

Appendix 1. Archotyping shared socioeconomic pathways across scales: an application to central Asia and European case studies.

Methodology: Process to develop participatory European SSPs (Eur-SSPs) and local European SSPs

For full stakeholder engagement methodology, we refer to Gramberger et al. (2015)

Stakeholder selection

A list of selection criteria were put in place to balance and broaden the different societal stakeholders' opinions and while ensure scientific credibility and societal relevance. The first criterion was to cover the relevant sectors in all case studies. The key sectors were identified within the region to include both the local specific context and enough generalization to ensure consistency across case studies. Next to a few generally agreed sectors – infrastructure, water, energy, finance/insurance – there were also a number of sectors that are unique to a smaller number of case studies or even unique to one. These were, for example, agriculture, food & nutrition, whisky, forestry, biodiversity conservation and tourism.

The second criterion was to cover the individual and professional geographical scope of activity of participants and respective organizations. The geographical criterion was multi-level and includes municipal/local, regional, national, European and international levels.

The third criterion included individual characteristics, such as age, sex and function.

The final selection of criteria for each case study are reported in Table A1. In total the following numbers of individuals could be identified per case study: • Central Asia: 54 individuals • Europe: 77 individuals • Scotland: 39 individuals • Iberia: 67 individuals • Hungary: 74 individuals. The difference in number was due to the different set-up as well as the different level of evolution of the case studies. The Scottish case study, for example, could build on a dense stakeholder network that has been working with the project partners in the past and had already indicated their commitment to participating in the workshops.

Stakeholders attendance

Due to process design and budget limitations, a small number of participants attended each workshop (between 20 and 25 participants). This restriction introduced a key methodological challenge for stakeholder selection, because the main objective of was be inclusiveness of different views and perspectives and avoid overrepresentation of certain typologies of stakeholders and sectors. These challenges were overcome by adding quotas to each criterion. Whereas quota for general criteria are the same in all case studies, i.e. 30% of male and female participants per workshop, other quota differ amongst case studies depending on the relevance of the criterion. For example, the relevance and quota of the sector “energy” compared to other sectors was different in each case study. All criteria were fulfilled during the invitation process, although, finally, only 4 out of 143 quotas were not fulfilled, mainly relating to last minute cancellations.

Table A1: overview of stakeholder selection criteria for each case study

Case study	Central Asia	Europe	Scotland	Iberia	Hungary
Organizational affiliation					
- Government	x	x	x	x	x

- Economy/Enterprise	x	x	x	x	x
- Civil society	x	x	x	x	x
- Research	x	x	x	x	x
Level of operation of the organization					
- Municipal	-	-	-	-	x
- Local	x	x	x	x	x
- Regional	x	x	x	x	x
- National	x	x	x	x	x
- European	x	x	x	x	x
- International	x	x	x	-	-
Function of the stakeholder					
- Politician	x	x	x	x	x
- Policy makers/ experts/advisor	x	x	x	x	x
- Regulators	x	x	x	x	x
- Practitioners	x	x	x	x	x
- Technical expert	x	x	x	x	x
- Advocacy/lobbyists	x	x	x	x	x
- General public	x	x	x	x	x
- Other	x	x	x	x	x
Sector					
- Water	x	x	x	x	x
- Infrastructure	x	x	x	x	x
- Energy	x	x	x	x	x
- Finance/Insurance	x	x	x	x	x
- Agriculture	x	x	x	-	x
- Food & Nutrition	-	-	x	x	x
-Whisky	-	-	x	-	-
- Forestry	-	x	x	-	x
- Biodiversity conservation	-	x	-	x	-
- Tourism	-	-	x	-	-
- Health	-	x	x	x	x
- Land use/land use management	-	x	x	x	x
- Land owners	-	-	x	-	-
- Trade	x	-	-	-	-
- Security	x	x	-	x	x
- Migration	x	-	-	x	-
- Disaster risk reduction	x	-	-	-	-
- Humanitarian relief	x	-	-	-	-
- Other	x	x	x	x	x
Age					
- 30 years and under	x	x	x	x	x
- 30-50 years	x	x	x	x	x
- 50 years and above	x	x	x	x	x
Gender					
- female	x	x	x	x	x
- male	x	x	x	x	x

Note: x indicates each criterion per case study; dashes indicate non-relevance of the criterion for the case study.

Engagement process

The engagement process was built to meet specific objectives:

- Create draft case-study specific scenario storylines
- Provide quantifiable input to modelling
- Assess the effects of high-end climate change on the scenario storyline

The methodology was built on the “STIR” approach (Gramberger et al. 2015), which aims at maximizing stakeholder knowledge input during a workshop to strengthen co-production between stakeholders and scientists. The process could be summarized in the following way:

Day 1

Stakeholders started the scenario development process through an interactive identification of driving forces: a long list was created consisting of factors that would have an important influence on the development of the case study until 2100, apart from climate change. After grouping these driving forces into clusters, the most impactful and uncertain were determined through a voting procedure. The stakeholders then conducted an uncertainty analysis on this selection of clusters, determining the key uncertainty for each cluster as well as the polarities.

Day 2

Four input scenarios, i.e. ‘Sustainability’, ‘Regional Rivalry’, ‘Inequality’ and ‘Fossil-fueled Development’ were presented individually to the stakeholders.

Following this presentation, the workshop continued with stakeholders mapping the previously identified key uncertainties and their polarities onto the input scenarios, and by developing the main thrust of these four narratives. The second day of the workshop ended with a presentation and discussion of the developed narratives.

Day 3

The third day, stakeholders, provided with additional comments and feedback, reworked and expanded the narratives developed the previous day.

Methodology: European SSPs (Eur-SSPs), local European SSPs and Central Asian SSPs: narratives

Modified from Supplementary Material in Pedde et al. (2019)

In this document, we report the sketches of the European SSPs (Eur-SSPs) and local European SSPs. For the full text, we refer to the deliverable 2.2 of the IMPRESSIONS project (Kok and Pedde 2016). The Eur-SSPs and local European SSPs reported below result from the engagement process and are reported here in the form of narratives and key trends.

The SSP narratives and key trends are reported for the following case studies: Europe, Central Asia, Hungary, Iberia and Scotland. For each case study, we omit the SSP2 scenario as it was not developed in the participatory process.

Amongst the key trends for each SSP in each case study, we report the levels of capitals (human, social, manufactured, financial and natural), as indicators of material and immaterial wealth (Porritt 2007). Increases or decreases in 3 time steps (2040, 2070, 2100) compared to present are qualitatively indicated with “-” or “+” (“½” indicate very small changes). For example, “(0, +, ++)” means “no change up to 2040 compared to present, increase up to 2070 compared to present, strong increase up to 2100 compared to present”

Eur-SSP1 Sustainability

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.

The interplay of financial, environmental, and economic crises fuel the feeling that behavior 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. 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. The European Union expands further and participates in new global governance initiatives. Advances in green technologies are further stimulated by international competition leading to a CO₂ neutral society by 2050. By 2100, Europe is characterized 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.

Key elements	Sustainability
Decision-making level	International/EU leader
International cooperation	Strong, EU important player
Net migration- low in-migration	Low immigration
Economic development	Gradual (with hiccups at the beginning)
Mobility	No barriers, but movements are limited
Social cohesion	High
Technology development	High, but not pervasive
Quality of Governance	High – focus on sustainability
Human health investments	High
Education investments	High
Environmental respect	High
Human capital	Strong increase (0, +, ++)
Social capital	Strong increase (0, +, ++)
Manufactured capital	Steady increase (0, ½+, +)
Financial capital	Steady increase (0, ½+, +)

Eur-SSP3 Regional Rivalry

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.

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. 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. Long-term policy planning becomes rare with hardly any money for education, research or innovation. Eventually the EU breaks down, with new regional blocs forming in the north and in the south of Europe, while new alliances with other countries are forged to ensure sufficient energy supply. Social counter-movements temporarily appear but do not take root in a fragmented and divided Europe with strong regional rivalry and conflict. Ultimately, a high-carbon intensive Europe emerges that is not worse off than the rest of the world, but struggles not to become the world's backwater with high inequalities predominantly between but also within countries.

Key elements	Regional Rivalry
Decision-making level	National/Local+ fragmentation
International cooperation	Weak
Net migration- low in-migration	Outmigration
Economic development	Low
Mobility	Low
Social cohesion	Low EU\higher within countries
Technology development	Low
Quality of Governance	Low and ineffective
Human health investments	Low
Education investments	Low
Environmental respect	Low
Human capital	Decrease (0,-,-)
Social capital	Increase, then decrease (0, +, 0). Increase because group of people cluster against others
Manufactured capital	Decrease (0,-,-)
Financial capital	Strong decrease (-,-,-)

Eur-SSP4 Inequality

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, although Europe becomes an important player in a world full of tensions.

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. At the same time, however, inequalities are rising because of a number of simultaneously acting factors, including highly unequal investments in education. This leads to a large and widening gap between an internationally-connected society and a more fragmented collection of lower-income societies that work in a labor intensive, low-tech economy. Technological development has not resulted in reduced energy prices, but has instead established an oligarchy of green business developers that control energy supply. By 2100, Europe is an important player in a world full of tensions, but with growing inequalities across and within European countries.

Key elements	Inequality
Decision-making level	International / Europe leader on the global scale
International cooperation	Strong , EU important player
Net migration- low in-migration	Selected immigration
Economic development	High
Mobility	High
Social cohesion	Low
Technology development	High in some areas; low in labor intensive areas
Quality of Governance	High and effective
Human health investments	High for elites
Education investments	High for elites
Environmental respect	High in pockets
Human capital	Decrease and then increase (0, -, 0). Middle class re-emerges
Social capital	Decrease and then increase (0, -, 0).
Manufactured capital	Increase (0, +, +). Depends on sector
Financial capital	Strong increase (0, ++, ++) with saturation after 2050.

Eur-SSP5 Fossil-fueled Development

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.

Global markets are increasingly integrated, with interventions focused on removing institutional barriers. There are also strong investments in health, education, and institutions to enhance human and social capital. The push for economic and social development is coupled with the exploitation of abundant fossil fuel resources, including large-scale extraction of shale gas. This 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. Faith is strong in the ability to effectively manage social and ecological systems, including by geo-engineering. Population across all societal classes adopts a very energy intensive lifestyle. The environment degrades, but the majority of the population is unaware because of successful technological innovation. 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.

Key elements	Fossil-fueled Development
Decision-making level	International/EU not a leader on the global scale
International cooperation	Strong (trade)
Net migration- low in-migration	High to cities and from poorer countries
Economic development	High
Mobility	High
Social cohesion	High
Technology development	Strong and crucial
Quality of Governance	High – focus on businesses
Human health investments	High
Education investments	High
Environmental respect	Low, but high NIMBY
Human capital	Strong increase (1, 1 ½ +, ++)
Social capital	Strong increase (1, 1 ½ +, ++)
Manufactured capital	Strong increase (1, 1 ½ +, ++)
Financial capital	Strong increase (½ +, +,++)

Central Asian SSP1 – Utopistan

This scenario is characterized by cooperation between nations in the region and between external actors. Underpinning this cooperation is a distinct Central Asian identity, based on a set of common values and shared lifestyles. The cooperation is ensured by both with top-down and bottom-up initiatives. Firstly, with diversification of resources and energy dependency in the region, which stabilizes Central Asia by decreasing differences between oligarchic interests. Secondly, the region is characterized by an increased attention for common traditional values, which leads to a shift towards sustainability also at more individual level. Countries start to collaborate effectively thanks to the establishment of an effective supervisory intergovernmental body in key common policy areas such as energy diversification, water policy and food production. Population grows steadily. Thanks to effective long-term oriented governance, larger shares of the population have access to resources and global markets. Additionally, people actively participate in the political life, where regional identity is increasingly important and brings people together.

Key elements	Utopistan
Decision-making level	International
International cooperation	Strong
Net migration- low in-migration	Low immigration
Economic development	Fast
Mobility	No barriers, but movements are limited
Social cohesion	High
Technology development	High
Quality of Governance	High – focus on community
Human health investments	High
Education investments	High
Environmental respect	High
Human capital	Strong increase (+, +++, +++)
Social capital	Strong increase (+, +++, +++)
Manufactured capital	Strong increase (+++, ++, ++)
Financial capital	Steady increase (0, 0, +)

Central Asian SSP3 – Regional Rivalry

This scenario is characterized by rivalry between nations in the region and between external actors. There is strong competition for the resources (water, hydropower, uranium, as well as oil and gas and population) in the region. At first there is strong competition for resources within the region accompanied by “exclusive” economic development. This leads to increasing rivalry between groups in society and a build-up of tension and instability. As competition within the region becomes stronger, the system becomes more and more exclusive with restrictions and controls introduced to maintain the system. Ultimately, the tensions are so large that a breakdown occurs and chaos ensues. External actors then step in to ensure their continued access to the resources of the region. The region is stabilized through the influence of the external actors but again the spiral of competition leading to tensions builds up; this time the competition is between the external actors. Again a breaking point is reached and chaos ensues until 2100. Technology development is low in this scenario. Low technology uptake and low investment continues. Agricultural yields remain far below potential. Soil quality deteriorates through bad irrigation practices. Low investment is one of the drivers for increased competition by reducing the ‘available’ resources, in particular water.

Key elements	Regional Rivalry
Decision-making level	National/Local+ fragmentation
International cooperation	Weak and temporary
Net migration- low in-migration	Strong outmigration and Influx of Chinese workers from 2040
Economic development	Low
Mobility	Low
Social cohesion	Low
Technology development	Low
Quality of Governance	Low and ineffective
Human health investments	Low
Education investments	Low
Environmental respect	Low
Human capital	Strong decrease (-,--,---)
Social capital	Strong decrease (-,--,---)
Manufactured capital	Decrease (0,0,--)
Financial capital	Strong decrease (-,--,---)

Central Asian SSP4 – A Game of Elites

This scenario is characterized by large and growing inequalities particularly within countries, with a powerful elite established in all countries of Central Asia. These strong and connected elites ensure a high level of stability within and across countries through international connections and collaborations. At the same time, they actively pursue an increase of inequalities by suppressing the majority of the population. The elite is furthermore responsible for effective management of migratory fluxes with China and Russia; establishment of common environmental standards across Central Asia; cross-regional cooperation related to infrastructural projects; water management; and exploitation of natural resources. The large majority of the population ('the masses') are kept quiet, but not happy. Many services (health, education, welfare, housing) are kept at minimum acceptable levels, all of which become largely privatized. Towards 2100, a new religion emerges and which is channeled by the elite, thus successfully decreasing the chance of uprising of the masses.

Key elements	Game of Elites
Decision-making level	International elite
International cooperation	Strong
Net migration- low in-migration	Selected immigration of Chinese migrants
Economic development	High
Mobility	High
Social cohesion	Low
Technology development	High in some areas; low in labor intensive areas
Quality of Governance	High and effective
Human health investments	High for elites
Education investments	High for elites
Environmental respect	High in pockets
Human capital	Decrease (-,-,--).
Social capital	Strong decrease (-,--,--).
Manufactured capital	Decrease (-,-,-)
Natural capital	Strong decrease (--,--,--)

Central Asian SSP5 - Fossil-fueled Development

The global scene is characterized by a positive attitude to competitive markets, innovation and participatory societies to produce rapid technological progress and development of society. As a result the economic development is generally good and international trade is intensified. Partly this is driven by exploitation of fossil fuel resources. There is also a lack of environmental concerns in the world and the life style is ‘globalized’ with high material consumption. The implementation of the Sustainable Development Goals (SDGs) has been relatively successful with regard to reducing inequality between countries, but less successful with regard to environmental issues. Also in Central Asia, there is a competitive economic development largely based on the fossil fuel industry. The region experiences a boom and there is an inflow of investments and people, partly reinforced by an international development of increased international mobility and opening of labor markets. Also the agricultural sector has seen a good development of its productivity, partly due to improved technologies within this sector. However, the environment in Central Asia pays a high price for the development, and governments mainly focus collaboration on issues that are of importance for the economic development.

Key elements	Fossil-fueled Development
Decision-making level	International
International cooperation	Strong (trade and policy)
Net migration- low in-migration	High immigration especially from young educated people
Economic development	High
Mobility	High
Social cohesion	High
Technology development	Strong
Quality of Governance	High – focus on businesses
Human health investments	High
Education investments	High
Environmental respect	Low, but high NIMBY
Human capital	Strong increase (+, ++, ++)
Social capital	Strong increase (+, ++, ++)
Manufactured capital	Strong increase (+, ++, ++)
Natural capital	Decrease (--, -, -)

Hungarian SSP1 - Rózsaszín álom

Triggered by changing public opinion on current economic and demographic problems, local governments take the initiative to invest in services. This results in the local increase of skills and good practices: Veszprém becomes a knowledge center and Szekszárd turns to sustainable agricultural practices. New generation of policy-makers come from local communes and represent the will of people. Because of more transparency and accountability of politicians, corruption decreases. This leads also to an economic shift in many sectors, whereby technology development and high-value exports become the new backbone of the Hungarian economy. International cooperation is strong also thanks to stable neighboring countries and decrease in migration. Emigration and birth rates also stabilize. Hungary in 2100 is a fully sustainable, financially healthy and safe country.

Key elements	Hungarian SSP1 - Rózsaszín álom
Decision-making level	Multilevel – development model upscaled from local to national
International cooperation	Strong, EU important player
Net migration- low in-migration	Moderate immigration – reverted brain drain
Economic development	Gradual
Mobility	No barriers, but movements are limited
Social cohesion	High
Technology development	High – focus on renewable and re-use
Quality of Governance	High – focus on sustainability
Human health investments	High
Education investments	High
Environmental respect	High
Human capital	Increase and levelling (++,+,+) (gets high soon)
Social capital	Increase and levelling (++,+,+) (gets high soon)
Manufactured capital	0,-,-
Natural capital	0,+,+

Hungarian SSP3 – Regional Rivalry

In the context of increased geopolitical instability and higher energy prices, the Hungarian government shifts its budget away from environmental and social services towards industrial development and defense. However, stalling wages, low resources and unemployment trigger social tensions and brain drain. The government responds with authoritarian measures, further decreasing social services and implementing fossil-fuel subsidy schemes to keep prices artificially low. Poverty increases and people move out of cities: urban and rural ghettos develop. People try to become self-sufficient by re-learning old practices. By 2100, Hungary is affected by energy shortages: large-scale agricultural and urbanization are halted. Because of increased migration, a new multicultural society emerges.

Key elements	Hungarian SSP3 - Regional Rivalry
Decision-making level	National
International cooperation	Weak - conflict
Net migration- low in-migration	Brain drain – increased immigration
Economic development	Low
Mobility	Low – people move to ghettos
Social cohesion	Low
Technology development	Low
Quality of Governance	Low and ineffective
Human health investments	Low
Education investments	Low
Environmental respect	Low
Human capital	Decrease but flattening due to self-reliance (0,-,-)
Social capital	(+,-,-) increases due to crises, decreases due to institutions
Manufactured capital	(+,-,-)
Natural capital	Decrease – some flattening due to reduced input use and pressure (-,-,-)

Hungarian SSP4 – Inequality

The direction of tender systems strengthens a power system leading to concentration of power and landownership in the hands of few. With corruption and tensions on the rise, new elections promise change but fail: new leadership brings stability but strengthens the power of elites. The EU is complacent. A centralized Hungary stabilizes borders and supplied cheap (but low educated) labor force. Health and education services are minimal and the state prefer to manage crises rather than prevent. Besides an industrialized food production system, haven-nots self-organize even if life of the majority is still a struggle, with a controlled media and education system. With growing hunger riots, the elites show flexibility to avoid revolts (thawing of dictatorship) with a new charismatic leader. People live in a very unequal world but they are happy with what they have.

Key elements	Hungarian SSP4 - Inequality
Decision-making level	State - Europe
International cooperation	Strong for elites
Net migration- low in-migration	First high immigration, then controlled
Economic development	Medium-high
Mobility	High for elite
Social cohesion	Low – high for have-nots
Technology development	High in some areas; low in labor intensive areas
Quality of Governance	Effective (stability)
Human health investments	Low
Education investments	Low
Environmental respect	High in pockets
Human capital	(---,--, -)
Social capital	(0,--, -)
Manufactured capital	(-,--, -)
Natural capital	(--, -, 0)

Hungarian SSP5 - Pató Pál Úr

Lifestyle in Hungary is increasingly coupled with increased consumption, less social interactions and pervasive technology. Higher energy demand is met with readily available fossil fuels and little investments on new energy or infrastructure. An exclusive development model sets up, with rising corruption. However, popularity is high because of effective crises management and welfare spending. Even if education is stratified, with high mobility for the rich, all layers of society have a decent energy-hungry lifestyle. Technology can fix temporarily the wide spreading environmental and health degradation until the system collapse. Population decimates. The increasing awareness for change leads to a rebirth of communities. Hungary returns on the bumpy path towards a post fossil fuel era that was abandoned decades before.

Key elements	Hungarian SSP5 – Pató Pál Úr
Decision-making level	International/national
International cooperation	Strong (trade)
Net migration- low in-migration	High
Economic development	High, until collapse
Mobility	High
Social cohesion	Low, then higher
Technology development	Strong and crucial
Quality of Governance	High – focus on national level and industries
Human health investments	High – welfare system
Education investments	High – welfare system
Environmental respect	Low
Human capital	(-, -, -)
Social capital	(-, -, -)
Manufactured capital	(+, ++, ++)
Natural capital	(-, --, --)

Iberia SSP1 - Sustainability

Triggered by continuing and growing social participation in environmental, social, and economic issues and fueled by a European social-oriented political framework, Iberia embraces a path towards a new development model. Initially at slow pace, but increasing rapidly and supported by socially and environmentally sustainable policy making, a fundamental change is achieved towards boosting education, innovation, job opportunities in the green sectors (renewables and reuse of materials), and eventually green technologies. Because of the strengthening of the democratic governance structures, globalization is no longer opposed to local sustainability, but on the contrary, positive sustainable development synergies are being created. This leads also to an economic shift in many sectors, whereby technology development and high-value exports become the new backbone of the Iberian economy. By 2100, the new decision-making culture and practice culminates in the new development model for the Iberian countries. This model encourages broad public participation, institutional collaboration and includes a harmonic integration of health, social, economic, political and environmental sectors.

Key elements	Iberia SSP1 - Sustainability
Decision-making level	International – both bottom-up and top-down
International cooperation	Strong, EU important player
Net migration- low in-migration	Moderate immigration
Economic development	Gradual
Mobility	No barriers, but movements are limited
Social cohesion	High
Technology development	High – focus on renewable and re-use
Quality of Governance	High – focus on sustainability
Human health investments	High
Education investments	High
Environmental respect	High
Human capital	+,+++,+++
Social capital	++,+++,+++
Manufactured capital	-,+,++
Natural capital	-,++,+++

Iberia SSP3 - Regional Rivalry

Short-lived governments lead to a fragmentation of the social and economic fabric in Iberia. In 2030 Catalonia gains independence, which is later followed by other regions both in Iberia and in other Mediterranean countries. To counteract economic crises, the Southern countries unite in a separate Union, the 'Club Med'. Continued environmental and economic problems increase social tensions and social inequalities, which in turn negatively affect tourism. By the 2060s four countries have come to exist in Iberia: Portugal, Spain, Catalonia and the Basque Country, with strong borders between them. Over time, conflicts escalate although war over water and other scarce resources is prevented. By 2100, a deserted inland rural Iberia remains and this produces a large divide even further than with the rest of Europe. Continuous conflicts across multiple countries which experiment such similar disintegration processes occur elsewhere and this limit cooperation within Club Med and with other international power blocs.

Key elements	Iberia SSP3 - Regional Rivalry
Decision-making level	National/Local+ fragmentation
International cooperation	Weak
Net migration- low in-migration	Outmigration
Economic development	Low
Mobility	Low
Social cohesion	Low within and across Iberia
Technology development	Low
Quality of Governance	Low and ineffective
Human health investments	Low
Education investments	Low
Environmental respect	Low
Human capital	-,---,---
Social capital	-,---,--- and ½
Manufactured capital	--,---,---
Natural capital	-,---,---

Iberia SSP4 - Inequality

Economic challenges and environmental accidents are exacerbated by new European and global crises, which leads to an increased migration from Northern Africa and the Middle East. In Iberia, unemployment rises to record levels, this eventually results in social unrest and massive protests. Social stratification intensifies with strong high-income elites and a divided large lower class, bringing about strong tensions within and between social classes. This unstable social situation escalates in the 2040s, and lead to a shift in the political system. New governments establish an oligarchical system with power and money gradually centralized and controlled by an elite of a few companies and central governments. The political and industrial elite successfully implements a strategy of “subtle” enforcement of inequality through education and keeping people busy on low skilled tasks, with low future expectations. To their benefit, the elite invests in solar and wind energy, eventually becoming a market leader.

Key elements	Iberia SSP4 - Inequality
Decision-making level	International / Europe
International cooperation	Strong , Iberia strong player in EU
Net migration- low in-migration	First high immigration, then controlled
Economic development	High
Mobility	High
Social cohesion	Low
Technology development	High in some areas; low in labor intensive areas
Quality of Governance	High and effective
Human health investments	High for elites
Education investments	High for elites
Environmental respect	High in pockets
Human capital	+, - 1 and ½
Social capital	+, 0, -
Manufactured capital	½+, +, ++
Natural capital	+, ++, +++

Iberia SSP5 - Fossil-fueled Development

The burst of the financial bubble increases the need for social aid and subsidies for Iberia, which is facilitated by an increasing economic surplus in the north of Europe. Crucial is the establishment of a connection of electricity networks that increase access to external (fossil) resources. Iberia is part of this network and located strategically in the energy nexus. Iberia also starts exploiting its own resources, while intensifying agriculture and forestry. In the 2040s, environmental problems occur that are combatted with successful technological solutions. The accompanying environmental destruction goes by unnoticed as most people live in the cities, where water, food, and energy supply are secured. By 2060, Iberia totally depends on technology, fossil fuels, and investments of large companies. Ultimately, a number of environmental disasters lead to an increased awareness across Iberia that technology can no longer sustain agricultural production. The outlook is uncertain as the fossil-fuel based development model collapses and business opportunities decrease.

Key elements	Iberia SSP5 - Fossil-fueled Development
Decision-making level	International/EU not a leader on the global scale
International cooperation	Strong (trade)
Net migration- low in-migration	High to cities and from poorer countries
Economic development	High, until collapse
Mobility	High
Social cohesion	Medium
Technology development	Strong and crucial
Quality of Governance	Focus on businesses
Human health investments	High (private), then low
Education investments	High (private), then low
Environmental respect	Low
Human capital	++,+++,++
Social capital	+,+,-
Manufactured capital	+++,+++,++
Natural capital	-,--,-

Scottish SSP1 – Mactopia

Through increased societal involvement policy and effective governance, Scotland achieves the transition towards a sustainable and equitable society by 2040. This transition comes within the context of positive economic development and a further devolution from the UK. Scotland has stronger ties with other like-minded countries both within and outside the EU. More income is also generated from the export of surplus water and is invested in social and environmental policies. The shift towards a green (but highly taxed) economy increases tax evasion and resource smuggling. In addition, some social unrest develops as a result of the increase in both unskilled and highly skilled migrants, especially from the rest of the UK. These problems are, however, limited due to high government presence (e.g. with social assimilation programs). By 2070-2100, Scotland has become more aware of national security issues, but the core values of social and environmental sustainability and equity are dominant. Thus the country remains open to trade by consolidating healthy trade relationships with rich countries, as well as helping with the (economic) development of poor countries. The country has grown a bit less than business-as-usual, but unemployment and homeless people are now something of the past.

Key elements	SSP1 – Mactopia
Decision-making level	Multilevel and communitarianism
International cooperation	Strong with like-minded countries and BRICS
Net migration- low in-migration	High immigration
Economic development	Steady but somewhat slow
Mobility	No barriers,
Social cohesion	High
Technology development	High
Quality of Governance	High – focus on trade-offs and social inclusiveness
Human health investments	High
Education investments	High
Environmental respect	High
Human capital	Strong increase (+, ++, ++)
Social capital	Strong increase (+, ++, ++)
Manufactured capital	Increase (+, +, +)
Financial capital	Steady increase (+, +, ++)

Scottish SSP3 – Mad Max

On-going conflicts, political instability and demographic issues in other countries are drivers for increased resource issues and migration to Scotland. Because of increased pressure on resource exploitation, investors buy up land and access to water leading to volatile markets. More and more people have problems buying land but also food and water. This leads to a society with less solidarity. Energy becomes increasingly valuable and the government sells energy to the highest bidders. These are multinationals who also own large portions of land, control the scarce water and food supplies and determine the consistently high pricing of essential goods and commodities. Fragmentation of society leads to more sectarianism. Conflicts between Catholics and Protestants are rampant, especially in the small mining communities in the Highlands. By 2040 the EU breaks down and suffers from social unrest and an economic and energy crisis. In Scotland, a survival from day-to-day, “getting the sandbags out” type of mentality prevails over a long-term structural approach, especially for the Have-nots. The Haves on the other hand are preoccupied with securing their fortunes and the few remaining resources. By 2070-2100, we reach a balance, where both the Haves and Have-nots realize they have to organize themselves: the Haves to protect themselves and their property, the Have-nots to survive. These unions originate out of necessity. However, conflict within these groups is also common. There is no, or very limited contact between the different strata. The poorer Scots work for the richer Scots, but that is the only interaction between them. The whole society has learned to live with less.

Key elements	SSP3 - Mad Max
Decision-making level	Corporate and clan level
International cooperation	Weak
Net migration- low in-migration	High immigration at the beginning
Economic development	Low
Mobility	Very low
Social cohesion	Low between strata, higher within strata
Technology development	Low
Quality of Governance	Low and ineffective at national level (short-term)
Human health investments	Low
Education investments	Low
Environmental respect	Low
Human capital	Decrease (-, -, -)
Social capital	Decrease (-, ½ -, ½ -)
Manufactured capital	Decrease (1/2 - ,-,--)
Financial capital	Strong decrease (-,1 and ½ -, -)

Scottish SSP4 – Tartan Spring

The strong middle class and present prosperity pave the way for technological innovation which leads to more efficient use of resources. A whole new generation of highly educated young people takes the lead. To capture the full potential of all these technological developments, the Scottish government decides to open resource access to the private sector and to establish liberal market structures. As a result, by 2040 the influence of the private sector in Scotland has become very strong. Economic growth becomes the fundament of Scottish nationalism and of political independence is achieved in 2040. The middle class favors further deregulation and cuts in public spending, spearheaded by the economic growth. An unwanted consequence is the disappearance of welfare measures and more public GDP spent on overseas conflicts to secure ownership of access to resources. With more income from resources going to multinationals and little welfare, disparity between the poor and the wealthy in Scotland is more pronounced. This disparity further increases because technological innovation makes it possible to eliminate jobs and manpower. Those that have a job still benefit from privately organized health care schemes, but a large part of the workforce services the super-rich and has only limited social security, barely enough for a decent life. By 2070 people realize that is not enough to live in a rich country which lacks sustainability and accountability of governance. Strikes and uprising become more frequent and violent. Scotland enters turbulent times.

Key elements	SSP4 – Tartan Spring
Decision-making level	National/Multinationals
International cooperation	Strong , EU important player
Net migration- low in-migration	High migration
Economic development	High
Mobility	Low
Social cohesion	Low
Technology development	High
Quality of Governance	Ineffective
Human health investments	High and then private (exclusive)
Education investments	High and then private (exclusive)
Environmental respect	Low
Human capital	Decrease and then increase (+, 0, -).
Social capital	Many small up and downs between 2050 and 2100 (½+, 0, 0)
Manufactured capital	Increase (+, +, +)
Financial capital	Increase then decrease (½+, +, 0)

Scottish SSP5 – Fossil-fueled Development

A stabilization of the fossil fuel price has allowed for an increased tax on fossil fuels. Because of a concomitant increase of immigrants from outside the EU, the Scottish government invests extra income in health services, social housing and education. The government also invests in the establishment of for-profit publically owned energy companies, such as Statoil and the Scotland Energy Corporation (SEC). At the central level, SEC investment fund has a large stake in fossil fuels and can invest in public services. This means profits stay in Scotland, with SEC paying dividends to each Scottish resident. By 2040, Scottish policy is increasingly driven by technology in many sectors: finance, education (technology university), labor force. Strong devolution has also resulted in ‘clantons’. These become more and more powerful alongside public participation, e.g. with innovative internet referenda. The lack of focus in environmental problems, however, starts to have its toll. Some discontent starts to rise among pockets of the population, driven by issues such as ‘the last bumblebee in Scotland’. This is initially partly overshadowed by steady economic growth. By 2070 energy and food demands are met and surpassed. On the other hand, environmental degradation reaches a tipping point. Larger shares of the population realize the high costs of geo-engineering, and the increasing economic inefficiency of fossil fuels. As a result, unhappiness about environmental degradation spreads. After a major clean-up undertaken by SEC, a shift towards renewables triggers a change towards a whole new energy system. SEC investments in renewables slowly increase, matching those in fossil fuels by the end of the century.

Key elements	SSP5 – Fossil-fueled Development
Decision-making level	International/national and “clantons”
International cooperation	Strong (trade)
Net migration- low in-migration	High to cities and from non-EU countries
Economic development	High
Mobility	High
Social cohesion	High
Technology development	Strong and crucial
Quality of Governance	High – focus on profitable investments
Human health investments	High
Education investments	High (focus on sciences, engineering and technology)
Environmental respect	Low, but high NIMBY
Human capital	Increase (0, +, +)
Social capital	Decrease (0, -, -). High human but low social capital
Manufactured capital	Strong increase (+, ++,++)
Financial capital	Strong increase (+, ++, +++). Faster growth rate than present

Results

The narrative coding was analyzed for three authors. Expert 1 is reported in the Results of the main text. The results from experts 2 and 3 are reported below, in Figures A1 and A2

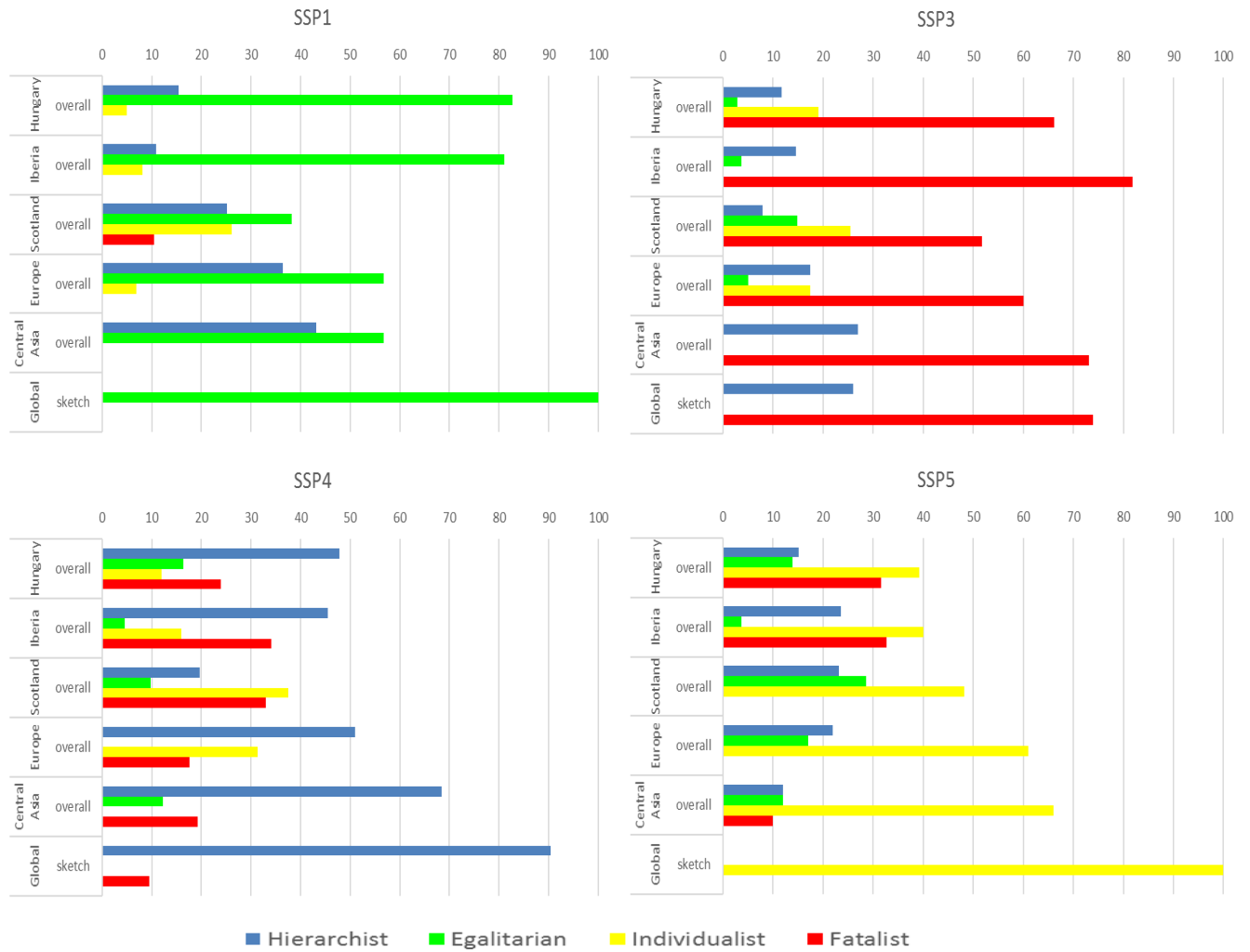


Figure A1: Analysis of worldviews (from expert 2)

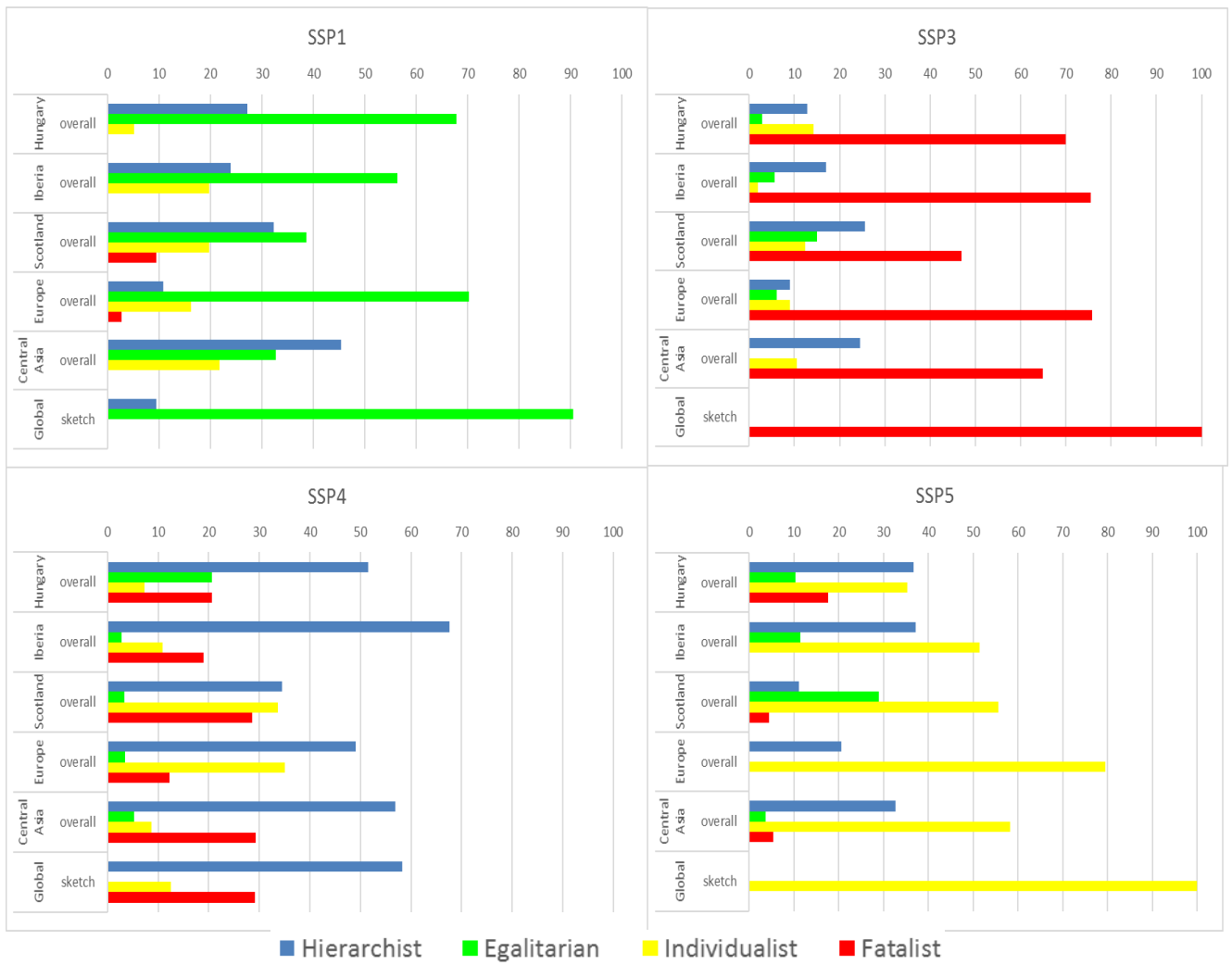


Figure A2: Analysis of worldviews (from expert 3)

References

Gramberger, M., Zellmer, K., Kok, K., Metzger, M.J. (2015). Stakeholder integrated research (STIR): a new approach tested in climate change adaptation research. *Climatic Change* 128(3-4): 201-214.

Kok, K. and S. Pedde (2016). "IMPRESSIONS socio-economic scenarios." IMPRESSIONS project

Pedde, S., Kok, K., Hölscher, K., Frantzeskaki, N., Holman, I., Dunford, R., Smith, A. and Jäger J. (2019). Advancing the use of scenarios to understand society's capacity to achieve the 1.5 degree target. *Global Environmental Change* 56: 75-85.

Porritt, J. (2007). The Five Capitals Framework. *Capitalism as if the World Matters*. London, UK, Earthscan: 137-142.