Vulnerability to climate shocks in Zambia: How does the tax-benefit system fare in the face of climate shocks?

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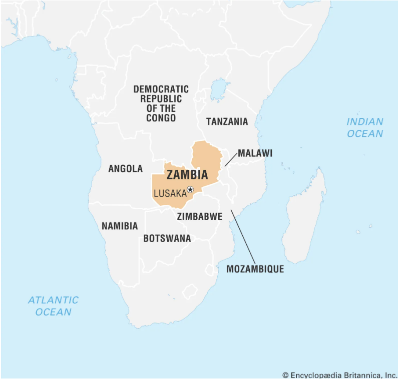
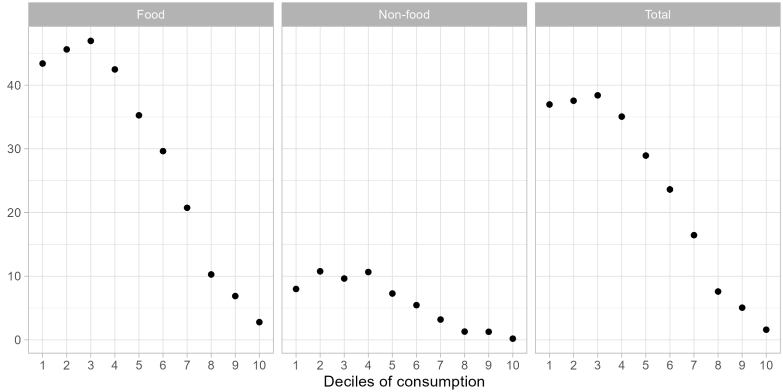
Zambia profile



- Population: 20 million.
- $\sim$ 50% of the population classified as extremely poor in 2022.
- Low economic activity and high informal employment, particularly in agriculture.
- Dependence on rain-fed agriculture.
- Crop growing season (rainy season): November - April
- Reliance on self-produced food, especially among poor households ($\sim$ 50% of food is self-produced).

Share of self-produced consumption items

Figure 1: Share of self-produced items in consumption in 2015 by deciles of consumption per household member



Source: Authors' calculations based on 2015 Living Conditions Monitoring Survey.

Droughts in Zambia in recent years

'Crippling' drought in Zambia threatens hunger for millions, says minister

Collins Nzovu says country's plight is foretaste of disasters that will increasingly afflict region as climate breakdown takes hold

Children fetch water using a wheelbarrow in Lilanda township in Lusaka. The rains failed in February and there is little prospect of saving the maize crop. Photograph: Tsvangirayi Mukwazhi/AP

Drought emergency in Zambia: Child marriage, HIV and hunger on the rise for women and girls

In Zambia's drought-hit Southern, Western, Central and Lusaka Provinces, acute malnutrition is high among pregnant and breastfeeding women and risks are rising of gender-based violence, sexual exploitation and abuse. © UNFPA Zambia/Julien Adam

Zambia declares national emergency as drought devastates food and electricity supply

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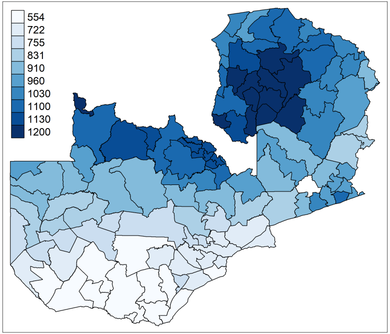
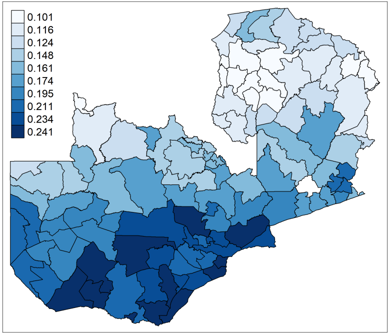
Historical average rainfall

Figure 2: Historical average rainfall during the growing season (mm) and coefficient of variation, 1981-2009



(a) Average accumulated rainfall during the growing season in 1981-2009, mm

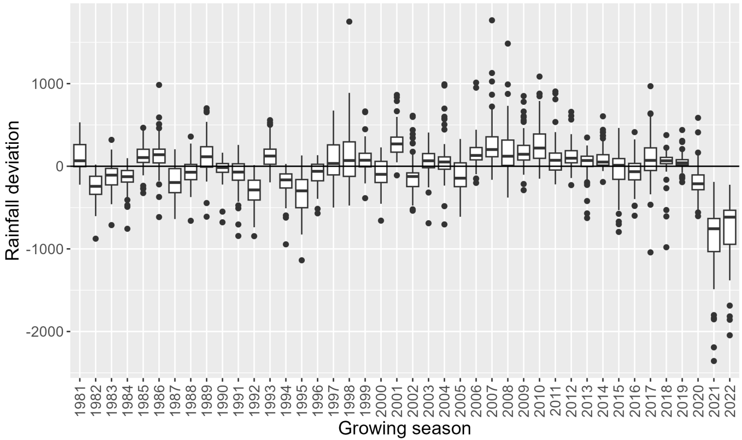


(b) Coefficient of variation of average accumulated rainfall during the growing season in 1981-2009

Source: Authors' calculations based on district-level data of monthly rainfall.

Strong rainfall shortages in recent years compared to previous years

Figure 3: District-level rainfall deviation from the historical average

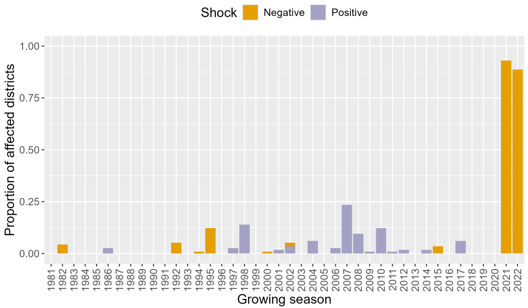


Source: Authors' calculations based on district-level data on monthly rainfall.

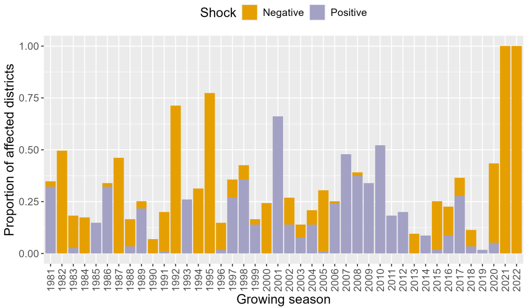
Frequency and geographic spread of droughts has increased

A rainfall shock occurs if the rainfall deviation from the historical average, calculated at the district level falls outside the interval of $\pm$ *2(1)* standard deviations around the average.

Figure 4: Proportion of districts affected by positive and negative rainfall shocks



(a) Shocks defined outside $\pm 2SD$



(b) Shocks defined outside $\pm 1SD$

Source: Authors' calculations based on district-level data of monthly rainfall.

This paper

- We **test the capacity of the social protection system** to alleviate the effects of rainfall shocks.
- We identify rainfall shocks based on historical rainfall data.
- We focus on **negative rainfall** shocks.

Data and outcome measures

- District-level data on monthly rainfall (millimeters) from January 1980 to December 2022.
- 2015 Living Conditions Monitoring Survey (LCMS).
- Tax-benefit microsimulation model for Zambia MicroZAMOD v2.16
- Outcome measures:
  - Use consumption and the national calorie-based equivalence scale
- Consumption poverty measured in absolute terms using national severe poverty line ($\sim 2USD/day$)

Approach

- Steps:
  - Identify rainfall shocks,
  - Shock household consumption and income in MicroZAMOD,
  - Calculate the distributional and poverty effects,
  - Analyze the role of the tax-benefit system.

Approach (cont.)

- We define rainfall shocks similarly to Asfaw et al. (2017): a negative rainfall shock occurs if the rainfall falls below 2 standard deviations from the historical average.
- We use elasticity estimates from Asfaw et al. (2017):
  - A 1 mm negative deviation in rainfall reduces household food consumption by 3.8-4.0%.
  - Non-food consumption is reduced by 3.0%.

Rainfall shock scenarios

- We simulate three rainfall shock scenarios:
  - **Optimistic scenario:** Assume the same amount of rainfall in all districts as in 2015.
  - **Pessimistic scenario:** Assume the same amount of rainfall as in 2022.
  - **Moderate scenario:** For each district, we calculate the average of the rainfall shocks from 2015 and 2022. If the calculated average shock for a district is smaller than the value assumed in the optimistic scenario, we use the optimistic scenario's value for that district.

Simulated rainfall shocks

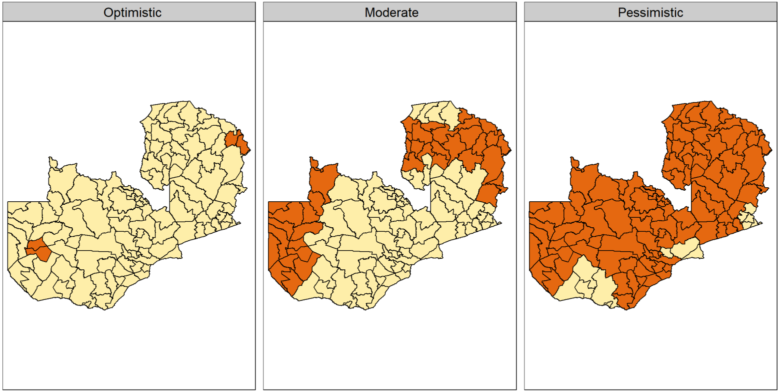


Figure 5: Districts impacted by negative rainfall shocks under optimistic, moderate and pessimistic scenarios

Implementing shocks in MicroZAMOD

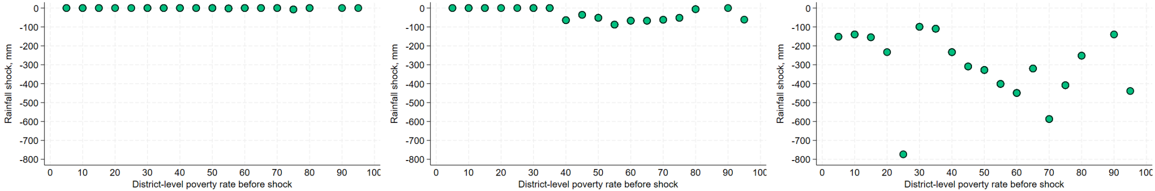
- For each rainfall shock scenario (optimistic, moderate, pessimistic), we simulate **three subscenarios**.
- The subscenarios differ in terms of which model variables are assumed to be affected by the shocks.
- Depending on the subscenario, we apply the shock to all or some of the following model variables:
  - Income of workers in agriculture,
  - Household consumption of purchased food,
  - Household consumption of self-produced food,
  - Household non-food consumption.

Baseline simulation: The effect of climate shocks – preliminary results

- In this section, we present baseline results on the effect of rainfall shocks on:
  - Consumption,
  - Poverty.
- We simulate the effect of rainfall shocks in 2022.
- Baseline simulation presents the results under actual tax-benefit system of 2022.
- Figures show the effect under subscenario 3 in each of the climate shock scenarios (optimistic, moderate and pessimistic)

Poorer regions tend to be more affected by rainfall shocks

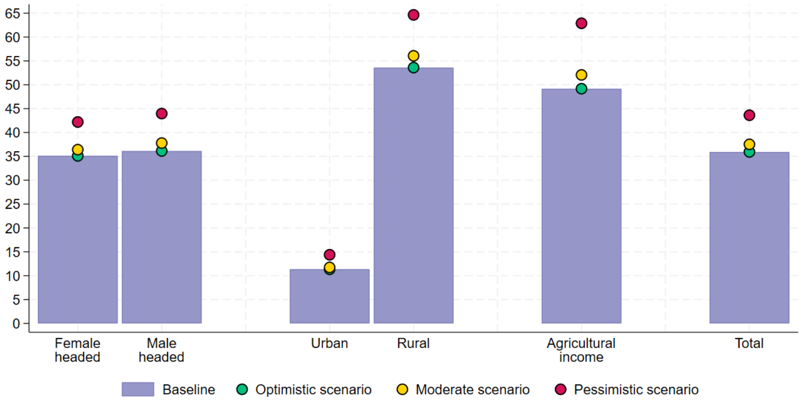
Figure 6: District-level poverty rate before shock vs. size of negative rainfall shock



(a) Optimistic scenario (b) Moderate scenario (c) Pessimistic scenario

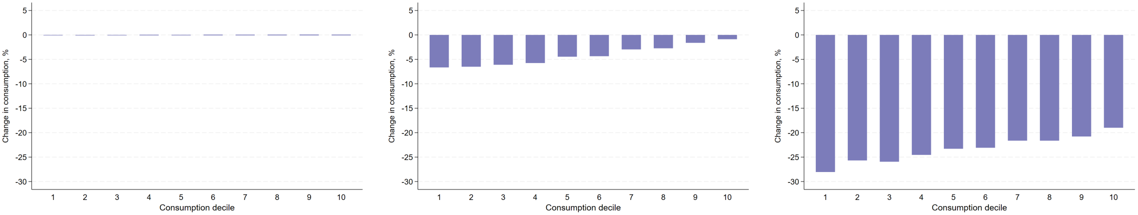
Baseline simulation: Effect of rainfall shocks on poverty

Figure 7: Poverty rates (%) by household type



Baseline simulation: Effect of the rainfall shocks on consumption

Figure 8: Change in consumption (%) by deciles of consumption



(a) Optimistic scenario

(b) Moderate scenario

(c) Pessimistic scenario

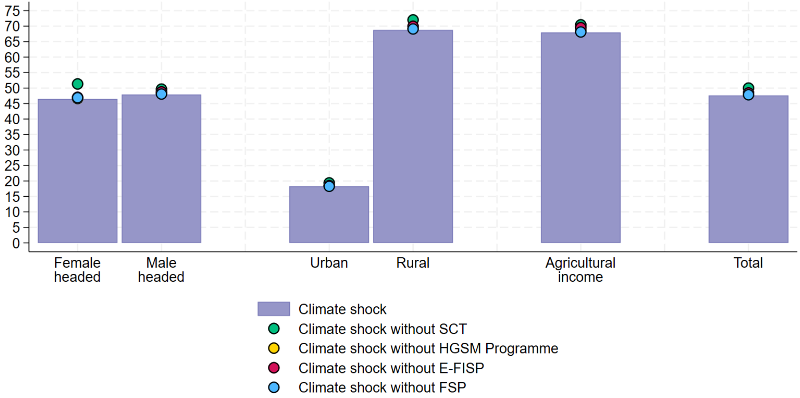
Effects of Social Transfers

Government expenditure on social transfers in 2022

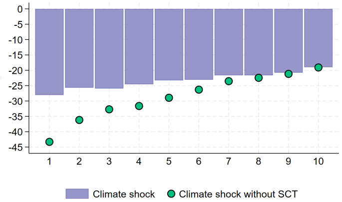
Table 1: Major expenditure components (model-based expenditure)

	Share of expenditure on social transfers	Description	Benefit amount
Social Cash Transfer	43.8%	(Proxy-) Means-tested benefit for the poorest households	200 ZMW per household (59% of poverty line, 24% of average consumption)
Electronic-Farmer Input Support Programme	33.3%	Access to agricultural inputs for smallholder farmers (fertilizers and maize seed)	442 ZMW per household (42% of poverty line, 17% of average consumption)
Home Grown School Meal Programme	10.1%	Free daily school meals to learners	33 ZMW per student (10% of poverty line, 4% of average consumption)
Food Security Pack	4.4%	Package of inputs for small-scale cultivation of maize and legumes; in some cases chicken and goats. Targets vulnerable small-scale farming households	202 ZMW per household (60% of poverty line, 24% of average consumption)

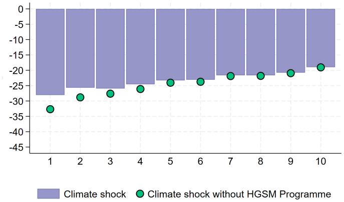
Poverty rate (%) by type of households under pessimistic rainfall scenario with and without social transfers



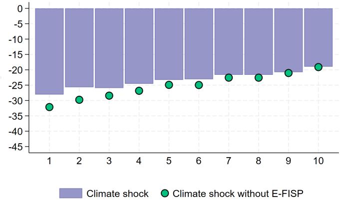
Change in consumption (%) under pessimistic rainfall scenario with and without social transfers



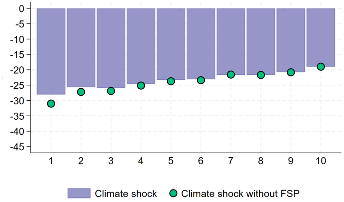
(a) Social Cash Transfer



(b) Home Grown School Meal Programme



(c) Electronic-Farmer Input Support Programme



(d) Food Security Pack

Summary of findings

- Droughts in Zambia are becoming stronger and more frequent.
- Poor households are disproportionately affected:
  - Droughts have a greater impact on poorer regions,
  - Poor households are more vulnerable due to their reliance on self-produced consumption.
- Social transfers effectively target the poorest population groups.
- Next step:
  - Propose social policy reforms to mitigate the effects of droughts,
  - Emphasis on shock-responsive benefit rules.

Thank you for attention!

Additional slides

Simulation of consumption changes in MicroZAMOD

Policy	Grp/No	ZM_2021	ZM_2022	Comment
xhhadj_zm		**on**	**on**	**DEF: Adjust consumption to new disposable income plus in-kind benefits**
fx DefConst		**on**	**on**	Specify share of own-account production consumed that is protected from changes
$protect_cons	1	0.25	0	An optional constant for the share of own-account production consumed that is protected from the shock. This is ca. 25% in Sub-Saharan Africa, but can be set to 0%.
fx BenCalc		switch	switch	Calculate adjusted consumption
Comp_Cond	1	yds<ils_dispyki	yds<ils_dispyki	Disposable income incl. in-kind benefits higher than in base year
Comp_perTU	1	xhh + (ils_dispyki - yds)	xhh + (ils_dispyki - yds)	... increase by change in disposable income incl. in-kind benefits
Comp_Cond	2	yds>=ils_dispyki	yds>=ils_dispyki	Disposable income incl. in-kind benefits smaller than in base year
Comp_perTU	2	xhh + (ils_dispyki - yds)	xhh + (ils_dispyki - yds)	... decrease by change in disposable income incl. in-kind benefits
Comp_LowLim	2	xhh * $protect_cons	xhh * $protect_cons	...but retain 'protected' share
Output_Var		xhh_s	xhh_s	
TAX_UNIT		tu_household_zm	tu_household_zm	

Note: Assume marginal propensity to consume of 1, i.e. all of an increase in income is consumed

Simulation of rainfall shocks

1. Identification of shocked districts (varies for optimistic, moderate, pessimistic scenario)
2. Calculate district-specific share of consumption and agricultural income after shock (varies for each sub-scenario):
   1 - (rainfall deviation * elasticity for specific consumption category)
3. Create new input datasets for each scenario and sub-scenario where:
   - agricultural income is multiplied by the share after the shock
   - consumption is split into food-specific, non-food-specific and own produce consumption and each consumption category is multiplied by the share after the shock
4. MicroZAMOD is run with each input dataset and results are compared to results based on the standard input dataset

Implementing shocks in MicroZAMOD

Table 2: Implementing shocks in MicroZAMOD (Note: applying each subscenario to each climate shock scenario)

	Income of workers in agriculture	Household food consumption	Household non-food consumption	Houshold consumption of self-produced food
Sub scenario 1	Apply elasticity of 3.8%, set maximum reduction at 30%	Apply elasticity of 3.8%, set maximum reduction at 30%	Apply elasticity of 3.0%, set maximum reduction at 30%	Not modelled
Sub scenario 2	Apply elasticity of 3.8%, set maximum reduction at 30%	Not modelled	Apply elasticity of 3.0%, set maximum reduction at 30%	Apply elasticity of 3.8%, set maximum reduction at 30%
Sub scenario 3	Apply elasticity of 3.8%, set maximum reduction at 30%	Apply elasticity of 3.8%, set maximum reduction at 30%	Apply elasticity of 3.0%, set maximum reduction at 30%	Apply elasticity of 3.8%, set maximum reduction at **50%**