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An analysis of climate change impacts and adaptation for a NUTS III region in Austria

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Introduction

This project analyses the interactions between climate change, its physical and socio-economic impacts, and policy responses to reduce these impacts (adaptation and mitigation) on the regional scale. Given that regions strongly diverge in climate change impact, vulnerability and response strategies, we provide a numerical illustration of emissions abatement and sector-specific adaptation to the impacts from climate change for a agrarian Austrian region (South-East Styria). The sectoral focus is on two particularly vulnerable sectors, agriculture and energy. As a first approach to quantify the costs of climate change for a particular region at NUTS 3 level, we analyse the economic impacts of climate change under autonomous adaptation, of policy-induced adaptation and of a mitigation scenario for the 2040ies. The simulation results of a small-scale computable general equilibrium (CGE) model show the direction and magnitude of effects for economic indicators such as regional GDP and welfare.

Methods

The present approach is intended to complement large-scale growth models used for the global analyses of climate change impacts and mitigation. While these large-scale models necessitate aggregation, models operating on a smaller scale allow for sectoral and regional disaggregation and can thus be used to study climate change impacts and effects of mitigation and adaptation from bottom-up. To this end, we develop a static three-region computable general equilibrium (CGE) model, thereby implementing a rural Austrian region at NUTS 3 level as test site. The parameterisation of this economic model as well as the modelling of climate-induced changes on the production and consumption side is supported by three sub-models (see Figure 1): a regional climate scenario (reclip:more, Gobiet et al. 2006) and sectoral models for agriculture (FAMOS, Schmid 2004) and energy (Koland and Steininger 2008, Prettenthaler et al. 2006). This modelling framework allows to analyse sectoral impacts and sector-specific policy options (mitigation, adaptation) as well as to take account of the feedback effects of these impacts and policies on the other sectors of the economy.

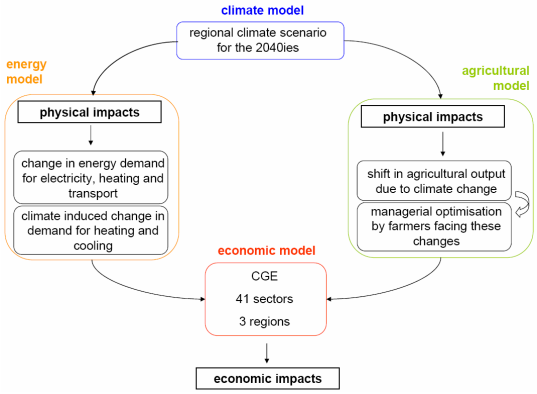

Figure 1: The modelling framework.

We construct four scenarios of the possible development of the economy by 2045 (see Table 1). The CGE model evaluates the regional economic effects triggered by the described scenarios for the agrarian core study region (Region 1) and the wider surrounding region (Region 2). Results for Region 3 (Austria and rest of the world) are not reported here.

	scenario	time horizon	climate change	autonomous adaptation	policy
scenario 1	business as usual	2045	no	no	no policy
scenario 2	reference scenario	2045	yes	yes	no policy
scenario 3	policy induced adaptation	2045	yes	yes	mixed agricultural cultivation
scenario 4	mitigation	2045	yes	yes	enforced insulation, passive houses and biomass energy production

Table 1: The four scenarios.

References:
Gobiet A, Truhetz H, Riegler A (2006) A climate scenario for the Alpine region, reclip:more project year 3. WegCenter progress report, Wegener Center for Climate and Global Change, University of Graz, Austria
Koland O, Steininger KW (coordination) (2008) Integrated Modelling of the Economy under Climate Change in Application of the Stern Review. Final Report StartClim2007.G, Vienna. Available at: http://www.austroclim.at/fileadmin/user_upload/reports/StCl07G.pdf
Prettenthaler F, Gobiet A, Habsburg-Lothringen C et al (2006) Auswirkungen des Klimawandels auf den Heiz- und Kühlbedarf in Österreich. Final Report StartClim2006.F, Vienna. Available at: http://www.austroclim.at/fileadmin/user_upload/reports/StCl06F.pdf.
Schmid E (2004) Das Betriebsoptimierungssystem FAMOS (Farm Optimization System). Discussion Paper DP-09-2004, University of Natural Resources and Applied Life Sciences, Institute for Sustainable Economic Development, Vienna

Results

To study impacts from **climate change and autonomous adaptation**, we quantify regional welfare and GDP of the reference scenario (scenario 2) relative to the business as usual (BAU, scenario 1). In agriculture, given altered climatic conditions, the same amount of inputs produces a lower level of output. For the energy sector, effects are dominated by the change in heating degree days, in particular by the decline in demand for heating energy. Effects of altered cooling energy are negligibly small.

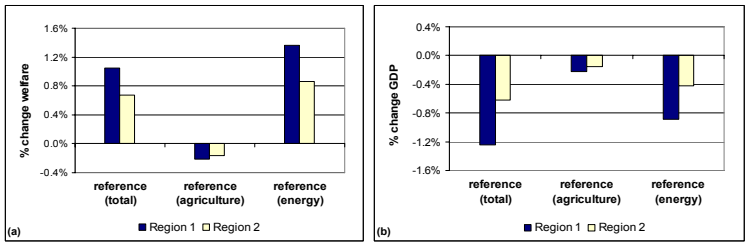

Figure 2: Effects of climate change and autonomous adaptation on regional welfare (a) and GDP growth (b) for Region 1 and Region 2.

Regarding **policy-induced adaptation**, we analyse the use of advanced agricultural techniques, such as the mixed cultivation of crops on the same lot of land, and their effects under climate change (scenario 3). By the use of mixed crops, farmers can reduce the damages otherwise caused by a climatic change. Although increasing the productivity of land, such alternative techniques are more expensive than conventional farming.

The cost of planned adaptation can be compared to the otherwise present negative climate change impacts (given by the reference scenario), expressed by a decline in agricultural production and thus in GDP. In particular, if adaptation increases production cost by less than 3.25%, regional GDP is higher with adaptation, ensuring BAU productivity, than in the reference scenario (scenario 2). Figure 3 depicts the shift in agricultural production and price level relative to the reference scenario.

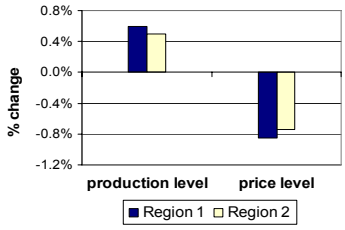

Figure 3: Effects of policy induced adaptation on the agricultural production and price level for Region 1 and Region 2.

In scenario 4, three **mitigation measures** are investigated (see Figure 4). Starting with the regional effects of each instrument separately, we find that measures such as fostering the insulation of residential buildings and constructing new dwellings uniformly as passive houses lower the energy needed for heating and therefore improve regional welfare relative to the reference scenario (scenario 2). The use of biomass for energy production has similar positive effects on the economy. While mitigation via passive houses and bio-energy are simulated in Region 1 only, small spill over effects on GDP and welfare are also found in Region 2 (see Figure 4).

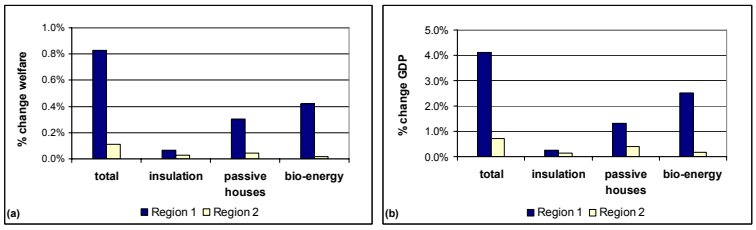

Figure 4: Effects of mitigation on regional welfare (a) and GDP (b) for Region 1 and Region 2.

Conclusions

This project serves as a first approach to quantify the socio-economic impacts of climate change for a study region in Austria at NUTS 3 level. To this end, a regionalised CGE model was fed with information from sectoral analyses of agricultural production and energy demand based on a highly resolved climate scenario for the region under consideration. The simulations evaluate the direction and magnitude of effects, but as is standard in studies on climate change, they outline possible development paths (scenarios) but should not be understood as forecasts.

In the agricultural sector, climate change and autonomous adaptation (scenario 2) are found to reduce welfare by 2045 in both the agrarian core study region (Region 1) and its surrounding region (Region 2). In the energy sector, by contrast, welfare rises in both regions with Region 1 experiencing a moderate increase in welfare due to a shift in energy demand. Furthermore, for agriculture we determine a limit for extra production cost (+3.25%) by policy-induced adaptation that ensures overall efficiency in terms of regional GDP stability. Finally, mitigation policy scenarios at the EU2020 objective level for the housing sector (enhanced insulation, passive house standard for new buildings) and particularly for renewable energies (expanded biomass) are found to raise regional GDP and, to a lower extent, welfare in Region 1.

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