An agent-based analysis of water-driven inequality traps and urbanization

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Project at a Glance

Water scarcity is often expected to push people out of rural areas, but it can also keep the poorest in place. The central question is: *when does water scarcity create a lasting rural inequality trap, and when does migration relieve it rather than shift the pressure to the city?* We address it with a simple agent-based model of one river basin shared by farmers and a city, linked by migration.



Motivation

Our starting point is the World Bank report *Ebb and Flow* [1], which examines how water shapes migration within countries. Its picture is more nuanced than the familiar image of drought-driven exodus. Water deficits do push people to move, but in poorer settings the most exposed households often lack the means to leave. Those who leave water-scarce areas tend to have less education and earn less at destination, often in cities that are themselves under water stress. Water shocks travel with people, shaping inequality both where migrants come from and where they arrive.

Average effects cannot tell us who moves, who stays, or why. If the poorest stay, is it because they cannot afford to leave? Or have they fallen below a point from which neither farming nor migration is within reach? A fall in rural inequality after a dry period may mean only that the poorest left and land concentrated among those who remained. And when farmers and a city share the same water, migration may relieve the countryside only by adding demand where water is already rationed. These feedbacks unfold over time, which is where simulation can complement empirical work.

Research Questions

The first question is whether water scarcity in a shared basin can create an inequality trap. In such a trap, farmers who lose access to irrigation during a dry period cannot regain it when water returns, while better-endowed farmers continue and expand. If such a trap exists, we ask whether it is driven by the rising cost of water, by the lack of cash to pay that cost upfront, or by both. The second question is whether migration is a stabilizing response for households, for the basin, and for the city, three perspectives that need not agree. We also ask how the rule allocating water between city and countryside changes who bears the cost of scarcity.

Approach and Experiments

The model combines two stylized mechanisms: migration driven by expected urban income when formal jobs are rationed [2], and asset thresholds created by fixed investment costs [3]. A single basin fills with rain each year and is drawn down by farmers and the city. Farmers irrigate only if it pays and they can cover the upfront cost, so as water becomes scarcer and more expensive, small and cash-poor farmers are excluded first. In the city, households and firms share the same water, and rationed firms cut jobs. Farmers migrate when expected urban income exceeds their own and they can afford the move, selling their land to those who remain.

We compare three nested versions (farmers only, a basin shared with the city, and a shared basin with migration) while varying inflows, the allocation rule, and the costs of irrigation and migration. A trap is identified when irrigation and inequality fail to recover after inflows decline and then return. Migration counts as stabilizing if, compared with a world without migration, it reduces rural deprivation, slows basin depletion, and does not depress urban informal wages. The goal is qualitative consistency with stylized facts, such as a weaker migration response where people are poorer [4], rather than precise reconstruction.

Expected Outcomes

A reproducible simulation framework, a short literature map, and a research report. The report will identify when water scarcity creates an inequality trap and through which channel. It will also assess whether migration relieves that trap or relocates the pressure to the city, and how allocation rules change who bears the cost of scarcity.

References

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