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Modeling interdependent critical infrastructures: The water–energy–food nexus in a macroeconomic framework

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Abstract

The interdependencies of energy generation, storage, and water provision across industries have been studied intensively in the last decade. Increasing severity of droughts has revealed the vulnerabilities of critical infrastructure systems to climate change. The cooling of nuclear power plants, the shipping of coal, and the storage of water for hydropower all depend on water availability in rivers and reservoirs, for example, whereas irrigation under drought conditions increases water and energy demand. Recently, agent-based models covering interdependent critical infrastructures have been proposed that help to inform infrastructure adaptation and expansion under climate change. This network of operational decision-making situations can be extended on the governance side to reveal the institutional decisions that are being made concerning system resilience and distributional outcomes across sectors. This extended network of action situations is illustrated by the case of electricity and water provision and the decision-making situations across connected sectors. The extension of an engineering-oriented agent-based model demonstrates how a network of action situations can be derived and extended from an agent-based model´s decision algorithms. The network reveals that the ability to cope with climate shocks requires a political renegotiation of natural resource use, societal resilience, and the development of capacity and storage rules for groundwater and reservoirs. Implications for modeling infrastructure production and provision functions within a macroeconomic agent-based model are drawn. This helps to simulate the macroeconomic repercussions of droughts.

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