European Shared Socioeconomic Pathways

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IMPRESSIONS – Impacts and Risks from High-End Scenarios: Strategies for Innovative Solutions (www.impressions-project.eu)

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Preface

The overall objective of WP2 is to develop multi-scale, integrated climate and socio-economic scenarios for five case studies (global/central Asia, Europe, Scotland, Iberia and Hungary), including high-end climate change scenarios and more extreme socio-economic scenarios. In this document we report the European socio-economic scenarios. Important elements included, for each scenario, are:

- A storyline
- One table with key elements
- and one with trends for key variables (in Annex)
- Preliminary top-down and bottom-up quantifications (in Annex)

1. Introduction on the European SSPs

This is a first draft of European SSPs, based on a mix of CLIMSAVE scenarios for Europe until the 2050s, the global SSPs until 2100, and material produced during an IMPRESSIONS meeting in Wageningen in January 2015 where CLIMSAVE scenarios were matched with global SSPs. The degree of detail differs by scenario and depends largely on the degree to which the CLIMSAVE scenario matched with one of the global SSPs.

As with the global SSPs, the EU-SSPs come in three parts, namely qualitative stories, tables with an overview of dynamics of key elements, and quantitative numbers. This document focuses on the narratives and key elements. The Annex presents an overview of other results from the meeting in Wageningen, related to qualitative estimates of model input parameters.

2. Qualitative stories

2.1 European SSP1 – We are the World

There is a high commitment to achieve sustainable development goals through effective governments and global cooperation, ultimately resulting in less inequality and less resource intensive lifestyles

2010-2040: The financial crisis continues to have strong repercussions and EU leaders are forced towards further integration of European financial and fiscal policies. The interplay of financial, environmental, and economic crises fuel the feeling that behaviour has to change away from an unregulated market-driven economy to a sustainable development path. This puts governments under pressure to take ambitious measures, including stimulating an energy transition towards renewables and facilitating innovative research, accompanied by investments in health, education, and social support. These investments are at the expense of somewhat slower economic growth and initially meet with some resistance. Eventually, system of national accounts is in place that essentially adopts a basket of well-being based performance measures instead of GDP. The resulting

higher quality of life and a growing feeling of security and safety are eventually embraced. In Europe and worldwide, trade wars and other economic crises are addressed increasingly effectively by multi-level governance configurations. Investment in green technologies and geo-engineering increases rapidly, focusing on renewables and energy efficiency. By 2040, efforts to transform Europe to a sustainable society are now starting to pay their dividends, reinforced by gradually changing lifestyles.

2040-2070: A decrease in conflicts in Europe's Southern and Eastern border regions leads to higher political stability and moderate but steady economic growth in an increasingly equitable Europe, which allows for the middle class to grow stronger. The European Union expands further and participates in new global governance initiatives. The larger EU takes responsibility for addressing its environmental impacts in the border regions and leads investments that help pursuing sustainable development goals in those regions. As a result, migration towards Europe starts to decline for the first time this century. There is a substantial shift in the European political agenda with a greater focus on well-being than economic growth, driven by human losses associated with climate change combined with positive improvements in accessible education and lifestyle. Advances in green technologies are further stimulated by international competition leading to a CO_2 neutral society by 2050.

2070-2100: Worldwide, consumption is now oriented toward low material growth and low resource and energy intensity. This results from the development of new technologies with radically reduced resource consumption and a strong increase in the use of renewable energy sources, facilitated by new flexible global, regional and national institutions that enhance international cooperation. Supported by a continued steady economic development and the strong middle class, economic and social inequality further decrease. By 2100, Europe is characterised by a high level of sustainability oriented political and societal awareness, focusing on renewable energy and low material growth in a strongly regulated but effective multi-level governance structure. International cooperation is strong, particularly with Asia.

2.2 European SSP3 – Icarus

Sparked by economic woes in major economies and regional conflict, antagonism between and within regional blocs increases, resulting in the disintegration of social fabric and many countries struggling to maintain living standards. Ultimately, a high-carbon intensive Europe emerges with high inequalities predominantly between but also within countries.

2010-2040: With the economy gradually picking up, the demand for resources increases, which turns out to be a tipping point for the state of the environment with severe ecosystem failures. At the same time, the world economy does not perform as expected with new crises across the European Union that stress the structural differences across and within Member States. Populist movements become increasingly mainstream and are further fuelled by increasing riots in multicultural neighbourhoods. The persistence of conflicts and decline in trade also substantially increases energy and food prices, while initiating a massive build-up of the defense sector, which is resource hungry but not resource efficient. Extreme weather events become more frequent and further increase the costs of resources, damage control and defensive measures; this causes the economy in Europe to start to stagnate. This, in turn, increases unemployment rates and leads to the phasing out of the social security system. In light of increasingly scarce public resources, long-term policy planning

becomes rare with hardly any money for education, research or innovation. Eventually the EU breaks down.

2040-2070: Continuing negative social, environmental, and economic developments widen the gap between the poorer countries and regions particularly in the periphery of Europe and the richer, larger, countries that maintain a decent level of social, economic, and political stability. With the disintegration of social fabric, Europeans in the poorer regions increasingly migrate in search of jobs, and are employed in countries that are somewhat better off, for relatively low wages. Most migration is within Europe. Eventually, new regional blocs are formed in the north and in the south of Europe, while new alliances with other countries are forged to ensure sufficient energy supply. By 2070, social counter-movements appear with some signs of a slight economic recovery and increased social cohesion. Yet, these signs are temporary and do not take root in a fragmented and divided Europe with strong regional rivalry and conflict. The general lack of economic resources and therefore of means to afford new technologies, coupled with weak institutions and governance structure, leads to an increasing resource intensity and fossil fuel use.

2070-2100: In the absence of strong (inter)national institutions, criminal organisations and corruption take hold, in the aftermath of failed counter movements. Europe has lost its leading position, reinforced by difficulties to re-establish effective collaborations. The far-reaching fragmentation and cultural diversity have triggered a brain drain with the well-educated migrating to regions outside Europe that offer (slightly) better possibilities. Eventually, Europe is not worse off than the rest of the world, but struggles not to become the world's backwater as new clean technologies are increasingly developed elsewhere and affordable only for the richer Member States. These ensure clean water, clean energy and health for those countries. However, the majority accept political instability and social injustice and learn to live with less.

2.3 European-SSP4 – Riders on the Storm

Globally, power becomes more concentrated in a relatively small political and business elite, accompanied by increasing disparities in economic opportunity, leading to substantial proportions of populations having a low level of development. However, Europe becomes an important player in a world full of tensions due to successful green technologies, despite the growing inequalities both across and within countries.

2010-2040: Sparked by the economic crisis and extreme weather events, the EU increases commitment to find innovative solutions to the depletion of natural resources and climate change. In combination with current relatively high levels of social cohesion, energy efficiency and environmental policy-making this initiates a shift towards a high-tech green Europe. This transformation is strongly supported by large businesses that successfully seek collaboration with the increasingly powerful European government. Eventually, average wealth starts to increase as crises are successfully combatted. At the same time, the centralised public-private partnerships and related policies result in increased social disparities within countries.

2040-2070: Technology development is strong in the high-tech economy and sectors. Energy companies hedge against price fluctuations through diversifying their energy sources, with investments in both carbon-intensive fuels like coal and unconventional oil, but also low-carbon energy sources. New high-tech sectors are growing in importance and gradually become the backbone of an economically strong Europe. At the same time, however, inequalities are rising because of a number of simultaneously acting factors. These include skill-based technology development; highly unequal investments in education; and less affluent groups having increasingly weak political power and limited access to credit. Together, these increasing disparities in economic opportunities and political power lead to increasing inequalities and stratification both across and within countries. The traditionally strong middle class decreases in influence but only slightly in numbers. By 2070, there is a large and widening gap between an internationally-connected society that is well educated and contributes to knowledge- and capital-intensive sectors of the global economy, and a more fragmented collection of lower- income societies that work in a labour intensive, low-tech economy, mostly in the service sector for the benefit of the elite. Despite a strong EU, power becomes increasingly concentrated in a relatively small political and business elite, while vulnerable groups have decreasing representation and influence. Among others, this results in increased conflicts in poorer regions of Europe and migration flows to safer areas, which become protected and clean `islands'. Migration flows into Europe are highly controlled by the elite, but Europe increasingly attracts illegal immigrants competing for decreasingly available low-skilled jobs.

2070-2100: Europe has become a market leader in (green) technologies, because of long-term under-investment in new resources in many other regions of the world related to uncertainty in fossil fuel markets. Protected by a strong elite, the a small "connected" upper class benefits with high-skilled workers moving easily across countries to tap into new business opportunities. The elite becomes increasingly separated from other social classes, importantly from the now quickly dwindling middle class. A large share of the population, however, does not benefit from technological breakthroughs and does not profit from alliances between big business and the political elite. This results in deepening inequalities within and among countries across Europe. With

decreasing public funding, good education is only accessible to those who can afford it. Technological development has not resulted in reduced energy prices, but has instead established an oligarchy of green business developers that control energy supply and reduce resource availability for the majority. As a governing body, the European Union is strong with strong ties with the lobbying industry. Social cohesion, however, is now low and stratified, while human health has decreased for most. By 2100, Europe is an important player in a world full of tensions, but with growing inequalities across and within European countries.

2.4 EU-SSP5 – Fossil-fuelled Development

Globally, driven by the economic success of industrialised and emerging economies, people in this world place increasing faith in competitive markets, innovation and participatory societies to produce rapid technological progress and development of human capital as the path to sustainable development. A lack of environmental concern leads to the exploitation of abundant fossil fuel resources. In Europe, innovations likewise lead to a large return on investment and increased social equity and health, also through overuse of non-renewable resources. Resulting environmental degradation is of secondary importance, but partly addressed by technological solutions.

2010-2040: Global markets are increasingly integrated, with interventions focused on removing institutional barriers to the participation of disadvantaged population groups. There are also strong investments in health, education, and institutions to enhance human and social capital. At the same time, the push for economic and social development is coupled with the exploitation of abundant fossil fuel resources. In the aftermath of the economic crises in Europe, there is a slow shift towards market deregulation, resulting in a strong labour market and increased purchasing power. This results in a decrease in political unrest. Of particular importance for Europe is the large-scale extraction of shale gas, which further stimulates economic wealth, part of which is used to stimulate the development of (green) technologies. Europe regains its leading position in the global economy, which further contributes towards a focus on economic growth and export markets rather than environmental policies. Nuclear energy is slowly phased out everywhere in Europe, while investments in biofuels are low, in favour of cheaper and more readily available fossil fuels.

2040-2070: Because of decreased energy price volatility and stabilising economies, public trust in political decision making increases which facilitates strategies related to further exploitation of natural resources. Faith is strong in the ability to effectively manage social and ecological systems, including by geo-engineering. High and low skilled immigration and mobility remain high as European economies flourish. Job availability across all market sectors is high and contributes towards a reduction of inequalities and competition. Population across all societal classes, and the strengthening middle class in particular, adopts a very energy intensive lifestyle. Where environmental problems occur, these are tackled locally and reactively with technological solutions. The environment degrades, but the majority of the population is unaware because of successful technological innovation in e.g. food and water production, vaccination availability and climate adaptation, which decrease the dependency on ecosystem services.

2070-2100: In general, Europe continues on its path towards economic and social sustainability through competitive markets; investments in education and health; innovation and a strong focus on technological solutions fuelled by an (over)exploitation of fossil fuel resources, with an ever stronger pressure on natural resources. The continuous high stability of the energy market and economies have changed European policy-making, now predominantly focusing on and investing in policies related to human and social capital, rather than environmental protection. National governments have less political power, which enhances free circulation of services, goods and people. Population continues to grow with many European cities having become economic hubs with efficient transportation means. Towards 2100, the environment is locally seriously degraded as non-

renewables are further exploited, which eventually results in a slow re-emergence of investments in renewables, deemed necessary as prices of fossil fuels rise.

3. Key elements

An overview of key elements for the four EU-SSPs is given in Table 1. The list of elements is based on the set of key uncertainties that is part of the CLIMSAVE scenarios (Gramberger 2013) and the tables with key elements as presented in O'Neill et al. (2015) describing the global SSPs. The final list was drafted during the expert workshop in Wageningen, in January 2015. Note that there is a good match for most key elements.

Table 1. Key elements of EU-SSP with an indication of corresponding key element in global SSPs and trends until 2100 for each EU-SSP.

EU-SSP element	Global SSP element	SSP1-WATW	SSP3-Icarus	SSP4-ROTS	SSP5- FFD
Decision-making level	*Institutions*	International/EU leader more than MS	National/Local+ fragmentation	International / Europe leader on the global scale	International/EU not a leader on the global scale
Geopolitical stability	*Combination of institutions and international cooperation*	High	Low	High	High
International cooperation -	*International cooperation*	Strong, EU important player	Weak	Strong , EU important player	Strong (trade)
Social respect	*Societal participation*	High	Low between countries	Low respect between societies	High
Net migration- low in-migration	*Population growth/ migration*	Low immigration	Outmigration	Selected immigration	High to cities and from poorer countries
Economic develop-ment	*Economic growth*	Gradual (with hiccups at the beginning)	Low	High	High
Mobility	*Migration*	No barriers, but movements are limited	Low	High	High
Globalisation	*Globalisation*	Unconstrained	Constrained	Uncontrolled (only controlled in parts)	Unconstrained
Choice	*Policies*	Free, but strong regulation on land use	Restricted	Free for elites	Free
Social cohesion	*Social cohesion*	High	Low EU\higher within countries	Low	High
Technology development	*Technology development*	High, but not pervasive	Low	High in some areas; low in labour intensive areas	Strong and crucial
Quality of Governance	*Policy orientation*	High – focus on sustainability	Low and ineffective	High and effective	High – focus on businesses
Human health investments	*Health investments*	High	Low	High for elites	High
Education investments	*Education*	High	Low	High for elites	High
Environmental respect	*Environmental policy*	High	Low	High in pockets	Low, but high NIMBY

Annex A: Additional information on model input parameters (qualitative trends)

Table a: Qualitative information on Input parameters for European scenarios derived from Wageningen workshop. Increase or decrease compared to 2010 are indicated in the brackets for 3 time slices as such ([increase2025], [increase2055], [increase2100])

Parameter	SSP1/ We are the world	SSP3/Icarus	SSP4/Riders on the Storm	SSP5
Water savings due to behavioural change	Strong increase (0, +, ++)	No change (0,0,0)	No change (0,0,0)	Stable, then decrease (0, 0, -)
Meat consumption	Strong decrease (0, --, --)	No change (0,0,-)	No change (0,0,-)	Strong increase (+, ++, ++)
Household externalities	Strong decrease (0, -, --)	Strong decrease (0,-,--) No change in North Europe	Decrease (0, -, -) Stable North Europe and (West Europe until 2050)	Strong decrease (0, -, --)
Water savings due to technological change	Strong increase (0, +, ++)	Increase and then decrease (0, +, 0)	Increase (0, +, +)	Increase (+, +, +)
Set aside	Strong increase (0, +, ++)	Stable, then decrease (0, 0, -)	Increase (0, +, +)	Strong decrease (-,--,--) until 0
Attractiveness of the coast	Strong decrease (0, -, --)	First increase, then abandoned (0,+,-)	Decrease and then increase (0, -, 0) (Elites limits access, but due to social pressure there are concessions)	Strong increase (0, +, ++)
Human capital	Strong increase (0, +, ++)	Decrease (0,-,-)	Decrease and then increase (0, -, 0). Middle class re-emerges	Strong increase (1, 1 ½ +, ++)
Social capital	Strong increase (0, +, ++)	Increase, then decrease (0, +, 0). Increase because group of people cluster against others	Decrease and then increase (0, -, 0).	Strong increase (1, 1 ½ +, ++)
Manufactured capital	Steady increase (0, ½+, +)	Decrease (0,-,-)	Increase (0, +, +). Depends on sector	Strong increase (½ +, +,++)
Financial capital	Steady increase (0, ½+, +)	Strong decrease (-,-,--)	Strong increase (0, ++, ++) with saturation after 2050.	Strong increase (½ +, +,++)

Annex B: Additional information on model input parameters: quantification of trends

Table B: Quantitative information on input parameters for European scenarios calculated for input to the Integrated Assessment Platform (version 2).

			Trend	Absolute Min	Credible Min	Default	Credible Max	Absolute Max
Change in energy price (% of 2010) – results from fuzzy sets from Wageningen meeting								
Europe	SSP1 (WATW)							
		2025	0	41.5	46.4	100.0	153.6	158.5
		2055	+	103.9	107.4	162.3	241.3	247.7
		2100	+	103.9	107.4	162.3	241.3	247.7
	SSP3 (Icarus)							
		2025	+	103.9	107.4	162.3	241.3	247.7
		2055	++	111.1	120.7	266.7	460.0	476.0
		2100	+++			350		
	SSP4 (Riders)							
		2025	++	111.1	120.7	266.7	460.0	476.0
		2055	++	111.1	120.7	266.7	460.0	476.0
		2100	++	111.1	120.7	266.7	460.0	476.0
	SSP5							
		2025	-	42.6478	45.1	74.67	96.8646	98.3225
		2055	-	42.6478	45.1	74.67	96.8646	98.3225
		2100	-	42.6478	45.1	74.67	96.8646	98.3225

			Trend	Absolute Min	Credible Min	Default	Credible Max	Absolute Max
Increase in arable land used for biofuel production (% change from 2010) - – results from fuzzy sets from Wageningen meeting								
Europe	SSP1 (WATW)							
		2025	0	-8.7	-8.0	0.0	8.0	8.7
		2055	+	13.2	360.5	145.0	360.5	376.7
		2100	+	13.2	360.5	145.0	360.5	376.7
	SSP3 (Icarus)							
		2025	0	-8.7	-8.0	0.0	8.0	8.7
		2055	0	-8.7	-8.0	0.0	8.0	8.7
		2100	0	-8.7	-8.0	0.0	8.0	8.7
	SSP4 (Riders)							
		2025	0	-8.7	-8.0	0.0	8.0	8.7
		2055	+	13.2	360.5	145.0	360.5	376.7
		2100	+	13.2	360.5	145.0	360.5	376.7
	SSP5							
		2025	-	-70.7	-68.0	-36.7	-9.5	-7.5
		2055	-	-70.7	-68.0	-36.7	-9.5	-7.5
		2100	-	-70.7	-68.0	-36.7	-9.5	-7.5

			Trend	Absolute Min	Credible Min	Default	Credible Max	Absolute Max
Food imports (% change from 2010) – results from fuzzy sets from Wageningen meeting								
Europe	SSP1 (WATW)							
		2025	+	6.0	6.9	21.7	45.5	47.3
		2055	-	-47.2	-45.5	-26.7	-8.7	-7.2
		2100	--	-95.3	-92.5	-62.5	-32.5	-29.7
	SSP3 (Icarus)							
		2025	0			0		
		2055	-	-47.2	-45.5	-26.7	-8.7	-7.2
		2100	-	-47.2	-45.5	-26.7	-8.7	-7.2
	SSP4 (Riders)							
		2025	+	6.0	6.9	21.7	45.5	47.3
		2055	+	6.0	6.9	21.7	45.5	47.3
		2100	+	6.0	6.9	21.7	45.5	47.3
	SSP5							
		2025	½+			10.8		
		2055	+	6.0	6.9	21.7	45.5	47.3
		2100	++	24.1	28.0	88.3	182.0	189.3

			Trend	*Absolute Min*	*Credible Min*	*Default*	*Credible Max*	*Absolute Max*
Water savings due to technological change (% from current) ***Model: WGMM; Modeller responsible: Florian Wimmer***								
rope	SSP1 (WATW)							
		2025	0	-10	-3	0.0	3	10
		2055	+	17.4	21	29.1	40	45.5
		2100	++	27.1	32.6	45.2	62.1	70.6
	Comments: based on assumptions in CLIMSAVE (2055) for scenarios with same trend: 0 :: no change, (-10%, -3%, 0 , 3%, 10%) (new) + :: as in WATW ++ :: as in ROTS -. -- :: not needed							
	SSP3 (Icarus)							
		2025	0	-10	-3	0.0	3	10
		2055	+	17.4	21	29.1	40	45.5
		2100	0	-10	-3	0.0	3	10
	Comments:							
	SSP4 (Riders)							
		2025	0	-10	-3	0.0	3	10
		2055	+	17.4	21	29.1	40	45.5
		2100	+	17.4	21	29.1	40	45.5
	Comments:							
	SSP5							
		2025	+	17.4	21	29.1	40	45.5

		2055	+	17.4	21	29.1	40	45.5
		2100	+	17.4	21	29.1	40	45.5
	Comments:							

			Trend	***Absolute Min***	***Credible Min***	***Default***	***Credible Max***	***Absolute Max***
Water savings due to behavioral change (% change from current) ***Model: WGMM; Modeller responsible: Florian Wimmer***								
Europe	SSP1 (WATW)		Strong increase					
		2025	0	-10	-3	0	3	10
		2055	+	16.1	19.3	21.5	23.6	26.8
		2100	++	38.9	46.7	51.8	57.0	81.0
	Comments: based on assumptions in CLIMSAVE (2025 or 2055) for scenarios with same trend: 0 :: no change, (-10%, -3%, 0 , 3%, 10%) (new) + :: as in ROTS (2025) ++ :: as in ROTS (2055) - :: ICARUS (2055)							
	SSP3 (Icarus)		No change					
		2025	0	-10	-3	0	3	10
		2055	0	-10	-3	0	3	10
		2100	0	-10	-3	0	3	10
	Comments:							
	SSP4 (Riders)		No change					
		2025	0	-10	-3	0	3	10
		2055	0	-10	-3	0	3	10
		2100	0	-10	-3	0	3	10
	Comments:							
	SSP5		Stable, then decrease					
		2025	0	-10	-3	0	3	10
		2055	0	-10	-3	0	3	10
		2100	-	-37.5	-33.0	-30.0	-27.0	-22.5
	Comments:							

			Trend	Absolute Min	Credible Min	Default	Credible Max	Absolute Max
Thermal energy production (change until repr. Year in % of 2010) ***Model: WGMM; Modeller responsible: Florian Wimmer***								
Europe	SSP1 (WATW)							
		2025				3.14		
		2055				-12.61		
		2100				-26.88		
	Comments: taken from IASSA SSP database (SSP1-Marker-RCP4.5-OECD-MAGPIE)							
	SSP3 (Icarus)							
		2025				-0.95		
		2055				29.66		
		2100				52.39		
	Comments: taken from IASSA SSP database (SSP3-Marker-RCP6.0-OECD-AIM/CGE)							
	SSP4 (Riders)							
		2025				15.98		
		2055				29.62		
		2100				25.72		
	Comments: taken from IASSA SSP database (SSP4-Marker-RCP4.5-OECD-GCAM)							
	SSP5							
		2025				16.92		
		2055				97.8		
		2100				48.27		
	Comments: taken from IASSA SSP database (SSP5-Marke-SSP6.0-OECD-REMIND-MAGPIE)							

			Trend	*Absolute Min*	*Credible Min*	*Default*	*Credible Max*	*Absolute Max*
Household externalities ***Model: RUG; Modeller responsible: Liz Clarke***								
Europe	SSP1 (WATW)		Strong decrease					
		2025	0	1	1	2	3	4
		2055	-	1	1	2	3	4
		2100	--	1	1	1	2	3
	Comments: Society/individuals seeking green space as a lifestyle choice							
	SSP3 (Icarus)		Strong decrease (No change in North Eu)					
		2025	0	1	1	3	4	5
		2055	-	1	1	2	3	4
		2100	--	1	1	1	2	3
	Comments: Disparate society some stay in cities some move to countryside							
	SSP4 (Riders)		Decrease (Stable North Europe and (West Europe until 2050)					
		2025	0	1	2	4	4	5
		2055	-	1	2	3	4	5
		2100	-	1	1	2	3	4
	Comments: Disparate society with high poverty leading to more people in cities							
	SSP5		Strong decrease					
		2025	0	1	1	2	3	4
		2055	-	1	1	1	2	3
		2100	--	1	1	1	2	3
	Comments: Individualistic, rich people move to the countryside							

			Trend	*Absolute Min*	*Credible Min*	*Default*	*Credible Max*	*Absolute Max*
Attractiveness of the coast ***Model: RUG; Modeller responsible: Liz Clarke***								
Europe	SSP1 (WATW)		Strong decrease					
		2025	0	Low	Low	Med	High	High
		2055	-	Low	Low	Low	Med	High
		2100	--	Low	Low	Low	Med	High
	Comments: Environmentally friendly population does not put pressure on coast. Also afraid of sea-level rise							
	SSP3 (Icarus)		First increase, then abandoned					
		2025	0	Low	Low	Med	High	High
		2055	+	Low	Med	High	High	High
		2100	-	Low	Low	Low	Med	High
	Comments: Decreasing wealth leads to a move away from the coast							
	SSP4 (Riders)		Decrease and then increase (Elites limits access, but due to social pressure there are concessions)					
		2025	0	Low	Low	Med	High	High
		2055	-	Low	Low	Low	Med	High
		2100	0	Low	Low	Med	High	High
	Comments: Decrease and then increase (Elite limit access, but to due social pressures there are concessions)							

	SSP5		Strong increase					
		2025	0	Low	Low	Med	High	High
		2055	+	Low	Med	High	High	High
		2100	++	Low	Med	High	High	High
	Comments: Individualistic society lives where it wants							

			Trend	***Absolute Min***	***Credible Min***	***Default***	***Credible Max***	***Absolute Max***
Compact vs sprawled development ***Model: RUG; Modeller responsible: Liz***								
Europe	SSP1 (WATW)		Stricter spatial planning→ more compact development					
		2025		Low	Low	Med	High	High
		2055		Low	Med	High	High	High
		2100		Low	Med	High	High	High
	Comments: Strict and increasing spatial planning							
	SSP3 (Icarus)		Sprawled development					
		2025		Low	Low	Low	Med	High
		2055		Low	Low	Low	Med	High
		2100		Low	Low	Low	Med	High
	Comments: Lack of planning intervention leads to sprawl							
	SSP4 (Riders)		Less choice, more ghettos, more control→ more compact					
		2025		Low	Low	Med	High	High
		2055		Low	Low	Med	High	High
		2100		Low	Low	Med	High	High
	Comments Some controls on spatial planning							
	SSP5		More sprawled as people can leave where they want					
		2025		Low	Low	Med	Med	High
		2055		Low	Low	Low	Low	Med
		2100		Low	Low	Low	Low	Low
	Comments: Individualism and little policy interventions leading to sprawl							

			Trend	*Absolute Min*	*Credible Min*	*Default*	*Credible Max*	*Absolute Max*
Climsave Baseline (% change from current)				***-100***		***0***		***100***
Change in dietary preferences for beef and lamb (% change from current) ***Model: mSFARMOD; Modeller responsible: Daniel***								
Europe	SSP1 (WATW)		Strong decrease					
		2025	0	-34	-24	-18	-6	0
		2055	--	-80	-66	-55	-23	0
		2100	--	-97	-90	-82	-43	0
	Comments: The basic curve form for beef is one of slowing decline towards a lower asymptote or rarely one of slowly accelerating growth towards a more favourable future point. I've assumed that the distance between the absolute min and max is 6 standard deviation and that the credible min and max are +/- one standard deviation							
	SSP3 (Icarus)		No change					
		2025	0	-10	-3	0	7	10
		2055	0	-33	-13	0	30	49
		2100	0	-57	-25	0	76	133
	Comments: ditto, but no change implies that the existing decline in beef consumption is arrested with the lower asymptote being current levels of consumption. No change could also be interpreted that the existing trends of meat continue							
	SSP4 (Riders)		No change					
		2025	0	-10	-3	0	7	10
		2055	0	-33	-13	0	30	49
		2100	0	-57	-25	0	76	133
	Comments: ditto, but no change implies that the existing decline in beef consumption is arrested with the lower asymptote being current levels of consumption. No change could also be interpreted that the existing trends of meat continue							
	SSP5		Strong increase					
		2025	+	0	3	5	9	10
		2055	++	0	14	22	39	49
		2100	++	0	33	53	102	133
	Comments: This curve of slowly accelerating increase might lead to unreasonable high levels in the far future and might warrant either slower growth or an upper limit say with a sigmoidal curve.							

			Trend	*Absolute Min*	*Credible Min*	*Default*	*Credible Max*	*Absolute Max*
Climsave Baseline (% change from current)				***-100***		***0***		***100***
Change in dietary preferences for chicken and pork (% change from current) ***Model: mSFARMOD; Modeller responsible: Daniel***								
Europe	SSP1 (WATW)		Strong decrease					
		2025	0	-6	-2	-1	0	0
		2055	--	-26	-16	-11	-1	0
		2100	--	-34	-34	-34	-20	-8
	Comments: I've assumed a sigmoidal response from 100 of current down to a lower limit which I've taken as 66% of current (80%of people eat half and 20% of people eat 30% more). I've assumed the mid points are occurring at 30, 43, 50, 83, and 100 years respectively							
	SSP3 (Icarus)		No change					
		2025	0	2	4	6	10	15
		2055	0	8	14	21	30	38
		2100	0	16	25	35	43	47
	Comments: For the rest of white meat where there is a long term historic growth I've assumed a Baule/Mitscherlich decelerating growth over time to an upper limit of 150% of current with 50% of the growth occurring at 150, 83, 50, 30, 20 years respectively. No change continues the existing trend but at a lower level to current rather than totally arresting it							
	SSP4 (Riders)		No change					
		2025	0	2	4	6	10	15
		2055	0	8	14	21	30	38
		2100	0	16	25	35	43	47
	Comments: For the rest of white meat where there is a long term historic growth I've assumed a Baule/Mitscherlich decelerating growth over time to an upper limit of 150% of current with 50% of the growth occurring at 150, 83, 50, 30, 20 years respectively. No change continues the existing trend but at a lower level to current rather than totally arresting it							
	SSP5		Strong increase					
		2025	+	6	12	21	30	38
		2055	++	21	34	45	49	50
		2100	++	35	45	50	50	50
	Comments: Ditto, but the mid points are brought forward to 50, 25, 13, 8, 5 years respectively							

			Trend	Absolute Min	Credible Min	Default	Credible Max	Absolute Max
Climsave baseline set-aside, %				***0***		***3***		***10***
Land allocated to set-aside/buffer strips/beetle banks etc (%change of current 3%) ***Model: mSFARMOD; Modeller responsible: Daniel***								
Europe	SSP1 (WATW)		Strong increase					
		2025	0	95	102	105	112	116
		2055	+	82	107	122	159	181
		2100	++	65	115	153	268	354
	Comments: The basic curve forms are compounded leading to accelerating growth. Any upper asymptote is beyond 2100							
	SSP3 (Icarus)		Stable, then decrease					
		2025	0	86	94	99	103	105
		2055	0	55	80	96	113	122
		2100	-	28	62	92	129	153
	Comments: The basic curve forms are compounded leading to decelerating contraction. This one might be better a sigmoidal with stable followed by contraction to lower limit							
	SSP4 (Riders)		Increase					
		2025	0	95	102	105	112	116
		2055	+	82	107	122	159	181
		2100	+	65	115	153	268	354
	Comments: The basic curve forms are compounded leading to accelerating growth. Any upper asymptote is beyond 2100							
	SSP5		Strong decrease until zero					
		2025	-	35	50	60	85	100
		2055	--	1	6	13	51	100
		2100	--	0	0	1	24	100
	Comments: The basic curve forms are compounded leading to decelerating contraction.							

			Trend	*Absolute Min*	*Credible Min*	*Default*	*Credible Max*	*Absolute Max*
Climsave baseline (%change of current)				***-50***		***0***		***150***
Change in agricultural yields (%change of current) ***Model: mSFARMOD; Modeller responsible: Daniel***								
Europe	SSP1 (WATW)		Decrease					
		2025		-10	-5	-2	0	5
		2055		-33	-18	-10	0	22
		2100		-57	-35	-19	0	53
	Comments: The underlying model of increasing technical performance is one of compounded improvements –ie exponential growth at varying speeds. However, land degradation, due to the accumulation of phytotoxins in the soil will work the other way. Transition to organic and extensive systems also implies moving to lower curves Which will win and when? Let's assume net growth can be negative							
	SSP3 (Icarus)		Decrease, more land degradation					
		2025		-18	-10	-5	0	10
		2055		-55	-33	-18	0	49
		2100		-82	-57	-35	0	133
	Comments: The underlying model of increasing technical performance is one of compounded improvements –ie exponential growth at varying speeds. However, land degradation, due to the accumulation of phytotoxins in the soil will work the other way. Which will win and when? Let's assume net growth can be negative							
	SSP4 (Riders)		Increase					
		2025		0	7	10	14	22
		2055		0	30	49	70	121
		2100		0	76	133	208	438
	Comments: The underlying model of increasing technical performance is one of compounded improvements –ie exponential growth at varying speeds.							
	SSP5		Increase					
		2025		0	10	16	18	22
		2055		0	49	81	94	121
		2100		0	133	254	308	438
	Comments: The underlying model of increasing technical performance is one of compounded improvements –ie exponential growth at varying speeds.							

			Trend	*Absolute Min*	*Credible Min*	*Default*	*Credible Max*	*Absolute Max*
Climsave baseline –Irrigation efficiency (%change of current)				***-50***		***0***		***100***
Change in irrigation efficiency (%change of current) -50% =-water halved per unit food Model: mSFARMOD; Modeller responsible: Daniel								
Europe	SSP1 (WATW)		Increase (tech change due to awareness)					
		2025		-18	-12	-9	-6	0
		2055		-55	-41	-33	-23	0
		2100		-81	-68	-57	-43	0
	Comments: The underlying model of increasing technical performance is one of compounded improvements –ie exponential growth at varying speeds.							
	SSP3 (Icarus)		Decrease					
		2025		0	3	5	7	11
		2055		0	14	22	31	49
		2100		0	33	53	77	135
	Comments: The underlying model of increasing technical performance is one of compounded improvements –ie exponential growth at varying speeds. (is negative growth justifiable or does that imply going back in time to retro technologies)							
	SSP4 (Riders)		Increase (less water available, but higher technology)					
		2025		-18	-12	-9	-6	0
		2055		-55	-41	-33	-23	0
		2100		-81	-68	-57	-43	0
	Comments: The underlying model of increasing technical performance is one of compounded improvements –ie exponential growth at varying speeds.							
	SSP5		Increase (tech invest due to higher food demand)					
		2025		-18	-12	-9	-6	0
		2055		-55	-41	-33	-23	0
		2100		-81	-68	-57	-43	0
	Comments: The underlying model of increasing technical performance is one of compounded improvements –ie exponential growth at varying speeds.							

			Trend	Absolute Min	Credible Min	Default	Credible Max	Absolute Max
Climsave baseline				***0.5***		***1***		***2***
Reducing diffuse source pollution from agriculture by reduced crop inputs of fertilisers and pesticides - factor where more is less inputs and by implication less diffuse pollution -% change from current Model: mSFARMOD; Modeller responsible: Daniel								
Europe	SSP1 (WATW)		Decreased pollution					
		2025		18	32	52	83	117
		2055		68	113	170	241	300
		2100		130	203	277	344	379
	Comments: The basic model I am assuming with pollution is one of exponential decay making each additional increment of input reduction harder to obtain. Varying assumptions about the rate of decline.							
	SSP3 (Icarus)		Increased pollution					
		2025		-11	-7	-5	2	5
		2055		-38	-26	-18	7	22
		2100		-64	-47	-35	15	53
	Comments: Exponential growth with varying rates of pollution growth							
	SSP4 (Riders)		Increased pollution (but not around rich neighbourhoods)					
		2025		-10	-6	-4	2	5
		2055		-33	-21	-15	8	22
		2100		-57	-40	-29	19	53
	Comments: Exponential growth with varying rates of pollution growth. Diffuse pollution is by nature intangible and thus nimby-sm is going to be very weak if relevant. More so with point source pollution unless, say the nimbys can impose NVZs based on postcode rather than hydrology.							
	SSP5		Increased pollution (but NIMBY)					
		2025		-10	-6	-4	2	5
		2055		-33	-21	-15	8	22
		2100		-57	-40	-29	19	53
	Comments: Exponential growth with varying rates of pollution growth. Diffuse pollution is by nature intangible and thus nimby-sm is going to be very weak if relevant. More so with point source pollution unless, say the nimbys can impose NVZs based on postcode rather than hydrology.							

			Trend	*Absolute Min*	*Credible Min*	*Default*	*Credible Max*	*Absolute Max*
Climsave Baseline –bioenergy production (% change from current)				***0***		***0***		***15***
Importance of wood for fuel (% change from current) ***Model: mSFARMOD; Modeller responsible: Daniel***								
Europe	SSP1 (WATW)		Low					
		2025		-40	-23	-13	-7	5
		2055		-87	-65	-42	-26	22
		2100		-99	-89	-69	-47	53
	Comments: The basic model for wood fuel is slow exponential decline with possible renaissance as exponential growth –any asymptotes are outside the current time periods. Various rates of negative/positive growth assumed							
	SSP3 (Icarus)		High → Less available resources					
		2025		0	5	8	16	34
		2055		0	22	35	81	226
		2100		0	53	89	254	1134
	Comments: The basic model for wood fuel is slow exponential decline with possible renaissance as exponential growth –any asymptotes are outside the current time periods. Various rates of negative/positive growth assumed. Very little is currently used for charcoal and direct combustion so it could increase dramatically under some conditions							
	SSP4 (Riders)		Low					
		2025		-40	-22	-12	-6	5
		2055		-87	-64	-40	-23	22
		2100		-99	-88	-66	-43	53
	Comments: The basic model for wood fuel is slow exponential decline with possible renaissance as exponential growth –any asymptotes are outside the current time periods. Various rates of negative/positive growth assumed							
	SSP5		Medium					
		2025		-22	-13	-7	0	16
		2055		-64	-42	-26	0	81
		2100		-88	-68	-47	0	254
	Comments: The basic model for wood fuel is slow exponential decline with possible renaissance as exponential growth –any asymptotes are outside the current time periods. Various rates of negative/positive growth assumed							

Change in agricultural mechanisation (change in the amount of labour saving mechanisation) % from current			***0***		***0***		***100***
		Trend	***Absolute Min***	***Credible Min***	***Default***	***Credible Max***	***Absolute Max***
Change in agricultural mechanisation (% change from current) Model: mSFARMOD; Modeller responsible: Daniel							
Europe	SSP1 (WATW)		Increase				
		2025		0	7	10	14	22
		2055		0	30	49	70	121
		2100		0	76	133	208	438
	Comments: as per changes in irrigation technical efficiency but the scale has a difference sense. Exponential model for increases						
	SSP3 (Icarus)		Decrease				
		2025		-10	-6	-5	-3	0
		2055		-33	-23	-18	-13	0
		2100		-57	-43	-35	-25	0
	Comments:						
	SSP4 (Riders)		Increase				
		2025		0	7	10	14	22
		2055		0	30	49	70	121
		2100		0	76	133	208	438
	Comments:						
	SSP5		Decrease				
		2025		0	7	10	14	22
		2055		0	30	49	70	121
		2100		0	76	133	208	438
	Comments:						

References

Gramberger, M., Harrison, P., Jäger, J., Kok, K., Libbrecht, S., Maes, M., Metzger, M., Stuch, B., and Watson, M. (2013). Report on the third CLIMSAVE European stakeholder workshop. CLIMSAVE deliverable. http://www.climsave.eu/climsave/outputs.html.

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