Climate Shocks and Social Intolerance *

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Abstract

Droughts in developing countries can have devastating effects on agricultural productivity, local economies, and livelihoods, intensifying social tensions among different groups. This study investigates whether droughts affect individuals' social intolerance, defined as the unwillingness to accept people from other social groups or identities as neighbors. Using georeferenced data on drought conditions across Africa and individual-level data from Afrobarometer surveys conducted between 2014 and 2021 in Africa, we find that droughts increase social intolerance: a severe or extreme drought shock significantly increases the probability that an individual is intolerant toward people of other religions by 18%, toward people from different ethnicities by 28%, and immigrants or foreign workers by 17%. This effect is concentrated among individuals living in rural areas and is more pronounced for those with lower levels of education, as well as for those residing in areas with low ethnic or religious diversity. We also explore the potential mechanisms underlying these effects using a variety of geospatial data on crop production and night lights, and our findings suggest that drought shocks negatively impact major crop yields, local economic activity, and employment, which may subsequently lead to increased intolerance among people.

Keywords: Climate Change, Social Tolerance, Africa
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1 Introduction

Social tolerance, broadly defined as openness and acceptance of diverse social groups, is crucial to building resilient, inclusive, and peaceful societies.[1] It can promote economic growth and development by fostering trust and cooperation among economic actors, strengthening democracy, and facilitating the free exchange of ideas and individual talents (Florida et al., 2008; Tabellini, 2010; Cerqueti et al., 2013). Despite growing awareness of the significance of social tolerance, little is known about what factors determine it. The economic literature on the determinants of social tolerance is even more limited largely due to the difficulties in measuring social tolerance.

One potential contributor to social intolerance could be climate change-driven extreme weather events. Climate shocks, especially droughts, can affect tolerance in various ways. Droughts can have negative impacts on agriculture and livelihoods(Kuwayama et al., 2019; Hasan et al., 2019), leading to economic hardships that may result in increased ethnic intolerance as different groups hold each other responsible for the decline in their well-being. Long-lasting droughts and severe weather events can create competition for scarce resources such as water and arable land, further intensifying tensions between social groups. Homer-Dixon (1999) argues that resource scarcity deepens social divides, reducing social capital and trust. Prediger et al. (2014) show that resource scarcity among Namibian pastoralists increases antisocial behavior. Additionally, climate shocks can affect human capital (Hyland and Russ, 2019; Park, 2017), which in turn affects social intolerance.

This paper explores whether climate shocks affect social intolerance in Africa. Africa is an ideal setting for studying the relationship between climate shocks and social intolerance because this region is highly vulnerable to climate change and extreme weather events such as droughts and is often disrupted by severe ethnic conflicts. [2] To explore the impact of climate shocks on social intolerance, we exploit spatial and temporal variability in drought conditions across Africa. We measure droughts at 0.5-degree resolution (55 km x 55 km grid cells) for each month of the years 2014-2021 using the Standard Evapotranspiration Index (SPEI)(Vicente-Serrano et al., 2010), which incorporates information about rainfall, temperature, and other weather inputs (Harari and Ferrara, 2018). We rely on georeferenced household data from the Afrobarometer survey between 2014 and 2021 to measure social intolerance. In the Afrobarometer survey, the respondents are asked whether they would like, dislike, or be indifferent to having people from other social groups or identities as neighbors, and we define a person as socially intolerant if s/he would dislike having neighbors from people from different social groups or identities. Our econometric specification uses a two-way fixed effects model combining the Afrobarometer data matched with data on droughts at 55 km x 55 km grid cell levels for years between 2014 and 2021.

We find that a drought shock in the locality significantly increases the probability that an in-

[1] Florida (2003) defines tolerance as "openness, inclusiveness and diversity to all ethnicities, races, and walks of life". Corneo and Jeanne define it as "respect for diversity".

[2] More than half of all African countries have experienced at least a year of armed conflict during the past three decades (Venkatasawmy, 2015)

dividual is intolerant towards people from a different ethnic group by 10.5 percent and towards immigrants by 8 percent. However, we do not find statistically significant impacts on intolerance towards people of other religions. When categorizing droughts into severe/extreme and moderate levels and analyzing their effects on social intolerance separately, we observe that a severe or extreme drought significantly increases respondents' intolerance toward people of other religions by 18 percent, people of different ethnicities by 28 percent, and immigrants or foreign workers by 17 percent. Moderate droughts, however, do not appear to have any measurable impact on social intolerance. Our results are robust to the inclusion of additional controls, to the choices of the levels of clustering of the standard errors, and to the alternative specification of drought shocks.

While exploring the heterogeneous effects of droughts, we find that the impact of a drought shock on social intolerance is primarily concentrated among individuals living in rural areas. This effect is more pronounced among individuals with lower levels of education and those living in areas with low ethnic or religious diversity than their counterparts.

Finally, we examine the potential mechanisms underlying this effect. Our results suggest that climate shocks adversely impact major crop yields, local economic activities, and employment, which could subsequently lead to increased intolerance among people.

Our work is related to two streams of literature. First is the literature on the social and economic impacts of climate change and/or extreme weather events. A substantial number of studies focuses on climate and economic development (For a detailed review, see Dell et al. (2014)) including the impacts of temperature shocks on economic growth (Dell et al., 2012), labor productivity (Graff Zivin and Neidell, 2014) and health (Burgess et al., 2014; Barreca et al., 2016). Recently, there is a growing literature on the impacts of climate change on social and political outcomes such as conflicts (Hsiang et al., 2013), ethnic trust(De Juan and Hänze, 2021), trust in political leaders(Ahlerup et al., 2024), support for democracy(Cerkez, 2023), crime (Ranson, 2014), and suicide (Takahashi, 2017).

The second strand of literature related to our work is on the determinants of social tolerance. In a recent paper, using cross-country data from the World Values Survey and European Values Study, Berggren and Nilsson (2013) document that economic freedom (measured by an economic freedom index based on the degree to which economic institutions and policies are market-oriented) has a positive effect on tolerance toward homosexuals, but it has no significant impact on tolerance toward different race. Using the World Value Survey and national-level income data on 35 developed countries, Andersen and Fetner (2008) finds that while GDP per capita positively impacts social tolerance towards homosexuality, income inequality has a negative impact. We contribute to this literature by documenting that income shocks as proxied by negative climate shocks significantly increase individuals' intolerance towards other social groups or identities.

The rest of the paper proceeds as follows. Section 2 describes the data and variables. Section 3 describes empirical strategy. Section 4 presents the results and discussion. Section 5 concludes.

2 Data

For our primary analysis, we combine data from two main sources to measure drought conditions and social intolerance in Africa, respectively. We also utilize agricultural production data and night light data to explore the mechanism through which climate shocks might affect social intolerance.

2.1 Measuring Drought Conditions Across Africa

We measure drought conditions using the Standardized Precipitation - Evapotranspiration Index (SPEI), developed by Vicente-Serrano et al. (2010). We utilize the Global SPEI database, which makes SPEI data available on a global scale, with a 0.5 degree spatial resolution (55 X 55 Km grid cell) and a monthly time resolution. It is based on monthly precipitation (P) and potential evapotranspiration (PET) data from the University of East Anglia's Climatic Research Unit since January 1901 and is continually updated with new data. This data has been widely used in the studies of drought impacts (Bachmair et al., 2018; Wang et al., 2014).

SPEI captures the climatic water balance in a given location, with positive values indicating a water surplus (P larger than PET) and negative values indicating a water deficit (P smaller than PET). The key idea behind this drought index is that the impact of rainfall on agriculture will depend not just on the amount of precipitation but also on the soil's ability to retain water. This is determined by potential evapotranspiration, a function of other weather inputs including temperature, pressure, sunshine exposure, and wind speed. SPEI incorporates all these inputs, calculating water deficit (or surplus) by subtracting potential evapotranspiration from precipitation. In jointly considering these various factors, SPEI performs better than other indices in predicting crop yields Vicente-Serrano et al. (2010).

The SPEI values are expressed in units of standard deviations from the grid cell's historical average and thus have a mean 0 by construction in the historical sample (For our case, 1901-2021)[3]. Since drought conditions in the current period are a function of precipitation conditions in the current and past periods, SPEI is constructed using moving averages of climatic water balance (P-PET) over different timescales (usually ranging from 1 to 48 months). The SPEI measured at a 6-month or below timescale reflects short-run drought conditions, while the timescales above 6 months reflect longer-run conditions. For this study, we calculate the SPEI at the grid-year level by averaging the monthly SPEI-12 (SPEI measured at 12-month scale) values over the months in each year. This approach captures the long-term effects of drought.

According to climatology literature, drought occurs when the SPEI falls below specific thresholds. These thresholds categorize drought conditions into seven classes: extreme droughts ($SPEI \leq -2$), severe droughts ($-2 < SPEI \leq -1.5$), moderate droughts ($-1.5 < SPEI \leq -1$), near normal

[3]SPEI is a standardized index, i.e., SPEI equal to -1 in a given time t implies that the difference between observed rain and potential evapotranspiration needs in t are one standard deviation lower than the average observed in the baseline period in a given locality

($-1 < SPEI < 1$), moderate wet ($1 \leq SPEI < 1.5$), severe wet ($1.5 \leq SPEI < 2$), extreme wet ($SPEI \geq 2$). For this study, we broadly classify them into severe/extreme droughts ($SPEI \leq -1.5$), moderate droughts ($-1.5 < SPEI \leq -1$), and non-droughts ($SPEI > -1$).

In Figure 1, we map the drought conditions across Africa for selected years. These figures show that drought conditions vary across space and time. Additionally, in Figure 2, we show the variation of the average level of SPEI over the years in Africa.

2.2 Data on Social Intolerance in Africa from Afrobarometer survey

Data on social intolerance outcomes comes from the latest three rounds of the Afrobarometer survey conducted between 2014 and 2021. High-quality data measuring social intolerance on a regular basis have been scarce in the context of Africa. Recently, the Afrobarometer survey started assessing respondents' attitudes towards people from other social groups or identities, starting with round 6 (2014/15). In the survey, the respondents were asked how much they would like to have people from other groups and identities as neighbors. Precisely, the survey asks respondents: *For each of the following types of people, please tell me whether you would like having people from this group as neighbors, dislike it, or not care: (a) people of a different religion (b) people from different ethnic groups, and (c) immigrants or foreign workers*. The respondents choose whether they would *strongly dislike (1), somewhat dislike (2), not care (3), somewhat like (4), or strongly like (5)*. Appendix Figure 3 plots the survey response to the social tolerance questions. Panel (a) shows the individuals' attitudes toward having neighbors from other religions, and panels (b) and (c) show attitudes toward having neighbors from different ethnicities and nationalities, respectively.

We define social intolerance as an attitude of disliking (not accepting) other social groups as neighbors [4]. We label an individual as socially intolerant if s/he would "strongly dislike", "somewhat dislike," having neighbors from other groups or identities. As our primary outcome variables, we construct three binary variables, each measuring intolerance towards other religions, intolerance towards other ethnicities, and intolerance towards immigrants/foreign workers separately.

The number of countries in the Afrobarometer survey varies by survey round. The survey rounds 6 (2014-15) has 36 countries and rounds 7 (2016-2018) and 8 (2019-21) have 34 countries each. Our study focuses on 31 countries that appear in all three rounds. Appendix table [] lists the countries, number of respondents, and surveyed rounds.

The response rates for the social tolerance questions are close to 100 percent. Out of about 128,690 respondents across rounds (Round 6, 46917; Round 7, 40783; Round 8, 40990) and countries that featured in all three rounds, at least 98 percent answered this set of questions. Pre-

[4] Hjerm et al. (2020) identified two main approaches to tolerance. The first view (Ref?) links it with prejudice, where tolerance means accepting disliked groups. The second view sees tolerance independent of prejudice, focusing on attitudes of acceptance or appreciation towards diversity(Dunn et al., 2009; Kirchner et al., 2011). Our measure of social tolerance is more closely aligned with the second view.

cisely, 98.5 %, 98.4 %, and 98 % of respondents answered the questions of whether they would like/dislike/not care about having neighbors from people of different religions, ethnicities, and immigrants, respectively.

Figure 4 plots the share of socially intolerant respondents over our sample. We can see that the respondents' intolerance toward other religions, ethnicities, and immigrants varies considerably across countries (Panel A) and over time (Panel B).

3 Empirical Strategy

To estimate the impacts of climate shocks on individuals' social tolerance we start by estimating the following:

$$Intol_{icy} = \alpha + \beta Drought_{cy} + X'_{icy}\gamma + \delta_c + \theta_y + \varepsilon_{icy}, \tag{1}$$

where $Intol_{icmy}$ is an outcome (i.e. intolerance towards other social identities) for the respondent i residing in grid cell c and surveyed in year y. $Drought_{cmy}$ is an indicator variable that takes 1 if the average monthly $SPEI \leq -1$ during a given year y in a given grid cell c. Recall that $SPEI \leq -1$ in a given year indicates that the difference between observed precipitation and potential evapotranspiration in the year is one standard deviation below the historical average, a condition that we define as a drought shock. β is the coefficient of interest, which captures the impact of a drought shock on individuals' tolerance towards people of other social identities. X'_{icy} is a vector of controls that includes individuals' socio-demographic characteristics such as age and age squared, gender, education level, and place of residence(urban/rural). δ_c represents the grid cell fixed effects that control time-invariant characteristics affecting cell variations. θ_y represents the year fixed effects that control time-specific shocks.

A drought shock may be severe or moderate depending on the dryness level. Therefore, to account for the heterogeneity in the dryness level, we further estimate the following:

$$Intol_{icy} = \alpha + \beta_1 SvrExtDrought_{cy} + \beta_2 ModDrought_{cy} + X'_{icy}\gamma + \delta_c + \theta_y + \varepsilon_{icy}, \tag{2}$$

Where $SvrExtDrought_{cy}$ and $ModDrought_{cy}$ are indicator variables that take 1 if $SPEI \leq 1.5$ and SPEI $\in (-1.5, -1]$, respectively, in grid cell c at year y. Recall that $SPEI \leq -1.5$ indicates severe/extreme drought conditions and SPEI $\in (-1.5, -1]$ indicates moderate drought conditions. β_1 and β_2, thus, capture the impacts of an individual's exposure to severe drought and moderate drought, respectively. Here, our reference category is $SPEI > -1$, which indicates non-drought conditions (normal or wet conditions).

When estimating Equations (1) and (2), we cluster the standard errors at the grid-cell level in our main specifications to account for correlations within each grid cell across time. Table 1 presents descriptive statistics of the key variables used in our analysis, which appear in the main tables.

4 Results

In this section, we present our findings on the impact of climate shocks on social intolerance. We first show the main results, provide several robustness tests, and then explore the heterogeneous effects. Finally, we explore the possible mechanisms underlying the observed effects.

4.1 Main results

Table 2 presents the main findings of this paper. In Panel A of Table 2, we document the effects of drought shocks on social intolerance outcomes by estimating equation (1). For each of the three outcome variables, we report two specifications with different sets of covariates: the specification in the odd-numbered columns controls for grid cells and survey year fixed effects, and the specifications in the even-numbered columns further control for the individuals' socio-demographic characteristics including age, age squared, sex, education, and type of place of residence (rural vs urban). We find that, in both cases, drought shocks cause a statistically significant 0.9 percentage point (PP) increase in the likelihood of being intolerant towards people from other ethnicities and a 1.5 pp increase in the likelihood of being intolerant towards immigrants/foreign workers (See columns (3)-(6)), which represent a roughly 10.5% and 8% increase from the respective outcome means. We, however, do not find any statistically significant impact of drought shocks on intolerance towards people of other religions, as shown in columns (1) and (2).

In Panel B of Table 2, we show results from equation (2), estimating disaggregated effects of droughts. We classify droughts into severe or extreme droughts and moderate droughts and assess their impacts on social intolerance. Across all specifications, we find that while severe/extreme drought shocks have significant positive impacts, moderate droughts have no statistically significant impacts on the respondents' intolerance towards outgroups. The estimated effects of severe/extreme droughts in Panel B are larger than those of overall drought shocks in Panel A: severe or extreme drought shocks increase respondents' intolerance toward people of other religions by 18.2% (Columns (1)-(2)), towards people from other ethnicities by roughly 26-28% (Columns (3)-(4)), and towards immigrants by roughly 17% (Columns(5)-(6)). These results suggest that our main estimates in Panel A are driven by severe/extreme droughts.

4.2 Robustness checks

We now turn to an examination of the robustness of our main findings. First, we show the sensitivity of our main results by incorporating additional controls in the regression models that may affect individuals' tolerance towards other social identities. Our first set of additional controls accounts for an individual's exposure to diverse social identities. People living in a diverse community may exhibit higher social tolerance, however, they also may exhibit lower social tolerance due to prejudices and any bad past experiences. Using Afrobarometer data, we create ethnic and religious fractionalization indexes at the grid cell level as measures of the ethnic and religious diversity of a community where a respondent lives, respectively. These indices measure the probability that two randomly chosen people living in a grid cell belong to different ethnicities or religions. We use the following standard formula to calculate the ethnic fractionalization index:

$$EFI_c = 1 - \sum_{i=1}^{n} s_i^2$$

s_i represents ethnic group i's share of a grid cell, which we proxy by the share of respondents belonging to ethnic group i in the grid cell.[5] This index ranges from 0 to 1 where higher values denote increasing fractionalization (diversity). At the extremes, a value of 0 represents perfect homogeneity (only one ethnic group occupying the grid cell) while a value of 1 means perfect diversity implying that each respondent in the grid cell is from a different ethnic group. We follow similar steps to construct the religious fractionalization index (RFI).

Controlling for both EFI and RFI the results are reported in Appendix Table A1. These indices do contain some missing values, so our sample size has dropped con-siderably. The results show that controlling for both EFI and RFI, the estimates of the effects of drought shocks (in both panels of the table) are still statistically significant, suggesting that our main results are robust to these additional controls.

Our second set of controls accounts for local economic conditions and social amenities available in the respondent's locality. We believe that economic and social inequalities are grounds for social vices including intolerance. Our estimates might suffer from omitted variable bias if we do not control for the confounding effects of such potential inequalities. Thus, we control the respondents' access to basic economic and social amenities. The Afrobarometer surveys have information on the presence of schools, paved roads, post offices, piped water, and electricity available in the area (primary sampling unit). We create dummy variables indicating whether a given public good is available in the local area (Primary sampling unit). Controlling for all these dummy variables that account for the local socio-economic conditions, the results are reported in Appendix Table A2. We can see that the estimates in Appendix Table A2 are almost the same as our main results in Table 2.

Second, we examine the robustness of our baseline results to alternative choices of the level of clustering of the standard errors. We cluster the standard errors at the grid cell $\times$ year, which accounts for intra-year correlation within each grid cell. The results are reported in Appendix Table A3. We find that the results are almost unchanged.

Finally, we examine the robustness of our results by using an alternative specification in which we employ a different reference category while estimating the impacts of drought shock on social intolerance. Initially, we used the non-drought condition, which includes both normal and wet conditions, as the reference category. Now, we re-estimate the effects using the normal condition

[5]Given n_c as the total number of respondents in grid cell c and e_n as the total number of respondents belonging to ethnic group e, then $s_i = e_n/n_c$.

as the reference category, allowing us to examine the impacts of both drought shocks and wet shocks. The results, presented in Appendix Table A4, show that this alternative specification does not significantly alter our main findings.

4.3 Heterogeneous Effects

We now examine whether the impacts of climate shocks on social intolerance differ depending on the respondents' socio-demographic characteristics and the ethnic and religious diversity of the people living in an area (grid cell).

Column 1 of Table 3 shows the heterogeneous effects of a drought shock on social intolerance by the rural-urban status of the respondent's residence. We find that the coefficients of drought and rural dummy interaction are statistically significant and positive (for all three outcomes of social intolerance), however, the coefficients on drought are negligible and no longer statistically significant. These suggest that the effects of drought on social tolerance are fully driven by the respondents living in rural areas. In other words, the drought shock has no detectable effect on social intolerance for the people living in urban areas.

In column 2 of Table 3, we test whether the impact of a drought shock on intolerance is larger for females by interacting the drought dummy with the female dummy variable. We see that, in all three panels, the coefficients of the interaction terms are small and insignificant, which suggests that being female has no moderating effects of drought shocks on any of the outcomes of social intolerance.

In column 3 of Table 3, we examine the heterogeneity of drought impacts by the education levels of the respondents. To do so, we interact the drought dummy with an indicator variable high-education which takes 1 if the respondent completed at least high school education. The coefficients of interactions in all three panels are negative and statistically significant, which suggests that having a high education is associated with reduced intolerance towards other social identities. In fact, it appears that having a higher education level wipes out the effects of drought on social intolerance. The coefficient of drought is still significant and positive suggesting that drought shocks increase social intolerance among the low-educated individuals.

We then turn attention to whether the impact of a drought shock on social intolerance varies depending on the ethnic and religious diversity of the people living in a grid cell. To this end, we interact the drought dummy with ethnic diversity (measured by ethnic fractionalization index) and religious diversity (measured by religious fractionalization index) in columns 4 and 5, respectively. The negative and significant coefficients of the interaction terms in columns 4 and 5 suggest that higher ethnic or religious diversity is associated with reduced intolerance toward other social identities. One standard devi-ation increase in the ethnic or religious diversity index wipes out the effects of drought on social intolerance. Since the coefficients of the droughts are positive and still significant in all specifica-tions in columns 4 and 5, they suggest that experiencing a drought increases intolerance for the respondents living in a grid cell with lower ethnic or religious diversity. We do the same exercises to examine the heterogeneity of severe/ extreme drought shocks on social intolerance and find similar results. The results are reported in Appendix Table A5.

4.4 Potential mechanisms

Our main results suggest that drought shocks significantly increase social intolerance towards out-groups. In this section, we investigate why social intolerance rises when people experience droughts. Our principle hypothesis is that drought shocks entail devastating economic loss which might lead to increased intolerance. Here, we present evidence to support this hypothesis.

Our first evidence is to show that drought shocks adversely impact agricultural output. We construct a spatial and time-varying dataset of crop yields using the International Food Policy Research Institute (IFPRI)'s global spatially-disaggregated Crop Production statistics data (IFPRI, 2024). We collect and aggregate the yields for five major cereal crops in Africa for the years 2010, 2017, and 2020. The crops examined are corn, wheat, rice, millet and sorghum. We report the findings in Table 4. Our results show that all forms of droughts reduce yield for all five different crops. The estimates in Panel B also suggest that the production loss is associated with the severity of the drought. In other words, severe droughts have a more pronounced negative impact compared to moderate droughts.

Our second evidence attempts to show that droughts contract local economic activities. We use night light data from 2010 to 2020 at the grid cell levels as a proxy for local economic activities and examine whether drought reduces a grid cell's light. Our results, shown in Table 5, indicate that drought has significant negative impacts on night lights. It reduces the probability of a grid cell having light by about 7 pp and grid cell's mean light by 14.6 percent. Panel B confirms, yet again, that the damage of drought is proportional to its magnitude.

Our third and final evidence tests the relationship between drought shocks and employment. Our employment measures come from Afrobarometer data between 2014 and 2021. We create three dummies indicating whether the individual is currently employed (Yes/No), whether the individual is employed in agriculture (Yes/No), and whether the individual is employed in non-agriculture (Yes/No). Droughts may affect both the agricultural and non-agricultural sectors. Droughts could reduce agricultural productivity which may reduce employment not only in the agricultural sector but also in local non-agricultural sectors due to negative spillover effects [Ref??]. Our results, reported in Table 6, show that severe/extreme droughts reduce overall employment by 10.11 percent as well as employment in agriculture by 23.2 percent and non-agriculture sectors by 5.5 percent. However, we did not find any significant impacts of the overall drought shock (as shown in Panel A) or moderate drought shocks (As shown in Panel B). The reason might be that agricultural workers are most likely to abandon their lands in extreme or severe droughts and may reallocate their labor to the non-agricultural sector. However, in moderate droughts, they could still manage to grow crops efficiently with the help of modern technology such as groundwater irrigation and drought-tolerant seeds.

5 Conclusion

This paper provides evidence on how negative climate shocks affect individuals' social intolerance in Africa. We utilize the geo-referenced Afrobarometer survey and exploit the spatial and temporal variation in drought conditions in Africa between 2014 and 2021 to investigate whether drought shocks affect individuals' intolerance towards outgroups. We also use a variety of geo-referenced data to explore underlying channels of impact.

We find that a drought shock significantly increases respondents' intolerance towards people from different ethnicities and immigrants, however, it has no statistically significant impact on intolerance towards people from other religions. Further, by classifying a drought into severe/extreme and moderate droughts and estimating their effects on social intolerance separately, we find that while a severe or extreme drought shock significantly increases the respondents' intolerance toward people from other social groups, a moderate drought has no measurable impacts on social intolerance.

While exploring the heterogenous effects, we observe that the impact of a (severe/extreme) drought shock on social intolerance is concentrated among individuals living in rural areas and is more pronounced for those with low levels of education, and those living in places with low ethnic or religious diversity. Finally, we examine the potential mechanisms underlying this effect. The results suggest that droughts have significant negative impacts on major crop yields, local economic activities, and employment, which could subsequently lead to increased intolerance among people.

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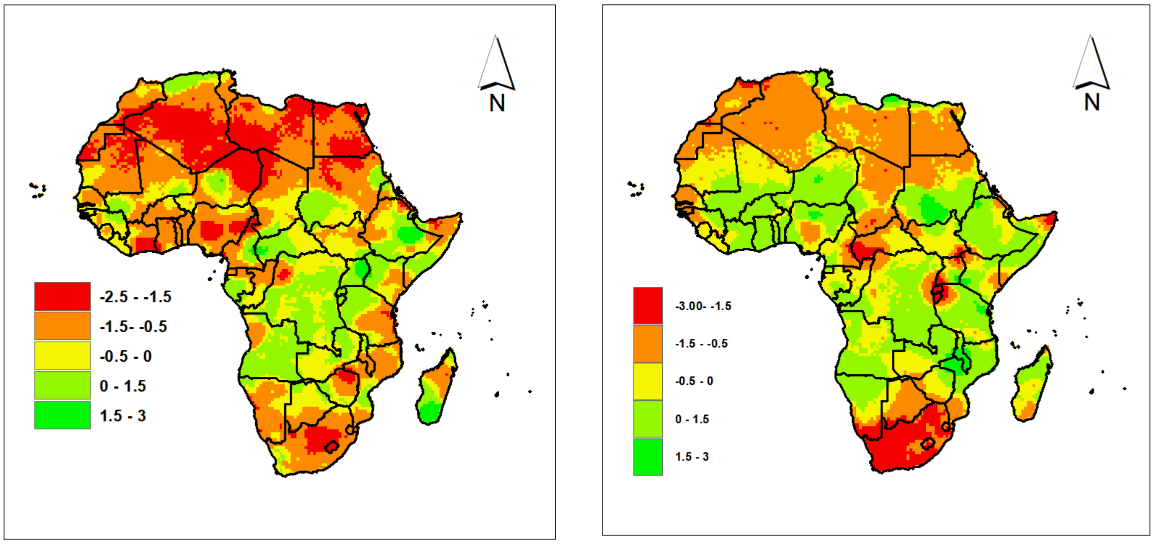
6 Figures and Tables

Figure 1. Variation in drought conditions in Africa

(a) Variation in SPEI in Jan 2014 **(b) Variation in SPEI in Jun 2019**



Notes: The figure shows the variation in drought condition across Africa. Panel(a) shows the variation in SPEI across Africa in Januray 2014 and Panel(b) shows the variation in SPEI across Africa in Jun 2019

Figure 2. Variation in SPEI over the time in Africa

(a) Mean SPEI at month-year level **(b) Mean SPEI at year level**

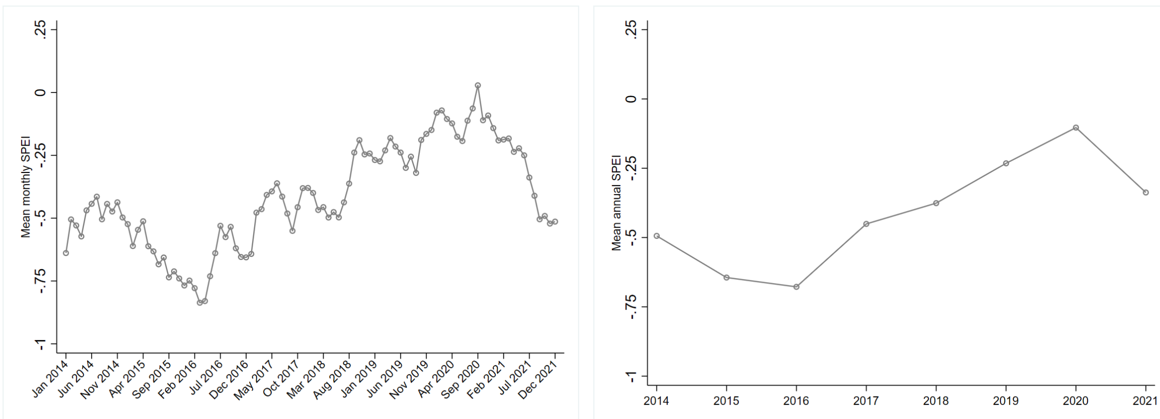
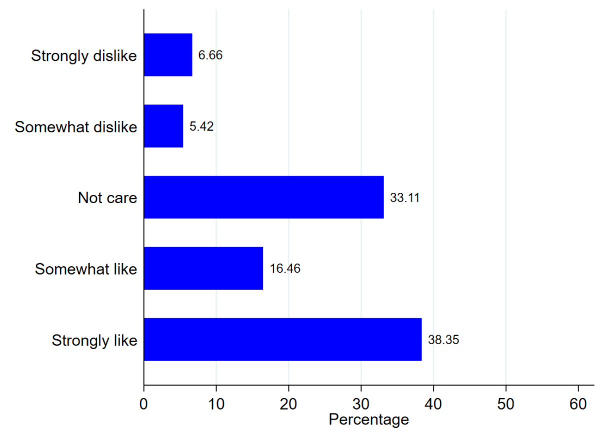


Table 1. Summary Statistics

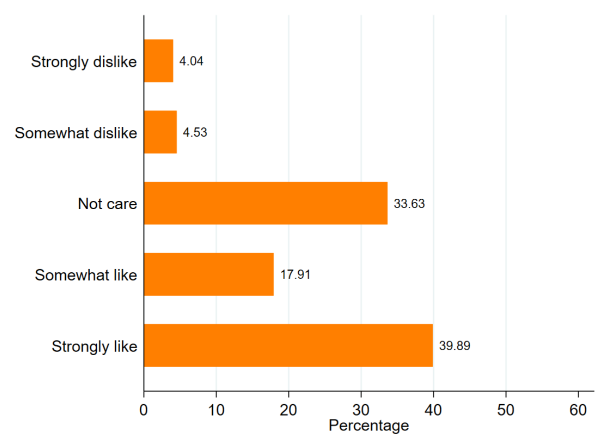
Variables	N	Mean	Std. dev.	Min	Max
Intolerant towards other religions	124,699	0.121	0.326	0	1
Intolerant towards other ethnicity	124,699	0.0857	0.280	0	1
Intolerant towards immigrants/foreign workers	124,699	0.183	0.387	0	1
SPEI	124,699	-0.282	0.870	-2.838	3.083
Drought ($SPEI \leq -1$)	124,699	0.207	0.405	0	1
Severe/Extreme Drought ($SPEI \leq 1.5$)	124,699	0.0554	0.229	0	1
Moderate Drought ($-1.5 < SPEI \leq -1$)	124,699	0.152	0.359	0	1
Non-drought($SPEI > -1$)	124,699	0.793	0.405	0	1
Age	124,699	37.24	14.79	18	115
Female	124,699	0.500	0.500	0	1
Secondary education or above	124,699	0.322	0.467	0	1
Rural	124,699	0.568	0.495	0	1
Employed	124,699	0.356	0.479	0	1
Employed:Agriculture	120,501	0.0819	0.274	0	1
Employed: Non-agriculture	120,501	0.271	0.444	0	1

Figure 3. Survey response on social tolerance questions

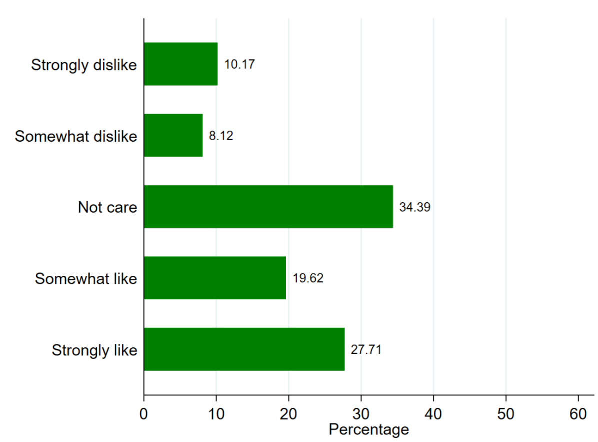
(a) Would you like/dislike/not care to having people from other religions as neigbors?



(b) Would you like/dislike/not care to having people from other ethnicities as neigbors?



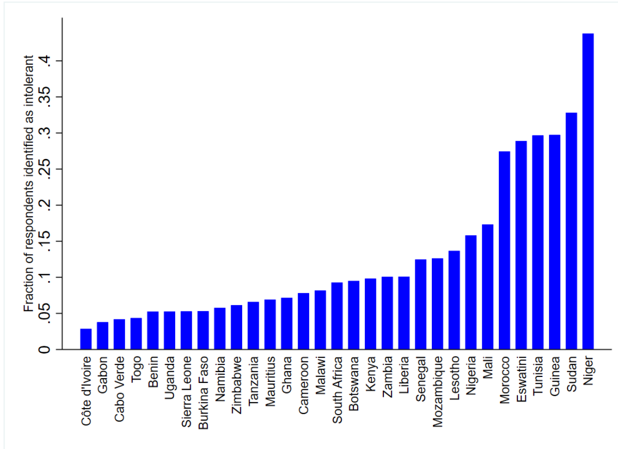
(c) Would you like/dislike/not care to having immigrants/foreign workers as neigbors?



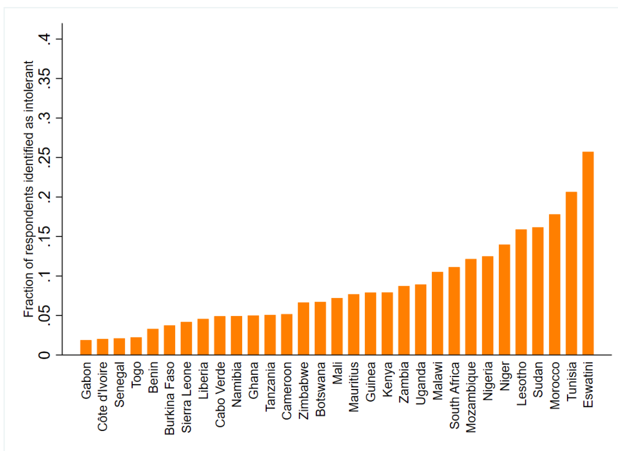
Notes: The above bar diagrams shows the attitudes of the respondents towards other social groups and identities

Figure 4. Variations in social intolerance across countries

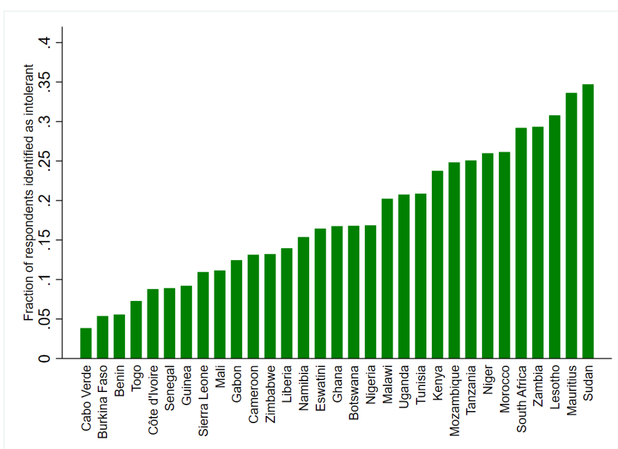
(a) Intolerant towards people of a different religion



(b) Intolerant towards people from a different ethnic group

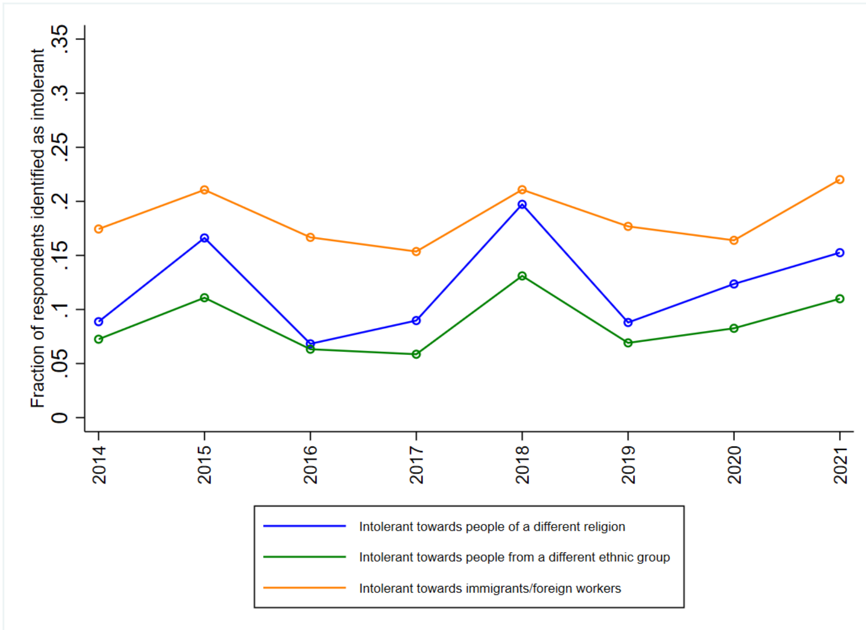


(c) Intolerant towards immigrants/foreign workers



Notes: The figure illustrates variations in social intolerance across different countries, highlighting intolerance towards other religions (Panel a), other ethnicities (Panel b), and immigrants or foreign workers (Panel c).

Figure 5. Variation in Social Tolerance over time



Notes: The figure displays variations in social tolerance over time within the sample, showing the changes in the fractions of individuals identified as intolerant toward people of other religions (Orange line), people from other ethnicities (Blue line), and immigrants (Green line).

Table 2. Climate Shocks and Intolerance

	Intolerant towards other religions		Intolerant towards other ethnicities		Intolerant towards immigrants	
	(1)	(2)	(3)	(4)	(5)	(6)
			Panel A: Drought			
Drought	0.007	0.007	0.009**	0.009**	0.015**	0.015**
	(0.005)	(0.005)	(0.004)	(0.004)	(0.006)	(0.006)
			Panel B: Severe/Extreme and Moderate Drought			
Severe/Extreme Drought	0.022**	0.022**	0.022***	0.023***	0.031***	0.032***
	(0.009)	(0.009)	(0.007)	(0.007)	(0.009)	(0.009)
Moderate Drought	0.002	0.002	0.004	0.004	0.009	0.009
	(0.005)	(0.005)	(0.004)	(0.004)	(0.007)	(0.007)
Observations	124,698	124,698	124,698	124,698	124,698	124,698
R-squared	0.137	0.142	0.080	0.084	0.089	0.093
Grid cell FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Individual controls	No	Yes	No	Yes	No	Yes
Outcome mean	0.121	0.121	0.0857	0.0857	0.183	0.183

Notes: Robust standard errors in parentheses clustered at grid cell level. Intolerant towards other religions (other ethnicity/immigrants) takes value 1 if the respondent would "somewhat dislike", or "strongly dislike" having neighbors from other religions (other ethnicities/immigrants). Drought takes the value of 1 when $SPEI \leq -1$ in a given grid cell, respectively. Severe/Extreme drought and moderate drought take the value of 1 when $SPEI \leq 1.5$ and $-1.5 < SPEI \leq -1$ in a given grid cell, respectively. Individual controls include the respondent's age, age square, gender, education level, and type of place of residence (urban/rural). * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 3. Heterogeneous effects: Drought and Intolerance

Indiv. Characteristic:	Rural	Female	High-Education	Ethnic diversity	Religious diversity
	(1)	(2)	(3)	(4)	(5)
Panel A	Outcome Variable: Intolerant towards other religions				
Drought	0.001	0.005	0.015***	0.038***	0.038**
	(0.007)	(0.005)	(0.005)	(0.011)	(0.015)
Drought ×Indiv. Characteristic	0.013*	0.004	-0.023***	-0.048*	-0.053**
	(0.007)	(0.004)	(0.007)	(0.019)	(0.021)
Observations	124,698	124,698	124,698	118,572	124,698
R-squared	0.142	0.142	0.142	0.133	0.142
Outcome mean	0.121	0.121	0.121	0.111	0.121
Panel B	Outcome Variable: Intolerant towards other ethnicities				
Drought	0.003	0.009**	0.013***	0.030***	0.042***
	(0.005)	(0.004)	(0.004)	(0.010)	(0.012)
Drought ×Indiv. Characteristic	0.012**	0.000	-0.014***	-0.035**	-0.057***
	(0.006)	(0.004)	(0.005)	(0.016)	(0.017)
Observations	124,698	124,698	124,698	118,572	124,698
R-squared	0.084	0.084	0.084	0.081	0.084
Outcome mean	0.0857	0.0857	0.0857	0.0805	0.0857
Panel C	Outcome Variable: Intolerant towards immigrants				
Drought	0.006	0.017***	0.021***	0.042***	0.044***
	(0.007)	(0.006)	(0.007)	(0.014)	(0.016)
Drought × Indiv. Characteristic	0.019**	-0.004	-0.018**	-0.044**	-0.049**
	(0.008)	(0.005)	(0.008)	(0.021)	(0.022)
Observations	124,698	124,698	124,698	118,572	124,698
R-squared	0.093	0.093	0.093	0.090	0.093
Outcome mean	0.183	0.183	0.183	0.178	0.183

Notes: Robust standard errors in parentheses clustered at grid cell level. Intolerant towards other religions (other ethnicity/immigrants) takes value 1 if the respondent would "somewhat dislike", or "strongly dislike" having neighbors from other religions (other ethnicities/immigrants). Drought takes the value of 1 when $SPEI \leq -1$ in a given grid cell, respectively. Individual controls include the respondent's age, age square, gender, education level, and type of place of residence (urban/rural).

Table 4. Mechanism: Crop Yield

	Log (Corn Yield)	Log(Wheat Yield)	Log (Rice Yield)	Log (Millet Yield)	Log (Sorghum Yield)
	(1)	(2)	(3)	(4)	(5)
Panel A: Drought					
Drought	-0.178***	-0.690***	-0.060	-0.104**	-0.296***
	(0.037)	(0.058)	(0.044)	(0.041)	(0.035)
Panel B: Severe/Extreme and Moderate Drought					
Severe/Extreme Drought	-0.304***	-0.936***	-0.295***	-0.253**	-0.466***
	(0.068)	(0.082)	(0.104)	(0.105)	(0.067)
Moderate Drought	-0.137***	-0.523***	-0.015	-0.083*	-0.245***
	(0.041)	(0.070)	(0.048)	(0.043)	(0.039)
Observations	9,510	4,182	6,286	7,382	9,193
R-squared	0.344	0.181	0.318	0.334	0.306
Country FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Outcome mean	10.11	9.471	10.14	9.191	9.555

Notes: Robust standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 5. Mechanism: Drought and Local Economic Activity

	Any nightlight (Yes=1) (1)	Log (Mean Nightlight) (2)	Log (Total Nightlight) (3)
	Panel A: Drought		
Drought	-0.068***	-0.158***	-0.715***
	(0.005)	(0.013)	(0.053)
	Panel B: Severe/Extreme and Moderate Drought		
Severe/Extreme Drought	-0.084***	-0.271***	-1.006***
	(0.008)	(0.019)	(0.079)
Moderate Drought	-0.060***	-0.093***	-0.559***
	(0.006)	(0.015)	(0.061)
Observations	41,061	41,061	41,061
R-squared	0.276	0.323	0.345
Country FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Outcome mean	0.618	-3.857	1.327

Notes: Robust standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 6. Mechanism: Employment

	Employed (Yes=1) (1)	Employed: Agriculture (2)	Employed: Non-agriculture (3)
	Panel A: Drought		
Drought	-0.007	-0.003	-0.002
	(0.006)	(0.004)	(0.005)
	Panel B: Severe/Extreme and Moderate Drought		
Severe/Extreme Drought	-0.036***	-0.019***	-0.015*
	(0.011)	(0.007)	(0.009)
Moderate Drought	0.003	0.002	0.003
	(0.007)	(0.004)	(0.006)
Observations	124,698	120,498	120,498
R-squared	0.219	0.221	0.207
Grid cell FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Individual controls	Yes	Yes	Yes
Outcome mean	0.356	0.0819	0.271

Notes: Robust standard errors in parentheses clustered at grid cell level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table A1. Robustness: including ethnic and religious diversity as additional controls

	Intolerant towards other religions (1)	Intolerant towards other ethnicity (2)	Intolerant towards immigrants/foreign workers (3)
	Panel A: Drought		
Drought	0.011**	0.010***	0.018***
	(0.005)	(0.004)	(0.006)
	Panel B: Severe/Extreme and Moderate Drought		
Severe/Extreme Drought	0.029***	0.030***	0.039***
	(0.010)	(0.007)	(0.009)
Moderate Drought	0.005	0.003	0.011
	(0.005)	(0.004)	(0.007)
Observations	118,572	118,572	118,572
R-squared	0.133	0.081	0.090
Grid cell FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Baseline controls	Yes	Yes	Yes
Additional controls	Yes	Yes	Yes
Outcome mean	0.111	0.0805	0.178

Notes: Robust standard errors in parentheses clustered at grid cell level. Intolerant towards other religions (other ethnicity/immigrants) takes value 1 if the respondent would ”somewhat dislike”, or ”strongly dislike” having neighbors from other religions (other ethnicities/immigrants). Drought takes the value of 1 when $SPEI \leq -1$ in a given grid cell, respectively. Baseline controls controls include the respondent's age, age square, gender, education, employment status, and type of place of residence (urban/rural). Additional controls include ethnic and religious diversity of the population in the grid cells as measured by ethnic and religious fractionalization index at grid cell level, respectively. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table A2. Robustness: including respondents' access to public goods as additional controls

	Intolerant towards other religions (1)	Intolerant towards other ethnicity (2)	Intolerant towards immigrants/foreign workers (3)
	Panel A: Drought		
Drought	0.007	0.009**	0.015**
	(0.005)	(0.004)	(0.006)
	Panel B: Severe/Extreme and Moderate Drought		
Severe/Extreme Drought	0.023**	0.024***	0.032***
	(0.009)	(0.007)	(0.009)
Moderate Drought	0.002	0.003	0.009
	(0.005)	(0.004)	(0.007)
Observations	122,223	122,223	122,223
R-squared	0.143	0.085	0.093
Grid cell FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Baseline controls	Yes	Yes	Yes
Additional controls	Yes	Yes	Yes
Outcome mean	0.121	0.0859	0.183

Notes: Robust standard errors in parentheses clustered at grid cell level. Intolerant towards other religions (other ethnicity/immigrants) takes value 1 if the respondent would "somewhat dislike", or "strongly dislike" having neighbors from other religions (other ethnicities/immigrants). Drought takes the value of 1 when $SPEI \leq -1$ in a given grid cell, respectively. Baseline controls include the respondent's age, age square, gender, education, employment status, and type of place of residence (urban/rural). Additional controls include dummy indicators for the presence of schools, post offices, piped water, paved roads, and electricity in the locality. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table A3. Robustness: alternative choice of level of clustering of the standard errors

	Intolerant towards other religions (1)	Intolerant towards other ethnicity (2)	Intolerant towards immigrants/foreign workers (3)
	Panel A: Drought		
Drought	0.007*	0.009***	0.015***
	(0.004)	(0.003)	(0.005)
	Panel B: Severe/Extreme and Moderate Drought		
Severe/Extreme Drought	0.022***	0.023***	0.032***
	(0.007)	(0.006)	(0.008)
Moderate Drought	0.002	0.004	0.009
	(0.004)	(0.003)	(0.006)
Observations	124,698	124,698	124,698
R-squared	0.142	0.084	0.093
Grid cell FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Baseline controls	Yes	Yes	Yes
Outcome mean	0.121	0.0857	0.183

Notes: Robust standard errors in parentheses clustered at grid cell$\times$ year level. Intolerant towards other religions (other ethnicity/immigrants) takes value 1 if the respondent would "somewhat dislike", or "strongly dislike" having neighbors from other religions (other ethnicities/immigrants). Drought takes the value of 1 when $SPEI \leq -1$ in a given grid cell, respectively. Baseline controls controls include the respondent's age, age square, gender, education, employment status, and type of place of residence (urban/rural). * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table A4. Robustness: Alternative drought shock definition

	Intolerant towards other religions (1)	Intolerant towards other ethnicity (2)	Intolerant towards immigrants/foreign workers (3)
Drought Shock	0.006	0.008**	0.015**
	(0.005)	(0.004)	(0.006)
Wet Shock	-0.028***	-0.013**	0.002
	(0.007)	(0.006)	(0.010)
Observations	124,699	124,699	124,699
R-squared	0.142	0.084	0.093
Outcome mean	0.121	0.0857	0.183
Grid cell FE	Yes	Yes	Yes
Month FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Individual controls	Yes	Yes	Yes

Notes: Robust standard errors in parentheses clustered at grid cell level. Intolerant towards other religions (other ethnicity/immigrants) takes value 1 if the respondent would "somewhat dislike", or "strongly dislike" having neighbors from other religions (other ethnicities/immigrants). * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table A5. Heterogeneous effects: Severe Drought and Intolerance

Indiv. Characteristic:	Rural	Female	High-Education	Ethnic diversity	Religious diversity
	(1)	(2)	(3)	(4)	(5)
Panel A	Outcome Variable: Intolerant towards other religions				
Severe/Extreme drought	0.008	0.015	0.031***	0.047**	0.068***
	(0.012)	(0.010)	(0.010)	(0.022)	(0.022)
Severe/Extreme drought×Indiv. Characteristic	0.032***	0.015*	-0.024**	-0.034	-0.097**
	(0.014)	(0.008)	(0.011)	(0.038)	(0.034)
Moderate drought	-0.002	0.002	0.009	0.033***	0.014
	(0.007)	(0.006)	(0.005)	(0.011)	(0.018)
Moderate drought×Indiv. Characteristic	0.008	-0.001	-0.023**	-0.051**	-0.020
	(0.008)	(0.005)	(0.008)	(0.020)	(0.026)
Observations	124,698	124,698	124,698	118,572	124,698
R-squared	0.142	0.142	0.142	0.133	0.142
Outcome mean	0.121	0.121	0.121	0.111	0.121
Panel B	Outcome Variable: Intolerant towards other ethnicities				
Severe/Extreme drought	0.014	0.018**	0.026***	0.056***	0.069***
	(0.009)	(0.008)	(0.008)	(0.018)	(0.022)
Severe/Extreme drought×Indiv. Characteristic	0.020*	0.011	-0.008	-0.048	-0.097***
	(0.011)	(0.007)	(0.009)	(0.029)	(0.033)
Moderate drought	-0.002	0.005	0.009**	0.020*	0.021*
	(0.005)	(0.004)	(0.004)	(0.010)	(0.013)
Moderate drought×Indiv. Characteristic	0.010	-0.004	-0.017***	-0.029*	-0.028
	(0.006)	(0.004)	(0.006)	(0.017)	(0.018)
Observations	124,698	124,698	124,698	118,572	124,698
R-squared	0.084	0.084	0.084	0.081	0.084
Outcome mean	0.0857	0.0857	0.0857	0.0805	0.0857
Panel C	Outcome Variable: Intolerant towards immigrants				
Severe/Extreme drought	0.022*	0.031***	0.039***	0.059***	0.060**
	(0.011)	(0.009)	(0.010)	(0.018)	(0.024)
Severe/Extreme drought×Indiv. Characteristic	0.022*	0.001	-0.022*	-0.038	-0.057
	(0.013)	(0.009)	(0.012)	(0.030)	(0.038)
Moderate drought	-0.001	0.012*	0.015*	0.036**	0.030
	(0.007)	(0.007)	(0.008)	(0.016)	(0.019)
Moderate drought×Indiv. Characteristic	0.020**	-0.006	-0.017*	-0.044*	-0.034
	(0.009)	(0.005)	(0.010)	(0.024)	(0.026)
Observations	124,698	124,698	124,698	118,572	124,698
R-squared	0.093	0.093	0.093	0.090	0.093
Outcome mean	0.183	0.183	0.183	0.178	0.183

Notes: Robust standard errors in parentheses clustered at grid cell level. Intolerant towards other religions (other ethnicity/immigrants) takes value 1 if the respondent would ”somewhat dislike”, or ”strongly dislike” having neighbors from other religions (other ethnicities/immigrants). Severe/Extreme drought and moderate drought take the value of 1 when $SPEI \leq 1.5$ and $-1.5 < SPEI \leq -1$ in a given grid cell, respectively. Individual controls include the respondent’s age, age squared, gender, education, and type of place of residence (urban/rural).