Extreme climate fluctuation drives South African domestic migration

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Using a modified network modeling approach, researchers at Princeton looked specifically at water availability, temperature extremes, and migrants' socioeconomic statuses during two migration periods in South Africa. They found that, in many cases, residents were likely to leave areas struggling with climate instability, and regions with more reliable climates were more likely to attract migrants. Credit: Egan Jimenez, Princeton University

As the climate crisis worsens, some South Africans are relocating to

places with more stable climate conditions, according to a study led by Princeton University researchers.

Using a modified network modeling approach, the team looked specifically at water availability, temperature extremes, and migrants' socioeconomic statuses during two migration periods in South Africa. They found that, in many cases, residents were likely to leave areas struggling with climate instability, and regions with more reliable climates were more likely to attract migrants.

Some of the biggest migration differences were seen between those relocating to urban areas, or non-urban areas, like farmlands. Migrants moving to urban areas often left places with heavy rainfall—likely relocating to escape urban flooding. However, people moving to non-urban areas left locations with excessive heat—potentially indicative of temperature-sensitive livelihoods from farming, the researchers noted.

Socioeconomic factors also seemed to play a role. Some migrants relocating to urban areas were particularly motivated by the country's fluctuating unemployment rate. Non-urban migrants appeared to be especially influenced by outside factors that were not explicitly modeled, like the abolition of apartheid policies in the late 1990s.

The findings, published in Population and Environment, showcase the benefits of using network modeling—which often isn't used in this context—to study migration. Because of the model, the research team was able to investigate a geographical network of districts, rather than just individual migration.

"This type of model presents a promising method for conceptualizing and analyzing migration flows," said Michael Oppenheimer, the Albert G. Milbank Professor of Geosciences and International Affairs at the High Meadows Environmental Institute. "We believe that it could be

applied in other migration cases, different types of network flows, and conflict analyses in a variety of contexts, including projection of climate-driven migration in a warmer world.

The study was led by Tingyin Xiao, associate research scholar, under Oppenheimer's direction.

"South Africa is predicted to experience severe increases in temperature averages, shifts in precipitation patterns, and greater exacerbation of extreme water scarcity. It also has a uniquely high rate of internal migration, which is why we chose it as the focus of our study," said Xiao, who is based at the Princeton School of Public and International Affairs' Center for Policy Research on Energy and the Environment.

Xiao and Oppenheimer conducted the study with Xiaogang He, who was a High Meadows Environmental Institute—Science, Technology, and Environmental Policy (PEI-STEP) graduate fellow at Princeton and now an assistant professor at the National University of Singapore; and Marina Mastrorillo, an economist at the Food and Agriculture Organization of the United Nations.

The team gathered migration and socioeconomic information from community surveys and censuses provided by Statistics South Africa. They examined the number of adults between ages 15 and 64 who moved from one district to another within five years. The time periods studied were between 1997 to 2001 and 2007 to 2011. These time frames were chosen based on the data available and also because these periods came after the apartheid, which could have played a role in migration at the time.

Migrants were then divided into two groups: those who moved to an urban destination and those who moved to non-urban locations. The researchers then observed the effects of the long-term water availability

reflecting streamflow and reservoir levels, excessive heat, rainy season water deficit, and soil moisture conditions on migration across South Africa.

Past studies focused on migration flows primarily use a "gravity model" to predict and examine migration flows. However, this type of model, said the authors, has many limitations and can lead to biased estimations and results. Instead, the researchers modified an existing network model not previously applied in the migration context to analyze each factor's influence on South African internal migration. This allowed the team to consider and observe many factors involved in domestic migration and predict their relationships. They were able to identify climate-specific movement patterns and differences for both urban and non-urban migrants, examine socioeconomic influences, and compare previous migration trends.

The team also determined that prior migration flows influence subsequent migration. Past migrants may form connections between locations they moved from and to, which facilitates more future migration between these locations. In certain cases, past movement patterns may weaken the associations the researchers found between climate change and South African migration. Still, each migration trend is inevitably dependent on various climate, destination, socioeconomic, and historical factors. Specific outcomes should not be generalized without considering these contextual factors, the researchers warn.

The authors believe this study successfully fills gaps in previous ones. It improves the understanding of the climate's impact on migration and indicates a need for preparation of more humane and effective migration policies in countries experiencing extreme climate conditions, or those that may receive migrants. They advocate for further environmental migration research with the use of network models.

The paper, "Complex climate network effects on internal migration in South Africa revealed by network model" was published on Jan. 6 in *Population and Environment*, an open-access academic journal.

More information: Tingyin Xiao et al, Complex climate and network effects on internal migration in South Africa revealed by a network model, *Population and Environment* (2022). DOI: 10.1007/s11111-021-00392-8

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