

**TSITICA WORKING
PAPER NO 11**
June 2023



CLIMATE CHANGE-RELATED SHOCKS, RESILIENCE AND EVIDENCE FROM GHANA, KENYA, AND SOUTH AFRICA

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**Climate Change-related Shocks,
Resilience and Welfare Outcomes: Evidence
from Ghana, Kenya and South Africa**

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DISCLAIMER

All opinions, interpretations and conclusions expressed in this Transforming Social Inequalities through Inclusive Climate Action (TSITICA) Working Paper are entirely those of the authors and do not reflect the views of the research funder UK Research and Innovation (UKRI).

ACKNOWLEDGEMENTS

The Transforming Social Inequalities Through Inclusive Climate Action (TSITICA) project investigates how climate change action can be socially transformative in three contrasting African countries: Ghana, Kenya and South Africa. The research agenda addresses the nexus between climate change, sustainable livelihoods and multidimensional poverty and inequality to tackle the overall question: how can climate actions be deliberately targeted to improve livelihoods and lead to equitable benefits for the most vulnerable and poor – especially for women and youth? With the goal of inspiring climate actions that also reduce poverty and inequality, based on evidence and insights from the research, TSITICA aims to contribute the Agenda 2030 ambition of leaving no one behind.

The full project team comprises researchers from two African Research Universities Alliance (ARUA) Centres of Excellence hosted by the University of Cape Town (UCT); researchers from the centres' regional nodes at universities in Ghana and Kenya; and collaborators from four universities in the United Kingdom:

- African Centre of Excellence for Inequality Research, hosted by UCT's Southern Africa Labour and Development Research Unit, School of Economics
- ARUA Centre of Excellence in Climate and Development, hosted by UCT's African Climate and Development Institute
- ARUA-CD and ACEIR nodes convened respectively by the Institute for Environment and Sanitation Studies and the Institute of Statistical, Social and Economic Research, University of Ghana
- ARUA-CD and ACEIR nodes convened respectively by the Institute for Climate Change and Adaptation and the School of Economics, University of Nairobi
- Grantham Research Institute on the Environment and Climate Change, London School of Economics and Political Science
- Townsend Centre for International Poverty Research, University of Bristol
- International Inequalities Institute, London School of Economics and Political Science
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Abstract

This paper introduces the approach taken to analyse the impact of climate change-related shocks on household welfare outcomes in Ghana, Kenya, and South Africa. The document reviews discussions on the diverse effects of climate change shocks on livelihoods and welfare, as well as the extent to which coping mechanisms mitigate these negative impacts. The paper emphasizes the use of assets as a framework for understanding resilience to climate change shocks, illustrating how varying asset levels relate to different welfare outcomes when households face such shocks. The evaluation of how climate change shocks, such as droughts and floods, affected household welfare in the three countries is described. Employing an asset lens allowed for the characterization of households' resilience and vulnerability to climate change shocks in these contexts. The paper outlines the data sources, quantitative methods, and identification strategy employed in each country to account for the interaction between climate change shocks, welfare outcomes, and assets. Additionally, the paper presents findings from the case studies, highlighting how the composition of asset portfolios shapes welfare outcomes in the face of climate change shocks, such as droughts or floods. It is observed that these shocks have a compounding effect, depleting assets, impacting livelihoods, and exacerbating poverty. However, this effect is more pronounced for households with fewer assets, and its manifestation varies depending on the specific contextual factors surrounding the shocks. Thus, different dynamics are observed between Ghana, Kenya, and South Africa.

Keywords: Poverty, wellbeing, welfare, assets, climate change, resilience Ghana, Kenya, South Africa.

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1. Introduction

Inequality has predominantly been studied in relation to the structures and policies that generate different wellbeing outcomes. Until recently, research on the relationship between climate change impacts and inequality was rare (Chancel, 2020). Even though climate change is a global issue, and climate breakdown is a global threat, there is a significant disparity in terms of exposure to climate change impacts and ability to cope with such exposures (across countries and between groups within a given country). Inequalities in communities' and households' ability to cope with and adapt to climate change-related shocks are caused by a variety of factors, including disparities in natural and physical assets, social capital, effective institutions, and governance.

In this paper, we provide a brief discussion of how the literature conceptualizes the relationship between climate change-related impacts and welfare outcomes, and how we have framed our analysis for studying the relation between assets, climate change shocks and welfare outcomes in the cases of Ghana, Kenya, and South Africa. In these papers, we aimed to understand the impact of climate change on welfare outcomes (measured by consumption levels). We are aware that in such type of analysis we are trying to describe complex and interconnected realities such as the interaction of inequalities, poverty, and their relation to social dynamics, and how they are affected by external shocks (such as climate change shocks). In this work, we narrow our focus by describing how climate change related shocks (such as droughts and floods) affected households' wellbeing.

Using Ghana, Kenya, and South Africa as case studies, we discuss the challenges of accounting for the differential impacts of climate change-related shocks on households' welfare outcomes. We argue that one lens to account for the resilience to such shocks is looking at the ownership of assets in households. This document frames the conceptual framework envisioned and the way in which these case studies relate to the literature that studies the impact of climate change on wellbeing and livelihoods.

Reflecting on how the ownership of assets related to different welfare outcomes after climate change shocks across different households, helped us to reflect about the resilience of households to the multidimensional shocks of climate change impacts in these three cases. Assets can complement the information from household income indicators and help us to understand the differences between households whose wellbeing is affected from external shocks, from those households who avoid having a negative impact in their wellbeing.

The paper proceeds as follows: it initially presents a brief framework for understanding the impact of climate change shocks on welfare outcomes (section 2); then it positions the value of looking at assets for understanding livelihoods and their resilience to climate change shocks (section 3). Following this, the document foregrounds the way in which the analysis was operationalized presenting the datasets, the identification strategy, and the main findings (section 4). Then, the paper concludes and discusses venues for future research of the impacts of climate change related shocks on welfare outcomes (section 5).

2. Understanding the impact of climate change-related shocks on welfare outcomes

Climate change shocks can be multiple and can occur in multiple ways (droughts, floods, forest fires, change in weather patterns), and the same shock can affect different communities in multiple and compounded ways. For example, in one community a drought might cause the absence of potable water, in another it might affect agricultural crops and limit the access to food; in another location it might affect the feeding of cattle that might ultimately die and affect the income of households, while also afflicting individuals and communities' access to food. In its most basic term, climate change is understood in this paper as an alteration in weather patterns which negatively affects a population and/or its environment.

The impact of past, current, and future climate change related shocks on livelihoods and social mobility is undeniable.⁸ However, our understanding of how such shocks will affect the livelihoods of individuals, households or groups or people remains limited. Given this, we aim to reflect on how past climate change shocks have affected livelihoods. This knowledge can inform future interventions to help communities mitigate external shocks.

Understanding the visible and pervasive impacts of external shocks like climate change is made difficult by the challenge of accounting for the multi-dimensional, and compounded impacts on socio-ecological systems that can have adverse impacts on communities. This difficulty stems from the fact that socio-ecological systems (any social system taking place in any ecosystem in this planet) respond to both exogenous impacts and endogenous dynamics which are difficult to account for (Barret & Costas, 2014), and involve many actors, groups, and institutions across different environments (Scricciu, 2021, p. 695).

Climate change related shocks affect the wellbeing of individuals and households. As our reporting of the impacts of these shocks on welfare creeps into our understanding more slowly than the effective degradation of livelihoods, we need to foreground the magnitude and the impact of climate change shocks on the livelihoods of citizens across the world, and their risk in deepening existing markers of marginalisation (Chancel, 2020, p. 89).

These impacts are more likely to affect those who were already vulnerable. Vulnerable individuals, communities and households are more likely to suffer the brunt impact of climate change related shocks. This, given the inequities that characterize access to resources and social protection networks. Not only the poor have less resources to respond to the impacts of climate change, but they are exposed to higher levels of risk (Tsenkwo et al., 2018). In addition, poorer

⁸ Understanding the impact of climate change on livelihoods and social mobility, while receiving greater attention more recently, has a long history of research that spans for decades. Because of this, we can account for how some climate change related shocks have affected livelihoods in the past. In addition to this, we have access to other sources of analysis and research that have accounted for the multidimensional impact of external shocks, which can help us in understanding the impacts of unforeseen external shocks on livelihoods and social mobility. For example, policy induced shocks, such as the aftermath of policies such as structural adjustment programs (Kabeer, 2015).

people are bound to lose more, relative to the non-poor in face of external shocks (Hallegatte & Rozenberg, 2017, p. 250).

Sub-Saharan Africa (SSA) is reported as being the most vulnerable region of the world to future climate breakdown shocks, this surfaces the urgency of understanding the factors that explain the resilience of individuals, households, or groups to such shocks. In this setting, is where these case studies aim to contribute. They do so by illustrating the challenges of understanding how assets can help us characterize the resilience of household's welfare levels in the face of climate change shocks. Also, these papers work as an example of how such type of analysis can be undertaken in a quantitative setting in African countries. This document frames the analysis undertaken in three different contexts (for more detail on this, see the different case studies). As such, these papers contribute to the understanding of the wider literature and the praxis of research that is interested in looking at how climate change shocks affect the wellbeing of people in Africa.

We depart by reflecting on how by looking at resilience and vulnerability to shocks can help us to describe how households, individuals, or communities cope (or fail to cope) with external shocks such as climate change impacts. Then, we foreground the use of assets as a lens to account for some of the factors associated with the resilience to climate change related shocks to frame our understanding of the relation between welfare and climate change shocks. This, in order to introduce how we studied the way in which welfare is affected by the impacts of climate change shocks, and how assets can be used to analyse different welfare outcomes.

3. Climate change-related shocks, resilience, and the role of assets

There are multiple approaches to the conceptualization of resilience and vulnerability (see Shifa et al., 2023 for a discussion on vulnerability). For instance, vulnerability can be understood as the exposure to the risk of an external shock (Winsemius, et al., 2018, p. 329), or being vulnerable can be associated with having suffered a negative climate change-related shocks (see for an example Zeleke et al., 2021).

However, a description of the vulnerability of households, individuals to climate change shocks involves identifying not only the threat – the exposure to a shock, but also the resilience to the negative effects of a climate change related shock. Thus, by looking at resilience, we can gain some understanding of the means mobilized in the face of hardships against the different impacts brought by climate change related shocks (Prowse, 2008, p. 47; Asmamaw et al., 2019, p. 3).

While resilience might be useful as a way to understand how households cope with climate change shocks, it is important to note that there remains a lack of specificity of what we understand as resilience and its relationship with livelihoods and welfare in the literature (Headey & Barrett, 2015, p. 11423). Because of this, research on resilience has led to “a loosely

organized cluster of concepts and tools for understanding and managing change in complex socio ecological systems” (Lade, et al., 2017, 2).

Resilience is a multidimensional concept constituting different components. These could be classified into two components: coping and adaptive capacity. Coping strategies relate to short term-strategies used to reduce the adverse effect of climate change-related shocks. On the other hand, adaptiveness relates to long-term strategies to avoid or reduce the exposure to future shocks.

In general, resilience has been understood as relating to the ideas of persistence, adaptability, and transformability of socio-economic systems (Lade, et al., 2017). In its most basic understanding, resilience relates to a noun describing the capacity of a structure, system, or object to return to a particular set of initial conditions after an external shock. Other authors define resilience as the ability to withstand shocks (Chancel, 2020, p. 88). Thus, with regards, to climate change-related shocks, resilience is understood in the following papers as the ability of communities, households, or individuals to withstand an external shock (such as a climate change shock) and maintain their welfare and livelihoods (Ibid).

Different researchers have looked at the role of assets in explaining households’ resilience in the face of climate related shocks (Dasgupta et al, 2010; Winsemius et al., 2018; Nsubuga et al., 2021; Acosta et al., 2021). Research on asset dynamics has also been instrumental to understand the interaction of poverty and social dynamics in the cases of South Africa (Adato, et al., 2006), among pastoralists in east Africa (Lybbert et al., 2004), in Kenya and Madagascar (Barret et al., 2006), looking at the impact of climate change in Ethiopia (Barret & Santos, 2014), or vulnerability to poverty traps (Stephens et al., 2012).

Assets generally refer to physical resources controlled by individuals, households or formal or informal groups, and/or financial assets (i.e., savings, investments) (Carr, 2020, Barret et. al., 2014). They also refer to the access to social capital and support networks (Prowse & Scott, 2008). Assets are defined in this paper as the vehicles used by households for storing value, as a way of “insuring” livelihoods which may provide a stream of financial and social resources across time (Doss et al., 2020, 147), and that can provide a “collateral” to raise funds (Mogues & Carter, 2005).

The definition of assets is usually related to the definitions of wealth and capital. Because of this, assets are usually understood and measured as those resources used to generate (or that can potentially generate) incomes including future income against which one might borrow (Barret et al., 2016). However, not only physical assets play a role in conditioning the well-being and the livelihoods of individuals, households, and communities. Non-labour productive assets play an important role. Examples of these are household relations, social capital, natural assets, and the existence of formal and informal social protection networks (Dasgupta & Baschieri, 2010).

Looking at assets can provide important insights to explain the existence of resilience to external shocks in different contexts as categorical inequalities condition resilience outcomes. Thus, by looking at assets, we can potentially explain the way in which different climate change shocks

affect livelihoods (Chancel, 2020, p. 89). Because of this, some researchers have highlighted the importance of reflecting about how the distribution of assets impacts the resilience and vulnerability of individuals in a society (Denning et al., 2015).

Assets have been argued to offer a clearer way to account for some of the strategies that individuals, households, and communities deploy in response to external shocks (Prowse & Scott, 2008, p. 48; Carr, 2020; Barret et al., 2016). Assets are the resources people can use to act and respond to the shocks and challenges impacting their livelihoods (Prowse & Scott, 2008, p. 47). Thus, assets can be seen as means to describe different welfare outcomes associated within climate change related shocks for individuals, households, or communities.

As the challenges of ongoing climate change related shocks are likely to exacerbate inequalities within and between generations, we argue that by describing the resilience to climate change shocks and environmental collapse via an asset lens, we can try to understand to what extent resilience to climate change shocks is/is not associated to the assets people have access to (Chancel, 2020, p. 4).

We argue that, while imperfect, assets can provide a processual lens to explain some of the impacts of negative shocks associated with climate change as well as allowing us to present a different account of the vulnerability and resilience of individuals, groups, or households to shocks.

Assets are also more stable than income variations, but also change faster than wealth variations, allowing us to better account for the resilience of household's welfare to the impact of external shocks such as climate change. Given that assets relate to security and support, assets play a role in most household's resilience strategies in light of external shocks (Tsenkwo, et al., 2018, p. 2163).

Assets can also account for the social function of statal and non-statal redistributive and social assistance mechanisms embedded in some communities and households, which can better account for the resilience of livelihoods in the face of negative external shocks.

Thus, for example, while a reduction of income will immediately show in the income of a household, assets can buffer and protect wellbeing against external shocks. Also, assets can be used in responses that aim to maintain welfare and consumption levels, such as the selling or pawning of assets across a period; in some cases, these assets were productive assets, whose sale or pawning is likely to improve the cash flow in the short term responding to a negative shock, but might affect its future sources of income (Kabeer, 2015, p. 196-197). Because of this, accounting for how assets relate to livelihoods and their resilience.

Assets, can thus reflect both past and future income generation opportunities, presenting an intermediate rung that can help us to connect income and wealth, that provides a constituent element of welfare and social dynamics associated with climate change related shocks. This lens can help in illustrating the relation between assets and resilience in the face of climate shocks (Vijaya, et al., 2014, 71).

Such a framing can help us to describe another set of factors explaining the resilience of households to such shocks. It also can help policy makers to understand how assets and their protection can support interventions aimed at protecting people from the negative impacts of climate change related shocks, while unveiling some of the mechanisms that can potentially protect people from falling into poverty (Barret, et al., 2019, 2).

The value of assets for understanding welfare relates to how the access (or the lack of access to) to different assets can contribute to explain different outcomes in the welfare of individuals. Assets can provide a different lens to describe the resilience and vulnerability of individuals, households or groups in a way that is not possible using only income data (Vijaya, et al., 2014, 72). Looking at assets therefore can help us better understand resilience and contribute to the understanding of poverty dynamics associated with climate change shocks (Townsend, 1993, p. 121).

Assets present important empirical benefits for the study of welfare in developing contexts. These benefits stem from the existence of data on assets in developing countries via different surveys, potentially allowing the comparability of data across countries. Assets can also help us overcome some of the challenges in accounting for incomes and wellbeing when looking at employment data. As high levels of informality are characteristic of the population of several developing countries, or the high levels of rural subsistence labour, accounting livelihoods and welfare by looking only at income might fail to account for other sources of income such as incomes from informal jobs or informal enterprises, whose data might be limited (Kruse et al, 2021).

Because of this, understanding who uses, has access to, and controls assets remains crucial for the appropriate design and targeting of interventions in response to shocks (Doss et al., 2020, 145). Thus, by looking at assets and their interaction with welfare, the country case studies of Ghana, Kenya, and South Africa introduced by this framing paper, can help us to have a more nuanced understanding the role assets play in explaining the resilience to external shocks in different African contexts.

4. Operationalising the analysis of climate change-related shocks, assets, and welfare outcomes in Ghana, Kenya, and South Africa

Households can utilise several ex-ante and ex post coping techniques to mitigate the impact of climate-related shocks. These can include the migration of household members, diversifying sources of income, drawing on assets and savings, among others (see Hirvonen et al., 2020; Ansah & Gardebroek, 2021; Zeleke et al., 2021; Abiona et al., 2022).

This section describes how the research of the cases of Ghana, Kenya and South Africa looked at the role of assets to describe whether and how assets played a role in mitigating the negative impact on welfare due to climate-related shocks.

This line of enquiry is supported by existing evidence which suggests that physical, financial, and social assets play an essential role in mitigating the negative effects of climate change-related shocks (Prowse & Scott, 2008; Ansah & Gardebroek, 2021; Zeleke et al., 2021). This is also motivated by evidence about how in the face of climate-related shocks, household resilience is associated with the ownership of different kinds of assets (see Prowse & Scott, 2008). Our working hypotheses -for the three case studies- is that asset ownership is expected to improve households' ability to mobilise resources and may observe lower welfare deterioration due to climate-related shocks (Moser, 1998, p. 3; Prowse & Scott, 2008, p. 47).

Climate-related shocks can vary in their nature, also can change within a given country can differ depending on the location and the period considered. Because of this, various conceptual frameworks have been used to link climate-related shocks, coping mechanisms, and welfare outcomes.

In Africa, droughts and floods are the most common type of climate-related shocks taking place in the continent, affecting a considerable proportion of the population (Diallo & Tapsoba, 2022), because of this, the study of Ghana, Kenya and South Africa looked only at the climate related shocks of droughts and floods.

Figure 1 depicts how we conceptualised the relationship between a climate-related shock, such as a drought, the role of assets as a coping mechanism, and welfare outcomes. As figure one illustrates, a climate change shock (i.e., a drought), can have more than one impact (depicted in figure one as first order or second order impact). The direct impacts would affect agricultural yield of crops, and the reduction of the area cultivated due to a drought. The compounded impact of these would imply an increase in the costs of food. On the other hand, a drought can have other type of impacts, such as affecting the amount of agricultural employment in each area and affecting some of the assets owned by households (i.e., livestock).

When shocks are not compounded (for example income is affected in Figure 1), they are less likely to affect welfare in the long term, however, when different shocks are combined, they are more likely to affect wellbeing negatively. This is illustrated by findings from research that have

illustrated how incremental effects increase the vulnerability of households, and how this relates to the absence of assets (Kodwo Ansah & Gardebroek, 2021, p. 414).

While Figure 1 represents the shocks affecting incomes, this diagram does not take into account the responses to past shocks and their relation to current asset portfolios. This illustrates the endogeneity of the relationship between climate change shocks and asset ownership, highlighting the importance of reflecting about the conceptualisation of such dynamics (Islam & Winkel, 2017), and the need for checking for endogeneity in the statistical analyses of the ownership of assets and the resilience to climate change shocks.

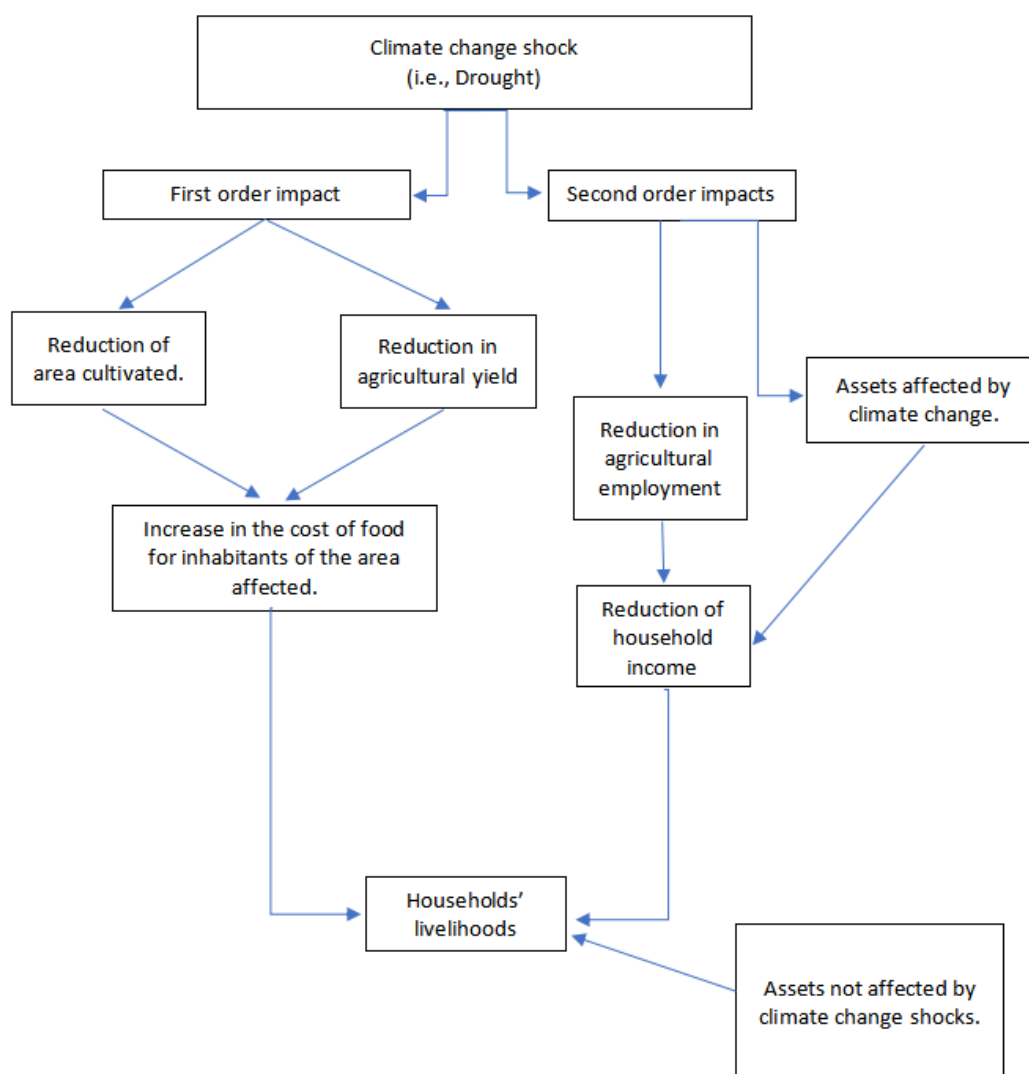


Figure 1: Illustration of the multiple impacts of a climate change shock

Source: Adapted from (Bimal, 1998)

There have been several methodologies used to evaluate the impact of climate change-related shocks on welfare outcomes, as well as the moderating function of assets and other coping mechanisms. These methodologies differ depending on the type of climate-related shocks under

consideration, the unit of analysis, and the country context. There are numerous approaches used for analysing this relationship, including asset vulnerability frameworks (Dasgupta, 2010; Winsemius, 2018), looking at poverty transitions in and out of poverty in relation to climate change shocks (Aggrawal, 2021; Islam & Winkel, 2017; Tesfaye 2020), distributional data (Gebrehiwot 2021; Hirvonen, 2020), simulation models (Hallegate, 2017; Gao and Mills, 2018; Rentschler et al., 2022), and mixed methods approach that bring together qualitative and quantitative information (Bimal, 1994; Nsubuga, 2021).

We describe below the sources of data, and methods employed in the study of Ghana, Kenya, and South Africa below (for more detail on the methods and data sources used in each case study, please see each of the country papers).

4.1 Data sources and measurements

The approach used to estimate the impact of climate related shocks on welfare outcomes varies depending on the type of data used and the unit of analysis. For example, if we have data on individuals, our analysis should link climate change shocks with individual subjects. On the other hand, if the data is related to a particular area, we need to account of how a climate change shock affects individuals located in a particular region. Thus, the nature of the data determines how the key variables of interests such as climate related shocks, welfare and assets are measured. Data also conditions the estimation approaches used to describe the relation between these three variables.

4.1.1 Measuring welfare and assets

In the context of the three countries studied (Ghana, Kenya, and South Africa), we had access to household survey data for each country to measure welfare and assets. In the case of Ghana, the Ghana Socioeconomic Panel Survey (GSEPS), a nationally representative panel dataset covering 5009 households was used. In case of South Africa, the data from three waves of the National Income Dynamics Study (NIDS) dataset, which is a nationally representative individual micro panel survey implemented across five different waves were used (Brophy et al., 2018). Panel data is lacking in the case of Kenya, therefore a cross-sectional data from the Kenya Integrated Household Survey (KIHBS) 2015/2016 was used. The datasets in the three case studies have their own limitations and advantages for estimating the impact of climate related shocks on household welfare (see the country papers for a detailed discussion for each case study).

Per capita expenditure has been one of the most widely used metrics in analysing the impact of climate-related shocks on welfare outcomes. Other welfare outcomes, such as food insecurity measurements, nutrition outcomes, and health outcomes, have been studied (see Hirvonen et al., 2020; Lohmann & Lechtenfeld, 2015). In our three case studies we measured welfare as the per adult equivalent or per capita consumption expenditure (measured by the logarithm of consumption expenditure) to measure individual or household welfare outcomes.

Assets have multiple dimensions, including both economic and non-economic dimensions (Johnston & Abreu, 2016, p. 402; UNDESA, 2019), leading to various approaches being used to quantify

assets in practice. However, in most circumstances, it is not possible to obtain data on all dimensions of assets, and our study of Ghana, Kenya and South Africa was no exception. As a result, for our case studies, given our data availability, our asset estimates excluded the analysis of natural and social assets, and were limited to financial or physical assets.

In addition to the implications of data availability, another challenge is determining how to aggregate varied asset portfolios into a single measure of total assets. One of the most common approaches for determining asset value is to estimate the price of assets and aggregate their collective value. However, because the value of assets is not always available in household surveys, the implementation of such approach is contingent to the existence of such kind of data. Due to this challenge, studies frequently rely on using specific assets – for example accounting for livestock as an indicator of general asset ownership. Another option is to calculate what is known as "an asset index", which is constructed using data on ownership of various assets (La Fleur, 2016; Wittenberg and Leibbrandt, 2017; Mckenzie, 2005).

In the case of Ghana, the GSEP survey collects data on asset ownership and their monetary values. These assets include livestock, agricultural equipment, non-agricultural land, financial assets, company assets, and consumer durables.

In the instance of Kenya, estimating the monetary values of assets was impossible due to a lack of price information of assets in the KIHBS. As a result, measuring asset holdings was made via an asset index. This was done via a principal components analysis approach that used information on numerous assets such as household goods, livestock, vehicles, and farm machinery.

In the case of South Africa, some of the NIDS waves capture data on various asset values, which provides the monetary value of total assets. The total asset value estimates include real estate assets, business assets, vehicles, financial assets, retirement annuities, livestock value, and household consumer durables (such as TV, washing machine, etc.). However, the values of consumer durables were not consistently measured across the three waves used in our analysis (for a more detailed discussion on this see the South African case study).

4.1.2 Measuring climate-related shocks

There are different ways for accounting for climate-related shocks. One of them is to use survey respondents' self-reported experience of climate-related shocks, or to use meteorological data such as rain anomalies and vegetation anomalies. Recent research has increasingly used meteorological data to measure or forecast climate-related shocks in each area. This, due to improvements in spatial and climate-related data collection, and the absence of surveys that incorporate such information. One example of the latter is the use of rainfall or temperature data to estimate the occurrence of climatic shocks⁹.

In case of Ghana and South Africa, the main indicator used to measure climate-related shocks was the Standardised Precipitation-Evapotranspiration Index (SPEI), created by Vicente-

⁹ This is usually estimated via different measures of standardised deviations of the trends of climatic variables from their historical averages (i.e., Gebrehiwot et al., 2021).

Serrano et al. (2010)¹⁰. In the case of Ghana, the most common shock observed was flooding. As a result, an indicator of flooding was created based on the SPEI data, with a value of 1 if the SPEI is greater than 0.5 and zero otherwise (see the Ghanaian case study). In the case of South Africa, a climate shock variable was constructed based on the SPEI index that indicates the occurrence of severe or extreme drought (SPEI ≤ -1.5) and extreme wetness (SPEI > 1.5) was created¹¹. Using the geographic information from the GSEP and NIDS surveys, the climatic data from geographic information systems (GIS) on climate was combined with the household survey information¹².

In the case of Kenya, the KIHBS survey includes information on self-reported drought and flooding experiences. As a result, in the study of Kenya, self-reported experience of climate-related shock was used as one of the measures used to account for climate-related shocks. In addition to this, monthly temperature, and rainfall data was retrieved with a spatial resolution of 0.5 x 0.5 degrees from the IGAD Climate Prediction and Application Centre (ICPAC) to calculate the occurrence of climate change shocks¹³. This information was merged to the household survey data at the country level¹⁴(see the Kenya case study for more detail).

4.2 Empirical strategies

The empirical methods used to evaluate the impact of climate-related shocks on welfare outcomes varied depending on the nature of data available, how the key variables of interest were measured, and the unit of analysis chosen. This is evinced in detail in the three country case papers. Below we provide a brief overview of the methods used.

A common approach to analyse the impact of climate-related shocks on welfare outcomes uses panel data regression methodologies such as fixed effects estimation strategies or the difference in difference (DiD) estimation method. In the cases of Ghana and South Africa, such estimation approaches were used.

In the case of Ghana and South Africa, for example, the following reduced form model was specified:

¹⁰ The SPEI is a standardised variable with a mean of zero and a standard deviation of one, and its value typically ranges from -5 to +5. Thus, negative numbers represent droughts and positive values represent floods. SPEI data with a spatial resolution of 0.5 x 0.5 degrees grids is accessible from the Global SPEI database or the World Meteorological Organisation (WMO).

¹¹ Only drought measures are analysed in South Africa because very few people have experienced flooding during the years for which we have available data (see the South Africa case study for more detail).

¹² The GIS data provided detailed information about climate data on a map across different regions and is referenced by latitude and longitude coordinates. On the other hand, household surveys had also latitude and longitude coordinates. The matching of data from GIS with household surveys integrated the information from both sources by matching the geographic locations. Thus, in the case where a grid had data on a particular climate change variable (i.e., drought), if a household is located within that specific grid, the data with regards to the occurrence of drought was ascribed to that household.

¹³ The climate-related shock was calculated by subtracting the 2-year and 4-year average monthly rainfall variations from the long-term average monthly rainfall, which is then divided by the long-run average standard deviation.

¹⁴ See footnote 8.

$$Y_{it} = \alpha_i + \psi_t + \delta D_{it} + X_{it}\beta + e_{it} \text{-----}(1)$$

Where Y_{it} indicates the real per capita consumption of individual i at time t , α_i indicates individual heterogeneity, ψ_t is time dummy, X_{it} indicates a vector of household and individual level controls, e_{it} is the error term, D_{it} is a binary variable equal to 1 if the SPEI index value is greater than 0.5 (for the case of Ghana) or if it is less than -1.5 (in the case of South Africa) and zero otherwise. The δ captures the impact of the drought on consumption outcome. An interaction term of the climate shock variable and asset values was included to test the heterogeneous impact climate related shocks on household welfare between those individuals with or without assets. The product of asset values and the SPEI index is included to measure the buffering effect of assets on climate shocks.

In the case of Ghana, the model was estimated using random effects estimation approach. The use of random effects was justified since the climate shock variable that was used to measure severe wetness or flooding is time invariable.

In the case of South Africa, a drought took place in 2016. Because of this, and given the data availability in South Africa, we could observe individuals before and after the drought year. In the case of South Africa, a difference in difference (DiD) model was evaluated as a robustness check. The following DID regression model was specified:

$$Y_{ipt} = \alpha_p + \psi_t + D_p\delta + X_{ipt}\beta + \mu_{ipt} \text{-----}(2)$$

Where Y_{ipt} indicates the real per capita consumption of individual i in location p , and time t , α_p is location fixed effects, ψ_t is time dummy, X_{ipt} indicates a vector of household and individual level controls, μ_{ipt} is the error term, D_p is a binary variable equal to 1 if the 2016 SPEI index values observes a severe drought and zero otherwise in location p . The impact of the drought on consumption outcome is measured by δ , which is the interaction of time and treatment status D_p . In equation (1), δ gives us the average treatment effect on the treated (ATET).

Given that there was no panel data available in the case of Kenya, a cross-sectional estimation method was used. In particular, the control function approach was used to test and address the potential endogeneity issues (see Wooldridge, 2002; 2015). The approach involved a two-stage residual inclusion (2SRI) procedure that follows Papke and Wooldridge, (2008) (see Kenya case study for a detailed explanation). The first step involves estimating the reduced form equation for household asset ownership (see equation 3).

$$HAI_i = \alpha + \lambda ACHAI + \gamma CCS_\tau + \sum \delta_k Z_{ip} + u_i \text{-----}(3)$$

Where, HAI is household asset index; ACHAI is cluster level average of household asset index which is used as an instrument for HAI; CCS is a set of climate change shocks, Z is a set of other control variables and u_i is the reduced-form error term.

The second step estimation is aimed at purging the potential endogeneity of household asset ownership and heterogeneity (see eq. 4). The dependent variable is the logarithm of per adult equivalent consumption expenditure (PAECE).

$$\ln(\text{PAECE}_i) = \alpha + \phi \text{CCS}_i + \mu \text{HAI}_i + \sum \beta_k Z_k + \theta_1 \text{HAI_res}_i + \theta_2 (\text{HAI}_i * \text{HAI_res}_i) + \varepsilon_i \text{-----}(4)$$

HAI_res_i is the reduced-form residual from equation (3), while $\text{HAI}_i * \text{HAI_res}_i$ is the interaction term constructed by interacting the reduced-form residual with the observed (actual) value for the index of the assets owned by a household (HAI). The disturbance term, ε_i , comprises random and the unobservable parts and α , λ , γ , δ , ϕ , μ , β , and θ are vectors of parameters to be estimated.

In the case of Kenya, two variants of the models in equations (3) and (4) are estimated: in the first variant, climate change shock is proxied by flooding/drought, as reported in the household surveys; in the second version, the climate change shock is generated using county level monthly rainfall data. This allowed to check whether there is any consistency in results based on climate change shocks reported at the household- and county levels.

Although climate change shocks are assumed to be exogenous, asset ownership is not random. Because of this, the asset variable may be correlated with unobservable components that are not included in the regression equation. To minimize such biases, the studies controlled for among other factors, education levels, individual and household level characteristics, access to social grants, and locations. We are aware that using an instrumental variable approach could be another alternative, however, finding an appropriate instrument that only correlates the asset variable but not with welfare (the consumption variable) remains difficult.

4.3 Results and main findings

We summarise some of the key findings of the empirical analysis in the three case country contexts in this section (for a more detailed analysis and discussion see each country paper).

In Ghana, the impact of severe floods on overall household consumption expenditures is negative, with individuals in rural communities suffering the brunt of the burden. The effect of severe flooding on overall household consumption expenditures is positive for urban families, but the analysis for food consumption shows a negative effect. This suggests that flooding occurrences likely to significantly increase non-food spending in urban families, resulting in a net positive effect. The extent to which floods affect household consumption expenditures is determined by the duration of the flooding and the location of the household. The effect tends to decrease as the length of flooding conditions increases in the overall sample, but not in the rural sample, where the effect increases with the length of flood. Furthermore, the potential of total household assets to buffer this effect is positive, but only over the long term (i.e., 48 months). While urban households' assets are maintained or protected during flood occurrences, the buffering effect of total assets is dynamic, alternating from a negative effect on consumption in the short term (12 months) to a positive effect in the long term (48 months).

According to the study from Kenya, the impact of drought/flooding on household welfare is negative and statistically significant at the national level, as well as in urban and rural samples. According to the self-reported climate linked shock indicator, the negative impact of climate related shocks on household welfare is greater in rural areas than in urban areas. Similar results were found when climate-related shocks were quantified using geocoded rainfall data, indicating that climate change shocks reduced Kenyan welfare. Regardless of the variable used to evaluate climate-related shocks, households that had assets and credit availability were more protected against the negative effects of climate related-shocks.

In South Africa, it was expected individuals with fewer assets would be more negatively affected by climate change shocks than individuals with more asset holdings. In contrast to the evidence from Kenya and Ghana, the South African analysis reveals that climate-related shock (drought) had no statistically significant impact on individual consumption. There are several reasons that could explain this. One possible reason for this result is the coverage of social protection in South Africa. A considerable proportion of the low-income population receives social grants. As of 2017/2018, 17 million South Africans received grants. In addition to this, subsistence agriculture is not the main source of income in South Africa, as it is in Ghana and Kenya. Only about 4% of households in South African participate in subsistence farming. Furthermore, a larger proportion of the population lives in urban regions with better access to infrastructure. Thus, it is possible that climate-related shocks did not significantly reduce household consumption for the poor because existing social grants can serve the function of an asset rent, which does not appear in asset indexes but provides an insurance function that allows welfare (measured by consumption levels) to be maintained.

6. Discussion and conclusion

There is little doubt that climate change shocks are a major concern globally and Kenya, Ghana and South Africa are no exception. Given that the most vulnerable in these countries will experience the brunt force of the shocks to come, it is imperative that we understand how the welfare of citizens can be protected in light of these future shocks.

These three papers illustrate the complexities of the study and the analysis of these shocks on livelihoods. While the main objective of these papers was to analyse the impact of climate change shocks on household welfare and assess the effects across poor and rich households, the study itself raises further questions such as the impacts of climate change on other dimensions of welfare (i.e., health), or the methodological challenges for undertaking this type of research.

The methodological diversity between these three cases stemmed from the challenges faced in aligning research questions, data, and methods to be able to rigorously evaluate the impact of climate change shocks. This highlights the need for researchers to be careful in the precision of our language when we speak of climate change shocks and the obligation of being more transparent about our findings and their caveats. We must remember our duty to provide nuance and context to our statements, this includes (but is not limited to) the need to contextualize

our analysis and the decisions associated with regards to concepts, data, methods, and indicators.

The results of the three case studies show that the occurrence of climate change shocks may affect household welfare. However, the fact that the significance, extent, and direction of the impacts of climate change shocks diverge as a function of the locations, the nature of the shock (drought or flood), or their duration (short term vs long term) illustrates the need for careful consideration and exposition of the contexts, conditions and factors leading to such outcomes. With these three country study papers we are aiming to illustrate such complexities and illustrate how can we evince the value of acknowledging the challenges of linking concepts, variables, data indicators and methodologies to inform future research.

As the continent remains vulnerable to future climate change impacts, this type of research becomes vital for the wellbeing of citizens in the continent, whether by coping strategies, extended social protection mechanisms, or social protection programmes. The African Centre of Excellence for Inequality Research aims to centre the excellence of African research and researchers. Such excellence needs to depart from the need to make knowledge and research about climate change shocks explicit (in their methods, conceptualisation, and implementation) for other researchers, to allow the construction of further knowledge of such topics by other researchers in the continent.

In Ghana, Kenya, and South Africa, we have found that existing markers of marginalisation (i.e., having many dependents, depending on social grants, or belonging to specific categories) are associated with lower per capita consumption levels, and higher values of assets was associated with higher wellbeing. This speaks of the inequities within each country and how they resonate with the impact of climate change shocks and the protection of those most vulnerable.

The research undertaken remained limited by different factors. Our concern for endogeneity brings to the fore the need for future studies and highlights the need to understand the social dynamics of resilience and vulnerability (which are not necessarily captured in the data sources we have) to properly account for the way in which inherited marginalisation and vulnerability positions people to face climate change shocks. This result brings further questions that should be considered in future research associated with the measurement of climate change shocks, assets, and the role of assets in mitigating consumption shocks and their time dimensions.

The composition of assets and their use in response to climate shocks illustrates the complexities in the way assets are utilised as buffering mechanisms. There is not a single magical asset that protects people equally across contexts. This calls for a deeper understanding of the idioms of asset accumulation and their individual and collective usage in light of climate change shocks.

Also, this calls for a deeper understanding of the role of other kinds of assets, such as cultural social, and natural capital in explaining the responses to climate change shocks. Such kind of research would require newer datasets, and different data collection and analysis techniques that can account for them.

Also, it is necessary to collect and gather information and evidence of other countries in the continent. This would allow us to build a typology of contexts and impacts- and hopefully responses to climate change shocks.

This information will prove vital for programs aimed at building the resilience of households against climate shocks. Understanding these relationships remains fundamental to enhancing design and effectiveness of various asset accumulation interventions to the negative welfare effects of protracted crises to come.

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