Quantified SUSFANS scenario drivers ready to be used by the modeling toolbox

Deliverable No. 10.1

SUSFANS DELIVERABLES

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This deliverable quantifies the most relevant scenario narratives spanning across the range of future challenges for the EU sustainable FNS for use in the SUSFANS toolbox.

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DELIVERABLE SHORT SUMMARY FOR USE IN MEDIA

The overall objective of the work package 10 in SUSFANS is to provide foresight on the future development of sustainable food and nutrition security (SFNS) in the EU. This concept encompasses sustainable food systems and sustainable and balanced diets.

The future of SFNS in the EU will depend, on the development of contextual variables such as economic growth and climatic change, and on the responses of the agro-food system through innovation and policies.

The foresight will rely on the SUSFANS modeling toolbox consisting of shortterm and longterm economic models to provide quantitative projections of indicators defining the sustainability of the EU food system. The quantitative information will be complemented by qualitative narratives derived from the scenarios reviewed by SUSFANS stakeholders.

This deliverable represents a first step in the quantitative part of the foresight. Its main objective is to quantify the contextual variables to be used as input by models in

the SUSFANS Toolbox.

The foresight has been deliberately designed to focus on solutions in terms of (a) innovation pathways, elaborated in the case study supply chains of livestock-fish and fruits-vegetables; and (b) agro-food-nutrition policies. From this perspective, the contextual scenarios are rather a mean to the foresight than its final outcome.

Quantitative foresight on food security has been expanding rapidly. It was decided to build on existing narratives and quantified scenario drivers rather than to develop a completely new set of contextual scenarios.

A literature review of existing scenarios, and participatory analysis with the SUSFANS stakeholder core group, resulted in two decisions: first, to collate the narratives developed in previous EU projects into a single new set; second, to combine them with quantified scenario drivers from the Shared Socioeconomic Pathways (SSPs), which represents a consistent set of contextual or `indirect‘ drivers of the global food system.

Three contextual scenarios were selected for quantification. From the policy making perspective, it seemed important to develop a business as usual baseline, REF0, representing the reference scenario with respect to which the innovation pathways and policies can be tested. In order to test the robustness of the developed solutions with respect to less favourable socio-economic developments, a scenario representing high challenges for EU sustainable FNS was implemented, REF-. Finally, to take into account also the potential alternative of highly positive development in socio-economic parameters and their capacity to contribute to solve the EU sustainable FNS issues, a contextual scenario representing low challenges for the EU FNS, REF+, was also applied.

For the purpose of this deliverable three groups of contextual variables were considered:

1. Variables matched with the SUSFANS scenarios narrative: Population, Gross Domestic Product (GDP), Technological change, and International trade policies
2. Variables constant across the scenarios: Common Agricultural Policy and Common Fisheries Policy. These policies, and their potential improvements, are subject of detailed standalone analysis at a next stage of SUSFANS.
3. Variables with multiple potential values for each SUSFANS scenario: Climate change impacts and climate change mitigation policies. Due to large uncertainty both in estimates of climate change impacts and in the developments of climate policies.

TEASER FOR SOCIAL MEDIA

The main objective of this deliverable is to quantify the key assumptions for contextual variables to be used in the SUSFANS foresight, on: population growth, economic growth, food distribution inequality, technological change (crops and livestock), climate change impacts, climate change mitigation, policies (trade, agriculture, fisheries).

Sustainability of the EU food system depends also on drivers such as economic growth and climate change. We provide their detailed quantification for three plausible scenarios.

Foresight, contextual scenarios, EU food system

Online driver database (open access): http://susfans.eu/wp-10-foresight

ABSTRACT

This deliverable represents a first step in the quantitative part of the SUSFANS foresight. Its main objective is to quantify the contextual variables to be used as input by models in the SUSFANS Toolbox. The quantification builds on the narratives developed in the EU projects FOODSECURE and TRANSMANGO, and the quantified scenario drivers from the Shared Socioeconomic Pathways (SSPs), which represents a consistent set of `indirect‘ drivers of the global food system.

Key assumptions are quantified, with more detail for the EU and less detail for world, on: population growth, economic growth, food distribution inequality, technological change (crops and livestock), climate change impacts, climate change mitigation, policies (trade, agriculture, fisheries).

This deliverable consists of three interrelated parts:

Concept note:	SUSFANS foresight on sustainable food and nutrition security in Europe: Quantification of the contextual variables A non-technical summary of the motivation approach and assumptions in the foresight and driver quantification.
Annex 1:	Slide-set A visual summary of the main scenario assumptions and quantified drivers
Annex 2:	Supplementary data: open-access database on the main scenario assumptions An open-access database on the quantified contextual variables

This particular format has been selected to facilitate maximum interaction with external audiences around the set-up and assumptions of the SUSFANS foresight study.
Part A and B are included in the present document. Part C is available on the SUSFANS website.
Full, technical documentation on the foresight approach driver quantification will be made available in the final report on SUSFANS foresight.

1. INTRODUCTION

The overall objective of the work package 10 in SUSFANS is to provide foresight on the future development of sustainable food and nutrition security (SFNS) in the EU. This concept encompasses sustainable food systems and sustainable and balanced diets (Zurek et al., 2016).

The future of SFNS in the EU will depend, on the development of contextual variables such as economic growth and climatic change, and on the responses of the agro-food system through innovation and policies.

The foresight will rely on the SUSFANS modeling toolbox consisting of shortterm and longterm economic models to provide quantitative projections of indicators defining the sustainability of the EU food system. The quantitative information will be complemented by qualitative narratives derived from the scenarios reviewed by SUSFANS stakeholders.

This deliverable represents a first step in the quantitative part of the foresight (see Figure 1). Its main objective is to quantify the contextual variables to be used as input by models in the SUSFANS Toolbox.

The foresight has been deliberately designed to focus on solutions in terms of (a) innovation pathways, elaborated in the case study supply chains of livestock-fish and fruits-vegetables in WP5; and (b) agro-food-nutrition policies elaborated as a next step in WP10. From this perspective, the contextual scenarios are rather a mean to the foresight than its final outcome. Quantitative foresight on food security has been expanding rapidly. It was decided to build on existing narratives and quantified scenario drivers rather than to develop a completely new set of contextual scenarios.

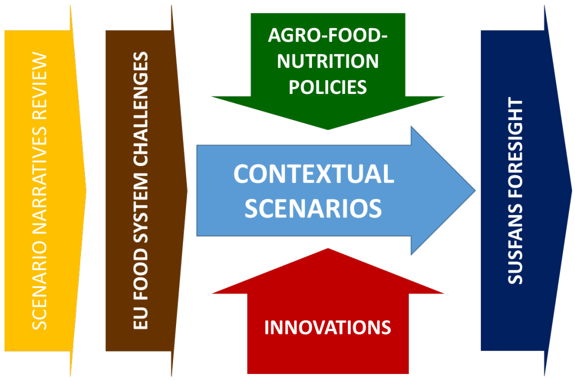


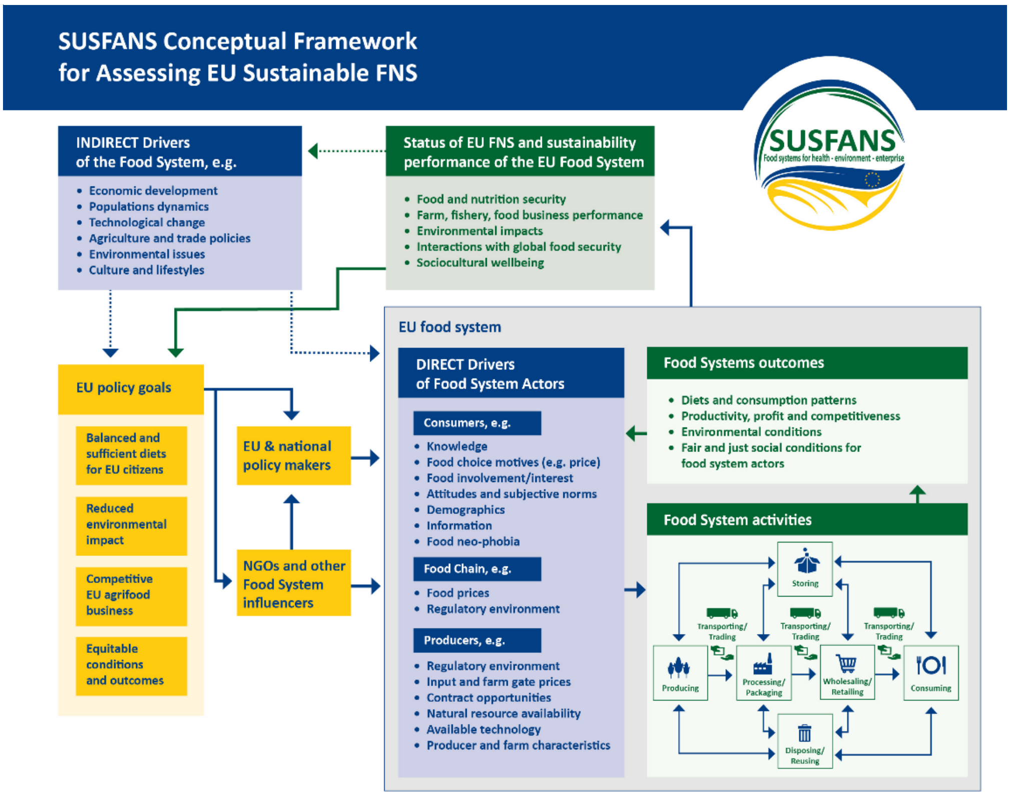
Figure 1. SUSFANS Foresight process

A literature review of existing scenarios, and participatory analysis with the SUSFANS stakeholder core group (Zurek, Vervoort and Hebinck, 2017) resulted in two decisions: first, to collate the narratives developed in the EU projects FOODSECURE (van Dijk *et al.*, 2016) and TRANSMANGO (Vervoort *et al.*, 2016) into a single new set; second, to combine them with quantified scenario drivers from the Shared Socioeconomic Pathways (SSPs), which represents a consistent set of contextual or `indirect‘ drivers of the global food system (see Figure 2, top left).

The SSPs (Riahi *et al.*, 2017) were developed by the scientific community initially to support climate change assessment within IPCC, but these scenarios progressively became the reference also in other assessments related to sustainability and global change, such as IPBES global assessment.

Three contextual scenarios were selected for quantification. From the policy making perspective, it seemed important to develop a business as usual baseline, REF0, representing the reference scenario with respect to which the innovation pathways and policies can be tested. In order to test the robustness of the developed solutions with respect to less favourable socio-economic developments, a scenario representing high challenges for EU sustainable FNS was implemented, REF-. Finally, to take into account also the potential alternative of highly positive development in socio-economic parameters and their capacity to contribute to solve the EU sustainable FNS issues, a contextual scenario representing low challenges for the EU FNS, REF+, was also applied.

Figure 2. The SUSFANS conceptual framework



For the purpose of this deliverable three groups of contextual variables were considered:

1. Variables matched with the SUSFANS scenarios narrative: Population, Gross Domestic Product (GDP), Technological change, and International trade policies
2. Variables constant across the scenarios: Common Agricultural Policy and Common Fisheries Policy. These policies, and their potential improvements, are subject of detailed standalone analysis at a next stage of SUSFANS.
3. Variables with multiple potential values for each SUSFANS scenario: Climate change impacts and climate change mitigation policies. Due to large uncertainty both in estimates of climate change impacts and in the developments of climate policies we opted for considering these variables as additional sensitivity analysis on the top of the main contextual variables.

Table 1. SUSFANS scenarios drivers quantification table. Definition of the contextual scenarios in terms of the corresponding narrative scenarios and sources of quantified driver values as proposed in deliverable D6.2 (Zurek et al. 2017), with a complete list of the contextual variables

	Baseline REF0	**High challenges to EU FNS REF-**	**Low challenges to EU FNS REF+**
Scenario narrative	Stakeholder Scenario 1	Stakeholder Scenario 4 & 6	Stakeholder Scenario 7
Socio-economic variables			
Population	EU reference / SSP2	SSP3	SSP1
Economic growth	EU reference / SSP2	SSP3	SSP1
Dietary energy consumption distribution	SSP2	SSP3	SSP1
Crop yield growth	CAPRI baseline / SSP2	SSP3	SSP1
Feed conversion efficiency growth	SSP2	SSP3	SSP1
Policy variables			
Trade policy: Ad valorem equivalents	Current	Current +50%	Current –50%
CAP: Producer support		Current policies	
CFP: Aquaculture capacity		Current policies	
CFP: Fishery capacity		Current policies	
Climate variables			
Carbon price		RCP2p6, RCP4p5, RCP6p0, noMITIG	
Forest area		RCP2p6, RCP4p5, RCP6p0, noMITIG	
Biomass for energy supply		RCP2p6, RCP4p5, RCP6p0, noMITIG	
First generation biofuels		RCP2p6, RCP4p5, RCP6p0, noMITIG	
Crop yield change		RCP2p6, RCP4p5, RCP6p0, RCP8p5	
Crop yield change		Historical, Plus1p5, Plus2p0	

2. DRIVER QUANTIFICATION

In what follows we briefly document the quantification of the individual contextual variables.

Population. KC and Lutz (2017) provided quantification of future population developments consistent with SSPs by sex, age and education level for each country globally up to 2100. This data is available from the IIASA SSP Database (https://tntcat.iiasa.ac.at/SspDb/dsd?Action=htmlpage&page=welcome) and was directly used for quantification of population developments of the three SUSFANS contextual scenarios. In order to increase relevance of the quantification for EU FNS assessment, population projections from the EU Reference scenario 2016 developed for assessment of trends in energy and GHG emissions up to 2050 (EC, 2016a) were used for REF0 in the EU countries. For REF-/REF+ the EU REF0 values were shifted by the relative difference between SSP2 and SSP3/SSP1.

Economic growth. Similarly as for population development, economic growth projections have already been carefully quantified for the SSPs by Dellink *et al.* (2017) and are available from the IIASA SSP Database. For the EU, we followed the same procedure based on EC (2016a).

Inequality. At the time of preparation of this deliverable, no dataset representing income inequality consistent with the SSPs was available for EU. In order not to miss this important aspect completely, we have included in the SUSFANS drivers database the coefficient of variation of dietary energy consumption distribution across population at country level. This parameter, together with the average dietary energy consumption, allows at least to calculate the indirect effects of EU food system change on the prevalence of undernourishment in developing countries following the methodology of FAO (2008). Hasegawa *et al.* (2015) estimated projections of the coefficient of variation consistent with the different SSPs, and this quantification has also been used for the SUSFANS contextual scenarios.

Technological change. Crop yields and feed conversion efficiencies have been identified as the key variables characterizing technological change in the contextual scenarios. Crop yield projections for six main European and global crops – barley, maize, rapeseed, rice, soybean, wheat – have been quantified. Global crop yield projections for SSPs were estimated based on statistical relationship between country level yields and GDP per capita in the EU project ANIMALCHANGE (Havlík *et al.*, 2012). EU crop yield projections for REF0, were informed by the baseline yield projections from CAPRI and adapted for the REF-/REF+ scenarios by the relative difference between the SSP projected yields for SSP3/SSP1 compared to SSP2. Feed conversion efficiency projections for REF0 for pigs and poultry, and for dairy, beef and small ruminant meat were also quantified as part of the ANIMALCHANGE project (Soussana *et* *al.*, 2012) based on past trends and biophysical feasibility.

International trade policies. Trade policy instruments applied in the EU and in the rest of the world were summarized in the form of applied ad valorem equivalents based on information in the CAPRI database. For REF0, the ad valorem equivalents were considered constant. In the high challenges scenario REF-, existing tariffs were increased by 50%, and 10% tariffs were introduced for commodities, that had no ad valorem equivalent tariff in REF0. In REF+, existing tariffs were reduced by 50%.

Agricultural policies. EU Common Agricultural Policy (CAP) consists of a very diverse set of measures, which are represented in the models belonging to the SUSFANS toolbox in different ways, depending on the model structure and focus. In order to allow for a minimum level of harmonization in the contextual scenarios setup, the value of different CAP support measures were summarized for the SUSFANS Drivers Database into a single premium value expressed per hectare of utilized agricultural area based on CAPRI model data. Scenarios for CAP reform and other policies scenarios will be introduced in a forthcoming SUSFANS foresight report on policies.

Fisheries policies. Considering the structure and needs of the modelling toolbox, these policies were quantified as contextual variables in the form of capture fisheries and aquaculture capacity development at the level of ten species aggregates. EU Common Fisheries Policy (CFP) affects capture fisheries capacity in several ways, including through the introduction of a legal obligation for member states to achieve Maximum Sustainable Yield (MSY) for all stocks fished by 2020, and the gradual introduction of a landing obligation for species/stocks with a quota, to be fully implemented by 2019. At the same time, growth in EU aquaculture production is promoted (EC 2013) and member states are encouraged to set up multiannual plans to develop aquaculture. The quantification of future fisheries capacity was based on the GLOBIOM database in combination with Guillen *et al.* (2016), and for aquaculture, the Multiannual National Aquaculture Plans (EC, 2016b) were directly used.

Climate change impacts. Four alternative GHG emissions scenarios were considered to quantify climate change impacts related to the gradual climate change: these Representative Concentration Pathways, or RCPs (van Vuuren et al. (2011)), map a wide range of potential global warming, from less than +1.5 °C to more than +4 °C compared to pre-industrial levels. In order to map the uncertainty coming from global climate models, all five models selected within the ISI-MIP project (Warszawski *et al.*, 2013) were retained. Finally, the climate change impacts on crop yields simulated with the crop growth model EPIC, with a sensitivity analysis with respect to the CO_2 fertilization effect, were used (Leclère *et al.*, 2014). For quantification of climate change impacts on yield variability and the resulting market volatility, outputs of the HAPPI project were used. HAPPI was designed with the aim to assess the benefits of moving from the traditional climate change stabilization target of 2 °C above pre-industrial levels, to the 1.5 °C target stipulated by the 2015 Paris Agreement, with focus on assessment of extreme weather events such as droughts (Mitchell et al., 2017). Here we use results from the EPIC model available for three experiments, i.e. historical, 1.5 °C temperature increase, and 2 °C temperature increase; four climate models; 20 ensembles of each of the climate models; and CO_2 sensitivity (Schleussner *et al.*, submitted). For the quantification of contextual scenarios, the three experiments were summarized in terms of median, lower and upper quartiles, and the minimum and maximum values.

Climate change mitigation policies. Ambitious climate stabilization targets will likely require anthropogenic emissions turning negative. The land use sectors, on the one hand, contribute 25% of anthropogenic greenhouse gas emissions, and on the other hand, provide the only widely considered sources of negative emissions – carbon sequestration in biomass and soils, and bioenergy production with carbon capture and storage (BECCS). From this perspective, the relevant contextual variables are carbon price, forest area developments, and biomass supply for energy generation. The quantitative values consistent with different levels of the climate change stabilization, RCPs, were taken from the SSP2 scenario family as estimated by the MESSAGE-GLOBIOM integrated assessment modeling framework (Fricko *et al.*, 2017). However, for the sensitive case of first generation biofuels, we used for all the RCPs the baseline values from Lotze-Campen *et al.* (2014).

SUSFANS Drivers Database. For practical use in the SUSFANS toolbox, the projected values of the above discussed variables going up to 2050, have been included in the SUSFANS Drivers Database. The database is available online (http://susfans.eu/wp-10-foresight) in two formats: Microsoft Office Excel for fast access and quick overview by SUSFANS partners, stakeholders, and by the public, and CSV files for direct use by modelers.

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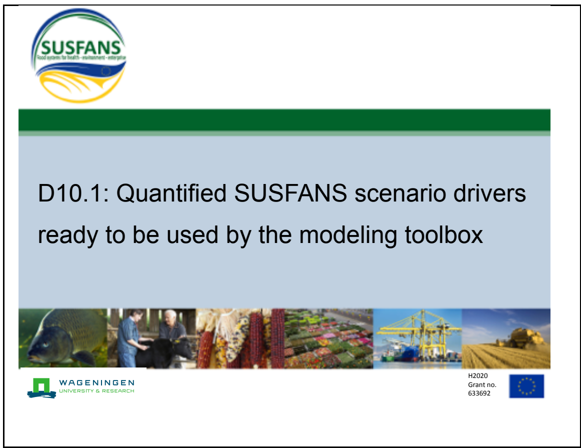
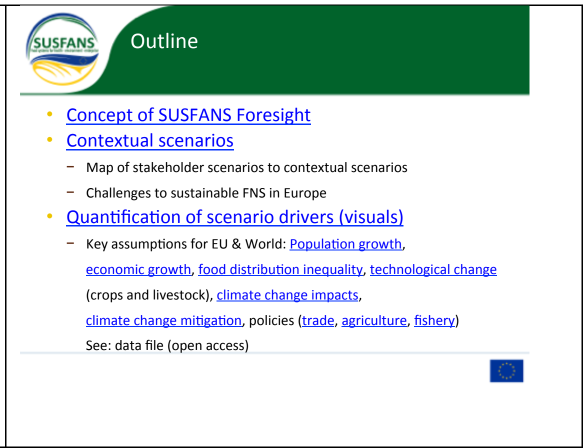
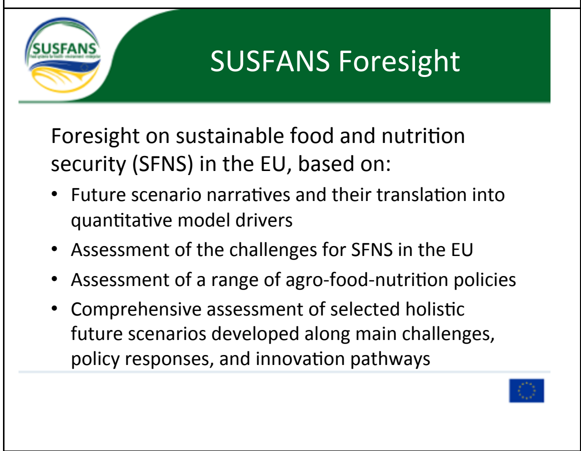
ANNEX I

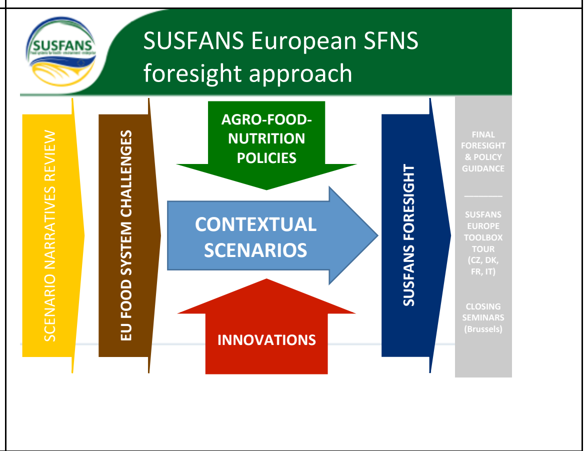
PowerPoint Presentation (PPT) :

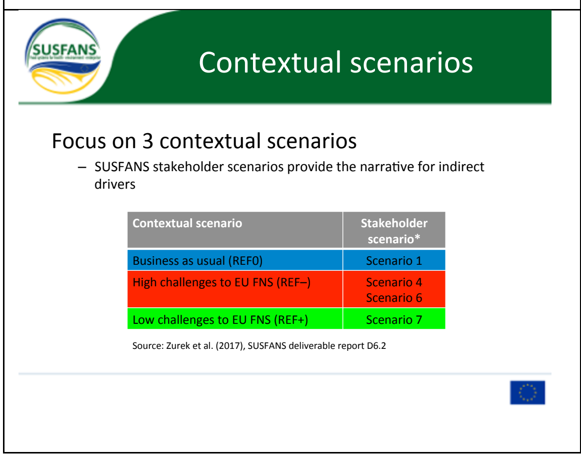
Quantified SUSFANS scenario drivers ready to be used by the modeling toolbox

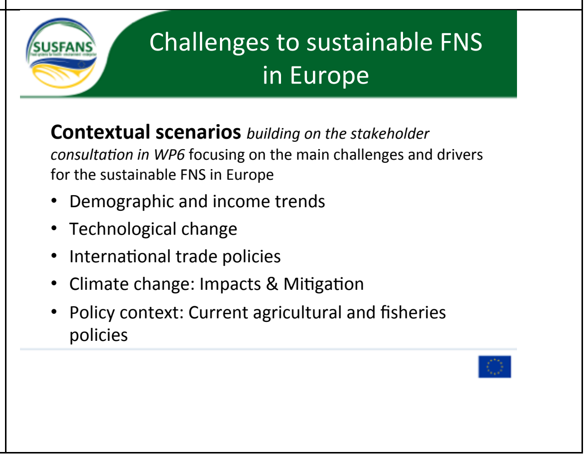












Quantification of scenario drivers

- Overview of the quantified driver variables included in the database and main scenario relevant assumptions

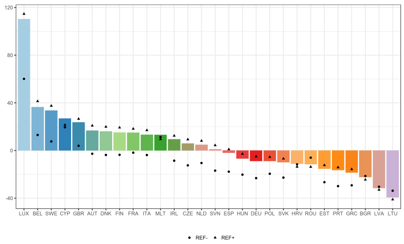
			Baseline REF0	High challenges for EU FNS REF-	Low challenges for EU FNS REF+
Scenario narrative			Stakeholder Scenario 1	Stakeholder Scenario 4 & 6	Stakeholder Scenario 7
Quantitative drivers		Unit			
Demographic trends	Population	Million	EU reference / SSP2	SSP3	SSP1
Income trends	GDP	USD Billion	EU reference / SSP2	SSP3	SSP1
Inequality	Dietary energy consumption distribution				
Technological change	Crop yield growth	Index (2010=1)	CAPRI baseline / SSP2	SSP3	SSP1
	Feed conversion efficiency growth	Index (2010=1)	SSP2	SSP3	SSP1
International trade policies	Ad valorem equivalents	%	Current	Current +50%	Current -50%
Agricultural policies	Producer Support	Euro/ha		Current policies	
Fisheries policies	Aquaculture Capacity	Million Tons		Current policies	
	Fishery Capacity	Million Tons		Current policies	
Climate change mitigation policies	Carbon price	USD/tCO2eq		RCP2p6, RCP4p5, RCP6p0, noMITIG	
	Forest area	Million Ha		RCP2p6, RCP4p5, RCP6p0, noMITIG	
	Biomass for energy supply	EJ		RCP2p6, RCP4p5, RCP6p0, noMITIG	
	First generation biofuels	EJ		RCP2p6, RCP4p5, RCP6p0, noMITIG	
Climate change impacts - trend	Crop yield change	Index (No CC =1)		RCP2p6, RCP4p5, RCP6p0, RCP8p5	
Climate change impacts - variability	Crop yield change	Index (No CC =1)		Historical, Plus1p5, Plus2p0	

Population growth

- Population projections consistent with the SSP storylines from KC and Lutz (2017)
- Dataset available from IIASA SSP database, including differentiation by sex, age and education
- For EU, business as usual scenario fitted to the EC (2016a) reference scenario. Alternative scenarios calculated using the relative difference between SSP2 and SSP1 or SSP3

Population growth: EU

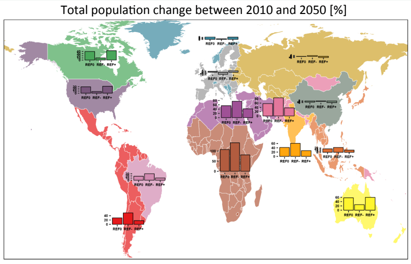
Total population change between 2010 and 2050 in REF0 (bars) [%]



Source: Own calculations based on EC (2016a), KC and Lutz (2017, IIASA SSP Database)

Population growth: World

Total population change between 2010 and 2050 [%]



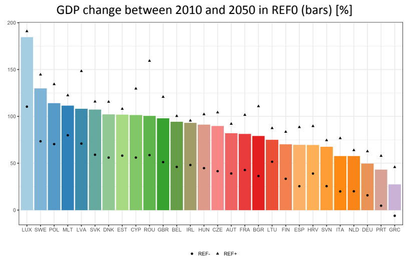
Source: Own calculations based on EC (2016a), KC and Lutz (2017, IIASA SSP Database)

Economic growth

- GDP projections consistent with the SSP storylines from Dellink et al. (2017)
- Dataset available from IIASA SSP database
- For EU, business as usual scenario fitted to the EC (2016a) reference scenario. Alternative scenarios calculated using the relative difference between SSP2 and SSP1 or SSP3

Economic growth: EU

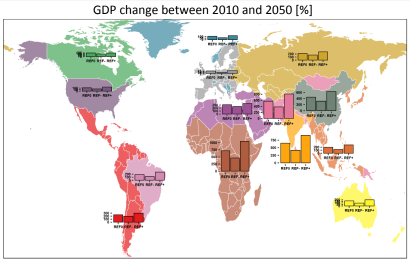
GDP change between 2010 and 2050 in REF0 (bars) [%]



Source: Own calculations based on EC (2016a), Dellink et al. (2017, IIASA SSP Database)

Economic growth: World

GDP change between 2010 and 2050 [%]



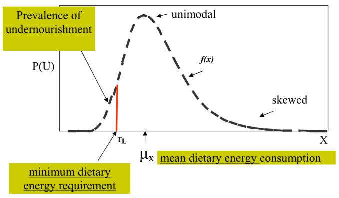
Source: Own calculations based on EC (2016a), Dellink et al. (2017, IIASA SSP Database)

Food distribution inequality

- Within a single country unequal distribution of food calories across population leads to co-existence of undernourishment and overconsumption
- The distribution is summarized through coefficient of variation (CV) following FAO (2008)
- Projected CV numbers consistent with SSP scenarios from Hasegawa et al. (2015)
- This driver is particularly important for global food security assessment

Food distribution inequality

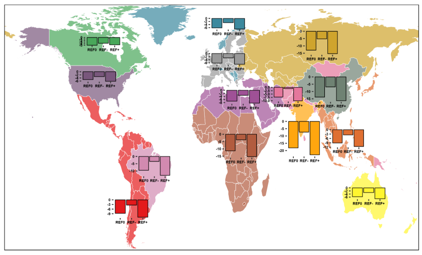
Theoretical distribution of dietary energy consumption



Source: FAO (2008)

Food distribution inequality

Change in CV of the dietary energy consumption between 2010 and 2050 in [%]



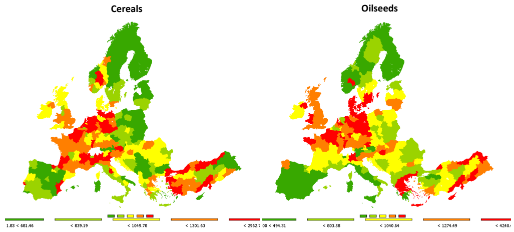
Source: Own calculations based on Hasegawa et al. (2015)

Technological change

- Focus on crop yields and feed conversion efficiencies
- 6 major EU/World crops: Barley, Maize, Rapeseed, Rice, Soybean, Wheat
- Projections for EU REF0 taken from CAPRI model baseline
- Projections the other scenarios and the rest of the world based on past relationships between GDP growth and crop yield developments as described in Havlík et al. (2012)

Crop yields: EU

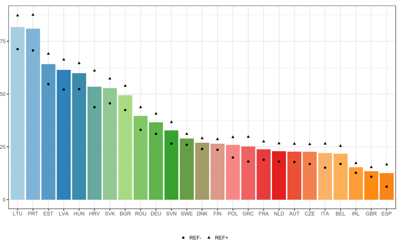
Yield change between 2010 and 2050 in REF0 [kg/ha]



Source: CAPRI model baseline

Crop yields: EU

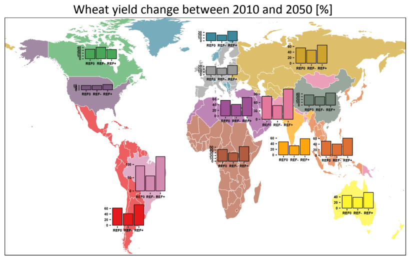
Wheat yield change between 2010 and 2050 in REF0 (bars) [%]



Source: Own calculations based on CAPRI model baseline and Havlík et al. (2012)

Crop yields: World

Wheat yield change between 2010 and 2050 [%]



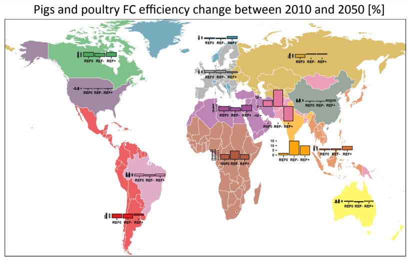
Source: Own calculations based on CAPRI model baseline and Havlík et al. (2012)

Feed conversion efficiency

- Feed conversion efficiency for two product aggregates
  - Pigs and poultry
  - Beef, dairy, and sheep and goat products
- REF0 projections based on historical developments derived from FAOSTAT in the EU project ANIMALCHANGE (Soussana et al. 2012)
- Alternative contextual scenario quantification based on the relative difference between these scenarios and REF0 for crop yields

Feed conversion efficiency

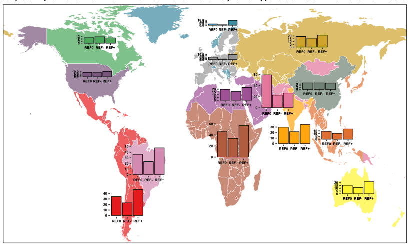
Pigs and poultry FC efficiency change between 2010 and 2050 [%]



Source: Soussana et al. (2012)

Feed conversion efficiency

Beef, dairy and small ruminants FC efficiency change between 2010 and 2050 [%]



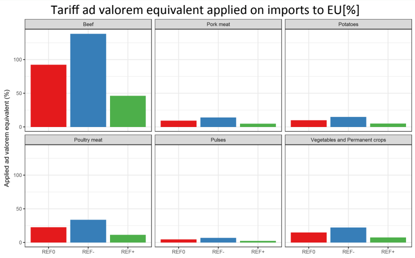
Source: Soussana et al. (2012)

International trade policies

- Protection of EU farmers if applied on imports from the RoW but reduced opportunities for EU farmers when applied on imports from EU elsewhere
- For quantification in the SUSFANS Toolbox, international trade policies represented through ad valorem equivalents
- For REF0, current values calculated from CAPRI model database and kept constant
- For REF-/REF+, ad valorem equivalents by 2050 increased/ reduced by 50%. Minimum 10% tariff introduced in REF- on all products

International trade policies

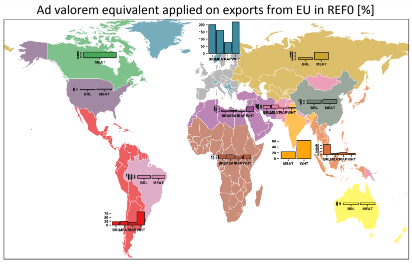
Tariff ad valorem equivalent applied on imports to EU[%]



Source: Own calculations based on CAPRI model baseline

International trade policies

Ad valorem equivalent applied on exports from EU in REF0 [%]



Source: Own calculations based on CAPRI model baseline

Common Agricultural Policy
(2014-2020)

Pillar I – Market Organization and Income support

- Basic payment scheme - a flat rate payment per hectare of agricultural land
- Greening measures – for compliance with environment freindly farming prcatices
  - diversifying crops
  - maintaining permanent grassland
  - dedicating 5% of arable land to 'ecological focus areas'
- Young farmer scheme (YFS), Voluntary coupled support (VCS), Small farmer's scheme, Payment to farmers in areas of natural constraint (ANC)

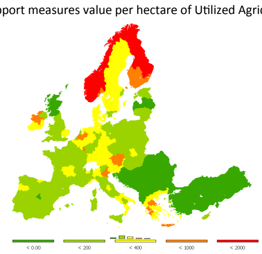
Common Agricultural Policy
(2014-2020)

Pillar II – Rural development

- Themes: Competitiveness, Environment and Diversity
- Diverse set of measures, selection and implementation by Member States within frame, e.g.
  - Physical investments support, Restoration of agricultural production potential, Agri-environment-climate measure, Risk management toolkit,…
- Measures from Pillar I & II summarized for scenario quantification in an aggregate premium per hectare of utilized agricultural area based on CAPRI database

Common Agricultural Policy
(2014-2020)

Aggregate CAP support measures value per hectare of Utilized Agricultural Area [euros]



Source: CAPRI model database

Common Fisheries Policy
(2013)

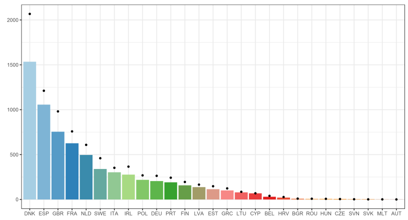
- All fished stocks shall be fished following Maximum Sustainable Yield by 2020
- Landing obligation fully implemented 2019 for all species/stocks under EU TAC management (= stocks that have a quota)
- Expand aquaculture sustainably (species with low feed requirements and/or innovative feed ingredients and compositions)

Common Fisheries Policy
(2013)

- In the contextual scenarios, EU capture capacity is assumed to be constant over 2000-2010
- Starting in 2020 and through 2050, EU capture fisheries are assumed to operate at the Maximum Sustainable Yield as defined in Guillen et al. (2016)
- EU aquaculture capacity for 2000-2014 calibrated to the available historical data of aquaculture production (FAO, 2017)
- EU aquaculture capacity increase over 2015-2050 is quantified based on the published Multiannual National Aquaculture Plans of the individual EU countries (EC, 2016b)

Common Fisheries Policy
(2013)

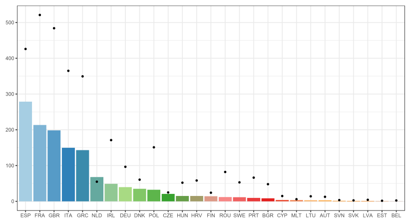
Capture fisheries capacity in 2010 (bars) and 2050 (dots) [1000 tons]



Source: Own calculations based on Guillen et al. (2016)

Common Fisheries Policy
(2013)

Aquaculture capacity in 2010 (bars) and 2050 (dots) [1000 tons]



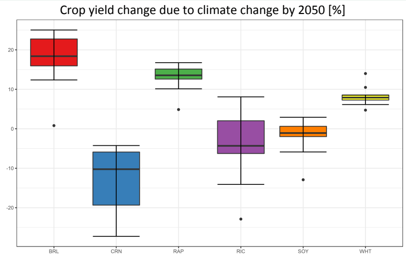
Source: Own calculations based on the EU countries' Multiannual National Aquaculture Plans

Climate change impacts

- Climate change affects crop yields by gradual change in weather patterns as well as by potential change in frequency and severity of extreme weather events
- For gradual change, climate change impact projections by the crop growth model EPIC from the 1st phase of the ISI-MIP project are used for
  - 4 Representative Concentration Pathways
  - 5 Global Climate Models
  - CO_2 fertilization sensitivity

Climate change impacts: EU

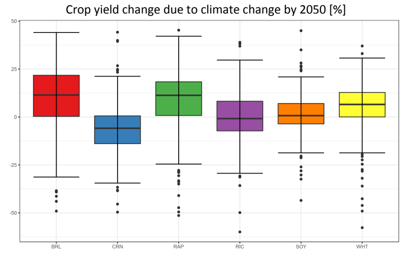
Crop yield change due to climate change by 2050 [%]



Source: Source: EPIC calculations from ISI-MIP Fast Track (Leclère et al. 2014)

Climate change impacts: World

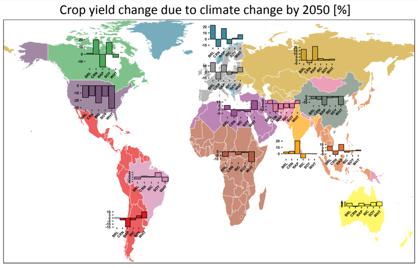
Crop yield change due to climate change by 2050 [%]



Source: Source: EPIC calculations from ISI-MIP Fast Track (Leclère et al. 2014)

Climate change impacts: World

Crop yield change due to climate change by 2050 [%]



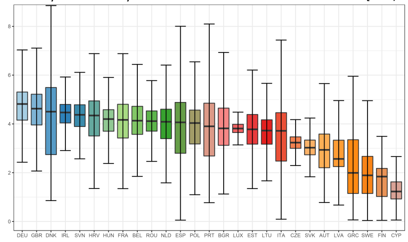
Source: EPIC calculations from ISI-MIP Fast Track (Leclère et al. 2014)

Climate change impacts

- Even with climate change stabilization at 1.5 degree above the pre-industrial age as stipulated by the 2015 Paris Agreement, the frequency of extreme weather events could substantially increase
- HAPPI project developed climate scenarios aiming to facilitate the extreme weather events assessment (Mitchell et al. 2017)
- Impact models, were used in HAPPI to quantify the impacts on different sectors, including crop yields
- SUSFANS uses crop yield simulations from the GEPIC model to inform the future variability in yields (Schleussner et al., submitted)

Climate change impacts: EU

Wheat yield variability under the HAPPI historic climate scenarios [tons/ha]



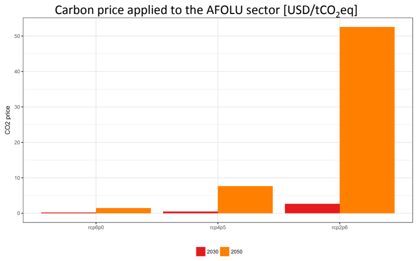
Source: GEPIC calculations from HAPPI project (Schleussner et al. submitted)

Climate change mitigation

- Ambitious mitigation pathways largely rely on land sector related mitigation from
  - Agricultural emissions reduction
  - Carbon sequestration in biomass and soil
  - Biomass supply for energy production
- The relevant drivers of FNS assessment through the SUSFANS toolbox are carbon price, forest area development, and biomass demand
- Integrated Assessment Model based mitigation pathways corresponding to RCP2p6, RCP4p5, and RCP6p0 under SSP2-SPA2 are used for quantification of the drivers

CC mitigation: Carbon price

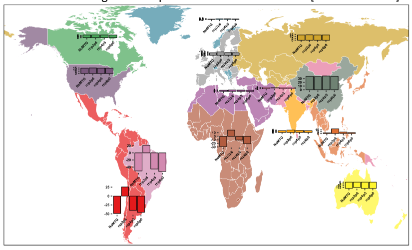
Carbon price applied to the AFOLU sector [USD/tCO_2eq]



Source: MESSAGE-GLOBIOM (Fricko et al. 2017)

CC mitigation: Forests

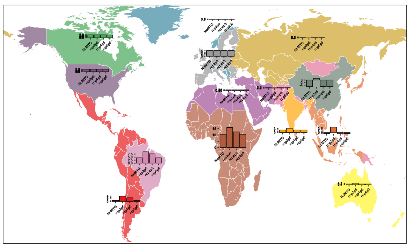
Forest area change in RCP2p6 between 2010 and 2050 [million hectare]



Source: MESSAGE-GLOBIOM (Fricko et al. 2017)

CC mitigation: Bioenergy

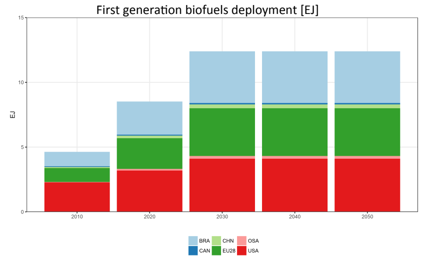
Biomass supply for energy production in RCP2p6 by 2050 [EJ]



Source: MESSAGE-GLOBIOM (Fricko et al. 2017)

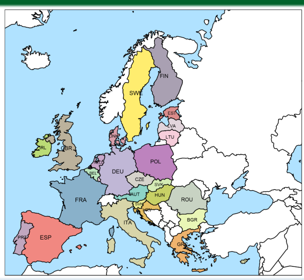
CC mitigation: 1st Gen Biofuels

First generation biofuels deployment [EJ]



Source: AgMIP (Lotze-Campen et al. 2014)

EU country labels



SUSFANS scenario drivers database

Online database accessibility

Title	filetype
WP 10: SUSFANS Drivers Metadata (XLSX)	xls (EXCEL)
WP10: SUSFANS Drivers Database (XLSX)	xls (EXCEL)
WP10: SUSFANS Drivers Database (ZIP)	zip (compressed CSV)

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ANNEX II

Link to online driver database (open access):

http://susfans.eu/wp-10-foresight