example, one popular news article referenced the ND-GAIN index and highlighted the five highest and lowest ranking nations (Anyadike, 2016). Lumping nations together into these broad categories may inadvertently give the impression that their needs are more alike than they actually are. To be fair, these critiques apply to many other indices created in the social sciences; there appears to be a tension between succinctly presenting results and oversimplifying to the point of misleading.

The creation of vulnerability scores also has implications for the general public’s understanding of vulnerability and the way it is discussed. Politicians and leaders of NGOs will throw around the word ‘vulnerable’ in speeches without specifying the way that they determine vulnerability. Take, for example, a well-known speech that then-President Barack Obama delivered to the United Nations in 2009. In it, he uses vulnerability to spur developed nations to act on climate change.

“We must also energize our efforts to put other developing nations – especially the poorest and most vulnerable – on a path to sustainable growth. These nations do not

have the same resources to combat climate change as countries like the United States or China do, but they have the most immediate stake in a solution.”

In general when policymakers reference vulnerable nations they do not specify which nations they are talking about or the criteria that makes those nations vulnerable. The danger here is that the public is given the idea that vulnerability is ‘one-size-fits-all,’ with a single definition.

In theory, international aid organizations conduct a vulnerability assessment before they create a project so they know where to locate it and what issues to address. My case studies showed that this is not the case and there are multiple points in the funding process when indices can be used. Overall, it appears that vulnerability scores are combined with interviews and other forms of input when organizations decide where to situate their projects. Structural constraints play a large role in the funding process and limit the influence of vulnerability scores.

Moving forward, assessing social vulnerability can be made more robust by better linking social vulnerability scores to adaptation techniques. There are various ways theorists have described the relationship between vulnerability and adaptation (Cutter et al., 2008). However it is clear that much can be gained from better linking the prescriptive nature of vulnerability assessments with observations of place-specific adaptation measures.

Across the indices there appeared to be differences based on the goals of the organization that created them. The types of institutions creating vulnerability are generally either development organizations (e.g. The World Bank) or research institutions,

such as universities. In the case studies examined in this paper there were noticeable differences between the approach each of these groups took in their research. The indices created by Dumenu and Antwi-Agyei clearly fall into the 'research' category because they are exploring the nature of vulnerability without trying to guide a specific project. These indices were more critical of common assessment approaches and Antwi-Agyei's article focused on the outlier communities. This makes sense considering that research institutions may try to differentiate themselves from the existing literature and broaden the theoretical understanding of vulnerability. Due to the limited number of case studies these generalizations cannot be applied to the entire field of vulnerability assessments; however this would be a fruitful area for further empirical research.

Conclusion

Grouping people by their vulnerability may not always be the most effective way to tailor interventions. Antwi-Agyei et al.'s 2013 assessment showed that livelihood characteristics played a key role in explaining the different types of vulnerability that exist within a given community. The logical implication is that in some cases it may be better to direct interventions to people of a certain livelihood instead of people labeled 'most vulnerable.'

My examination of scalar mismatch focused on whether the scales of vulnerability indices were appropriate for the researcher or organization's use of those index scores. However, the findings of the case studies call for a more nuanced discussion of the types of scalar mismatch. I argue there are two key ways that the scale of assessment needs to

match the outcome. The first type is for the scale of the vulnerability assessment to match the aspects of vulnerability it is attempting to capture. This means that showing larger themes, such as the effect of a national or regional agricultural policy, is not always best shown by household-scale indices. The second type of scalar match is between the level of assessment and the scale of the interventions it is being used to justify. Adding irrigation systems to one community should not be decided by a regional-scale vulnerability index. These two areas for potential scalar mismatch are currently lumped together in most of the prominent literature but should actually both be discussed when vulnerability scores are cited. The project proposal in my first case study assumed that the smallest scale of assessment was the best but was constrained by available data. This is an oversimplification, as there is a role for large-scale vulnerability assessments.

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