WORLD ECONOMIC AND SOCIAL SURVEY 2016:

Climate change resilience — an opportunity for reducing inequalities

BACKGROUND PAPER

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The Effects of Changes in Rainfall Patterns, Water Availability, and Desertification on Multidimensional Inequality

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Summary:

This background paper focuses specifically on the relationships between multidimensional inequality and climate change. It provides a review of the social science literature that tests the hypothesis that climate change and inequality are locked up in a vicious cycle, whereby initial inequality makes disadvantaged groups suffer disproportionately from the adverse effects of climate change, resulting in greater subsequent inequality.

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1. Brief Introduction and Scope of Paper

Given that climate models consistently predict an increased frequency and intensity of many types of negative climate events, many societies will become more vulnerable to extreme weather (IPCC, 2013). These shocks could exacerbate already existing structural inequalities given that the poor and marginalized are disproportionately exposed, susceptible, and face more barriers to coping and adaptation (World Bank, 2016). This paper reviews the theoretical and empirical literature for evidence that climate change vulnerability and multidimensional inequality are linked in a vicious cycle, whereby *initial* inequality makes disadvantaged groups suffer *disproportionately* from the adverse effects of climate change, resulting in greater *subsequent* inequality. This relationship can be viewed as a continually reinforcing process of interaction between various forms of inequality and climate change vulnerability. In terms of climate change, the paper examines the potential inequality-enhancing impacts of changing rainfall patterns, water availability, and desertification. The scope of the background paper notwithstanding, the relationship between inequalities and other types of extreme weather events are also considered when appropriate. The paper considers multiple dimensions of inequality including income/wealth, gender, race, age, ethnicity, location, power, and agency. It also examines how these different dimensions of disadvantage interact in dynamic ways to shape vulnerability to climate change. Given the growing body of evidence of increasing interpersonal inequalities at all spatial scales (see Rodríguez-Pose & Hardy, 2015), the relationship between climate change and multidimensional inequality (as opposed to income poverty) merits attention and provides the motivation for this background paper.

Specifically, the paper addresses three questions to see how the existing body of literature supports or refutes the existence of a vicious cycle:

- First, how does multidimensional inequality influence the exposure of certain groups or individuals and increase their vulnerability to the potential risks posed by slow-onset events (e.g., changes in rainfall patterns, water availability, and desertification)?
- Second, how do the negative impacts of processes and events associated with slow-onset climate change affect the quality of life and livelihood strategies of disadvantaged groups or individuals?

- Third, what coping mechanisms or observed adaptation strategies do disadvantaged groups or individuals adopt in order to deal with the negative effects of slow-onset climate change?

In addressing the above questions, this review considers how levels of inequality change before and after climate-related change, while keeping in mind that there are multiple dimensions of inequality. To the extent that precise measures of inequality are not available, the paper draws on indicative and qualitative evidence to support or refute the existence of a vicious inequality-climate vulnerability cycle. By examining inequalities, this paper aims to broader our understanding of how the poor are disproportionally vulnerable to climate change not simply because of their economic poverty, but because they are disadvantaged by context-specific social and cultural norms that restrict their control over resources, limit their livelihood options and ability to participate in decision-making, and constrain the support they receive from institutions.

The next section presents a brief discussion of the conceptual framework used, and a theoretical discussion supporting the concept of a vicious inequality-climate change vulnerability cycle. Section 3 reviews the limited literature that directly tests the hypothesis that inequality contributes to greater vulnerability to climate change with resultant increases in inequality. It Section 4 reviews the literature on inequality of water and land access. Although most of these studies do not explicitly address the role of climate change, they help identify the degree of already existing disparities in resource access that will likely be exacerbated by processes of desertification, water scarcity, and changing rainfall patterns. Section 5 then reviews existing literature that indirectly informs the inequality-climate change vulnerability nexus by analyzing complex causal chains and transitive relationships. Section 6 presents a case study of the African Sahel, exploring the complex causal chain linking reinforcing inequality and differential exposure, susceptibility, and the capacity to adapt to desertification, water scarcity, and changing rainfall patterns via climate-induced resource conflicts. The paper concludes with a brief discussion of policy implications and directions for future research.

2. Conceptual Discussion of How Inequality Differs from Poverty in Exacerbating Climate Change Vulnerability

Multidimensional inequality refers to the various types of disadvantages and marginalization that result from discriminatory social practices and economic exploitation, systematically limiting opportunities for certain individuals and groups within a society. These systematic disadvantages are largely based on predetermined characteristics that are often outside a person's control, including gender, race and ethnicity, parental education, and place of birth. Moreover, these disadvantages are often reproduced over time leading to the intergenerational reproduction of disadvantage and marginalization.

Considerable evidence demonstrates that the poor are more vulnerable to the negative impacts of climate change, via a variety of direct and indirect mechanisms or pathways (IPCC, 2014a, 2014b). The relationship between multidimensional inequality and climate change has received less direct attention in the literature, despite a general consensus that inequalities mediate the ways in which poverty shapes differential vulnerability to climate change (World Bank, 2016). While poverty refers to low economic status of individuals (according to absolute or relative measures), multidimensional inequality concerns the differences that exist between people, groups, and places. Examining inequality along multiple dimensions is important since human welfare and quality of life are not perfectly correlated with income levels. Thus monetary measures of inequality miss many other types of social disparities, such as health outcomes (Deaton, 2003; World Bank, 2005).

Inequality clearly differs from poverty, and may well have a different relationship to climate vulnerability. Studies have shown that having lower absolute levels of physical, human, financial, and social assets increases the vulnerability of individuals and groups to climate change (see World Bank, 2016). Poor people are disproportionality vulnerable because they lack the money or resources to mitigate exposure (e.g., live in safer areas), reduce susceptibility (e.g., invest in higher quality housing that can withstand extreme events), or strengthen their adaptive capacity (e.g., purchase insurance). The potential effect of inequality is an additional one: that the worse off members of society suffer enhanced climate vulnerability resulting from relative differences in income, power, and social participation.

In the case of multidimensional inequality, differences in opportunities and outcomes for marginalized or disadvantaged groups create conditions that negatively affect their exposure, susceptibility, and adaptive capacity to climate change. Disadvantaged people are more vulnerable to climate change, not just because they are poor, but also because they lack power and influence relative to other members of society. More powerful members of society are able exert influence on institutions and social norms in ways that benefit them at the expense of the less powerful. Given that adapting to climate change requires the ability to bring about institutional change (Alston, 2013), inequalities of power increase the climate vulnerability of some individuals and groups by excluding them from processes of governance.

Inequality may also increase climate vulnerability through economic channels as poor and otherwise marginalized individuals and groups are often vulnerable to economic exploitation by wealthier and more powerful people (Bales, 2012). For example, Barrett's (2013) study of climate adaptation finance programs in Malawi finds that pre-existing power imbalances within villages reinforce differential vulnerability to erratic rainfall, flooding, and droughts, leading to higher inequality through exploitative labor relations. Climate change adaptation among households with less land often involves working as farm laborers for wealthier households under highly exploitative conditions, thereby exacerbating local-level income differences within villages. Similarly, Bolwig (2001) finds that wealthier households in northern Burkina Faso gain access to cheaper and more flexible farm labor supplied by poorer households experiencing periods of hardship.

Discriminatory attitudes or restrictive social norms can also limit educational opportunities and labor market access for certain individuals and groups, allowing more powerful members of society better access to higher paying jobs. For example, Alston (2013) finds that restrictive cultural norms often place women at a disadvantage in adapting to climate change, relative to men, by restricting their employment opportunities outside the home, limiting their control over resources, constraining their movements and educational opportunities, and assigning them disproportionate care responsibilities. Barrett (2013) finds that uneven power relationships within villages leads to the most productive and well-connected households being the main recipients of climate adaptation funds, while women and households without strong affiliations to local leaders have less access.

The interactions between inequality and climate change vulnerability also operate through political channels. For example, more marginalized people are disproportionality vulnerable because government policies leave them more exposed to extreme events (e.g., government infrastructure and public services are limited in these areas), increase their susceptibility (e.g., governments fail to invest in these area over time), and weaken their adaptive capacity (e.g., government provide limited social supports or fail to intervene in the aftermath of climate-related shocks). Sen (1999) identifies these inequities in institutional relationships as an outcome of elite capture and political corruption within a society. Abdi, Glover, and Luukkanen (2013) also indicate that political power imbalances reinforce marginalization in the Sahel by leading to unstable land tenure, institutional failure, and market failure. These above examples demonstrate how more powerful members of society can influence governance in a way that increases the exposure, vulnerability, and adaptive capacity of the disadvantaged. In addition, Kahn (2005) finds that social capital and trust in government institutions are harder to build in more unequal societies and nations with weaker institutions suffer higher national death counts from natural disasters. Kahn (2005) also identifies corruption as one possible mechanism driving these higher death rates. Government corruption could lead to higher death counts of politically marginalized groups through the failure to provide quality infrastructure or necessary post-disaster emergency assistance. Within moral philosophy and development ethnics, notable scholars such as Amartya Sen, and David Crocker demonstrate how unfair or unjust social institutions can lead to the marginalization of disadvantaged groups in societies and, thus, can provide insights into how inequality (as opposed to poverty alone) make some members of society more vulnerable to climate change than others.

Examining the relationship between inequality, climate change vulnerability, and increasing inequality therefore requires explicit attention to uneven power dynamics in society (i.e., political channels of inequality). Poverty alone does not drive the vicious cycle under investigation, and empirical analysis must consider the propensity of the poor to be exploited by the rich at the local, regional, and national levels. Although economic inequality often translates into uneven power relationships (Sen, 1999) as the wealthy are able to exert more influence on governance institutions and policies, other dimensions of disadvantage can also play an important role in social processes of marginalization.

a. Examining the Vicious Cycle of Through Complex Causal Chains and Transitive Relationships

Relatively few studies directly measure levels of inequality before and after climate-related events. Moreover, measures of economic or educational inequality may be ill suited to capture the relationship between inequality, climate change vulnerability, and increasing inequality, especially when examining desertification, land degradation, water scarcity, and changing rainfall patterns. For example, climate change effects may have little impact on indicators of income and wealth inequality (e.g., the Gini Coefficient, Theil, etc.) in places where incomes and education levels are already very low, even among the relatively better off. In such cases, locally more advantaged individuals or groups may be able to better mitigate the effects of climate change on their well-being, but economic and educational gaps between the haves and have-nots might not alter significantly. Overall increases in economic or educational inequality levels in the aftermath of climate stress or shock may appear small in these situations and mask the differential vulnerability to climate change and resulting hardships for more marginalized groups. Thus, a look at other dimensions of inequality such as disadvantages stemming from gender, social positions, and other types of power disparities is particularly important in some areas of the developing world where monetary and educational measures might not fully represent the increasing gaps between those who face substantial disadvantage and those who do not. In addition, the limited temporal span of longitudinal socio-economic data for many low income countries make it difficult to use such data to test the inequality-enhancing aspects of climate vulnerability, particularly in the context of slow-onset events such as rainfall variability, desertification, and water scarcity.

Still, there are large and growing bodies of case study research, and strong theoretical motivations, suggesting the existing of a vicious cycle. If the poor are disproportionally vulnerable to the negative impacts of climate change, as the consensus in the literature suggests, then societies should experience increasing inequality as climate change worsens the quality of life of the poor more than it does for the better off. In other words, the welfare 'floor' should drop, increasing the gaps between have and have-nots in any particular society. This relationship theoretically applies to all spatial scales. Moreover, the IPCC (2014b) asserts that the negative effects of climate change are likely to outweigh any benefits. In effect, the scientific evidence to

date suggests that climate change is ultimately bad for everybody, but it is worse for some than it is for others.

This paper examines these issues by investigating how economic inequality interacts with political marginalization and other sources of multidimensional inequality. It does this by considering the limited direct evidence, and also synthesizing other empirical and theoretical work to examine the complex causal chains that compound different aspects of disadvantage. These complex causal chains are the general pathways, patterns, and relationships linking (and exacerbating) various dimensions of disadvantage and unequal outcomes. Surveying the literature in this manner, the paper aims to identify 1) which types of disadvantaged groups are the most exposed and susceptible to climate change; 2) how multidimensional inequities limit certain groups' abilities to cope with and adapt to climate-related impacts; and 3) how these inequities result in higher levels of inequality in the context of climate change.

The paper places particular emphasis on the cautious investigation of indirect, transitive links between inequality and climate change. For example, if climate change leads to water scarcity, and water scarcity exacerbates already existing inequalities, it is likely that that climate change increases inequality. Another example, to be explored in detail later in the paper, is as follows. If inequality leads to conflict in the context of climate change, and conflict leads to worsening inequalities, then climate change is likely to be associated with an increase in inequality via conflict. This approach requires caution, and such indirect relationships do not necessarily show causality. The paper examines select relationships involving inequality and climate change within a specific contexts.

3. Literature Review

a. Direct Evidence of a Vicious Inequality-Climate Vulnerability Cycle

The literature to date provides limited direct measurements of inequality before and after extreme climate-related events. However, some studies do find evidence to support the hypothesis of a vicious cycle whereby already existing inequality leads to higher levels of inequality via differential vulnerability to the negative impacts of climate change. However, few of these studies investigate all three dimensions (i.e., exposure, susceptibility, and adaptive capacity) and they often do not identify how vulnerability differs across different individuals and groups at the local level.

One study by Silva, Matyas, and Cunguara (2015) directly examines changes in income inequality (as measured by the Gini Coefficient) and polarization (as measured by the DER index) for Mozambican regions experiencing extreme weather between 2005 and 2008. Using satellite-based rainfall estimates, they identify eight regions of the country that experienced similar rainfall patterns, in order to examine the effects of rainfall variability and extreme events on income inequality and polarization. Each of the eight regions experienced distinct weather patterns over the time period of the study, but they can be broadly classified as those with near-normal rainfall, those experiencing at least one tropical cyclone or flooding event, and those experiencing progressively worsening drought conditions. The socio-economic survey data used in the analysis included only rural households and was regionally representative for the country.

All regions analyzed in the Silva et al. (2015) study had high initial levels of inequality. However the study finds no relationship between initial levels of regional inequality and the degree or direction of changes in the aftermath of extreme weather, suggesting that the original magnitude of inequality is not associated with the degree of post-climate impact changes. The same is true with polarization. This finding is unsurprising given some types of extreme events have more negative impacts and require more intensive coping than others

Silva et al. (2015) find that the hypothesis that inequality increases in the aftermath of extreme event held in three of the eight regions: in a region with substantial tourism

infrastructure that experienced one tropical cyclone, and in two regions that experienced progressively worsening drought conditions over the study period. In addition, the findings for the third drought region also lend some support to the hypothesis. Although inequality experienced a 1% reduction in this region, polarization increased substantially, suggesting that households had varying abilities to adapt to poor weather conditions.

In two other regions where extreme weather occurred (two consecutive cyclones, and two years of flooding) inequality and polarization actually decreased, runs counter to expectations. For example, inequality and polarization decreased in a region where households were impacted by two tropical cyclones, Jaya and Jokwe, in consecutive years. The findings of Silva et al. (2015) suggest that, in this case, a widespread increase in poverty drove the convergence in incomes, suggesting that even better-off households were unable to mitigate the negative impacts of consecutive extreme events. As this was already one of the poorest regions in 2005 and the proportion of lower income households increased by 2008, it is possible that increasing poverty rendered most households unable to invest in agriculture or other forms of capital and subsequently triggered severe economic setbacks for households even at the upper end of the income distribution. In extremely poor areas, some households might be better off than others, but still vulnerable to falling into poverty traps as a result of extreme weather. This points to the extremely context-specific nature of climate change vulnerability. The negative effects of climate change on inequality may be exacerbated or off-set by local economic conditions.

The mechanisms driving differential vulnerability in the Silva el al. (2015) study appear to primarily operate via exposure to extreme events, and the limited capacity of the poor to mitigate negative impacts and cope with their effects. However, other studies have shown that indirect effects on inequality after extreme events operate through uneven power structures. For example, a study of post-flood resettlement in Mozambique by Artur and Hilhorst (2014) found that wealthier households and local chiefs were often able to maintain disproportional access to capital, prime land, and social power in resettlement locations. The resettlement process reinforced social differentiation, particularly between men and women, more and less affluent households, and traditional leaders and other community members, Thus, Mozambique's attempts to mitigate flood risk in the Zambezi Valley through resettlement exacerbating already existing inequalities and illustrates that social inequalities can be transported to new places.

McKune and Silva (2013) examine the extent of multidimensional inequalities before and after increasing water scarcity and land degradation in Niger, and find support for the vicious cycle hypothesis. Examining vulnerability of Tuareg pastoral populations in Niger to processes of climate change and economic globalization, they find that historically high levels of power inequities, coupled with high location-based exposure to negative climate change impacts, ethnic marginalization, and declining effectiveness of traditional strategies to mitigate the effects of extreme weather resulted in increased marginalization of Tuareg pastoralists, higher levels of food insecurity, and more exposure to resource-based conflicts. Marginalization of Tuareg pastoralists in Niger was amplified under French colonial policies which favored the agricultural communities of the south over the pastoral populations of the north and extremely limited Tuareg rights and access to land. Upon Niger's independence, the Tuareg were essentially unrepresented within the new government.

McKune and Silva (2013) find that that multiple years of lower than normal rainfall coupled with declining access to land has threatened the viability of historic livelihood systems in some pastoral communities. Households that choose to stay in their historical homelands suffer from decreasing yields over time and their herds must travel farther afield in search of grazing lands. The case study respondents also stated that traditional coping strategies for maintenance herd health are no longer as effective as they once were. For example, in 2005 and in 2010 communities reported that they were no longer able to use the traditional restocking system where female livestock are loaned for a period of time long enough to produce offspring for the borrower, then returned to the original owner. Due to malnourishment of animals and the consequent length of time required for maturation and reproduction, in addition to the widespread loss of livestock among pastoral families due to illness, starvation, and sale, study respondents commonly said this practice was no longer employed as a coping mechanism. The study also found that community members identified migration as a traditional coping mechanism in times of climate-related stress but this was also no longer as effective at mitigating the negative impacts of climate change as it once was. Focus groups in Dareram and Abdounezé indicated that one key driver of this change involved recent negative experiences arising from migration including loss of family members to outmigration, increased danger for migrating men given the political conflicts in neighboring countries that traditionally served as destination areas for migrants, and less reliable remittances. Research participants described migration as now

having long-term repercussions on social vulnerability for family members who remain in their original location, including a loss of solidarity within the community and increased divorce rates. Moreover, traditional knowledge about livelihood practices, an important form of security, is lost, as these traditional coping strategies fall out of use. Coping mechanisms still in use during the 2005 and 2010 crises included sedentarisation, consumption of famine foods, collection and sale of wood, increased number of days of fasting, and reduction in number of meals – all of which negatively affect nutrition and health, increasing overall vulnerability and marginalization of Tuarag pastoralists. These coping strategies have particularly negative effects for women and children.

The study findings indicate that interactions between climate change and globalization also exacerbate political instability in the region. First, climate change at the global scale has decreased the mobility of pastoralists. Their herds severely reduced by excessive heat and droughts, pastoralists increasingly settle near water sources and attempt to position themselves in areas serviced by international aid organizations. Their inability to re-grow herds after severe, consecutive droughts increases the likelihood of diversifying livelihood strategies to include crop farming, a choice that increases local level conflicts over land with already existing agricultural communities in the area. In addition, local resistance to state appropriation of land for mineral exploration by foreign multinational firms serves to further marginalize an already disenfranchised group. Drier climatic conditions and global commodity markets create competition for resources that escalates the likelihood of local-level conflict, and conflict serves to limit people's ability to cope with or adapt to severe weather. During periods of environmental crisis, resultant conflict inhibits international development and humanitarian relief efforts within the region. Conflict also creates disincentives for foreign direct investment in the region, thereby contributing to more economic marginalization. Thus the Tuaregs become more isolated, increasing the disadvantages they face compared with other populations in Niger.

All the processes examined in the study are found to interact in a way that decreases Tuareg pastoralists' resilience to future climate shocks, which suggests that their food security will worsen over time. The study results indicate that climate change has the most direct influence in altering local livelihoods. Given the declining effectiveness of traditional coping

strategies, pastoral populations are less likely to be able to cope with additional climate shocks, leading to further increased vulnerability and disadvantages of an already marginalized group.

Some other studies that directly examine the existence of a vicious cycle focus on the ways in which climate change vulnerability can exacerbate already existing gender inequalities. For example, Onta and Resurreccion (2011) find that changes in precipitation (rainfall variability and reduced rainfall) increase already existing gender inequalities in Nepal. Their case study findings suggest that changes in summer and winter precipitation reduce crop yields and viable grazing land, and that people alter agricultural production strategies to cope with these impacts. Gender and caste intersect to drive differential vulnerability to these negative climate change impacts. Dalit women have few livelihood options other than farming, which is highly sensitive to climate change. Moreover, the already existing disadvantages faced by this group of women were exacerbated by the observed adaptive strategy of planting drought-resistant crops which are more labor intensive. The cultivation of these crops reinforced gendered patterns of agricultural work since women take on a disproportionate share of farming activities as well as household reproduction. The study found that men became more involved in itinerant trading outside of their villages as a response to climate change, whereas the women's culturally defined farming responsibilities restricted their ability to work off-farm. As a result, women are less likely to be able to escape from locational and livelihood-based disadvantages stemming from changing rainfall patterns, and are more exposed to future events, such as floods and landslides.

McCune et al. (2015) also find that climate change's impacts on economic inequality can be mediated through existing gender inequalities. They find climate change can lead to higher poverty among women pastoralists in Africa (and thus higher economic inequality between men and women) by decreasing the financial autonomy of women when small animal assets are sold to cope with climate-induced food insecurity. It can also increase time demands on women for collection of water and fuel. McCune et al. (2015) find that the time women allocate to household labor increases due to negative climate change impacts and that this has a direct effect on child nutrition. For example, women with increased demands on their time are more likely to reduce the time spent breast feeding or initiate complementary feeding at an earlier age, consequently reducing consumption of higher quality food by younger children. Since poor nutrition in early childhood is associated with lower educational attainment and reduced incomes

over the lifespan of affected children, the susceptibility to climate change and limited coping strategies available to female pastoralists would likely have negative effects on their children and act as drivers of intergenerational inequality.

Finally, one important study to note is that of Burke, Hsiang, and Miguel (2015), who examine the effects of temperature on national level economic production over time. They find that increasing global temperatures associated with climate change will likely result in a significant increase in global income inequality via a reduction in economic production for poorer countries. Importantly, they find no evidence that technological advances or greater levels of wealth since 1960 (the earliest time period in their analysis) alters the inequality-increasing effects of higher temperatures. In other words, the study finds no evidence that wealthier countries employ more effective adaptation to climate change than poor countries. Rather, the mechanism driving the inequality-increasing effect of climate change is locational disadvantage, because poorer countries are already hotter than in richer countries. While this study calls into question the generally accepted view that the rich are less vulnerable to climate change at the national level, it provides no evidence to refute the existence of differential vulnerability at the local-level.

4. Indirect Evidence of a Vicious Inequality-Climate Vulnerability Cycle

In addition to the relatively limited direct empirical evidence testing the hypothesis of a vicious inequality-climate change cycle, one body of studies that indirectly address inequality's relation to climate change do so by examining the uneven distribution of climate-sensitive resources, such as water and land.

a. Studies of water access inequalities

Climate change is predicted to reduce water availability, particularly in already water-scarce regions (IPCC, 2007, 2014a). Direct examination of inequalities in water access exist in the literature, although they often do not directly examine the mechanisms driving differential access in the context of climate change. However, some studies suggest a strong locational disadvantage, particularly for African countries, and above all, in African cities. For example, Pullan, Freeman, Gething, and Brooker (2014) examine 41 countries in sub-Saharan Africa and find evidence of geographic inequalities in access to water and sanitation services. In general, rural-urban inequalities indicate that rural dwellers have less access to water and sanitation services than urban residents. However, within urban areas, they also find high levels of uneven access. Ashton (2002) also finds high levels of inequality in water access within African countries.

Bhattacharya and Sinha (2016) examine inequality in per capita water availability at the national level using standard inequality measures across multiple countries in six major geographic regions. Although the authors make no direct mention of how climate change or extreme weather may have influenced the trends presented, the results suggest that inequality of water access is wide-spread. They find that, generally, water access became more evenly distributed within broad regional groupings between 1990-2012. However, overall levels of access remain very low, particularly in Africa. The general trends towards more equal access to water holds when looking exclusively at rural areas. In urban areas, inequality of water access has increased in Africa, Central and South America, Europe, and the Middle East. Bhattacharya and Sinha (2016) find evidence of particularly radical increases of water access inequality for urban areas in African countries. Thus, locational disadvantages seem apparent, in that people

residing in Africa generally have less access to water and disparities of access are increasing within African cities.

One limitation of the previously discussed studies is the limited discussion of which groups or individuals have more (or less) access at the local level, beyond identifying disadvantages broadly associated with rural or urban place of residence. Some other studies do discuss specific mechanisms by which multidimensional inequalities shape uneven access to water. For example, Jaglin (2002) examines uneven access to water, and notes that increasing poverty in Africa is accompanied by increasing polarization and growing disparities in living conditions within urban societies. Christenson, Elliot, Banerjee, Hamrick, and Bartram (2014) examine the relationship between national Human Development Index (HDI) rankings and water scarcity. They find that lower levels of human development, as measured by levels of educational attainment, life expectancy, and income, are associated with higher exposure to water scarcity. These findings suggest that income alone does not shape differential exposure, susceptibility, and adaptive capacity to water scarcity. Van Aelst and Holvoet (2015) find that gender and marital status interact to influence differential vulnerability to water scarcity in rural Tanzania. Their findings suggest that vulnerability to climate change is uneven among women, and that access for women depends more on marital status than it does for men. Among women, widows and the divorced are more disadvantaged when it comes to agricultural water management and access. Moreover the discriminatory social norms that disadvantage widows and divorced women in terms of water access also make them more susceptible to future climate change by limiting their ability to adapt. For example, they find widows face high barriers to diversifying their livelihoods because they lack access to non-farm or off-farm employment opportunities. The study illustrates how individuals that disproportionally lack access to water (widows and divorced females) also remain restricted to climate-sensitive agriculturally-based livelihoods, thus increasing the probability that they will become more disadvantaged and marginalized if climate change contributes to growing water scarcity.

b. Studies of inequality related to desertification and land degradation

While definitions for desertification remain debated, one of the more widely used comes from the United Nations (1994, p. 4) which defines the process as "land degradation in arid, semiarid and sub-humid areas resulting from various factors, including climate variations and human activities." Furthermore, the United Nations (1994, p.5) defines land degradation as "reduction or loss, in arid, semi-arid and dry sub-humid areas, of the biological or economic productivity and complexity of rainfed cropland, irrigated cropland, or range, pasture, forest and woodlands resulting from land uses or from a process or combination of processes, including processes arising from human activities and habitation patterns". The IPCC (2014a) identifies climate change as a driver of desertification through feedbacks between land degradation and spatial and temporal changes in rainfall, temperature, solar insulation, and winds. They also note that the potential increase in drought frequency and severity is likely to exacerbate desertification. Several regions are identified as at high risk of increasing desertification, including Mexico, Central Asia, the Mediterranean and Central-Eastern Europe, and Sub-Saharan Africa.

Studies examining the relationship between desertification, climate vulnerability, and inequality are limited in much the same manner as with water scarcity. Few studies examine inequalities of land access before and after climate change-related impacts, and those that do often do not explicitly identify the mechanisms driving differential access to land. Blaikie and Brookfield (1987) offer some important insights into how inequality could contribute to, and be worsened by, land degradation although they do not specifically focus on the role of climate change. Their political ecology framework has been widely used in the literature to analyze uneven distribution of resources and the role of power. Some studies within political ecology find that rigid inequality of land distribution limits the success of sustainable land management practices. These studies may provide some insight into how climate change could contribute to increased land degradation and exacerbate uneven access to land.

Some studies find evidence of very high inequalities with regards to land holdings in rural regions of low-income countries. For example, Headey and Jayne (2014) estimate land holding inequality in developing regions for 1996-2010 using the Gini coefficient. They find

high levels of inequality ranging from a Gini coeffienct of .85 in South America to .46 in high population density African countries. Their results indicate that land endowments as measured by hectares per rural capita have declined in all regions. Only in the Middle East have hectares per agricultural worker increased between the 1970s and 2000s. Moreover, Jayne, Chamberlin, and Headey (2014) find that median farm size is decreasing and land ownership concentration is rising in rural Africa. Jayne et al. (2014) also find that land inequality is very high in many African countries, particularly Kenya and Nigeria, with Gini coefficients of 0.55 and 0.70, respectively. Moreover, they find evidence of rising Gini coefficients over time.

A limited number of studies do explicitly examine the relationship between land inequalities and climate. For example, Bolwig (2001) finds that land holdings are highly uneven among the Rimaïbe of northern Burkina Faso (both in terms of the size of land holdings and quality of land accessible to households), and that households with less land are less food secure and face more barriers to climate change adaptation. The study indicates that land scarcity has become particularly problematic for young farmers since they cannot earn sufficient cash income to increase their field sizes as was done by older generations, and suffer from decreased social mobility as a result. High land prices, population increase, and growing land scarcity has accentuated inequality and poverty for younger farmers. In particular, land poverty reduced returns to labor and contributed to local-level income inequality. Bolwig (2001) also finds that the ability to accumulate land and livestock is associated with the ability to diversify income sources (e.g., off-farm employment) and greater adaptive capacity to deal with drought-induced crop failures. Thus, the study illustrates how the uneven distribution of land can make some people more vulnerable to climate change impacts associated with land degradation, ultimately exacerbating inequality.

Shameem, Momtaz, and Rauscher (2014) examine the processes shaping rural vulnerability in coastal Bangladesh, and find that uneven access to land is prevalent throughout their case study villages. Their findings indicate that, in terms of climate-related stressors, tropical cyclones and salinity intrusion (caused by low rainfall, coastal flooding, and, maybe, sea level rise) impact livelihood security in their case study areas. In terms of climate-induced inequality, they find that salinity intrusion may have exacerbated already existing land

inequalities. They find that 70% of farmers in the case study area had leased or sold land to wealthier community members as farms become less productive due to land degradation.

Fisher and Naidoo (2016) find that gender plays a large role in determining land access, although they do not address issues associated with climate change. Globally, their results show that male-headed households on average own 303% more land than their female counterparts. When using median figures, male-headed households have 28% more land than those headed by females. In their study of 47 countries, only in Senegal do female-headed households have significantly higher levels of land ownership. However, they find that within Senegal, female-headed households own more land only in specific geographic areas. The authors note that one general mechanism underlying gender inequalities of land holdings in developing countries involves women's lack of secure land tenure, particularly when they are widowed. Furthermore, they state that gender inequality operates at the household, community, and national levels via discriminatory cultural, political, and market systems.

5. Using Complex Causal Chains to Investigate the Vicious Inequality-Climate Change Cycle

The causal, multidirectional pathways between inequality and vulnerability to climate change may be long and far-reaching. Inequalities may indirectly lead to greater vulnerability to climate change via its effects on multiple factors including resource conflicts, migration patterns, and disease outbreaks, which themselves have the potential to increase inequalities. In this section, the paper synthesizes the findings from different bodies of literature that suggest a complex causal chain whereby already existing inequalities act as a mechanism that triggers conflicts in the context of climate change, and that these conflicts exacerbate climate change vulnerability and already existing inequalities.

Conceptually, the vicious cycle in this case operates with conflict as a major mechanism. Various forms of inequality can drive local-level conflicts over scarce resources –whose scarcity is induced by climate change – with resultant increases in multidimensional inequality. The relationship between climate change and conflict, particularly within water scarce regions, has received considerable attention in the literature. Although the most recent IPCC (2014a, 2014b) has limited confidence that climate change drives conflict, the expanding body of work on the topic points to the likelihood of such a relationship. Hsiang, Burke, and Miguel (2013) suggest that one causal pathway linking climate change to conflict involves inequality. Specifically, they discuss a set of hypotheses that focus on grievances generated from already existing inequalities within societies. Hsiang et al. (2013) contend that climate events may increase actual or perceived socio-economic inequalities in a society or group, which then prompt conflict by motivating attempts to redistribute assets.

Numerous studies have found evidence of a general relationship between economic inequality and the increased likelihood of conflict, although they do not consider how climate change may act as a threat multiplier in these situations. Gavrilets and Fortunato (2014) find that groups characterized by higher inequality between members will expend more effort in between-group conflicts, and their results suggest this dynamic applies to all collective action problems. Bartusevičius (2015) finds that income and educational inequalities between ethnic groups increase the likelihood of popular rebellions. Fjelde and Østby (2012) find that economic

inequality increased the risk of conflicts in Africa over a 1990-2008 time period. They identify government corruption and ethnic favoritism as mechanisms that create incentives for marginalized individuals to mobilize against other groups in order to secure access to scarce economic benefits (e.g., fertile land and water wells). Moreover some studies find that higher levels of inequality are positively associated with the magnitude of the civil conflict. In the case of Nepal, Murshed and Gates (2005) identify regional inequalities not only as a chief cause of civil war, but also positively link the extent of these inequalities with the intensity of the conflict. Østby, Nordås, and Rød (2009) and Fjelde and Østby (2012) get similar results in their studies of conflicts in Sub-Saharan African countries.

Another body of work present considerable quantitative evidence linking climate stresses and shocks to conflict, although most studies caution that the relationship is far from simple or direct. Numerous studies have found evidence that inequalities often increase the likelihood of climate-related conflicts when natural resources, such as land and water, become increasingly scarce. Hendrix and Salehyan (2012) suggest that climate-induced water scarcity can generate and amplify existing grievances between social groups. In their study of conflict in African countries over a period of 20 years, they find that extreme deviations in rainfall are positively associated with all types of political conflict. Measuring inequalities in per capita water distribution using the Gini Coefficient, Gunasekara et al. (2016) find a positive relationship between uneven access to water and conflicts. The study findings show that higher levels of access inequality have a statistically significant association with risks of water conflict, particularly within African, Asian, and South American countries with the lowest water availability and high levels of poverty. Ashton (2002) also finds that inequality in the distribution of water resources in Africa plays a major role in increasing the potential for conflicts.

Political inequalities have also been found to increase the likelihood of climate-related conflicts. For example, Raleigh (2010) finds climate change-induced environmental scarcity in the African Sahel is more likely to lead to conflicts between small ethnic groups with limited political power (e.g., governments increase the risk of resource-related conflicts for marginal groups by ignoring local issues related to resource access). He finds that the communities most vulnerable to climate change are also the least equipped to challenge the government, and are thus more likely to fight with neighboring communities in order to access necessary resources.

Hendrix and Salehyan (2012) also find evidence that politically motivated conflicts increase in Africa in the aftermath of natural disasters.

Finally, a large and growing body of literature suggests that conflict contributes to increasing inequality in various dimensions by destabilizing economic livelihoods, decreasing food insecurity, and disrupting access to essential health and education services (Bircan et al., 2010; Chamarbagwala & Moran, 2011). For example, Ostby and Urdal (2014) finds that conflict leads to higher educational inequalities in Sub-Saharan Africa. In their case study of Ethiopia, Akresh et al. (2012) find that conflict may exacerbate health inequalities.

Taken together, these studies offer evidence in support of a vicious cycle whereby initial inequality increases vulnerability to conflicts driven by climate-induced resource scarcity, and results in greater inequality. However, the bodies of literature linking climate change, inequality, and conflict often do not identify which groups or individuals are more likely to lack access to resources, beyond identifying broad locational disadvantages or political marginalization. In the following section, the paper explores some of the factors driving differential exposure, susceptibility, and adaptive capacity to climate change using the case study of the African Sahel.

6. Regional Case Study – Inequality, Climate Change, and Conflict in the Sahel

Examining the case of Sahelian countries provides an opportunity to look at three slow-onset climate change related processes (changing rainfall variability, desertification, and water scarcity) within a relatively large regional context. Synthesizing broad bodies of different literature suggests that one way climate change exacerbates already existing inequalities is via its influence on conflict. The inequality/climate change/conflict nexus involves several different dimensions of disadvantage, with political marginalization being a key factor. Evidence from the Sahel illustrates how unequal societies can lead to elite capture of state institutions and, thus, contribute to marginalized groups facing higher exposure to climate hazards, greater negative impacts, and reduced ability to cope with these events. Disadvantaged groups not only receive fewer public resources to deal with climate change, but evidence suggests that they become more susceptible to the negative impacts as local level conflicts over increasingly scarce resources are not arbitrated by the state and, thus, run the risk of escalating.

Evidence suggests that rural populations in Sahelian countries are disproportionately exposed to multiple climate change processes. In the last 25 years, the Sahel region has experienced the largest decline in rainfall anywhere on Earth (IPCC 2014a). Batterbury and Warren (2001) estimate that the Sahel region has experienced a reduction in rainfall of about 20 to 30% in in the second half of the 20th century. This processes feeds into desertification, land degradation, and increasing water scarcity. Desertification in the Sahelian belt is estimated to be spreading southwards at the rate of 6-10 km per year (Abdi et al., 2013). Severe droughts, diminishing rainfall, increasing deterioration of soil quality, and increasing loss of vegetation cover have contributed to growing scarcity of fertile land. Water stress conditions are predicted to increase in the Sahel due to climate change (Hanasaki et al., 2013).

Exposure:

Locational disadvantages associated with living in an area characterized by harsh climate conditions are the main drivers of exposure to climate change in the Sahel, and the associated risks posed by desertification, water scarcity, and changing rainfall patterns. Abdi et al. (2013) find land degradation and drought in the Sahel aggravate already existing income inequalities

and decrease in food security. Galvin (2009) also finds that socioeconomic stratification is increasing among pastoralist populations, and identifies distance from infrastructure and access to natural resources as the two key factors driving economic inequality with negative implications for the poor. However, regional income inequality in Sahel states is relatively low (Lessmann & Seidel, 2015), suggesting that other sources of disadvantage also drive differential vulnerability to climate change.

An examination of the Uppsala Conflict Data Program Georeferenced Event Dataset (UCDPGED) for 2005-2014 and the Armed Conflict Location and Event Data (ACLED) for 1997-2015 indicate that a large number of socially, economically, and politically disadvantaged minority ethnic groups reside in rural areas of the Sahel. Residents of the region are largely dependent on crop agriculture and agropastoralism for their livelihoods, with about 80-90% of the population actively engaged in these activities (Doso, 2014). Pastoral and semi-subsistence crop agricultural livelihoods require living in rural locations, effectively keeping people in high-exposure locations. Poor access to labor markets limit the ability of some populations, particularly nomadic pastoralists, from leaving the climate-affected regions (Sen, 1981). Limited transportation infrastructure, poor educational facilities, and lack of access to information also limit migration opportunities or the ability to diversify livelihoods into less climate-sensitive activities. Thus, locational disadvantages interact with other types of marginalization to amplify on-going exposure to climate change.

Susceptibility to Observed Impacts:

In his work on vulnerability to famines, Sen (1981) discusses how negative impacts of extreme climate events (e.g., droughts) differentially affect members of society. Sen explicitly notes that ‘the poor’ is not a very useful category to understand ‘who’ starves during a famine, and ‘why’ they starve as opposed to others who do not. In his study of drought-induced famines in Ethiopia and countries in the West African Sahel region, Sen finds that pastoral nomadic populations were the most vulnerable because they lacked access to labor markets and government social supports.

Some recent studies have examined the factors shaping differential vulnerability to climate change within pastoralist populations. For example, Opiyo, Wasonga, and Nyangito (2014) note that vast majority of respondents in their case study of Turkana pastoralists in

northern Kenya live below the poverty line (87.5%). They find that poverty alone did not drive differential vulnerability at the local level, but that gender, marital status, length of residency, low education levels, and lack of access to extension services and early warning information were the dominant factors. Specifically, the study finds that households headed by females (especially those who are divorced or widows), households in the area less than 5 years, household heads with no primary education, and those without any access to extension services or early warning information are disproportionately affected by climate stresses and shocks. These households tend to have fewer alternative livelihood options to diversify incomes as a means to cope with droughts, floods, and other extreme events. Moreover, in pastoral communities, social norms limit the ability of female household heads to move away from traditional, climate-sensitive livelihoods, and they frequently lack credit or the necessary capital assets to pursue effective adaptation strategies.

Raleigh (2010) finds that political and economic marginalization increases vulnerability to climate change in the African Sahel. McKune et al. (2015) note that pastoralists are highly sensitive to climate change-related impacts because of the complex interdependency of livestock, ecosystem, and human health. They find that climate change has considerably increased the level of flexibility required of pastoral communities. Some types of susceptibility to negative climate change impacts are mediated through uneven power relationships between rural dwellers and governing elites residing in cities. In their study of climate change adaptation in Chad, Kalame, Kudejira, and Nkem (2011) find that stakeholder participation is limited to selective consultations, and only a small group of people have a role in the actual design of adaptation measures.

Coping and Conflict:

A considerable amount of research points to a relationship between climate change and conflict within the African Sahel. For example, Opiyo et al. (2014) found in their study of Turkana pastoralists in Kenya that respondents identified climate-related resource scarcity (e.g., grazing land and water) as a factor in increasing inter-ethnic animosity and driving local conflict. The report that households stated that violent conflicts regularly resulted in heavy loss of life, disrupted livelihoods, restricted human and livestock population mobility, and resulted in the loss of physical and financial assets. Moreover, in the absence of state support, people attempt to

cope with increasing scarcity by trying to appropriate grazing land and water wells already in use by others. The resulting conflicts are mainly ignored by the state, allowing them to escalate. Raleigh (2010) also finds that politically marginalized ethic groups are more likely to engage in resource conflicts particularly if the state is known to be unwilling or unable to redistribute resources in a society.

Abouyoub (2012) argues that, although the Darfur conflict had an important ethnic dimension, numerous other factors contributed to the violence, including social and economic injustice, and climate-induced ecological degradation. He finds that low-level conflicts over resources escalated, in large part, because severe drought in the region forced nomadic groups to change their livelihoods and seek permanent settlements in lands that were already occupied by other ethnic groups.

McKune and Silva (2013) find that people located in high conflict areas are less likely to receive food aid, making them more vulnerable to starvation and severe negative health outcomes. In addition, migration and other traditional coping options become restricted and remittances less reliable. McKune et al. (2015) find that discriminatory social structures and political policies, coupled with economic change, have pushed many pastoral communities to the limits of their adaptive capacity.

7. Concluding Remarks and Policy Recommendations

Despite the relatively limited direct empirical evidence testing the hypothesis of a vicious inequality-climate change cycle, the existing studies support the mutually reinforcing relationship between multidimensional inequality and differential vulnerability to climate change. An analysis of the complex causal chains also supports the existence of a relationship between various types of inequalities and climate vulnerability via their combined effects on resource scarcity, competition, and resultant conflicts. Moreover, there are strong theoretical motivations for supporting the hypothesis. If the poor are disproportionally vulnerable to the negative impacts of climate change, as the consensus in the literature suggests, then societies should experience increasing inequality as climate change worsens the quality of life of the poor more than it does for the better off. In other words, the welfare 'floor' should drop and, thus, increase the gaps between have and have-nots in any particular society. This relationship theoretically applies to all spatial scales. Focusing on inequalities merits greater attention in the social science literature given that, although climate change is bad for everybody (IPCC 2014a, 2014b), it is measurable worse for some individuals and groups than it is for others.

Inequality in high poverty countries has more of an impact on climate change vulnerability (and resultant increases in inequality). Poverty plus inequality is worse than just poverty via the economic and political channels that can increase political marginalization and associated conflicts. Thus, policies are particularly needed in low income countries to limit exposure and susceptibility to slow-onset climate events such as desertification, water scarcity, and changing rainfall patterns while also building adaptive capacity to these long-term processes.

The impact of inequality on climate change vulnerability is likely to be difficult to measure using income or wealth as the indicator. Even the relatively better off, by economic standards, in low income countries are likely to face considerable challenges to mitigating exposure and susceptibility to climate change, as well as hindering the ability to successfully cope with the negative impacts of climate change. Social indicators likely hold more promise for best capturing the inequality-enhancing impacts of climate change, and future work on social and political processes of marginalization merits further and immediate attention.

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