Chapter 2
Weather Shocks, Gender, and Household Consumption: Evidence from Urban Households in the Teso Sub-region, Uganda

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2.1 Introduction

Weather shocks such as intense or prolonged droughts and floods are becoming more prevalent in sub-Saharan Africa (SSA) due to climate change (IPCC 2018; Niang et al. 2014). At the same time agricultural, the seasons are becoming increasingly unpredictable in the continent (Patricola and Cook 2011), often affecting negatively crop yields and food consumption (Akampumuza and Matsuda 2017) and food security (Wheeler and Von Braun 2013), especially among rural farming communities (Fafchamps and Lund 2003; Dercon et al. 2005; Kurosaki 2006; Lobell and Burke 2009; Lema and Majule 2009; Ringler et al. 2010; Jack and Suri 2014) (Chap. 1 Vol. 1; Chaps. 1, 3 Vol. 2). Such climatic effects are also expected to have negative effects on food production – and especially cereals – (Fraser et al. 2013; McMichael et al. 2007; Parry et al. 1999; Xiong et al. 2010; Rosenzweig and Parry 1994; Parry et al. 2004) and exert upward pressures on food prices (Vermeulen et al. 2012). This could eventually reduce food affordability and calorie availability and increase childhood malnutrition in the region (Jankowska et al. 2012). It is also projected that food security and livelihoods could be affected in SSA due to the loss of access to drinking water (Wheeler and Von Braun 2013). In urban areas, weather shocks often disrupt food flows from rural areas, further affecting food security in the continent (Gasper et al. 2011).

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The ability of households to insure against such weather shocks is limited given the market imperfections in African insurance markets (Alderman and Haque 2007; Townsend 1995). In such contexts, households strive to maintain food security and their livelihoods through different coping strategies such as increasing their participation in the labor market (Beegle et al. 2006; Ito and Kurosaki 2009), selling livestock (Hoddinott 2006), adjusting grain stocks (Kazianga and Udry 2006), receiving remittances from family members and friends (Jack and Suri 2014; Munyegera and Matsumoto 2016), and diversifying their income sources (Kochar 1999; Porter 2012) (see Chap. 3 Vol. 2).

However, the negative outcomes of weather shocks on household livelihoods and food security are sometimes far too strong to be fully offset through common coping strategies (Akampumuza and Matsuda 2017; Fafchamps et al. 1998; Dercon 2002). The effectiveness of coping strategies is often limited by the technological, environmental, and economic constraints faced by the affected households (Fafchamps 1999). It is also noteworthy that climatic and environmental hazards affect urban residents differently, depending on their assets and coping capabilities, which in turn depend on multiple factors such as income (Mendelsohn et al. 2006; Bohle et al. 1994), age (Striessnig et al. 2013), level of education (Muttarak and Lutz 2014), and gender (Akampumuza and Matsuda 2017; Asfaw and Maggio 2018). Thus when designing pro-poor adaptation strategies aimed at protecting individual, household, and community assets and capabilities, it is necessary to understand the factors that give rise to such differentiated vulnerabilities (Muttarak et al. 2016).

The above suggest that securing urban livelihoods and ensuring food security in the context of climate change are major sustainability challenges in SSA. This is because ensuring food security and livelihood resilience, two major sustainability challenges in their own right (Chap. 1 Vol. 1), is further compounded in the context of urbanization and climate change, two of the major changes facing the region (Chap. 1 Vol. 1). This interface spans multiple sustainable development goals (SDGs) such as SDG1 (No poverty), SDG2 (Zero hunger), SDG11 (Sustainable cities and communities), and SDG13 (Climate action), to mention some. This constitutes a multifaceted sustainability challenge for which most SSA countries lack capacity and resources to prepare against (Chap. 5 Vol. 1).

Although many studies have analyzed the effect of (and coping strategies against) weather shocks in SSA (Akampumuza and Matsuda 2017; Jack and Suri 2014; Ito and Kurosaki 2009; Kazianga and Udry 2006; Beegle et al. 2006; Hoddinott 2006), there is little evidence on whether common coping strategies are effective enough to restore the pre-shock levels of livelihoods and/or food security. Besides, most existing studies in SSA have analyzed the impacts of weather shocks in rural contexts (Kazianga and Udry 2006; Dercon et al. 2005), while impacts to urban households remain less studied. Achieving the comprehensive understanding of such phenomena is quite important because rural-urban disparities imply that weather shocks could pose different impacts and available coping strategies to rural and urban households.

Another major knowledge gap is whether female-headed households have different vulnerability to (and ability to cope with) weather shocks compared to male-headed households (Klasen et al. 2014). Female-headed households in SSA tend to have lower access to productive assets such as land (Deere and León 2003) and education (World Bank 2012), as well as face more restrictive entry requirements into the formal labor market due to prevailing economic and socio-cultural inequality (Contreras and Plaza 2010) (Chap. 1 Vol. 1). Such differences might reduce the ability of urban female-headed households to cope with changes in food consumption due to weather shocks.

Uganda is one of the SSA countries characterized by high gender inequality and urban vulnerability to extreme weather events, which create certain preconditions for the disruption of livelihoods and food security. The climate is generally bimodal, with two rainfall seasons (March–May and October–November) and two dry seasons (June–August and December–February) (Egeru 2012; Mubiru et al. 2012; Nimusiima et al. 2013). However, climate change over the past three decades has affected the onset, offset, and duration of the rainy seasons, making it increasingly unpredictable (Mcsweeney et al. 2010; Funk et al. 2012; Lipper et al. 2014). There is also a notable increase in surface temperature (+1.5 °C between 1960 and 2030), with the number of extremely hot days expected to further increase by 15–43% by 2060. Extreme weather events such as droughts and floods are equally changing in both frequency and severity (Irish Aid 2017). For example, between 2001 and 2011, Uganda experienced five major droughts in 2001, 2002, 2005, 2008, and 2010 (Masih et al. 2014). It has been argued that the increasing occurrence and intensity of droughts and floods also increased socioeconomic risks in a country where 33.2% of the households (representing 43% of the population) were below the international poverty line of USD 1.9 per day in 2015 (World Bank 2018). It has been estimated that between 2006 and 2013, two thirds of Ugandan households that had escaped poverty fell back into it, partly due to weather shocks (World Bank 2018). At the same time, women constitute most of the workforce in agriculture (which is a highly climate-sensitive sector), but do not have the same access to resources compared to males (Hill and Vigneri 2014). Urban livelihoods are also becoming increasingly vulnerable to weather shocks, especially considering the adverse consequences on urban infrastructure (Mcsweeney et al. 2010). In fact, damages in urban infrastructure often contribute to the disruption of food flows from rural areas to urban areas, threatening urban food security (Akampumuza and Matsuda 2017).

The aim of this study is to assess the impact of weather shocks on household consumption (including food-related consumption) and identify the coping strategies employed by urban residents against such shocks. We focus on the Kumi district of Uganda, as it is located in the Teso sub-region, which is one of the most vulnerable sub-regions in the country. We explore four interrelated objectives as follows: (a) the effect of exposure to weather shocks on household welfare (in terms of consumption expenditure); (b) the gender-differentiated impacts of (and response strategies against) weather shocks; (c) the types of coping strategies that the affected households adopt to mitigate potential consumption loss due to weather shocks; and (d) the extent to which the coping strategies effectively safeguard the affected households from consumption declines due to exposure to one or more weather shocks. Section 2.2 explains the key methodological aspects of this study including the study site (Sect. 2.2.1) and the data collection and analysis methods (Sects. 2.2.2

and 2.2.3). Section 2.3 outlines the main results across the objectives outlined above. Section 2.4 identifies the main patterns and outlines the policy and practice implications and recommendations of this study.

2.2 Methodology

2.2.1 Study Site

The Teso sub-region is located in the Eastern Region of Uganda and comprises of eight districts: Kumi, Ngora, Soroti, Serere, Amuria, Bukedea, Kaberamaido, and Katakwi (Fig. 2.1). According to the 2014 population census, the sub-region has a total land area of 13,027 km^2 and is inhabited by 1,819,790 people, implying an average population density of 140 residents/km^2 (Uganda Bureau of Statistics 2014). Relative to other sub-regions, Teso has a high incidence of poverty, with approximately 28% of the inhabitants being categorized as "poor" in 2018, compared to a national poverty rate of 19.7% for the same year (World Bank 2018). Furthermore, the Teso sub-region is one of the most vulnerable sub-regions in Uganda, characterized by frequent floods and prolonged droughts (Akampumuza and Matsuda 2017; Kisauzi et al. 2012; Majaliwa et al. 2015).

Farming is the main economic activity in the sub-region, with the main cultivated crops being cassava, sorghum, millet, sweet potatoes, and groundnuts. Like in many other parts of Uganda, the vast majority of the residents are smallholder farmers relying directly on rain-fed agriculture for livelihoods and subsistence. This has raised concern due to the associated high vulnerability to extreme weather events such as prolonged droughts, floods, and changing and/or unpredictable seasons (see below) (see Chap. 3 Vol. 2).

The main focus of this study is Kumi Town (the administrative capital of the Kumi district) and its surrounding areas.[1] Similar to the Teso sub-region (see above), the Kumi district is one of the most vulnerable districts to extreme weather events in Uganda and especially droughts (UNDP 2014). Kumi district is characterized by a bimodal rainfall pattern, with peaks in April–May and July–August. The annual mean temperature is 24 °C, and the total rainfall is 800–1000 mm. However, the rainfall seasons have become less predictable and less stable over recent years (Sect. 2.1). The risk of droughts, floods, and food insecurity varies substantially within the Kumi district. For example, the northern sub-counties such as Ongino, are at particularly high risk of flooding mainly due to the siltation of Lake Bisina from human activities such as farming and logging. However, there is very low capacity in

[1] Kumi Town Council consists of eight local councils 1 (LC1s). LC1s are the lowest administrative units in Uganda's administrative structure and are headed by chairmen. These chairmen are tasked to address village-level issues before they are escalated to higher administrative levels (i.e., parish, sub-county, county, and district in ascending order) if critical decisions cannot be taken at the LC1 level.

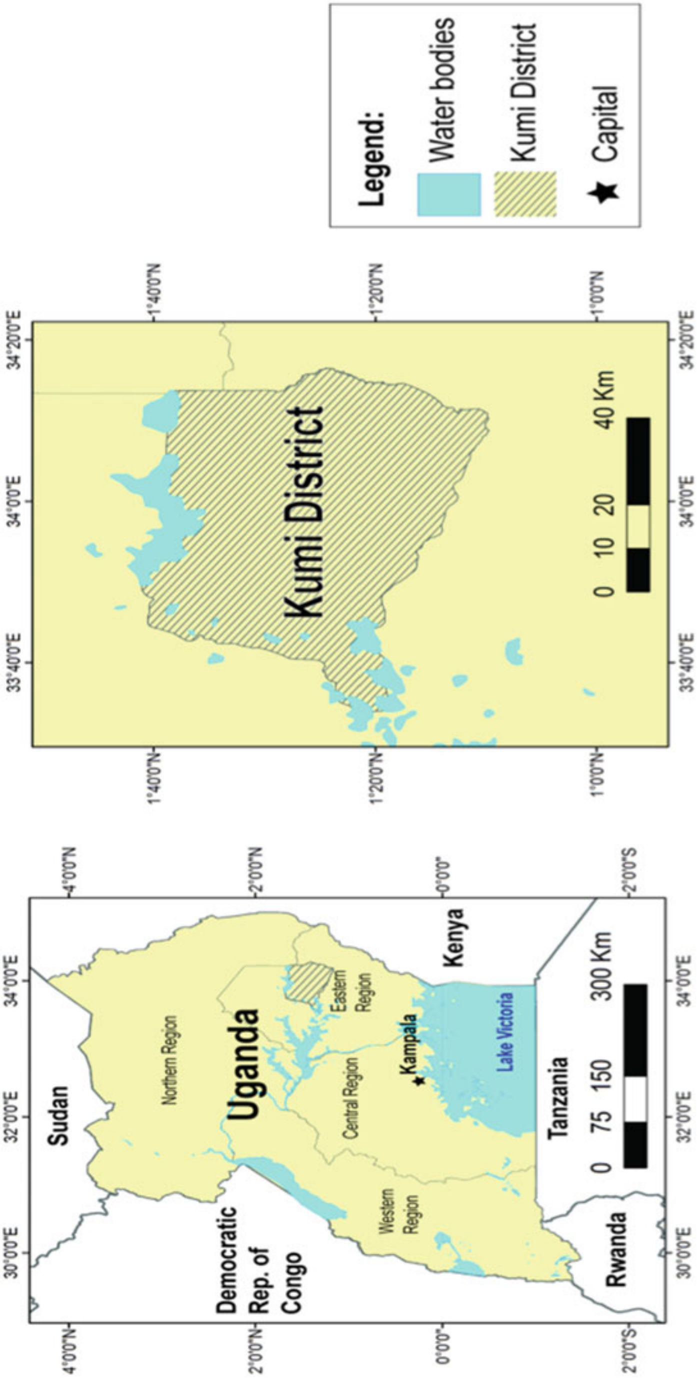

Fig. 2.1 Location of the study site

the district to maintain, operate, analyze, interpret, and predict weather data. In particular, there is no resident weather expert, with the closest expert assisting with weather information in the region being based at the Serere Agricultural and Animal Research Institute (SAARI), located 45.9 km away.

Frequent droughts and floods (due to erratic rainfall with heavy storms) have become common in Kumi district and often result into crop loss and the destruction of infrastructure. In particular the sub-region has experienced five major droughts between 1990 and 2010, specifically in 1998, 1999, 2002, 2005, and 2008. In one of the biggest floods that swept through Eastern Africa and the Horn of Africa in 2007, about 30 people died, and an estimated 8500 acres (3440 ha) of cropland was affected in the sub-region. On the aftermath of the flood, many smallholder farmers experienced bad harvests, which clearly contributed to the outbreak of acute famine in 2008 and the further deterioration of food security in many villages across the sub-region.[2] Even as late as mid-2008, approximately 135,987 people in 4 highly affected districts (i.e., Amuria, Katakwi, Bukedea, Soroti) needed food assistance due to crop failure, poor harvest, and surging food prices (Rukandema et al. 2008). Shortly after, the Teso region experienced a prolonged drought in 2009, which was followed by a short drought and a flood in 2010.

Reports reveal the tremendous decline in food production in the Teso region during (and following) these flood and drought events, as well as the reduction of food flows to Kumi Town from nearby villages following these weather shocks. This reduction of food flows to Kumi Town is often associated with the combined effect of crop loss in surrounding villages (i.e., reduced food production) and the disruption of communication channels due to road destruction from flooding. Outbreaks of crop and animal diseases have also been linked to weather shocks and have posed major challenges to smallholder farmers in the district. Common animal epidemics include swine fever, foot and mouth disease, nagana, and bird flu, while common crop diseases include coffee wilt, banana bacterial wilt, cassava mosaic, and cassava brown streak disease.

Gender issues permeate smallholder farming in Kumi district. Women provide more than 70% of agricultural labor in Kumi, yet only 30% have control over means of production, and only 7% own land (KUMI District Hazard, Risk and Vulnerability Profile Report 2014). Given their limited access to agricultural resources and low decision-making power, women are possibly more vulnerable to the numerous weather shocks discussed above. However, despite their relatively higher vulnerability, women still spend more on education and health than their male counterparts. For example, according to the 2014 KUMI District Hazard, Risk and Vulnerability Profile (UNDP 2014), women and children tend to seek health services more often

[2]Famine is defined as the sudden and sharp reduction in food supply resulting in widespread hunger (Buringh 1977). Other scholars define famine as a sudden collapse in the level of food consumption of a large population (Scrimshaw 1987) or a set of conditions that occurs when a large population in a region cannot obtain sufficient food, resulting in widespread, acute malnutrition (Cuny and Hill 1999).

than men, with 67% of the total outpatient department attendance for persons above 5 years of age in 2013 in the district being female.

2.2.2 Data Collection

To tackle the four research objectives outlined in Sect. 2.1, we collected between February and March 2015 (a) structured household surveys, (b) focus group discussions (FGDs), and (c) secondary datasets from relevant organizations.

First, we randomly selected 25 households through transect walks in the urban and peri-urban areas of each of the eight LC1s (N = 200). These households were surveyed through structured questionnaires that targeted the main decision-maker (i.e., the household head). These household surveys aimed at capturing household welfare dynamics and how they evolve amidst weather shocks. For most of the key variables, retrospective data was also collected for 2009, when a major drought affected the Teso sub-region (and most parts of the Horn of Africa) (Sect. 2.2.1). Thus, the main analysis presented in this chapter is based on a random sample of 200 households, constituting a quasi-panel of 400 household-year observations (i.e., for the year 2009 and 2015).

The main variables included in the household questionnaire were expenditure, exposure to each of the four weather-related shocks (i.e., drought, flood, pests, and diseases), household assets, land endowment, distance to market, and demographic characteristics (e.g., household size, gender, level of schooling, the age of the household head). We broadly categorized consumption expenditure into three main categories: (a) food and food-related items, (b) semi-durable household items referred to as basics (e.g., education, health, transportation, clothing, cooking/lighting items, fuel), and (c) contributions to socio-cultural and religious activities (e.g., funeral, wedding, churches, mosques) (hereafter called contributions).

Due to concerns over data reliability for questions using recall periods, we allowed respondents to use different recall periods of each of the key household variables. For example, for food consumption expenditure, the surveyed households were asked to estimate the monetary value of the consumed food items in the past 7 days prior to the survey (for 2015) and in a typical week (for 2009). For food-related expenditures such as sugar, salt, beverages, and tobacco, we established a monthly recall period. To capture properly the food and food-related expenditures, respondents were asked to estimate the market value of any self-produced items such as food crops from their family farms. Basic expenditures, contributions, as well as savings [e.g., to Savings and Credit Cooperative Organizations (SACCOs)] were asked for the year before the survey.

Additionally we conducted three FGDs as follows: (a) one FGD with eight LC1 chairpersons; (b) one FGD with food transporters and suppliers, and (c) one FDD with market vendors. Each FGD consisted of five participants and provided information about broader phenomena in the study areas such as the dynamics of weather shocks and food security at LC1 and district levels. Lastly, we gathered secondary data that mainly relates to food production in the study area. This information was collected through visits to relevant district offices and agencies, such as those related to agriculture and the environment.

2.2.3 Data Analysis

2.2.3.1 Weather Shocks and Household Consumption Expenditures

We presume a linear association between consumption expenditure and household-level covariates following the specification below (Eq. 2.1):

$$Cons_{ijt} = \alpha + f_j + f_t + \beta_1 H_{ijt} + \beta_2 Shock_{ijt} + \varepsilon_{ijt} \tag{2.1}$$

. . .where $Cons_{ijt}$ is the aggregate real expenditure on all consumption categories (i.e., food-related and basic expenditures and social contributions, Sect. 2.2.2). Subscripts *i*, *j*, and *t* indicate household, LC1, and year, respectively; H_{ijt} is a vector of household characteristics (i.e., age, gender, years of schooling of the household head, land and household asset endowments, and household size). f_j and f_t are dummy variables that, respectively, capture LC1 and bimodal effects., $Shock_{ijt}$ is a binary variable that takes the value one if a household was affected by at least one of the weather shocks and zero otherwise.

In order to investigate potential reallocation among expenditure categories (especially when a household is affected by a weather shock), we also estimate separate regressions for expenditures on each of these consumption components. By expressing household consumption expenditure in adult equivalent units (rather than per capita units), this allows us to adjust for differences in expenditure needs due to the demographic composition of households. Otherwise, this would account for part of the observed consumption difference between affected and unaffected households. We then deflate all consumption values using the consumer price indices (CPIs) obtained from the Uganda Bureau of Statistics (UBOS) for the 2 years used in this analysis (i.e., 2009 and 2015). For both 2009 and 2015, the UBO uses a common financial year (2005/2006) as the base year for the CPIs, which facilitates the comparability of our results across survey years.

The parameter β_2 is expected to have a negative sign to reflect the expected negative impact of exposure to shocks on household consumption. It is also expected that the coefficient for the female headship dummy will be negative, as the literature already points to high female vulnerability to poverty (Klasen et al. 2014). Household size is presumed to have a negative sign because a larger number of household members are expected to place a marginal burden on the household budget (Akampumuza and Matsuda 2017; Munyegera and Matsumoto 2016). On the contrary, we expect a positive sign for education of the household head because education generally increases the chance of paid employment, which, in turn, increases consumption and ability to cope with shocks (Muttarak and Lutz 2014).

Similarly, asset and land endowments ought to boost household consumption and are expected to have positive signs (Munyegera and Matsumoto 2016).

To enhance the reliability of the results and ameliorate heteroscedasticity concerns that would affect the results, we report robust, heteroscedasticity-free standard errors in all regression specifications. Given the quasi-panel nature of the data used in this study (Sect. 2.2.2), various analytical methods can be used, including household fixed effects and random effects. However, for brevity, we present only the fixed effects results. Fixed effects are a better method based on a formal Hausman test for model selection. The two models differ only in the assumption made about the association between household-specific characteristics and covariates. The random effects approach assumes no such association, while the fixed effects approach assumes that individual households have unobserved constant attributes that could be correlated with covariates and in turn affect the relationship between covariates and the dependent variable.

The null hypothesis of the Hausman test is that there is no systematic difference between fixed effects and random effects estimates. A p-value lower than 0.05 points to the rejection of the null hypothesis, implying that the estimates of the two models are significantly different. This difference could be attributed to the effect of unobserved fixed characteristics, which could affect the results. In that case, as a rule of thumb, fixed effects estimation should be adopted to smooth out their potentially confounding effect.

2.2.3.2 Heterogeneous Shock Impacts and Coping Strategies by Gender of the Household Head

One critical factor mediating the potentially heterogeneous impacts of weather shock is the gender of the household head. This is reflected by Eq. 2.2, which is an extension of Eq. 2.1 outlined in Sect. 2.2.3.1:

$$\begin{aligned} Cons_{ijt} = \alpha + f_j + f_t + \beta_1 H_{ijt} + \beta_2 Shock_{ijt} + \lambda_1 Fehead_{ijt} \\ + \lambda_2 Fehead_{ijt} \text{X } Shock_{ijt} + \varepsilon_{ijt} \end{aligned} \tag{2.2}$$

. . .where $Fehead_{ijt}$ is a dummy variable that takes the value one if the household head is female and zero otherwise. The coefficient λ_2 on the interaction term between the female head dummy and the shock dummy captures the potentially heterogeneous impact of shocks by gender of the household head. It is expected to have a negative sign, which reflects the relatively higher vulnerability of female-headed households, and is indicative of the higher consumption poverty of female-headed households (see Klasen et al. 2014). In other words, the food consumption decline due to shock exposure is expected to be larger among female-headed households than among their male-headed counterparts. All other explanatory variables are as explained in Eq. 2.1.

2.2.3.3 Coping Strategies Against Weather Shocks

We presume that households respond to exposure to weather shocks by adopting one (or more) coping strategy. We adopt a probit model (Eq. 2.3) to estimate the likelihood of the household adopting a particular coping strategy, conditional on shock exposure, and other covariates.

$$Strategy_{ijt}^{k} = \theta_0 + f_j + f_t + \theta_1 H_{ijt} + \theta_2 Shock_{ijt} + v_{ijt} \tag{2.3}$$

…where $Strategy_{ijt}^{k}$ is a binary indicator taking one if the *i-th* household in LC1 j adopts a coping strategy k in year t. Coefficient θ_2 captures the extent to which shock exposure induces the household to adopt in a certain coping strategy. It is expected to have a positive sign, indicating that the occurrence of a weather shock ideally induces the affected household to adopt the respective coping strategies.

We investigated coping strategies that are commonly cited in the literature. These include the receipt of remittances from family members and friends (Jack and Suri 2014), off-farm employment (Ito and Kurosaki 2009), livestock sales (Kazianga and Udry 2006), and household assets (Akampumuza and Matsuda 2017). All explanatory variables are as explained in Eq. 2.1.

2.2.3.4 Effectiveness of Coping Strategies

Section 2.2.3.3 assumes that households respond to weather shocks by adopting a particular coping strategy and that this would be a positive signal of its ability to offset the effects of the shock on consumption expenditure. However, it is quite possible that even after adopting and employing coping strategies, the affected households may still experience a significant decline in household consumption (Fafchamps 1996). We therefore slightly modify Eq. 2.1 to assess the effectiveness of each of the studied coping strategies (Eq. 2.4):

$$\begin{aligned} Cons_{ijt} = \alpha + f_j + f_t + \beta_1 H_{ijt} + \beta_2 Shock_{ijt} + \mu Strategy_{ijt}^{k} \\ + \psi Strategy_{ijt}^{k}\, \mathrm{X} Shock_{ijt} + \varepsilon_{ijt} \end{aligned} \tag{2.4}$$

…where the additional term is an interaction between the shock dummy and dummies for each coping strategy k, with its coefficient ψ capturing the effectiveness of the coping strategies. A positive and statistically significant coefficient would imply that the particular coping strategy is effective in offsetting the negative impact of the shock on consumption expenditure. Similarly, a significant negative or insignificant coefficient would suggest that the coping strategy either exacerbates consumption decline or does not offer any significant protection to consumption against weather shocks.

2.2.3.5 Robustness Check and Propensity Score Matching

The observed differences in consumption expenditure and coping strategies against weather shocks between households affected and unaffected by weather could be due to severe differences between household characteristics across the two categories. The household fixed effects results (Sect. 2.3.3) ameliorate time-invariant unobserved heterogeneity, but do not rigorously smooth out differences in time-variant observed heterogeneity, which, if present, could confound our results. To overcome this challenge and appropriately attribute consumption differences between households affected and unaffected by weather shocks, we perform propensity score matching (PSM) to identify comparable counterpart households between the two household categories along observed characteristics (Rosenbaum and Rubin 1985). In non-randomized observational studies where covariate balance is often challenging, PSM provides a remedy to the treatment (shock exposure in this case) that is potentially prone to selection bias (Morgan 2017).

2.3 Results

2.3.1 Key Regional Patterns

According to the FGDs, food production declines whenever the Kumi district is affected by weather shocks due to crop loss and crop failure. Furthermore, crucial infrastructure is destroyed, which cuts off food supply routes from the surrounding villages to Kumi Town. During these occasions, food prices immediately skyrocket, especially in towns, as the reduced food production in nearby villages necessitates costly food imports from distant districts. Additionally the infrastructure breakdown exacerbates transportation costs.

The food production data obtained from the district agriculture office corroborated the above results from the FGDs. Figure 2.2 shows the food production trends for the Kumi district between 2005 and 2013 for the main food crops such as rice, finger millet, sorghum, sweet potatoes, groundnuts, and cassava. It is important to note the sharp decline in food production for each of the seven crops between 2010 and 2013, with the combined production decreasing substantially from well above 120,000 t to below 30,000 t for that period. As mentioned in Sect. 2.2.1, the region experienced a major drought in 2009 and a severe flood in 2011. FGD participants suggested that these extreme weather events could be partially responsible for the observed decline in food production.

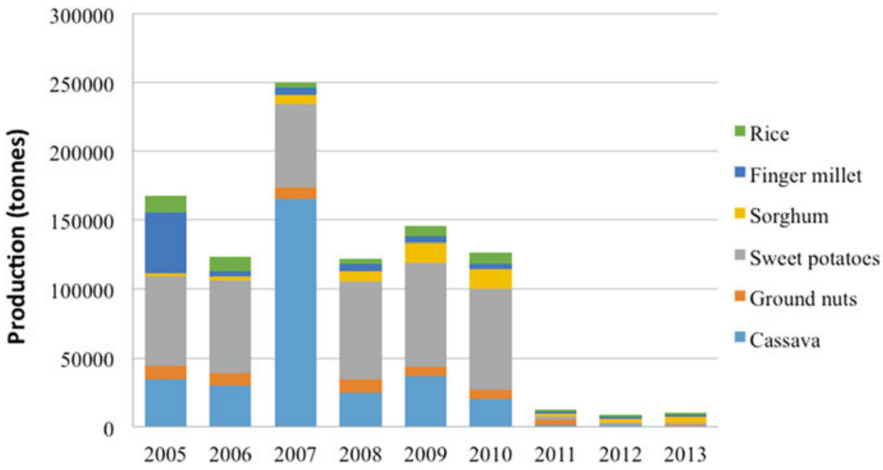

Fig. 2.2 Production of major food crops in the Kumi District (2005–2013)
Note: Based on food production data from Kumi District Office

2.3.2 Main Household Characteristics

Table 2.1 outlines household characteristics based on whether households were reported of having been affected by any of the four weather shocks studied in this chapter. Households that were affected by any (or a combination) of these weather shocks tend to have significantly larger household sizes ($p < 0.05$). Furthermore, a higher proportion of female-headed households have been affected by weather shocks, although this difference is not statistically significant at conventional levels. There are also differences in the age and education level of the household heads in relation to exposure to weather shocks. Household heads that self-reported exposure to weather shocks are more than 3 years older and completed 1 year less of schooling relative to the household heads of unaffected households.

The monthly per capita consumption expenditure of unaffected households by weather shocks is UGX 179,902 (USD 62), which is approximately 1.5 times larger than that of self-reported weather shock victims (UGX 117,069, USD 41) ($p < 0.05$).[3] Also remittance flows are significantly different between households affected and unaffected by weather shocks ($p < 0.05$), with the proportion of remittance recipients being twice as high among affected households. This could partly reflect the receipt of remittances from family members and friends as an ex-post strategy to cope with weather shocks.

Table 2.2 provides summary statistics stratified by the gender of the household head. In this respect, it crudely illustrates differential vulnerability to weather shocks and heterogeneity in key household characteristics between households headed by

[3]The official exchange rate used in this study was obtained from the Bank of Uganda. The exchange rate around the survey month (February 2015) was around USD 1 = UGX 2890.

Table 2.1 Summary statistics by exposure to weather shocks

Variables	Affected		Unaffected		Difference
	Mean	SD	Mean	SD	
Distance to market (km)	0.91	0.41	0.82	0.46	0.09
Household size (people)	6.24	3.20	5.24	3.48	0.99***
Savings (1 = belongs to SACCO)	0.36	0.48	0.27	0.45	0.08*
Age of household head (years)	39.05	12.12	35.73	12.18	3.32**
Gender of household head (1 = female head)	0.26	0.44	0.21	0.41	0.05
Education of household head (years of schooling)	9.97	5.14	11.34	5.72	−1.36**
Education of household head (1 = head attended secondary school or higher)	0.58	0.03	0.58	0.04	0.00
Food-related expenditure (UGX/month/person)	39,020	44,336	37,337	55,531	1682
Basic expenditure (UGX/month/person)	37,947	52,394	66,631	88,068	−28,684***
Social contributions (UGX/month/person)	13,395	19,130	26,716	80,373	−13,320**
Total expenditure (UGX/month/person)	117,069	103,236	179,902	297,538	−62,833***
Asset value ('000 UGX)	4029	11,325	3324	8774	705
Asset ownership (1 = owns mobile phone)	0.76	0.43	0.74	0.44	0.02
Remittances (1 = received remittance)	0.42	0.49	0.24	0.43	0.17***
Number of observations	262	–	138	–	–

Note: Student t-test is used to establish the significance of difference in the means of key variables between households affected and unaffected by shocks $***p < 0.01$; $**p < 0.05$; $*p < 0.1$

males and females. Approximately 65% and 70% of male-headed and female-headed households, respectively, reported having been exposed to weather shocks in the past 5 years.

There is a significant difference in the years of schooling, with female household heads having 3 years of schooling less compared to their male counterparts. Additionally, while 65% of male household heads attained at least secondary school, only 39% of female household heads achieved so. This reflects common patterns of gender gap in education that are observed elsewhere in SSA (World Bank 2012) (see Chap. 1 Vol. 1). Nonetheless, the overall literacy level in our sample (11.35 years for male heads, 7.74 years for female heads) is notably higher than the average years of schooling reported nationally in 2012 (4.7 years) (UNDP 2013). Female household heads are also significantly older and spend more on household basics, although this difference in expenditure is marginally significant.

Table 2.2 Summary statistics by gender of the household head

Variables	Male-headed Mean	Male-headed SD	Female-headed Mean	Female-headed SD	Difference
Distance to market (km)	0.86	0.44	0.94	0.38	−0.08
Household size (number of members)	5.90	3.41	5.93	3.06	0.02
Savings (1 = belongs to SACCO)	0.33	0.47	0.35	0.48	−0.03
Age of household head (years)	36.87	11.28	41.17	14.20	−4.30**
Education of household head (years of schooling)	11.35	4.99	7.74	5.51	3.61***
Education of household head (1 = head attended secondary school or higher)	0.65	0.02	0.39	0.05	0.26***
Exposure to weather shock (1 = experienced drought)	0.55	0.50	0.60	0.45	−0.04
Exposure to weather shock (1 = experienced flood)	0.15	0.36	0.14	0.35	0.007
Exposure to weather shock (1 = experienced pests/diseases)	0.42	0.49	0.44	0.50	−0.02
Food-related expenditure (UGX/month/person)	39,872	51,466	34,518	35,653	−5354
Basic expenditure (UGX/month/person)	43,215	67,552	56,466	62,302	−13,250*
Social contributions (UGX/month/person)	19,578	53,921	11,157	14,961	8420
Total expenditure (UGX/month/person)	138,281	207,048	129,958	111,078	8323
Asset value ('000 UGX)	4292	11,530	2276	6447	2016
Asset ownership (1 = owns mobile phone)	0.77	0.42	0.72	0.45	0.04
Remittances (1 = received remittances)	0.35	0.48	0.38	0.49	−0.02
Exposure to weather shock (1 = experienced weather shock)	0.65	0.48	0.70	0.46	−0.05
Livestock ownership (number)	8.12	1.49	5.61	0.76	2.51
Livelihood sources (1 = household member involved in off-farm employment)	0.43	0.04	0.17	0.05	0.27***
Income (UGX/year/person)	830,442	147,230	248,560	42,928	581,882**
Number of observations	302	–	98	–	–

Note: The student t-tests were used to establish the significance of difference in the means of key variables between male-headed and female-headed households $***p < 0.01$; $**p < 0.05$; $*p < 0.1$

There are also some notable differences in asset ownership and monthly per capita consumption. Female-headed households report a lower value of household assets and expenditures on food and social contributions, albeit these differences are statistically insignificant. Female-headed households are less likely to engage in the off-farm employment, and especially waged employment, and thus report significantly lower per capita income than male-headed households. Additionally, female-headed households own significantly fewer livestock, which could further curtail their ability to offset the adverse effects of weather shocks through livestock sales. This implies that fewer coping options are available to female-headed households, possibly influencing them to adopt more severe coping strategies such as missing meals and reallocating from other expenditure components such as education.

Table 2.3 categorizes households by educational attainment of the household head (secondary education or higher). The main economic activities carried out in the study area are broadly classified as off-farm paid labor, although some households are engaged in smallholder farming in nearby villages. However, further disaggregation reveals striking heterogeneity in access to opportunities that could potentially augment the ability to cope with weather shocks. First, households whose heads have secondary education (and above) are more likely to have at least one member working in the off-farm sector, particularly regular waged jobs. They also earn significantly higher per capita income than households headed by members with primary education or lower. In an urban setting where off-farm employment is the most usual and important source of livelihoods, it is thus not surprising that households headed by less educated members earn significantly lower per capita income and are more likely to report missing meals after experiencing a weather shock.

2.3.3 Impact of Shocks on Household Consumption Per Adult Equivalent

We find a negative and significant association between self-reported exposure to weather shocks and real household consumption per adult equivalent. We first present the OLS estimates of this association in Table 2.4. Column 1 reveals exposure to at least one of the weather shocks is associated with a 15.1% decline in real household consumption per adult equivalent. Disaggregating consumption into food-related expenditures, basic expenditures, and social contributions indicates that weather shocks have no significant impact on food-related consumption. Rather households seem to reallocate basic expenditures and social contribution to supplement food consumption. In fact, exposure to weather shocks reduces expenditure on basics and social contributions by 38% and 40%, respectively.

The education level of the household head augments household consumption, which perhaps indicates their relatively better access to productive resources and income opportunities including paid employment. Likewise, wealthy households in terms of asset ownership have significantly higher expenditures on non-food basics and social contributions. For every 1% increase in the value of household assets, expenditure on the two consumption categories increases by 8.2% and 14.1%, respectively. On the contrary, household size reduces consumption expenditure, which indicates the financial burden of maintaining larger households.

Table 2.3 Summary statistics by education level of the household head

Variables	Primary or lower		Secondary or higher		Difference
	Mean	SD	Mean	SD	
Distance to market (km)	0.79	0.35	0.91	0.46	0.12
Exposure to weather shock (1 = experienced weather shock)	0.73	0.44	0.66	0.48	0.07
Livestock ownership (number)	4.72	20.02	3.44	5.17	1.28
Household size (number of members)	6.25	0.29	5.67	0.20	0 0.58*
Savings (1 = belongs to SACCO)	0 0.30	0.03	0.35	0.03	−0.06
Age of household head (years)	39.67	1.13	36.87	0.71	2.80**
Food-related expenditure (UGX/month/person)	29,760	3074	44,476	3614	−14,716***
Basic expenditure (UGX/month/person)	42,390	5725	49,490	4350	−7100
Social contributions (UGX/month/person)	12,290	2050	20,782	3897	−8492*
Total expenditure (UGX/month/person)	114,700	11,561	150,186	14,487	−35,486*
Asset value ('000 UGX)	3947	1153	3682	398	264
Asset ownership (1 = owns mobile phone)	0.62	0.03	0.85	0.02	−0.23***
Remittances (1 = received remittance)	0.21	0.03	0.46	0.03	−0.25***
Livelihood sources (1 = household member involved in off-farm employment)	0.44	0.03	0.62	0.03	−0.18***
Income (1000UGX/year/person)	730	131	2518	286	−1787***
Weather shock impact (1 = missed meals during weather shock)	0 0.89	0.07	0.40	0.11	0.49***
Number of observations	169	–	231	–	–

Note: The student t-tests were used to establish the significance of difference in the means of key variables between households whose heads attained at least secondary education and households headed by members that attained primary education and below $***p < 0.01$; $**p < 0.05$; $*p < 0.1$

Table 2.4 Relation between weather shocks and household consumption using ordinary least squares (OLS)

Variables	(1) Log (cons)	(2) Log (food)	(3) Log (basics)	(4) Log (contribution)
Exposure to weather shock (1 = experienced weather shock)	−0.151** (0.0699)	0.0205 (0.136)	−0.385*** (0.128)	−0.408** (0.207)
Dependency ratio	0.0390 (0.0341)	0.148** (0.0629)	0.0222 (0.0646)	0.0157 (0.0851)
Age of household head (years)	0.00223 (0.0122)	−0.0269 (0.0312)	0.0196 (0.0278)	0.0826** (0.0381)
Age squared of household head (years^2)	5.88e-05 (0.000136)	0.000318 (0.000343)	4.36e-05 (0.000319)	−0.000725* (0.000428)
Gender of household head (1 = female)	0.111* (0.0639)	−0.124 (0.139)	0.506*** (0.125)	−0.110 (0.182)
Education of household head (years of schooling)	0.0216*** (0.00622)	0.0241** (0.0111)	0.0402*** (0.0120)	0.0476*** (0.0156)
Asset value (log)	0.0367 (0.0328)	0.0339 (0.0440)	0.0829** (0.0363)	0.141** (0.0696)
Asset ownership (1 = owns mobile phone)	−0.102 (0.104)	−0.184 (0.179)	−0.0851 (0.188)	0.199 (0.289)
Household size (number of members)	−0.0345*** (0.0100)	−0.0517*** (0.0189)	−0.0210 (0.0220)	−0.0390 (0.0277)
Livelihood sources (1 = household member involved in off-farm employment)	0.0597 (0.0625)	−0.0405 (0.129)	0.0314 (0.118)	0.521*** (0.190)
Year (2015)	0.511*** (0.0629)	2.744*** (0.132)	0.0333 (0.115)	0.371** (0.187)
Constant	10.52*** (0.441)	8.194*** (0.805)	7.342*** (0.709)	3.439*** (1.092)
Observations	376	376	376	376
R-squared	0.359	0.676	0.272	0.286

Note: Robust standard errors are reported in parentheses. Dummy variables for community and year are controlled for in all specifications for location- and time-specific effects $***p < 0.01$; $**p < 0.05$; $*p < 0.1$

The OLS results are corroborated by the fixed effects estimates indicated in Table 2.5. The smaller coefficients are suggestive of a positive bias due to confounding time-invariant household characteristics in the OLS estimates which was smoothed out by fixed effects estimation. Although we do not find systematically lower aggregate consumption among female-headed, their food-related expenditures and social contributions are significantly lower. This could indicate their relative higher vulnerability to poverty and shocks.

Table 2.5 Relation between weather shocks and household consumption using fixed effects

Variables	(1) Log (consumption)	(2) Log (food)	(3) Log (basics)	(4) Log (contribution)
Exposure to weather shock (1 = experienced weather shock)	−0.132* (0.0743)	0.00362 (0.211)	−0.185** (0.0882)	−0.206 (0.205)
Gender of household head (1 = female)	−0.163 (0.139)	−1.005*** (0.336)	−0.264 (0.191)	−0.432* (0.261)
Age of household head (years)	0.0312 (0.0230)	−0.0218 (0.0600)	0.0398 (0.0255)	0.159*** (0.0467)
Age squared of household head (years^2)	−0.000352 (0.000415)	0.000766 (0.00110)	−0.000588 (0.000495)	−0.00248*** (0.000893)
Education of household head (years of schooling)	−0.00575 (0.0391)	−0.00328 (0.101)	−0.0351 (0.0337)	0.00286 (0.0793)
Asset value (log)	−0.0112 (0.0421)	0.00738 (0.0704)	−0.0241 (0.0270)	−0.0339 (0.0617)
Asset ownership (1 = owns mobile phone)	−0.0431 (0.114)	−0.257 (0.319)	−0.00737 (0.165)	0.194 (0.265)
Household size (number of members)	−0.00333 (0.0159)	−0.00715 (0.0435)	0.00705 (0.0216)	−0.0286 (0.0395)
Livelihood sources (1 = household member involved in off-farm employment)	−0.0562 (0.0841)	−0.0808 (0.201)	−0.0550 (0.102)	0.180 (0.221)
Constant	11.11*** (0.822)	8.540*** (1.805)	9.886*** (0.654)	6.181*** (1.410)
Observations	376	376	376	376
R-squared	0.487	0.798	0.097	0.256
Number of households	188	188	188	188

Note: Robust standard errors are reported in parentheses. Dummy variables for community and year are controlled for in all specifications for location- and time-specific effects $***p < 0.01$; $**p < 0.05$; $*p < 0.1$

2.3.4 *Heterogeneity of the Impacts of Shocks by Gender of the Household Head*

We explore potential heterogeneities in the impact of weather shocks by gender of the household head. The results suggest that female-headed households are more severely affected by exposure to weather shocks, with the difference being significant ($p < 0.05$). Table 2.6 contains fixed effects estimates of Eq. 2.2 (Sect. 2.2.3.3) for both total and disaggregated consumption. The negative and statistically significant coefficient on the interaction term between the female headship dummy and the shock exposure dummy indicates that (conditional on shock exposure) the consumption decline is larger for female-headed households than male-headed counterparts. This reflects studies, which found that the drought-induced consumption decline in Ethiopian villages was significantly more pronounced among female-headed households (Dercon et al. 2005).

Table 2.6 Heterogeneous weather shock impacts by gender of the household head

Variables	(1) Log (consumption)	(2) Log (food)	(3) Log (basics)	(4) Log (contribution)
Exposure to weather shock (1 = experienced weather shock)	−0.0590** (0.0300)	−0.0737** (0.036)	−0.316** (0.146)	−0.285 (0.244)
Gender of household head (1 = female)	0.276* (0.142)	−0.486* (0.293)	0.751*** (0.279)	0.0740 (0.341)
Interaction of female head dummy and shock dummy	−0.186** (0.087)	0.586* (0.319)	−0.263** (0.125)	−0.180* (0.411)
Education of household head (years of schooling)	0.0236*** (0.00648)	0.0247** (0.0118)	0.0429*** (0.0119)	0.0562*** (0.0165)
Household size (number of members)	−0.0351*** (0.0109)	−0.0493** (0.0216)	−0.0178 (0.0225)	−0.0472* (0.0286)
Age of household head (years)	0.00370 (0.0122)	−0.0261 (0.0327)	0.0186 (0.0295)	0.0870* (0.0451)
Savings (1 = belongs to SACCO)	0.177*** (0.0673)	0.123 (0.131)	0.270** (0.117)	0.970*** (0.180)
Age squared of household head (years^2)	3.55e-05 (0.000135)	0.000280 (0.000359)	4.03e-05 (0.000339)	−0.000795 (0.000504)
Asset value (log)	0.0304 (0.0312)	0.0313 (0.0433)	0.0761** (0.0341)	0.135** (0.0618)
Asset ownership (1 = owns mobile phone)	−0.139 (0.104)	−0.219 (0.182)	−0.160 (0.197)	0.0608 (0.277)
Constant	10.28*** (0.388)	8.136*** (0.895)	7.238*** (0.700)	3.151*** (1.073)
Observations	376	376	376	376
R-squared	0.384	0.678	0.300	0.348

Note: Robust standard errors are reported in parentheses. Dummy variables for community and year are controlled for in all specifications for location- and time-specific effects $***p < 0.01$; $**p < 0.05$; $*p < 0.1$

As noted above, the likelihood of exposure to shocks does not significantly differ with the gender of the household head. This implies that the observed differences in the impact of weather shocks would be indicative of the relative inability of female-headed households to cope with the shocks. A partial confirmation of this premise is that female-headed households are less likely to engage in the off-farm sector (especially waged employment) and that they own significantly fewer livestock compared to male-headed households. This implies that fewer coping strategies are available to female-headed household, possibly leading female-headed households to adopt more severe coping strategies such as missing meals (Sect. 2.3.1). In fact, female-headed households report significantly fewer years of schooling and are less likely to have household members engaged in off-farm employment. Column 3 in Table 2.6 further reveals that female-headed households spend significantly more money on basic expenditure including education and health.

2.3.5 Exposure to Shocks and Livelihood Coping Strategies

In this section, we investigate whether exposure to weather shocks influences the affected households to adopt more in ex-post coping strategies. Results reveal a positive and significant relationship between exposure to weather shocks, on one hand, the likelihood of engagement on waged employment, and receipt of credit/ remittances on the other hand (Table 2.7). Since the outcome variables are binary

Table 2.7 Exposure to shocks and likelihood of adopting individual coping strategies

Variables	(1) Sell livestock	(2) Sell assets	(3) Work off-farm	(4) Receive credit	(5) Receive remittance
Exposure to weather shock (1 = experienced weather shock)	0.0786 (0.0547)	0.00552 (0.0522)	0.213∗∗∗ (0.0637)	0.142∗∗ (0.0603)	0.143∗∗ (0.0579)
Dependency ratio	0.0274 (0.0284)	0.0521∗ (0.0282)	0.0119 (0.0348)	−0.0522 (0.0326)	0.0196 (0.0333)
Household size (number of members)	0.0225∗∗ (0.00915)	−0.00385 (0.00780)	−0.00286 (0.0102)	0.0102 (0.0108)	−0.00380 (0.00967)
Savings (1 = belongs to SACCO)	0.0792 (0.0558)	0.000329 (0.0499)	0.0777 (0.0616)	0.200∗∗∗ (0.0615)	0.0455 (0.0603)
Age of household head (years)	0.000130 (0.0126)	0.0140 (0.0115)	0.0172 (0.0140)	0.0499∗∗∗ (0.0166)	−0.00795 (0.0125)
Age squared of household head (years^2)	−8.12e-05 (0.000153)	−0.000125 (0.000132)	−0.000216 (0.000159)	−0.000575∗∗∗ (0.000193)	0.000145 (0.000145)
Gender of household head (1 = female)	−0.0496 (0.0592)	0.112∗ (0.0648)	0.108 (0.0700)	0.0588 (0.0714)	0.0645 (0.0688)
Education of household head (years of schooling)	−0.00112 (0.00523)	0.00533 (0.00397)	0.0138∗∗ (0.00617)	0.00418 (0.00572)	0.0188∗∗∗ (0.00596)
Asset value (log)	0.0215∗ (0.0122)	0.00297 (0.00755)	0.0395∗∗∗ (0.0125)	0.0503∗∗∗ (0.0163)	0.0308∗∗∗ (0.0106)
Asset ownership (1 = owns mobile phone)	0.0557 (0.0725)	−0.188∗∗ (0.0818)	0.116 (0.0866)	0.00622 (0.0804)	0.0745 (0.0774)
Log-likelihood	−162.23	−108.62	191.87	199.78	206.63
Pseudo R-squared	0.1250	0.1382	0.1853	0.1739	0.1236
Observations	345	345	345	345	345

Note: Robust standard errors are reported in parentheses. Dummy variables for community and year are controlled for in all specifications for location- and time-specific effects $***p < 0.01$; $**p < 0.05$; $*p < 0.1$

indicators (i.e., whether or not a household adopts a particular coping strategy), we estimate probit regressions and present their marginal effects in Table 2.7.

Columns 1 and 2 in Table 2.7 indicate that exposure to weather shocks is associated with an increased, albeit statistically insignificant, likelihood of selling livestock. This is contrary to previous studies that have found a positive and statistically significant effect of weather shock exposure on the likelihood of engaging in livestock sales (Hoddinott 2006). This difference is possibly due to the relatively higher representation of urban residents in our sample, whose main source of livelihood is off-farm employment (combined with minimal livestock ownership). In fact, results in Column 3 support this conjecture, as exposure to weather shocks increases by 21% the probability that at least one of the household members is engaged in paid off-farm employment (Table 2.7).

Households with a high dependency ratio are more likely to sell household assets when experiencing weather shocks, perhaps due to their relative lack of alternative coping strategies. Columns 4 and 5 reveal that the probability of borrowing (from formal and/or informal sources) and receiving remittances (from family members/friends) increases by 14% following exposure to weather shocks. Membership to a savings and credit association (SACCO) increases borrowing probability, something that is consistent with the main functions of such groups (i.e., rotational saving and borrowing).

Wealth, in terms of asset ownership, augments the likelihood of adopting all types of coping strategies, with the exception of asset sales. This further confirms that relatively poorer households with no access to alternative coping strategies resort to selling household assets to cope with the impacts of weather shocks. Column 3 of Table 2.7 further reveals that for each additional year of schooling of the household head, the probability of at least one household member engaging in off-farm waged employment and receiving remittances increases by 1.4% and 1.9%, respectively. This implies that these households tend to invest more in education, making it in turn easier to find off-farm employment (both within Kumi Town and other urban centers). This ultimately enhances the ability to assist financially the household in the form of remittances.

2.3.6 Effectiveness of Coping Strategies Against Weather Shocks

Often the coping strategies discussed in Sect. 2.3.4 may not enable the effective offsetting of the devastating impacts of weather shocks on consumption. Below, we assess the effectiveness of each coping strategy using interaction terms between the dummy variable for weather shocks and dummy variables for each of the respective coping strategies.

Table 2.8 indicates that households receiving remittances can offset shock impacts. This is indicated by the positive and significant interaction term between

Table 2.8 Effectiveness of remittances as a coping strategy

Variables	(1) Log (consumption)	(2) Log (food)	(3) Log (basics)	(4) Log (contribution)
Exposure to weather shock (1 = experienced weather shock)	−0.166* (0.0889)	−0.00745 (0.186)	−0.439*** (0.159)	−0.279 (0.242)
Remittances (1 = received remittances)	−0.0319 (0.155)	−0.0688 (0.290)	0.0635 (0.0435)	0.188 (0.404)
Interaction of shock dummy and remittance receipt dummy	0.150** (0.073)	0.216** (0.110)	0.122 (0.292)	−0.162 (0.449)
Gender of household head (1 = female)	0.150** (0.0693)	−0.0780 (0.146)	0.566*** (0.128)	−0.0601 (0.184)
Education of household head (years of schooling)	0.0227*** (0.00674)	0.0232* (0.0127)	0.0406*** (0.0121)	0.0549*** (0.0165)
Household size (number of members)	−0.0342*** (0.0110)	−0.0513** (0.0211)	−0.0157 (0.0226)	−0.0473* (0.0283)
Age of household head (years)	0.00559 (0.0121)	−0.0272 (0.0316)	0.0218 (0.0298)	0.0887** (0.0448)
Savings (1 = belongs to SACCO)	0.165** (0.0659)	0.142 (0.131)	0.255** (0.117)	0.964*** (0.179)
Age squared of household head (years^2)	6.97e-06 (0.000135)	0.000296 (0.000350)	−7.39e-06 (0.000342)	−0.000817 (0.000500)
Asset value (log)	0.0306 (0.0306)	0.0257 (0.0431)	0.0756** (0.0339)	0.135** (0.0620)
Asset ownership (1 = owns mobile phone)	−0.144 (0.101)	−0.259 (0.181)	−0.160 (0.196)	0.0769 (0.276)
Constant	10.33*** (0.394)	8.154*** (0.889)	7.280*** (0.712)	3.119*** (1.086)
Observations	345	345	345	345
R-squared	0.387	0.674	0.303	0.348

Note: Robust standard errors are reported in parentheses. Dummy variables for community and year are controlled for in all specifications for location- and time-specific effects $***p < 0.01$; $**p < 0.05$; $*p < 0.1$

the dummy variables for weather shock and remittance receipt for total and food-based consumption expenditure (see Columns 1 and 2 in Table 2.8, respectively). However, although the coefficient is positive for basic expenditures, it is statistically indistinguishable from zero. This implies that remittances are perhaps allocated to food consumption during crises, rather than non-food consumption categories like durable household items and social contributions.

Table 2.9 presents a similar analysis for asset sales. The negative coefficient on the dummy variable for asset sales points to the possibility that poor households (in terms of assets) generally have lower consumption per adult equivalent. However, the positive and significant coefficient on the interaction term between the dummy variables for exposure to weather shocks and asset sales shows that (conditional to shock exposure) selling household assets provides temporary insurance against consumption decline. The coefficient is higher for food-related consumption, possibly indicating that asset sales are made to temporarily supplement food intake.

Table 2.9 Effectiveness of asset sales as a coping strategy

Variables	(1) Log (consumption)	(2) Log (food)	(3) Log (basics)	(4) Log (contribution)
Exposure to weather shock (1 = experienced weather shock)	−0.154** (0.0764)	−0.0773 (0.149)	−0.460*** (0.139)	−0.403* (0.224)
Coping strategy (1 = sold assets)	−0.325* (0.185)	−0.973*** (0.343)	−0.375 (0.371)	−0.563 (0.465)
Interaction of shock dummy and asset sale dummy	0.380* (0.197)	1.226*** (0.388)	0.603 (0.395)	0.579 (0.497)
Gender of household head (1 = female)	0.154** (0.0688)	−0.0652 (0.141)	0.571*** (0.127)	−0.0363 (0.183)
Education of household head (years of schooling)	0.0249*** (0.00647)	0.0279** (0.0120)	0.0444*** (0.0118)	0.0584*** (0.0165)
Household size (number of members)	−0.0346*** (0.0110)	−0.0517** (0.0209)	−0.0160 (0.0227)	−0.0471* (0.0284)
Age of household head (years)	0.00312 (0.0123)	−0.0334 (0.0334)	0.0166 (0.0285)	0.0863* (0.0441)
Savings (1 = belongs to SACCO)	0.164** (0.0649)	0.130 (0.128)	0.252** (0.114)	0.954*** (0.178)
Age squared of household head (years^2)	3.95e-05 (0.000135)	0.000371 (0.000368)	5.64e-05 (0.000327)	−0.000787 (0.000491)
Asset value (log)	0.0321 (0.0303)	0.0270 (0.0425)	0.0776** (0.0333)	0.137** (0.0603)
Asset ownership (1 = owns mobile phone)	−0.135 (0.102)	−0.240 (0.181)	−0.135 (0.200)	0.0551 (0.279)
Constant	10.33*** (0.386)	8.222*** (0.903)	7.303*** (0.683)	3.227*** (1.051)
Observations	326	332	333	328
R-squared	0.390	0.685	0.305	0.351

Note: Robust standard errors are reported in parentheses. Dummy variables for community and year are controlled for in all specifications for location- and time-specific effects $***p < 0.01$; $**p < 0.05$; $*p < 0.1$

However, this strategy may not necessarily be used to safeguard other components of consumption.

Finally, Table 2.10 presents the results for the remaining coping strategies, i.e., credit access, livestock sales, and participation in both farm and off-farm waged employment. There is no evidence to suggest that the households that adopt each of these coping strategies experience lower consumption decline following exposure to weather shocks. This finding is not surprising for livestock sales due to the predominately urban sample used in this study. However, when it comes to farm and off-farm employment, the results point that wages might be too low to offset the strong impact of weather shocks on consumption. Moreover, demand for farm labor in nearby villages reduces due to the declining productivity during periods of weather shocks, thus likely causing the wages to decline further. We also find similar results for the disaggregated consumption measures, but these results are not reported for reasons of brevity.

Table 2.10 Effectiveness of access to credit, off-farm employment, and on-farm employment as coping strategies

Variables	(1) Credit	(2) Off-farm labor	(3) Farm labor	(4) Livestock sale
Exposure to weather shock (1 = experienced weather shock)	−0.117 (0.103)	−0.203* (0.105)	−0.108 (0.0821)	−0.182** (0.0826)
Coping strategy (1 = received credit)	0.0829 (0.120)			
Interaction of shock dummy and credit dummy	−0.0144 (0.141)			
Livelihood sources (1 = household member involved in off-farm employment)		−0.0274 (0.128)		
Interaction of shock dummy and off-farm employment dummy		0.141 (0.141)		
Livelihood sources (1 = household member involved in on-farm employment)			−0.0797 (0.197)	
Coping strategy (1 = sold livestock)				−0.105 (0.144)
Interaction of shock dummy and livestock sale dummy				0.217 (0.157)
Education of household head (years of schooling)	0.0226*** (0.00636)	0.0223*** (0.00635)	0.0215*** (0.00616)	0.0224*** (0.00628)
Household size (number of members)	−0.0344*** (0.0102)	−0.0339*** (0.0101)	−0.0337*** (0.0102)	−0.0357*** (0.0102)
Age of household head (years)	8.02e-05 (0.0125)	0.00160 (0.0124)	0.00230 (0.0125)	0.00234 (0.0122)
Gender of household head (1 = female)	0.126* (0.0657)	0.126* (0.0655)	0.120* (0.0665)	0.140** (0.0664)
Asset value (log)	0.0347 (0.0317)	0.0363 (0.0309)	0.0342 (0.0334)	0.0372 (0.0312)
Asset ownership (1 = owns mobile phone)	−0.102 (0.105)	−0.111 (0.106)	−0.126 (0.104)	−0.104 (0.105)
Observations	(0.432)	(0.421)	(0.434)	(0.402)
Observations	335	335	335	335
R-squared	0.374	0.376	0.376	0.377

Note: Robust standard errors are reported in parentheses. Dummy variables for community and year are controlled for in all specifications for location- and time-specific effects $***p < 0.01$; $**p < 0.05$; $*p < 0.1$

2.3.7 Robustness Checks and Propensity Score Matching

The OLS and fixed effects results presented above assume no systematic differences in household characteristics between households affected and unaffected by weather shocks. Although the fixed effects estimates control for unobserved time-invariant

Table 2.11 Propensity score matching (PSM) of weather shocks and household consumption

Variables	(1) Log (consumption)	(2) Log (food)	(3) Log (basics)	(4) Log (contribution)
ATE (weather shock)	−0.173*** (0.0612)	0.150 (0.125)	−0.227** (0.103)	−0.148 (0.225)
ATE (drought)	−0.0499 (0.0786)	0.140 (0.151)	−0.221* (0.128)	−0.417* (0.220)
ATE (flood)	−0.00744 (0.0493)	0.0805 (0.150)	−0.308* (0.165)	−0.240** (0.0970)
ATE (pests/diseases)	−0.0532 (0.0642)	−0.111 (0.134)	−0.0886 (0.126)	0.0736 (0.203)
Observations	342	342	342	342

Note: Robust standard errors are reported in parentheses $***p < 0.01$; $**p < 0.05$; $*p < 0.1$

Table 2.12 Propensity score matching (PSM) of weather shocks and coping strategies

Variables	(1) Sell livestock	(3) Sell assets	(5) Work off-farm	(6) Receive credit	(7) Receive remittances
ATE (weather shock)	0.0261 (0.0610)	0.00290 (0.0402)	0.125* (0.0753)	0.116* (0.0621)	0.171** (0.0665)
ATE (drought)	0.0551 (0.0641)	0.0696 (0.0467)	0.183*** (0.0595)	0.183** (0.0725)	0.0377 (0.0625)
ATE (flood)	0.110 (0.0693)	0.0580 (0.0712)	0.270*** (0.0757)	0.110 (0.0921)	0.322*** (0.0960)
ATE (pests/diseases)	0.0145 (0.0596)	−0.0232 (0.0436)	0.0580 (0.0573)	0.0551 (0.0604)	0.0116 (0.0603)
Observations	345	345	345	345	345

Note: Robust standard errors are reported in parentheses $***p < 0.01$; $**p < 0.05$; $*p < 0.1$

household heterogeneity, observed and time-variant unobserved heterogeneity could confound our results. In fact, Table 2.1 indicates that households affected and unaffected by weather shocks are systematically different along key characteristics such as household size and age and education of the household head. These differences could be responsible for the observed consumption difference between these groups of households. Similarly, such differences could also imply variations in the ability of households to adopt coping strategies, even in the absence of weather shocks.

The average treatment effect (ATE) presented in Tables 2.11 and 2.12 is used to compare consumption expenditures and the likelihood of adopting a certain coping strategy between comparable households that have been affected and unaffected by weather shocks. The negative impact of weather shocks identified through the OLS and fixed effects analyses is also confirmed through the PSM analysis (Table 2.11). Exposure to weather shocks reduces household consumption expenditure per adult equivalent by 17%. When disaggregating consumption expenditures, there is a 22% decline in expenditure for household basics and a negative but statistically insignificant effect for social contributions. When analyzing individual weather shocks, droughts and floods significantly reduce expenditure on basics and social contributions, while shocks related to animal/crop pests and diseases have no significant impact on any of the consumption categories.

Table 2.12 confirms the findings of Table 2.7 and particularly the positive and significant impact of exposure to weather shock on the likelihood to be involved in off-farm waged employment, borrow money, and receive remittance, as well as a positive but insignificant impact on the sale of livestock and household assets.

Finally, Table 2.13 reports the results of covariate balance tests to assess the comparability of covariates before and after matching. P-values for the equality of means covariates such as distance to the market, SACCO membership dependency ratio, age, and years of schooling of the household head are lower than 0.05 before matching but higher than 0.1 after matching. This indicates that covariates were unbalanced before matching but became balanced after matching. Failure to reject the hypothesis of joint equality of means after matching (as indicated by a p-value higher than 0.05) shows that covariates for households affected and unaffected by weather shocks are drawn from comparable distributions (Caliendo and Kopeinig 2008). Additionally, the mean absolute bias of 3.3% is lower than the recommended value of 5% to yield reliable estimates (Rosenbaum and Rubin 1985). This implies that the propensity score matching technique reliably compared shock-affected households with unaffected households sharing similar observable characteristics, hence ameliorating the issue of observed heterogeneity that would confound the results.

2.4 Discussion

2.4.1 Synthesis of Findings

As already discussed in Sect. 2.1, the interface of climate change, food security, and livelihoods is a very important sustainability challenge in SSA (see also Chaps. 1–3 Vol. 1). Climate variability can increase the frequency and intensity of droughts and floods, which can have multiple negative socioeconomic effects (Sect. 2.1). Agriculture is one of the most vulnerable sectors (Howden et al. 2007), with many studies having identified or predicted possibly severe yield declines in SSA due to climate change (Ringler et al. 2010; Dinar et al. 2012; Schlenker and Lobell 2010; Kurukulasuriya and Mendelsohn 2007; Roudier et al. 2011).

Our analysis suggests that exposure to weather shocks significantly reduces the aggregate household consumption expenditure per adult equivalent by approximately 17% (Sect. 2.3.7). By disaggregating consumption to its components, we can deduce that food-related consumption is not affected by weather shocks but non-food expenditures are severely reduced (Sect. 2.3.3). This indicates a potential reallocation of household resources upon exposure to shocks away from other consumption components to supplement food purchases. In fact, empirical literature has revealed that households tend to reallocate internal resources when faced with

Table 2.13 Covariate balance check before and after propensity score matching (PSM)

Variables	Mean before			Mean after			% |Bias|
	Shock = 1	Shock =0	P-value	Shock =1	Shock =0	P-value	Reduction
Dependency ratio	1.0326	1.3944	0.062	1.0326	0.82387	0.168	73.3
Education of household head (years of schooling)	9.97	11.34	0.041	11.347	12.405	0.137	35.3
Age of household head (years)	39.05	35.73	0.037	39.438	39.884	0.801	28.4
Household size (number of members)	6.24	5.24	0.009	5.7273	5.5868	0.709	26.1
Gender of household head (1 = female)	0.26	0.21	0.366	0.2562	0 0.22314	0.549	980.0
Asset value (log)	14.283	13.989	0.309	14.283	14.456	0.357	41.1
Distance to market (km)	0.91694	1.043	0.044	0.91694	0.81481	0.138	23.4
Savings (1 = belongs to SACCO)	0.36	0.27	0.067	0.34711	0.38889	0.597	176.9
Asset ownership (1 = owns mobile phone)	0.76	0.74	0.812	0.75	0.75	1.000	100.0
Pseudo R^2	–	–	0.088	–	–	0.0043	–
Mean bias	–	–	11.8	–	–	3.3	–
P-value (joint mean equality)	–	–	0.040	–	–	0.154	–

Note: Balance check before and after PSM for observations for which $0.1 < e(X) < 0.9$. Pseudo R^2 indicates how well covariates explain treatment probability. A small value after matching indicates goodness of the matching technique (Sianesi 2004). A standardized absolute mean bias <5 after matching indicates effective matching (Rosenbaum and Rubin 1985). A non-significant p-value for the joint mean equality test after matching shows significant similarity between treatment and control groups after matching (Caliendo and Kopeinig 2008) negative income shocks from weather events (Akampumuza and Matsuda 2017; Sawada and Shimizutani 2011). Even in the case of positive income shocks, changes in the relative importance of consumption components may necessitate intra-household resource reallocation. For example, Prina (2015) finds that households obtaining access to a banking account for the first time tend to increase their spending on education, meat, and fish and reduce spending on health and dowry.

We also find significant gender differences in poverty and vulnerability to weather shocks. Although the gendered impacts of climate change and weather shocks have attracted increasing policy and academic attention in SSA (Akampumuza and Matsuda 2017; Asfwa and Maggio 2018), empirical evidence based on micro-data is still scanty. Generally, our study finds that irrespective of the exposure status to weather shocks, female-headed households are, on average, poorer in terms of consumption (including food-related consumption) relative to male-headed households (Sect. 2.3.3). Following their exposure to weather shocks, female-headed households decrease consumption expenditure per adult equivalent more sharply relative to male-headed households (Sect. 2.3.4). This finding is consistent with some of the existing evidence attributing such gender-differentiated vulnerability to the relative lack of access to coping resources and opportunities (Akampumuza and Matsuda 2017; Klasen et al. 2014). Although our chapter focuses on the short-term effects of weather shocks, it is likely that the food consumption among households affected by weather shocks will divert severely from its long-term trajectory. For example, panel evidence from Malawi indicates that the overall consumption, food consumption, and calorie intake divert significantly from their long-term trajectories after periods of abnormally high temperatures (Asfaw and Maggio 2018).

With regard to the coping strategies, we find that affected households are more likely to engage in off-farm waged employment (Sect. 2.3.5). This reflects existing literature that has stressed the importance of participation in labor market as an ex-post coping strategy (Mathenge and Tschirley 2015; Ito and Kurosaki 2009). For example, studies have found that off-farm employment has increased for adults and children during shocks in Tanzania (Beegle et al. 2006). However, studies often fail to examine the effectiveness of such strategies in safeguarding consumption and income against shocks. Some of the other coping strategies identified in this study include remittances and the sale of household assets (Sect. 2.3.5). However, contrary to studies that have identified livestock selling as a crucial coping strategy (Hoddinott 2006), this was not observed in our case. This is possibly due to the relatively larger representation of urban residents in our sample, which mainly engage in off-farm employment and had low level of livestock ownership.

Finally, we find that most of the adopted coping strategies do not effectively safeguard the consumption of the affected households (Sect. 2.3.6). The only exception is remittances, which seem to fully offset the potential adverse effect of weather shocks on consumption (Sect. 2.3.6). This stresses the importance of both domestic and international remittances for poverty alleviation and vulnerability reduction, irrespective of the rural or urban contexts. This finding is consistent with a study that found that predominately rural Kenyan households that use

M-PESA (i.e., Safaricom's mobile money platform) are able to offset the negative effect of shocks from weather and illness, by receiving remittances from family and friends (Jack and Suri 2014).

2.4.2 Policy Implications and Recommendations

As mentioned in Sect. 2.1, the results of this study are relevant to various SDGs such as SDG1 (No poverty), SDG2 (Zero hunger), SDG5 (Gender and equality), SDG11 (Sustainable cities and communities), and SDG13 (Climate action) to mention some. Thus the findings outlined above carry important policy and practice implications for designing strategies and interventions to reduce the negative outcomes of weather shocks in urban contexts of SSA.

Firstly, they point to the need for designing and implementing comprehensive strategies to increase the resilience of food systems against weather shocks. To achieve this it would be necessary to achieve a much broader understanding of food systems spanning from the production to the distribution and consumption of food, especially in the context of urbanization and climate change (Chap. 1 Vol. 1). Considering that smallholder-based farming is a crucial source of livelihoods and food for a large portion of the Ugandan population (and SSA more generally), increasing its resilience to weather shocks would not only enhance food security but also safeguard their income against weather shocks. Strategies that simultaneously support climate-smart food crop production through the use of drought-tolerant crop varieties, soil management practices, and seasonal weather forecast would be particularly important (Chaps. 6, 10 Vol. 1; Chap. 3 Vol. 2). Beyond food crop production, it would be important to develop an efficient food supply and distribution system, especially for urban households that are often not engaged in agriculture and rely on food crops produced in surrounding rural areas. This would necessitate the strengthening of critical infrastructure to maintain steady rural-urban food flows and prevent any disruptions to the food supply chain during weather shocks and especially floods. Ultimately, such resilient food production systems and efficient and reliable food distribution channels could enhance food availability, avoid unnecessary food price hikes (especially during times of weather shocks), and sustain food consumption especially among poorer urban households. Such policy and practice interventions could contribute to SDG 2 (Zero hunger) and SDG 13 (Climate action) but also catalyze poverty alleviation and vulnerability reduction, thereby directly contributing to the achievement of SDG1 (No poverty).

Secondly, effective livelihood support strategies need to specifically target female-headed households, as these are disproportionately affected by weather shocks. For example, improving female education and skills, easing labor market restrictions, and providing relevant and timely weather forecasts to female farmers could potentially increase their resilience to weather shocks. Such strategies could increase women's access to alternative coping options and opportunities, which could in turn reduce both their vulnerability to weather shocks and the severity of impacts. Additionally, by increasing coping capacity, this could help female-headed households (and women in general) to recover faster from the adverse effects of weather shocks. This could contribute to wider national efforts to achieve gender equality (and overall equality of opportunities) and achieve more inclusive growth as stipulated in SDG5 and SDG10, respectively.

Thirdly, as most coping strategies do not seem to adequately safeguard household consumption against weather shocks, there is need to reinvigorate credit and insurance markets. In principle promoting agricultural insurance could safeguard smallholder farmers from severe income loss due to extreme weather events. These, coupled with credit guarantee schemes, reduced interest rates and strategies to increase access to credit could increase the ex-post coping ability of households affected by weather shocks. This is particularly important to households that lack the necessary collaterals to enter formally the credit market. Indeed, improved and inclusive agricultural insurance and credit markets could go a long way reducing poverty and vulnerability to climate change (SDG1) and reduce food insecurity and hunger (SDG2).

2.5 Conclusions

Urban households in many parts of SSA are potentially susceptible to food insecurity and the disruption of livelihoods due to extreme weather events. Weather-related shocks such as droughts, floods, and severe incidence of animal and crop pests and diseases have direct adverse impacts on food production in surrounding rural areas. Furthermore, some weather shocks such as floods can cause the breakdown of critical road infrastructure and disrupt rural-urban food flows. The ultimate outcome is the significant compromise of livelihoods and the decline of food availability, which, coupled with increased food prices, can curtail the ability of many poor urban households to access sufficient food following weather shocks. Sometimes this situation is even worse among female-headed households, as they generally have access to fewer resources and a lower ability to adopt appropriate coping strategies.

However, there is a lack of robust empirical analysis of these dynamics in the existing literature, as most available studies either focus on rural areas where the impact of weather shocks is direct (i.e., through crop loss and crop failure) or aggregate households and ignore gender heterogeneity for household heads. This chapter therefore contributes to the existing literature by (a) analyzing the impact of weather shocks on consumption expenditure among urban households, (b) investigating gender dynamics related to vulnerability to weather shocks, (c) assessing the effectiveness of different coping strategies against weather shocks, and (d) assessing potential reallocation of household expenditures among its different sub-components during weather shocks.

The results suggest that self-reported exposure to weather shocks reduces household consumption expenditure per adult equivalent by 17%. The consumption decline is particularly severe among female-headed households, partly owing to their relative lack of access to productive resources and opportunities including land, credit, and off-farm employment. By disaggregating consumption elements, we highlight how households reallocate expenditures from health, education, semi-durables, and contributions toward social, cultural, and religious functions, to augment food intake following weather shocks. We also find that shock exposure is associated with a higher likelihood of engaging in off-farm employment, borrowing and receiving remittances as coping strategies against weather shocks. However, we also find that most of the coping strategies adopted by affected households do not effectively safeguard against household consumption decline with the exception of remittance receipt.

These findings suggest the critical need to strengthen food production, distribution, and supply systems and increase the resilience of household consumption against extreme weather events. This, in return, could safeguard urban livelihoods and food security following weather shocks. Policy interventions should also target highly vulnerable households, for example, those headed by females, considering their lower access to resources (e.g., land), opportunities (e.g., access to credit, formal employment), and ability to adopt many of the appropriate coping strategies.

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