



Title

Peri-cene Policy Lab

Sub-title

A working knowledge
platform for peri-urban-
climate analysis & synthesis

Deliverable #

D3-1

Version, Date

Vo.92

December 2020

Author

Joe Ravetz

Publication details

Deliverable No.	D3-1
Work Package	WP 3
Main Author(s)	Joe Ravetz
Contributor(s)	
Date	12-12-20
Version	V0.92 – near final, pending internal review
Reviewed by (if applicable)	

This publication has been produced as part of the Peri-urbanisation and climate-environment interactions (Peri-cene) project. Peri-cene was funded by the Natural Environment Research Council (NERC), with the Economic and Social Research Council (ESRC) under the *Towards a Sustainable Earth* programme (2019 – 2021).

NERC is the UK's main agency for funding and managing research, training and knowledge exchange in the environmental sciences. Our work covers the full range of atmospheric, Earth, biological, terrestrial and aquatic science, from the deep oceans to the upper atmosphere and from the poles to the equator. We coordinate some of the world's most exciting research projects, tackling major environmental issues such as climate change, environmental influences on human health, the genetic make-up of life on Earth, and much more. NERC is part of UK Research & Innovation, a non-departmental public body funded by a grant-in-aid from the UK government.

Other funders of the programme included Formas, a Swedish government research council for sustainable development, and the Department of Biotechnology, India.

Peri-cene partners include the University of Manchester (UK), KTH Royal Institute of Technology (Sweden) and the Indian Institute of Technology Madras (India).

Front cover image: Kevin Gong @ Flickr [CC BY 2.0 (<https://creativecommons.org/licenses/by/2.0>)]



Contents

List of Tables	4
List of figures	4
1 SUMMARY	Error! Bookmark not defined.
1.1.1 Policy Lab Overview.....	6
1.1.2 Who are the partners?.....	6
1.1.3 How does the Policy Lab work?.....	7
1.1.4 What are the outcomes?	8
1.1.5 When does this happen?	8
1.1.6 What next?	9
2 POLICY LAB: SPATIAL MAPPING	10
2.1 Where is the peri-urban?.....	10
2.1.1 Mapping the peri-urban baseline	11
2.2 How is the peri-urban changing?	12
2.2.1 Global urbanization perspective.....	12
2.2.2 A simple global mapping approach	13
2.2.3 Mapping of climate risk.....	14
2.2.4 Peri-urbanization-climate dynamic index.....	15
3 POLICY LAB THEMES & VARIATIONS	17
3.1.1 Spatial change:	17
3.1.2 Climate change:.....	18
3.1.3 Vulnerability:	18
3.1.4 Governance:	19
3.1.5 Scenarios:	19
4 WORKED EXAMPLE.....	20
4.1 Context.....	20
4.1.1 Overview of method	20
4.2 Phase 1a: Causal model: basic interactions	21
4.3 Phase 1b: Synergistic model: deeper & wider systems.....	23
4.3.1 Systems (baseline) mapping	25
4.3.2 Scenario (change) mapping	26
4.3.3 Synergy (opportunity) mapping	27
4.3.4 Strategy (pathways) mapping.....	28
4.4 Focus on topical themes	29

5	ANNEX.....	30
5.1	The Peri-cene framework	30
5.1.1	Framework application: 20-question template	31
5.2	International Workshop program & method.....	33
5.2.1	Structure.....	33
5.2.2	Objectives.....	33
5.2.3	Global comparison.....	33
5.2.4	Synergistic Pathways toolkit.....	34
5.2.5	Visual thinking templates.....	35
5.3	'20 questions' template: worked example.....	35
5.4	Policy Lab partners	38
5.4.1	inter-governmental organizations	38
5.4.2	City-region partners.....	38
5.5	Citations	40

List of Tables

List of figures

1 SUMMARY

The Peri-cene project has the challenge of working with a multiplicity of causes, effects and responses. The Policy Lab is a community of over 20 city-regions around the world, from South and North, with a wide range of climatic conditions and risks.

This report is a basic introduction and manual for the work of the Policy Lab. It can be updated and extended during the course of the 2021 program.

It contains the following:

Section 2: Outline – provides an overview of the Policy Lab, how it works, what methods are used, and when are the program stages

Section 3: Spatial Mapping – discusses the basics of where is the peri-urban on the map, how to show urban expansion and change, how to represent climate change risk in the peri-urban, and how a dynamic index of change can be calculated.

Section 4: Themes & Variations: an overview of the main themes (peri-urban, climate, vulnerability, governance), and the variations across the Policy Lab, with illustrations to bring these to life.

Section 5: Worked example: taking peri-urban Manchester, this shows a step by step approach with visual thinking / systems mapping

Section 6: Annex – contains a summary of the Peri-cene Framework, the international Pathways Workshop program, Policy Lab partners etc.

2 POLICY LAB OUTLINE

Overview and outline of the Policy Lab and the 2021 program

The 'peri-urban' hinterland, the area between and around cities, shows the extended footprint of human settlements. Both poor and rich sprawl into the peri-urban, often in the line of flood, fire, storm, sea-level rise and other climate hazards. To improve the climate resilience of cities we have to start in the peri-urban.

The Peri-cene project aims to provide the first ever comprehensive assessment of global peri-urbanisation, with its climate impacts, risks and vulnerabilities.

We aim to provide new peri-urban spatial mapping with an interactive [P-CAT tool](#). Then we engage stakeholders in dialogue to explore the nature of the problem and possible ways forward. We explore the likely 'adaptive pathways' in a [Policy Lab](#) of 21 city-regions from around the world. And we look in detail and compare the [Case studies](#), from the global south in [Chennai](#) (India), and the north in the [Manchester Region](#) (UK).

2.1.1 Policy Lab Overview

At the centre of the Peri-cene project is an international 'Policy Laboratory'. This is a space for (a) diagnosis / mapping of problems, and (b) design of responses and 'adaptive pathways'. Its activities include:

- Interviews with partners and dialogues by webinar;
- International workshop in mid-2021 (Stockholm / online);
- Peri-cene Analysis Tool ('P-CAT'): for spatial mapping of urban / climate interactions;
- Peri-cene Pathways Tool: for system mapping of peri-urban problems / pathways.

The **output** will be an online resource library, with policy reports and academic papers.

The **outcome** aims at new insights on peri-urban / climate interactions, both in the problems and responses. This includes an outline global assessment, and in a set of 'adaptive pathways' in each of the partner city-regions. Alongside we develop a practical framework and toolkit, to help prepare and set up more detailed studies in the future.

2.1.2 Who are the partners?

- 21 city-regions are currently partners: (from east to west), Melbourne, *Tokyo, Guangzhou, Changsha, Surabaya, Bangkok, Dhaka, Cairo, Doha, Johannesburg, Kumasi, Helsinki, Stockholm, Naples, Granada, Belo Horizonte, Santiago, Toronto, Mexicali, San Diego, (associate partners shown in italics).*

- 2 major in-depth studies are running in Chennai, India: and the Manchester wider region, UK.
- These are supported by 3 inter-governmental organizations: UN Habitat, UN Global Compact on Cities, and ICLEI (International Council for Local Environmental Initiatives). Many of the partners have also been members of the Rockefeller 100 Resilient Cities community.



Together these partners represent the major urban types and climate risk types, from both developing (urban South) and developed countries (urban North). See the next section for an outline of types, and the Annex for a full list.

2.1.3 How does the Policy Lab work?

With the 'Lab' as an experimental zone, each city/region is invited to participate in a collaborative process. This is based on the Peri-cene Framework, which helps to make sense of complex problems and emerging opportunities / pathways.

First in phase 1a, we explore the 4 main themes of peri-urban / climate interactions, with mapping of the problems, and their direct causes and effects (i.e. in a 'Causal model'):

- a) peri-urban development and multi-level urban systems
- b) climate change impacts, hazards and risks, social and technical
- c) climate change, vulnerability and sensitivity, social and technical
- d) governance and adaptive capacity

In Phase 1b, we extend the scope to indirect, intangible and system effects, using a 'Synergistic model' (with the system / scenario mapping methods). For example in peri-urban Manchester, where fluvial flood risk is growing:

- we can assess the direct 'causal' flood risk and returns, and the interaction with peri-urban developments and landscapes;
- to follow up we explore more 'Synergistic' indirect problems, such as land ownership upstream, or the structure of local government:
- this includes 'stress-testing' scenarios with the SSP ('Shared socio-economic pathways') alternative futures framework from the IPCC.

In Phase 2 we use the Synergistic Model again (with synergy / pathway mapping methods), to explore the potential visions and ideas, synergies and collaborations, innovations and opportunities: and then

how to put these into practice. We put all cards on the table in the international Pathways workshop, and then follow up with a final round of interviews.

- In peri-urban Manchester, we work with stakeholders to explore system level responses & opportunities, such as new forms of community land stewardship, ecosystem markets, digital platforms etc.

A set of '*adaptive pathways*' is the practical outcome of such discussions, combining both levels of responses: in the Manchester example the pathways might include:

- 'Causal' and functional level responses, such as building flood defences
- 'Synergistic' and strategic level responses, such as new forms of land stewardship.

2.1.4 What are the outcomes?

For policy and practice, the Policy Lab will help to build capacity, highlight the adaptive pathways, and point towards a '*collective eco-urban intelligence*', in 5 main sectors:

- Urban-rural / climate-environment planning, (mainly public sector);
- Development / real estate, (mainly corporate sector);
- Social economy & community enterprise, (mainly civic sector);
- Resource management & urban infrastructure, (various sectors).
- A global assessment of peri-urbanization and climate risk (inter-governmental sector)

For academic agendas, the Policy Lab will provide:

- Insight on peri-urban / climate change interactions
- Demonstration of 'adaptive pathway' development
- Mapping methods for situations of collective intelligence, and/or, '*cognitive systems of deeper complexity*'
- A global resource for others to build on.

2.1.5 When does this happen?

The Policy Lab program stages include:

- **Jan 2021:** launch of Policy Lab and platform: includes partner profiles & baseline analysis:
- **Jan-March:** phase 1a: first interview program for the policy-lab database, for the 'causal model': we follow the '20-questions' template with spatial analysis.
- **April-June:** phase 1b: follow-up interviews on systemic & indirect problems, for the 'Synergistic Model', with scenario analysis.
- **July:** phase 2: international Pathways Workshop: Stockholm and/or online, depending on the Covid-19: (signed partners are travel funded, associate partners are strongly invited).
- **Aug-Sept:** phase 2 interviews continue on adaptive pathways:
- **Oct-Nov:** synthesis of adaptive pathways: final reports & dissemination materials: prepare for follow-up research.

NOTE - The COVID-19 situation has caused major delays to the program, which now runs to 30th November 2021.

2.1.6 What next?

The Peri-cene team will be in touch shortly to arrange an interview / small group discussion. This will generally follow the '20-questions' framework (see Annex), and start with the baseline picture and potential scenarios. As far as possible we will follow up recommended sources, maps, papers etc.

We are building up materials for each city-region on www.peri-cene.net/policy-lab - with online pages in progress:

- 'global page': results from the global mapping, together with any local maps.
- 'resource page': shortlist of policy reports & academic papers, to be checked with local knowledge.
- 'PCAT page': 20 question template on the peri-urban / climate risk / vulnerability.
- 'Pathways page': results of the synergistic Pathways Toolkit, and the pilot 'adaptive pathways'.

In April-June 2021 a further interview / small group discussion will then explore the wider systems and indirect problems: together with first ideas on potential synergistic / adaptive pathways. In July we aim to come together for the Policy Lab workshop in Stockholm, for collaborative thinking on the adaptive pathways, comparing between locations, peri-urban effects and climate effects. (if on-site meeting is not practical we will work online over several sessions). A final round of interviews will follow this up in August-September and prepare for the final reports.

3 POLICY LAB: SPATIAL MAPPING

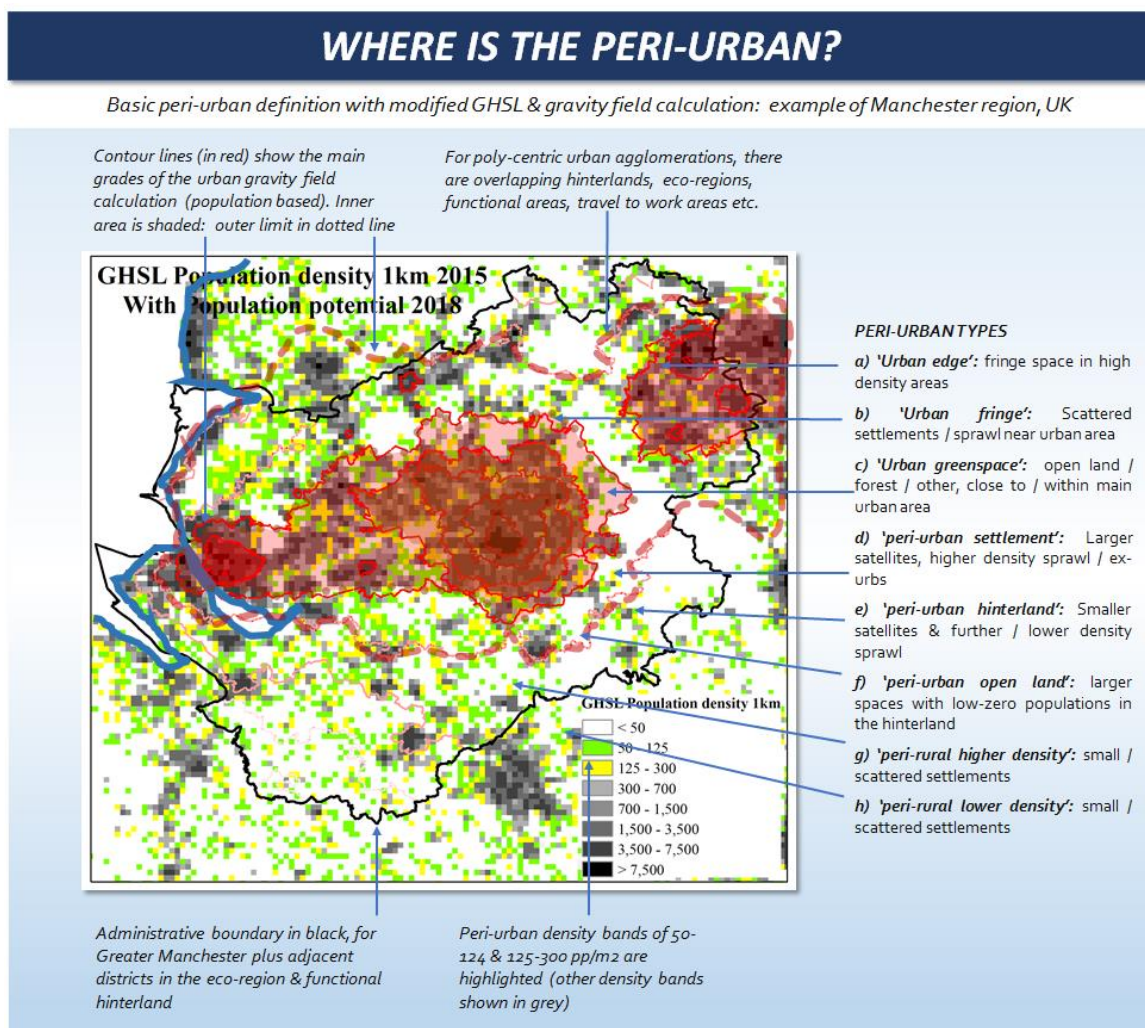
This is an overview of the spatial mapping used in the Policy Lab (details in WP2)

3.1 Where is the peri-urban?

This first question could have many possible answers. The Peri-cene takes a practical approach, building on the JRC-GHSL (Global Human Settlements Layer) system of urban mapping - <http://ghsl.jrc.ec.europa.eu>. The peri-urban mapping results depend on the unit size and calculation method, so a final objective definition is not possible. In response the Peri-cene takes a simple pragmatic approach, where the peri-urban mapping / definition is not a final answer, but the start of discussion with local experts and stakeholders.

The Peri-cene basic scheme includes 6 main types, to be adapted for very different city / regions around the world: *Figure 1* shows the example of the Manchester region.

Figure 1: Where is the peri-urban? Manchester region example



3.1.1 Mapping the peri-urban baseline

The Peri-cene method extends the GHSL system with 2 further bands of population density: 50-125 and 125-300 p/km². It also includes the open land / rural type of <50p/km².

It then places these in geographical context of proximity to the main urban centres, '*near-urban: further-urban: ex-urban / peri-rural*'. For detailed case studies the proximity can be calculated as a 'potential' or urban gravity field (see WP2 working paper). If local calculations are not available, we simply draw a 20km circle for the inner urban, and 40km circle for the outer limit (for mega-cities a further 60km radius may be also relevant). These circles have been checked against the proximity calculations and show a good fit to the iso-lines (at least for mono-centric city-regions). They also correspond to the 'theory of urban fabrics' with 3 types of urban form: walking city (<2km radius), transit city (<20km), and automobile city (<40km) (Newman et al 2016).¹

However, the gravity field calculation tends to weight the larger conurbation against smaller satellites or rural towns, as seen in the mapping above. Work is in progress on ways to combine the metropolitan gravity field with a localized short-range effect, to better represent these other peri-urban spaces.

The summary here at *Table 1* then shows the 8 main types, as combinations of:

- density range bands: 0-50, 50-125 and 125-300 p/km²,
- proximity range from '*near-urban: further-urban: ex-urban / peri-rural*'.

Table 1: Summary of basic peri-urban types

	'NEAR URBAN' (main urban fringes) <20km ('medium potential' / inner gravity field)	'FURTHER URBAN' (main urban hinterland) 20-40km (or 'low potential' / outer gravity field)	'EX-URBAN / PERI-RURAL' (other areas) Outside main urban gravity fields
HIGHER DENSITY: (125-300 inhabitants / km ²)	a) 'Urban edge': fringe space in high density areas	d) 'peri-urban settlement': Larger satellites, higher density sprawl / ex-urbs	g) peri-rural higher density small / scattered settlements
LOWER DENSITY: (50-125 inhabitants / km ²)	b) 'Urban fringe': Scattered settlements / sprawl near urban area	e) 'peri-urban hinterland': Smaller satellites & further / lower density sprawl	h) peri-rural lower density small / scattered settlements
RURAL / OPEN LAND: (0-50)	c) 'Urban greenspace': open land / forest / other, close to / within main urban area	f) 'peri-urban open land': larger spaces with low-zero populations in the hinterland	-

¹ By comparison, the Atlas of Urban Expansion focuses on built up area, with bands of 'urban' (50-100%), 'suburban' (25-50%), and 'rural' (0-25% built up): a previous scheme identified a 10% band so it would be possible to identify a 'peri-urban' 10-25% band. (Angel et al 2016)

Note there is a wide range of situations around the world, which may change this simple picture: for instance:

- Typical south Asian cities (e.g. Chennai) – densities of rural areas, with many large villages and subsistence farming, may be over 300 p/km²
- Typical European cities (e.g. Manchester) – strongly regulated Green Belt and development on urban fringes, so that the proximity based functional urban region may extend for greater distances
- Typical North American cities (e.g. Denver) – average suburban / ex-urban sprawl densities may be under 125 p/km².

Again much of this depends on the unit of analysis. Our default scheme is the 1km grid of the GHSL, but there is also a 250m population grid which shows a finer grain. As above, this mapping is not a fixed answer, rather the beginning of an informed discussion with local experts and stakeholders. This may well provide alternative perspectives on the meaning of the peri-urban and its application, for instance:

- Functional economic region, rapidly shifting to global networks
- Labour / housing market and commuting region
- Social-cultural region of identity & kinship
- Eco-region / 'bio-regional' hinterland for water, materials, biomes and micro-climates

The implication is that the peri-urban concept itself is changing as the 'urban' itself changes from a former land-use concept and 'unit of analysis', towards a more territorial / global networked system.

3.2 How is the peri-urban changing?

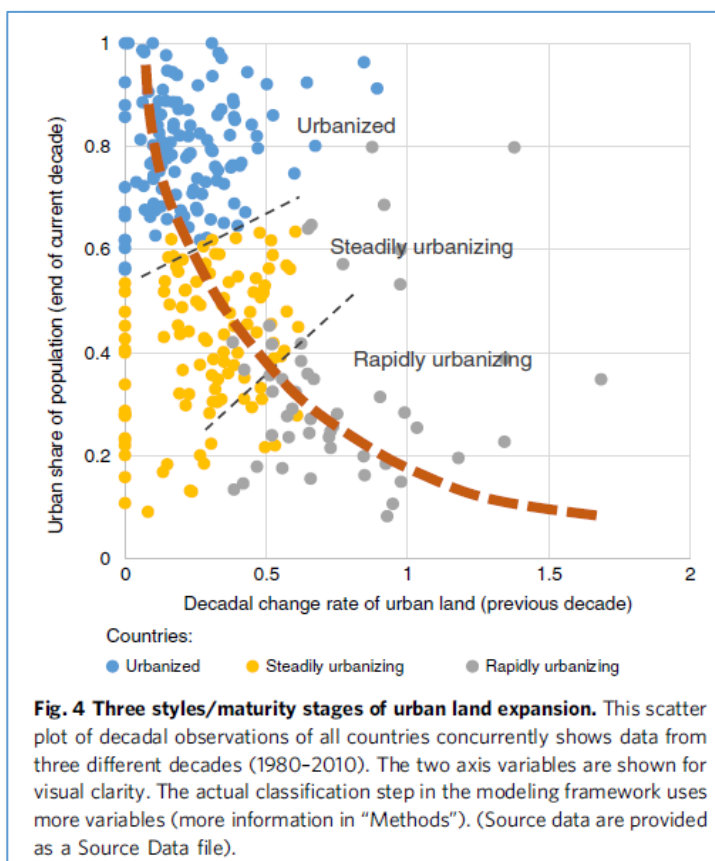
The peri-urban in most cases is a dynamic moving frontier, a zone of disruption and transition, both physical, social and economic. The conditions and processes vary greatly around the world:

- In some cases (typically S&E Asia) the peri-urban shows unique patterns of combination of urban and rural, in the desakota.
- In other cases (typically Europe) peri-urban land use change is strictly controlled, so the most visible changes are likely to be more social and economic, than in physical land-use alone.
- In other cases (typically N America but also world-wide), the peri-urban is an extended indistinct zone of potential, of 'post-metropolis' and 'edge city' sprawl and urban-rural transition, in both land-use, and social / economic terms.

3.2.1 Global urbanization perspective

Two key factors are the rate of urban expansion, and the national urbanized share of population. Generally the higher rates of expansion are seen in less urbanized countries, and vice versa. Recent recent work by Gao & O'Neill 2020 uses multiple models and sources, including the GHSL (Figure 2)

Figure 2: global urbanization types (from Gao & O'Neill 2020)



Work is now in progress to define the peri-urban component of expansion / agglomeration, using the GHSL based dynamic index below. This should help to identify the main variations:

- More urbanized areas with slower expansion: peri-urban development may be slowed by policy constraint, or accelerated by new infrastructure and economic activities;
- Less urbanized areas with rapid expansion: peri-urban development may be slowed by lack of infrastructure: or accelerated by encroachment of informal settlements.

The experience of the Policy Lab partners will help to populate this.

3.2.2 A simple global mapping approach

For a simple picture of a complex situation, we take the baseline map above, compare to a historic map, and identify the changes to and from the peri-urban areas. The map below shows, in the same 1km² cells, from 1990-2015 (figure 3):

- Cells moving into peri-urban densities 50-300 p/km²: generally development on open land
- Cells at peri-urban densities 50-300 p/km² which stay the same
- Cells moving out of peri-urban densities 50-300 p/km²: generally, urban development filling in and raising densities.

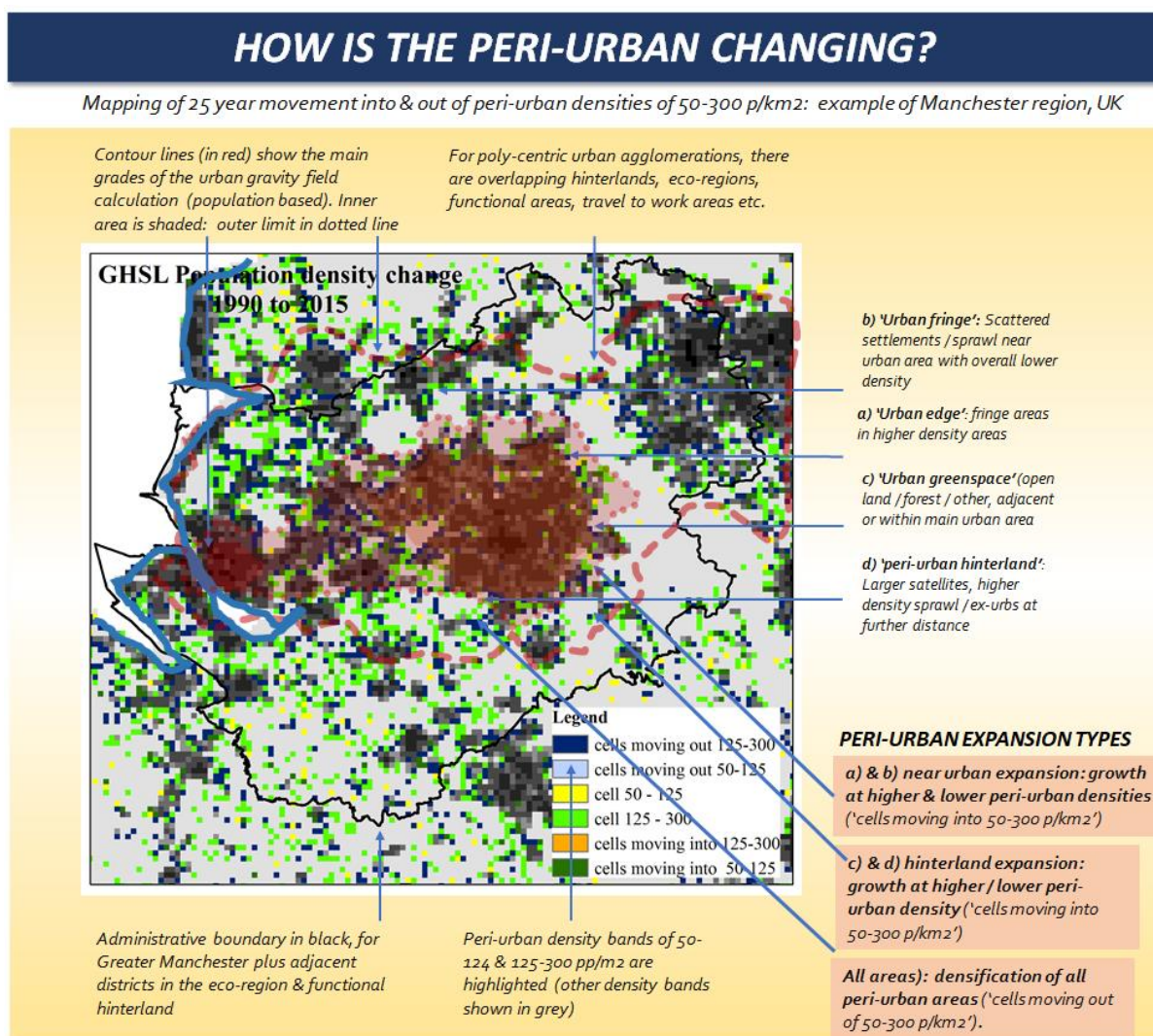
These can then be placed in the 8 peri-urban types in the summary table above:

- density range from 0-50, 125 and 300 p/km²:
- proximity range from 'near-urban: further-urban: ex-urban / peri-rural'.

In each type we aim to track the rate of peri-urbanization, both rapid and slow.

This can then be compared to the climate risks below, the social vulnerabilities and the governance types and capacities (see following sections).

Figure 3: How is the peri-urban changing?



3.2.3 Mapping of climate risk

(note this is early stage work in progress)

Many climate change hazards and risks are not simple to show on localized maps, e.g. extreme heat, water stress, ecosystems dieback and so on. So the Peri-cene mapping focuses on 2 key aspects with local spatial visibility: sea level rise and riverine flood risk.

Possibly the best and most consistent global datasets are in the WRI Aqueduct Global Flood Risk Maps (<https://www.wri.org/resources/data-sets/aqueduct-global-flood-risk-maps>), in conjunction with www.climatecentral.org –

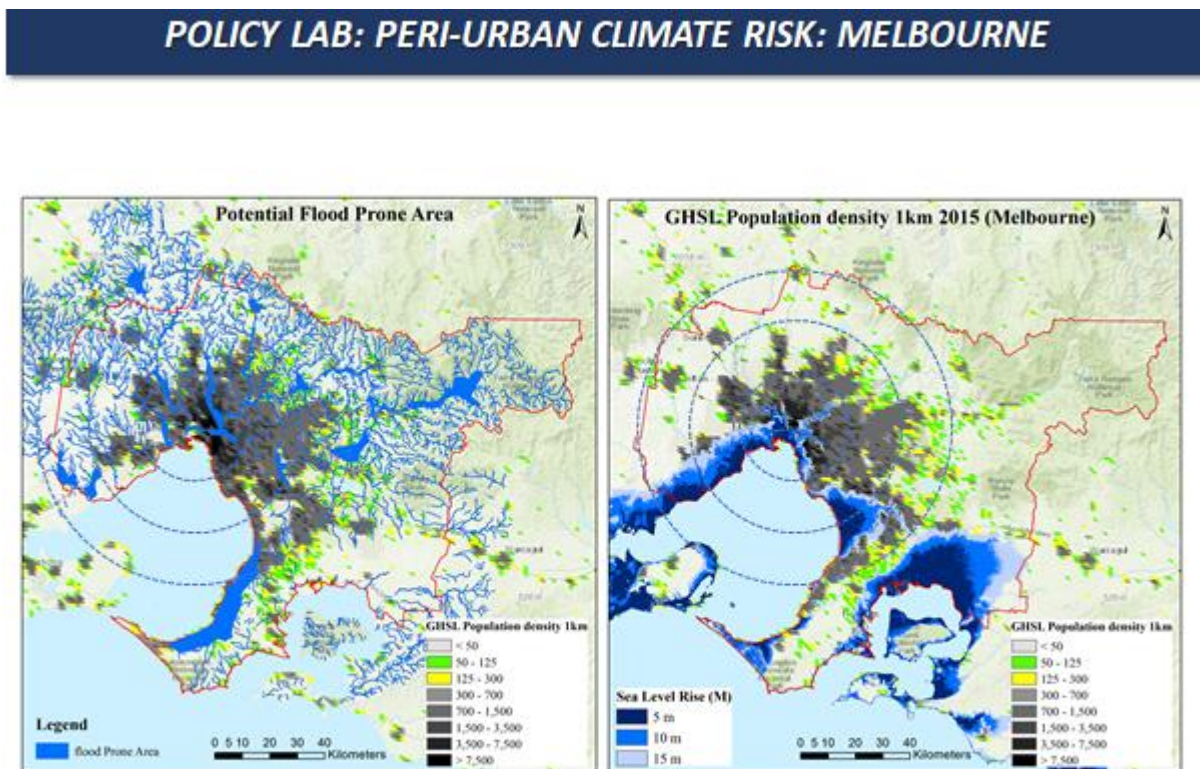
'The WRI maps provide current and future river flood risk estimates in urban damage, affected GDP, and affected population by country, river basin, and state. The datasets in these maps include current and

future river flood risk estimates in urban damage, affected GDP, and affected population by country, river basin, and state. For the current scenario, we used hydrological data from 1960 through 1999 for generating flood inundations for 9 return periods, from 2-year flood to 1000-year flood, and 2010 GDP, population, and land use data for assessing flood impacts.

For future projections, we used 5 GCMs (Global Climate Models) from CMIP5 (Coupled Model Intercomparison Project Phase 5) projecting future flood inundations under two climate scenarios, RCP4.5 (Representative Concentration Pathway) and RCP8.5, and projected socio-economic changes using SSP2 (Shared Socio-economic Pathway) and SSP3, from the Intergovernmental Panel on Climate Change Assessment Report 5.'

At a preliminary stage these samples for Melbourne are shown as work in progress (Figure 4):

Figure 4: Peri-urban climate risk



3.2.4 Peri-urbanization-climate dynamic index

With this simple mapping above, a simple quantitative analysis then explores questions such as –

- What is the current proportion of the population in the peri-urban classes?
- What is the rate of growth of population in peri-urban classes? (1990-2015)
- How many peri-urban residents now live in zones of projected sea level rise, or fluvial flood risk?
- What is the simple projected growth of peri-urban population?

This can be calculated for all cells within the defined boundary (admin unit), all normalized at 1km² grid level:

- For the pilots we also test with 250m grid level, for any difference
- For other cities without suitable admin/data boundaries, we take a 60km radius as an effective hinterland
- Sea level rise is calculated as from climatecontrol.org, RCP8.5 for 2070
- Fluvial flood risk depends on local data (climatejust.org etc)

Table 2 here shows a summary of the key data:

Table 2: statistical summary & peri-urbanization index

MELBOURNE						
		Proportion of total area 2015	Proportion of total population 2015	25yr change (% on 1990)	Population change annual % (compound)	25yr population trend projection: (1000s)*
PERI-URBAN						
open land & peri-rural	< 50 p/km2	67%	2%	83%	2.4%	149
lower density peri-urban	50-125 p/km2	5%	1%	23%	0.8%	75
higher density peri-urban	125-300 p/km2	4%	3%	24%	0.9%	160
urban & suburban	>300 p/km2	24%	95%	38%	1.3%	6520
Total %		100%	100%	38%	1.3%	6905
Total values	area in km2: pop. in 1000s	8921	5005			
CLIMATE IMPACTS						
Sea-level rise of 1m: total	total land & pop affected	35%	32%		2.5%	78
Sea-level rise of 1m: in peri-urban	50-300p/km2: land & pop		0.8%	88%	2.5%	
Riverine flood risk: total	total land & pop affected	22%	16.0%		2.1%	53
Riverine flood risk: peri-urban	50-300p/km2: land & pop		0.6%	66%	2.1%	

**This is a straight 25 year compound growth projection, assuming no constraints from policy or land-use*

These simple numbers point to topical issues for the Melbourne example –

- For ex-urban densities of <50, growth of **2.4%** = projected doubling time of 30 years
- For the main urban / suburban area, growth of **1.3%** = projected doubling time of 50 years
- For sea level rise / flood risk population growth of **2.1-2.5%** = projected doubling time of 30-35 years

4 POLICY LAB THEMES & VARIATIONS

Here is a visualization of the cause-effect scheme with typical variations.

There is great diversity of cause-effect chains and interactions between peri-urbanization and climate risk, vulnerability and adaptation around the world. We use a practical structure for mapping these interactions, the Peri-cene 'Causal' model. This includes four main themes:

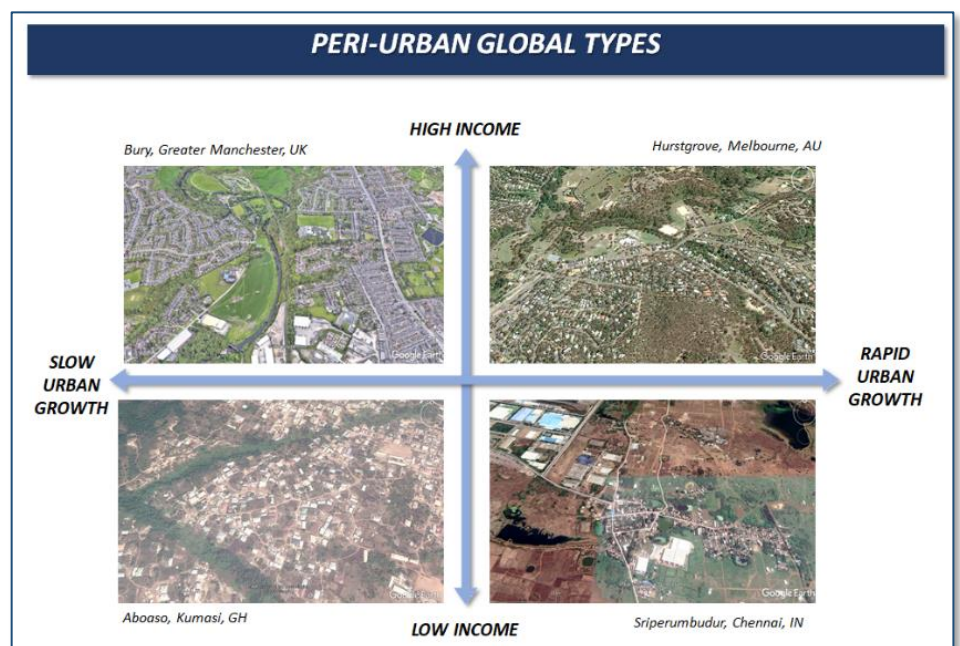
- peri-urban development and urban / regional spatial systems
- climate change physical hazards and risks
- climate vulnerability and sensitivity
- governance and adaptive capacity

These four themes are represented in the '20 question' template, and the Peri-cene Framework, as detailed in the Annex.

For each theme, there is a wide range of variations seen in different city-region locations, or in different zones within any one city-region. To make this workable & practical we have simplified this down to a 2x2 matrix for each theme, representing the most significant types of variation. These are shown here with visual examples, suitable for stakeholder dialogue:

4.1.1 Spatial change:

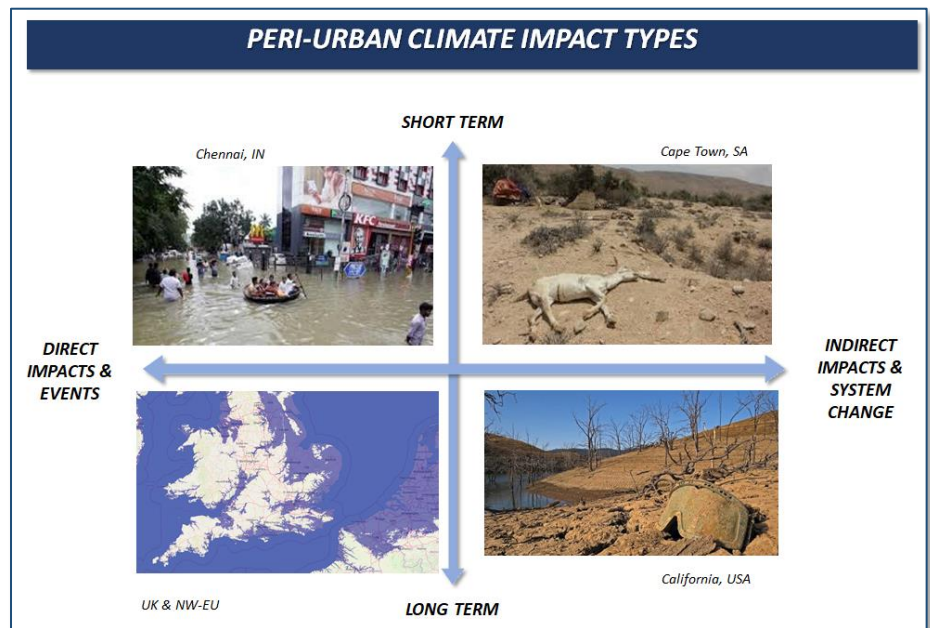
Including 'drivers / stressors': this covers spatial peri-urban types & patterns of urban expansion: spatial peri-urban functional dynamics of techno-economic change: other social and cultural drivers of change: global inter-dependencies. Where possible we look closely at the urban forms and eco-urban landscape structures. (Figure 5)



4.1.2 Climate change:

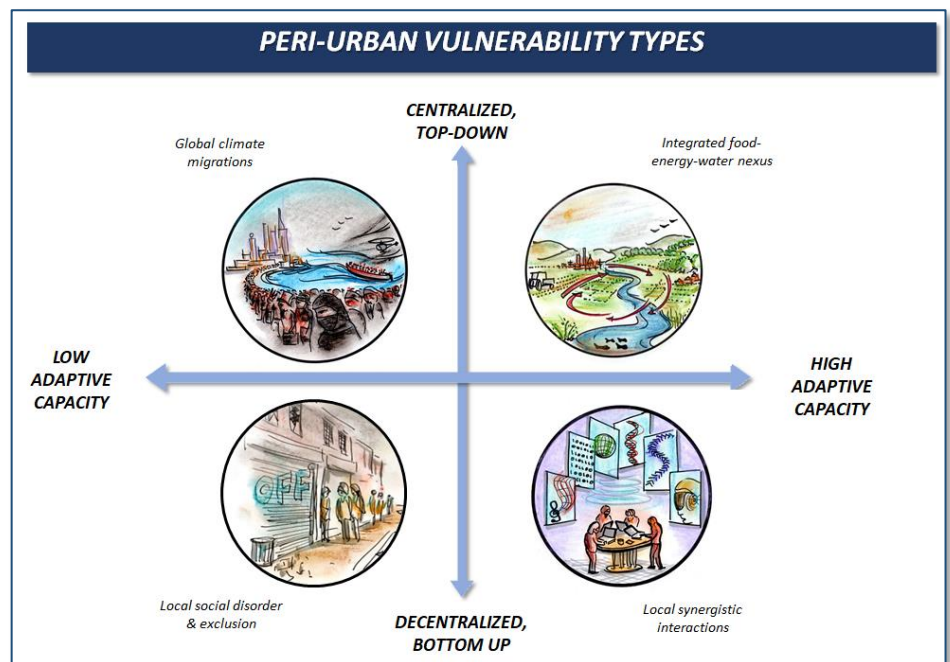
Including direct / indirect hazards: this covers direct climate change in temperature, precipitation etc, together with the direct effects of wildfire, heat, drought, flood, coastal sea level rise and storm surges, etc. Indirect impacts then include the multiple and inter-connected hazards of food, energy, land, water, ecosystems, buildings and human health.

(Figure 6)



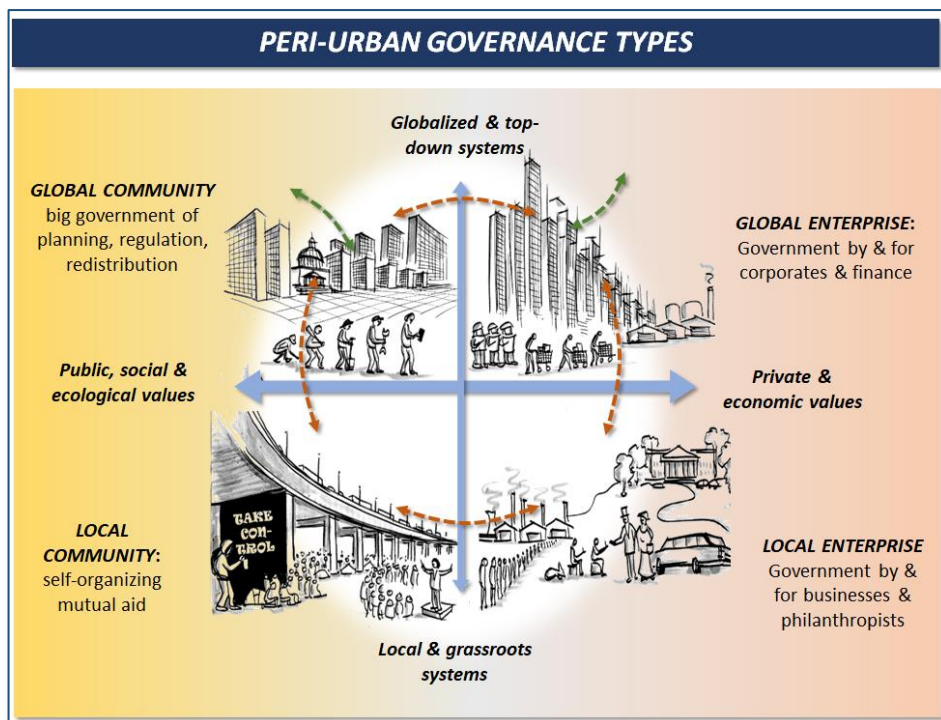
4.1.3 Vulnerability:

Including sensitivity / adaptive capacity: This theme includes physical and biological capacity, in landuse, farming and forestry: social deprivation, health, housing, social cohesion etc: technology / critical infrastructure: economic / business / livelihood vulnerability. The combinations can be typed here from low to high adaptive capacity, and between top-down and decentralized systems. Note, these combinations are not discreet and tangible, rather they are different angles on the same complex reality. (Figure 7)



4.1.4 Governance:

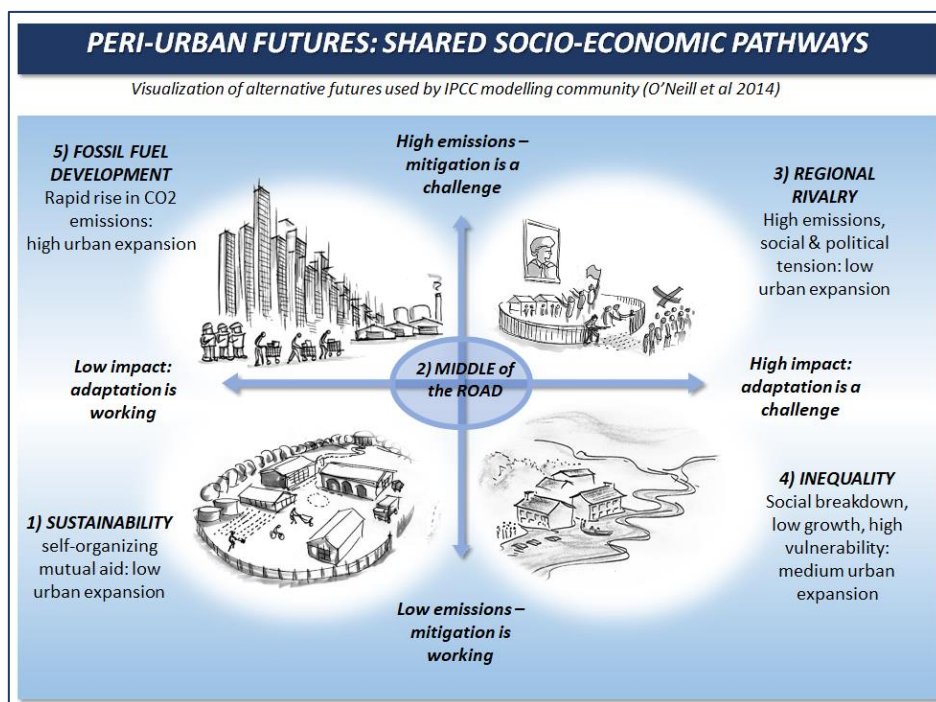
Including government and other institutions: Formal policy & governance, both spatial / economic and other: adaptive institutions, networks, collaborations, partnerships: Informal factors both positive (social innovation etc) and negative (corruption, elite capture etc): Systemic qualities of resilience, adaptive capacity, collective intelligence. The governance types shown here are based on the IPCC (2001) 'SRES' report, which was used in a major previous project 'PLUREL' on the peri-urban (Ravetz et al 2013). (Figure 8)



These four themes with combined cause-effect interactions, can then be explored with a perspective of dynamic change. This is represented by a fifth cluster, that of alternative future scenarios:

4.1.5 Scenarios:

It seems exploring alternative futures via scenarios is the best way to generate creative thinking, on the problems of the peri-urban/climate interface, and then potential adaptive pathways. The Peri-cene applies the SSP ('Shared Socio-economic Pathways') scenarios, as used by the IPCC climate modelling community, and then explores the implications for peri-urban and climate interactions. (Figure 9).



5 WORKED EXAMPLE

Here is an example from work in progress, in the South Pennine uplands north and east of Manchester.

5.1 Context

The South Pennine uplands north and east of Manchester is a unique peri-urban landscape area: based on a sandstone geology, with peat bog uplands of 5-600m altitude, sheep farming, steep sided valleys and former industrial settlements along the river. The population reduced by half from its industrial peak, now it is growing again with pressure for new housing. However the settlements along the river valleys suffer increasingly severe levels of flooding, in some way due to climate change. This combines with the vulnerability of the landscape, due to long term decline of farming and forestry, and the flood events then tend to affect the most vulnerable and least abled populations, along with the critical infrastructure of road and rail.

The area is in the hinterland of 3 major conurbations (Greater Manchester, West Yorkshire and East Lancashire, and covers 13 different local authority areas. In response a best practice 'adaptive governance' partnership organization has been set up, Pennine Prospects, which aims to promote sustainable peri-urban development across the area.

5.1.1 Overview of method

First we work with the 'Causal Model' and define the functional problems of flooding and landscape decline. This points to direct responses, building of flood walls, water retention basins, protection of critical infrastructure, and other defensive actions.

Meanwhile practical problems such as town centre flooding, point towards more systemic factors: e.g. the pattern of upstream land ownership, fragmentation and under-funding of local government, and privatization of many public services. In response, the Synergistic Model helps to define more systemic '*adaptive pathways*', such as new forms of community land stewardship, eco-neighbourhood governance, or agro-ecological land-uses. To develop these opportunities calls for collaborative (co)-learning and co-creation, involving residents, businesses, public services, engineers, social workers, local government and others.

The Policy Lab dialogue here is structured around 2 main phases:

- **Phase 1a** starts with the direct problems, framed with the 'Causal Model'
- **Phase 1b** explores system level & indirect issues with the 'Synergistic Model'. This includes '*Systems / Baselines*' for the present situation: and '*Scenarios / changes*' for future trends
- **Phase 2** then explores responses, mainly in the frame of the Synergistic Model. This includes methods from the Pathways Toolkit: '*Synergies / visions*', for future ideas: and '*Strategies / pathways*', for practical action.

5.2 Phase 1a: Causal model: basic interactions

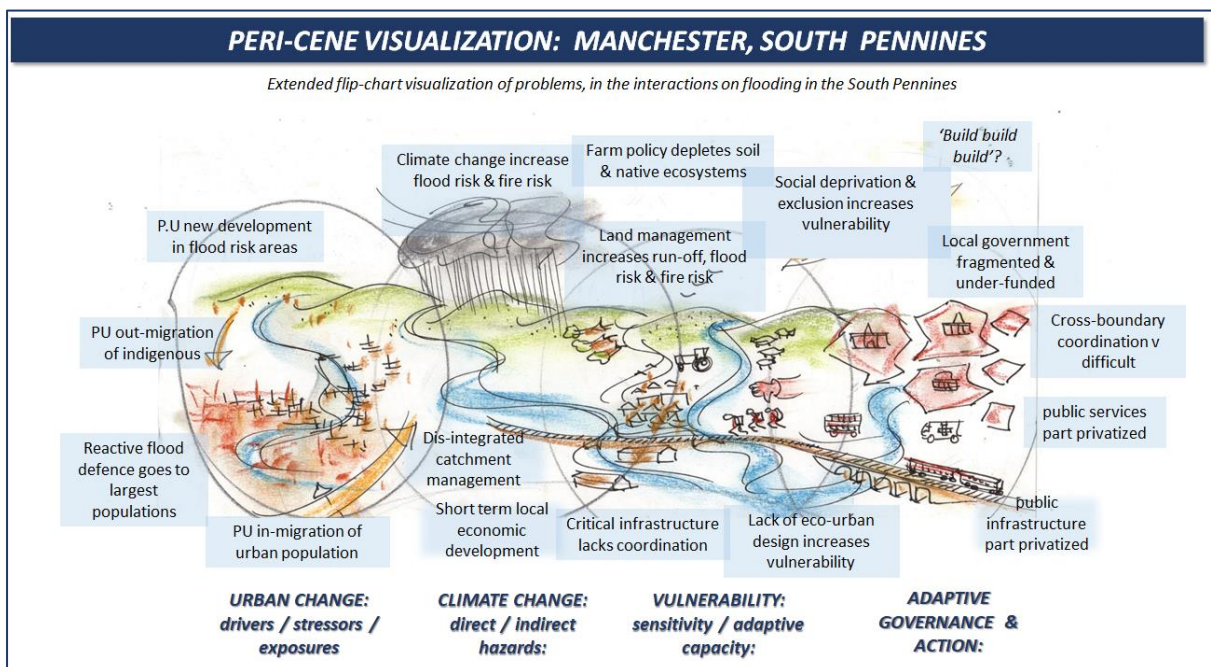
First we work with stakeholders on a 'causal model'. This assumes (as far as possible) direct and tangible causes and effects, in 4 main themes: peri-urban, climate, vulnerability, governance.

We work mainly with 3 types of evidence:

- Interviews and dialogues
- Policy & other documents
- Spatial mapping analysis

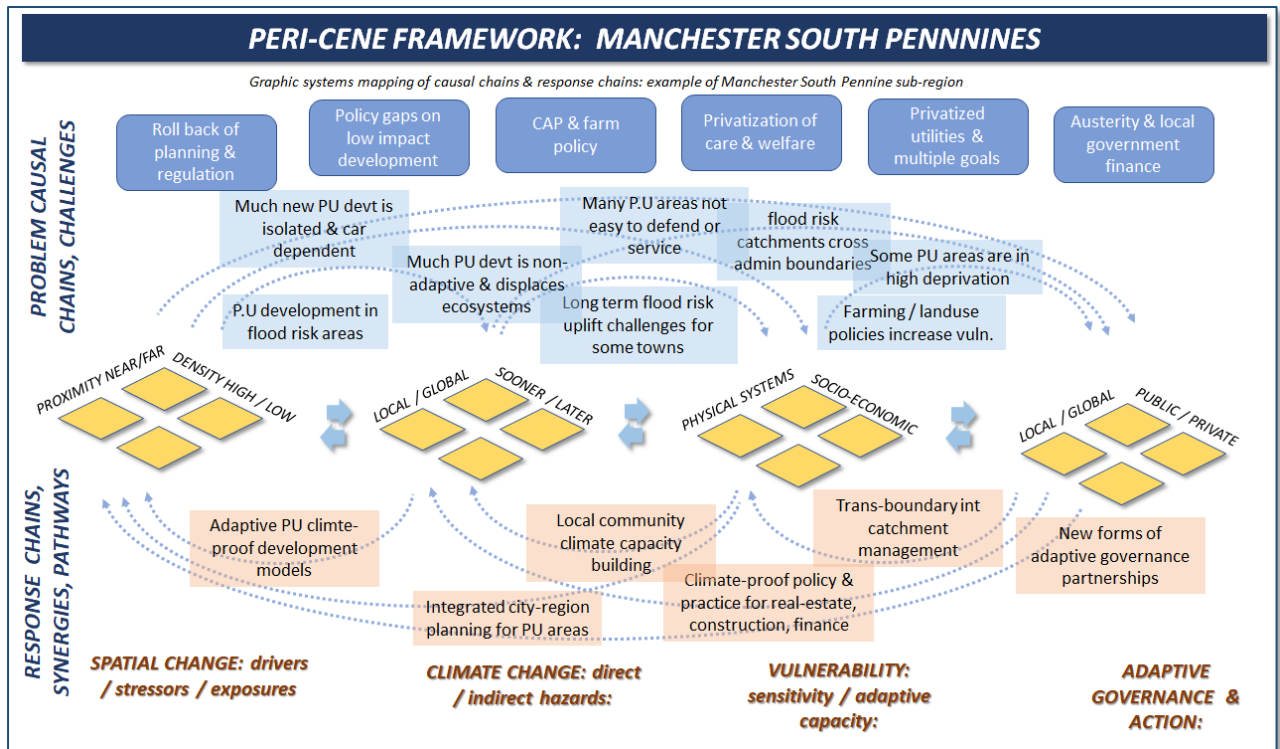
To get started we explore and visualize the situation, on an open-ended series of flip-charts: *Figure 10* shows an edited version, drawn from a series of interviews and a stakeholder workshop.

Figure 10: Peri-cene visualization: Manchester South Pennine area



These rough sketches can then be translated to a more analytic diagram as below, which simplifies but recognizes the complexity of the situation, with many possible links of cause and effect. (*Figure 11*)

Figure 11: Peri-cene framework mapping: Manchester South Pennine area



Note this 'framework diagram' is just the first stage in mapping the stakeholder comments, on both problems and opportunities (as in practice these are often mixed up). Further steps as below then explore systematically the detail of the problems, changes, potentials and pathways forward.

The results can be summarized in the '20-questions' online template, as follows (see Annex for full table):

Peri-urban theme - Upland landscape with former industrial valley development

Geographical type: small-medium industrial towns in river valleys, scattered upland villages & small farm settlements

post-industrial economy in transition, to niche production, semi-retired livelihoods, hobby farming etc.

Middle class in-migration & eco-gentrification: decline of family farming: enclaves of deprivation & post-industrial traumas

S.Pennines covers parts of 13 municipalities, provides headwaters & retention capacity, with visitor & ecosystem services for 3 city-regions. But it is at the fringe of urban centred policy.

Climate theme: Fluvial flood & flash flood: wildfire, heat & drought, soil erosion

Summer drought & storm: winter precipitation & storm.

fluvial & flash flooding, upland & valley soil erosion, summer wildfire: progressive landscape change impacts on vulnerable landscape: ecosystems destruction, soil loss, air pollution, climate emissions. Upland farming is already marginal and may become more so.

Loss of peat bog carbon storage & vegetation: loss of (some) ancient woodlands. Transport CO₂ is high due to location & geography

Vulnerability theme: Landscape sensitivity & marginal livelihoods

Upland peat bog with rapid run-off: upland semi-wild vegetation, thin & acidic soils. Most valley bottoms are in flood risk zone 3.

privatized land management increases run-off & flood risk: much low cost housing remains in high risk areas: River valleys magnify flood risk:

polarization of local residents vs incomers who tend to live on higher ground:

Governance theme: Fragmentation of government: self-help tradition & eco-social innovation

Main regulation is for containment of urbanization under housing pressure: big challenges in governance for in-between area on the fringes of 13 municipalities

From local history of cooperatives etc, many examples of networks, eco-innovations, partnerships etc.

Tradition of social enterprise, self-help, creative action. But, landowning is highly centralized into large 'estates': the majority are excluded, most farmers are tenants.

Enhanced social resilience with small town effect, with many synergistic enterprises / networks: however there are class & cultural divides.

5.3 Phase 1b: Synergistic model: deeper & wider systems

With some basic data in place we can then work on the 'synergistic model'. This shows a wider and deeper view of the problems, with system level or indirect causes and effects.

For this we can use the synergistic 'Pathway Toolkit', as from Ravetz 2020. This includes a 4-stage process of visual thinking and mapping: systems (baselines): scenarios (changes): synergies (opportunities): strategies (pathways). The above Causal model forms the first step of this toolkit, i.e the 'factors' question of cause and effect (*figure xxx*).

In this Phase we work on steps A-C and D-F, as the first half of the whole process. We look at deeper and wider effects in the systems / baselines: and then explore the forces of change, and alternative future scenarios.

For this stage we use a wider range of inputs:

- Visual thinking for systems mapping & design: examples are shown below
- Creative dialogue via interviews and workshops
- Wider range of documents – social, cultural, political etc

The synergistic toolkit uses visual thinking, as the primary means to explore the deeper and wider situation: first in the problems, and then in the responses / opportunities / solutions.

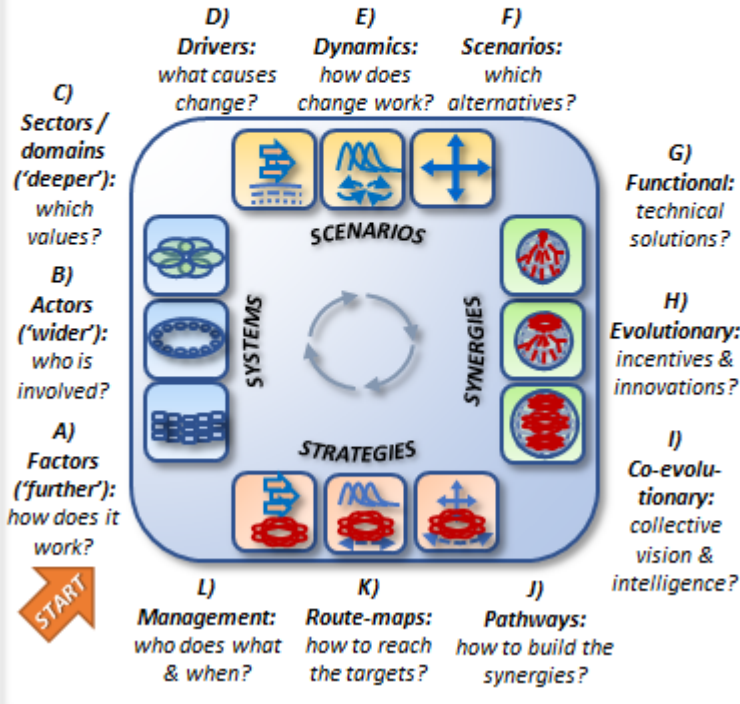
Each of the 12 steps has a visual thinking template, summed up here (*Figure 12.*) Each step has some leading questions to open up creative ideas. As with any toolkit, we select the tools needed for a particular task. The worked example overleaf uses 9 of these templates.

SYNERGISTIC PATHWAYS TOOLKIT - TEMPLATES

Each of the 4 stages & 12 steps has a visual template, for flip-charts, white-boards, napkins, off-line or online.

Each step has leading questions

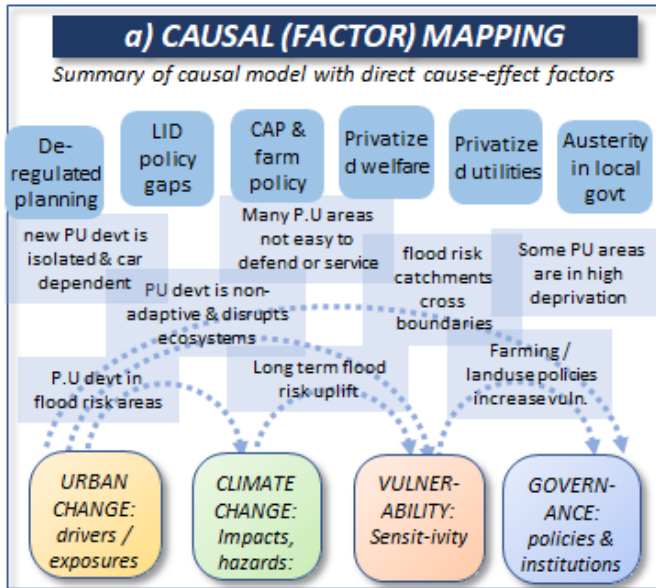
(note: steps G-H-I each contain new versions of steps A-B-C: generally we focus on step I)



Generally the visual templates are done by stakeholder dialogue in meetings or workshops. As of 2020, the same templates are uploaded into online whiteboards: these are then edited and summarized for the online 'Pathways' tool.

Below is the worked example with summary outputs (shown as vignettes) from each step.

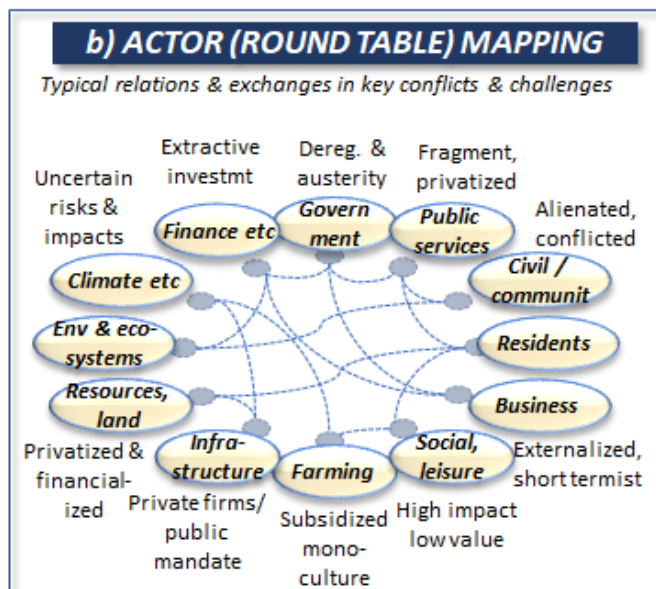
5.3.1 Systems (baseline) mapping



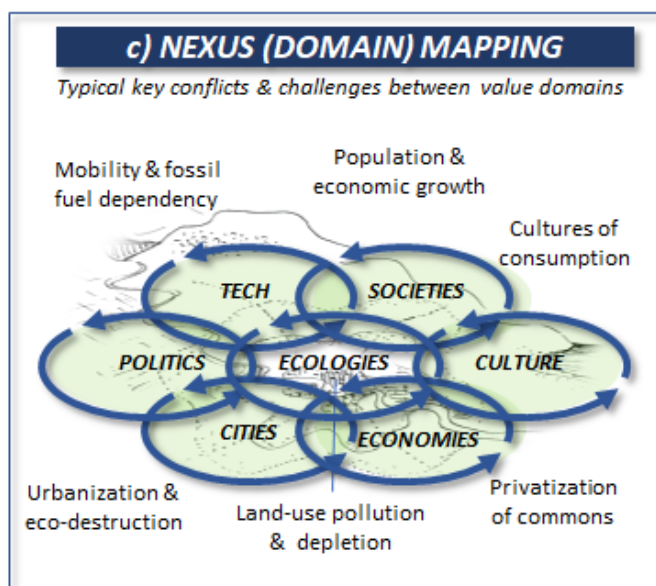
(Figure 13)

Step (a) This is a summary of the above 'causal model'. The main direct surface-level problems are shown in the middle of the diagram: some more structural problems are shown above. In summary,

- Peri-urban theme - Upland landscape with former industrial valley development
- Climate theme: Fluvial flood & flash flood: wildfire, heat & drought, soil erosion
- Vulnerability theme: Landscape sensitivity & marginal livelihoods
- Governance theme: Fragmentation of government: self-help & eco-social innovation



b) The actor (round table) mapping is basically a diagram of all stakeholders (in reality they may be around different tables at different times). This helps to explore the relations of power and wealth, knowledge and inclusion, versus dependency, exclusion, peripherality etc. Here we see the problems of extreme inequality in landowning, fragmented governance, eco-gentrification, private sector alienation, etc.

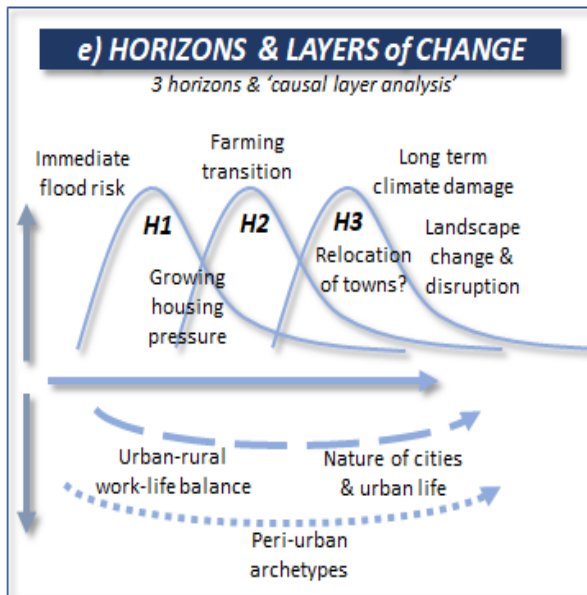


c) this is a simple mapping of the various dimensions of the problem – social, cultural, economic, urban, political and technologies...

With that in mind we can begin to explore the overlaps between the circles. Further versions could put the circles in a different order, with other agendas at the centre of the picture.

5.3.2 Scenario (change) mapping

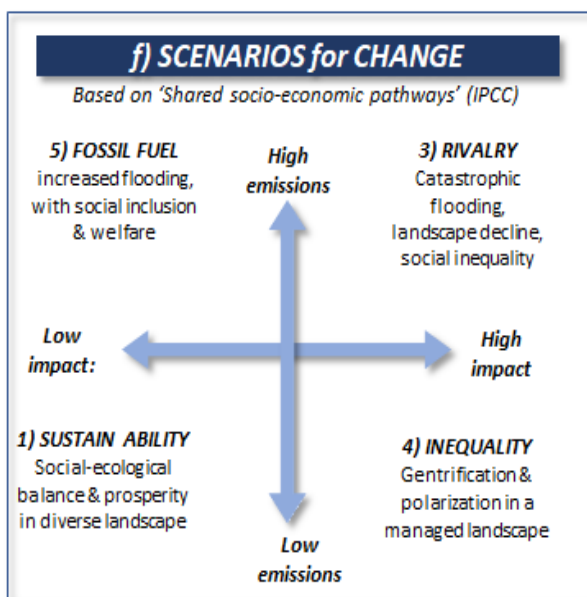
(Figure 14



e) the 'timeless landscape' of the S.Pennines may not stay the same for long. Here we look at the main forces & features of change, over 3 horizons:

- Horizon 1 (1-5 years): with near term flood risk and growing housing pressure
- Horizon 2 (5-20 years): with the impending transition of farming, more catastrophic flood risk, and the possibility of urban relocation
- Horizon 3 (20-50 years): with the likelihood of long term climate damage / landscape disruption.

Also the 'causal layer analysis' in the lower part of the diagram, highlights some underlying 'myths' and cultural archetypes, which may then drive the material changes in peri-urban lifestyles & livelihoods.



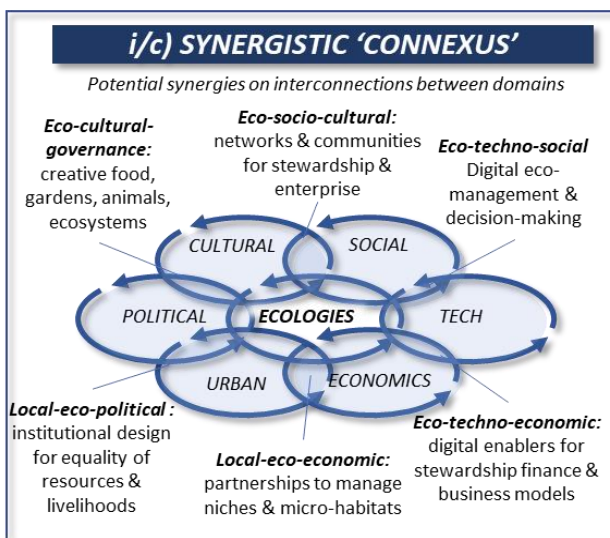
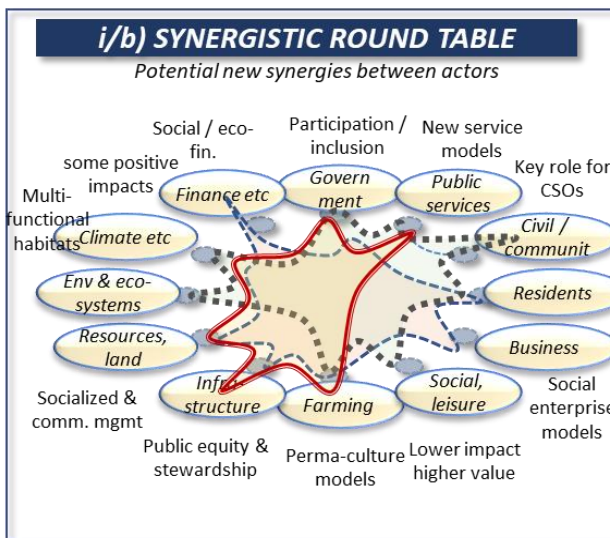
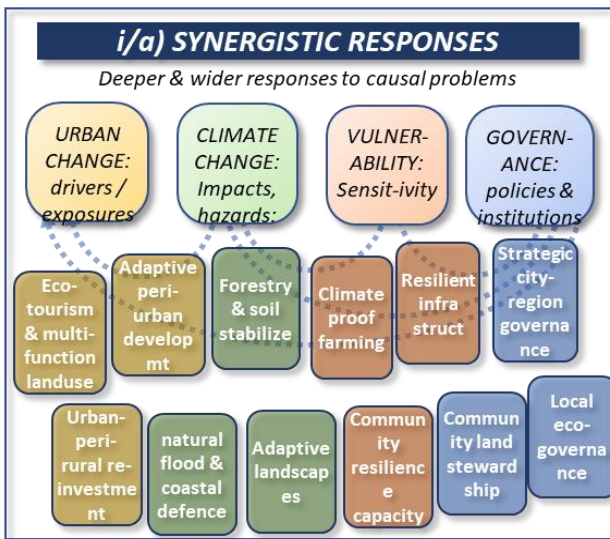
f) these 'alternative futures' are based on the 'SSP' scenario set from the IPCC. (note, the 'middle' scenario is omitted). Looking towards horizons 2 and beyond, the S. Pennines may face some very challenging conditions ahead:

- 1) **SUSTAINABILITY**: Social-ecological balance & prosperity in diverse landscape
- 3) **RIVALRY**: Catastrophic flooding, landscape decline, social inequality

- 4) **INEQUALITY**: Gentrification & polarization in a managed landscape

- 5) **FOSSIL FUEL**: increased flooding, with social inclusion & welfare

5.3.3 Synergy (opportunity) mapping



(Figure 15): In this 'synergy mapping' phase we look 'deeper & wider', at the potential for shared visions, synergies, collaborations, value-chain innovations, win-win solutions etc.

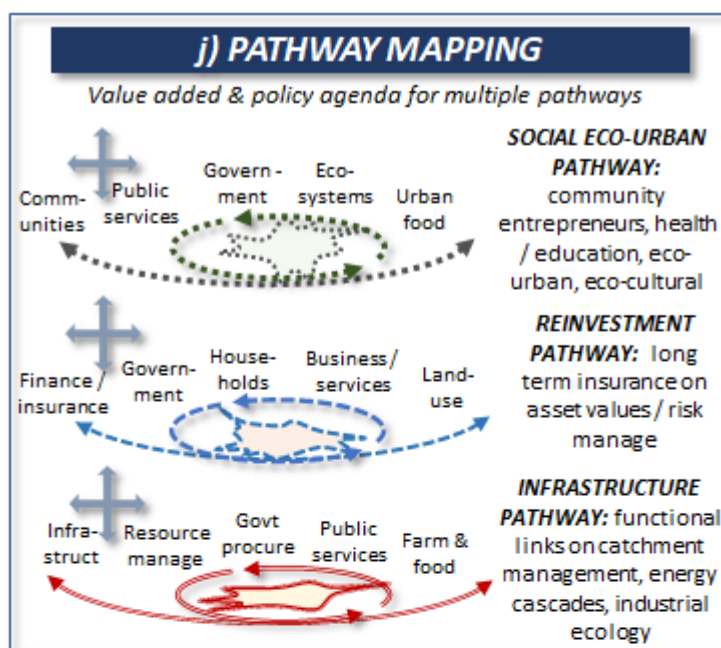
i/a) First we look again at the Causal Model (urban, climate, vulnerability, governance): and discuss with stakeholders, what lies behind these problems? What kind of structural / **strategic responses** could address them? We see a whole set of aspirational agendas, visions, policy goals: e.g. 'local eco-governance', or 'adaptive peri-urban development':

i/b) '**synergistic round table**' is the main hub for new thinking on deeper / wider challenges. We look for potential new synergies, opportunities, value chains, enterprise models etc, which connect the various stakeholders. These can be drawn around the table with the visual mapping, as shown in different lines and colours. Each one is a combination of 2 or more different domains of value & logic: financial, social, technical, economic, ecological, political, cultural or other.

i/c) From the 'nexus' map above, we can now sketch a '**connexus**', with potential to turn conflict / crisis into opportunity / transformation. Again we look for overlaps between different domains (social, technical, economic etc), & for innovations in new value-chains, which generate win-win opportunities. This mapping shows a full range, where priorities can be decided, e.g:

- **Eco-socio-cultural synergies:** networks & communities for stewardship & enterprise;
- **Eco-techno-social synergies:** Digital eco-management & decision-making.

5.3.4 Strategy (pathways) mapping

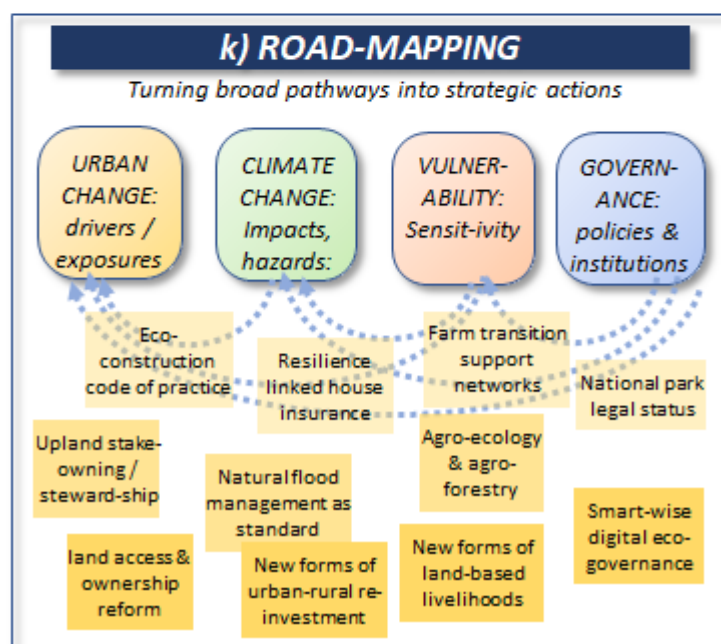


(Figure 16)

j) following the synergy mapping above, we look more closely at each of the priority pathways. We need to firm up, on who is involved, what logic of synergy / collaboration can work, over what time horizon. Each pathway needs to be resilient to the challenges of the alternative scenarios above, and also flexible to respond to opportunities and events. The S.Pennines pathways include:

- **REINVESTMENT PATHWAY:** long term insurance on asset values / risk manage

- **SOCIAL ECO-URBAN PATHWAY:** with community entrepreneurs, health / education, eco-urban, eco-cultural tourism projects etc.



k) **road-mapping** is a mainstream method: when the objectives are more clear and agreed, then we can design at the strategic level, policies, plans & programs. Shown here in the frame of the Causal Model, the S.Pennines road-mapping includes:

- Flood finance linked house insurance
- Eco-construction special code of practice
- Upland stake-owning / steward-ship
- Farm transition support networks
- National park legal status

Following that, each of the pathways / road-maps would be taken into actual details (policies, funding, institutions, next steps etc): this is for the stakeholders to action, (outside the Peri-cene research scope).

5.4 Focus on topical themes

Here the Peri-cene can focus in and explore topical themes of particular interest in each locality, according to time and resources and stakeholder interest. This example is an ongoing stakeholder discussion in progress

ELM (Environmental Land Management) is very topical in post-Brexit UK. It has several potential roles to play – and so a prime example of joined up thinking ... For the starting point – we map the different roles in the ELM scope - each with problems & opportunities: and with examples (*Figure 17*):

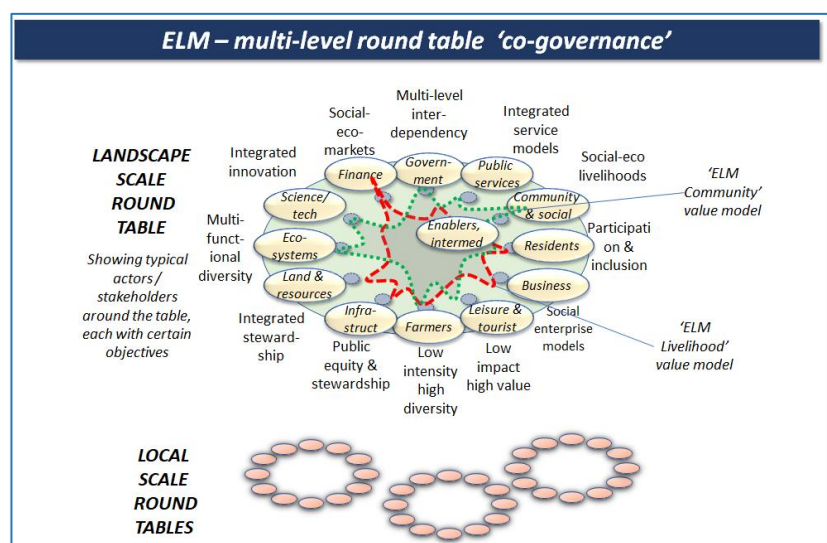
- ELM as socio-eco 'enterprise' – e.g. Fair-Shares cooperative model –
- ELM as stewardship of 'commons' – as in IAD (institutional analysis & design)
- ELM as multi-level governance for inter-dependency – e.g. ICM (integrated catchment management)

We can identify different 'pathways' (i.e. 'synergistic' or 'adaptive' pathways in some terminology): each one is formed around a typical 'value model / loop' i.e. a process of mutual learning & exchange, where value is generated and circulated. Three kinds of pathways seem to be useful, which we can name -

- **'ELM livelihood'**: (socio-economic values & logic): pro-active incentives for jobs, skills, enterprise, re-investment
- **'ELM community'**: (socio-cultural values & logic): eco-education, eco-health, leisure, heritage & culture etc
- **'ELM landscape'** (eco-political values & logic): integrated territorial governance for catchments. In this case the peri-urban location of the SP is a key to such opportunity.

So - we set up a forum / round table / peer group / 'action learning set', along the lines of 'co-governance' (collaborative-adaptive governance) – at the landscape level (i.e. S.Pennines area)

- Different pathways can be developed with & by combinations of stakeholders, i.e. where there are tangible benefits:
- These are transparent to all stakeholders, for socio-eco auditing, & also to enable potential synergies between them.
- Each may depend on some kind of enabler / intermediary role (person, organization, role – also information platform etc).

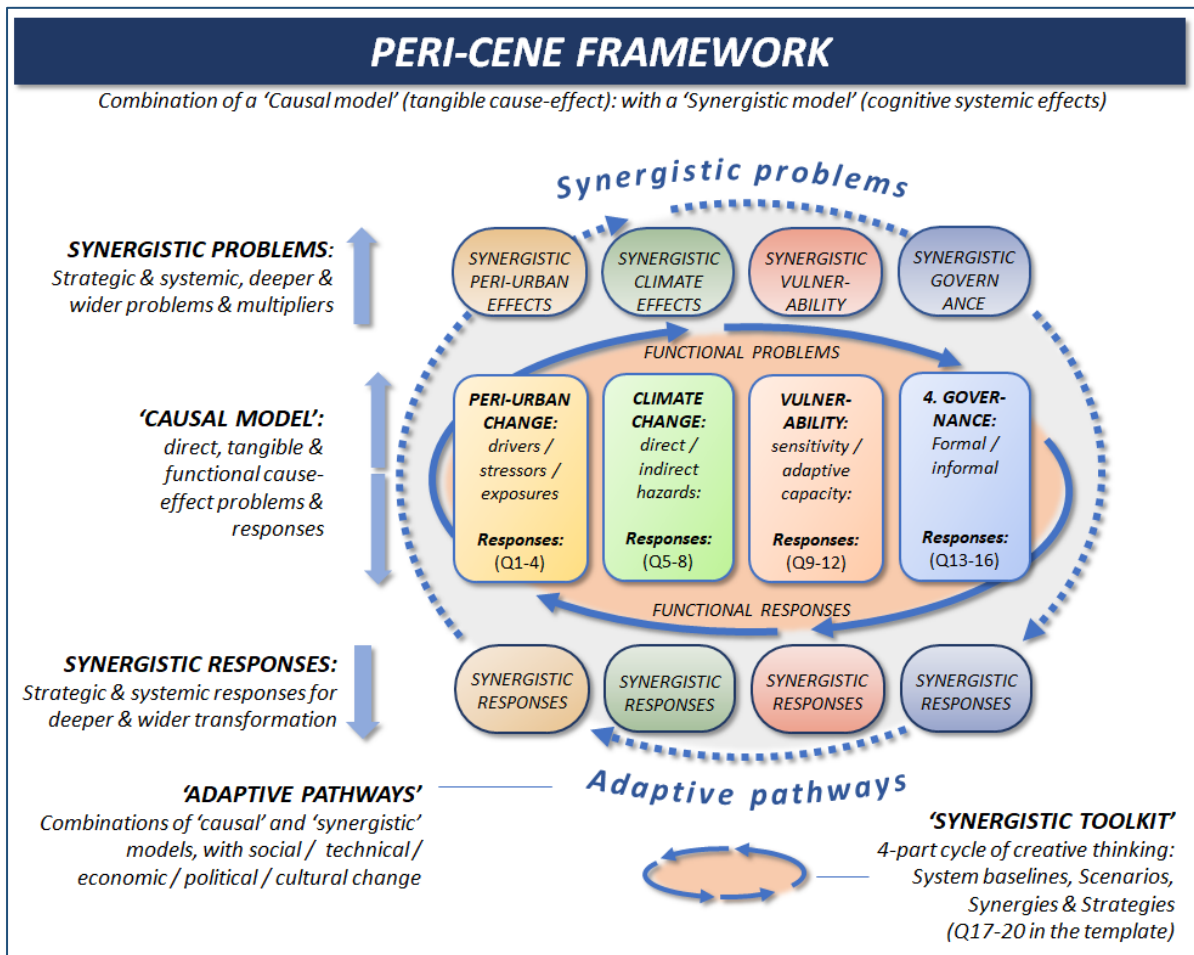


6 ANNEX

6.1 The Peri-cene framework

The Peri-cene project has the challenge of working with a multiplicity of complex causes, effects and responses. To provide a theoretical structure and practical tools for such complexity, we have developed the **Peri-cene Framework**, with a set of tools and templates. This provides a practical structure for exploring and mapping, not only problems which are tangible and direct, but those of 'deeper complexity' (Figure 18). (For full detail see the D1-2)

Figure 18: Peri-cene Framework



The Peri-cene Framework is a combination of two main 'Models':

- The '**Causal Model**' follows a mainly functional picture of cause and effect, in direct problems and responses, between four main factors: peri-urban / climate / vulnerability / capacity.

- The **'Synergistic Model'** addresses wider systems with deeper complexity and potential for transformation via collective intelligence, with strategic level problems and responses.

Each Model has a role and purpose. The *Causal Model* is a practical place to start to gather data and explore the more tangible peri-urban-climate-environment interactions. The *Synergistic Model* is more realistic for complex real-world problems, but more challenging for research: generally it is more suited to creative collaborative (co) design and dialogue.

The *Causal Model* contains four main themes, i.e. thematic clusters of tangible causes-effects (based on the IPCC risk framework, as developed in Connelly et al 2018):

- peri-urban development and urban / regional spatial systems
- climate change physical hazards and risks
- climate vulnerability and sensitivity
- governance and adaptive capacity

The *Synergistic Model* then extends the scope of the functional version, in three dimensions

- **'Wider'** communities of stakeholders, outside of established structures
- **'Deeper'** layers of value and logic, i.e. social, economic, ecological, political, cultural etc.
- **'Further'** scope of upstream causes and downstream effects

To illustrate the scope of each model, here is a typical example from peri-urban Manchester, where there is increasing severity of fluvial flooding (see the 'worked example' below):

- With the ***Causal Model*** we can assess the flood levels and risk of return: and then look at how to build up the local flood defences;
- With the ***Synergistic model*** we can explore more indirect / strategic factors in the problem, such as the ownership of land upstream: and then envision the indirect / strategic opportunities for response, such as new forms of land stewardship and governance.

With results from both models we then develop some combined **'adaptive pathways'**:

- Direct / tangible / functional responses, such as building flood defences
- Strategic / systemic responses, such as new forms of land stewardship.

Generally such adaptive pathways will emerge through a process of participative dialogue and co-design with stakeholders. To help guide this, we use the ***Synergistic Pathway Toolkit***, a four part process with 12 steps (details - <https://sites.manchester.ac.uk/synergistics/toolkit/> (Ravetz 2020).

6.1.1 Framework application: 20-question template

The Peri-cene Framework can be structured by the '20-question' template, which we use for interviews, modelling and mapping.

- Each of the 4 themes in the Causal model (peri-urban, climate, vulnerability, governance) has 4 questions each, making up questions 1-16 in the template
- The Synergistic Pathway Toolkit model provides questions 17-20, with the results of the 4-part process (baselines, scenarios, synergies, strategies).

As in the D1-2 Framework report, the filled template is then put online in the Policy Lab library:

- In summary form, as 5 main themes, where the different peri-urban zones in any city-region may be mapped and compared;
- In detailed form, where the four main themes expand into the full 20 questions, for each peri-urban zone where these are defined:

This 20-question format cannot fully describe the longer story and detailed analysis of each zone in each city-region. But it does aim to help with summary and comparison, between zones and between locations around the world. A working example of the 'summary framework' is shown here:

Table 3: summary framework example: Chennai case

	Chennai - Ennore	Chennai - Industrial corridor	Chennai - I.T. corridor	Chennai - hinterland
Peri-Urban	Heavy-industries complex along ecologically-degraded coastline and scattered towns and farmlands	Major highways criss-crossing industrial hubs and gated communities interspersed with farmlands and water bodies	Coastal-to-hinterland landscape with hi-tech industrial & entertainment / scenic corridors, interspersed with fishing villages, salt pans and small-scale farming	Large watershed area with mid-sized cities, villages and farmlands and small-medium scale industries
Climate Risk	Sea level rise, increase in extreme events - storm, storm surges	Extreme rainfall events triggering floods and droughts and subsequent impacts on land, biodiversity	High-risk coastal infrastructure, floods, fragmented land/waterscape	(heat, precipitation and storm: impacts on water systems & agricultural livelihoods)
Vulnerability	urban eco-social-economic mix in some areas has growing vulnerability	Fringe villages and towns adjacent to water bodies at higher levels of risk from flooding;	Rapid urbanisation leading to fragmented landscapes coastal infrastructure risk and loss of livelihoods	marginal livelihoods in sensitive landscapes with growing pressure of urbanization
Governance	Quasi-government arrangements with industries, limited overview and regulation;	pockets of civil society action and local innovation could trigger pathways of transformation	fragmented local governance, complex	fragmented local governance & civil society
Synergistics	from the world's first industrial city-region to the first post-industrial eco-region	Growing pressure on fragile landscapes & settlements: potential for socio-eco-resilience	potential new forms of eco-urban form & design, in new forms of community	Can a new eco-social order emerge?

6.2 International Pathways Workshop

The Policy Lab international workshop is planned in Stockholm summer 2021. This will be the main arena for collaborative dialogue and co-design on the adaptive pathways, comparing between locations, peri-urban effects and climate effects. If however the on-site meeting is not practical we will work online over several sessions.

6.2.1 Structure

Outline of program includes (could be condensed to 2.5 days depending on logistics)

- Day 1 pm – introductions
- Day 2 – ‘problems’: system mapping & scenarios mapping
- Day 3 – ‘responses’: synergy mapping & strategy /pathway mapping
- Day 4 am – wrap up & depart

6.2.2 Objectives

- Review the ‘Peri-cene’ – global assessment of peri-urban /climate interactions
- Compare peri-urban / climate interactions from cities around the world
- Explore ways to understand these challenges of deeper complexity
- Look ahead to 2050/2100 with best available projections / scenarios
- Generate new ideas for responses to the challenges,
- Outline likely pathways for strategic actions (‘from smart to wise’)

We aim for a tangible output, both online & print with visual media

6.2.3 Global comparison

The Policy Lab community includes global south and north, with a mix of climate, economic & urban types. We work in tables of 4-5, where each participant has a role & task. The tables are rotated to cover selections of different types:

- Climatic types: tropical /temperate/arid: inland/coastal
- Economic types: developed / emerging / LDC
- Peri-urban types: rapid /slow / controlled / self-organizing
- Governance types: planned / fragmented / authoritarian

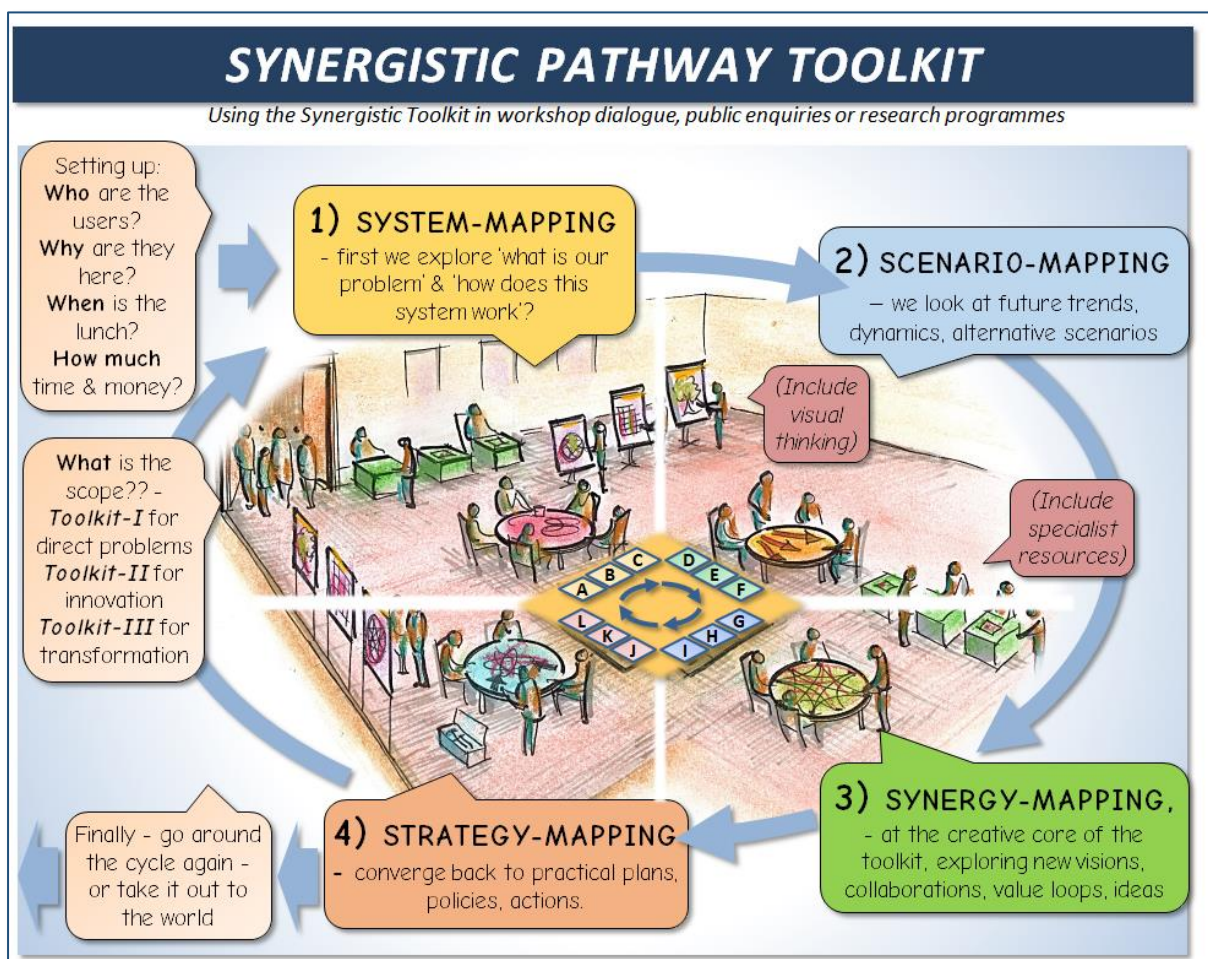
Each table would work on a generic type example in each session. These can then be cross-checked with the real case studies, and compiled into individual profiles for each real case study. (e.g. Kolkata is a ‘tropical, riverine, fast expanding, low income, with bio-reserves: its profile would be built up from each of those types).

6.2.4 Synergistic Pathways toolkit

The future of cities or climate change are 'grand challenges' or problems of 'deeper-complexity' – a tangle of societal, technology, economic, environmental, political and cultural issues. How to work with them in a positive way?

'Synergistics' – the science and art of working with synergies – has been developed for such challenges. It provides practical methods and tools, where progress depends on building 'collective intelligence'. It can work in organizations, institutions, supply chains or value-chains, enterprise models, networks or communities (Figure 19).

Figure 19: Synergistic / Pathway Toolkit in use



Synergistic methods call for creative 'out-of-the-box' thinking. For this we use the synergistic / pathway toolkit, a flexible set of tools and techniques. There are generally four stages ('4S'), each with a 'co' word (i.e. 'co'-llaboration):

- a) **Systems / co-learning:** issues on the table in the present day:
- b) **Scenarios / co-knowledge:** the drivers / dynamics of change and alternative futures:
- c) **Synergies / co-creation:** design of opportunities, synergies, innovations:
- d) **Strategies / co-production:** design of practical pathways, road-maps, policies.

The online version of this toolkit is in preparation. This combines:

- Online version of the causal model 4 themes / 20 questions as above
- Messaging platform for stakeholder dialogue
- Online whiteboards with visual templates
- Flexible structure which replicates the room in Figure 19, and can scale vertically or horizontally.

6.2.5 Visual thinking templates

As in the diagram in the 'worked example' above, these visual templates provide a simple practical structure for building and visualizing complex information, i.e. concept maps / systems maps / *deeper-mind* maps. (these are different to *mind-maps*, as they focus on collective intelligence with multiple agendas).

The templates can be easily copied onto flip charts with writing or images on sticky notes. The order of using the templates depends on the theme, the event, the participants etc. Sometimes we start with the Scenario Mapping (D,E,F): in others we start with Synergy Mapping (G,H,I).

Overall, visual thinking is one of the best ways to explore creative, out-of-the-box, inter-connected ideas.

- Participants are asked for visual ideas or small sketches, to be completed by a graphic facilitator.
- Participants can respond to 'future cards', 'scenario visions', or other visual inputs
- Participants are encouraged to draw concept mappings, using the visual templates.
- The templates are very flexible, and can be used in a creative open-minded way.
- If participants don't agree on the images or mappings, each can do their own version.
- The templates in stage 1 & 3 are focused on the development of collective intelligence.
- The templates in stage 2 & 4 fit with mainstream futures / scenario methods: and with standard route-mapping / project management methods.

6.3 '20 questions' template: worked example

This worked example is shown in four main stages, based on the 'peri-urban-climate-risk' model above, with a fifth on the 'synergistic model'. Each part has 4 topics, making a total of '20 questions'.

Rows in blue show potential maps / indicators / images, which are supplied in the online version.

Each case city/region can be divided into 'zones', i.e. distinct peri-urban types in climate/geographical or socio-economic profiles. A 5th component is a summary of the synergistic process, i.e. the cycle of co-learning & co-creation described above.

The worked example here is the South Pennines upland area, to the north & east of the Manchester region. See online for the relevant maps. (*Table 4*)

THEMES	SCOPE & TOPICS	EXAMPLE: SOUTH PENNINES
PERI-URBAN FRAMEWORK:		
<i>("drivers / stressors / exposures")</i>	General overview:	<i>Upland landscape with former industrial valley development</i>
Spatial peri-urban types & patterns:	<ul style="list-style-type: none"> • Urban direct expansion • Urban / rural fringe & gradient • Counter-urbanization effect • Urban agglomeration effect 	Geographical type: small-medium industrial towns in river valleys, scattered upland villages & small farm settlements
Spatial peri-urban functional dynamics (growth / restructuring / transition).	<ul style="list-style-type: none"> • Population growth & housing • Technology & infrastructure • Economy & employment • Real estate & markets 	post-industrial economy in transition, to niche production, semi-retired livelihoods, hobby farming etc.
Other drivers (STEEP: social, technical, ecological, policy, culture etc)	<ul style="list-style-type: none"> • Social demographics & lifestyle • Environment & resources • Policy & governance • Culture & ethics 	Middle class in-migration & eco-gentrification: decline of family farming: enclaves of deprivation & post-industrial traumas
Global-local dynamics & inter-dependencies	<ul style="list-style-type: none"> • Internal structures • external interactions • power dynamics • challenges & conflicts 	S.Pennines covers parts of 13 municipalities, provides headwaters & retention capacity: It provides visitor & ecosystem services for 3 city-regions. But, at the fringes of the policy agenda.

THEMES	SCOPE & TOPICS	EXAMPLE: SOUTH PENNINES
CLIMATE FRAMEWORK		
<i>("causes / hazards"):</i>	General overview:	<i>Fluvial flood, wildfire, heat & drought, soil erosion, landscape</i>
Climate change direct effects:	<ul style="list-style-type: none"> • temperature, • precipitation, storm etc • coastal effects 	Summer drought & storm: winter precipitation & storm.
Climate change direct hazards & impacts:	<ul style="list-style-type: none"> • wildfire, heatwave, drought, • flood, storm, cyclone • landslide, sea incursion etc, 	fluvial & flash flooding, upland & valley soil erosion, summer wildfire: progressive landscape change
Indirect hazards & nexus effects	water resources farming & forestry energy & resources ecosystems & microclimates critical infrastructure	impacts on vulnerable landscape: ecosystems destruction, soil loss, air pollution, climate emissions. Upland farming is already marginal and may become more so.
Causal loops (impacts of peri-urban on climate change)	CO ₂ emissions from energy GHG emissions from land-use Land-use & forestry change Carbon storage	Loss of peat bog carbon storage & vegetation: loss of (some) ancient woodlands. Transport CO ₂ is high due to location & geography

THEMES	SCOPE & TOPICS	EXAMPLE: SOUTH PENNINES
VULNERABILITY FRAMEWORK		
'sensitivity / adaptive capacity'	General overview:	Landscape sensitivity & marginal livelihoods
Physical-ecological vulnerability-sensitivity	<ul style="list-style-type: none"> • Soil & vegetation • Topography & stability • Settlement form & structure 	Upland peat bog with rapid run-off: upland semi-wild vegetation, thin & acidic soils. Most valley bottoms are in flood risk zone 3.
Functional-economic-infrastructure layers of vulnerability-sensitivity:	<ul style="list-style-type: none"> • technical & infrastructure • Markets & value effects • Employment & livelihoods 	privatized land management increases run-off & flood risk: much low cost housing remains in high risk areas
Eco-social-cultural layers of vulnerability-sensitivity:	<ul style="list-style-type: none"> • Affluence / deprivation • Education / communication • Cultural issues 	River valleys magnify flood risk: polarization of local residents vs incomers who tend to live on higher ground:
Adaptive governance capacity-vulnerability-sensitivity-	<ul style="list-style-type: none"> • Local government • Public services & infrastructure • Emergency services • Civil & community 	fragmented & shrinking local governance: community under change & stress. Privatized infrastructure, fragmented governance

THEMES	SCOPE & TOPICS	EXAMPLE: SOUTH PENNINES
GOVERNANCE FRAMEWORK		
Adaptive action & governance	General overview:	Fragmentation of governance: self-help tradition & eco-social innovation
Formal government, (governance, regulation)	<ul style="list-style-type: none"> • Spatial planning green belt etc • Housing policy • Infrastructure development 	Main regulation is for containment of urbanization under housing pressure: the area is on the fringe of 13 municipalities
<u>Associative</u> governance & institutions: (networks, coalitions, partnerships)	<ul style="list-style-type: none"> • Public sector • Private sector • Civic sector • Citizens etc 	From local history of cooperatives etc, many examples of networks, eco-innovations, partnerships etc. Big challenges in governance for in-between area on the fringes of 13 municipalities
Informal governance, (corruption, development, community, livelihood,)	<ul style="list-style-type: none"> • Informal land-use, settlements • Corruption & nepotism • Social innovation & enterprise 	Tradition of social enterprise, self-help, creative action. Landowning is centralized, majority are excluded, most farmers are tenants.
System effects, resilience, collective intelligence	<ul style="list-style-type: none"> • Social learning & collaboration • Social co-creation & mobilization potential • System transformation potential 	Enhanced social resilience with small town effect, with many synergistic enterprises / networks: however there are class & cultural divides.

Finally, the last questions 17-20 cover a summary of the Synergistic Pathway toolkit:

THEMES	SCOPE & TOPICS	EXAMPLE: SOUTH PENNINES
SYNERGISTIC MODEL		
<i>Based on synergistic process</i>	<i>General overview:</i>	<i>Growing pressure on fragile landscapes & settlements: potential for growing socio-eco-resilience</i>
Systems / syndromes / baselines (present)	Main cross-cutting issues: e.g. Airport / port cities: Rural livelihoods: Informal development	Private land management increases: flood risk increases in river valleys: Urban dependency increases:
Scenarios (future possibilities, wild cards & tipping points)	Critical themes: (STEEP): e.g. Social cohesion declines AI / IOT emerges Climate change accelerates	Climate change accelerates: collapse of upland ecosystems & farming: settlements in valleys become uninhabitable: social divides increase
Synergies (future vision & opportunities)	Potential ideas, connections, opportunities	Synergies of ecosystems & social systems: new semi-rural livelihoods: digital solution to fringe location. Possible new forms of collaborative 'co-governance' for in-between area
Strategies (present pathways for action)	Goals, objectives, targets for ways forward.	integrated adaptive upland landscapes: agro-forestry & eco-social innovation: innovative urban / building design for unstable & high risk locations. Prototype co-governance models

6.4 Policy Lab partners

6.4.1 inter-governmental organizations

NGO & IGO PARTNERS					Organization
UN Habitat					Urban Design and Planning Services Unit
UN Global Compact Cities					c/o RMIT, Melbourne
ICLEI					Local Govts for Sustainability

6.4.2 City-region partners

Listed from east to west: (*associate partners in italics, tbc*)

PARTNERS	net works	Climatic type	Economic type	Peri-urban type (estimated)	Organization contact
Melbourne, AU	100RC	Coastal, temperate	OECD	Urban expansion, formal	Urban Vitality & RMIT
Victoria, AU		Coastal, semi-arid	OECD	Poly-centric, formal	State Govt of Victoria, Dept of Environment, Land, & Planning
Tokyo, Japan		Coastal temperate	OECD	Poly-centric, formal	University of Tokyo
Guangzhou, China	Citi-states	Coastal sub-tropical	Upper middle	Poly-centric, formal	Guangzhou Institute for Urban Innovation
Changsha, China		Inland, sub-tropical,	Upper middle:	Urban expansion, mainly formal	Hunan University
Surabaya, Indonesia	100RC	Coastal, sub-tropical	Lower middle:	Urban expansion, mainly formal	Universitas Brawijaya
Bangkok, Thailand	100RC	Coastal, sub-tropical	Upper middle	Poly-centric, part formal	Chulalongkorn University
Dhaka, Bangladesh		Coastal, sub-tropical	LDC	Urban expansion, mainly informal	University of Dhaka
Chennai, India	100RC	Coastal tropical	Lower middle	Urban expansion, mainly informal	IGCS at IIT Madras
Doha, Qatar,	GBC	Coastal, arid	High income	Urban expansion, formal	Qatar Green Building Council
Cairo, Egypt		Coastal, arid	Lower middle:	Urban expansion, part formal	Ain Shams University
Johannesburg, SA	SACities	Inland, semi-arid	Upper middle:	Poly-centric, legacy	South African Cities Network
Kumasi, Ghana	100RC	Coastal, tropical	Lower middle:	Urban expansion, mainly informal	Old Tafo Municipal Assembly
Naples, Italy		Coastal, Mediterr	OECD	Poly-centric, part formal	Università degli Studi di Napoli Federic
Helsinki, Finland		Coastal, northern	OECD	Urban expansion, formal	Finnish Environment Institute / Ministry of Planning
Manchester region	100RC	Maritime, temperate	OECD	Poly-centric, formal	Greater Manchester Combined Authority
Granada	Bio-regional	Inland, arid	OECD	Urban expansion, formal	Universidade de Granada
Belo Horizonte, Brasil	100RC	Inland, tropical	Upper middle	Urban expansion, part formal	Federal University of Minas Gerais
Santiago, Chile		Maritime, temperate	Upper middle	Poly-centric, part formal	Universidade de Chile FAU
Toronto, Canada	100RC	Inland, continental	OECD	Urban expansion, part formal	Friends of the Greenbelt Foundation
San Diego, USA	Bio-regional	Coastal, semi-arid	OECD	Poly-centric, formal	University of California, San Diego
Mexicali, Mexico		Inland, arid,	Upper middle:	Urban expansion, part formal	Autonomous University of Baja California

6.5 Citations

Angel et al., *Atlas of Urban Expansion—2016 Edition, Volume 1: Areas and Densities*, New York: New York University, Nairobi: UN-Habitat, and Cambridge, MA: Lincoln Institute of Land Policy, 2016

Connelly, A., Carter, J., Handley, J., Hincks, S., 2018. Enhancing the Practical Utility of Risk Assessments in Climate Change Adaptation. *Sustainability* 10, 1399.

<https://doi.org/10.3390/su10051399>

EC-JRC (European Commission, Joint Research Centre): *Atlas of the Human Planet 2019 –A compendium of urbanisation dynamics in 239 countries*, EUR 30010, European Commission, Luxembourg, 2020, ISBN 978-92-76-17418-9, doi:10.2760/014159, JRC118979.

Newman, P. and Kosonen, L. and Kenworthy, J. 2016. Theory of urban fabrics: Planning the walking, transit/public transport and automobile/motor car cities for reduced car dependency. *Town Planning Review*. 87 (4): pp. 429-458.

Ravetz, J, (2020) *Deeper City: collective intelligence and the pathways from smart to wise*. NY, Routledge: <http://www.routledge.com/books/details/9780415628976/>

Ravetz, J, Fertner, C, & Nielsen, T.S, (2013): The dynamics of peri-urbanization: In: Pauleit, S., Bell, S., and Aalbers, C., (eds), *Peri-Urban Futures: Land Use and Sustainability*, Berlin: Springer. Available on http://link.springer.com/chapter/10.1007%2F978-3-642-30529-0_2