Impact of global change on regional agricultural land use in the Austrian Upper Danube catchment

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***Abstract* - ACRE-Danube is an Agro-eConomic model for agricultural pRoduction on rEgional level and was developed as a decision tool with respect to questions of global change scenarios for the Upper Danube river basin. In order to estimate the impacts of global change on the Austrian part of the Danube river basin, scenarios were calculated where global change as well as the CAP reform 2003 were considered. This paper introduces results of the scenario calculations.** [1]

Global Change and Agricultural Land use

Agricultural use is influenced by climatic, biological, physical, socio-economic, political and technological environment. Current impact studies on agricultural land use tend to focus either on the consequences of economic and policy conditions or on climate change, only few studies explicitly consider both. In order to estimate possible future impacts on agricultural production in the Upper Danube catchment, scenarios of climate and socio-economic change were simulated using the regional optimization model ACRE-Danube.

The Optimisation Model ACRE-danube

ACRE-Danube is a comparative static partial-equilibrium model, which maximises the total gross margin on a regional level by calculating optimal production. The calibration method of ACRE-Danube is based on the extension of Positive Mathematical Programming published by Röhm & Dabbert (2003). Agricultural production in each of the model's sub regions at district-level (NUTS3-level) is represented by a single farm. The simulated period is one year. Agricultural production includes 19 food and non food crops, as well as 12 production processes for livestock. The model consists of a process analytical approach, feeding of animals and fertilization of crops is optimized by using feed and manure produced model-endogenously. Trade between the districts is not possible. ACRE-Danube is calibrated with statistical data for the reference year 1995. The complete model region of ACRE-Danube includes a total of 74 districts out of which 16 districts are located in Austria.

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Global Change Scenarios

Socio-economic scenarios

The agricultural policy scenario of CAP reform 2003 was modelled in ACRE-Danube by assuming reformed payments according to BMLFUW (2003) and AMA (2005). *Single Farm Payments* (SFP) were derived for the Austrian districts on the basis of the calculated average of direct payments received for crops and livestock, as well as the reference amount of milk within the period from 2000 to 2002. *Coupled direct payments* are granted for protein and energy crops as well as for suckler cows. Selected elements of *Cross Compliance* (e.g. erosion prevention) are taken into account while *Modulation* is not considered. *Compensatory Allowances for Mountain or Less Favoured Areas* and *Agri-environmental Payments* are also implied in ACRE-Danube as well as changes of set-aside rates. Changes in subsidies and prices were derived from the socio-economic scenarios described in the ACCELERATES study (Anonymous, 2004) which are identified by the symbols WM (World Markets), RE (Regional Enterprises), GS (Global Sustainability) and LS (Local Stewardship). Changes in subsidies were related to subsidies in the CAP reform 2003 scenario, as projected for the end phase in 2013 and assumed to remain constant up until 2020 as SFP. Price changes were related to the prices according to which ACRE-Danube was calibrated.

Climate Change and Technological Advance

In order to simulate global change with respect to climate change and technological progress, crop yield data were modified. The scenarios consider different effects of climate change and increasing CO_2 as well as technology development, in particular crop management and breeding. For the scenario calculations the summarised changes due to technological progress described in the ACCELERATES study (Anonymous, 2004) in combination with results of the crop model ROIMPEL (Catalin 2007) for each *IPCC Special Report on Emissions Scenario* (Nakićenović 2000), were used accordingly.

Results

Table 1 represents changes in agricultural production for the Austrian part of the Danube river basin and for selected economic and environmental indicators under different global change scenarios for

2020. The comparison between the reference scenario (Agenda 2000 with no changes of crop productivity) and the baseline and global change scenarios in the year 2020 (CAP reform scenario, and assumed socio-economic and crop productivity modifications) illustrates that agricultural area falls abandoned in all global change scenarios. Grassland production is in general either extensified or abandoned, least for the LS scenario. Fodder crops (silage maize and clover) tend to decrease, whereas grain maize increases. Cereals (except grain maize) increase only in the WM scenario. Set aside area increases in all scenarios save in the WM scenario, where no obligatory set aside quota is assumed. The difference between crop productivity within the global change scenarios count 76% for the total region (basically driven by the assumed technological advance), whereby the differences between the shares of acreages count 11% for grassland and only 4 % for arable crops, respectively. The total gross margin increases in general, particularly in the LS scenario. At the same time nitrogen input increases are least in the LS scenario.

Table 1. Changes in production and for indicators under different scenarios for the year 2020.

		2000	2020				
		REF	Base	WM	RE	GS	LS
production							
Cereals		15	14	18	14	15	14
Grain maize		5	5	8	7	7	6
Legumes		2	2	2	2	1	2
Oilseeds	% of	2	1	2	1	1	2
Silage maize	AL	18	15	12	14	13	14
Clover		20	17	15	15	15	17
Set aside		3	9	0	9	9	10
Abondoned AL		0	5	1	6	4	5
Intensive GL	% of	30	31	21	25	26	30
Extensive GL	GL	61	67	67	67	67	67
Abondoned GL		9	2	13	8	7	3
Economic	% of						
Gross margin	REF	100	108	103	104	122	135
Environment	% of						
Nitrogen input	REF	100	99	158	133	135	116

REF (reference scenario), Base (CAP reform 2003, no changes of crop productivity), WM (World Markets), RE (Regional Enterprises), GS (Global Sustainability) and LS (Local Stewardship); AL (arable land), GL (grassland). Source: own calculations

Potential impact of climate change on agricultural land use for the Austrian Upper Danube basin for the next decade appears relatively small. The generally predicted reduction in agricultural area, particularly for grassland (up to 13% of grassland becoming abandoned), is caused primarily by large assumed increases in yield driven by technological development in combination with variations in feeding of dairy cattle and subsidies for grassland. In respect to the preservation of agricultural landscapes, farm income and nitrogen input the LS scenario can be considered as beneficial, due to high subsidies which make grassland farming attractive, irrespective of fodder production. Fodder crop cultivation, particularly clover and silage maize, are also influenced by scenario assumptions, whereas changes in cereal production are considered as being less important in relation to their total share of arable land. The increase in set-aside area, except in the WM scenario where no obligation is assumed, is caused solely by the increase of prescribed set-aside area in CAP reform.

Conclusions and Discussion

According to scenario calculations presented here, global change in the Austrian Upper Danube catchment will result in slight changes in agricultural land use, particularly grassland production becoming either extensified or abandoned. The influence of climate change and technical advance appears to be small. However, it should be taken into consideration that important factors and their potential interactions are not considered e.g. the impact of pests and diseases or the follow up costs of climate change, such as insurance for natural disasters. Also the used time horizon is not long enough to induce significant impacts of climate change.

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