LISER
Luxembourg Institute of Socio-Economic Research

POLICY BRIEF ISSUE 2026-24



Can irrigation mitigate intentions to migrate following a drought?

Katrin Millock[1]

[1] *Paris School of Economics, CNRS*

Corresponding author:
Katrin Millock
millock@univ-paris1.fr

This policy brief is based on Debray, A., L. Dehouck, K. Millock, and I. Ruyssen:. (2026), Does irrigation reduce migration intentions after drought? Evidence from West Africa, Journal of Development Economics, 182 (103806).

Climate change affects societies in multiple ways, including negative effects on productivity due to higher temperatures and falling crop yields due to drought and water scarcity. There is also an increased incidence of vector-borne diseases, as well as an increased risk of conflict and violence (Carleton and Hsiang, 2016). One much-discussed impact is the potential for increased migration flows, particularly from southern to northern latitudes. Although migration is now regarded as an adaptation strategy to climate change, the Sixth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) acknowledges that there is still much uncertainty surrounding the scale of anticipated migration, particularly with regard to international migration.

Analyses of migration and climate change must take into account alternative adaptation strategies

In fact, individuals can adapt to drought locally, either independently or with the help of the government and other institutions. For example, farmers can use irrigation systems, adopt more drought-resistant seeds, and increase their use of other variable inputs, such as fertilisers and pesticides. Governments can provide social safety net payments, and formal and informal credit can also mitigate the impact of climate change on affected populations. International aid is another potential factor that could encourage people to remain in their place of origin rather than migrate. So far, the use of these alternative adaptation strategies in relation to migration has been underexplored. In a recent study with Alix Debray, Lucile Dehouck, and Ilse Ruyssen, we set out to answer the following question: to what extent can access to irrigation mitigate migration intentions?

To understand climate change's effects on migration, assessing how people adapt is key

The potential effects of irrigation access on migration

Irrigation can reduce heat stress and improve agricultural yields. It can also increase agricultural incomes by enabling the cultivation of high-value crops and facilitating multiple and off-season cropping. In an analysis of the impact of access to irrigation on long-term emigration and urbanisation rates using global country data, Benonnier et al. (2022) found that although irrigation could mitigate the effect of rising temperatures on urbanisation, it had no impact on emigration. However, this international analysis relied on highly aggregated country-level data and a fixed measure of how much land was set up for irrigation. Another strand of the literature has drawn on micro-level household data on irrigation use, but from one country (typically India, but also Mexico) and hence with limited external validity, so the findings may not carry to other contexts. A recent study of sub-Saharan Africa offers a close parallel to our setting. Using International Organization for Migration survey data from 2018 and 2019, Martinez Flores et al. (2024) tracked migration at a fine geographic scale. In areas hit by unusually dry conditions, they found no migration response among locations with above-average irrigation coverage (as of 2000) – an early sign that irrigation may blunt the migration effects of drought.

Focus on West Africa – a region with a high vulnerability to climate change

Our focus is on West Africa, a region characterised by high population density and a large proportion of people working in agriculture, as well as being highly vulnerable to climate change. The region also has a history of internal and international migration. The average proportion of irrigated cropland is low overall in sub-Saharan Africa, but there is substantial variation between regions. In our study, we combine Gallup World Poll data on individual migration intentions with sub-national level weather, cropland, and irrigation data to measure the extent to which having access to irrigation influences stated migration intentions. The only previous study to measure the effect of weather shocks on migration intentions, Bertoli et al. (2022), found that drought influences migration intentions in West Africa but that the significance, direction and magnitude of this effect vary substantially across countries in the region. Our analysis aims to further investigate whether irrigation could potentially help to explain the contrasting drought impacts that can be found in the literature.

The usefulness of migration intention data

In the international survey 'Gallup World Poll' (GWP), individuals are asked whether they are likely or unlikely to move away from the city or area where they live within the next 12 months. This provides a comprehensive measure of intentions to move, whether within or outside the country of origin, and it is highly correlated with actual migration (Docquier et al., 2014; Dustmann and Okatenko, 2014; Tjaden et al., 2019). We can also control for various characteristics associated with migration, including age, education, household size and international connections. Our analysis covers the period 2008–2015 and includes the following countries: Benin, Burkina Faso, Côte d'Ivoire, Ghana, Guinea, Liberia, Mali, Mauritania, Niger, Nigeria, Senegal, Sierra Leone and Togo. Although migration intentions are measured at the individual level, the GWP does

not reveal individuals' locations with greater detail than the first administrative subdivision of a country (e.g., region or state). We therefore collect data on drought, crop cover, and irrigation at this level.

Measuring drought and crop seasons accounting for local conditions

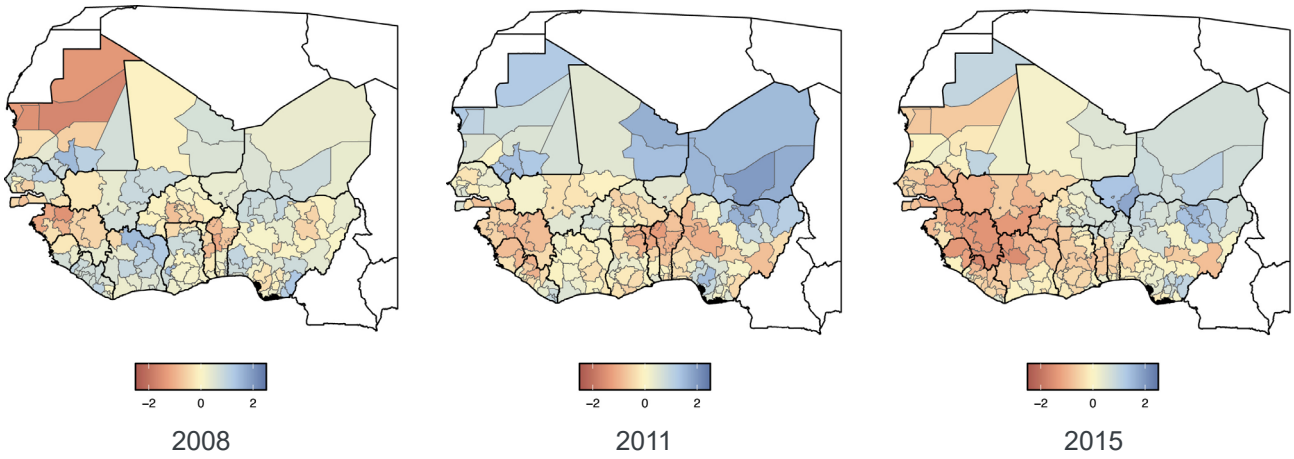
An important feature of our study is that we consider local crop seasons for eight staple crops in the region. We measure drought using the standardised precipitation evapotranspiration index (SPEI). The SPEI is a widely used drought indicator. It compares a region's water balance – rainfall minus the water lost through evaporation and plant transpiration – against that region's own long-term normal. Negative values signal drier-than-normal conditions (drought) and positive values wetter-than-normal conditions; because the index is standardised, a given value means the same thing in a humid zone as in an arid one, which makes it comparable across regions and over time. We measure the SPEI during the crop season months over the 24 months prior to the individual's interview. We also test alternative measures, such as the SPEI values over the past 60 months, or the number of months with drought over the past 24 months. The SPEI shows substantial variation both across the regions in our sample and over time as illustrated in Figure 1. The irrigation data come from Nagaraj et al. (2021), who used machine learning to obtain annual measures of irrigation extent at a very fine geographical scale. Access to irrigation could influence farmers' choice of crops. We therefore account for the crop cover in the region by adding the data on which crops are grown in each region.

To what extent does irrigation mitigate migration intentions following a drought?

Our main results show that migration intentions increase with the intensity of the drought, but that higher irrigation coverage has no statistically significant effect on the likelihood of expressing migration intentions. Our main analysis considers drought intensity in the 24 months prior to the individual's interview, and we also tested alternative definitions of drought. When we consider the cumulative impact of drought by measuring its intensity during the 60 months prior to the individual's interview, we find that migration intentions increase with drought intensity for individuals in regions with no irrigation. However, this relationship becomes less pronounced as irrigation coverage increases. During severe drought, we observe a statistically significant difference between individuals in highly irrigated regions and those in non-irrigated regions. Irrigation thus has a mitigating effect on migration intentions during severe drought.

Migration intentions rise sharply during severe drought – but irrigation can mitigate the effect

Figure 1 – Drought conditions across the sample countries, 2008, 2011, and 2015



Note: The maps show the SPEI-12 – the Standardised Precipitation-Evapotranspiration Index calculated over a 12-month accumulation window – for the first (2008, left), intermediate (2011, center) and last (2015, right) years of the study period. Blue shades indicate wetter-than-normal conditions and red shades drier-than-normal (drought) conditions; darker shades denote larger deviations from the long-term local average. Source: authors' elaboration based on SPEI data.

The role of confounding factors

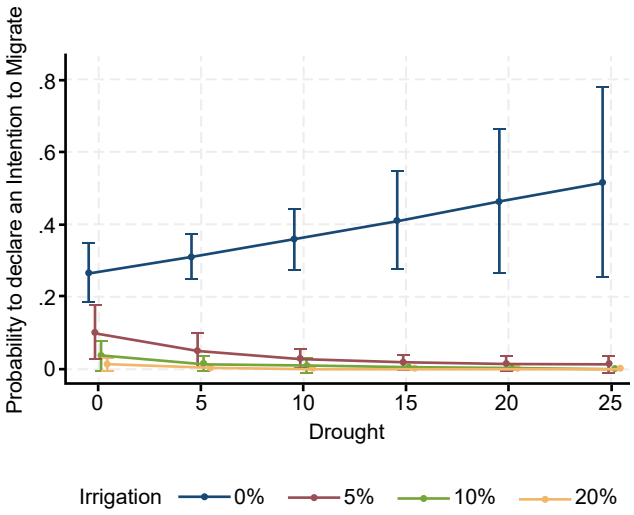
Our central result remains similar when accounting for other potential confounding factors that may be correlated with both irrigation and migration. These factors include conflict in the region in which the household is located, whether the household has received remittances or agricultural aid, the total amount of aid received from World Bank projects in the region, and the region's average per capita income. The only additional factor with a statistically significant effect on migration intentions is remittances, whose important role for development is well recognised in the literature. This suggests that remittances are positively associated with migration intentions. In addition, the impact of drought on migration intentions diminishes and becomes non-statistically significant. These effects indicate that individuals with at least 20% irrigated cropland experience no increase in migration intentions following a medium or high-intensity drought, compared to those with no irrigation.

Differential effects of irrigation coverage according to income and drought measures

The central result of no average effect of irrigation coverage on migration intentions may mask important variation. On the one hand, access to irrigation mitigates the impact of drought on agricultural incomes, and encourages investment in local livelihoods. On the other hand, higher income also enables individuals to realise their migration aspirations. Our findings suggest that the impact of irrigation varies across income groups within the sample. Predicted migration intentions increase with drought intensity for the middle-income group, and the effects become larger at a higher level of irrigation coverage than for individuals in a region with no access to irrigation. Thus, we observe that irrigation strengthens the positive association between drought and migration intentions in this group. For the richest households, the predicted probability of migrating is positive and increases with drought intensity in the absence of irrigation. However, when irrigation is available, this relationship becomes flat, indicating that irrigation mitigates the impact of drought on migration. These results for the richest households are illustrated in Figure 2, where the blue line indicates the effects of drought at zero irrigation coverage and the other lines the predicted response at higher levels of irrigation.

Irrigation raises migration intentions for middle-income households, but for richer ones, it cancels the effect of drought entirely

Figure 2 – Predicted migration intentions by drought intensity and irrigation coverage



Note: Each line shows the predicted probability that an individual in the richest income group (top 20%) declares an intention to migrate, as drought intensity increases (horizontal axis), for four levels of irrigated cropland: 0%, 5%, 10% and 20%. Capped vertical bars are 95% confidence intervals. With no irrigation (blue), migration intentions rise with drought, from about 0.27 to 0.52; at any positive irrigation share the probability is far lower and flat or declining, indicating that irrigation offsets the effect of drought for these households.

Source: Authors' estimate.

No overall effect of irrigation but strong differences depending on drought severity and individual income

In conclusion, our analysis reveals the complex relationship between irrigation coverage and migration following a drought. While there is no general mitigating effect of irrigation coverage on migration intentions within our sample, irrigation can mitigate migration following cumulative drought over a five-year period, and therefore have an impact during severe drought conditions. The effect also depends on the individual's income. While irrigation reduces migration intentions following drought for the richest households, it increases migration intentions for individuals in the middle-income group. This is consistent with a relaxation of cash/credit constraints that make moving hard to afford. Thus, irrigation acts as both a protective and an enabling factor for individuals confronted with drought.

This study provides new evidence of the links between climate change and migration by integrating spatially detailed, time-varying measures of irrigation with individual data on migration intentions in a multi-country analysis of a region which is highly vulnerable to climate change and has a long history of migration. The study thus contributes to an active area of research focusing on how local adaptation strategies interact with and modify the links between extreme climate events and migration.

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The author



Katrin Millock is Professor at the Paris School of Economics, Senior Researcher at the CNRS, and Affiliated Researcher to the Institute of Public Policies (IPP) in France. Her research focuses on environmental economics and migration, often in the context of developing countries. She has published in leading economic and disciplinary journals such as the Journal of Development Economics, Journal of Environmental Economics and Management, Ecological Economics, or Energy Policy.

Email: millock@univ-paris1.fr

Acknowlegment

Luxembourg National Research Fund

Supported by the Luxembourg National Research Fund (FNR) (PRIDE19/14302992) and (RESCOM/2024/LE/18786706).

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Publisher: LISER
Series: Policy Brief
e-ISSN: 2716-7437

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To cite this brief: Millock, K. (2026, Nov). Can irrigation mitigate intentions to migrate following a drought?. LISER Policy Brief; 2026-24, 8p.