Putting Scotland in the context of global Shared Socio-economic Pathways to inform Land Use Transformations for Net Zero and Resilience

C3 Land Use Transformations

Milestone M1.3 Shared Socio-economic Pathway Scenario Analysis

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Summary

The aim of this report is to detail the global Shared Socio-economic Pathways (SSPs) narratives and their structure used to organise climate change assessments by the Intergovernmental Panel on Climate Change, and how the SSPs can be used to inform research on Land Use Transformation in Scotland. The SSPs detail five possible future societal development pathways.

The objective is to explore the development of Scotland-focussed SSPs and place them in a spatial context to inform discussion, research and analysis on achieving net zero and socio-ecological system resilience in the context of land use transformation.

Information is provided about the five main Shared Socio-economic Pathways, a critique of the assumptions, caveats and benefits of their use. We provide references and links to work done elsewhere to translate the global SSPs to a UK and devolved nation scale.

Whilst the SSPs may have limitations due to their assumptions and caveats, the structure and detail within their narratives enables researchers to project and model future scenarios and identify possible actions to mitigate or adapt to these scenarios.

In this report we make the case for adding spatial analyses to the SSPs to address questions on what net zero looks like with respect to land use in Scotland.

Conclusions

There are sufficient benefits to the structure and coverage of the Shared Socio-economic Pathways, coupled with our understanding of their limitations and considering efforts undertaken elsewhere to develop them at the UK and Devolved Government scale, to warrant their use within the Land Use Transformation project. Using the SSPs as an overarching framework can help us understand how key drivers influence land use, and how spatial resource biophysical constraints and opportunities determine localised possibilities. From this it may be possible to better assess the plausibility of achieving net zero objectives and hence inform key policy development questions.

To implement the use of scenarios within the Land Use Transformation project and develop analytical approaches, we have chosen to use two SSPs with contrasting scenario narratives: SSP1 – Sustainable development, as it aligns with the Scottish Government social, economic and environmental objectives and is associated with the higher probability of achieving the Paris Agreement target of keeping global warming below 2°C; and SSP3 – Regional Rivalry, as it provides a 'cautionary tale' on the consequences were policy ambitions are not achieved, and leads to warming in excess of 2°C and challenges for societal development and environmental quality.

A key challenge and essential step is to translate the SSP into land use transformation narratives. This is underway and presented as an evolving Land Use Transformations story map.

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1 Introduction

1.1 Scope of this report

This report is an output of analysis within the Land Use Transformations (LUT) research project (C3-JHI-1) part of the 2022-27 Scottish Government (SG) Strategic Research Programme. The LUT project has a focus on how to deliver high level policy outcomes – especially achieving "Net Zero and other environmental objectives". The LUT project takes a broad approach to land use, recognising the need to understand and integrate multiple uses of land to deliver the Scottish Government's Economic Transformation and the Bute House priorities. This report presents how global Shared Socio-economic Pathways (SSPs) narratives can be used to inform research on Land Use Transformation in Scotland.

1.2 Why the SSPs matter for analysing Scotland's land use

There are five main SSPs developed by the global climate and Integrated Assessment modelling communities (Raihi et al 2017) and used by the IPCC in their Climate Change Assessments, including in the 6th Assessment Report (IPCC 2021). The RCPs are used to help to categorise sets of alternative future climate change scenarios for research on impacts, mitigation and adaptation and for use in policy development and planning by governments.

People via their decisions on, and interactions with land cover, land use and management and their consumption of land-based goods and services, will need to play large roles in helping to achieve net zero emissions by 2045. For example, the global food system accounts for one third of all GHG emissions (Crippa et al 2021). The UK Climate Change Committee latest report indicates that current programmes of decarbonisation will not achieve net zero in the UK and acknowledge that both individual and societal behaviour change is essential in transforming to a low carbon economy (CCC 2022).

However, decisions within land use and management are influenced by many key external drivers, not all of which are aligned with transition toward net-zero emissions. The use of the SSPs is an informative way of helping to organise and understand these drivers, the scale on which they operate, their direct and indirect consequences and how they may influence localised responses to combined climate change impacts, mitigation needs and adaptation responses. SSPs aspire to be internally coherent narratives that combine drivers and the pressures or impacts they generate, the states of the land use or other systems and the socio-political responses (normative based choices).

1.3 Objectives for the analysis

The objective of this report is to present the development of Scotland-focussed SSPs and their use to inform discussion and analysis on Land Use Transformation. We seek to understand how drivers within the SSP narratives could interact with, and otherwise influence, achieving Scotland's net zero emissions and other environmental objectives. The report shows the way in which SSP scenarios were chosen and translated into a Scottish context. The report shows the importance of using map-based analysis to test and/or make spatially explicit the implications of the SSPs (how much of what of where) to facilitate both macro- and micro- analysis.

Use of SSPs means the need to consider several questions that together can frame and make more credible future land sue scenarios. These questions include:

- What are the SSP alternative assumptions and their implications?
- What could a Scotland level net zero pathway look like, considering both external drivers and the need to avoid emissions offshoring.
- How might the broad SSP narratives be interpreted to inform assumptions on future, local drivers of land use, e.g. population, GDP, energy use.

- What level of SSP detail is needed to be useful for assessing drivers and impacts on land use?
- What does Scotland actually need to adapt to (not just climate but also competing objectives for land etc.)?
- What are the relationships between sectors. For example, what happens to net zero goals for land use and agriculture if other sectors miss their targets?

2 About the Shared Socio-economic Pathways

2.1 The five SSP scenarios

The Shared Socio-economic Pathways (SSPs) describe a set of possible trajectories of how society may develop in the future. They are based on hypotheses about which societal elements are the most important determinants of response to climate change mitigation and adaptation challenges and make explicit the uncertainty in the magnitude of future climate change.

The SSPs were developed by an international team of climate scientists, economists and energy systems modellers. The SSPs were an evolution of earlier scenarios developed for the IPCC (Nakicenovic et al 2000).

Five main SSPs were developed covering a combination of challenges to mitigation and adaptation (Figure 1):

- **SSP1: Sustainable Development** (Low challenges to mitigation and adaptation)
- **SSP2: Middle of the Road** (Medium challenges to mitigation and adaptation)
- **SSP3: Regional Rivalry – A Rocky Road** (High challenges to mitigation and adaptation)
- **SSP4: Inequality – A Road Divided** (Low challenges to mitigation, high challenges to adaptation)
- **SSP5: Fossil-fuelled Development – Taking the Highway** (High challenges to mitigation, low challenges to adaptation)

Table 1 in Appendix 2 provides summarises we have made of the original source narratives for each SSP. The published papers detailing the SSPs are available in Global Environmental Change issue 42

Figure 1 (below) illustrates the overall position of the SSPs in respect of degree of global socio-economic challenges for adaptation and mitigation. We also provide illustration of the data for population change and Gross Domestic Product (GDP) associated with each SSP and used in Integrated Assessment Models.

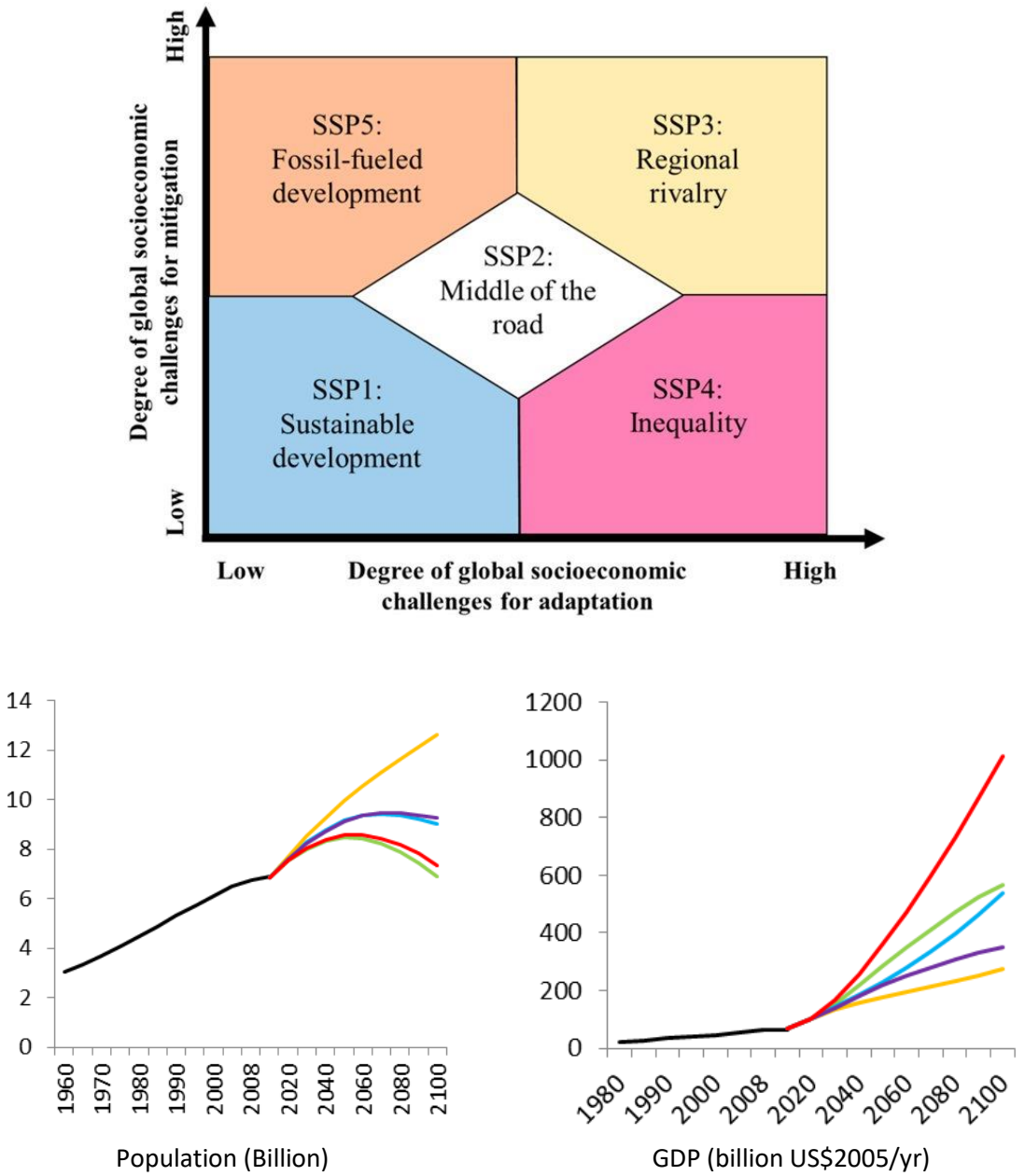


Figure 1: The five main Shared Socio-economic Pathways and their degree of global socio-economic challenges for mitigation of and adaptation to climate change (top) and associated data for two key drivers: Population (left) and Gross Domestic Product (ight). Green = SSP1; Blue = SSP2; Yellow = SSP3; Purple = SSP4; Red = SSP5

2.2 SSP scenarios and their alignment with SG policy positions

SSP 1 can be described as the one that aligns best with the Scottish Governments objectives in terms of achieving net zero, a Just Transition, National Outcomes and developing a Wellbeing based economy whilst seeking to achieve the Sustainable Development Goals. There are however implementation issues as well as gaps in the detail and coverage of the SSP.

Note: We have utilised SSP1 within a story map on Land Use Transformations to address the question "How land use change in Scotland can contribute to the delivery of net zero, climate adaptation and other environmental objectives"? The story map presents analysis of how land use in Scotland would need to change if the net-zero GHG emission, climate adaptation and other environmental objectives are to be achieved.

A further useful related set of reports are the Hamburg Climate Futures Outlook publications that consider the socio-technical plausibility of implementation of pathways that may lead to achieving the 1.5 or 2°C global warming targets[1]. This includes consideration of a scenario for decarbonisation that has similarities to SSP, hence the report findings, though taking a global perspective, are informative on questions of enabling or constraining drivers of change and behaviours in Scotland.

3 Using the SSPs

3.1 Benefits of the SSPs:

SSPs help organise plausible future visions and help identify the connectivity between drivers and their influence on societies, economies and to a limited extent (see below), the consequences on the environment. From this it becomes possible to consider links between drivers and impacts. This means they can be used to help indicate risks and cascading consequences, as well as trade-offs between key socio-economic drivers.

The SSP narratives can help to make consistent, credible, assumptions on societal development at a range of spatial scales and levels of detail, e.g., broad level questions about consequences of an SSP at a global level, or at a national or even regional level, though the latter require increasingly location specific interpretations of the broad SSP assumptions.

A further benefit is that the overall SSP based approach is one used by many organisations around the world including the IPCC, and in the UK, for the Climate Change Risk Assessment. This means different research approaches, each using the SSPs share the same explicit underlying assumptions, known caveats and an overall framework. This makes the research more consistent and comparable across a variety of national and international studies.

It is also worth noting that all of the SSP scenarios are considered to be plausible without any implication that one scenario is more likely to occur; and are not predictions. The longer the time horizon for any SSP the greater the inherent level of uncertainty becomes. It is also worth recognising that though each single SSP scenario is a unique overall pathway, they are all made up of a mix of potentially contrasting activities, e.g. an SSP scenario could include both sustainable intensification and regenerative / agroecology approaches to agriculture. The uniqueness comes from the balance of the activities – and where they occur.

3.2 SSP limitations

This section details issues that are important to aid understanding of how the SSPs can be used and what the boundaries are in respect of their utility. Whilst they are valuable assets in researching multiple aspects of climate change and development pathways, they were developed using some key assumptions and thus contain limitations.

3.2.1 Uncertainty on future climate

Alongside the SSPs, a set of Representative Concentration Pathways (RCPs) were developed. RCPs detail trajectories of greenhouse gas (GHG) emissions and assumptions on their radiative forcing (see Text Box 1) to make explicit the uncertainty on future climate regimes.

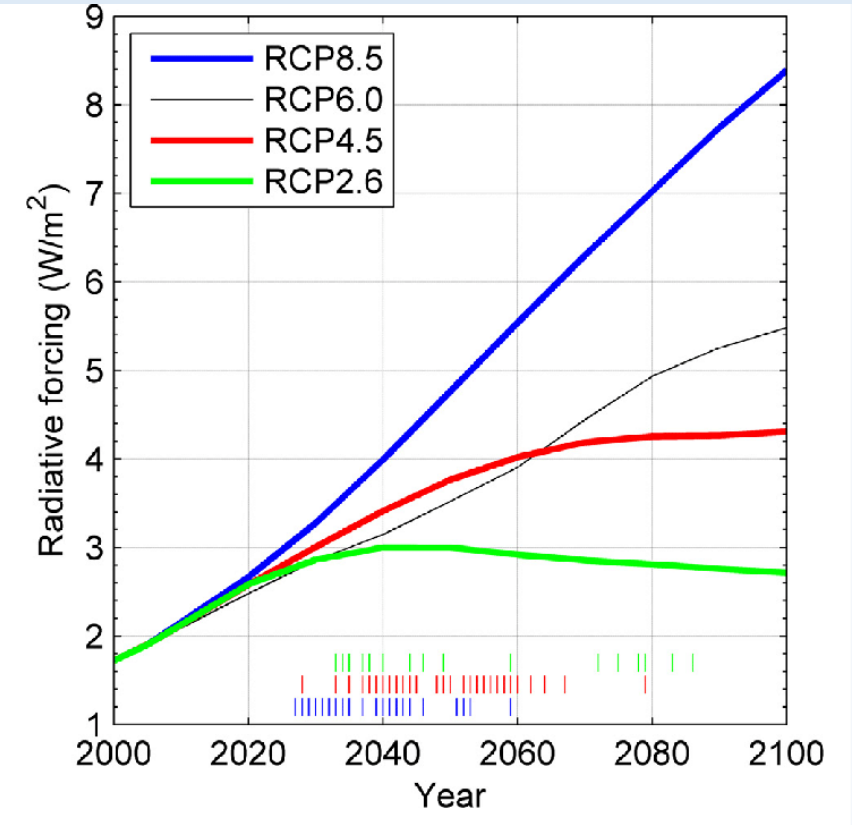
Four main RCPs were developed, spanning a broad range of radiative forcing in effect by 2100 (2.6, 4.5, 6.0, and 8.5 watts per meter squared). For each SSP there can be multiple RCPs that can plausibly be associated with them. However, some RCPs are not compatible with some SSPs, e.g., RCP2.6 (lowest

[1] Hamburg Climate Futures Outlook 2021: Hamburg Climate Futures Outlook 2021 (uni-hamburg.de)
Hamburg Climate Futures Outlook 2023: Hamburg Climate Futures Outlook 2023 (uni-hamburg.de)

radiative forcing) with SSP5 (highest GHG emissions). The relationships between RCPs and SSPs are important as they make explicit the assumptions of how the pathway's narratives contribute to GHG emissions and ensure that modelling of climate change impacts has to explicitly take into account uncertainty.

Text Box 1: Illustrating Radiative Forcing

Radiative forcing measures how much energy is coming in from the sun (as solar radiation), compared to how much is leaving (as infrared radiation), hence is a term used to represent the 'greenhouse' effect and the balance of energy entering and leaving the Earth's atmosphere. High levels of greenhouse gases leads to higher levels of radiative forcing by affecting the balance by trapping more energy in the atmosphere (less infrared radiation leaving).



The amount of radiative forcing varies between the different Representative Concentration Pathways (RCP). The lowest RCP and associated radiative forcing is RCP2.6, which is seen as the one most likely to maintain temperatures below 2°C. RCP2.6 the one most aligned with SSP1.

Full details on radiative forcing are available from the IPCC:
2.2 Concept of Radiative Forcing - AR4 WGI Chapter 2: Changes in Atmospheric Constituents and in Radiative Forcing (ipcc.ch)

3.2.2 The entrained climate change – adaptations, dynamics and feedbacks

Even if at a global level as the commitments to net zero emission are delivered then there will still be a substantial degree of climate change caused by emissions to date and during the transition to net zero. These entrained climate changes are unavoidable, though their degree can be lessened by faster progress to net zero, but adaptation to climate change impacts will be required.

The SSPs, though contain little on how climate change impacts on the environment and how this can disrupt assumed societal development pathways. The assumption in the SSPs is, that global ecosystems will continue to provide ecosystem services without interruption. This is not a safe assumption as the SSPs may have potentially under-estimated both the scale of ecological impacts of climate change and of their consequences for societal development.

Where ecological tipping points exist (e.g., risk of Amazon rainforest transformation to savannah) then risks of highly non-linear effects (large impact from small changes) mean the need for a strongly precautionary approach. The Intergovernmental Platform on Biodiversity and Ecosystem Services report (IPBES 2019) and the Dasgupta Report on the economics of biodiversity (Dasgupta 2021) both make clear that ecosystems are rapidly degrading, that biodiversity is at risk, and that these natural capitals have a fundamental role in supporting societies.

3.2.3 SSP plausibility - technical and social transformation

Some SSPs have the intention of delivering low/no net emissions and these align with ambitions of SG. There is though considerable debate and uncertainty concerning the feasibility of both technical and Nature-based Solutions (NbS) approaches to achieve net zero (e.g., with questions of feasibility of delivering the scale and intensity of new technology needed for carbon capture and storage, or the capacity for ecosystems to provide climate regulation ecosystem services under climate change impacts). There is also large uncertainty and many unknowns about the acceptability of the necessary transformations within society to deliver the require emissions reductions. This undermines the plausibility of some SSP scenarios.

For example:

> *"Very low emissions scenarios, if they are designed to achieve the Paris Agreement's 1.5°C target, require decarbonization of the global economy by around the year 2050. Many known technical or economic options would in principle achieve this decarbonization goal in time. Yet existing assessments have only begun to evaluate the plausibility of the societal transformations necessary for deep decarbonization. Such a plausibility assessment requires the definition of the political, economic, and cultural conditions under which the necessary transformations become plausible".* (Stammer et al. 2021)

On this basis, Stammer et al. (2021) develop a framework to assess a set of ten social drivers and their effects on decarbonisation. They found that none of their drivers showed sufficient movement toward deep decarbonization, and two of their social drivers, consumption patterns and corporate response, currently oppose decarbonization.

4 Translating the SSPs to a UK context

The SSPs were originally developed at the global scale with regional contexts (e.g., the UK was considered part of Europe). To translate the SSPs to a more detailed UK level, the Meteorological Office commissioned a project, UK-SCAPE, funded by the UK Climate Resilience Programme, to 'downscale' and extend the global SSPs to the UK and Devolved Government scale. UK-SCAPE identified 14 key drivers that underpin the UK's societal development this century:

- Demography
- Economic Development
- Education
- Energy
- Food
- Health
- International Relations
- Natural Resources
- Policy and Governance
- Public Attitudes
- Response to Global Shocks
- Social Structure
- Technology
- Transport

The connectivity between the 14 key drivers in the UK-SCAPE translation for each SSP has been set out, for example *UK-SSP1 Sustainability | Insight Maker* for SSP1 and UK-SSP3 Regional Rivalry | Insight Maker for SSP3.

Whilst including some regional aspects, this project had limited scope for incorporating key spatial elements, particularly the spatial configuration of natural resources, land use and interaction with socio-ecological systems (e.g., land-based industry infrastructure). Full details about the UK-SCAPE translations of the global SSPs to a UK context are available here: *UK Shared Socioeconomic Pathways (UK-SSPs) | UK-SCAPE | UK Centre for Ecology & Hydrology (ceh.ac.uk).* A useful infographic is available here: UK-SSPs infographic - (ukclimateresilience.org). A list of products, including videos detailing the UK-SSPs is available here: Products of the UK-SSPs project - (ukclimateresilience.org). A description of each SSP for the whole UK and Devolved Governments is provided in *Appendix 2 – UK SSP scenarios*.

5 Conclusions, SSP choices and next steps

The overview presented here of the Shared Socio-Economic Pathways has highlighted their benefits in providing a structure and set of narratives of plausible future societal development that facilitates the development of analyses of land use transformations in a Scottish context that also considers global scale drivers. We have also presented details of the assumptions and caveats that limit the scope of the use of the SSPs. These assumptions and caveats do not prevent the utilisation of the SSPs but highlight the need for caution when using them in developing analytical approaches.

The research being undertaken in the Land Use Transformations project (JHI-C3-1), and elsewhere in the SRP (e.g. C5 Large Scale Modelling and D5-2 Climate Change Impacts on Natural Capital) can, to some extent, help to address issues concerning the lack of feedback from climate change impacts on development pathways. For example, through use of spatial impacts modelling (e.g., of diffuse pollution, soil erosion, GHG emissions from land, benefits of habitat connectivity, changes in land capability and crop production). From these it may be possible to identify constraints to, or opportunities for localised variations of a "standard" SSP development pathways to unfold.

The resource requirement to assess all five SSPs is beyond the capacity of the LUT project, hence it is necessary to select those that are most appropriate for the research purposes (i.e., an SSP closest to the desired direction of travel as elaborated by SG and a "cautionary tale" one to highlight the consequences were the policy ambitions not realised. Based on our knowledge of the SSPs, we chose to use two SSPs representing very different future societies and the pathways by which they develop and contrasting levels of global temperature increase:

- SSP1: Sustainable Development, as this is the pathway that has the better potential to avoid catastrophic climate change and aligns with the Sustainable Development Goals. In this sense it may be seen as a more 'desirable' pathway, with the narratives on land use and land use change being relevant to Scottish Government policy. The emissions associated with SSP1 (for each relevant RCP) lead to the lower levels of projected climate warming.

- SSP3: Regional Rivalry will be used as it presents a plausible “worse case” pathway that results in increased emissions and thus increases the risk of severe climate impacts.

By using the SSPs as an overarching framework to understand how key drivers influence land use (top down) and how spatial resource biophysical constraints and opportunities determine localised possibilities (bottom up), it may be possible to better assess the plausibility of achieving net zero objectives and hence inform key policy development questions.

Translating an SSP into land use scenarios is hence a key challenge but an essential step and is reported in the Land Use Change Story Map - https://storymaps.arcgis.com/stories/c3d3feff85f14460b6c973127089d6f9.

This presents a Scotland-wide land use change scenario informed by SSP1 - focussing on a by 2050 scenario of low emissions towards net zero. The story map provides further details on the process of developing the scenario mapping development that enables the spatial context analysis.

Appendix 1 – Global SSP Narratives

Table 1: Overview summary of the global scale Shared Socio-economic Pathways narratives (Note: abridged summary made by this report's authors).

SSP	Name and Narrative summary and reference
1	**Sustainable Development 'Take the Green Road'** (Low challenges to mitigation and adaptation) - Slow move towards a sustainable path; inclusive development that respects perceived environmental boundaries. Management of the global commons slowly improves, educational and health investments accelerate the demographic transition, and the emphasis on economic growth shifts toward a broader emphasis on human well-being. Driven by an increasing commitment to achieving development goals, inequality is reduced both across and within countries. Consumption is oriented toward low material growth and lower resource and energy intensity (van Vuuren et al 2017[2]).
2	**Middle of the Road** (Medium challenges to mitigation and adaptation) - The world follows a path in which social, economic, and technological trends do not shift markedly from historical patterns. Development and income growth proceeds unevenly, with some countries making relatively good progress while others fall short of expectations. Global and national institutions work toward but make slow progress in achieving sustainable development goals. Environmental systems experience degradation, although there are some improvements and overall the intensity of resource and energy use declines. Global population growth is moderate and levels off in the second half of the century. Income inequality persists or improves only slowly and challenges to reducing vulnerability to societal and environmental changes remain (Fricko et al 2017).
3	**Regional Rivalry 'A Rocky Road'** (High challenges to mitigation and adaptation) - A resurgent nationalism, concerns about competitiveness and security, and regional conflicts push countries to increasingly focus on domestic or, at most, regional issues. Policies shift over time to become increasingly oriented toward national and regional security issues. Countries focus on achieving energy and food security goals within their own regions at the expense of broader-based development. Investments in education and technological development decline. Economic development is slow, consumption is material-intensive, and inequalities persist or worsen over time. Population growth is low in industrialized and high in developing countries. A low international priority for addressing environmental concerns leads to strong environmental degradation in some regions (Fujimori et al 2017).
4	**Inequality 'A Road Divided'** (Low challenges to mitigation, high challenges to adaptation) - Highly unequal investments in human capital, combined with increasing disparities in economic opportunity and political power, lead to increasing inequalities and stratification both across and within countries. Over time, a gap widens between an internationally connected society that contributes to knowledge- and capital-intensive sectors of the global economy, and a fragmented collection of lower-income, poorly educated societies that work in a labour intensive, low-tech economy. Social cohesion degrades and conflict and unrest become increasingly common. Technology development is high in the high-tech economy and sectors. The globally connected energy sector diversifies, with investments in both carbon-intensive fuels like coal and unconventional oil, but also low-carbon energy sources. Environmental policies focus on local issues around middle- and high-income areas ((Calvin et al 2017).
5	**Fossil-fuelled development 'Taking the Highway'** (High challenges to mitigation, low challenges to adaptation) - This world places 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. Global markets are increasingly integrated. 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 and the adoption of resource and energy intensive lifestyles around the world. All these factors lead to rapid growth of the global economy, while global population peaks and declines in the 21st century. Local environmental problems like air pollution are successfully managed. There is faith in the ability to effectively manage social and ecological systems, including by geo-engineering if necessary (Kriegler et al 2017).

[2] Note: Abbreviated from original source

Appendix 2 – UK SSP scenarios

SSP1: Sustainable Development- towards net zero

See UK-SSP1-ScenarioFactSheet.pdf (ukclimateresilience.org) for UK-SCAPE full narrative description.

SSP1: Main features: • Public support for the environment • Strong public and government support for regionalisation & sustainable development
Land Sector: • Tax relief on land ownership abolished by the 2030s • Sustainable intensification in agriculture • Reduced externalities of agro-food systems, nationally and internationally • UK-CCC[3] recommendations followed • "Abandoned" (low grade?) land is devoted to species conservation
Between 2020 to 2040: • Public support for the environment • Strong public and government support for regionalisation & sustainable development
Between 2040 to 2070: • Gradual development of a non-monetary economy • Enhanced nature protection on a wide scale and application of the polluter pays principle • Network of connected "core areas" of habitats and protected areas • Reduced nutrient input to land + stream buffers • Restoration of riparian woodlands to mitigate water temperature increase • Govt policies oriented to strong sustainability: • Rapid move to carbon neutral transport by the 2050s • Free public transport and infrastructure for bike transport • Remote-working
By 2100: • Circular economy fully implemented • Food waste and poverty is eliminated

SSP2: Middle of the Road

See UK-SSP2-ScenarioFactSheet.pdf (ukclimateresilience.org) for UK-SCAPE full narrative description.

SSP2: Main features: • Economic growth but higher inequality than at present • Remote working is widespread • Private-public partnerships deliver services • Improved spatial planning • Cities become city-states late in the century
Between 2020 to 2040: • Healthcare and pensions mostly privatised • Public-private partnerships finance deliver technological development in transport, energy and IT sectors • UK maintains a strong role international role • Strong competition between land-use types, e.g. high-speed rail vs housing or agriculture • Environmental planning improves

[3] Climate Change Committee: Climate Change Committee (theccc.org.uk)

Between 2040 to 2070: • Environmental shocks trigger improvements in genomics and agricultural resilience to pests • Existing farm payments replaced by Payments for Ecosystem Services schemes (PES) • Nuclear power boost, financed by public-private partnerships • Strong water crisis in the south of England in the 40s [summer droughts in the East of Scotland]
Between 2070 to 2100: • **Expanded urban areas and higher population** • Expanded green infrastructure • Effective agriculture intensification: large-scale vertical agriculture & lab-based meat production; participatory planning is widespread

SSP3 – Regional Rivalry

See [UK-SSP3-ScenarioFactSheet.pdf (ukclimateresilience.org)] for UK-SCAPE full narrative description.

SSP3: Main features: • Barriers to trade • Low or no growth: stagflation & high poverty levels • Populist politics • UK-based manufacturing • Environmental regulations strongly curtailed and not enforced • UK breaks apart • Most public spending on defence • Transition to self-subsistence lifestyle (late century)
Present to 2040: • Barriers to trade result in focus on national manufacturing sector • Expansion of agriculture for food security • Environmental regulations lifted to help economic “growth” & food production • UK increasingly closes its borders • Funding for health care, education and science restricted • High expense on defence • Foreign Immigration decreases (semi-militarised borders) • Exploited workforce, increase of working poor • Nationalism leads to political and social tensions between UK countries
Between 2040 to 2070: • Around 2040, the UK breaks up into four nations • Strict border control results in decreased trade between the 4 UK countries • Internal migration increases to search for jobs, leading to regional tensions • Defence spending continues to be prioritised at the expense of health care, welfare, and public infrastructure spending • Previously eradicated diseases return to the UK • Collapse of the Railway system and National Health Service • Agricultural area expands significantly as growing food becomes essential for household’s food security • Widespread return to subsistence farming and bartering systems

SSP4: Inequality

See UK-SSP4-ScenarioFactSheet.pdf (ukclimateresilience.org) for UK-SCAPE full narrative description.

SSP4: Main features: • High inequality: rich elites and poor masses • National Strategy Development Plan promotes green technology & growth • The North-South divide widens • Demise of the welfare state
Between 2020 to 2040: • National Strategy Development Plan (NSDP) o Promotion of STEM[4], teleworking o Promotion of agribusiness and bioenergy o Intensification & vertical farming o Low environmental regulation o Urban expansion on prime land • Efficient transportation supports economic development • Open borders for skilled immigrants • Working poor and food insecure households increase
Between 2040 to 2070: • Values of generation Alfa (born in 2010s) transform society: o Business culture o Individualistic lifestyles o Recreational drugs o Privatised services • International skilled workforce • Removal of access to public land (lack of demand) • Welfare state reduced
Between 2070 to 2100: • Economic deterioration • Inequality increases as resources are limited • High crime levels • Gated communities and slums develop • High levels of property concentration, including land • Widespread forestry plantations, bioenergy fields indoor farming

SSP5: Fossil-fuelled Development

See UK-SSP5-ScenarioFactSheet.pdf (ukclimateresilience.org) for UK-SCAPE full narrative description.

SSP5: Main features: • High energy-high emissions lifestyles • Reduced support for carbon taxation • Shale gas development drives growth • Economic growth and high welfare • National manufacturing • Reduction of North-South divide • High-tech development • Environmental tipping point
Between 2040 to 2070:

[4] STEM: Science, Technology, Engineering, Maths

- Financial shocks cause reduction in tax revenue
    - Reduced public support for carbon taxation
    - Increased demand for fossil fuels
- Shale gas production in Northern England leads to stable energy costs & high revenues and removal of North-South divide
- Low emphasis on curbing emissions. Positive trade-off with income
- Intensification of agriculture
- Environmental degradation starts to increase
- Increased spending on healthcare and (STEM) education
- Strong urban expansion – technology hubs
- Investments in manufacturing and high-tech development increases exports

Between 2070 and 2100:

- Fossil fuel energy prices begin to increase
- UK technology and manufacturing sectors are still internationally competitive and exports increase
- Cities expand
- Environmental degradation : uplands/lowlands divide
    - Good environmental conditions in the uplands, but loss of habitat and pollution in the lowlands: high extinction levels
    - Environmental feedback reduce water resources and land productivity
    - Tipping points lead to securing resources with other solutions (sic)

References:

Calvin K., B. Bond-Lamberty, L. Clarke, J. Edmonds, J. Eom, C. Hartin, S. Kim, P. Kyle, R. Link, R. Moss, H. McJeon, P. Patel, S. Smith, S. Waldhoff, M. Wise (2017) The SSP4: A world of deepening inequality. Global Environmental Change 42, 284-296. http://dx.doi.org/10.1016/j.gloenvcha.2016.06.010

CCC (2022) Progress in reducing emissions 2022 Report to Parliament. Climate Change Committee. ISBN 978-1-5286-3372-7. https://www.theccc.org.uk/wp-content/uploads/2022/06/Progress-in-reducing-emissions-2022-Report-to-Parliament.pdf

Crippa, M, E. Solazzo, D. Guizzardi, F. Monforti-Ferrario, F. N. Tubiello & A. Leip (2021) Food systems are responsible for a third of global anthropogenic GHG emissions. Nature Food 2, 198–209. https://www.nature.com/articles/s43016-021-00225-9

Dasgupta P. (2021) Final Report - The Economics of Biodiversity: The Dasgupta Review. UK HM government. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/962785/The_Economics_of_Biodiversity_The_Dasgupta_Review_Full_Report.pdf

Stammer, Detlef; Anita Engels; Jochem Marotzke; Eduardo Gresse; Christopher Hedemann; Jan Petzold (eds.); 2021. Hamburg Climate Futures Outlook 2021. Assessing the plausibility of deep decarbonization by 2050. Cluster of Excellence Climate, Climatic Change, and Society (CLICCS). Hamburg, Germany.

Dimbleby (2020) National Food Strategy Part One. https://www.nationalfoodstrategy.org/wp-content/uploads/2020/07/NFS-Part-One-SP-CP.pdf

Dimbleby (2021) National Food Strategy – Independent Review. The Plan. HM Government. https://www.nationalfoodstrategy.org/wp-content/uploads/2021/07/1669_NFS_The_Plan_July21_S11.pdf

Fricko O., et al (2017) The marker quantification of the Shared Socioeconomic Pathway 2: A middle-of-the-road scenario for the 21st century. Global Environmental Change 42, 251-267. http://dx.doi.org/10.1016/j.gloenvcha.2016.06.004

Fujimori S., T. Hasegawa, T. Masui, K. Takahashi, D.S. Herran, H. Dai, Y. Hijioka, M. Kainuma (2017) SSP3: AIM implementation of Shared Socioeconomic Pathways. Global Environmental Change 42, 268-283. http://dx.doi.org/10.1016/j.gloenvcha.2016.06.009

IPBES (2019) Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. E. S. Brondizio, J. Settele, S. Díaz, and H. T. Ngo (editors). IPBES secretariat, Bonn, Germany. 1148 pages. https://doi.org/10.5281/zenodo.3831673

IPCC (2021) Summary for Policymakers. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S. L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M. I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T. K. Maycock, T. Waterfield, O. Yelekçi, R. Yu and B. Zhou (eds.)]. Cambridge University Press.

Kriegler E., et al (2017) Fossil-fueled development (SSP5): An energy and resource intensive scenario for the 21st century. Global Environmental Change 42, 297-315. http://dx.doi.org/10.1016/j.gloenvcha.2016.05.015

Kriegler, E., Edmonds, J., Hallegatte, S. *et al.* (2014) A new scenario framework for climate change research: the concept of shared climate policy assumptions. *Climatic Change* 122**,** 401–414. https://doi.org/10.1007/s10584-013-0971-5

Nakicenovic, N. et al (2000). *Special Report on Emissions Scenarios: A Special Report of Working Group III of the Intergovernmental Panel on Climate Change*, Cambridge University Press, Cambridge, U.K., 599 pp. Available online at: http://www.grida.no/climate/ipcc/emission/index.htm

Riahi K., et al (2017) The Shared Socioeconomic Pathways and their energy, land use, and greenhouse gas emissions implications: An overview. Global Environmental Change 42, 153-168. http://dx.doi.org/10.1016/j.gloenvcha.2016.05.009

Rivington M, Duckett D, Burgess P, Begg, G, Iannetta P, Haws C, Stewart D, (2021) Post-COVID-19 land use options for healthy diets and environment: Report on the opportunities and constraints of UK food and land management options in terms of production potential and environmental impacts. The James Hutton Institute. D4 Report Post-Covid-19 land use options to achieve food security FINAL 12-12-21-21.pdf (hutton.ac.uk)

van Vuuren D.P., et al, (2017) Energy, land-use and greenhouse gas emissions trajectories under a green growth paradigm. Global Environmental Change 42, 237-250. http://dx.doi.org/10.1016/j.gloenvcha.2016.05.008

Williams A, et al (2018). Assessing the Environmental Impacts of Healthier Diets. Final report to Defra on project FO0427. Cranfield University. 79 pp.