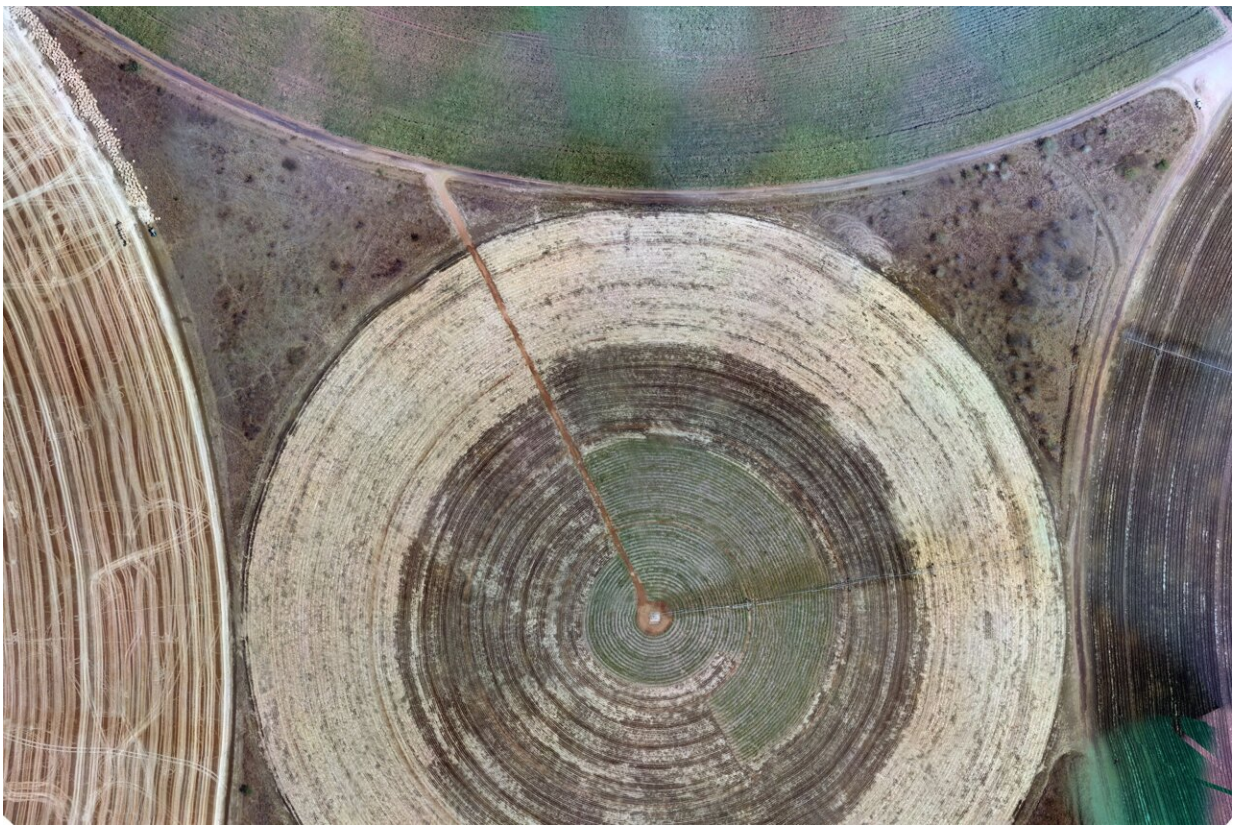
Coordinated approaches required to address climate change and reduce unintended consequences for African river basins

February 1 2022



Sugar cane fields require irrigation throughout the year via pivot irrigation, which uses sprinklers rotating around a central water pump generating gigantic circles. Water thirsty crops often produce considerable environmental impact. Credit: ATEC-3D

The Water-Energy-Food Nexus is a major global focus as the world seeks to address climate change and meet sustainable development goals. To help guide future policy decisions, an international team led by the Environmental Intelligence for Global Change Lab at Politecnico di Milano in collaboration with researchers from Tufts University, Pacific Northwest National Laboratory, and Cornell University developed an integrated socio-economic, climate, hydrologic, irrigation, and power systems model to simulate thousands of possible scenarios of global change, climate mitigation policies, and their local effects. A key finding from their results: it will be necessary to carefully coordinate global policies to reduce unintended harmful local impacts to African river basins.

The study, published in *Nature Climate Change*, explores more than 7,000 future scenarios that combine different climate and socio-economic projections with alternative mitigation policies. Results show that policy fragmentation between developed and developing countries in their approach to addressing carbon emissions from land-use changes can increase vulnerabilities in African basins. Specifically, the research shows how such fragmented policies could encourage proliferation of large-scale agricultural projects in Africa if land-use emissions are priced lower there.

This rapid increase in agricultural land use could generate irrigation demands two times higher than under globally coordinated approaches to emissions reduction, which can both address climate change and reduce local vulnerabilities. Higher irrigation demands constrain the availability of water resources for hydropower production or the provision of ecosystem services, particularly in river deltas, which could add stress to African economies and natural ecosystems.

The study sheds light on the importance of connecting global climate change mitigation policies to their potential impacts on local multisector

dynamics.

"Water resources management studies are mostly developed within the physical boundaries of river basins and seldom capture interconnections across larger scales. This research develops one of the first "glocal" studies, where the impacts of global mitigation policies are downscaled and analyzed at the finer river basin scale" says Professor Andrea Castelletti, head of the Environmental Intelligence Lab at Politecnico di Milano. "Our results show how globally designed strategies should be reconsidered in the lights of unexpected and unintended local impact to foster a more sustainable transition to a decarbonized future."

The research is one of the main outputs of the EU Horizon 2020 project Decision Analytic Framework to explore the water-energy-food Nexus in complex transboundary water resource systems of fast developing countries (DAFNE). The DAFNE project incorporates tools from different research fields—mathematical models, optimization algorithms, climate science and socio-economic projections—to promote an integrated and participatory approach for water resources planning and management. This approach was tested in the Zambezi Watercourse and the Omo-Turkana Basin to support local stakeholders and decision makers in the identification of sustainable development pathways addressing the Water-Energy-Food Nexus.

"There is no doubt that it is absolutely critical to immediately act to mitigate the climate crisis, but our approach can't be focused on sectors in isolation or ignore how local challenges may evolve," says Dr. Patrick Reed, Joseph C. Ford Professor of Engineering at Cornell University. "The Zambezi serves as an important example in this study that illustrates how global land use policies can increase tensions and tradeoffs across impacted water, energy, and agricultural systems."

"Every day we're learning just how interconnected the world is, that

actions taken in one region or sector can have far reaching impacts," says Dr. Jonathan Lamontagne, Assistant Professor in Civil and Environmental Engineering at Tufts University. "Our study is an early example tying local challenges to global drivers in the context of reservoir management. As the world moves to mitigate and adapt to climate change, this style of analysis will become increasingly important in navigating tradeoffs within food, energy, and water systems."

"We can't emphasize enough the importance of a coordinated approach to climate change policies based on the exploration of a wide range of possible future scenarios for better understanding synergies, tradeoffs, and vulnerabilities across scales" says Dr. Matteo Giuliani, Assistant Professor in the Environmental Intelligence Lab at Politecnico di Milano, who led the paper "This work is a major step towards the achievement of a better understanding of the impacts of global policies at the local scale, and calls for a collective effort towards the identification of more sustainable and equitable climate change mitigation policies."

More information: Matteo Giuliani et al, Unintended consequences of climate change mitigation for African river basins, *Nature Climate Change* (2022). DOI: 10.1038/s41558-021-01262-9

Provided by Politecnico di Milano