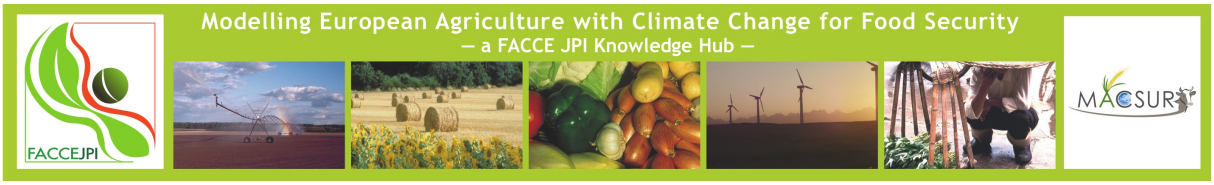

FACCE MACSUR

Filling gaps: AgMIP scenario results from CAPRI

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Abstract

Climate change impacts on food production, socioeconomic changes (population and income growth in large parts of the world) and biofuel policies affecting demand quantities have risen scientific, political and public interest in long-term forecasts on food security. Whereas first quantitative analyses from global economic models are starting to appear (e.g. (von Lampe et al., under review)), similar studies on smaller regional scales are not yet available. However, acknowledging that climate change affects crop yields differently across scales and regions (e.g. (Reidsma et al., 2007)) and considering the specific political setting given through the Common Agricultural Policy (CAP) in Europe, the MACSUR project focuses on the impact of climate change and socioeconomic changes on European agriculture and its contribution to global food security. We present a Europe-wide analysis of the effect of selected climate and socioeconomic scenarios on food security in terms of food prices using the Common Agricultural Policy Regionalised Impact modelling system (CAPRI).

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1 Introduction

Climate change impacts on food production, socioeconomic changes (population and income growth in large parts of the world) and biofuel policies affecting demand quantities have risen scientific, political and public interest in long-term forecasts on food security. Whereas first quantitative analyses from global economic models are starting to appear (e.g. (von Lampe et al., under review)), similar studies on smaller regional scales are not yet available. However, acknowledging that climate change affects crop yields differently across scales and regions (e.g. Reidsma et al. 2007) and considering the specific political setting given through the Common Agricultural Policy (CAP) in Europe, the MACSUR project focuses on the impact of climate change and socioeconomic changes on European agriculture and its contribution to global food security. For this purpose and in order to reflect specific regional settings, a number of regional pilot studies will be conducted within the project. We present a Europe-wide analysis of the effect of selected climate and socioeconomic scenarios on food security in terms of food prices as input for the regional pilot studies. The analysis is accomplished with the Common Agricultural Policy Regionalised Impact (CAPRI) model.

Task T1.4 was initially named "development of approaches to fill gaps". However, during the course of the first project year two issues arose, which made a readjustment of the aims of this task necessary:

1. The first one is that only few project partners have already conducted climate change (CC) impact analyses with their economic models. This made it impossible to compare the results of those analyses as initially intended for the first project phase and to learn from this comparison in terms of identifying gaps for future analysis.
2. Instead, the major gap that could be identified in order to enable country- or regional-scale models to run CC scenarios was the missing input data on those scenarios from larger scale models. More specifically, country-level price data derived based on the CC scenarios is missing.

Therefore, the – readjusted – main aim of the deliverable is to provide CC scenario results in form of price data from the Common Agricultural Policy Regionalised Impact Modelling System (CAPRI). Based on the project decision to use the AgMIP scenarios as starting point for the MACSUR project, we will briefly describe those scenarios and their implementation in CAPRI after having provided some basic facts on the CAPRI model. After that the results will be presented followed by a discussion of limitations and potential solutions and some concluding remarks.

2 Overview of CAPRI

The CAPRI modelling system (Britz and Witzke 2012) consists of specific databases, a methodology, its software implementation, and the researchers involved in their development, maintenance and applications. Following, the core model, data, and calibration are briefly described. These parts are taken from the much more detailed CAPRI model documentation of (Britz and Witzke, 2012)).[1]

2.1.1 The core model

The core of CAPRI consists of a comparative-static partial equilibrium economic model which is based on the linkage of a European-focused supply module and a global market module.

The supply module consists of independent aggregate non-linear programming models which cover the EU27, Norway, Western Balkans and Turkey. They represent all agricultural production activities and related output generation and input use at regional[2] or farm type level (Gocht and Britz, 2011).[3]

[1] At the same time the description is equivalent to Britz et al. (2013) (paper presented at MACSUR workshop Haifa, Israel).

[2] 280 NUTS2 regions are represented.

With respect to policy implementation, the different coupled and de-coupled subsidies of Pillar I of the Common Agricultural Policy (CAP), as well as major ones from Pillar II (Less Favoured Area support, agri-environmental measures, Natura 2000 support) are depicted in detail for the EU. Prices are exogenous to the supply module and provided by the market module.

The market module consists of two sub-modules. The sub-module for marketable agricultural outputs is a spatial, non-stochastic global multi-commodity model for about 50 primary and processed agricultural products, covering about 80 countries or country blocks in 40 trading blocks. The Armington approach (Armington, 1969), assuming that the products are differentiated by origin, allows the simulation of bilateral trade flows and of related bilateral and multilateral trade instruments, including tariff-rate quotas. This sub-module delivers the output prices used in the supply module and allows for market analysis at global, EU and national scale, including a welfare analysis. A second sub-module deals with prices for young animals by clearing young animal markets. As the supply models are solved independently at fixed prices, the link between the supply and market modules is based on sequential calibration (Britz 2008).[4] Equally, in between iterations, CAP premiums are re-calculated to ensure compliance with national ceilings.

Post-model analysis includes the calculation of different income indicators as variable costs, revenues, gross margins, etc., both for individual production activities as for regions. A welfare analysis at Member State level, or globally, at country or country block level, covers agricultural and processing profits, tariff revenues, outlays for domestic supports and the money metric measure to capture welfare effects on consumers. Environmental indicators cover NPK balances and output of climate relevant gases according the guidelines of the Intergovernmental Panel on Climate Change (IPCC).

The simulation model and post-model analysis are programmed in GAMS, while a graphical user interface (Britz 2011) allows to steer applications and to exploit model results based on interactive maps and as thematic interactive drill-down tables. The economic model builds on a philosophy of model templates which are structurally identical so that instances for products and regions are generated by populating the template with specific parameter sets. This approach ensures comparability of results across products, activities and regions, allows for low cost system maintenance and enables its integration with other models or modeling frameworks. At the same time, the approach opens up the chance for complementary approaches at different levels, which may shed light on different aspects not covered by CAPRI.

CAPRI encompasses further modules which are of minor interest for the topic discussed in here, such as a downscaling component to 1x1 km grid cell clusters and, since 2013, a layer of regional CGE with a focus on rural development measures.

2.1.2 Input data and model parameterization

The databases exploit wherever possible well-documented, official and harmonised data sources, especially data from EUROSTAT, FAOSTAT, OECD and extractions from the Farm Accounting

[3] The programming models are a kind of hybrid approach, as they combine a Leontief-technology for variable costs covering a low and high yield variant for the different production activities with a non-linear cost function which captures the effects of labour and capital on farmers' decisions. The non-linear cost function allows for perfect calibration of the models and a smooth simulation response rooted in observed behaviour.

[4] The link between the supply and market modules is based on an iterative procedure. After each iteration, during which the supply module works with fixed prices, the constant terms of the behavioural functions for supply and feed demand are calibrated to the results of the regional aggregate programming models aggregated to Member State level. Solving the market modules then delivers new prices. A weighted average of the prices from past iterations then defines the prices used in the next iteration of the supply module.

Data Network (FADN). Specific modules ensure that the data used in CAPRI are mutually compatible and complete in time and space. They cover about 50 agricultural primary and processed products, from farm type to global scale including input and output coefficients. Parameters steering the model response are as much as possible based on past observations. The supply response of each regional farm (on NUTS2 level) is estimated using time series data on land use and corresponding price and cost developments (Jansson and Heckelei, 2011). The parameters of the global market model are synthetic, i.e. to a large extent taken from the literature and other modelling systems. As the CAPRI simulation engine is not able to simulate over time, the model is calibrated to one (or several) given equilibrium point(s) in the future. This point, called the ex-ante baseline, is generated by trend estimations and expert information (e.g. from FAO or other models). In climate change studies usually long-term projections are needed. For those, the baseline is usually created for the year 2050.

3 Scenarios

The scenarios applied in this deliverable are based on the scenarios developed in the context of the Agricultural Model Intercomparison and Improvement Project (AgMIP, www.agmip.org). In (von Lampe et al., under review) these scenarios were applied in 9 large-scale economic models with significant agricultural components. In this deliverable the same set of scenarios is applied in the CAPRI model in order to provide a specific focus on European agriculture. Below, first an overview of the AgMIP scenarios is given, followed by some details on their implementation in CAPRI.

3.1 AgMIP scenario overview

The Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC AR5) distinguishes between two dimensions of scenarios: the Representive Concentration Pathways (RCPs) (Moss et al., 2010) and the Shared Socioeconomic Pathways (SSPs) (Kriegler et al., 2012). Four RCPs were developed each of which corresponds to a specific radiative forcing pathway (Moss et al., 2010) (cf. Appendix, Figure 1). Additionally, five SSPs exist (cf. Appendix, Figure 2). SSPs are characterized by a catch phrase, a narrative, quantitative population and Gross Domestic Product (GDP) scenarios, quantitative elements coming from Impact Analysis Models (IAM), and other quantitative elements (e.g. ecosystem productivity) (Köchy and Zimmermann, 2013). RCPs and SSPs can be combined with each other, whereby some combinations are inconceivable (cf. Appendix, Figure 3).[5]

The AgMIP project uses a selection of eight scenarios (cf. Appendix, Table 7), two of which (S6-S8) are bioenergy scenarios. The MACSUR partners decided to initially build only on the RCP and SSP scenarios used in AgMIP and depicted in Table 1 (without explicit consideration of bioenergy scenarios).

[5] More detailed information is also provided in (Köchy and Zimmermann, 2013).

Table 1. AgMIP scenarios used in MACSUR

Scenario code	SSP	RCP	GCM	Crop model
S1	SSP2	Present climate	none	none
S2	**SSP3**	Present climate	none	none
S3	SSP2	**RCP8p5**	**IPSL-CM5A-LR**	**LPJmL**
S4	SSP2	**RCP8p5**	**HadGEM2-ES**	**LPJmL**
S5	SSP2	**RCP8p5**	**IPSL-CM5A-LR**	**DSSAT**
S6	SSP2	**RCP8p5**	**HadGEM2-ES**	**DSSAT**

Scenario S1 represents the reference run, consisting of SSP2 and present climate. SSP2 is associated with the catch phrase "Continuation" representing medium challenges and continuation of current trends. The only other SSP considered in the AgMIP scenarios is SSP3, which is represented in AgMIP scenario S2 in combination with present climate. SSP3 is characterised by the catch phrase "Fragmentation" representing high challenges and global socioeconomic fragmentation. S3 to S6 analyse SSP2 combined with RCP8p5. They differ in the General Circulation Models (GCMs) predicting regional temperature and precipitation and the crop models predicting climate change induced changes in average crop yields applied (Table 1).

3.2 Scenario implementation in CAPRI

For the scenarios implementation in CAPRI necessary input data comes from the GLOBIOM model (e.g. Havlík et al. 2013). Apart from the AgMIP scenarios everything else is kept constant in CAPRI. With respect to policy assumptions this means that the most recent policy decisions (e.g. Common Agricultural Policy, WTO negotiations) apply and are not changed during the simulations. The base year is 2004. In line with project decisions, simulations are conducted for 2030 and 2050. The scenarios analysed in this report are S1, S2, S3 and S6. The baseline (reference run) scenario S1 is compared across different simulation years (2010, 2030, and 2050). The other scenarios are compared to the baseline in 2050.

4 Scenario output data available

Results are analysed focusing on food prices. The main characteristics that are considered are:

- Prices
  - Producer prices
  - Consumer prices
- Simulation years
  - 2010
  - 2030
  - 2050
- EU27 at national level (prices do not differ at NUTS2 level). In general price data for the following countries and country aggregates are available (Table 2).

Table 2. Country and country aggregates

European Union 27	Mediterranean countries (Tunesia, Algeria, Egypt, Israel)
European Union 25	Morocco
European Union 15	Turkey
European Union 12	Tunesia
European Union 10	Algeria
Bulgaria and Romania	Egypt
Europe, Non-EU	Israel
Africa	Middle East
North America (USA, Canada, Mexico)	Africa
Middle and South America	Nigeria
Asia	Ethiopia
Australia and New Zealand	South Africa
European Union 27	Africa LDC nes
European Union 25	Africa rest (mostly ACP)
European Union 15	North America (USA, Canada, Mexico)
Belgium	USA
Denmark	Canada
Germany	Mexico
Austria	Middle and South America
Netherlands	Middle and South Americs, ACP
France	Mercosur (Argentina, Brazil, Uruguay and Paraguay)
Portugal	Brazil
Spain	Argentina
Greece	Uruguay and Paraguay
Italy	Paraguay
Ireland	Uruguay
Finland	Mercosur associated (Venezuela, Bolivia, Chile)
Sweden	Venezuela
United Kingdom	Bolivia
European Union 12	Chile
European Union 10	Rest of Middle and South America
Czech Republic	Asia
Estonia	India
Hungary	Pakistan
Lithuania	Bangladesh
Latvia	China
Poland	Japan
Slovenia	Malaysia
Slovak Republic	Indonesia
Cyprus	Taiwan
Malta	South Korea
Bulgaria and Romania	Viet nam
Bulgaria	Thailand
Romania	Asian and Oceania LDC
Europe, Non-EU	Asian and Oceania Rest
Switzerland	Australia and New Zealand
Norway	High Income
Western balkans	Middle income
Albania	LDC and ACP
Macedonia	LDC
Serbia	ACP
Montenegro	Non-EU
Croatia	World
Bosnia and Herzegovina	
Kosovo	
Rest of Europe	
Russia	
Ukraine	
Belarus	
Kazachtan	
Belarus, Kazachtan ..	

Source: CAPRI database.

- The products considered in this report are cereals, meat and dairy products. Generally, data on the following products are available (Table 3).

Table 3. Products and product categories

Products and product categories	
Cereals	Beef
Oilseeds	Pork meat
Other arable field crops	Sheep and goat meat
Vegetables and Permanent crops	Poultry meat
Coffee, Teas and Cocoa	Other Animal products
All other crops	Raw milk
Meat	Eggs
Other Animal products	Fish and other acquatic products
Fish and other acquatic products	Fresh water fish
Dairy products	Saltwater fish
Oils	Other acquatic
Oil cakes	Dairy products
Secondary products	Butter
Cereals	Skimmed milk powder
Wheat	Cheese
Rye and meslin	Fresh milk products
Barley	Cream
Oats	Concentrated milk
Grain maize	Whole milk powder
Other cereals	Casein
Oilseeds	Whey powder
Rape seed	Oils
Sunflower seed	Rape seed oil
Soya seed	Sunflower seed oil
Other arable field crops	Soya oil
Pulses	Olive oil
Potatoes	Palm oil
Yams, Manioc, Cassava and Other Roots & Tubers	Oil cakes
Vegetables and Permanent crops	Rape seed cake
Tomatoes	Sunflowe seed cake
Other vegetables	Soya cake
Apples pears and peaches	Secondary products
Table grapes	Rice milled
Citrus fruits	Sugar
Other fruits	Bio diesel
Table olives	Bio ethanol
Wine	Destilled dried grains from bio-ethanol processing
Coffee, Teas and Cocoa	Protein rich by products
Coffee	Energy rich by products
Tea	Total diesel
Cocoa	Agricultural land
All other crops	Feed energy input
Flax and hemp	Total gasoline
Tobacco	Fat content
New energy crops	Protein content
Meat	All non agricultural goods

Source: CAPRI database.

5 Baseline results

The baseline results are compared with each other at different points in time (2010, 2030, and2050). They are given in Table 4. The comparison is done for 10 selected countries/country aggregates. The following country aggregates are considered in order to provide an approximately global coverage: EU27, Africa, North America, Middle and South America and Asia. Additionally, a number of single countries is considered, thought to represent MACSUR regional case study areas: Italy, Finland, Norway, Poland and Germany. More countries can be considered in the analysis based on project decisions. The products taken into account are cereals, meat and dairy products. Output variables are producer and consumer prices, they are given in absolute values (Euro/t). Differences of the baseline results in 2030 and 2050 in comparison to 2010 are given in percentages below the absolute values.

Table 4. AgMIP baseline results, years 2010-2030-2050

		S1 2010		S1 2030		S1 2050	
Country/country group	Product	Producer price - [Euro / t]	Consumer price - [Euro / t]	Producer price - [Euro / t]	Consumer price - [Euro / t]	Producer price - [Euro / t]	Consumer price - [Euro / t]
European Union 27	Cereals	141.78	2118.7	200.75	3458.25	246.05	6218.57
				41.60%	63.23%	73.55%	193.51%
	Meat	1972.99	5009.85	2665.46	7202.68	3369.53	11575.86
				35.10%	43.77%	70.78%	131.06%
	Dairy products	1328.94	1674.32	1688.59	2184.04	1753.03	2967.75
				27.06%	30.44%	31.91%	77.25%
Africa	Cereals	124.92	470.61	152.52	685.93	192.91	1037.65
				22.09%	45.75%	54.43%	120.49%
	Meat	2260.37	2815.31	3192.35	4176.89	3435.79	5302.06
				41.23%	48.36%	52.00%	88.33%
	Dairy products	339.85	743.55	424.71	948.99	386.75	861.23
				24.97%	27.63%	13.80%	15.83%
North America (USA, Canada, Mexico)	Cereals	98.51	2100.94	157.8	4716.99	148.62	8246.59
				60.19%	124.52%	50.86%	292.52%
	Meat	1493.92	4374.59	2077.26	8762.16	2504.26	13816.36
				39.05%	100.30%	67.63%	215.83%
	Dairy products	1475.38	1876.88	1847.83	2849.84	1290.76	2879.62
				25.24%	51.84%	-12.51%	53.43%
Middle and South America	Cereals	115.36	664.04	208.25	1571.29	172.8	3082.27
				80.52%	136.63%	49.79%	364.17%
	Meat	992.48	1581.06	1427.12	2983.97	1835.49	5129.15
				43.79%	88.73%	84.94%	224.41%
	Dairy products	448	562.66	537.27	747.22	445.84	798.14
				19.93%	32.80%	-0.48%	41.85%
Asia	Cereals	143.78	570.07	154.82	1336.68	204.74	2681.48
				7.68%	134.48%	42.39%	370.38%
	Meat	1221.6	1873.93	1560.58	3795.99	2087.41	6596.07
				27.75%	102.57%	70.88%	251.99%
	Dairy products	397.83	499.56	460.35	660.72	391.07	658.49
				15.72%	32.26%	-1.70%	31.82%
Germany	Cereals	134.47	3084.76	190.96	4606.18	238.61	8146.25
				42.01%	49.32%	77.44%	164.08%
	Meat	1703.5	5274.61	2255.67	8394.99	2870.88	13734.23
				32.41%	59.16%	68.53%	160.38%
	Dairy products	1265.87	1938.21	1571.78	2695.36	1620.91	3749.5
				24.17%	39.06%	28.05%	93.45%
Italy	Cereals	196.87	2175.71	273.67	3194.43	337.47	5691.45
				39.01%	46.82%	71.41%	161.59%
	Meat	2371.74	5495.39	3309.21	7002.65	4222.18	11023.05
				39.53%	27.43%	78.02%	100.59%
	Dairy products	1923.3	2144.87	2392.74	2585.59	2198.41	3523.29
				24.41%	20.55%	14.30%	64.27%
Finland	Cereals	124.35	2808.7	178.09	5084.82	229.82	8972.9
				43.22%	81.04%	84.82%	219.47%
	Meat	1832.78	5937.75	2508.95	9205.2	3094.58	14776.27
				36.89%	55.03%	68.85%	148.85%
	Dairy products	1073.97	1523.33	1444.01	2192.97	1449.42	2911.68
				34.46%	43.96%	34.96%	91.14%
Poland	Cereals	112.78	966.56	176.12	1886.92	226.28	3509.27
				56.17%	95.22%	100.64%	263.07%
	Meat	1375.17	3026.72	1908.87	3902.92	2397.5	6316.25
				38.81%	28.95%	74.34%	108.68%
	Dairy products	714.1	1033.4	1006.75	1231.01	1000.32	1715.19
				40.98%	19.12%	40.08%	65.98%
Norway	Cereals	260.43	4132.58	372.5	6916.49	461.8	11625.46
				43.03%	67.36%	77.32%	181.31%
	Meat	2747.94	8546.71	3681.85	10169.95	4410.04	15823.78
				33.99%	18.99%	60.49%	85.14%
	Dairy products	1524.39	2143.82	1935.75	3361.48	2158.24	4242.27
				26.98%	56.80%	41.58%	97.88%

6 Scenario results

The scenarios results S2, S3 and S6 are compared to the baseline results for the year 2030 and 2050. This is done for 10 selected countries/country aggregates. The following country aggregates are considered in order to provide an approximately global coverage: EU27, Africa, North America, Middle and South America and Asia. Additionally, a number of single countries is considered, thought to represent MACSUR regional case study areas: Italy, Finland, Norway, Poland and Germany. More countries can be considered in the analysis based on project decisions. The products taken into account are cereals, meat and dairy products. Output variables are producer and consumer prices.

6.1 Simulation year 2030

[To be done (will be very similar to year 2050 analyses).]

6.2 Simulation year 2050

Below (Table 5) the scenarios S2 and S3 are compared to the baseline scenario S1 for the simulation year 2050. Additionally, the RCP8.5 scenarios S3 and S6 are compared to each other (Table 6). They differ in the GCM and crop models applied.

Table 5 shows the absolute values (Euro/t) for S1, S2, and S3 as well as the differences of S2 and S3 compared to the baseline S1 in percentages.

Table 5. AgMIP scenario results (S1-S3), year 2050

		AGMIP_S1		AGMIP_MACRO_S2		AGMIP_YLDS_S3	
Countries/ country groups	Products	Producer price - [Euro / t]	Consumer price - [Euro / t]	Producer price - [Euro / t]	Consumer price - [Euro / t]	Producer price - [Euro / t]	Consumer price - [Euro / t]
European Union 27	Cereals	246.05	6218.57	230.45	5453.66	313.26	6283.46
				-6.34%	-12.30%	27.32%	1.04%
	Meat	3369.53	11575.86	2679.18	9983.9	3702.78	11934.73
				-20.49%	-13.75%	9.89%	3.10%
	Dairy products	1753.03	2967.75	1253.38	2271.08	1831.45	3050.37
				-28.50%	-23.47%	4.47%	2.78%
Africa	Cereals	192.91	1037.65	206.86	819.89	253.35	1098.61
				7.23%	-20.99%	31.33%	5.88%
	Meat	3435.79	5302.06	3192.93	4692.92	3906.16	5780.89
				-7.07%	-11.49%	13.69%	9.03%
	Dairy products	386.75	861.23	322.17	772.92	421.79	931.97
				-16.70%	-10.25%	9.06%	8.21%
North America (USA, Canada, Mexico)	Cereals	148.62	8246.59	134.48	6704.5	198.13	8295.7
				-9.51%	-18.70%	33.31%	0.60%
	Meat	2504.26	13816.36	1984.54	11876.71	2789.17	14114.63
				-20.75%	-14.04%	11.38%	2.16%
	Dairy products	1290.76	2879.62	934.38	2256.51	1387.55	3013.57
				-27.61%	-21.64%	7.50%	4.65%
Middle and South America	Cereals	172.8	3082.27	176.23	2079.86	222.01	3143.32
				1.98%	-32.52%	28.47%	1.98%
	Meat	1835.49	5129.15	1812.22	3942.08	2048.25	5325.33
				-1.27%	-23.14%	11.59%	3.82%
	Dairy products	445.84	798.14	424.71	661.58	477.62	834.76
				-4.74%	-17.11%	7.13%	4.59%
Asia	Cereals	204.74	2681.48	222.7	1791.06	269.7	2778.75
				8.77%	-33.21%	31.73%	3.63%
	Meat	2087.41	6596.07	1983.79	4847.31	2273.9	6809.37
				-4.96%	-26.51%	8.93%	3.23%
	Dairy products	391.07	658.49	388.78	569.77	425.03	693.58
				-0.59%	-13.47%	8.68%	5.33%
Germany	Cereals	238.61	8146.25	222.15	7270.49	306.27	8211.64
				-6.90%	-10.75%	28.36%	0.80%
	Meat	2870.88	13734.23	2290.63	11932.3	3162.2	14071.15
				-20.21%	-13.12%	10.15%	2.45%
	Dairy products	1620.91	3749.5	1176.11	2860.34	1694.39	3849.22
				-27.44%	-23.71%	4.53%	2.66%
Italy	Cereals	337.47	5691.45	313.38	5116.58	430.01	5758.67
				-7.14%	-10.10%	27.42%	1.18%
	Meat	4222.18	11023.05	3355.93	9502.05	4640.48	11407.45
				-20.52%	-13.80%	9.91%	3.49%
	Dairy products	2198.41	3523.29	1589.95	2604.87	2277.67	3624.78
				-27.68%	-26.07%	3.61%	2.88%
Finland	Cereals	229.82	8972.9	212.09	8091.49	294.42	9040.05
				-7.72%	-9.82%	28.11%	0.75%
	Meat	3094.58	14776.27	2465.36	12941.68	3403.96	15141.56
				-20.33%	-12.42%	10.00%	2.47%
	Dairy products	1449.42	2911.68	1031.25	2262.28	1509.91	2984.34
				-28.85%	-22.30%	4.17%	2.50%
Poland	Cereals	226.28	3509.27	214.64	3027.83	275.63	3560.84
				-5.14%	-13.72%	21.81%	1.47%
	Meat	2397.5	6316.25	1949.55	5312.9	2615.13	6527.48
				-18.68%	-15.89%	9.08%	3.34%
	Dairy products	1000.32	1715.19	711.18	1292.31	1055.02	1775.44
				-28.90%	-24.65%	5.47%	3.51%
Norway	Cereals	461.8	11625.46	416.59	10456.95	567.65	11808.82
				-9.79%	-10.05%	22.92%	1.58%
	Meat	4410.04	15823.78	3483.47	14059.41	5022.97	16198.56
				-21.01%	-11.15%	13.90%	2.37%
	Dairy products	2158.24	4242.27	1442.56	3241.82	2273.07	4382.58
				-33.16%	-23.58%	5.32%	3.31%

Source: CAPRI.

[Analysis of the results about here.]

Table 6. AgMIP scenario comparison S3-S6, year 2050

		AGMIP_YLDS_S3		AGMIP_YLDS_S6	
Countries/ country groups	Product	Producer price - [Euro / t]	Consumer price - [Euro / t]	Producer price - [Euro / t]	Consumer price - [Euro / t]
European Union 27	Cereals	313.26	6283.46	326.34	6284.97
				4.17%	0.02%
	Meat	3702.78	11934.73	3745.91	11981.24
				1.16%	0.39%
	Dairy products	1831.45	3050.37	1861.81	3080.58
				1.66%	0.99%
Africa	Cereals	253.35	1098.61	267.56	1115.17
				5.61%	1.51%
	Meat	3906.16	5780.89	3926.22	5842.57
				0.51%	1.07%
	Dairy products	421.79	931.97	418.68	946.17
				-0.74%	1.52%
North America (USA, Canada, Mexico)	Cereals	198.13	8295.7	249.15	8345.61
				25.76%	0.60%
	Meat	2789.17	14114.63	3041.14	14398.6
				9.03%	2.01%
	Dairy products	1387.55	3013.57	1472.47	3133.43
				6.12%	3.98%
Middle and South America	Cereals	222.01	3143.32	242.65	3161.13
				9.30%	0.57%
	Meat	2048.25	5325.33	2114.66	5385.73
				3.24%	1.13%
	Dairy products	477.62	834.76	490.61	851.23
				2.72%	1.97%
Asia	Cereals	269.7	2778.75	360.48	2904.1
				33.66%	4.51%
	Meat	2273.9	6809.37	2368.54	6916.18
				4.16%	1.57%
	Dairy products	425.03	693.58	462.35	733.84
				8.78%	5.80%
Germany	Cereals	306.27	8211.64	310.82	8217.26
				1.48%	0.07%
	Meat	3162.2	14071.15	3218.4	14124.83
				1.78%	0.38%
	Dairy products	1694.39	3849.22	1722.31	3886.8
				1.65%	0.98%
Italy	Cereals	430.01	5758.67	456.93	5760.38
				6.26%	0.03%
	Meat	4640.48	11407.45	4677.06	11437.55
				0.79%	0.26%
	Dairy products	2277.67	3624.78	2307.97	3664.52
				1.33%	1.10%
Finland	Cereals	294.42	9040.05	305.05	9040.98
				3.61%	0.01%
	Meat	3403.96	15141.56	3465.74	15184.82
				1.81%	0.29%
	Dairy products	1509.91	2984.34	1535.24	3010.55
				1.68%	0.88%
Poland	Cereals	275.63	3560.84	282.63	3552.93
				2.54%	-0.22%
	Meat	2615.13	6527.48	2658.85	6583.03
				1.67%	0.85%
	Dairy products	1055.02	1775.44	1074.76	1797.35
				1.87%	1.23%
Norway	Cereals	567.65	11808.82	492.15	11787.67
				-13.30%	-0.18%
	Meat	5022.97	16198.56	4988.26	16158.3
				-0.69%	-0.25%
	Dairy products	2273.07	4382.58	2237.78	4344.77
				-1.55%	-0.86%

Source: CAPRI.

[Analysis of the results about here.]

7 Limitations and potential solutions

8 Conclusions

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We thank NN for sharing data and models and ….
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The work was funded by … BMBF/BMELV grant xyvz ….

References

Suggestion: Please follow the format of Agricultural Systems (Elsevier) and include the DOI.

Link for Endnote Style is here: ftp://support.isiresearchsoft.com/pub/pc/styles/endnote4/Agricultural%20Systems.ens

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Strunk Jr., W., White, E.B., 2000. The Elements of Style, fourth ed. Longman, New York.

Reference to a chapter in an edited book:

Mettam, G.R., Adams, L.B., 2009. How to prepare an electronic version of your article, in: Jones, Smith, B.S., Miller, R.Z. (Eds.), Introduction to the Electronic Age. E-Publishing Inc., New York, pp. 281–304.

Appendix

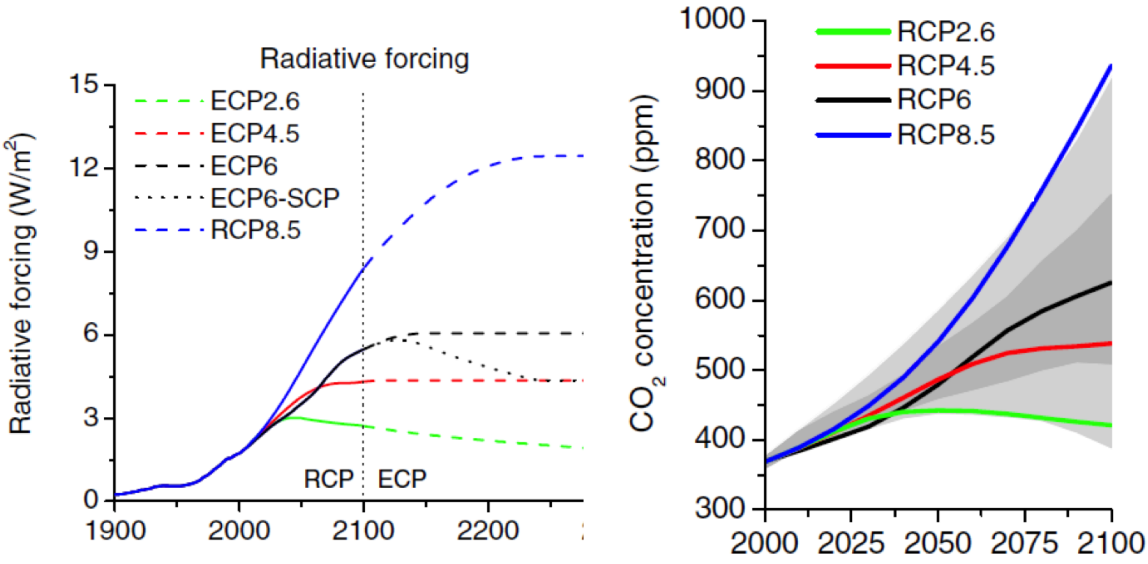

Figure 1. Relationship between global atmospheric CO2 concentration and radiative forcing charachterised by Representative Concentration Pathways (RCPs) and extended Concentration Pathways (ECPs) (figure contributed by M. Semenov)

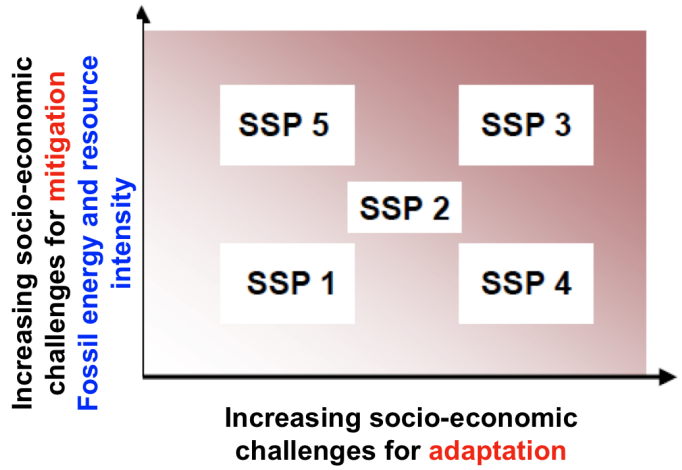

Figure 2. Groups of Shared Socioeconomic Pathways (SSPs) within a range of socioeconomic challenges for mitigation and adaptation (figure contributed by F. Piontek)

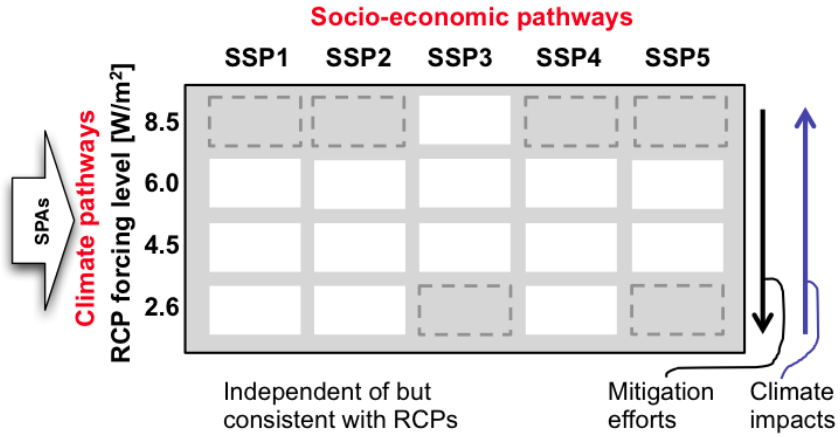

Figure 3. Different Shared Socioeconomic Pathways (SSPs) can explain different levels of radiative forcing in the Representative Concentration Pathways (RCPs) depending on the assumed future climate policies (SPA) (adapted from F. Piontek and Tom Kram)

Table 7: Summary of scenarios analyzed in the AgMIP project

Scenario code	SSP	RCP	GCM	Crop model	Bioenergy
S1	SSP2	Present climate	none	none	Model-specific
S2	**SSP3**	Present climate	none	none	Model-specific
S3	SSP2	**RCP8p5**	**IPSL-CM5A-LR**	**LPJmL**	Model-specific
S4	SSP2	**RCP8p5**	**HadGEM2-ES**	**LPJmL**	Model-specific
S5	SSP2	**RCP8p5**	**IPSL-CM5A-LR**	**DSSAT**	Model-specific
S6	SSP2	**RCP8p5**	**HadGEM2-ES**	**DSSAT**	Model-specific
S7	SSP2	Present climate	none	none	**1st-gen. ca. 6EJ; no 2nd-gen. (2050)**
S8	SSP2	Present climate	none	none	**1st-gen. ca. 6EJ; 2nd-gen. ca. 108EJ (2050)**

Source: (von Lampe et al., under review).

Table 8. Broad characterisation of SSP2 and SSP3

SSP2: "Continuation"	SSP3: "Fragmentation"
•Slowly decreasing fossil fuel dependency	•Regions of extreme poverty, pockets of moderate wealth, bulk of countries struggling to maintain living standards for strongly growing population
•Slowly decreasing fossil fuel dependency	•Little coordination between regional blocks of countries
•Reductions of resource and energy intensity	•Energy and food security within regions
•Uneven development of low-income countries	•De-globalization, severe restrictions on international trade
•Few weak global institutions	•Little international cooperation
•Slow continuation of globalization with some barriers remaining	•Low investments in technology development and education
•Well regulated information flow	•High population growth , low economic growth
•Medium economic growth, slow convergence	•Lack of governance and institutions
•High intra-regional disparities	
•Medium population growth related to medium educational investments	
•Delay of achievement of MDGs	

Source: (Köchy and Zimmermann, 2013).