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The consequences of relocating in response to drought: human mobility and conflict in contemporary Kenya

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Abstract

As global temperatures rise, drought-induced human relocation is expected to increase. Using original national survey data from Kenya, we investigate whether people who report relocating due to drought are more likely to be victims of violence than people who do not move. We also examine whether this migrant sample supports the use of violence at higher levels than the general population, conditional on their experiences. We measure the duration of relocation (temporary versus permanent) as well as the characteristics of the arrival area, including co-ethnic demographics. Controlling for many individual-level and contextual variables, we find that those who have relocated are consistently more likely to be victims of violence than those who have not. We also find that those who relocated temporarily support the use of violence at higher levels than the general population if and only if they are themselves victims of violence. Vulnerable migrant populations may be subject to violence as observational aggregate studies suggest, but they are not likely to be the sources of violence unless victimized first.

1. Introduction

As much as 12% of the world's population in 2010 feared being forced to relocate due to severe environmental problems [1 p. 52]. Both domestically and across borders, permanent and temporary migration is a common climate change adaptation strategy [2–7] and while such mobility may have positive effects under certain circumstances [8], these moves can also lead to violent conflict [9–14]. Scholars have emphasized the value of investigating environmental migration at an individual-level [15, 16], because doing so allows us to understand mobility related to employment opportunities [17], land use [18], and other outcomes. Nevertheless, associations between human

mobility and climate change in relationship with violence and insecurity remain understudied. Our research advances a growing body of related conflict studies [19–25] in gathering and analyzing original national survey data from Kenya. Both empirically and theoretically, we build upon research [26] that questions the most simplistic narratives about climate-induced migration and violence.

It is not our goal to test competing theories on why people decide to migrate, to where, or for how long. Instead, we seek to understand how several varied experiences with mobility (e.g. temporary versus long-term) relate to the risk of violent conflict. Nuanced relationships between environmental changes and conflict have been found to operate through a host of

mediating circumstances, including livestock market price volatility [27], rising costs for food [28–30], and preferable conditions for cattle grazing that attract hostile communities to common areas [31] or facilitate livestock relocation after a raid [32]. In contrast, livelihood diversification [33], and robust institutions for negotiating access to common resources such as pasture or cropland [34, 35] are found to have pacifying effects on the risk of violence. Identifying these mediating influences in detail allows policymakers to design strategies that increase adaptive capacity for affected populations. The circumstances encountered by Kenyans who report moving due to drought constitute potential stimuli for the social tensions generated by global warming.

Some household- and individual-level research has been conducted in Kenya [36, 37] and Ethiopia [38] investigating links between environmental change and violent conflict. Such detail is a noteworthy improvement upon studies using aggregated country-level data, because asking individuals it is possible to probe their motivations rather than only surmise them. However, these and similar accounts of environmental change dynamics in East Africa are frequently ethnographic in nature and cover relatively few actors within a limited number of regions in the respective countries. The chain of events that could lead from environmental change through migration to conflict is a complex sequence. In interviewing 1400 Kenyans, we seek to balance attention to specific detail and the ability to generalize (see supplementary data for our survey questions, available online at stacks.iop.org/ERL/13/094014/mmedia). To our knowledge, no other large national survey has recorded such data on conflict for a sub-Saharan Africa case.

With increasingly uncertain weather patterns, households in countries where the prevailing livelihoods are closely tied to agricultural sectors commonly face socioeconomic stress. Among our survey respondents, 64.4% had farms that reportedly did not produce enough to feed their family throughout the year (those without farms could reply ‘not-applicable’). At approximately the same time as our survey, the Kenya Food Security Steering Group reported that 1.5 million Kenyans were ‘acutely food insecure’ [39 p. 1]. A strong relationship between these troubling circumstances and migration is plausible if people relocate to grow food more effectively, graze livestock on more consistently favorable land, or enjoy better access to markets. Indeed, 15.5% of our respondents reported moving either temporarily or permanently due to drought or water shortages. Extrapolating from our sample, several million Kenyans may have migrated at some point during the last decade in response to changing weather. Violence is also endemic in certain Kenyan regions. During the year preceding our survey, 21.6% of respondents reported being violently attacked outside of their home. This risk of victimization is not shared evenly

among Kenyans. A staggering 43.1% (94 of 218) of those who reported relocating due to drought were attacked compared to only 12.7% (143 of 1124) in the general population. Our focus in this study is on this uneven burden of violence.

To understand these dynamics in greater detail we pose two questions. Controlling for demographic characteristics, are people who reported relocating due to droughts more likely to be victims of violence than those who did not report relocating due to droughts? Second, are people who report moving due to droughts and, if applicable, violence victimization, more likely than the general population to support the use of violence? Our goal is not to explain migration caused by drought, but rather to evaluate some of the effects of self-reported relocation due to water shortages. As household earnings diminish for farmers during periods of drought, individuals seeking alternative employment could relocate and enter saturated labor markets. This move could be associated with hostilities between newcomers and long-term residents if individuals, ethnic communities, and political parties challenge one another for access to scarce resources and jobs. We anticipated different experiences according to the duration of relocation and therefore asked respondents about both temporary and permanent forms of migration. Even for repeated seasonal relocation (e.g. forms of ‘circular migration’ [40]) this logic applies, as migrants must still negotiate the challenges of living and working in a different place. The difficulties associated with arriving in a new setting can extend beyond the labor market. Among recent arrivals, there may be animosities against government agencies for not offering assistance, at other communities for perceived injustices related to housing access, or towards populations who engage in different cultural practices or subscribe to different religious beliefs. In addition to moving within the traditional home region of their ethnic community, members of some Kenyan pastoralist groups occasionally follow rainfall and graze livestock in others’ territories. This is a particularly risky scenario for cattle raiding [36].

Our four propositions are that people who have relocated: (1) permanently, (2) temporarily, (3) outside of the traditional ethnic community region, or (4) into regions experiencing conflict among new arrivals and long-term residents will all be more likely to report having been victims of violence than their more sedentary peers. Similarly, we propose that these mobile respondents will be more likely to support the use of violence if they were victims of an attack. We capture the conditional effect of both relocation and victimization experiences using an interaction term in our models of support for using violence.

2. Methods

2.1. Data

We gathered our original survey data in June–July 2014 after testing the instrument extensively with collaborators at the Institute for Development Studies (IDS) at the University of Nairobi. The stratified random sampling design recruited 1400 adult respondents from 29 counties and 175 enumeration areas (EAs). We had a response rate of 75.5% and the average interview took 45.5 min. We surveyed eight people in every EA, with each member of a four-person enumeration team drawing respondents randomly from every fifth and tenth household as they walked north, south, east, and west from a sampling starting point (SSP) designated by Kenya National Bureau of Statistics (KNBS) for collecting the 2009 census. Respondents reported their personal traits and experiences unless specifically answering on behalf of the household as indicated in the question. We used the same SSP maps from KNBS as the widely-used Afrobarometer [41] survey, which our colleagues at IDS also administer. See the supplementary data section for the exact wording of all questions. Descriptive statistics for all demographic and regional variables are presented in table S1.

Our two dependent variables are *exposure to violence* (victimization experience) and *support for the use of violence* (an indicator of latent attitudes). To measure exposure to violence we asked, ‘During the past year, have you or anyone in your immediate family: Been physically attacked outside of the home?’ Respondents could reply ‘no,’ ‘yes, once,’ ‘yes, twice,’ or ‘yes, three or more times.’ We created a dichotomous indicator for whether an individual or immediate family member was personally victimized one or more times within the preceding year (referring to ‘the past year’ distinguishes from experiences in an earlier location long ago).

Attitudes supporting the use of violence are difficult to measure reliably. To elicit honest sentiments about using violence, we use endorsement experiments similar to those developed for research on militant groups in Pakistan and Afghanistan [42]. An endorsement experiment is based on a respondent’s assessment of an innocuous policy cue. Our survey instrument outlines three hypothetical but realistic short policy descriptions related to education, financial budgets, and policing. For each respondent, we measure the average level of support for the three policies, each ranked from low (1) to high (5). Using an average for several cues reduces the possibility that one policy is skewing our measurement. We modify the policy cue text in a treatment version of the question (randomized within the sample) so that it includes a reference to a violent actor or organization. If we have two survey respondents with similar characteristics but respondent A expressed level 5 support for the treatment version of the policy cue and respondent B

had level 3 support for the control version, the comparatively high value for A captures a greater latent tendency to support the use of violence. Without asking individuals directly, we can therefore estimate how mobility and victimization experiences influence these latent attitudes.

In Kenya, the probability that violent conflict will take place between the country’s approximately 40 major ethnic communities is greater than it taking place within them. However, it would be difficult to design an endorsement experiment that accounts for each of the many communities’ specific concerns. Our questioning thus had to be thematically specific but also generalizable across geographic regions and ethnic groups. After each policy cue, our endorsement is a reference to violent behavior carried out by ‘violent youth from your ethnic/tribal community’ [35].

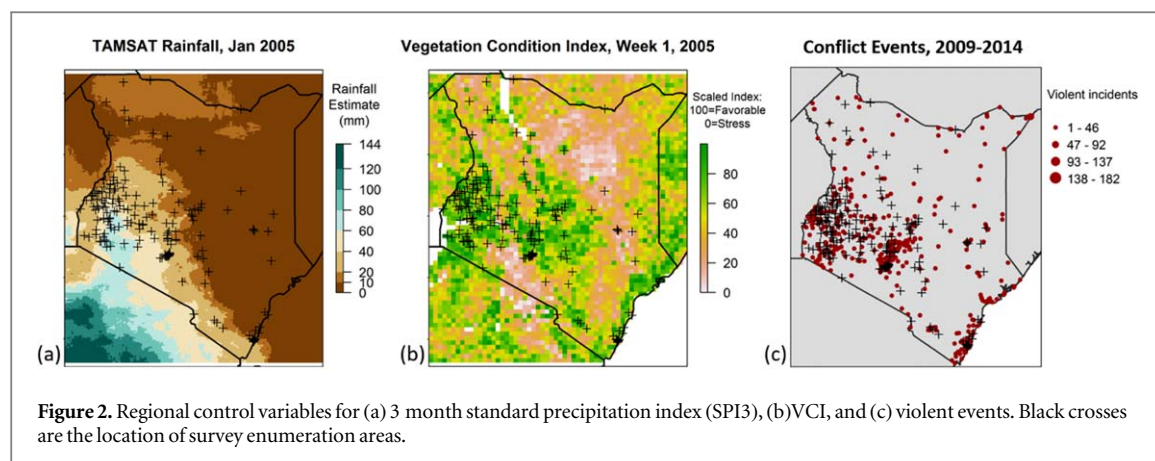
For the independent variables measuring migration experiences we rely on three questions. First: ‘in the last 10 years have you or members of your immediate family been forced to move to a new location because of drought or water shortages?’ Respondents could report ‘yes, permanently,’ ‘yes, temporarily,’ or ‘no.’ Corresponding with propositions one and two, we created separate variables measuring whether the individual reported relocating permanently or temporarily. Our variables for the third and fourth propositions captured whether respondents moved across traditional ethnic group boundaries and if generally there was conflict between new arrivals and long-term residents. We asked each participant: ‘did you or members of your immediate family move within the ethnic community home area, or was the relocation into the traditional territory of another ethnic community/tribe?’ We coded relocation outside the area if respondents moved into another group’s territory. Finally, we created a variable with the following question: ‘whether the movement was within your home area or into the home area of another ethnic community, did the movement result in tensions or physical violence?’ Respondents replied with four answers (and ‘do not know’): first, ‘tension between newcomers and longtime residents that was resolved peacefully through dialogue;’ second, ‘tension between newcomers and longtime residents that resulted in conflict between communities after failed dialogue;’ third, ‘tensions between newcomers and longtime residents that resulted in conflict between communities without any dialogue taking place;’ fourth, ‘there was no tension between newcomers and longtime residents.’ We coded people as reporting regional conflict if they selected option two or three. In figure 1, we map the corresponding proportions of respondents in each county.

To rule out alternative explanations of both violence exposure and violence support, we control for age, gender, primary livelihood sector (pastoralism versus others), employment status (full or part-time cash income), perceived socioeconomic status (worse



or much worse than other Kenyans), education (post-secondary schooling), and the existence of dialogue among communities in the respondents' area (frequent or very frequent). We include a variable measuring the respondents' proximity to protected land (within 10 km of national parks), which may increase population pressures. Respondents whose reported

move was from outside of the county might be less likely to have had social ties upon their arrival. We control for this possibility using a question that asks people where they most recently lived. To account for the effects of patronage ties to the presidency, we control for the two ethnic communities that have lead Kenya's executive branch (Kikuyu and Kalenjin). The



most recent arrivals in an area may have less time to assimilate, and we therefore control for number of years in the current residence. To account for land tenure status, an important political force in Kenya, we control whether respondents report private ownership of the land that they use. Whether for farming or livestock grazing, we expect private tenure to be less contentious than using commonly held, government, or rented land. To control for the possibility that a respondent relocated for a reason other than drought or water shortages, we create a variable from two separate questions. If respondents *did not* report relocating 'due to drought or water shortages' in our main independent variable question and also reported moving in our additional question about the distance of a move (e.g. outside of the current county), they were coded as moving for another reason. We also control for whether the enumerator gender and ethnic community match those of the respondent (addressing potential social desirability bias [43]). In our supplementary data analysis of only pastoralist respondents, we include an ethnic community fixed effect to account for unique community practices.

We use two environmental control variables characterizing EAs. Doing so reduces the possibility that conditions in the EA bias a respondent's report of having moved due to drought. Precipitation indicators are based on the TAMSAT 4 km Meteosat data calibrated to historical rain gauge information [44]. We use a standard precipitation index (SPI3) three-month average (e.g. January–March) that compares a given three-month period to all others that preceded it (all other Januaries–Marches). Brown areas in figure 2(a) are SPI3 deficits and blue–green areas are wetter than the long-term precipitation average for an illustrative month, January 2005. We measure vegetation health patterns using a vegetation condition index (VCI) derived from the National Oceanic and Atmospheric Administration's Advanced Very High Resolution Radiometer sensor. VCI data have a resolution of 16 km (see figure 2(b)). Healthy vegetation regions appear in green, and unhealthy in yellow–orange, with VCI values ranging from 0 to 100, respectively. We

process these values with a 10 year reference period to correspond with the survey questions.

In addition to environmental controls, the level of violence before the survey is a third regional indicator. We believe that living in an area prone to conflict may present a greater baseline risk for experiencing a violent attack and also skew individuals' attitudes about the use of violence. Violent events reported in the media (not by survey respondents) are measured using the Armed Conflict Location and Event Data Project [45]. For each EA location, we calculate the number of conflict incidents that occurred within 25 km and within the five years preceding the start of our interviews. We map violent events next to EA locations in figure 2(c).

2.2. Estimation

For the binary outcome measuring exposure to violence, we estimate a generalized linear mixed (multilevel) logistic regression model fit by maximum likelihood (Laplace approximation). We model violence exposure Y for individual i in county j and EA k as a function of migration experience (M) with effect β_M in:

$$Y_{ijk} = \beta_0 + J_{0j} + K_{0k} + \beta_M M_{ijk} + \beta_1 X_{1ijk} \dots \beta_n X_{nijk} + \epsilon_{ijk}.$$

We include control variables $X_{1\dots n}$ with coefficients $\beta_{1\dots n}$ and intercepts for counties (J_{0j}) and EAs (K_{0k}) within counties [46 p 7]. Stochastic error is captured in ϵ .

In our endorsement experiments, the level of support for policy cues is a continuous variable, calling for an ordinary least squares [42] estimation of a model similar to the above. We model policy support (P_{ijk}) as a function of hierarchical random intercepts (β_0 , J_{0j} , and K_{0k}), individual control variables ($X_{1\dots n}$) and an interaction term of effect β_{MT} for an independent variable of interest such as migration experience (M) and the treatment status (T) of the respondent:

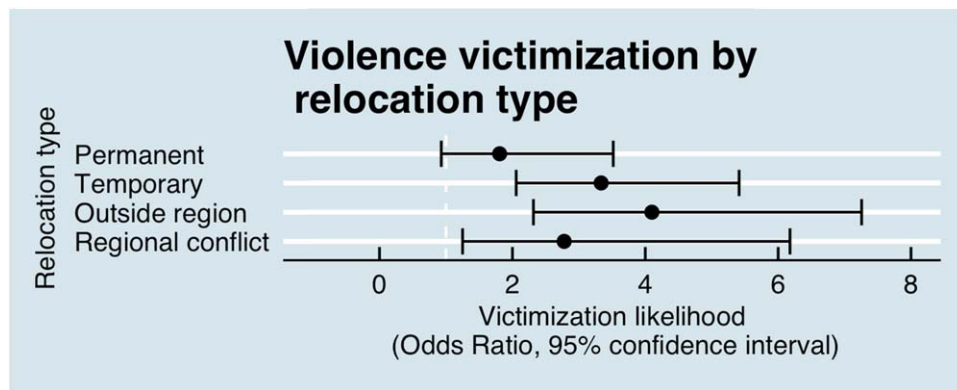


Figure 3. Multilevel logistic regression model estimates of violence victimization likelihood. Odds ratios are derived from the models reported in table S2.

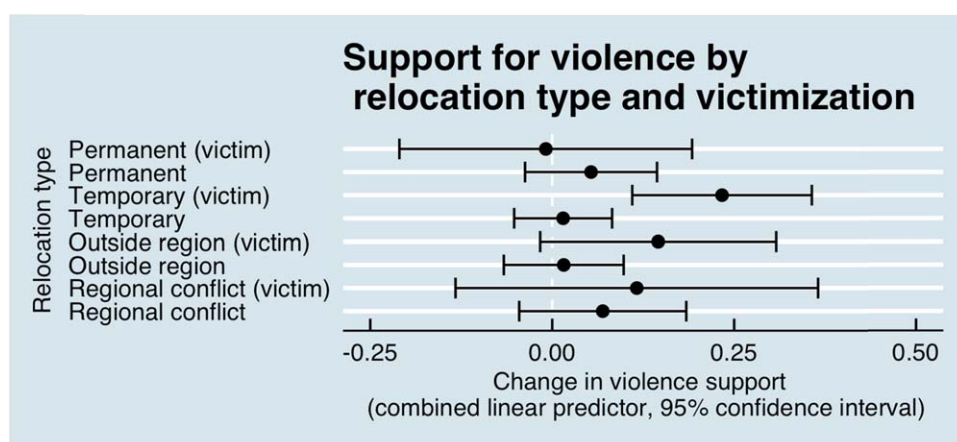


Figure 4. Ordinary least squares multilevel regression model estimates of support for the use of violence. Effects are derived from the model reported in table S3.

$$P_{ijk} = \beta_0 + J_{0j} + K_{0k} + \beta_{MT} M \times T_{ijk} + \beta_1 X_{1ijk} \dots \beta_n X_{nijk} + \epsilon_{ijk}.$$

The estimate of β_{MT} quantifies support for the policy *with the violence endorsement* and is therefore our main measurement of latent support for the use of violence. To facilitate the interpretation of our results, we present the combined linear predictor—or ‘total treatment effects’ [42 p 38]—graphically using ‘ghlt’ (general linear hypothesis) in the *multcomp* R package. We report raw coefficients, their standard errors, and model diagnostics separately in supplementary data tables.

3. Results

Figure 3 presents our results for the likelihood (odds ratio) of violence victimization. There is no statistically significant effect where 95% confidence intervals cross the dashed white line at 1.0. We include all control variables in these analyses. See tables S2–S9 for comprehensive results. Kenyans who move temporarily—and report doing so because of drought and water shortage—increase their odds of victimization, lending support

to our second proposition. These respondents were 3.33 times more likely ($e^{1.20}$) to experience conflict than the general population. That we do not also find elevated risks of being attacked among those who moved permanently (proposition one) is interesting. One interpretation of this result is that permanent migrants strive to establish personal and employment relationships in new areas, ‘lay low’ to avoid confrontations, and seek positive bonds within the community whenever possible. Those who relocate temporarily, in contrast, may be doing so out of desperation with no long-term plans for integration. These differences between permanent and temporary mobility are especially likely if an individual planned to remain in the destination when leaving the original location, an intention that we have not measured.

The greatest odds of experiencing violence are found among the respondents who moved outside of their traditional ethnic community region (OR = 4.09; $e^{1.41}$), confirming the expectation stated in our third proposition. Survey respondents who migrated into regions where conflict among arrival and resident populations took place were also 2.78 times ($e^{1.02}$) more likely to

experience violence, supporting proposition four. The effect of moving into a region where there are hostilities among arrival and original communities is lower than the result for having moved temporarily. It may be that Kenyans who move into regions with elevated inter-group tensions are acutely aware of how dangerous living in such places can be. With sensitivity to such risks, these migrants probably avoid confrontations that could escalate existing hostilities.

After excluding all control variables (not graphed, see table S4), permanent mobility raises the risks of experiencing conflict ($OR = 2.43$; $e^{0.89}$), but these odds are the lowest of all the effects. The greatest likelihood of victimization is still found among survey respondents who relocated outside of the home ethnic community region ($OR = 5.05$; $e^{1.62}$). Tables S6 and S8 present similar violence exposure results for the pastoralist sub-sample (with and without ethnic community controls, respectively).

Unless they are victims of violence, Kenyans who reported relocating due to drought are no more likely to support the use of violence than those who have not moved. We present the differences in support for using violence in figure 4. The relevant comparison is between victims and non-victims for each mobility experience. The baseline difference in latent support for the use of violence among those who moved permanently ($N = 57$) or temporarily ($N = 153$) is not statistically significant (confidence intervals cross zero). However, temporary migrants who also reported being attacked—and there are strong odds of this occurring (see figure 3)—express .233 (23.3%) more support for violence than non-migrants who were not attacked ($p < 0.001$). Our findings for the link between short-term relocation and support for the use of violence are consistent in models without controls, but the magnitude of difference in support for the use of violence is slightly greater (see table S5). The difference in attitudes between migrants who were not attacked and migrants who were victims is noteworthy and this finding has important policy implications. All things equal, whether migrants have higher levels of latent support for the use of violence is a function of their experience in the host community. These effects are not statistically significant if we restrict the sample to only those with pastoralist livelihoods (see tables S7 and S9).

4. Conclusion

We examined the experiences of Kenyans who self-report relocating because of drought or water shortages. Our expectation is that these respondents would have a greater risk of exposure to violence due to labor and residential housing market competition, insufficient provision of public goods, and other socioeconomic dynamics within the areas that are new to them. These forms of social stress do not

emerge naturally, however, and attitudes in support of using violence could emerge for migrants as a result of discrimination and hostile acts directed toward them. Frustration at a lack of government adaptation initiatives could also contribute to resentment of government officials among those who relocated, producing tensions with state institutions in addition to residents of the area.

Our results show that Kenyans who have relocated due to droughts and water shortages are more likely to be attacked outside of the home than those who have not reported moving for this reason. Those who reported moving due to drought are no more likely to support the use of violence than the general population. Migrants are often physically vulnerable and rather than promoting violence may fear and avoid it. However, short-term migrants may be more likely to support using violence *if they are themselves victims of violence*.

While scholars have observed conflict events in areas of substantial in-migration, our analysis confirms some expectations of aggregated analysis using more detailed individual-level data. Existing studies have proposed that in Sudan's Darfur region, for example, 'rising ethnic diversity and resource competition' may lead to conflict [12 p. 22]. Our results validate the notion that these interactions among arrival and host communities might be particularly important. Our findings similarly mirror the conclusions of cross-national studies indicating that violence victims are most likely to endorse violence [31 p. 93]. More broadly, this study also relates to traditions of trying to understand perceptions of migrants' activities and livelihoods in migrant host regions across sub-Saharan Africa [47].

Ineffective political structures may contribute to instability where environmental degradation and drought are worsening, forcing struggling populations to adapt. While human mobility and resettlement may be difficult for developing countries to manage, migrants are not to blame for violence without considering the treatment that they receive. The hostilities that precipitate violent conflict warrant attention from policymakers and our results provide a valuable opportunity for institutional interventions that could mitigate conflict risks.


Our ongoing research extends the scope of this study, which is limited to investigating climate-migration-conflict effects in one country. Our supplementary analysis of the pastoralist sub-sample has also revealed some deviations from the main results. These differences are not a fatal flaw—our general findings hold when controlling for pastoralist livelihoods in the full sample—but certainly warrant further attention. We also acknowledge that there are limitations in any research using a cross-sectional design, where survey data for multiple points in time would be ideal.

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References

- [1] Inc G. The Many Faces of Global Migration. Gallup.com. <http://news.gallup.com/poll/152660/Faces-Global-Migration.aspx> (Accessed: 2 October 2017)
- [2] Hsiang S M and Sobel A H 2016 Potentially extreme population displacement and concentration in the tropics under non-extreme warming *Sci. Rep.* **6** 25697
- [3] Nawrotzki R J, Hunter L M, Runfola D M and Riosmena F 2015 Climate change as a migration driver from rural and urban Mexico *Environ. Res. Lett.* **10** 114023
- [4] Hahn M B, Riederer A M and Foster S O 2009 The livelihood vulnerability index: a pragmatic approach to assessing risks from climate variability and change—a case study in Mozambique *Glob. Environ. Change* **19** 74–88
- [5] Hunter L M *et al* 2014 Rural outmigration, natural capital, and livelihoods in South Africa *Popul. Space Place* **20** 402–20
- [6] Afifi T *et al* 2016 Human mobility in response to rainfall variability: opportunities for migration as a successful adaptation strategy in eight case studies *Migr. Dev.* **5** 254–74
- [7] Leyk S, Runfola D, Nawrotzki R J, Hunter L M and Riosmena F 2017 Internal and international mobility as adaptation to climatic variability in contemporary Mexico: evidence from the integration of census and satellite data *Popul. Space Place* **23** e2047
- [8] Black R, Bennett S R G, Thomas S and Beddington J R 2011 Climate change: migration as adaptation *Nature* **478** 447–9
- [9] Reuveny R 2007 Climate change-induced migration and violent conflict *Political Geogr.* **26** 656–73
- [10] Hegre H, Buhaug H, Calvin K V, Nordkvelle J, Waldhoff S T and Gilmore E 2016 Forecasting civil conflict along the shared socioeconomic pathways *Environ. Res. Lett.* **11** 054002
- [11] Bernauer T, Böhmelt T and Koubi V 2012 Environmental changes and violent conflict *Environ. Res. Lett.* **7** 015601
- [12] De Juan A 2015 Long-term environmental change and geographical patterns of violence in Darfur, 2003–2005 *Political Geogr.* **45** 22–33
- [13] Homer-Dixon T F 1994 Environmental scarcities and violent conflict: evidence from cases *Int. Secur.* **19** 5–40
- [14] Kelley C P, Mohtadi S, Cane M A, Seager R and Kushnir Y 2015 Climate change in the Fertile Crescent and implications of the recent Syrian drought *Proc. Natl Acad. Sci.* **112** 3241–6
- [15] Koubi V, Spilker G, Schaffer L and Böhmelt T 2016 The role of environmental perceptions in migration decision-making: evidence from both migrants and non-migrants in five developing countries *Popul. Environ.* **38** 134–63
- [16] Koubi V, Böhmelt T, Spilker G and Schaffer L 2017 The determinants of environmental migrants' conflict perceptions *Int. Organ.* **1**–32
- [17] de Brauw A, Mueller V and Woldehanna T 2017 Does internal migration improve overall well-being in Ethiopia? *J. Afr. Econ.* **27** 347–65
- [18] Greiner C and Sakdapolrak P 2013 Rural–urban migration, agrarian change, and the environment in Kenya: a critical review of the literature *Popul. Environ.* **34** 524–53
- [19] von Uexkull N, Croicu M, Fjelde H and Buhaug H 2016 Civil conflict sensitivity to growing-season drought *Proc. Natl Acad. Sci. USA* **113** 12391–6
- [20] Schleussner C-F, Donges J F, Donner R V and Schellnhuber H J 2016 Armed-conflict risks enhanced by climate-related disasters in ethnically fractionalized countries *Proc. Natl Acad. Sci. USA* **113** 9216–21
- [21] Hsiang S M, Burke M and Miguel E 2013 Quantifying the influence of climate on human conflict *Science* **341** 1235367
- [22] Hsiang S M, Meng K C and Cane M A 2011 Civil conflicts are associated with the global climate *Nature* **476** 438–41
- [23] O'Loughlin J, Linke A M and Witmer F D W 2014 Effects of temperature and precipitation variability on the risk of violence in sub-Saharan Africa, 1980–2012 *Proc. Natl Acad. Sci.* **111** 16712–7
- [24] Buhaug H, Benjaminsen T A, Sjaastad E and Theisen O M 2015 Climate variability, food production shocks, and violent conflict in Sub-Saharan Africa *Environ. Res. Lett.* **10** 125015
- [25] Hendrix C S and Salehyan I 2012 Climate change, rainfall, and social conflict in Africa *J. Peace Res.* **49** 35–50
- [26] Brzoska M and Fröhlich C 2016 Climate change, migration and violent conflict: vulnerabilities, pathways and adaptation strategies *Migr. Dev.* **5** 190–210
- [27] Maystadt J-F and Ecker O 2014 Extreme weather and civil war: does drought fuel conflict in Somalia through livestock price shocks? *Am. J. Agric. Econ.* **96** 1157–82
- [28] Smith T G 2014 Feeding unrest: disentangling the causal relationship between food price shocks and sociopolitical conflict in urban Africa *J. Peace Res.* **51** 679–95
- [29] Bellemare M F 2015 Rising food prices, food price volatility, and social unrest *Am. J. Agric. Econ.* **97** 1–21
- [30] Raleigh C, Choi H J and Kniveton D 2015 The devil is in the details: an investigation of the relationships between conflict, food price and climate across Africa *Glob. Environ. Change* **32** 187–99
- [31] Detges A 2014 Close-up on renewable resources and armed conflict: the spatial logic of pastoralist violence in northern Kenya *Polit Geogr.* **42** 57–65
- [32] Adano W R, Dietz T, Witsenburg K and Zaal F 2012 Climate change, violent conflict and local institutions in Kenya's drylands *J. Peace Res.* **49** 65–80
- [33] Thornton P K and Herrero M 2015 Adapting to climate change in the mixed crop and livestock farming systems in sub-Saharan Africa *Nat. Clim. Change* **5** 830–6
- [34] Linke A M, O'Loughlin J, McCabe J T, Tir J and Witmer F D W 2015 Rainfall variability and violence in rural Kenya: investigating the effects of drought and the role of local institutions with survey data *Glob. Environ. Change* **34** 35–47
- [35] Linke A M, O'Loughlin J, McCabe J T and Tir J 2017 Drought, local institutional contexts, and support for violence in Kenya *J. Conflict Resolution* **62** 1544–78
- [36] McCabe J T 2004 *Cattle Bring Us to Our Enemies: Turkana Ecology, Politics, and Raiding in a Disequilibrium System* (Ann Arbor, MI: University of Michigan Press)
- [37] Bollig M 1993 Intra- and interethnic conflict in northwest Kenya. A multicausal analysis of conflict behaviour *Anthropos* **88** 176–84
- [38] Bogale A and Korf B 2007 To share or not to share? (Non-) violence, scarcity and resource access in Somali region, Ethiopia *J. Dev. Stud.* **43** 743–65
- [39] FEWS NET Kenya Food Security Outlook: September 2014 to March 2015. http://fewsn.net/sites/default/files/documents/reports/Kenya_OL_10_2014.pdf (Accessed: 3 March 2018)

- [40] Potts D 2010 *Circular Migration in Zimbabwe and Contemporary Sub-Saharan Africa* NED-new edn (Suffolk: James Currey)
- [41] Afrobarometer. <http://afrobarometer.org/>. (Accessed: 7 July 2017)
- [42] Blair G, Fair C C, Malhotra N and Shapiro J N 2013 Poverty and support for militant politics: evidence from Pakistan *Am. J. Political Sci.* **57** 30–48
- [43] Adida C L, Ferree K E, Posner D N and Robinson A L 2016 Who's asking? Interviewer coethnicity effects in African survey data *Comp. Political Stud.* **49** 1630–60
- [44] Maidment R I *et al* 2014 The 30 year TAMSAT African Rainfall Climatology And Time series (TARCAT) data set *J. Geophys. Res. Atmos.* **119** 2014JD021927
- [45] Raleigh C, Linke A, Hegre H and Karlsen J 2010 Introducing ACLED: an armed conflict location and event dataset *J. Peace Res.* **47** 651–60
- [46] Bates D, Machler M, Bolker B and Walker S 2015 Fitting linear mixed-effects models using lme4 *J. Stat. Softw.* **67** 1–48
- [47] Black R and Sessay M 1998 Forced migration, natural resource use and environmental change: the case of the Senegal river valley *Int. J. Popul. Geogr.* **4** 31–47