DYNAMIC MODELING OF REGIONAL CLIMATE CHANGE ADAPTATION STRATEGIES: IMPACTS, OPTIONS AND CONFLICTS IN THE NORTWEST METROPOLITAN REGION OF GERMANY

MATTHIAS RUTH[*1]; ANDREW BLOHM[1]; REBECCA GASPER[1]; NANA KARLSTETTER[2]; JAKOB WACHSMUTH[3]; MARINA BEERMANN[4]; TOBIAS EICKEMEIER[5]; STEFAN GÖSSLING-REISEMANN[6]
1.UNIVERSITY OF MARYLAND; 2.UNIVERSITÄT OLDENBURG;

Objective

As the role of human activity in climate change is increasingly established as scientific fact, growing attention is being paid by investment and policy makers to the impacts on the regions and sectors in which they operate, and the options available to them to prepare for the climate change to which humanity has already committed itself. Both impacts and options will likely differ across regions and sectors. Conversely, strategies to promote resilience in any particular region or sector – if properly chosen – may contribute to resilience overall. Given this premise, we ask the following interrelated questions:

1. What are the existing synergies and conflicts between agriculture and energy?

2. What are the impacts of select climate mitigation and adaptation strategies on these synergies and conflicts?

3. How may climate change alleviate or exacerbate sectoral interdependencies?

4. What options may be available to reduce sector-specific climate vulnerabilities?

5. How would adaptation actions in one sector affect performance of another sector in the region?

To answer these questions, we have developed a dynamic computer model for the northwest metropolitan region of Germany as part of a larger project that has as its ultimate goal a sustained planning and development process that promotes regional resilience. The role of the model in this process is three-fold: provision of a structured platform for data organization and dialog with stakeholders; exploration of a wide range of what-if scenarios in preparation of investment and policy making; and recursive (adaptive) planning where the results of past actions are assessed within an ever-changing socioeconomic, technological and environmental context to guide future action. In this paper, we present the model and its uses with stakeholders to identify climate robust adaptation strategies for the region, focusing on synergies and conflicts between the energy and food production sectors.

Model

Formally, the model is a spatio-temporal dynamic model specified as a set of differential equations that are solved simultaneously for each time step and across time and space. It does not presuppose market equilibration, as is standard in economic models of climate change and adaptation responses, but instead allows for time-lagged, interrelated adjustments in and among sectors and sub-regions that are much closer to the evolutionary dynamics observed in the region.

The inner core of the model consists of modules to capture demographic change; energy sector developments; agriculture, food processing and land use decisions; and associated demands on port infrastructure and logistics. Special attention is given in the model to changes in demand for housing stock, that comes form changes in demographic characteristics and incomes, and the associated demand for energy, food and space. Of particular interest within the energy module are the influences from technology, policy, and demand on power generation, transmission and distribution, which affect food production and processing, for example, via space conditioning needs in households sectors, or cooling and processing needs in the food processing sector as well as demand for biomass to operate biogas generators. Land use conflicts between food and energy production and shipping demands for feed and food products are captured as well.

These core modules are linked to climate variables that describe temperature and precipitation profiles, along with assumptions about future sea levels and extreme events. Largely through scenario and wild card analysis, the model is also able to accommodate socioeconomic influences that come from outside the region, such as through migration, imports and exports of energy, most notably electricity and the fossil fuels to generate it, supply of feed and demand for food products, and provision of transport and logistics services.

For each of the modules, such as electricity production capacities, we specify initial conditions, on the basis of the most relevant and timely data from within the region, where possible, through a variety of sources including official government data bases, surveys, expert opinion and scientific reports. The model runs from a base year of 2010 until 2050. Initial conditions and functional relationships within and among modules are then tested and, where necessary, revised through a series of stakeholder meetings including industry experts and representatives.

There are two dynamic elements to this process. One of these lies in the process by which modules are updated through time on the basis of influences from other modules, whose behavior in turn may feed back to affect the sources of the original stimulus for change.