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The Influence of Social Capital on Drought-Caused Climate Change: Low-Income Farmer Adaptation.

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Abstract

Climate change continues to destroy ecosystems, cause extreme shifts in weather patterns, and threaten the livelihood of people across the globe. Drought has become one of the most pervasive weather changes, with a particularly hard impact on low-income farmers. In order to combat the impacts of drought, farmers now must take adaptive measures, which include investing in technology, shifting planting schedules, employing different irrigation methods, and more. Social capital has been recognized as an important element in supporting livelihoods, yet it is less clear how social capital influences adaptation to climate change. This paper is a literature review, examining the role of social capital in climate change adaptation for low-income farmers. Studies include research from Africa, China, Indonesia, and Bangladesh. The review consistently finds that social capital has a positive influence on adaptation decisions; farmers with a higher degree of social capital are more likely to adopt various adaptation measures. Further, the literature highlights the importance of government intervention to support social capital in adaptation. Farmers that lacked any government intervention were found to have less adaptive capacity. Government and NGO interventions should focus on extension programs that promote social capital, support local traditions and customs in solving adaptation issues, and provide financial support.

Introduction

Climate change is happening today all across the globe and will continue to worsen. Extreme weather events, sea level rise, higher temperatures, and other global ecological climate events are rapidly intensifying; irreversible damage has already been done (IPCC, 2021). As climate change worsens, rural populations–especially farmers–are the most vulnerable (Austin, 2020; Wang et al., 2014, as cited in Gong et al., 2018). Most of those farmers live in low-income countries; according to the Food and Agriculture Organization of the United Nations (2021), 90% of the world's farms are small farms, and most of those farms are in low-income nations. Most of these smallholder farmers are impoverished, food insecure, and have little to no access to markets or services (FAO, 2021). Thus, the people who supply the rest of the world with food are the most vulnerable to the detrimental impacts of climate change. Smallholder farmers are in critical need of adaptation measures to combat the changing climate. Sociodemographic factors, such as age of farmers, household size, and income, influence adaptation decisions in various ways (Deressa et al., 2009). Social capital (or the networks of relationships within and across communities) is frequently cited as an important factor that enhances farmer adaptation to the impacts of climate change (Saptutyningsih et al.,2020; Gong et al., 2018). Although the role of social capital has been the focus of considerable research since the 1990s, we still lack a complete understanding of the complexities of social capital, specifically if and how social capital can support climate change adaptation (Adger et al., 2005, Ostrom and Ahn, 2003, as cited in Paul et al., 2016).

The purpose of this paper is to evaluate the literature to determine whether or not social capital has a positive influence on the climate change adaptation decisions of populations in the agriculture sector in low-income countries. Although there are many nuances to what constitutes social capital, how it can affect decision making, and the barriers to social capital's influence on climate change, this paper will discuss social capital in broad terms. I look at how climate change is impacting smallholder farmers, the various ways such populations are adapting, how social capital is influencing adaptation decisions, and the implications of my research in future development goals and policies aimed in aiding those populations. This paper will provide necessary understanding for policy makers, corporations, NGOs/CSOs, and other developmentorganizations to better incorporate appropriate forms of climate change interventions for smallholder farmers in low-income countries.

Context

Impacts of Climate Change

Climate change is having a detrimental impact on farmers across the globe. Climate change is the global phenomenon of changing weather caused by an increase in greenhouse gas emissions. Changing weather includes extreme weather events, variable and unpredictable temperatures, flooding, and drought (Saptutyningsih et al., 2020). Average global temperatures have increased by about 2˚F, and the average global ocean temperatures have increased about 0.5˚F since the late 1900s (NASA, 2021). Global sea level has risen 20 centimeters (8 inches) in the last century, and surface ocean water acidity has increased 30% since the industrial revolution (NASA, 2021). Some communities will experience an increase in intense rainfall, while others will experience an increase in droughts (Belay et al., 2017; NASA, 2021). Research has also indicated a change in infectious disease, crop yields, and hunger prevalence due to climate change (McMichael et al., 2006). Parts of South Asia and South America have seen an increase in malaria and dengue fever outbreaks (McMichael et al., 2006).

It is now widely accepted that climate change is causing detrimental effects to many communities around the world. While different communities face different issues, vulnerable populations are at a higher risk of climate change impacts (Austin, 2020), particularly, poor agrarian communities and farmers of low-income countries (Belay et al., 2017; Paul et al., 2016). According to the World Bank (2020), 65% of working adults made a living through agriculture in 2016. A particular concern farmers face is a decrease in crop yields, which can result in a decrease of income, reduced agro-economy, and can threaten food security, health, and well-being (McMichael et al., 2006; Saptutyningsih et al., 2020). For example, the impacts of climate change may decrease the production of grains by 10% in Southeast Asia (IPCC-TGICA, 2007, as cited in Saptutyningsih et al., 2020), as well as decreasing crop yields in Sri Lanka, Ethiopia, West Africa, China, and many other low-income countries around the world (Barbier et al., 2018; Carrico et al., 2019; Gong et al., 2018; Paul et al., 2016; Yaméogo et al., 2018). Combating the damages of climate change has become a global challenge, one that must be met with rigorous research and effective problem solving.

Adaptation to Climate Change

Problem solving for climate change issues can take many forms. Adaptation to climate change can be considered the human response to actual or expected impacts of a shifting climate by modifying natural or human systems. (IPCC, 2012, as citedin Deressa et al., 2009). Adaptation is seen as an important policy and social option in reducing the impacts of climate change (Adger et al., 2003; Kurukulasuriya et al., 2008, as cited in Deressa et al., 2009). Adaptation can include growing and planting changes, such as the use ofnew crop and livestock varieties, crop diversification, the use of irrigation or new irrigation plans, and

changing planting dates (Bradshaw et al., 2004; Kurukulasuriya et al., 2008; Nhemachena et al., 2007, as cited in Deressa et al., 2009). Gong also describes adaptation as the "adoption of new technologies, practices, and institutions, technology transfer across different regions, and international trade" (Gong, 2018, p.76). Factors that influence farmer adaptation include social capital, financial stability and support, access to climate and adaptation information, as well as various sociodemographic factors such as: age and gender of the household head, education within the household, household size, household income, and farm size (Alam et al., 2016; Belay et al., 2017; Chen et al., 2014; Deressa et al., 2009; Gong et al., 2018; Saptutyningsih et al., 2020; Yaméogo et al., 2018).

The Role of Social Capital

Social capital refers to the social networks and social ties that people have within a community and outside a community that can have an effect on individual and collective decisions (Yaméogo et al., 2018). The definition of social capital varies, and the details of how social capital operates is debated (Coleman, 1990; Putnam et al., 1994; Kawachi et al., 1997, 1999, as cited in Carrico, 2019; Portes, 1998; Lin, 2002, as cited in Carrico, 2019; Putnam, 1995; Uphoff et al.,2000; Lin, 2002; Subramanian et al., 2002, as cited in Carrico, 2019; Yaméogo et al., 2018). In this paper, social capital should be understoodas a "multifaceted construct that has both structural (i.e., social hierarchy) and cognitive (i.e., cultural beliefs) components that exist at both micro (i.e., individual) and macro (i.e., community) levels" (Carrico, 2019, p. 196).

The forms of social capital that are being analyzed in this paper can be broken into four categories: Social bonding and bridging, trust, farmer-to-farmer extension, and structural and cognitive social capital. This paper analyzes these forms of social capital because they are discussed most in the literature and seen as important forms of social capital.

Social bonding refers to the social ties within one's community, while social bridging refers to the social ties one has outside of the community (Belay et al., 2017; Chen et al., 2014; Gong et al., 2018). Trust refers to the confidence one has in others to act on commitments reliably and with reciprocity (Paulet al., 2016; Saptutyningsih et al., 2020). Farmer-to-farmer extension refers to the exchange of resources between farmers in the form of knowledge or physical tools (Alam et al., 2016; Deressa et al., 2009). Structural social capital refers to the social hierarchy and norms within a community (Yaméogo et al., 2018). Cognitive social capital refers to the cultural beliefs within acommunity (Yaméogo et al., 2018). Although there is overlap in social capital types, and the types are related to one another, categorizing them attempts to make a straightforward analysis.

Methodology

This analysis used a systematic review of published articles from various online databases such as EBSCOhost, Elsevier, Sage Journals, and ProQuest. The scope of the literature review includes publications after the year 2000 and includes search terms such as "climate change," "adaptation," "drought," "poverty," "farmers," and "social capital." Publications that presented a variety of specific climate change concerns were reviewed in order to understand a wide breadth of impacts, including drought, floods, and economic concerns, among other issues. When reviewing the findings of the influence of social capital on climate change adaptation, only publications that focused on farmers in countries of West and East Africa, South Asia, and China were considered. This paper only focused on these countries because they are discussed most in the literature. Eight studies were evaluated to meet the criteria above, to be relevant to the topicof social capital, climate change, and adaptation, to be peer-reviewed, and to be an empirical study.

Findings

The articles reviewed discuss the importance of the aforementioned forms of social capital: Social bonding and bridging, trust, farmer-to-farmer extension, and structural and cognitive components. Further, the reviewed articles focused on drought adaptation. Table 1 presents a condensed summary of each study that was examined.

Table 1.
Literature Summary

Source	Scope (Location and Participation)	Methodology	Climate Impacts	Type of Social Capital Emphasized	Other Factors Influencing Adaptation	Barriers to Adaptation	Authors Recommendations
Belay et al., 2017	200 households in the low-land, mid-land, and high-land of Central Rift Valley Ethiopia	Surveys, interviews, focus groups, and observations & Multinomial logit modelling	Drought and flood	Social bonding and bridging	Gender, age, education, household size, farm size, income, livestock production	Lack of information and market access	Institutional, policy, and technological support from NGOs and government
Chen et al., 2014	108 villages, 36 townships, and 18 counties across six provinces in China	Surveys & Econometric modelling	Drought	Social bonding and bridging	Government policies	Lack of government intervention	Government intervention
Gong et al., 2018	96 households from 8 villages in the Lancang River Basin of China	Surveys and interviews & Econometric modelling	Drought, frost, and pest damage	Social bonding and bridging	Income	Access to credit and financial constraints	Government policies that alleviate financial constraints and promote social bridging
Paul et al., 2016	400 households from 20 villages of the Rift Valley, Ethiopia	Interviews, surveys, and field experiments & Linear regression modelling	Drought	Trust	Education and wealth	Lack of extension programs and government intervention; close social ties	Local level policy making
Saptutyningsih et al., 2020	286 households from 22 villages in Yogyakarta, Indonesia	Surveys and focus groups & Logistic regression modelling	Drought, flood, and pest damage	Trust	Age, family size, literacy, and farm size	Lack of institutional capacity and knowledge about environmental engagement	Local and governmental support of social traditions and the promotion of new
Alam et al., 2016	380 households in Bangladesh	Interviews and focus groups & Econometric modelling	Drought and riverbank erosion	Farmer-to-farmer extension	Education, age, gender, household income, and average land holding	Lack of information, knowledge, appropriate crop varieties, market and transportation facilities, and credit	NGO and government intervention
Deressa et al., 2009	5 regional states, 20 districts, and 1000 households in the Nile Basin of Ethiopia	Surveys & Multinomial logit modelling	Drought and flood	Farmer-to-farmer extension	Education, age, wealth, gender, household size, access to extension and credit, and agroecological setting	Lack of information and financial constraints	Investment in large scale irrigation schemes and government policies focused on providing information
Yaméogo et al., 2018	450 households from three communities in Burkina Faso, West Africa	Surveys and focus groups & Econometric modelling	Drought and changes in temperature	Structural and cognitive social capital	Education, age, land ownership, and household size	Lack of perception for the need to adapt	NGO and government intervention

Social Bonding and Bridging

Belay et al. (2017) present a case study that discusses the perceptions of climate change and the factors influencing adaptation decisions of farmers in the Central Rift Valley of Ethiopia. Factors of social bonding and bridging were shown to have significant influence on adaptation decisions. Social bonding includes factors such as family relations and access to information through these relations. Social bridging includes factors such as access to market inputs and outputs, access to extension (programs offered by government agencies or NGOs), and access to information. Data was collected through surveys, interviews, focus groups, and observations. A regression model was employed to analyze the determinants of adaptation decisions. The study found that 90% of farmers perceive climate change to be a threat, and 85% of farmers have employed some adaptation measure. Further, the study found that social bonding had a significant positive influence on soil and water conservation and crop planting changes, while social bridging had a significant positive relationship on crop diversification, soil and water conservation, tree planting, and changes to crop planting.

Similar to Belay et al. (2017), Chen et al. (2014) assessed the influence of social bonding (family networks) and social bridging (connections to government institutions) in China. The study examined these social capital factors on two types of adaptation methods, what the studycalled "engineering" and "non-engineering" methods. Engineering methods include investments and maintenance of wells, irrigation, and pumps. Non-engineering methods include adjusting crop planting, irrigation, and harvesting schedules. The study employed a large-scale village and household survey across six major provinces in China. A regression model was then used to analyze the influence of various factors on adaptation decisions. The study found that 86% of households have taken some adaptive measures. Further, the study showed that all householdsthat have taken adaptive measures adopted non-engineering measures, while only 10% adopted engineering measures. The study concluded that social capital, in terms of both bonding and bridging, have a significantly positive influence on non-engineering and engineering adaptive measures.

Gong et al. (2018) took a different approach, examining the role of social bonding and social bridging for farmer adaptation methods through the adoption of technology in the Lancang River Basin of China. Surveys were employed at both the household and the village level. Interviews of the village heads and the household heads were then conducted. Various regression models were also used to analyze the relationship between social bonding, bridging, and climate change adaptation through technology. The study found that 96% of the households had taken adaptation measures through the adoption of technologies. The study concluded that social bonding had a significantly positive influence on adaptation decisions, while social bridging had an insignificant influence on adaptation decisions.

Trust

Paul et al. (2016) presented a case study of how and why adaptation decisions occur at thehousehold, community, and government levels in rural Ethiopia. The study discussed social capital as trust and cooperation within the community. The first element of data collection included interviews of household heads, community representatives, and government officials. The second element was household surveys. The third element was field experiments consisting of investment and risk games. Regression models were then used to analyze the surveys and field experiments. The study found that 40% of survey respondents believed everyone in the community can be trusted. The study observed that trust significantly influences support for community and household adaptation.

Similarly, Saptutyningsih et al. (2020) assessed how trust interacts with other componentsof social capital, examining the willingness of farmers in Indonesia to pay for adaptation costs and the impacts of social capital on such decision-making. The study discussed social capital as the trust, community engagement, and personal relations between farmers. Focus groups were conducted to understand the willingness of farmers to pay and whether or not farmers agreed or disagreed with adaptation strategies. Then a survey was employed to a larger population. A regression model was employed to analyze the relation between social capital and adaptation decisions. The study observed that 70% of the farmers were willing to pay for adaptation costs. The study also found that farmers with more trust were more likely to adopt adaptation costs and measures. This implies that farmers who trust other farmers are more likely to adopt recommendations for climate change adaptation.

Farmer-to-Farmer Networks

Alam et al. (2016) examined how farmer adaptation decisions are affected by access to institutions and information and how such access is influenced by farmer-to-farmer extension in Bangladesh. Face-to-face interviews were conducted, and focus groups were run in order to collect the necessary data. Regression modelling was used to analyze adaptation decisions. The study found that farmer-to-farmer extension positively influenced the adoption of adaptation decisions from increased institutional and information access. Through newly accessed institutions, farmers had greater financial support, while information introduced adaptation measures were previously misunderstood or unknown.

Building on the research of Alam et al. (2016), Deressa et al. (2009) discussed specific adaptation measures taken by farmers in the Nile Basin of Ethiopia, such as crop diversification,irrigation, and soil conservation, and how adaptation decision-making is influenced by factors of social capital. Surveys were conducted from three of the four major agroecological zones. A regression model was employed to analyze the determinants of adaptation decisions. The study found that farmer-to-farmer extension significantly increased

the likelihood of two specific adaptation methods: crop diversification and tree planting. Farmer-to-farmer extension was also shown to increase other adaptation methods, although such results were not statistically significant.

Structural and Cognitive Social Capital

Yaméogo et al. (2018) assessed the role of social capital on certain adaptation measures inBurkina Faso, West Africa. Social capital is distinguished between structural social capital (SSC) and cognitive social capital (CSC). Structural social capital refers to the social organizing of a community, such as roles, rules, procedures, as well as social networks. Cognitive social capital refers to norms, shared values, attitudes, and beliefs. The data was collected through two approaches: a survey at the household level and focus group discussions. A regression model was then used to determine the factors that influenced farmers adaptation decisions. The study found that the CSC of the household head positively influenced soil and water conservation, agroforestry, and adoption of other technologies. Further, the study found that the SCC of the household head had a positive influence on conservation tillage but a negative influence on crop diversification.

Discussion

The literature discussed in this paper suggests that there are some clear benefits of social capital in regard to farmers adopting drought adaptation measures. The literature also suggests that there are many nuances to the influences of social capital. It is important to remember that all forms social capital discussed in this paper are interrelated. The forms of social capital underline the social connections and networks that make up a community. This section will discuss the benefits of social capital, and thus the social relationships within a community in the context of drought adaptation.

Social Capital and Adaptation

Across all of the reviewed literature, it is broadly accepted that social capital has a positive influence on drought and climate change adaptation. Smallholder farmers who have a higher degree of social capital are more likely to adopt some adaption measures; smallholder farmers who have a low degree of social capital are found to be less likely to adopt adaptation measures (Alam et al., 2016). Some of the important forms of social capital discussed in the reviewed articles include social bridging and bonding, trust, farmer-to-farmer extension, and structural and cognitive social capital. All these forms provided a variety of support mechanisms that contributedto adaptation. Furthermore, the access of disseminated information was seen across most of the studies as a critical outcome of social capital and adaptation decision making. Farmer's adaptation decisions were influenced by a variety of

information sources, such as peers, traditional knowledge, and government, and farmers who had access to climate information made "better informed adaptation decisions" (Belay et al., 2017, p. 10), such as planting different crop varieties (Deressa et al. 2009; Paul et al., 2016; Saptutyningsih et al., 2020). This suggests that various social capital factors— relationships within, between, and outside of the household, and the roles, procedures, norms, and beliefs of the community—are important for access to climate information, which has a significant, positive influence on adaptation decisions.

Access to information clearly plays an important role in farmer adaptation decisions because farmers are more informed. However, whether the information is accepted and translated into action seems to depend, in part, on trust. The literature found that trust is important to adopting adaptation decisions—both by the individual and collective—because trust creates receptivity to recommendations and information in regard to climate change adaptation (Paul et al., 2016; Saptutyningsih et al., 2020; Yaméogo et al, 2018). These results are corroborated by other studies, "stating that trust is needed in order to establish interpersonal relationships and adaptation" (Saptutyningsih et al., 2020, p. 4). This suggests that trust between members within a community and trust of external relationships are crucial in influencing the adoption of adaptation measures.

The Role of Government

Lack of climate information is one of the biggest barriers to farmers' adoption of adaptation measures. Almost as influential are the financial capacities of farmers, access to credit, and access to capital investment opportunities (Alam et al., 2019; Chen et al., 2014; Deressa et al., 2009; Gong et al., 2018). Both the informational and financial factors are significantly influenced by government policies and interventions. Studies found that government policies that provided various meansof support, including financial and informational support, significantly influenced the positive adaptation by farmers (Chen et al., 2014). Furthermore, a lack of extension programs has a negative effect on adaptation and suggests that government policies and intervention should include bolstering extension programs (Belay et al., 2017; Deressa et al., 2009; Paul et al., 2016). Clearly, government policy and intervention are important factors contributing to the adoption of adaptation measures. Government policymakers, as well as NGOs (Belay et al., 2017), should emphasize the role of social capital, financial support, and information dissemination. Further research is needed to understand the role of government and how social capital impacts farmer adaptation.

Conclusion

Rapid and dangerous climate change is impacting communities across the globe. Communities of low-income countries, especially smallholder farmers, are most vulnerable to the detriments of such change. Research and support are needed in order to assist the communities that produce the global food supply. It is clear that social capital plays an important role in climate change adaptation of these communities. Smallholder farmers with more social bonding and bridging, trust, access to farmer-to-farmer extension, structural and cognitive social capital, and access to various types of resources are more likely to adapt and take appropriate adaptation measures. These social connections and networks clearly provide critical information, resources, and support when it comes to climate change adaptation decisions.

This review of the literature provides some crucial insights regarding the role of social capital in adaptation and the ways in which external organizations might support it. Tapping into local markets, learning about emerging climate information, and receiving funds can all result from social capital. Additionally, financial support from external sources is necessary in order for farmers to better adopt various adaptation measures (The World Bank, 2021; Murtinho et al., 2013). Understanding how external interventions can contribute to the role of social capital is paramount in aiding farmers of low-income countries to adapt to climate change. Doing so will save the global food supply and save lives.

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