UK-SSPs: setting out socioeconomic trajectories for climate resilience research

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Met Office

UK Research and Innovation

Motivation for the project

- No regionally enriched versions of the global SSPs are publicly available for the UK to combine with the UKCP18 climate projections
- This research seeks to address this gap
- The project builds upon previous work - CCC project 'Socioeconomic Dimensions for the CCRA3 Evidence Report' and the work of the UK-SCAPE project
- The work is to be completed in May 2021

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cambridge econometrics clarity from complexity
UK Centre for Ecology & Hydrology
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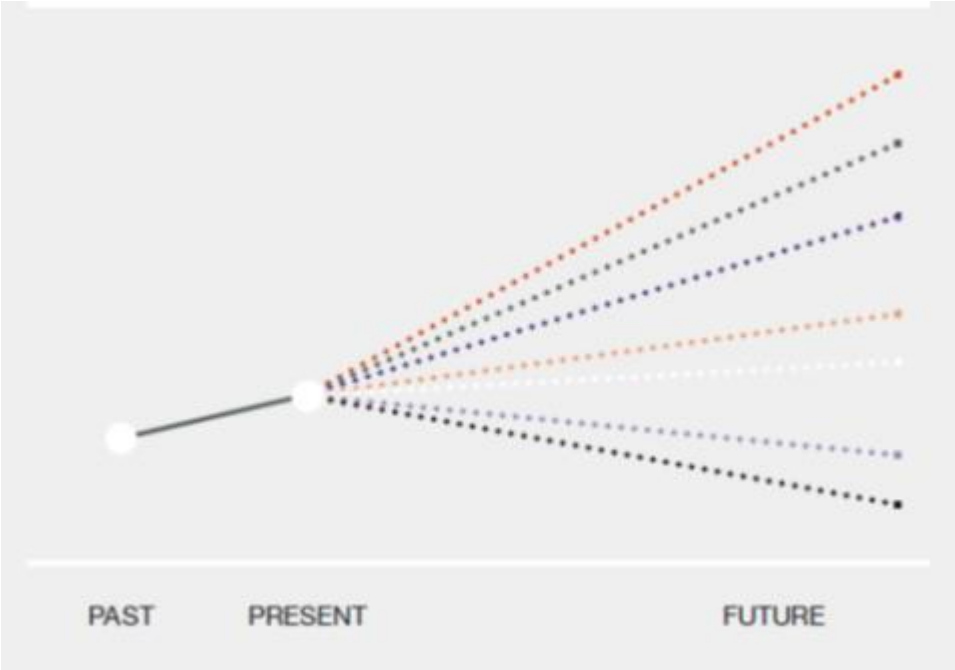
The role of scenarios and the SSPs

- Scenarios are tools to assess possible futures, acknowledging uncertainty – they are not predictions
- The SSPs are exploratory scenarios;
  - What *might* happen…
  - …not what we *want* to happen
- Climate change will interact with socioeconomic and political changes in complex ways
  - …and there are feedback loops between climate change, socioeconomics and (therefore) politics
- Socioeconomic factors also affect exposure, vulnerability and capacity to adapt to climate hazards
- **The development of spatially detailed UK SSPs will benefit future research into UK climate risk and resilience, including the 4th Climate Change Risk Assessment (CCRA)**

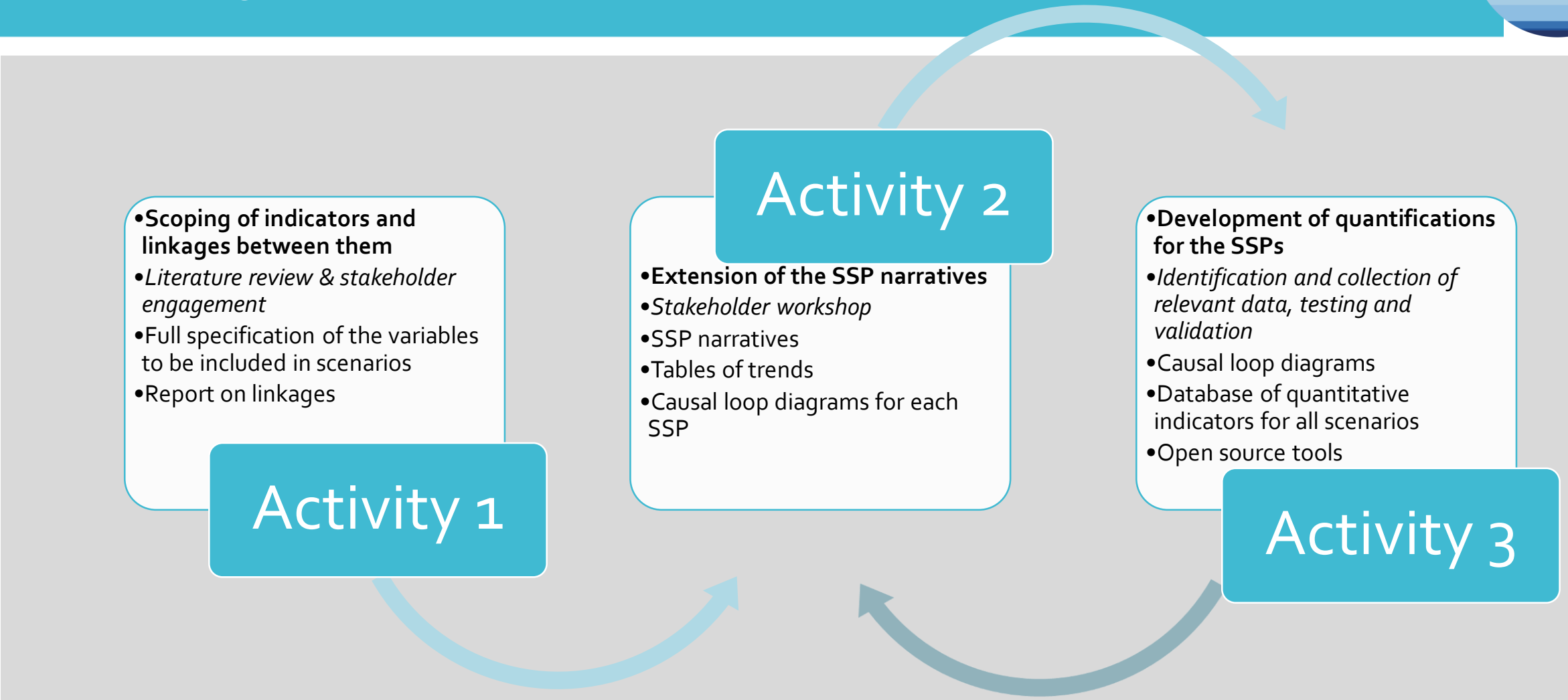


Project outcomes

- Narratives for all five SSPs for the UK and its constituent countries that have been regionally, sectorally and temporally extended from the global SSPs
- Tables of semi-quantitative trends for a wide range of socioeconomic indicators
- Quantifications for specific indicators at the appropriate temporal and spatial resolution
- A set of causal loop diagrams that visualise and quantify the interrelationships between the key drivers represented in the scenarios

Outputs are intended to support the research community interested in UK climate risk and resilience, including CCRA4

Key project activities



Activity 2 SSP narratives

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UK-SSP5 Fossil-fuelled Development

Abstract

Reduced public support for carbon taxation and taxes to finance green transform
to continued demand for cheaper and more readily available fossil fuels. Strong
manufacturing is supported by the discovery of shale gas, which leads to reduc
public investments in shale gas production in northern England heavily contrib
North-South divide. The economy increases exponentially providing benefits fo
protection is reduced and agriculture intensifies in lowland areas, whilst upland
Technological solutions are used to mask large-scale environmental degrad
population lead to rapidly expanding "city states" and massive urban sprawl.

Full narrative

Present to 2040

A series of shocks in the exchange of international financial services result in a
sector and loss of tax revenues. Reduced public support for carbon taxation a
transformation of infrastructure, lead to continued demand for cheaper and m
fuels. Public opinion also drives demand for domestic manufacturing and prod
strengthen the economy and create jobs. As government intervention is geared t
buy-in, energy security and immediate economic growth, the increase in demand
development results in the opening of more oil and gas fields from the North S
with cost-effective strategies.

Investments become targeted towards the manufacturing and technology se
manufacturing are supported by the discovery of sources of shale gas, which lea
when combined with the import of cheap fossil fuels from Europe. Shale gas pro
England becoming a net contributor to tax revenues, and hence receiving a
government investment. Shale gas, therefore, heavily contributes to the remova
This leads to a strong UK within a globalised economy with less interventionist go

Cities expand very fast, driven by the strong economic development in the tech
energy sectors and high population growth. This prevents a centralisation of
England. However, urban sprawl leads to a steady loss of agricultural land surr
throughout the UK. Strong competition for land also leads to an overall decreas
for land use is given to the urban and agricultural sectors. Urban spawl also
transport infrastructure, with a focus on road building and support for regional
investment in the rail network.

To meet increasing demand for food and other natural resources, the UK
administrations roll-back environmental protection legislation. Agri-environ
removed to maximise technologically-driven agricultural intensification. This lead
water for irrigation and decreasing water quality due to leaching from increasing
the lowlands and most markedly in former Nitrate Vulnerable Zones. This h
environmental health and biodiversity. Increasing faith in finding effective s
degradation is placed in overall technological and economic development, includ
(but not green technology). The UK also exports a large part of its environmental
world through increasing food imports. This supports livelihoods, particularly ir
and subsequently reduces global inequalities.

Domestically, lower unemployment and higher public income, arising from
economy, lead to increased spending on healthcare and education. Thi
healthcare, which results in general improvements in human health and life
importance, particularly for STEM, as young people are encouraged to gain
demand for highly skilled labour. Increases in employment income and r
"shale gas effect" stimulate growth in spending. This in turn feeds ba
technology sectors, helping to maintain buoyant economic growth.

Social structures are strongly influenced by the importance attached to
collective good. Consequently, whilst individual wealth and investment in
are at relatively high levels, there is little sense of community. Lifestyles
consumption of goods and services, such as cars, other manufactured ar
services. High incomes and the availability of free-time provide many oppo
Diets are high in red and white meat consumption, although fruit and veg
and consumed, especially those imported from overseas, including tropical

Thanks to these economic successes, the UK becomes less reliant on im
international trade. This includes increases in exports out of the UK, making
However, the UK also *de facto* ignores the Paris Agreement. Greenho
legislative binding instruments are not enforced upon the UK and adver
monitored.

2040 to 2070

Environmental health continues to deteriorate, with soils and water bodi
the UK lowlands. However, technological developments are used to de
environmental degradation, i.e. techno-fixes that deal with the conse
degradation. For example, the huge increases in water demand and decline
decades are addressed through increased water storage, inter-basin transfe
desalination plants. Therefore, water abstraction peaks at the end of the 2
on water availability, such as the agricultural sector, are not affected in spit

Agriculture becomes consolidated in fewer, larger farms on the most prod
have been spared from urban sprawl. Large increases in yields arising f
continue, but use of N and P fertilizers gradually decrease from 2040 be
Investments in crop breeding and nutrient-efficient farming technologies e
and profits from intensive lowland farms.

The removal of subsidies, increased productivity of lowlands and the increas
to a contraction in upland agricultural areas. Former upland farms are re-
acceptable to local communities who see opportunities for income ger
products such as game meat. By the 2060s, international tourism flourishes

The re-wilding of the uplands contributes to a relatively better environmen
tourism strategies are implemented to maintain the aesthetic value of th
includes a slight expansion in attractive native woodlands. Biodiversity is p
areas by the rewilding initiatives, including the maintenance of some Na
development of large estates for intensive tourism and sporting activities
other land with market value is commercially exploited, usually to the detr

Environmental impacts continue to increase, but the distribution of impac
more just. That is, the 'winners' compensate the 'losers' where develo

damage that affects some sectors of society, either through mon
targeted techno-fixes.

By the 2050s, UK society is very diverse and dynamic due to high m
and substantial international tourism. A housing boom results fro
especially in cities. Whilst migration is important in driving populatio
on skilled labour with restrictions on unskilled migrants. In spite of
conflicts do not arise as less land is needed for agriculture. In additio
driven by lassaiz-faire economics, becomes more inclusive and pa
needs. This includes market mechanisms to keep house prices at a le
the population. Cities become technology hubs and rapidly expand. T
and results in massive urban sprawl due to weak spatial planning poli

Governmental intervention through policy is in general relatively
investment in the education and health sectors, since these are consi
development. The drive to "hands-off" government means that t
relatively less important as disparities in wealth, education and health
is well educated and consumes high levels of goods and services, th
and this leads to low levels of unemployment, and equity of opportu
and corporate taxation levels are low, the overall strength of the
sufficient taxation income to invest in education and health.

Air pollution worsens within the city states and in general across th
lung diseases. But large investments in the National Health Service m
in reasonably good health as new drug treatments and technologi
transplants) become rapidly and widely available.

2070 to 2100

With increasing energy demand and decreasing availability of shale
increase. However, the UK technology and manufacturing sectors r
exports continue to increase. The problems of peak oil are lar
development and application of oil and gas exploration technology, ar
fuel resources on the global market.

Cities continue to expand, stimulated by further population increase
degradation continues, but as most of the UK population live in urb
natural environment. Because of high incomes and low unemployme
resource-intensive lifestyles.

Technological solutions are still sought for environmental degrad
successful. The water industry is able to maintain plentiful good qualit
ground- and surface-water less than present. But intensive agricultura
due to soil erosion and poor soil health despite agri-tech. Polarisati
increases in spite of the social distribution of the negative impacts o
biodiversity loss is more limited where rewilding took place (upla
disappeared in the degraded lowlands. As it becomes clear that techn
fully counteract the environmental damage of previous decades, ot
shortages and maintain living standards.

Country specificities in relation to the full narrative

The following paragraphs build on the main narrative, emphasising d
full narrative or providing specific regional examples. They should
narrative.

Scotland

As the UK as a whole becomes stronger, differences between t
Government becomes relatively less important in economic decision-
economic policies. However, Scottish Government maintains cor
Permission is granted for further exploration of new oil and gas fiel
the North Sea. Scottish Government also lifts bans on unconventi
including shale gas fracking and coalbed methane extraction, which fo
oil and gas plants are also opened in the Central Belt. These foss
Scotland, which it uses to improve the social governance system,
operates within the larger UK system. As the economic power of th
private partnerships form to ensure revenues are brought into the pu
redistributed in line with the "Scottish spirit". This is supported by
exploitation, but also compensation and redistribution of the wealth
from both corporations and the general public as society quickly be
and Glasgow thrive becoming city states with substantial urban sprav
high-tech hub. In the Scottish uplands, income from re-wilding comes
activities, including tourism, leisure, game meat and whisky. Fores
conifer plantations to provide timber and wood for wood-burning
production (e.g. Aberdeen Angus beef) expands in the uplands suppo
to meet the demand for cattle feed.

Wales

The power and autonomy of the Welsh Government erodes as Wale
on England increase. Fossil fuel exploitation leads to reduced inequa
as part of a UK-wide energy plan. A few locally produced and econom
especially in the least populated areas of mid-Wales and coastal
otherwise the energy mix of Wales shifts substantially to fossil fuels
back across the UK nations, Welsh Government legislation on sustain
the shale gas dividend through increases in their allocation of public e
in the UK economy. The infrastructure of key ports in Wales, particula
is further developed, turning them into major oil importing hubs. P
Wales experience more migration to cities and commuting to places
economy in Wales focuses on the development of niche markets for h
such as market gardening or fruit or potato production. These pro
consumers in Wales and the rest of the UK. Agricultural intensificatio
of eastern Wales (e.g. Wye Valley). The re-wilding of the Welsh uplan
abandonment of sheep breeding), being driven by income gener
including tourism and leisure, and game meat. As land becomes a c
land in Wales for tourism or niche agricultural activities, which is em
planning in Wales heavily relies on a vibrant tourism sector with w
England. Socially and politically, England begins to absorb Wales. Th
Wales becomes the "weekend playground" for tourists from English

England

The discovery and exploitation of shale gas in northern Englands strengthens ties across English regions and levels of society. The UK Government invests in extracting the energy resources in the north and ensures the economic benefits are redistributed across the country and throughout society through Sovereign funds. This results in a decline in the North-South divide. Communities in northern England that are impacted by the extraction of fossil fuels accept the impacts, as they receive lots of income for such high environmental impact activities. A hybrid public-private system, involving both central and local governements, slowly leads towards slighly more autonomy. Specific policies and interventions (e.g. shale gas) are administered by local governments, but taxes remain centralised in Westminster. Socio-economic differences across England are less related to social inequality, but rather to the source of income generation in the uplands and lowlands. The uplands are no longer needed for agricultural production and re-orientate towards high-value tourism, such as in the Yorkshire Dales and the Lake District. In the lowlands of England, much land is taken up by the expansion of cities into city-states with substantial urban sprawl. The remaining lowlands in southern and eastern England focus on highly intensive agriculture. Many staple foods are imported, so domestic production turns to high-quality meat, high-end specialised goods and artisan products.

Northern Ireland

With a move towards lassaiz-faire market economics by the UK government operating in a globalised world, Northern Ireland's economic ties with the Republic of Ireland increase. Extractions of hydrocarbons and shale gas around Northern Ireland (including fracking) escalate, particularly in the border region with the Republic of Ireland. This is facilitated by a weaker environmental framework and less public resistance to fossil fuel extraction as the population see the economic benefits from the "shale gas effect" in northern England. Multi-national energy companies work together with government in the search for new sources of fossil fuels through exploratory or extraction licenses. The increase in resource extraction in the cross-border area leads to greater collaboration between Northern Ireland and the Republic of Ireland. This also reinforces energy security so that local supplies can be supplemented by fossil fuel imports from both the Republic of Ireland and the EU. This collaboration extends to the agricultural sector where an all-Ireland free trade area for agricultural goods is established. The strong drive for economic growth partly overcomes historic political animosities, as economic interests overtake social priorities. This is reinforced through changing societal attitudes as people become wealthier, which become more individualistic and focused on making money, rather than notions of nationalism. Social and political tensions ease, but divisions are not completely overcome. The major cities in Northern Ireland expand rapidly as the country gradually urbanises. Belfast, in particular grows quickly but poor planning results in considerable urban sprawl. Other cities also grow, such as Derry, Newtownabbey and Craigavon, but Belfast dominates as the major city-state in Northern Ireland and a hub for the ICT sector. Derry expands to sprawl across the border into the Republic of Ireland further strengthening collaboration between the two countries. Increases in tourism to generate income lead to greater international visitors and urban growth around coastal towns, such as Bangor and Portrush. Pockets of protected areas remain in the uplands where they are particularly important for economic activity associated with local tourism.

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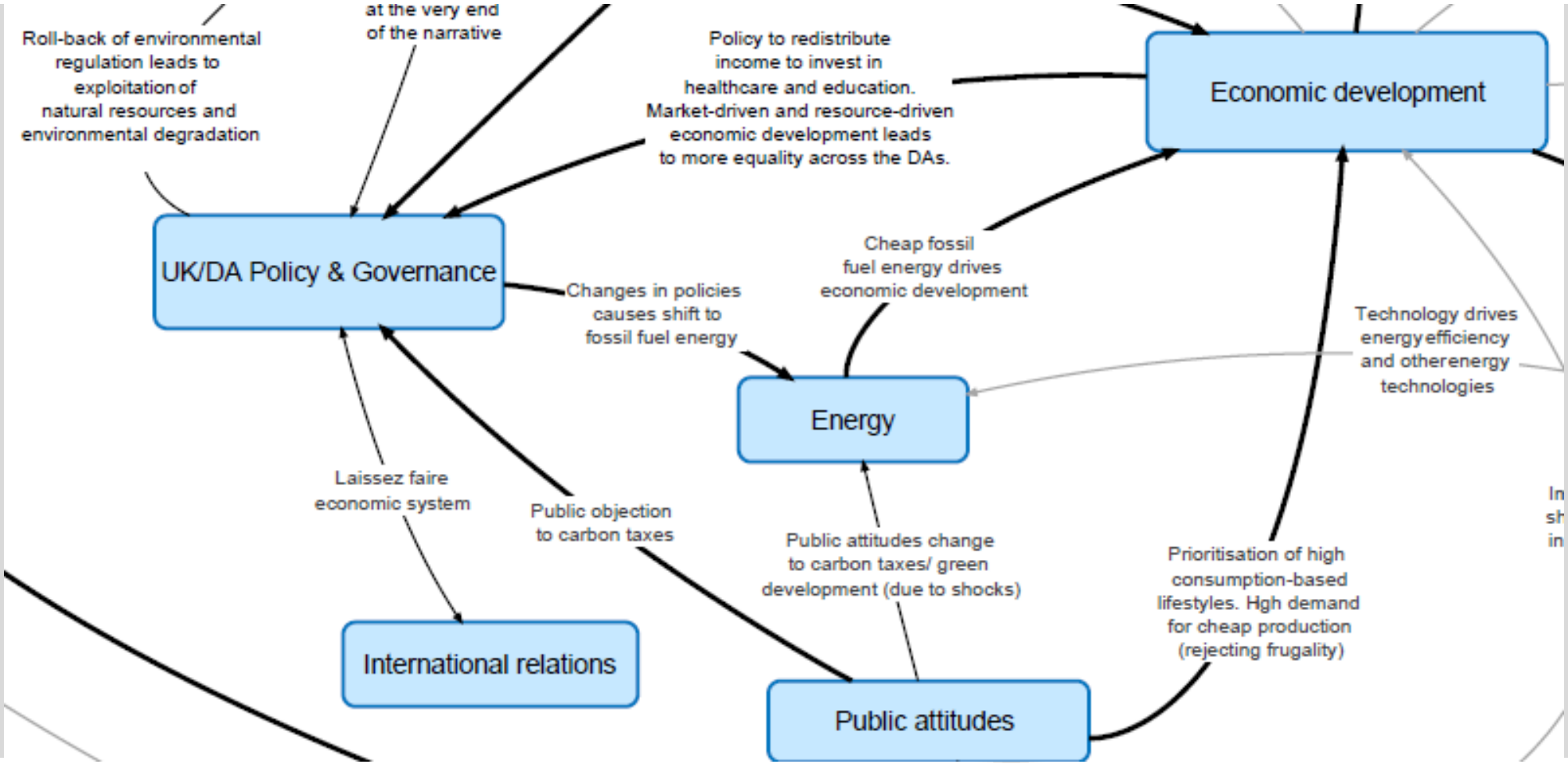
Activity 2 UK-SSP Systems Diagrams



Activity 2 Semi-quantitative trends

Trends identified in 7 categories relative to present:

---, --, -, no change, +, ++, +++

Variables cover wide range of socioeconomic drivers (societal, technological, environmental economic, cultural, policy/institutions).

Derived for 3 time periods:

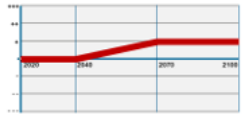
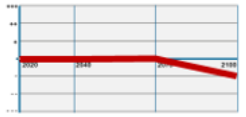
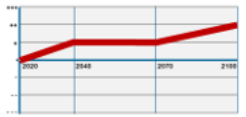
- Present to 2040
- 2040 to 2070
- 2070 to 2100

Fully consistent with narratives.

	SSP element	UK-SSP1	UK-SSP2	UK-SSP3	UK-SSP4	UK-SSP5
Society (Demographics and Human Development)	Population*	+; ++; ++	+; +; ++	+; -; ---	+; +; +	+; +++; +++
	Mobility	+; ++; +++	+; +; +	-; --; ---	--; --; ---	+; ++; +++
	Migration	0; - ;- (net-migration=0 in 2100)	0; 0; 0	-; -; -	-; -; -	+; +; +
	Urbanisation (overall: area and # people)	+, +, + (densely populated cities)	+, ++, +++ (central planned city-states)	+, ++, +++ (sprawl)	+, ++, ++ (ghettos, North-South divide)	+, ++, +++ (sprawl)
	Education	+; ++; +++	+; +; +	-; --; ---	--; --; ---	+; ++; +++
	Health investments	+; ++; +++	+; +; +	-; --; ---	--; --; ---	+; ++; +++
	Social cohesion/ participation	+; ++; +++	+; +; +	-; --; ---	--; --; ---	+; ++; +++
Technology	Tech Development	+; ++; +++	+; +; +	-; --; ---	--; --; ---	+; ++; +++
	Tech transfer	+; ++; +++	+; +; +	-; --; ---	--; --; ---	+; ++; +++
	Energy Development	+; ++; +++	+; +; +	-; --; ---	--; --; ---	+; ++; +++
	Agriculture yields	+; ++; ++	++; ++;++	++; 0; -	- ; 0; 0	++; ++; +++
	Water abstraction change	--; ---; ---	++; ++; +	0; +; 0	+; ++; ++	-; -; -
Environment	Protected areas **	+; ++; +++	0; 0; 0	---; ---; ---	---; ---; ---	---; ---; --- (environmental designation)
	Agriculture area**	---; ---; ---	++;++;+	0; +; 0	+; ++; ++	0; 0; 0
	Fertiliser use**	--;---;---	-;-;-	++;---;---	0;-;1	++;0;0

Activity 2 Semi-quantitative trends

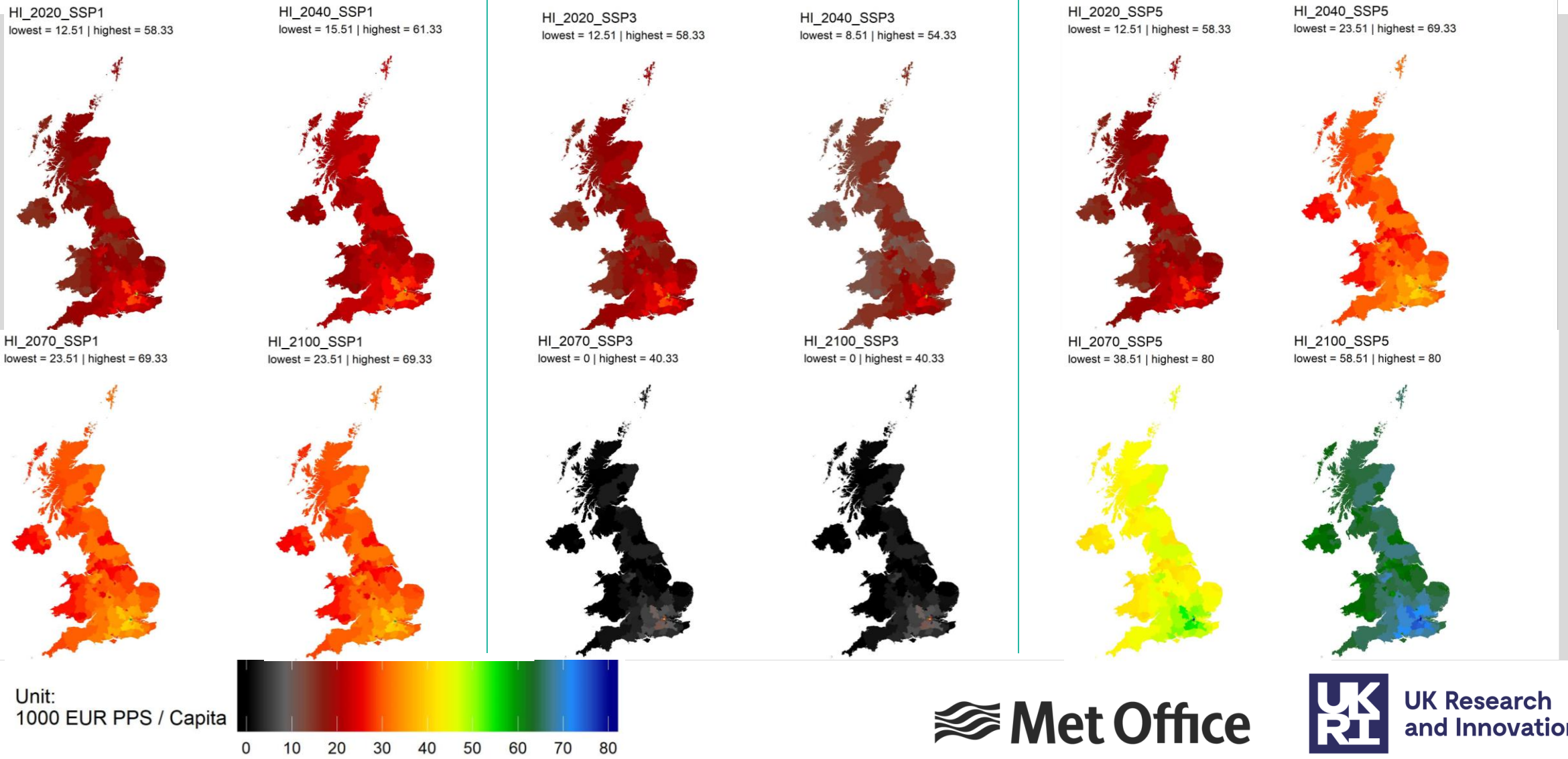
Table 2a: Semi-quantitative trends in variables related to the Society category of the STEEP driver classification.

Nr	Variable and definition	UK-SSP1			UK-SSP2			UK-SSP3			UK-SSP4			UK-SSP5		
		present – 2040	2040 – 2070	2070 – 2100	present – 2040	2040 – 2070	2070 – 2100	present – 2040	2040 – 2070	2070 – 2100	present – 2040	2040 – 2070	2070 – 2100	present – 2040	2040 – 2070	2070 – 2100
1	Population	0	+	+	0	+	+	0	-	- -	0	0	-	+	++	+++
	Population level based on IIASA SSP population projections (model IIASA-WiC POP)															
		Trends according to IIASA SSP population projections.			Trends according to IIASA SSP population projections.			Trends according to IIASA SSP population projections.			Trends according to IIASA SSP population projections.			Trends according to IIASA SSP population projections.		
2	Ageing	+	++	++	+	+	++	+	+	+	+	+	++	+	++	+++
	Proportion of citizens >65 based on IIASA SSP population projections (model IIASA-WiC POP)															
		Trends according to IIASA SSP population projections.			Trends according to IIASA SSP population projections.			Trends according to IIASA SSP population projections.			Trends according to IIASA SSP population projections.			Trends according to IIASA SSP population projections.		
3	Physical mobility	0	-	-	+	+	+	+	++	++	++	0	-	+	++	+++
	Level of physical intra-national mobility, transport and accessibility															
		Increasingly localised lifestyles.			Public-private partnerships promoting tech development in transport.			People migrate to regions with jobs and natural resources for subsistence.			First, tech development in transport connecting cities to support econ development. Then polarisation increases and the majority have to migrate to find better job opportunities.			Development of infrastructure is paramount to economic growth.		

Activity 3 Quantification of indicators

- A number of different approaches are applied to compiling quantifications;
  - Use of process-based and statistical models
  - Thematic models (UK CRAFTY, FTT-Power, E3ME)
  - Imposition of semi-quantitative trends onto historic baselines
  - Use of existing projections (e.g. from IIASA IAM database)
  - Downscaling of results to more detailed geographical levels
- Embed quantifications in system conceptualisations
- Consistency checks, testing of the final database

Activity 3 Preliminary projection maps – household income per capita



Activity 3: Example SSP5 Urban Land Cover Change

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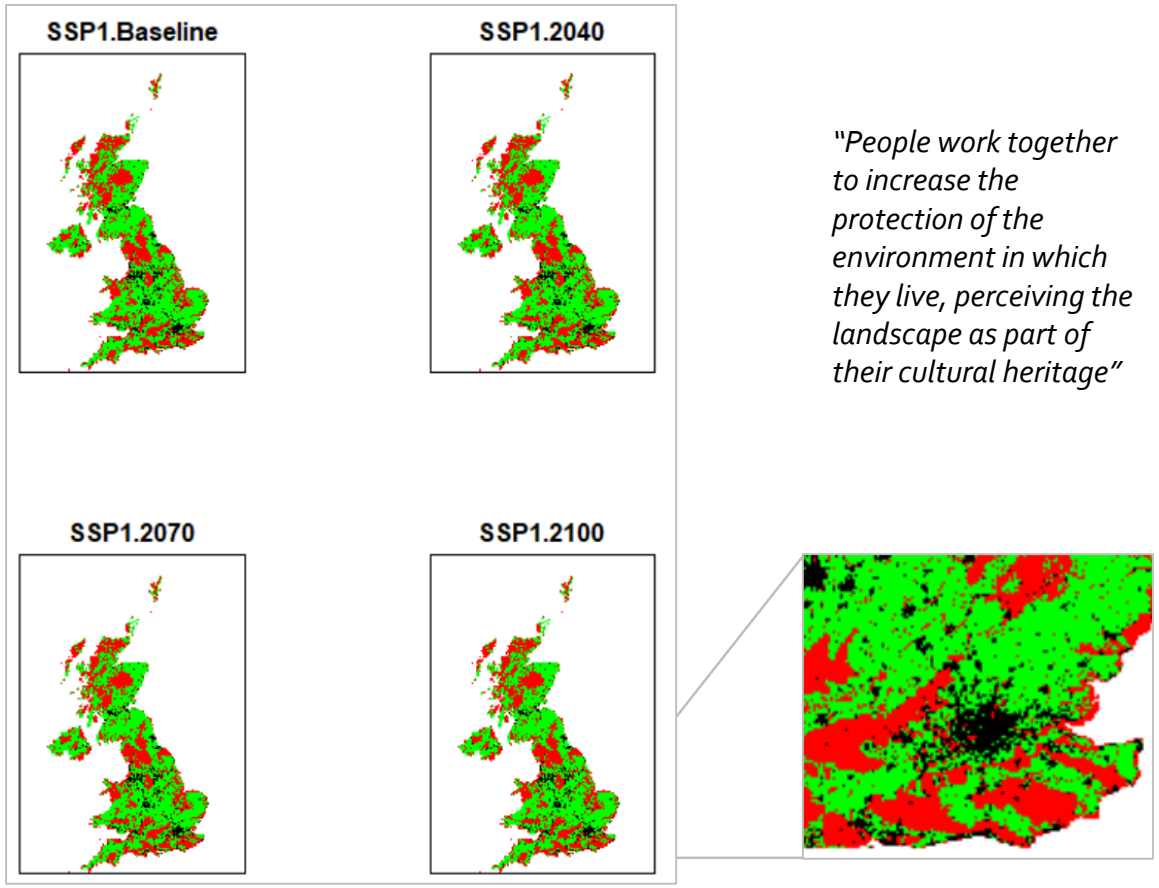
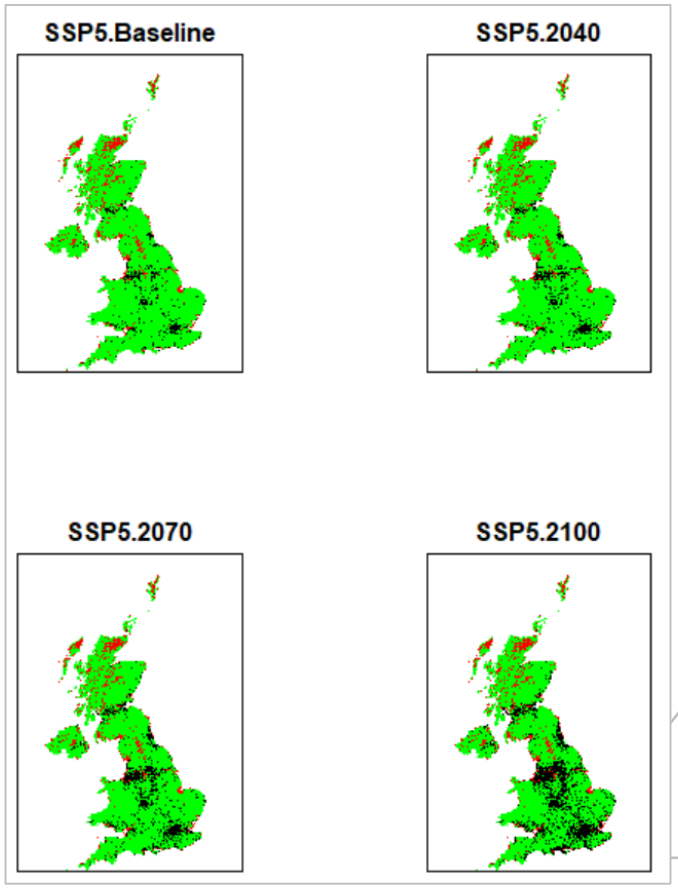
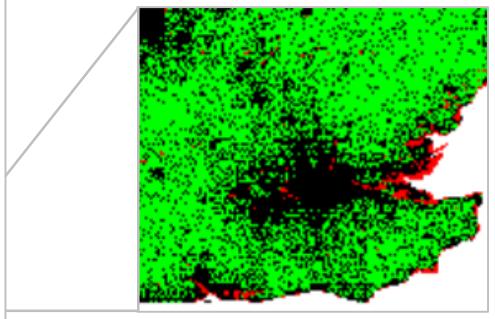


"People work together to increase the protection of the environment in which they live, perceiving the landscape as part of their cultural heritage"



"Large increases in population lead to rapidly expanding "city states" and massive urban sprawl."



black = urban
red = excluded (due to assumed environmental protection, floodrisk, or unsuitable surface)
green = other

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Any questions?

Thanks for your attention!

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Find out more

Websites
https://www.camecon.com/uk-socioeconomic-scenarios/
https://www.ukclimateresilience.org/projects/uk-socioeconomic-scenarios-for-climate-research-and-policy/

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UK CLIMATE RESILIENCE PROGRAMME

The UK Climate Resilience programme is supported by the UKRI Strategic Priorities Fund.
The programme is co-delivered by the Met Office and NERC on behalf of UKRI partners AHRC, EPSRC, ESRC.

Contact details

Website: www.ukclimateresilience.org

Twitter: @UKCRP_SPF

YouTube: UK Climate Resilience programme

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Activity 3 Indicators that are being quantified

First Priority	Second Priority
Population & Demographics, incl. Migration	Trade
Health (life expectancy) & healthcare (doctors)	Regional Development Transfers
Income Inequality	Infrastructure (road,rail)
GDP, GVA	R&D Expenses
Food Demand	Education (tertiary)
Employment & Incomes	Social Cohesion (neighbours help)
Food Production	Produced Capital
Land Use	Savings
Natural capital	Urbanisation
Emissions	Access to Housing
Technological Development	Water Use
Energy Supply, by Sources	Fibres Demand
	Agricultural Inputs Use

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