



Title

Peri-cene Synthesis Report: Overview

Sub-title

A first exploration of the
'peri-eco-urban
anthropocene'

Deliverable #

D3-3

Version, Date

**V0.9
March 2022**

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Publication details

Deliverable No.	D3-3
Work Package	WP 3
Main Author(s)	Joe Ravetz
Contributor(s)	
Date	11-01-22
Version	Vo.9 – draft for consultation
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).

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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).

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Peri-cene Synthesis Report: Overview

A first exploration of the ‘peri-eco-urban anthropocene’

CONTENTS

1	SUMMARY.....	5
1.1	Overview	6
1.2	‘Frequently asked questions’	7
1.3	From global to local	9
1.4	Responses: adaptive pathways & governance	11
1.5	Cross-cutting themes	13
1.6	Next steps	15
2	Introduction	16
2.1	Global context.....	19
2.2	Where is the peri-urban?.....	22
2.3	When & what lies ahead: scenario mapping	25
2.4	How to map & analyse: methods & tools	27
2.5	How to respond: adaptive pathways	30
2.6	How to manage: adaptive governance	31
3	CASE STUDIES.....	32
3.1	Overview of cases	32
3.2	Spatial profiling & analysis of the case studies	33
3.3	Global peri-eco-urban types	36
4	ADAPTIVE PATHWAYS.....	39
4.1	What is the problem? Exploring impacts & syndromes.....	39
4.2	General pathway analysis	42
4.3	Global menu of adaptive pathways	43
4.4	Pathway & the ‘collective peri-eco-urban intelligence’	44
5	ADAPTIVE GOVERNANCE	46
5.1	Issues & challenges of adaptive governance	46
5.2	Outline of adaptive governance.....	47
6	CONCLUSIONS.....	52

6.1	Recommendations to policy	52
6.2	Recommendations to research	54
6.3	Next steps	55
7	ANNEX:	56
7.1	Global menu of adaptive pathways	56
7.2	Practical guide: P-CAT	61
7.3	Practical guide: Pathways tool	62
7.4	Glossary	65
7.5	Citations	66

List of figures

List of tables

Acknowledgments

1 SUMMARY

Overall, as the Peri-cene has worked through the most challenging of situations, we can draw some overall conclusions so far –

- The peri-urban is not only a variety of the urban, but a new concept, even more challenging to analyse or manage;
- Climate change trends are likely to accelerate (following the COP26, see the ongoing [Climate-wise](#) program of the [Laboratory for collective intelligence](#));
- Meanwhile ‘socio-climatic’ social and governance systems seem likely to fragment, via instability, hijack, extremism or ‘post-truth’;
- Even facing such huge challenges we can still aim to build adaptation / resilience capacity in territorial units at multiple scales;
- Peri-urban areas (aka ‘urban-rural linkage, urban hinterland, bio-region, etc), are the key to adaptation / resilience in both urban and rural areas;
- Managing the transformations towards such adaptation / resilience, calls for a collective ‘*peri-eco-urban intelligence*’;
- Such intelligence can be realized and mobilized via ‘*adaptive pathways*’ – combined actions based on synergy and learning with all stakeholders involved;
- Such pathways can be realized and mobilized via ‘*adaptive governance*’: new structures and processes which are collaborative, participative, deliberative and inclusive.
- For such a huge and transformative mission, we need both more research, and research-into-action.

Peri-cene: summary for policy-makers

Fire & flood on the edge in the global Peri-cene

(*'peri-eco-urban anthropocene'*)

1.1 Overview

With the Peri-cene project now completing in challenging times, here are some key findings:

- The **peri-urban** is more than a spread-out urban: new kinds of 'metro-scapes' are emerging – distributed / bypassed\ communities, networked economies, displaced ecosystems;
- Likewise, **climate change risk** at the city-region level is more than a variation on known hazards: more a new kind of regime with new challenges – technical, social, economic and political;
- The interactions of peri-urbanization with climate risk involve a host of **direct problems** (flood, fire, storm, rising seas). They also involve many **indirect and structural challenges** (inequality, fragmentation, corruption & exploitation).

As for how the Peri-cene project worked –

- We focused the enquiry on **four key themes**: a) peri-urbanization – b) climate impacts and risks – c) societal vulnerability – d) governance capacity.
- We explored these at **three different scales**: global comparison, city-region systems, and local initiatives.
- We developed responses in **two key agendas**: adaptive pathways and adaptive governance, each essential for managing the peri-urban-climate interactions
- **Cross-cutting themes and insights** are also crucial: peri-urban-rural linkages: bio-regional thinking: system design thinking, and the emerging '*collective peri-cene intelligence*'.
- Overall this responds to the emerging IPCC agenda for risk, resilience and transformative adaptation.

This short SPM starts with key FAQs, and then follows with global-local comparison, adaptive pathways and governance, and cross-cutting themes.

It also introduces the main Synthesis Reports, in 2 parts:

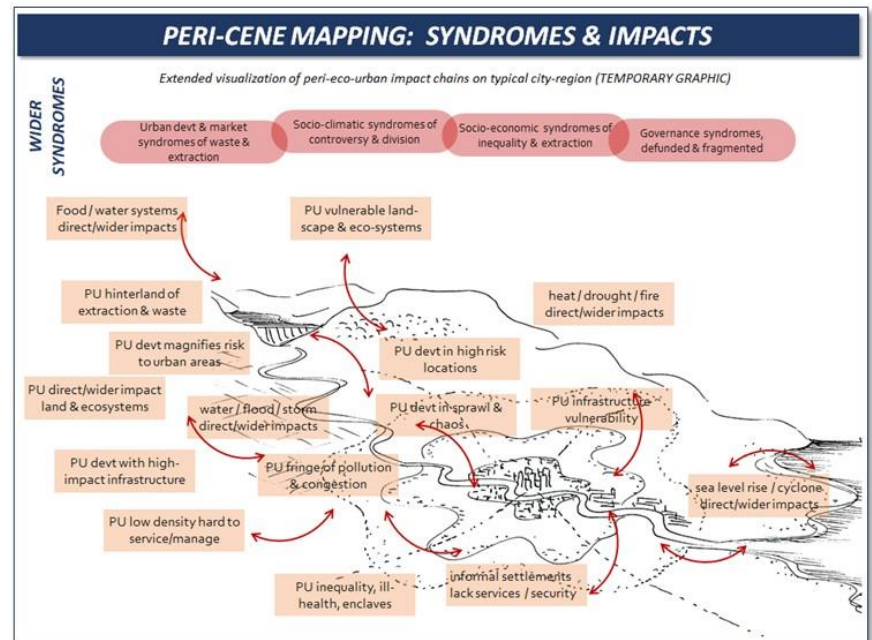
- **A) Overview**: with methods, themes, adaptive pathways and recommendations.
- **B) Compendium of cases**: with outlines, maps and charts for each case study.
- This also links to the PCAT online mapping system, via <http://peri-cene.net>

1.2 'Frequently asked questions'

a) What is the problem?

In many parts of the world peri-urban settlements, both rich and poor, suffer the impacts of extreme weather caused by climate change - hurricanes in Central America and South East Asia: catastrophic wildfires in Australia and California: fluvial flooding in UK and Europe.

Peri-urban development is also likely to reduce the resilience of urban areas – where coastal mangroves are cleared away for tourist development: historic water systems are filled in: forest natural cycles are disrupted.



b) Where is the peri-urban?

The peri-urban is broadly, the area in the gravity field or hinterland of urban areas: there are many ways to define this: by population density, economic activity, travel patterns, urban infrastructure, water or bio-regions.

As defined by the (basic) Peri-cene method, peri-urban areas include land within the 'functional urban area' (FUA) at densities of 0-300 inhabitants/km²: outside the FUA, 50-300. This covers a wide range of types: from the dense *desakotas* (urban-rural combinations) of South East Asia, to post-industrial UK, to the extended edge cities of North America and similar.

c) How big is the peri-urban & how is it changing?

Drawing from our 10% global sample, total peri-urban land around the world could be in the order of 1.8 million km² (approx. the size of Mexico). The rate of growth could be 3% of this, in the region of 60,000 km² per year (approx. the size of Ireland).

Peri-urban land areas overall have doubled in 25 years (urban land areas are slower growing at 9%). Meanwhile **peri-urban populations** have increased by 22% (urban area populations by 37%); this shows a smaller population spreading out, while the majority are still expanding and infilling urban areas.

d) Which climate risks are most crucial?

62% of our sample were in areas with 'high hazards' in over 3 multiple categories (World Bank data).

- **Peri-urban impacts on climate change 'hazard'**: Peri-urban development leads to destruction or degradation of ecosystems (forests, water bodies, soils, mangroves etc) which protect urban areas from climate-related events or stresses.

- **Peri-urban impacts on 'exposure'**: peri-urban population growth in areas of high risk (fire, flood, landslides, cyclones, coastal zone etc): many in informal settlements lacking infrastructure or defences:
- **Peri-urban impacts on 'adaptive capacity'**: dependency on critical but vulnerable infrastructure: social vulnerability: lowers population density where defence is more difficult (e.g. fire risk zones): urban centred economic development leads to disruption or bypassing of lower income livelihoods, which increases social & ecological vulnerability.
- **Peri-urban impacts on 'governance'**: governance is typically fragmented in political units, lacking connection to ecological zones: collaborative governance is more difficult, with a society polarized into higher / lower income enclaves.

e) What can be done?

Starting from the challenges – that the peri-urban is typically between units and policy sectors: climate change is either a short term disaster, or longer term risk and uncertainty. In response we look for a '*collective peri-eco-urban intelligence*' – the capacity for communication, learning, innovation and co-production between all involved. Then we look to design and plan for one of the 25 adaptive pathways, as co-designed by the Peri-cene Policy Lab:

- Direct and strategic adaptation for flooding, wildfires, drought, sea level rise etc;
- Design thinking and systems approach for food, energy, water, housing, landscape etc;
- Peri-urban-rural linkages and bio-regional ecosystems approach

To support these, we set up adaptive governance systems in each of four tracks:

- Formal government: strategic multi-level, integrated planning & public services
- Market-centred governance: integrated social & ecological values in markets & enterprises
- Civil society governance: collaborative, inclusive & participative forms of governance
- Grassroots social initiatives: enabling the energy of social innovations

f) What are the next steps?

First there is a need to raise the awareness of this vital interface in the new global '*peri-eco-urban anthropocene*'. Our case studies showed that the peri-urban is often little understood, and climate change policy is typically in near-denial. Given that this project is but a small pilot for others to follow on, some next steps include -

- Building the knowledge base, communications and learning;
- Building on the insights and responses to the IPCC and similar;
- Building capacity in governance enterprise and civil society.

1.3 From global to local

Global overview

This summary table includes land and population as defined by the Peri-cene method: (inside the 'Functional Urban Area' or FUA, 0-300 p/km²: outside the FUA, 50-300 p/km²). *Data is compiled for the sample of 21 city-regions, each with a 200km frame, from the GHSL mapping system, which covers 10% of the global urban population).*

	2015	1990	growth 25 years	APR	Doubling time years
LAND AREA (1000km²)					
peri-urban land	182	89	105%	2.9%	22
urban land	158	145	9%	0.3%	
total populated land	340	234	45%	1.5%	48
POPULATION (millions)					
peri-urban population	15	12	22%	0.8%	90
urban population	410	299	37%	1.3%	
total population	424	311	37%	1.3%	50

The headline is that peri-urban areas around the world (as here defined) are doubling every 22 years. Such trends are the result of many factors, but the implication is, (if all else stays equal), peri-urban areas may be four times their present size by 2060, as the climate crisis accelerates.

City-region profiles

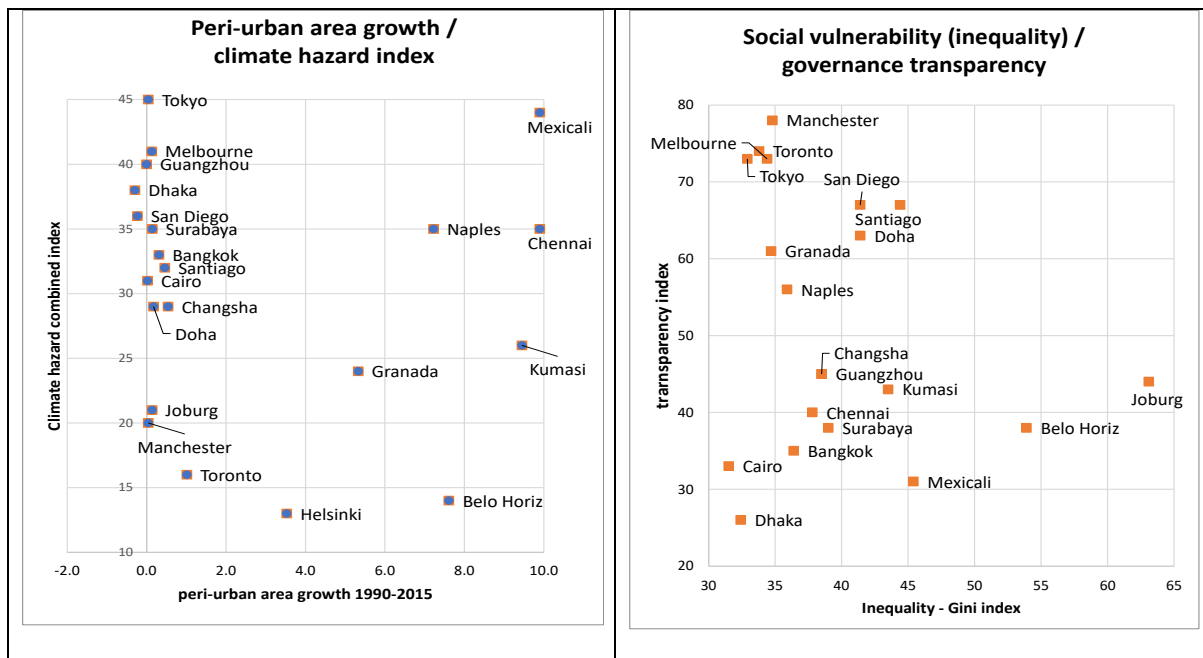
Following from the 'spatial profiling' (section 2.2), we use these key indicators for each city-region, to explore various cross sections. Our sample size is 21, so the analysis here is not about statistical analysis: more about comparison and insights on the peri-urban typology. These are selected indicators for the four key themes above:

- **Peri-urban area growth** (1990-2015): a broad measure of the scale of change in peri-urban areas (from GHSL data); a range from Cairo, Manchester (near zero) to Chennai (12.5);
- **Peri-urban climate hazard**: a combined index of 11 direct impacts, including flood, fire, sea level rise etc (World Bank data 2020): from Toronto (16) to Melbourne (41);
- **Social vulnerability / inequality** (national-level Gini index, World Bank 2020): a proxy for social capacity and resilience: a range from Helsinki (27) to Johannesburg (63);
- **Governance capacity** (transparency index of corruption 2020), as a proxy for many forms of adaptive capacity: ranging from (Manchester (78) to Dhaka (26);

The charts below then put these together:

- **Combined peri-urban growth / climate hazard index**: Mexicali, Chennai, Naples each show problematic combinations;
- **Combined social vulnerability / governance index**: Johannesburg, Belo Horizonte, Mexicali again show problematic combinations.

Figure xx: global comparison



Local initiatives

There are countless local examples of grassroots resilience in the face of climate risk and disruption.

- In the Manchester region, the peri-urban town of Todmorden set up the Incredible Edible food project, linking environmental goals with social, economic, and cultural innovations.
- In the Chennai region, the village of Katchipattu shows how mobilization of excluded social groups can create new possibilities in ecosystems resilience. Different levels from local to regional can be seen in this combined case study:

Chennai is a rapidly growing coastal megacity. Its story shows vulnerability to sea level rise and cyclones, riverine flooding and water stress, and the major disruption of livelihoods and ecosystems by the impact of peri-urban sprawl on a very complex sensitive water-based landscape.

- **Peri-urban syndromes:** rapid urban & industrial sprawl into low-lying landscape of complex water systems, & further hinterland: general disruption of ecosystems & livelihoods, development in high risk locations:
- **Climate change syndromes:** riverine & flash flooding: major cyclones: sea level rise & incursion: general water stress, disruption to soil & ecosystems, displacement of floodwater to urban areas: urban heat island & air pollution: increasing extreme wet heat days:
- **Societal vulnerability:** large scale transformation of rural economies & livelihoods: rapid social change & gentrification: disruption to rural farming & landscape systems:
- **Governance syndromes:** political fragmentation, widespread elite capture, illegal construction & encroachment: growing climate awareness but policy so far is lacking:
- **Adaptive pathways:** social grassroots innovations & community resilience (village scale): urban-rural linkages and integrated water & adaptation management (district scale): agro-ecology & integrated food systems (regional scale)
- **Adaptive governance:** integrated regional climate-wise planning: public / private sector partnership & market integration: civil society mobilization.

1.4 Responses: adaptive pathways & governance

Adaptive pathways

On the positive side, there are great examples of renewing the 'peri-eco-urban' resilience. Looking beyond one-off projects, the Peri-cene **21 adaptive pathways** combine ecological stewardship, collaborative governance, agro-ecology farming, integrated water systems, low impact coastal defence, nature based livelihoods, and so on. And to make all these work calls for enhanced forms of governance – adaptive, collaborative and inclusive of all stakeholders.

These **adaptive pathways** are likely to be combinations of many actions (social, technical, ecological, economic, political, cultural etc), which can overcome multiple challenges, and lead towards transformation.

The Peri-cene project aims at a unique contribution to these adaptive pathways – an interactive co-design process, with systematic analysis & development, from direct solutions to structural transformations.

The more direct pathways include, for **flood and storm**:

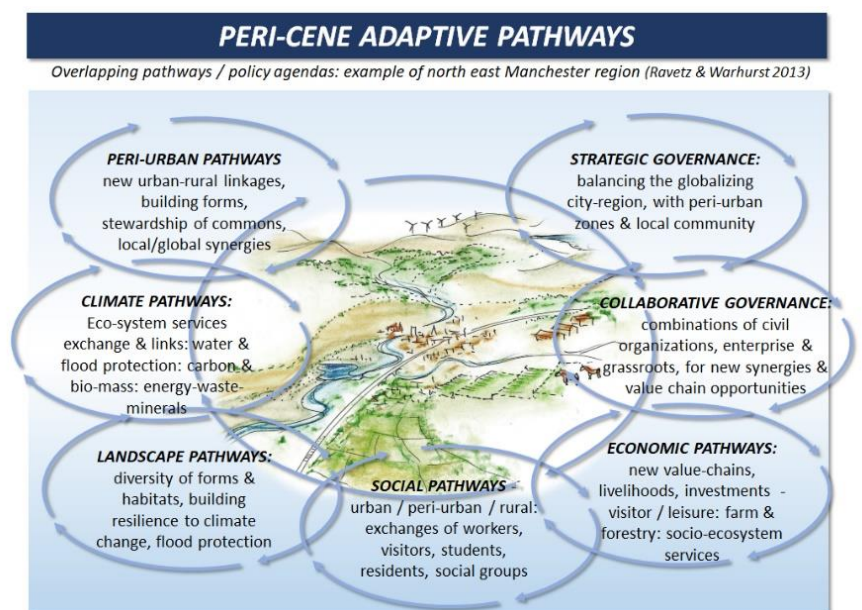
- Short term: we need ways to manage rising floodwaters and extreme events, via SUDS, canals and basins, all integrated to the peri-urban metro-scape.
- Longer term: (in some areas) we need to rethink – where are the settlements, what kind of forms & surroundings, how can low impact eco-design manage a transformation towards a water-friendly co-existence.

And then for drought, heat and wildfire:

- Short term: arid zone water management in buildings and land: fire defence via forest breaks and natural fire cycle management.
- Longer term: (in some areas) we need to rethink – where are the settlements, what kind of forms & surroundings, how can low impact eco-design manage a transformation towards a drought / fire-friendly co-existence.
- For extreme heat, a growing agenda for building eco-design, social welfare, public health & safety, adaptation of livelihoods etc.

Also for sea level rise:

- Short term: sea defences, adaptation of coastal peri-urban livelihoods: cyclone-proofing buildings, infrastructure, ecosystems where possible.
- Longer term: (in some areas) we need to rethink – where are the settlements & infrastructure, can they be defended, managed retreat or whole relocation. For cyclones etc, replanting of mangroves, dunes & coastal ecosystems



Adaptive governance

To enable these pathways calls for advanced forms of governance, able to manage complex problems with wider communities and deeper values. In practice nearly all our case studies found the current governance situation problematic:

- Peri-urban governance: typically trans-boundary, divisive and fragmented, lacking lines of authority and accountability;
- Climate adaptation governance: dealing with large uncertainties, controversial and divisive, hard choices between possible future impacts and present day costs / benefits.

The synergistic approach then helps to define different 'modes' of governance, and map the pathways towards a '*collective peri-urban governance intelligence*': (i.e. the communication, learning, innovation and co-production between all stakeholders). This also provides the logic for analysis of the case studies. We tracked in each one the various sectors of governance - public, private, civic and grassroots - where different kinds of logic may be dominant:

- Mode 1 'functional': the logic of bureaucratic efficiency, with possible dysfunctionality & inertia in the face of complex problems;
- Mode 2 'mal-evolutionary': elite / corporate capture, corruption either tacit or open;
- Mode 2 'evolutionary': innovative, entrepreneurial, mobilizing new forms of value;
- Mode 3 'co-evolutionary': collaborative-associative-participative-inclusive forms of governance, with *deeper* forms of value, with *wider* communities.

This provides a crucial insight to complex governance situations around the world, facing the special challenges of the peri-urban and climate response. In Manchester we see well established functional systems, in a 'mal-evolutionary' context of tacit elite capture and austerity, also with marginal possibilities on the co-evolutionary front. In Chennai, the 'mal-evolutionary' logic tends to be dominant over the functional, while the co-evolutionary potential is also a powerful force, as seen with agro-ecology.

This analytic framework has now been applied to a practical scheme, 'ELSA':

- Engage: collaborative, participative etc;
- Learning: knowledge based, deliberative, experimental;
- Situated: responsive to local issues and stakeholders, in multi-level systems;
- Action-oriented: innovative, creative, 'SMART' etc.

This is then applied to explore and define the meaning of 'adaptive governance' for each sector:

- Formal government: strategic multi-level, integrated planning & public services
- Market-centred governance: integrated social & ecological values in markets & enterprises
- Civil society governance: collaborative, inclusive & participative forms of governance
- Grassroots social initiatives: enabling the energy of social innovations

1.5 Cross-cutting themes

As peri-urban / climate interactions are typically complex, uncertain and controversial, we need new ways to understand and manage them. Starting with cross-cutting peri-urban syndromes (car based sprawl, inequality and gentrification, rural disruption and bypassing, high risk housing and so on) – we look at cross cutting themes of linkages, design thinking, bio-regional thinking, and the ‘*collective peri-eco-urban intelligence*’. These are highlighted below as common syndromes – *versus* – potential pathways.

Peri-urban-rural linkages:

Urban & rural areas are highly linked and inter-dependent, in resources, infrastructure, housing, travel and ecosystems, and the peri-urban adds another dimension to that mix. ‘PURL’ (peri-urban-rural linkages) planning aims to maximize opportunities and minimize impacts on each kind of territory.

- Peri-urban commuter sprawl, congestion, isolation & exclusion – *versus* - **local livelihood pathways** for community resilience: (e.g. Melbourne, San Diego);
- Peri-urban flood defence diverts water down to the urban - *versus* - **integrated catchment pathways** with natural flood management and multi-functional landscape: (e.g. Chennai, Manchester);

Peri-urban bio-regional thinking

This puts the ecological bio-region (bio-ome, eco-region etc) at the centre of integrated planning (social, technical, ecological, economic, political, cultural), at multiple scales between urban / peri-urban / rural. Again the contrast includes:

- Peri-urban exploitation by intensive agri-business, with cheap migrant workers, pollution of air & water: - *versus* - **agro-ecology** pathways for local livelihoods & food democracy, circular resource systems (e.g. Granada, Toronto)
- Peri-urban forests and catastrophic fire risk from disruption by housing, infrastructure, mismanagement - *versus* – **integrated forestry pathways** with re-wilding, landscape diversity, fire-wise design (e.g. Bangkok, San Diego).

Peri-urban systems design thinking

Seeing the peri-urban as a complex system, we need to look beyond one-off solutions, towards collaborative (co-) design for system levels: for example,

- Peri-urban overloaded by combined flood and storm, water stress & heat stress – *versus* - **integrated design pathways** for buildings & urban form, natural flood / drought / heat management: (e.g. Cairo, Bangkok);
- Peri-urban development patterns which magnify up the exposure and vulnerability to fire or flood – *versus* – **integrated climate-wise pathways** for emerging development patterns: (e.g. Mexicali, Surabaya);

Strategic thinking & 'collective peri-eco-urban intelligence'

The pathways outlined above are basically starters for debate, on how far can the existing stakeholders can go to be creative or radical, for situations which are contested or controversial. Sooner or later such pathways will challenge in some way the existing system which has produced and reproduced such problems.

Here we apply the concepts of '*collective peri-eco-urban intelligence*' (aka '*deeper peri-eco-urban mind*'): the capacity for communication, learning, innovation and co-production between all stakeholders. This can be framed with 3 levels:

- **Functional intelligence**, (*mode 1*): fixing of defined problems with known methods: e.g. raising of flood defence walls
- **Evolutionary intelligence**, (*mode 2*): where one-off innovation / competition can produce new responses: e.g. peri-urban ecosystem markets
- **Co-evolutionary intelligence**, (*mode 3*): where deeper and wider effects are all included: e.g. peri-eco-urban community enterprise with multi-level adaptive governance.

Climate risk & transformative adaptation

All the above responds to the IPCC report AR6-WGII, chapter 1, and its overview of key concepts. One is the **adaptation gap** - '*the difference between actually implemented adaptation and a societally set goal*'. For the peri-urban reality this seems problematic, as often there is little idea of what kind of adaptation, for complex systems in rapid change, and with few 'societally set' goals.

There is a simple technical version for building flood defence. But a more strategic transformative adaptation has to include for the transformation of the peri-urban itself (ongoing and/or intentional), highlighting all the stresses and contradictions of the society around it. In our case studies the lower income megacities (e.g. Chennai, Dhaka) show this directly: but also the apparently safer places (Manchester, San Diego) show deeper layers of vulnerability and myopia. This points to the **socio-climatic interface**, where most case studies show little consensus or evidence 'out there', on climate change – instead there are power games, hijack, displacement, inertia and myopia

As for **transformative adaptation**, the Peri-cene contributes some essential insights. The first is to reframe the problem, as **not** all about climate change – more about finding common opportunities and pathways, in which climate adaptation is an added 'co-benefit'.

Another is to look for **adaptation pathways**, not as one-off solutions, more as extended processes of collaboration, which can enhance and mobilize the seeds of positive change: e.g. in urban design, real estate markets, landscape diversity, community development (*e.g. Toronto Greenbelt Foundation, Manchester South Pennine Park, Indian agro-ecology programs etc*). These also bring in parallel perspectives, such as gender issues, indigenous and first peoples, decolonization, general social inclusion and empowerment.

A third theme is the '**Climate-wise**' agenda, starting with 'what could possibly go wrong: how can these pathways be hijacked to make more money, power, ideology? Could money or power be better made by blocking or stalling climate action? In the light of current events it seems more than ever essential to explore the 'big bad world' effects and possible responses.

1.6 Next steps

Here these research findings / recommendations feed into ongoing research-policy agendas.

- **IPCC WGII: a research-policy agenda:** Recommendations / guidance for strategic urban / peri-urban policy, planning & design;
- **ARA (adaptation research alliance), a research agenda:** guidance & demonstrations for ‘trans-boundary / trans-formative / trans-modal’ research;
- **Urban-rural linkages (UN Habitat), a practical agenda** – (<https://unhabitat.org/topic/urban-rural-linkages>): This aims at case studies, policy recommendations, capacity building.

Generally there is an urgent need to understand and manage the new global ‘*peri-eco-urban anthropocene*’. Our case studies showed that the fast expanding peri-urban is little understood, and strategic climate adaptation in most peri-urban areas is hardly started. Given that this project is but a small pilot for others follow on, the next steps aim to continue –

- Building the knowledge base, communications and learning;
- Building further insights and responses to the IPCC and similar;
- Building adaptive capacity in governance enterprise and civil society.

All who are interested in the global peri-cene – research, policy, business, civil society – are invited to join this challenge.

As a first step we are now exploring ways forward, with some options;

- Community of experimentation, exploring pathways towards the ‘*collective peri-urban intelligence*’: (in association with the [Laboratory for collective intelligence –](#))
- Community of practice, for applications of these insights on the ground: (in association with UN Habitat <https://unhabitat.org/topic/urban-rural-linkages>.)
- As a first milestone, a special issue in the journal *Frontiers of Sustainable Cities*;

We propose to take this forward at the WPSC Track 10, in 2 special sessions and paper presentations – (<https://wpsc-apsa2022.org/track-10-rural-regional-and-small-island-development/>):

2 Introduction

In Australia, the hottest summer on record at 49 degrees brings rampant wildfires, and the election of a coal-burning government. In the Arctic the rate of melting is so far beyond the predictions, that rain now falls on the mountains of Greenland. In India and Bangladesh half a billion people in the Ganges basin depend on fast-receding glaciers, and shelter from ever stronger cyclones.

It's not easy to see how the deadly combination of climate change with toxic overload and species extinction can be stabilized, while material consumption continues, and while half the world appears to deny the science, and build walls against climate refugees. The implication is that climate change is the ultimate game-changer, with impacts ranging from 'very significant' to 'existential'.

So far 'the city' has been the object of attention, research and policy. Cities are part of the problem, in that they concentrate resources, economic development and infrastructure. They are also concentrations of population in harm's way of flood and storm, heat and drought. Cities are also part of the solution, not just with compact city reduction in travel, but in the prospects for circular economics, low-zero carbon, or inclusive liveable communities.

However the nature of cities is changing, along with our perceptions. Cities are not only grey areas on the map, but extended systems of production, consumption and exchange across ever larger hinterlands. There is massive peri-urban expansion, sprawl and decentralization across many parts of the world. In other countries already urbanized, the attempt to manage peri-urban social and economic change then creates problems of inequality and exclusion, along with unforeseen vulnerabilities to climate impacts.

For example, in the peri-urban hills north of Manchester (UK), the geography of narrow valleys and upland peat bogs results in growing levels of catastrophic flooding, both locally and downstream in the main conurbations. This is arguably as a result of private land ownership and management, and the gaps in an already complex set of public / private governance. In response is a leading example of 'adaptive-collaborative governance', the *South Pennine Trust*: their mission demonstrates exactly the adaptive pathways which this research highlights.

Meanwhile in the fast changing peri-urban hinterland of Chennai (India), a landscape of subsistence farming villages is being over-ridden with industrial plants and IT corridors, wealthy enclaves and resettlement housing. As a result water systems are disrupted and encroached, and with looming sea level rise and cyclones, Chennai is prone to both flooding and water shortage. In response is a new policy agenda, overlaid on a complex fabric of civil society organizations and CSR, each with initiatives from hi-tech to informal grassroots innovations.

Generally, there are countless examples of rebuilding the 'peri-eco-urban' resilience. Such 'adaptive pathways', aim to combine new forms of ecological stewardship, collaborative governance, agro-

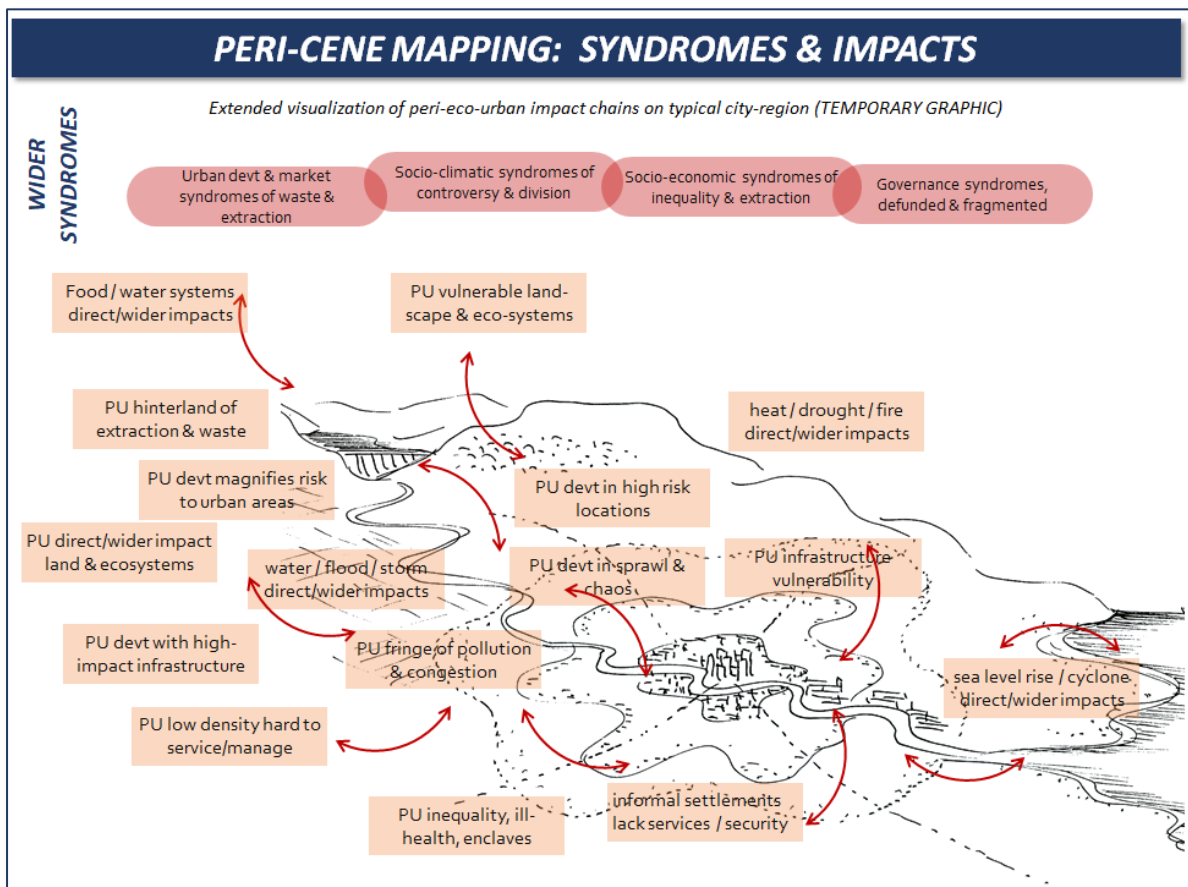
ecological farming, digital technology, integrated water management, local jobs and livelihoods, low impact coastal defence, and so on.

This project Peri-cene aims to make a modest contribution. We developed a first global assessment of peri-urbanisation, along with its climate impacts and risks. We aimed to provide new peri-urban spatial mapping with an interactive - [P-CAT tool](#). Then we engaged stakeholders in policy dialogues to explore the nature of the problem and possible ways forward. We hosted the co-creation of 'adaptive pathways' in a [Policy Lab](#) of 21 city-regions from around the world. And we looked in detail at contrasting [Case studies](#): from the global south in [Chennai](#) (India), and [Manchester Region](#) (UK).

What's the problem? Syndrome & impact mapping

The relation of the peri-urban-climate to its host city or agglomeration, and then to the risks and uncertainties of climate change, and then to the new agenda of adaptation, is a complex set of causes and effects, direct and indirect. Some of the most topical emerging from the Peri-cene are shown graphically in Figure 1x:

Figure 1x:



- a) Peri-urbanization puts its population directly in the line of climate hazards: flood, fire, storm, coastal effects
- b) Peri-urbanization increases the vulnerability of its hub city / agglomeration, indirectly or displacement via flood, fire, storm, coastal effects.
- c) Peri-urbanization also generally increases the contribution to climate change via transport emissions, industrialized agriculture, landuse change and deforestation, larger consumption footprints etc.
- d) Peri-urbanization itself increases the vulnerability of its population, by disruption of livelihoods, social inequality and exclusion, degradation of landscape, critical infrastructure
- e) Peri-urbanization can reduce the effectiveness of governance, between urban / rural in different units: and amplify governance syndromes such as fragmentation, corruption, elite capture and global extraction.

Overall these impacts and vulnerabilities depend on the level of development, social cohesion, infrastructure types, effective governance etc, as well as the physical pattern of peri-urbanization. It also depends on the sub-surface 'extended syndromes' of fragmentation, corruption, elite capture, alienation and distrust in governance and society.

How to respond? synergy & pathway mapping

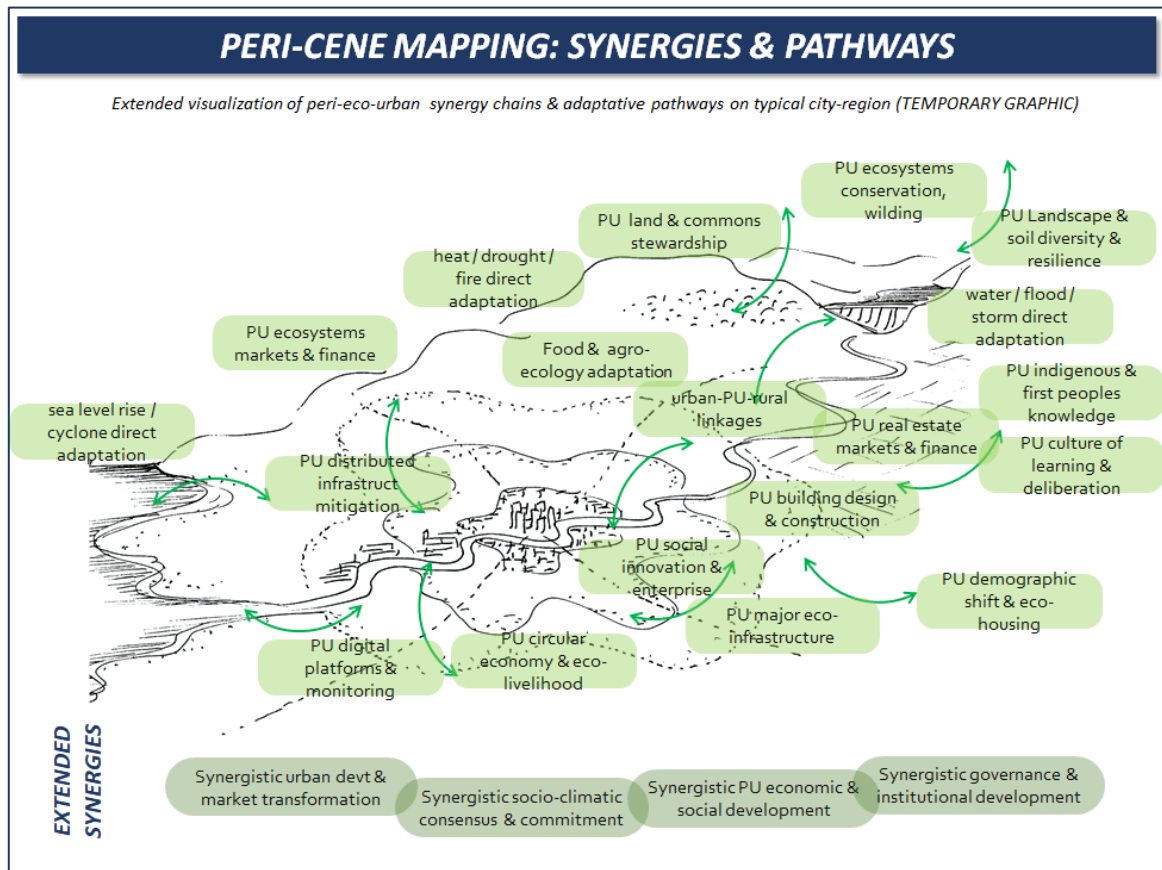
In response there are many opportunities for the unique qualities of the peri-urban, to increase the resilience of its population, and also that of the urban agglomeration, and the surrounding rural hinterland. These opportunities in this project are framed as 'adaptive pathways'.

Looking beyond one-off projects, these **adaptive pathways** are various combinations of ecological stewardship, collaborative governance, agro-ecology farming, integrated water systems, low impact coastal defence, nature based livelihoods, and so on. And to make all these work calls for enhanced forms of governance – adaptive, collaborative and inclusive of all stakeholders.

These **adaptive pathways** are likely to be combinations of many actions (social, technical, ecological, economic, political, cultural etc), which can overcome multiple challenges, and lead towards transformation. They are flexible, creative, long-range, open to opportunity and change (in contrast to a policy or program with specific objectives and actions).

The Peri-cene identified through a series of stakeholder workshops a 'global pathway menu': the graphic mapping here shows most of these on a generalized city-region. Each of the city-region cases (section 5) then selects and customizes from this 'global pathway menu'.

Figure xxx



2.1 Global context

Climate change is now a clear and present danger (IPCC, 2021). Whatever the result of the next COP, there is a huge momentum in both the global climate system, and the 'techno-economic' system of industry, energy, infrastructure and economic development. There is also a huge momentum in land-use change, urbanization and peri-urbanization.

Unless there is radical transformation of technical systems, economic and political systems, which enable a complete zero-carbon transition in about one decade, the world appears likely to continue on its current trajectory of 3-4 degrees temperature rise.

The urban climate agenda is well-known, with countless research and policy applications. Some of the most common include: storms, floods, drought, heat, fire, sea-level rise and tidal surge, crop failure, pandemics, and climate-induced migration. New findings come every day, for instance that future global warming may be double the current projections, that sea levels may rise up to 6 metres with two degrees warming, large areas of the polar ice caps could collapse, with wildfire destruction of tropical forests.¹

Then comes a long catalogue of follow-on or induced climate-related hazards: landslips, subsidence, spoil erosion, dust storms, urban smog, invasive species, groundwater depletion, tidal surge, saline incursion, destruction of mangrove swamps, wetlands and old-growth forests. And then second or third order effects: collapse of food chains, large uninhabitable areas, mass migration of climate refugees, decline and fall of great cities: all this is likely to contribute to political instability, social extremism, economic collapse of vulnerable nations.

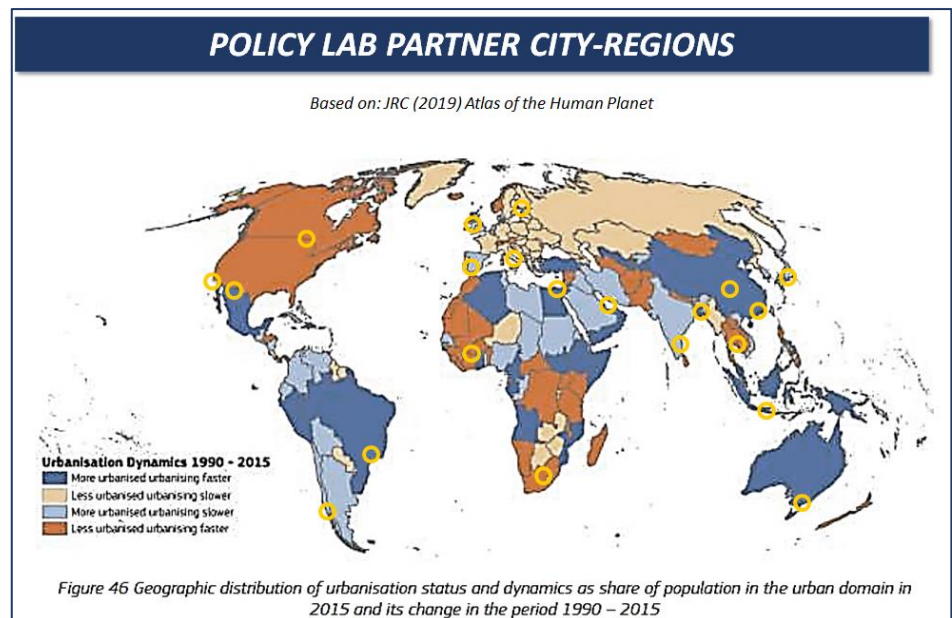
Outline of Policy Lab

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'. Due to the pandemic all activities moved online: this was a challenge for creative thinking, but also an opportunity for a wider consultation. This included structured interviews with a '20 questions' template, small group meetings, and an international workshop. This ran in parallel with the development of the Peri-cene Analysis Tool ('P-CAT') for spatial mapping of peri-urban-climate interactions. The general method followed the Peri-cene Pathways Tool for system mapping of problems and pathways, with its unique '1-2-3' combination of online whiteboards and virtual meeting hubs.

The Lab partners include 2 main case studies and 15 active partners: (from east to west), Melbourne, Tokyo, Guangzhou, Changsha, Surabaya, Bangkok, Dhaka, Chennai, Cairo, Doha, Johannesburg, Kumasi, Helsinki, Manchester, Naples, Granada, *Belo Horizonte*, Santiago, Toronto, Mexicali, San Diego (*sleeping partners shown in italics*).

Together these partners represent the major urban types and climate risk types, from both developing (urban South) and developed countries (urban North). They also cover the various types of urbanization dynamics, (as defined in the Atlas of the Human Planet), as in Figure xxx:

- Urbanized - more / less:
- Urbanizing - faster / slower.



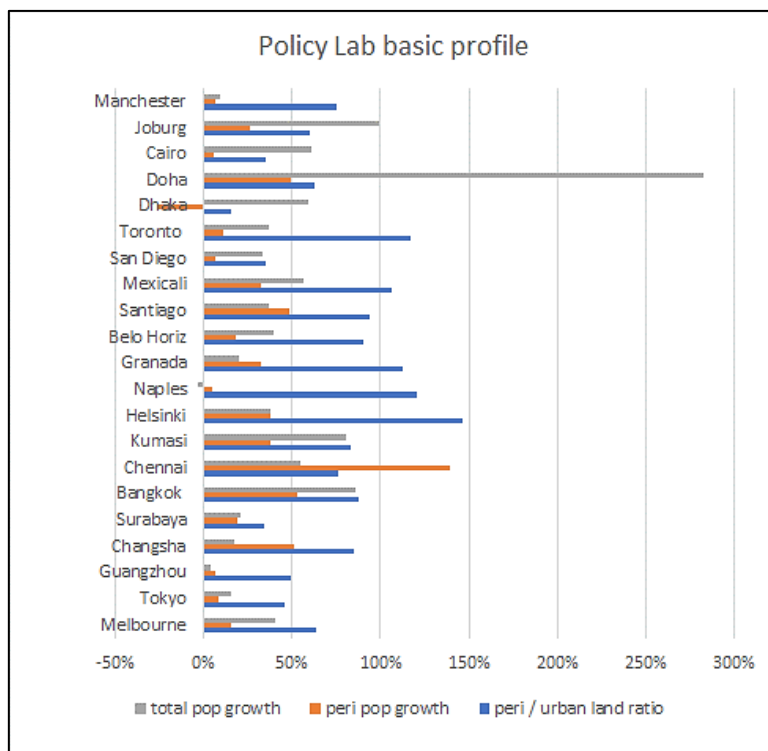
Global peri-eco-urban types

Our case study sample shows 8 main peri-eco-urban types. In reality there are likely to be many different zones within each type:

- Lower income – rapid P-U growth – wet climates: Dhaka, Surabaya, Chennai, Bangkok
- Lower income – rapid P-U growth – dry climates: Mexicali, Cairo, Johannesburg
- Lower income – slow P-U growth – wet climates: Kumasi, Changsha,
- Lower income – slow P-U growth – dry climates: Santiago, Belo Horizonte
- Higher income – rapid P-U growth – wet climates: Helsinki
- Higher income – rapid P-U growth – dry climates: Melbourne, San Diego
- Higher income – slow P-U growth – wet climates: Toronto, Manchester
- Higher income – slow P-U growth – dry climates: Granada, Naples, Doha,

Each type brings up a different mix and profile of peri-urban climate problems, and potential responses or adaptive pathways. (see detail in Section 3).

Figure xxx



Global peri-urban profile

In our basic sample of 21 city-regions (Figure xxx), each was mapped on a standard 200km square frame, to allow for a 100km radius. This frame size was drawn to include the peri-urban hinterland of larger city-regions, and also the wider peri-rural hinterland of smaller or poly-centric city-regions. This is also a response to the many-layered question of ‘where is the peri-urban?’ (next section).

The peri-urban land categories of 50-300pp/km² were defined using the GHSL standard mapping data at 1km² resolution (details in D2-1). The time period was taken at 25 years with data 1990-2015. (See the Part 2 Synthesis – Compendium, for data tables in the Annex).

- The total sample contains a 2015 population of 424 million (over 10% of the global urban total). The size (including the extended megacities and polycentric hinterland) ranges from Dhaka and Cairo (69 and 60 million), to Mexicali and Helsinki (1.7 and 2.6 million).
- The growth 1990-2015 of the total population (in the sample) is 37% or 1.26% APR.
- The growth 1990-2015 of the peri-urban population (in the sample) is 22% or 0.79% APR.
- The growth 1990-2015 of the peri-urban land area (in the sample) is

2.2 Where is the peri-urban?

The Peri-cene has used global mapping systems combined with local consultations, to address the basic question – where is the peri-urban?. The Manchester region example shows the complexity – with its many satellite towns, extended suburbs, urban greenspaces and river-valleys, post-industrial hinterland, tourist hotspots, upland peat bogs and so on. We can list multiple layers of the peri-urban, in a combined ‘socio-ecological region’:

- Residential density – with peri-urban somewhere between urban and rural
- Proximity to the metropolitan economic zone – again, between urban and rural
- Physical bio-region: water catchments, topography, food zones, climate types;
- Economic region: commuting, labour market, housing market, access to global services;
- Social region: other layers of local identity, migration, culture etc;

With this in mind the Peri-cene typology is a simple summary of a very complex picture, based on two main factors:

- **Residential population density:** the peri-urban is defined as 2 land-use types, between 50-125 and 125-300 persons/km², as defined by the GHSL system (Pesaresi et al 2019)
- **FUA (‘Functional Urban Area’)**, i.e. zones of clustered economic activity, from a global classification (OECD 2020)

If we fit the different densities with the FUA units (or equivalent), we have a set of 5 geographical zones:

- **a) ‘Urban edge’** (125-300 p/km²): suburban / extended settlements, within the FUA:
- **b) ‘Urban fringe’** (50-125 p/km²): Scattered / extended / sprawl, within the FUA;
- **c) ‘Urban greenspace’** (0-50 p/km²): open land / forest / other, within the FUA:
- **d) ‘peri-urban settlement’** (125-300 p/km²); larger satellites & higher density settlements, outside the FUA;
- **e) ‘peri-urban hinterland’** (50-125 p/km²): Smaller satellites & lower density settlements outside the FUA.

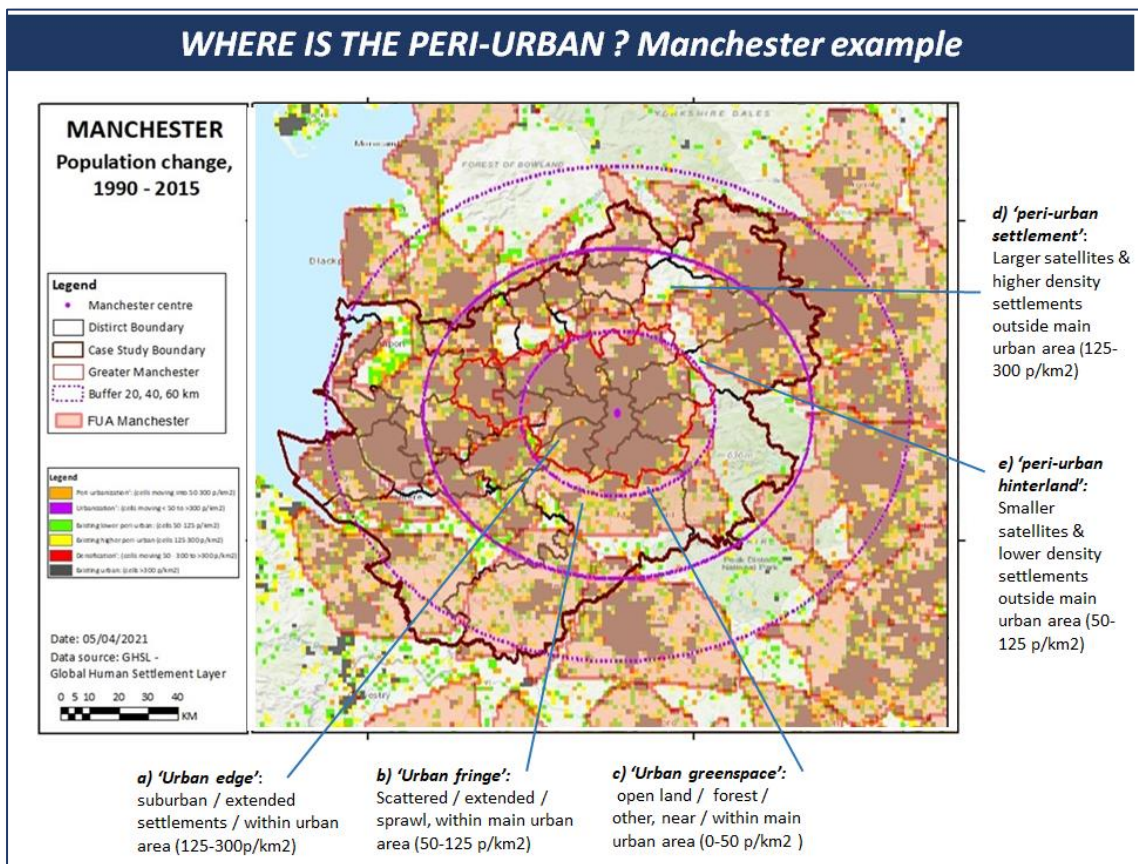
Table 1: Peri-urban types

PROXIMITY	Within the FUA	Outside the FUA
DENSITY p/km²		
125-300	a) ‘Urban edge’: suburban / extended settlements / within urban area	d) ‘peri-urban settlement’: Larger satellites, higher density sprawl / ex-urbs.
50-125	b) ‘Urban fringe’: Scattered / extended / sprawl near / within urban area:	e) ‘peri-urban spread’: Smaller satellites & further / lower density sprawl / ex-urbs.
0-50	c) ‘Urban greenspace’: open land / forest / other, near / within main urban area:	-

Overall, we aimed for a simple practical definition of peri-urban, based on Figure xxx -

- all locations not in the grey urban areas, but inside the 60km radius:
- yellow and green squares of between 50-300 p/km², outside the 60km radius on the map.

Figure xxx



In more detail: the peri-urban typology map in *Figure xxx* is based on the global 'GHSL' system, which charts all land and urban areas on a 1km square grid. In this key map:

- Orange shaded areas show the 'functional urban areas', defined by the OECD as areas of most concentrated urban / economic activity.
- Yellow squares show the higher peri-urban densities of 125-300 p/km²
- Green squares show the lower peri-urban densities of 50-125 p/km²
- Orange red and purple squares show changes from 1990-2015 (see the legend on the left)
- The circles of 20, 40, and 60km show a very rough travel time radius of up to 1 hour from the main CBD. (this is more complex in polycentric agglomerations, and in reality travel time depends on the mode and infrastructure).

How is the peri-urban changing?

The peri-urban in the majority of cases is a moving frontier, a zone of disruption and transformation. This again varies greatly around the world:

- 'combined urban-rural' (mainly in S&E Asia): here the peri-urban shows particular patterns which are both rural and urban, such as the *desakota* model.
- 'policy regimes' (mainly Europe / OECD countries): here peri-urban land use change is strictly controlled, so that rapid changes are more likely to be social and economic, than in physical land-use.

- ‘edge cities’ (the American model which is now world-wide), the peri-urban is an extended indistinct zone of potential, of ‘post-metropolis’ and ‘edge city’ sprawl and transition, in both land-use and infrastructure, and social / economic terms.
- ‘frontier cities’ (the Gulf and similar desert regions): in arid climates the peri-urban is often a scattering of built form with little between.

The map in Figure xxx shows, in the same 1km² cells, changes from 1990-2015:

- 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.

All this points to the challenge of defining peri-urban change, in a simple mapping of population density and proximity.

Peri-urbanization indices

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)
- 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

One example is shown here for Chennai city-region (see Compendium for full list).

Table 2xx: Example key indicators for the peri-urban

PERI-URBAN Classes	Density bands	total land Area 2015	Total Land area (in %)	total population 2015	total population 1990	25yr CHANGE (total pop)	25yr pop change (% on 1990)	Pop change annual % compound
Open land & peri-rural	< 50 p/km	1387.0	9.4%	43	19	24	126.4%	3.32%
Lower density peri-urban	50—125 p/km ²	2512.0	17.0%	216	89	126	141.0%	3.58%
Higher density peri-urban	125-300 p/km ²	3260.0	22.1%	654	271	383	141.4%	3.59%
Urban & suburban	urban use (>300 p/km ²)	7611.0	51.5%	23732	15586	8146	52.3%	1.70%
Total	Total area	14770.0		24647	15966	8680	54.4%	1.75%

2.3 When & what lies ahead: scenario mapping

Scenario development is a standard method in climate change analysis & policy - for creative thinking on urban-climate problems and on forward pathways. Scenarios are not forecasts, more like 'what if' questions, or 'stress testing' of policy. The Peri-cene project uses the SSP (Shared Socio-economic Pathway) scenarios, as these are compatible with global climate modelling. These are 'exogenous', i.e. outside the city-region system & decision frame: the city-region can then work out what to do in response, to the 2 critical scenarios here. In summary there are 2 main applications:

- Forward look to future agendas: what level of climate / social change should we plan for?
- Stress-test the draft pathways: are they robust and will they work in extreme conditions?

The events of July 2021 in China, India, Siberia, Germany and USA seem to show that apparently rare 1000-year events are now very frequent, and that both low & high income societies are increasingly vulnerable.

Hence the crucial role of scenarios in responding to complacency / apathy / denial: and then for creative thinking 'outside the box'....

These are some headlines for the example of Chennai, with SSP scenarios 4&5:

SSP Scenario #4 ('inequality') social breakdown (climate change)

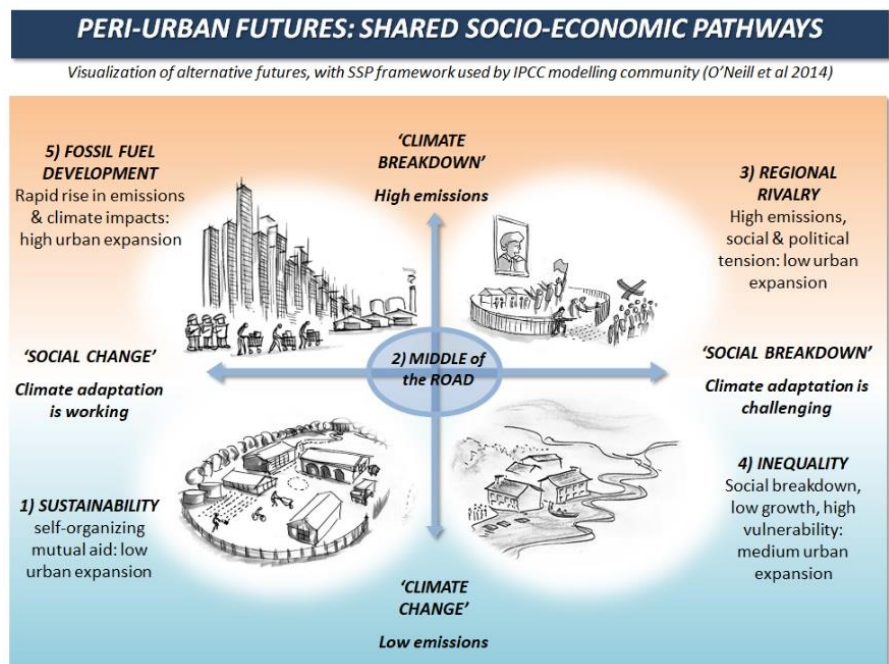
Sea level rise, cyclones, riverine flooding and extreme heat all hit Chennai and its region, but less than the worst predictions. However, urbanization continues in a tidal flow of concrete and steel: villages near and far are displaced, water systems are laid to waste, livelihoods expropriated. The poor and landless are crowded into burgeoning peri-urban sprawl, huddled under the roads and behind factory walls, scavenging for waste. Meanwhile fossil fuels are cheap and millions of SUVs tear around the new road systems as if there is no tomorrow....

SSP Scenario #5 ('fossil growth') climate breakdown (social change)

Here the climate takes back control. A series of super cyclones bring new levels of storm surge, and 1/3 of the Chennai urban area is already under water, when a hyper-monsoon dumps a whole season on the region in 2 days... sorting through the swampy remains of a once-great mega-city, the authorities are more determined than ever to confront the climate monster, with new levels of social control and business regulation - but it's rather too late..

To apply these scenarios to a 'future-proofing' of potential pathways, we explore both challenges and opportunities under each of the axes of climate and society:

- Societal breakdown: Scenario 4



- Climate breakdown: Scenario 5
- (note scenario 3 is a combination of both climate and societal breakdown, which we leave out of this analysis)
 - For the **challenges**, clearly a society which is in extreme climate change, or falling apart into conflict, could be very challenged both in physical terms and in the social institutions.
 - For the **opportunities**, such disruption and rapid change may also bring new scope and openings for innovation and enterprise, all the way to radical social-political restructuring.

The table here shows the first part of a list of pathways, with likely challenges and opportunities for each: (based on consultation and workshop materials). The city-region briefings are then selected from this global menu. As with much scenario work, the result here is not so much an ‘answer’, more like a resource for continuing discussions with stakeholders, for stress-testing, co-creating, road-mapping / strategic planning and so on.

Table 1:

		Climate extreme change / breakdown: (Scenarios 3&5)	Societal extreme change / breakdown: (Scenarios 3&4)
Peri-urban pathways			
• urban-peri-rural linkages		Challenges: water, land-use, energy, transport systems under stress. Opportunities: rethink on the technical interactions of urban & rural	Challenges: social economic & governance systems under stress Opportunities: Rethink of social systems, economic markets, governance systems
• peri-urban building design & form		Challenges: buildings pushed to the limits by storm, flood, heat Opportunities: Push for new designs for extreme conditions	Challenges: more defensive building forms, shortage of skills. Opportunities: radical solutions for housing forms & designs.
• peri-urban land stewardship		Challenges: land & landscapes under pressure from storm, flood, drought Opportunities: new types of landuse may emerge	Challenges: social norms & capitals for stewardship are under stress Opportunities: more space for social innovation with breakdown of system
• peri-urban major infrastructure		Challenges: existing infrastructure may be obsolete for new conditions Opportunities: design innovation for more extreme conditions	Challenges: large infrastructure funding more difficult with economic stress Opportunities: to rethink zero-carbon low impact infrastructure.
Climate change pathways			
• water / flood / storm adaptation		Challenges: major inundations & reshaping of water landscapes Opportunities: redesign / relocation of peri-urban building in high risk zones	Challenges: gaps in social fabric & cohesion affects disaster response & recovery Opportunities: scope for radical & grassroots innovation to fill the gaps in state or corporate provision.
• heat / drought / fire adaptation		Challenges: catastrophic heat / fire / drought conditions, disruption of water supply in ‘zero peri-urban’ areas Opportunities: accelerated disaster recovery & adaptation.	Challenges: social inequality & disorder amplifies the heat / fire vulnerability of poor & excluded groups. Opportunities: common emergencies may trigger new means of social cohesion & institutions.
• sea level rise / cyclone adaptation		Challenges: major surges, rapid erosion, subsidence, saline incursion, Opportunities: planned retreat & withdrawal of coastal communities.	Challenges: marginalized communities on the front line may be displaced by elites Opportunities: new forms of eco-planning may emerge in response to societal gaps.
• agro-ecology & food democracy		Challenges: primary impact on food security for the most vulnerable Opportunities: new forms of water / drought proof & eco-sensitive peri-urban agriculture.	Challenges: agro-ecology & climate-wise farming may not survive social exclusion & fragmentation; Opportunities: stronger institutions in agro-ecology systems, to respond to social stress.

2.4 How to map & analyse: methods & tools

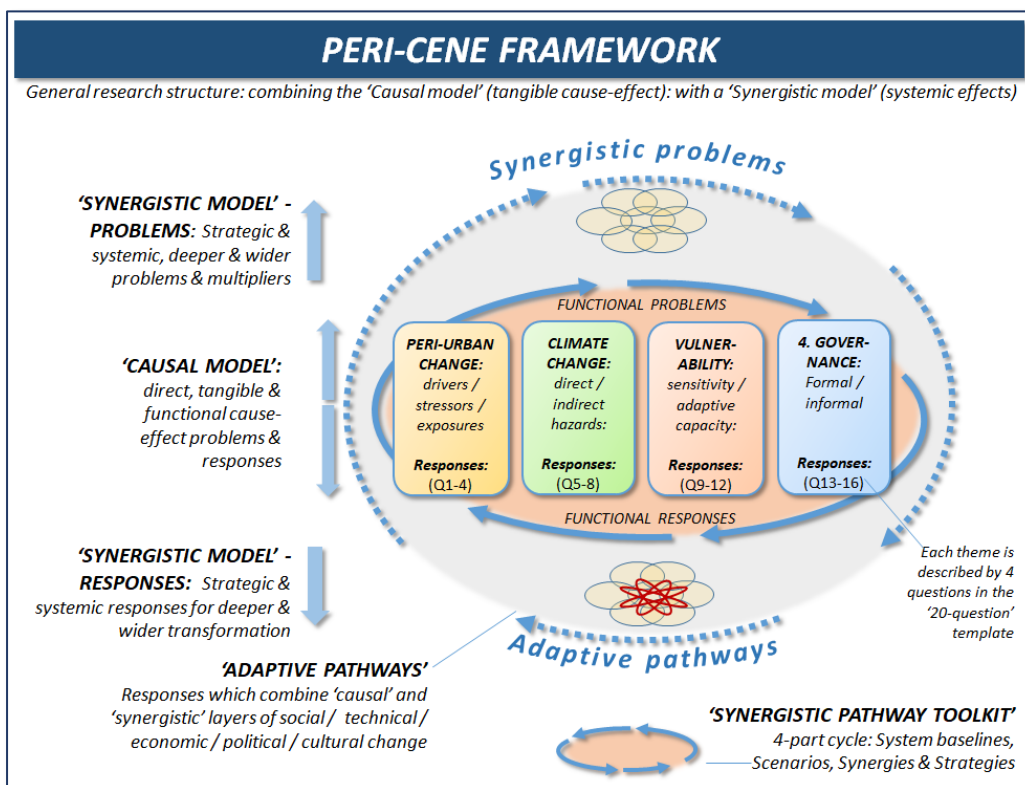
Peri-urban development, climate risk and vulnerability, governance and adaptive pathways, are complex and often controversial. For such challenges, the Peri-cene project developed the **Peri-cene Framework**, and its applications through various templates and tools. This combined Peri-cene Framework is a combination of two main 'Models':

- The **'Cause-effect model'** assumes a mainly functional frame of cause and effect, in direct problems ('syndromes'), impact chains, and possible responses, between the four main factors: peri-urban / climate / socio-economic vulnerability / governance.
- The **'Synergistic Model'** addresses wider systems with deeper complexity, and potential for transformation via *'collective climatic intelligence'*

Each Model has a role and purpose. The *Cause-effect Model* is a practical place to start to gather data and explore the tangible interactions of the peri-urban with climate change. The *Synergistic Model* is actually more realistic for real-world problems of multi-layered 'deeper complexity' – but also more challenging for mainstream research, and more suited to a creative (co)-design and dialogue process.

The *Cause-effect Model* contains four main stages of tangible causes-effects and responses:

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



These four stages also provide the logic for the '20 question' template used in the interview process and reporting on each case study.

This is shown by a typical example, from peri-urban Manchester, where there is increasing severity of fluvial flooding:

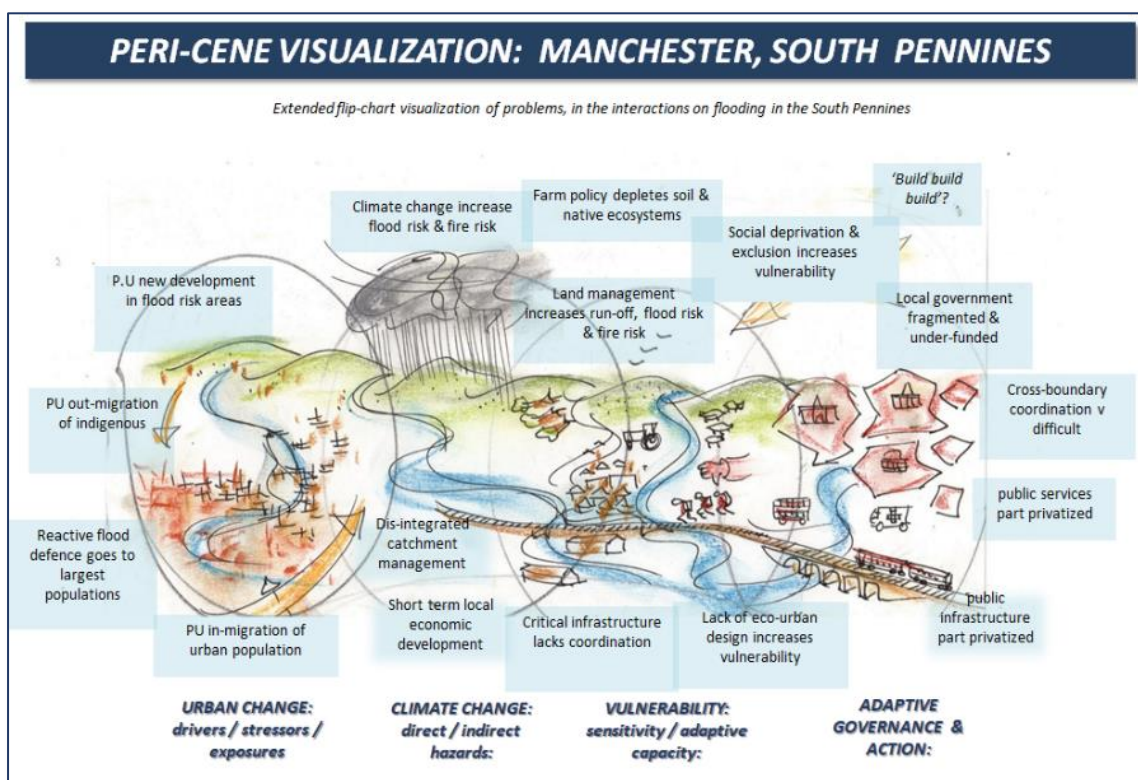
- The **Causal Model** looks at the peri-urban pattern, flood risk, social vulnerability, and then the governance needed to build up the local flood defences;
- The **Synergistic model** looks for more strategic factors, (e.g. ownership of land upstream, or the under-funding of local government). It then explores more strategic responses, (e.g. new forms of collaborative land stewardship).

From real world complexity to system mapping

The Peri-cene local consultations and desk studies open the door on many layers of uncertainty and complexity. Peri-urbanization, economic development, demographic change, and climate change impacts are each long stories, and the overlays and combinations are beyond any simple analysis. Furthermore there are layers of contradictions and conflict, which are difficult to include in any formal analysis: while economic inequalities might in some ways be measured, social exclusion, alienation, corruption or fragmentation are challenging.

Our approach is to take firstly at face value the 'raw' results of problems and cause-effect chains, using visual thinking as in the example in figure xxx. This is then material for an ordering process, using the above framework in four stages and multiple levels.

Figure xxx



The four stages then translate to 20 questions, which are framed with an online template, also very useful for interview results. The report D3-2 shows the full versions developed for each partner city. This can also be useful for comparison and linking with other information. Here is a worked example:

Table xxx: international comparison (example)

	CHENNAI	MANCHESTER
Spatial framework: (drivers / exposure)	Rapid urbanization of edge & near rural Peri-urbanization of further rural Rural-urban migration, mainly unplanned	(N&E) river valley development (S&W) urban edge development, some large extensions
Climate-environment (causes / hazards):	Growing water demand, reducing resources Local food shrinking	(N&E) impacts on vulnerable landscape (S&W) impacts on farming
Social-economic drivers / sensitivities ('STEEP')	National modernization & global value chains socio-eco transition to middle income digital / infrastructure transition	(N&E) post-industrial economy in transition (S&W) farming in flux: commuter in migration: extreme wealth enclaves
Adaptive – collaborative governance	Growth in education, digital, open democracy	(N&E) fragmented & shrinking governance (S&W) pressures of affluence & polarized society
Synergistic model:	Some seeds emerging	(N&E) new synergistic enterprises / networks

Towards a 'collective peri-eco-urban intelligence'

With disasters looming ahead, we might assume the peri-urban / climate problem is an urgent material problem of land-use, infrastructure, flood and fire, ecosystems and food systems, government and public services. But from each of the case studies, an alternative story comes up – more about the communication and learning between different parts of society, the creation of new ideas, and the collaboration and co-production between all involved.

For example the 'socio-climatic' approach (Section 4) looks at the problem of flooding and its defence / response / recovery / adaptation. Evidence on the ground shows many different interpretations of risk distribution, climate science and social responsibility: the buzz-word 'resilience' is deeply entangled with power and inequality.

To explore this the Peri-cene uses the synergistic methods and tools for *cognitive systems mapping* – i.e. the flow of knowledge, learning, ideas, actions and feedback. This helps to respond to the complexity of peri-urban / climate interactions, and provide a practical way of pathway mapping. For a whole system, such learning and thinking can then build up towards a '*collective peri-cene intelligence*'. Different 'modes' of pathways with various levels of collective intelligence can be mapped:

- **Mode-I** functional pathways focus more on technical issues and analysis: for instance, peri-urban flood management can focus on building physical defences.
- **Mode-II** evolutionary or 'smart' pathways are more about transition by evolution, innovation, incentives and competition: here the flood management is framed to maximize market values (with typical side-effects of social inequality, displacement of impacts etc).
- **Mode-III** co-evolutionary or 'synergistic pathways' explore the potential transformation via the qualities of *collective peri-cene intelligence*. To enable this the design of synergistic / adaptive pathways look for *deeper* layers of value and logic, with a *wider* community of

interest, and further scope of cause and effect. In practice we then look for the most effective combinations of social change, technologies, economic markets, ecological techniques, government policies, cultural changes and urban development.

Synergistic method: example application

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, with 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 6 of these templates. 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.

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

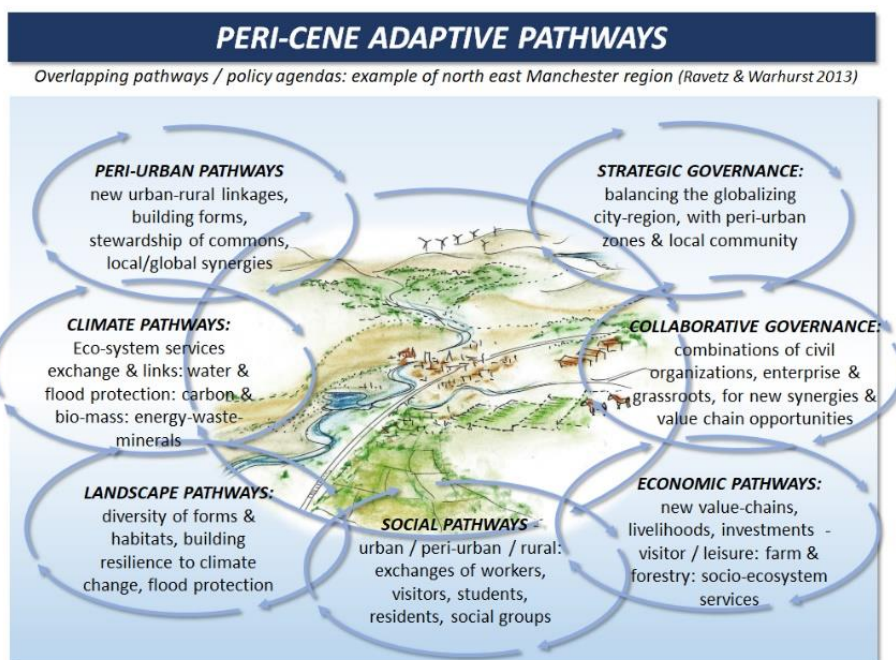
2.5 How to respond: adaptive pathways

The expansion of cities around the world puts peri-urban settlements, both rich and poor, directly in harm's way – the climate-induced disasters of cyclones, wildfire, drought, flood and storm. Much peri-urban development also reduces the resilience of its host city – where coastal mangroves are cleared, water systems are filled in, forest cycles are disrupted, communities are displaced.

On the positive side, there are great examples of renewing the 'peri-eco-urban' resilience. Looking beyond one-off projects, these **adaptive pathways** combine ecological stewardship, collaborative governance, agro-ecology farming, integrated water systems, low impact coastal defence, nature based livelihoods, and so on. And to make all these work calls for enhanced forms of governance – adaptive, collaborative and inclusive of all stakeholders.

These **adaptive pathways** are likely to be combinations of many actions (social, technical, ecological, economic, political, cultural etc), which can overcome multiple challenges, and lead towards transformation.

The Peri-cene project aims at a unique contribution to these adaptive pathways – an interactive co-design process, with systematic analysis & development, from local to global.



Key findings and insights on the pathways theme are in Section 4.

2.6 How to manage: adaptive governance

The first requirement for an adaptive pathway is a system of *adaptive governance* (meaning not only the formal system government and public services, but the wider / deeper set of institutions and practices which surround it). Adaptive governance (here defined) can include various combinations:

- Formal statutory government
- Market-based governance
- Collaborative / third sector / partnership governance
- Informal / grassroots movements & actions

The Peri-cene method looks at several levels which may be relevant in each case study:

- area-based: e.g. Pennine area of Manchester region
- pathway or policy focused: e.g. agro-ecology
- organization focused: e.g. Pennine Prospects
- Specific local place or case: e.g. the town of Hebden Bridge.

Cognitive system mapping: the synergistic scheme above, is very useful to define different ‘modes’ of governance:

- Mode 1: (functional) - command & control government
- Mode 2: (evolutionary) - market based competition / innovation
- Mode3: (co-evolutionary) – collaborative partnership, associational co-production etc.

For this mode 3, fundamental qualities of ‘adaptive / collaborative governance’ were defined by systematic desk study, and then used as the template for analysing consultation results.

- a) Deliberative governance: ‘Deeper’ integration of policy agenda formation & competing values:
- b) Multi-level governance: ‘Vertical’ multi integration of spatial / systems levels
- c) Associative governance: ‘Wider’ integration of stakeholder interests & potentials:
- d) Responsive governance: ‘Further’ integration of policy & service value chains
- e) Collaborative governance: ‘Deeper’ dynamics of informal / self-organized / co-creative actions

This analytic scheme has now been put into practice with a four part scheme, ‘ELSA’:

- Engage: collaborative, participative etc;
- Learning: knowledge based, deliberative, experimental;
- Situated: responsive to local issues, stakeholder groups; multi-level systems;
- Action-oriented: innovative, creative, SMART etc.

Key findings and insights on the governance theme are in Section 5.

3 CASE STUDIES

This is a overview and general analysis of the cases in the Policy Lab. For detail on each location see the Peri-cene *Synthesis Compendium*, and for full detail see D3-1 and D3-2.

3.1 Overview of cases

At the centre of the Peri-cene project is the international 'Policy Laboratory'. This is a space for (a) diagnosis / mapping of problems, and (b) design of responses and 'adaptive pathways'. Due to the pandemic all activities moved online: this was a challenge for creative thinking, but also an opportunity for a wider consultation.

This included structured interviews with a '20 questions' template, small group meetings, and an international series of online workshops.

This ran in parallel with the development of the Peri-cene Analysis Tool ('P-CAT') for spatial mapping of peri-urban-climate interactions. The general method followed the Peri-cene Pathways Tool for system mapping of problems and pathways: this provided a unique '1-2-3' combination of online whiteboards and virtual meeting hubs.

The case study partners

include: 2 in-depth case studies and 15 active cases (*also there were 4 tacit cases, shown in italics*).

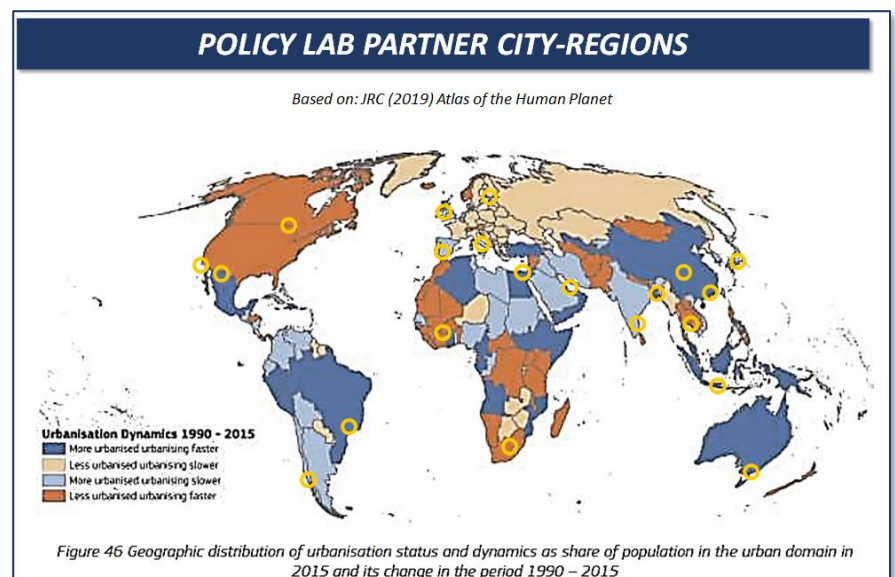
These appear in this report approximately from east to west - Melbourne, Tokyo, Guangzhou, Changsha, Surabaya, Bangkok, Dhaka, Chennai, Cairo, Doha, Kumasi, Helsinki, Johannesburg, Manchester, Naples, Granada, *Belo Horizonte*, Santiago, Mexicali, San Diego, Toronto.

The total population represented is around 420 million (as of 2015) or nearly 10% of the global urban total. Maps and charts for the full list of 21 are available in **Part II – Compendium**.

The global stakeholder / user community is represented by UN Habitat, Regional and Metropolitan Planning Unit, Urban-Rural Linkages program. The Peri-cene findings aim to contribute to that program of research and capacity building. There is also strong linkage with ICLEI (International Council for Local Environment Initiatives).

Together these partners represent the major urban types and climate risk types, from both developing (urban South) and developed countries (urban North). They also cover the various types of urbanization dynamics, (as defined in the Atlas of the Human Planet), as shown in *Figure 1* above:

- Urbanized - more / less:
- Urbanizing - faster / slower.



3.2 Spatial profiling & analysis of the case studies

Following from the 'spatial profiling' (section 2.2), we use these key indicators for each city-region, to explore various cross sections. Note the sample size of 21 is small, so the analysis here is not focused on statistical significance: it aims more to provide comparison, context to the case studies, and insights on the peri-urban typology:

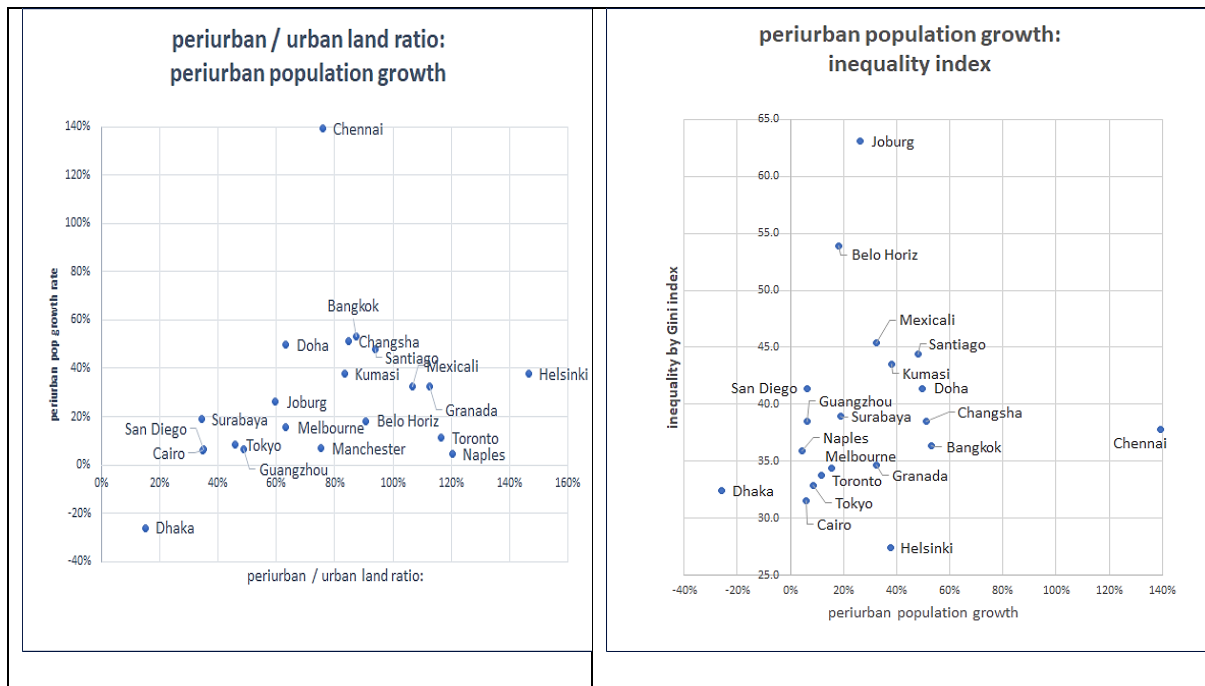
- **Peri-urban to urban land ratio:** (i.e. '**peri-urban footprint**'): this compares (as of 2015) the total peri-urban land area (defined on the GHSL system as 50-300 pp/km²), to urban land (over 300 pp/km²). A higher figure shows a more diffused lower density urban form. The range is from Helsinki and Naples (146 and 120%) to Dhaka and Cairo (15 and 35%).
- **Peri-urban population change:** (i.e. '**peri-urban dynamic**'): average growth (1990-2015) of the total population living on peri-urban land (50-300 pp/km²). A higher figure shows a more rapid spread, either outward from the urban area, or infilling / peri-urbanization of rural areas.
- **Average income** (shown as national GDP in USD \$1000 per person, from World Bank data): this is a key reference point, despite widespread critique of both the data and of GDP as an indicator. Our sample shows a huge range from India (\$2.1k) to USA (\$63.5k).
- **Average inequality** (shown as a national-level Gini index from World Bank data 2011-2020): this is taken as a rough proxy for a wide range of social and institutional factors, which then indicate the level of social vulnerability to climate change. The chart shows the range from Helsinki (27.4) to Johannesburg (63.1).
- A further table (not shown here) charts total population growth, 1990-2015: this will generally be dominated by the main urban population. Such growth may be indigenous or a result of in-migration. Here the extreme cases of emergent cities are Doha and Johannesburg (283 and 99%): and the case of negative growth in Naples (-3.6%) and static in Guangzhou (3.8%). The Manchester wider region also shows slower growth at 9% in the 25 years.

The scatter plots here (Figures xxx below) demonstrate the different combinations, with some insights on the typologies. Also note the GHSL data is on a coarse 1km grid, so that the same density of e.g. 150pp/km², could indicate either many small villages, or free-standing dwellings on large lots. Given its limits, however, this quite basic analysis is a starting point, and the first to address directly the peri-urban and peri-urbanization on a global comparative basis.

Peri-urban to urban land ratio: Peri-urban population growth: this combines the 'peri-urban footprint' with the 'peri-urban dynamic'. A high/low combination shows a relatively static but diffused pattern: (e.g. Helsinki, with a smaller core and larger hinterland). A low/high combination shows rapid change on a modest starting point (e.g. Chennai, with a large urban core rapidly filling up its surroundings). There is a cluster of medium-high growth with medium footprints (Bangkok, Santiago, Doha) and a lower growth / smaller footprint corner. The outlier here is Dhaka with -26% shrinkage, indicating a rapid densification / urbanization of previously higher-density rural areas, (which show up as peri-urban in this global classification).

Peri-urban population growth: inequality index: this charts the 'peri-urban dynamic' against the index of inequality, acting as a proxy for social vulnerability and institutional dysfunction of many kinds. There are clear outliers, with the grotesque inequality of Johannesburg, and runaway peri-urbanization of Chennai, and negative growth in Dhaka. A cluster of very different cities shows up in the corner of lower inequality / lower growth, and another cluster in the middle of the ranges.

Figure xxx



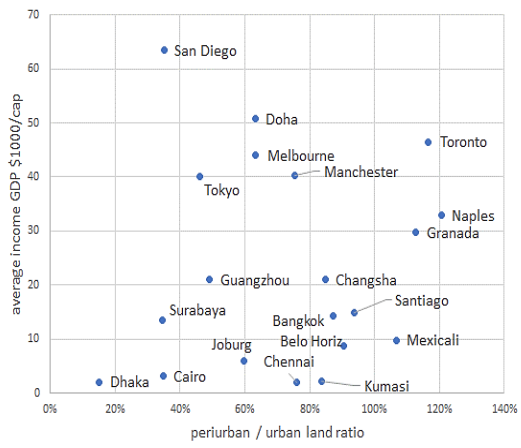
Peri-urban to urban land ratio / average income: a basic measure of the type and quality of the peri-urban footprint is the level of affluence, which indicates housing conditions, infrastructure and social vulnerability in general. The west coast model of San Diego shows a relatively contained peri-urban footprint, while others such as Toronto, Naples and Granada are more spread out, each with a highly populated hinterland. At the other end of the scale, Asian cities such as Surabaya or Guangzhou are relatively higher density in much of the hinterland (with such areas classed as urban).

Peri-urban population growth / average income:

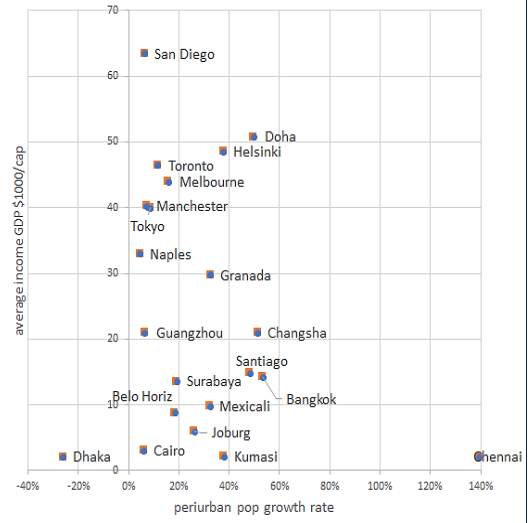
The dynamic side of the picture then shows the growth against the same income data. Here the outliers range from Chennai (high growth / lower income), to Cairo and Dhaka (low growth / lower income). At the top of the scale is San Diego, with a second tier of Doha, Helsinki, Toronto and Melbourne, each with relatively medium levels of peri-urban population growth.

Figure xxx

periurban / urban land ratio:
average income



periurban population growth:
average income



3.3 Global peri-eco-urban types

The next step is to fit these basic urban geographical types with the climate impacts, risks and adaptation agendas. Here the data gets very patchy: the downscaling of global-regional projections is very approximate, the available modelling of riverine flooding or sea-level rise has very high uncertainties, and many of the most important effects are second-order and not in the models. So to get started, our case study sample shows 8 main peri-eco-urban types, at a very general level, while in reality there are many nuances and differences within each type (Table 3x):

Table 3x

DEVELOPMENT TYPE	CLIMATIC TYPE	EXAMPLES	TYPICAL DIRECT IMPACTS	TYPICAL PRIORITY PATHWAYS
Lower income – rapid P-U growth	Hot / wet climates:	Dhaka, Surabaya, Chennai , Bangkok	Floods, cyclones, heat, sea level	Governance, flood, sea levels, food, livelihood
Lower income – rapid P-U growth	Hot / dry climates:	Mexicali, Cairo, Johannesburg	Drought, heat, (flood)	Governance, water, heat, landscape, social resilience
Lower income – slower P-U growth	Hot / wet climates:	Kumasi, Changsha,	Flood, drought, heat	Governance, flood, food, urban-rural links, eco-urban
Lower income – slower P-U growth	Temperate / dry climates:	Santiago, (<i>Belo Horizonte</i>)	Flood, drought, heat	Governance, flood, water, heat, landscape, social resilience
Higher / mid income – rapid P-U growth	Temperate / wet climates:	Helsinki (<i>Guangzhou</i>)	Flood, ecosystems	Flood, eco-peri-urban, infrastructure, ecosystems, governance
Higher income – rapid P-U growth	Temperate / dry climates:	Melbourne , San Diego	Wildfire, drought, heat, flood	Wildfire, water, flood: landscape, eco-peri-urban, governance
Higher income – slower P-U growth	Temperate / wet climates:	Toronto, Manchester , (<i>Tokyo</i>)	Flood, heat, ecosystems	Landscape, flood, eco-peri-urban, governance
Higher income – slower P-U growth	Temperate & hot / dry climates:	Granada, Naples, (<i>Doha</i>),	Drought, heat, flood, sea level	Landscape, water, heat, flood, livelihood, social resilience, governance

There follows a brief overview of each of these types:

Lower income – rapid P-U growth: hot / wet climates:

These coastal megacities represent the largest single concentrations of population at direct risk. In various ways they are each prone to rising sea levels, subsidence and landslides, tropical cyclones, riverine flooding, extreme drought and extreme heat. In each case the hinterland is also suffering climate impacts, which displace farmers and communities to migrate to the peri-urban areas, which then causes further disruption to landscapes, forest and water systems. In most cases the hinterland is also struggling with deforestation, soil erosion, disruption of water systems and ecosystems, with further knock-on effects.

Examples include: Chennai: Dhaka, Surabaya, Bangkok:

Chennai:

Lower income – rapid P-U growth: hot / dry climates:

These mainly inland cities are each heavily water dependent and vulnerable to extreme drought and extreme heat. Peri-urban areas show high levels of informality and speculation, overlaid on governmental type legacies or interventions. Again often the hinterland is also suffering climate impacts, which displace farmers and communities to migrate to the peri-urban areas, which then causes further disruption to landscapes, forest and water systems.

Examples include: Mexicali, Cairo, Johannesburg

Johannesburg

Lower income – slower P-U growth: hot / wet climates:

These inland cities are growing albeit more slowly, each with a unique mix of encroachment, or (in the case of China) complex arrangements for government licensed development, with conversion of rural to urban communities and livelihoods. Climatic challenges again revolve around water stress, occasional flooding, rural conversion, and the possibility of extreme heat.

Examples include: Kumasi, Changsha,

Changsha,

Lower income – slower P-U growth: temperate / dry climates:

These more moderate rates of growth depend on the viability of the surrounding rural hinterland, the government systems and their legacies, the appropriation of land for speculation and building of enclaves. Climatic impacts are a combination of water stress, disruption of the hinterland of mountains or forests.

Examples include: Santiago, Belo Horizonte

Santiago,

Medium-higher income – rapid P-U growth: temperate / wet climates:

Mainly northern cities contain the most advanced systems of planning and infrastructure, however there are strong growth pressures, rural in-migration and counter-urbanization. Climate challenges centre on riverine flooding and storm, ecosystems disruption and forest systems change, with threats to critical infrastructure in the further hinterland.

Examples include: Helsinki, Guangzhou

Higher income – rapid P-U growth: temperate / dry climates:

Such cities may be wealthy but live in a fragile landscape, not far from the climate frontiers of drought, wildfire and flooding. The direct local syndromes are likely to be more or less contained, but the wider hinterland is increasingly vulnerable. The peri-urban climate interactions are then overlaid on a mix of extended social, economic and cultural syndromes.

Examples include: Melbourne, San Diego

Higher income – slower P-U growth: temperate / wet climates:

These mainly northern cities are about the least vulnerable. Peri-urban growth is relatively moderate and carefully planned, while social or economic change is more rapid. Climate challenges are relatively moderate levels of riverine flooding and storm, ecosystems and forestry disruption. In such cases the indirect and extended effects may be more problematic, such as social inequality, poor housing, vulnerable livelihoods, dysfunctional governance.

Examples include: Manchester, Toronto,

Higher income – slower P-U growth: hot / dry climates:

Finally, these locations in the Mediterranean or Gulf regions raise questions on the nature of peri-urbanization: with combinations of declining rural economies, burgeoning city-regions. In the Gulf case, there is a rapidly growing conurbation, in a hostile desert climate, with autocratic centralized infrastructure and planning systems. In each case there are rising climatic challenges – extreme heat and drought, occasional flooding, collapse of hinterland landscapes.

Examples include: Granada, Naples, Doha,

4 ADAPTIVE PATHWAYS

The expansion of cities around the world puts peri-urban settlements, both rich and poor, directly in harm's way – the climate-induced disasters of cyclones, wildfire, drought, flood and storm.

Much peri-urban development also reduces the resilience of its host city – where coastal mangroves are cleared, water systems are filled in, forest cycles are disrupted, communities are displaced.

On the positive side, there are great examples of renewing the 'peri-eco-urban' resilience. Looking beyond one-off projects, these **adaptive pathways** combine ecological stewardship, collaborative governance, agro-ecology farming, integrated water systems, low impact coastal defence, nature based livelihoods, and so on. And to make all these work calls for enhanced forms of governance – adaptive, collaborative and inclusive of all stakeholders.

This 'pathways global menu' is a draft compilation of all the ideas and examples so far from the Peri-cene Policy Lab, with its partner cities around the world. There are many overlaps and inter-connections between them, new combinations are also possible, and each one can be customized for applications on the ground.

Firstly, a brief recap on the 'adaptive pathway design method': this works with two parallel strands or conceptual 'models': -

- a) **cause-effect model:** in each case this focuses on -
 - Identify impact chains & compare to global menu
 - Identify most relevant pathways from global menu
- b) **synergistic model:** in each case this focuses on -
 - Actor / factor mapping of combined systems and typical syndromes / value gaps
 - Actor / factor mapping of combined systems with potential synergies / value chains
 - Pathway mapping which can realize the synergies by mobilizing actors & factors.

4.1 What is the problem? Exploring impacts & syndromes

First we explore some more into the nature of the problem, for insights on the highly inter-connected nature of urban-climate interactions. To sum up the challenge of such complexity:

- Peri-urbanization is a highly complex interaction of social and economic forces, overlaid on geography, shaped by technologies and moderated (more or less) by governance systems.
- Climate change impacts and adaptation is a highly complex interaction of physical forces over extended spaces and times, acting on complex landscapes and urban infrastructures, mediated by human perceptions of risk, uncertainty, responsibility etc.

With that in mind, to make the research question practical, we look here for 'syndromes', i.e. where some kind of conflict or contest reveals some significant features of these complex system interactions.

Peri-urban development syndromes

These are based on case study consultations, together with a complexity perspective on systems change (Rauws & de Roo 2012). From the many possible framings of the peri-urban (see the Lit Review in D1-1), these typical 'system conditions' of the peri-urban can be distilled:

- Extractive of land & resources (urban sprawl)
- Divisive of inequality – (enclaves of poverty & wealth)
- Invasive infrastructure (pollution & congestion)
- Disruptive bypass – (exclusion & waste)

Peri-urban development: alternative framings / perceptions of peri-urban change: (Meth et al 2021)

- State infrastructure: conflict of scales, from large interventions on local communities.
- Market speculation: widening inequality gaps is the general outcome
- Suburban consolidation: stagnation / fixity of urban forms and livelihoods
- Grassroots informality: insecurity of tenure and livelihood

Peri-urban relationality: i.e. the relation of peri-urban to urban, rural, wider hinterland or the whole region (these notes follow from the European project PLUREL, as in Ravetz et al 2013):

- Direct locations of high risk: e.g. local people may live in flood or fire risk zones;
- Direct impacts of infrastructure: e.g. peri-urban farming may disrupt urban water supply;
- Indirect impacts on landscape: e.g.
- Indirect impacts of the peri-urban on urban areas: peri-urban development may amplify inequality and vulnerability.

Socio-climatic syndromes

This opens the door to a moving frontier of socio-ecological studies, risk society, and the social science of climate change etc (e.g. Pielke 2016). From the case study consultations it is clear that there is little or no consensus or robust evidence base 'out there', on the reality of climate change, or the need to act and invest to avert future threats. Instead there is a contested area of risk perceptions, power games, local/global conflicts.

- Socio-climatic risk (hazard / exposure): the sociology of risk provides insights on how a technical assessment is filtered through a socio-cultural-political lens.
- Socio-climatic uncertainty (socio-technical): this is the counterpart, where
- Socio-climatic distribution in time & space: this turns political, (e.g. a municipality in Colombia refused to provide flood defences for an informal settlement, deemed to be a risky investment (Heinemann et al 2016)
- Socio-climatic controversy / consensus: this opens up a wider range of pathologies: climate denial, scepticism, blame-shifting, displacement, delay and fatalism.

Eco-socio-economic syndromes

Each of these broad areas is a complex mix: this can be framed as more or less the opposite of a blank slate waiting for rational policy on climate adaptation).

- Ecological

- Technology / infrastructure
- Social
- Economic
- Cultural

Governance syndromes

- **Formal government & policy gaps:** even well organized and funded government systems are challenged by the multi-level, multi-sector, multi-horizon agenda for climate adaptation. And even these can then struggle with embedded elite capture and civic alienation. The peri-urban governance challenge then amplifies these syndromes: by default this tends to be cross-boundary, fragmented, polarized, hijacked by development agendas.
- **Market-led governance gaps:** a business frame for governance is a logical conclusion to the questions of resource allocation, or valuation / investment for non-market goods. However there are structural issues with speculation and distributional effects, as shown with 'payment for ecosystems services' or carbon offset markets.
- **Civil-led governance gaps:** the next step is to look for civil society partnerships, forums and many other groupings, on the general approach of associative and deliberative governance. From the Peri-cene case studies, the reality often brings complexity and confusion, or an illusion of democracy which covers the real political economy of land and resources.
- **Informal / grassroots gaps:** often seen as the source of social innovations, community partnerships, social enterprises, cultural creativity and so on. In reality there is (in many areas) a stronger tendency towards corruption, nepotism, elite capture of many kinds. In some countries this is relatively quiet and embedded in the social order: in others there is overt crime and disorder, which may flourish in the peri-urban.

Combined peri-eco-urban syndromes

From our consultations, most peri-eco-urban syndromes are not seen in that light, as specific one-off problems. Such syndromes are more likely to be embedded with wider agendas of power, wealth, technology, and (in some cases) ideology. Putting together the above syndromes with the peri-eco-urbantypes in the previous section, a combined 'peri-urban-climatic' typology begins to emerge:

- **Peri-urban development:** from a well-ordered urban form and moderate growth: to a chaotic runaway peri-urban sprawl;
- **Climatic variables:** from known moderate effects with suitable defence / adaptation: to unknown catastrophic effects with little or no defence / adaptation;
- **Societal vulnerabilities:** from affluent cohesive and/or egalitarian: to lower income fragmented and polarized;
- **Governance:** from well-organized, well funded and fully open-democratic: to chaotic and/or broke, and/or authoritarian.

This provides 16 possible combinations, as a useful backdrop to the 'adaptive pathways' and governance outlines which follow.

4.2 General pathway analysis

For simplicity we divide the cases into 'developing' and developed (i.e. global south and north). The reality is much more complex (e.g. the DAC categories of '*least-developed, lower-middle, upper-middle, and OECD*'): however there are clear differences in average income, between \$2100 (e.g. India), and \$65000 (e.g. USA).

Developing countries –

These are typical direct syndromes in the *causal model*. This is a generalization which varies greatly between each city-region, and often between different zones in the same city-region.

- Higher than average levels of peri-urban chaos and dysfunctionality
- Higher levels of climate hazard and exposure
- Higher levels of poverty and infrastructure gaps
- Higher levels of informality & elite capture

And then come the indirect syndromes in the background

- Urban development & market syndromes of waste & extraction
- Socio-climatic syndromes of controversy & division
- Socio-economic syndromes of inequality & extraction
- Governance syndromes of capture & fragmentation

These proportions vary according to the case, for example:

Developing countries

In general experience most of all the above syndromes: for example,

- ***Chennai*** has extended peri-urban chaos and dysfunctionality: exposure to riverine flooding, sea level rise and potential extreme heat: poverty and infrastructure gaps. Many of the indirect syndromes also apply, however these may be countered by higher levels of active civil society, social innovation and multi-cultural inclusion.
- ***Surabaya*** has extended areas of peri-urban *desakota* combinations, with exposure to riverine flooding, sea level rise and potential extreme heat. For the indirect syndromes there is more of the urban development syndromes of waste & extraction, and socio-economic syndromes of inequality & extraction, whereas governance capacity is relatively functional.

Developed countries

in general, are more likely to experience a partial selection of some of the above. It is not easy to draw averages, but for example:

- ***Manchester*** has generally moderate levels of the direct syndromes in the *causal model*. However these are overlaid on a range of indirect syndromes, i.e. rising inequality and right wing extremism, climate scepticism or blame-shifting, poor housing conditions in high risk locations, local government de-funding and fragmentation.
- ***Melbourne*** is a booming metropolis, in a fragile landscape, not far from the climate frontiers of drought, wildfire and flooding. The direct local syndromes are likely to be more or less contained in such an affluent, but the wider hinterland is at growing risk. The peri-urban climate

interactions are then overlaid on a different mix of extended syndromes: rural displacement, post-colonial trauma, cultures of extraction, social stress and alienation (see the 100C report on Rockefeller 2016).

4.3 Global menu of adaptive pathways

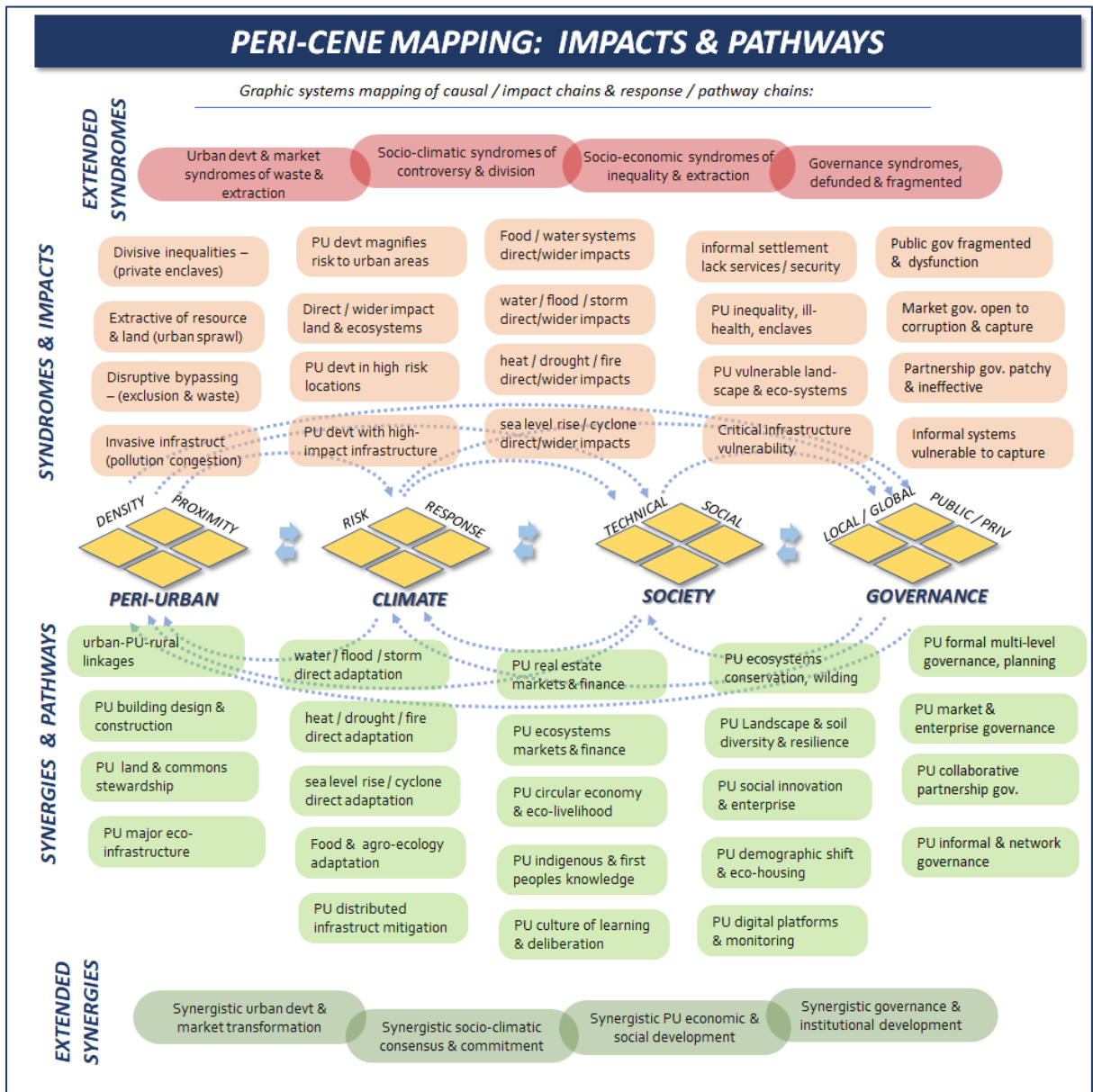
In the Annex is a first version global menu of adaptive pathways, arranged by the Peri-cene cause-effect model. Nearly all the pathways here may be relevant in some way to each city location, but some more than others. Some may appear more practical than others, due to the geographic, political, economic and social situation: some are relevant for the shorter term, others for the longer term. Each pathway includes for work in progress on 3 tracks:

- Analysis: further technical description where needed
- Sources: scientific references where possible
- Examples: applications around the world, with best practice examples where possible.

For the comparison between case studies, we combined all the local results into one framework, as in *Figure xxx*

- a) Above, this shows a global menu of typical problems, syndromes & impacts: both direct & indirect / extended / synergistic;
- b) In the centre we see the basic framework for the cause-effect chain. This also shows the typical ranges: peri-urban near / far: socio-climatic risk / response, etc;
- c) Below there is the global menu of 'adaptive pathways': from direct problem-fixing to indirect / extended / synergistic transformation): to be selected & customized for each case study.

In the Compendium, each of the case studies has this basic framework customized to the local situation and opportunities.



4.4 Pathway & the 'collective peri-eco-urban intelligence'

These pathways are not fixed at all – they contain many components which can be put together in other ways: various of the case studies above see potential with a cross-cutting focus: social, economic, technical etc.

For example an '*integrated catchment community pathway*' based on social innovation in the Manchester hinterland, would aim to include each of the 4 key themes of the Peri-cene:

- *Peri-urban theme*: eco-urban housing based on social innovation (community land trusts etc)
- *Climate theme*: flooding response & adaptation based on social innovation (community stewardship)
- *Livelihood theme*: integrated agro-ecology with local-visitor social innovation (community enterprise)
- *Governance theme*: multi-level governance via social innovation (business-community partnership).

This raises the issues of such pathways, as basically up for debate: creative / radical / contested / controversial. It may not be easy to get all stakeholders into a room, to agree on such pathways in the practical details.

We can look for partial solutions, or with the synergistic approach above, look for specific value chains and synergies which 'keep some people happy most of the time'. With such partial, heuristic opportunities, progress might be made.

However this positive outlook may be perpetually challenged, with the 'extended syndromes' such as structural inequality, elite capture, corruption, exclusion, alienation and general fragmentation.

In that case, the peri-urban-climate agenda is subsumed in a larger and more uncontrollable moving picture of power conflict and social turbulence. This shows up in practical cases.

In Chennai for example, the climate adaptation agenda translates into practice, with the clearing informal settlements from the banks of the rivers and water bodies, for the management of flood defence etc. However the residents are then moved to peri-urban 'resettlement colonies', cut off from jobs and services and communities: quite likely to be adding to the disruption of water and ecosystems in the hinterland which contributes to such flooding...

In the Manchester hinterland, it is not entirely coincidental, that the wealthy landowners of the upland peat bogs have little or no responsibility for climate management: so when the storms come, the water run-off cascades down to the narrow rivers in the valley, where (generally) the most poor and vulnerable communities live in the most sub-standard and under-insured housing.

The implications: sooner or later the Peri-cene 'adaptive pathways' and recommendations, have to challenge in some way the existing system, which has produced such problems, and enables them to continue and reproduce.

A positive way to frame such challenges is with the '*collective peri-eco-urban intelligence*' (aka '*deeper peri-cene mind*').

As in the methods above, we look for the most viable synergies, value-chains and loops, and then for the collaborative learning, innovation and co-production to make them work.

However in reality such methods could and should be challenged. Where structural change is called for, the most elaborate and costly flood defences may exacerbate, or at best maintain, the existing structure of inequality and expropriation.

Where a wider and deeper transformation is called for, in land-use, livelihoods or socio-ecological systems, such agendas will naturally be contested. In that cause the Peri-cene and similar efforts can aim to provide evidence and insight for a higher level of contest.

5 ADAPTIVE GOVERNANCE

(this temporary version is from the summaries of D5-1 and D5-2 led by KTH)

5.1 Issues & challenges of adaptive governance

(KTH, D5-1)

This chapter offers three frameworks for developing solutions and pathways for adaptive governance. It addresses three research questions that focus on problems, solutions, and pathways: What are the main challenges to realising adaptive governance in peri-urban areas? What are the principles of effective 'adaptive' governance in peri-urban areas? Which kinds of pathways could lead towards adaptive governance?

The first section summarizes the challenges of enacting adaptive governance to facilitate the identification of pathways to address these challenges. A framework for organizational level governance mapping focuses on '*collective governance intelligence*' and is intended for specific organizations, policies and programmes. This helps to explore some of the typical overlaps and inter-connections, e.g. a formal local government may set up an agency, with a business spin-off, and stakeholder partnership forum, which represents informal networks. This includes five types of governance: deliberative, multi-level, associative, responsive, and collaborative.

The second section focuses on better understanding the theoretical tenets of adaptive governance to be applied to case studies. The framework is designed to clarify the key principles of adaptive governance and provide a general tool to assess the adaptive governance characteristics in a particular place. It offers four principles based on a review of literature: 'Engage, Learn, Situate, and Act'. How these key principles of engaging, learning, situating, and acting play out in different contexts will continue to inform the emergence of new modes of governance that can engage with climate adaptation.

The third section identifies seven potential pathways for more adaptive governance of climate adaptation in peri-urban areas. This includes ecological, economics, territorial, social, political, functional, and institutional. The final section provides a case study example of Greater Manchester. It provides an overview of the climate change and peri-urban context of Greater Manchester and then applies the frameworks to the case. In particular, it offers examples on flooding governance in the South Pennines. The application of these frameworks shows their utility and flexibility to progress theoretical and empirical understandings of adaptive governance in peri-urban areas.

Context: syndromes & contested spaces

(UOM notes)

As a starting point for 'issues and challenges', we can frame the peri-urban as a space of contestation / disruption, with powerful dynamics:

- Land & resource ownership & grabs
- Urban vs rural power dynamics
- Gentrification & inequality
- Novel combinations of urban / rural & local / global
- (in some areas) Stable & structured surface, concealing embedded inequality

Climate change (i.e. 'socio-climatic change') is also framed as a space of contestation & disruption, including:

- Risk distribution & perception
- Long vs short term planning
- Adaptation gaps & transformation gaps
- (in some areas) stable & structured policy framework, conceals embedded power and inequality

From the Peri-cene consultations, looking for ways forward in collaborative governance, a wider range of pathologies or syndromes comes to light:

- Hidden agendas & power structures
- Confusion & ambiguity on roles & responsibilities
- Hijack & bypassing effects -
- Unrealistic expectations & perceptions
- conflict / competition / dissonance of agendas & goals
- organization structure is unsuited to the problem
- pressure & change overtakes the capacity to respond
- diffusion of responsibility makes real action impossible
- uncertainty & complexity is greater than ability to respond
- (in some cases) direct corruption & elite capture

This can be condensed into a 7 point list of 'barriers' (Ravetz & Connelly 2018):

- Barrier No. 1: Administrative Gap
- Barrier No. 2: Funding Gap
- Barrier No. 3: Policy Gap
- Barrier No. 4: Information Gap
- Barrier No. 5: Capacity Gap
- Barrier No. 6: Accountability Gap
- Barrier No. 7: Objectives Gap

These long lists do not make solutions any easier: but any pathways which do come out of such an enquiry should be more robust and significant, and ultimately successful.

5.2 Outline of adaptive governance

(KTH, D5-2)

Here we elaborate on the frameworks for developing solutions and pathways for adaptive governance. Adaptive governance can be defined as 'decision-making systems comprising formal and informal institutions and social networks that are able to adapt in the face of uncertainty' (Boyd and Juhola 2015, p. 1235). Adaptive governance can include various combinations of formal statutory government, market-based measures, collaboration, and more informal actions. D5.1 provides more details on adaptive governance for climate change adaptation while D1.1 includes more information on peri-urban characteristics and challenges.

Adaptive governance is often seeking synergies across these combinations, systems, and levels. It is closely related to three modes of urban and regional governance (Ravetz 2020). Mode 1 is a functional approach that involves command and control government. This is a traditional approach to governing that involves a strong central government with policies, regulations, and bureaucratic procedures. Mode 2 is an evolutionary approach that is informed by market-based competition and an embrace of innovation. There is a conscious effort by stakeholders to go beyond traditional

modes of governance (Mode 1) and provide fresh ways of organising society. However, Mode 2 continues to rely on existing societal structures related to economics, politics, and culture. Mode 3 can be characterised as ‘co-evolutionary’ and emphasises the importance of collaborative partnerships to co-produce decisions and actions. This mode of governance varies significantly from the previous two because of its emphasis on democratic inclusion and distributed agency of involved stakeholders.

Beyond the mode of governance, peri-urban climate change issues involve various spatial and government scales of analysis. Of particular relevance to the Peri-cene project are four different scales. An area-based approach is geographical that focuses on various sectors in a particular location. An agenda or sector approach focuses on the activities of a particular group of stakeholders such as farmers and how they are implicated in peri-urban governance issues. An organisational approach zeroes in on groups of stakeholders and how they influence governing processes. Finally, case studies provide a tangible, context-rich approach to interpreting and assessing how climate governance unfolds in a particular place.

This report outlines a theoretical approach to adaptive governance pathways to focus on solutions to climate change adaptation in peri-urban areas. It addresses three research questions that focus on problems, solutions, and pathways:

RQ1: What are the main challenges to realising adaptive governance in peri-urban areas?

RQ2: What are the principles of effective ‘adaptive’ governance in peri-urban areas?

RQ3: Which kinds of pathways could lead towards adaptive governance?

The first three sections are devoted to developing frameworks for each research question. RQ1 focuses on the challenges to enacting adaptive governance in order to better identify pathways to address these challenges. RQ2 focuses on better understanding the theoretical tenets of adaptive governance to be applied to case studies. RQ3 then seeks to identify potential pathways for more adaptive governance of climate adaptation in peri-urban areas. The final section provides a case study example of Greater Manchester.

Organization Level Governance Mapping

This section responds to *RQ1: What are the main challenges to realising adaptive governance in peri-urban areas?* Table 1 below focuses on collective governance intelligence and is intended for specific organizations, policies and programs. This helps to explore some of the typical overlaps and inter-connections, e.g. a formal local government may set up an agency, with a business spin-off, and stakeholder partnership forum, which represents informal networks. Common challenges of various governance systems are highlighted in Table 5xx.

Table 5xx: Organizational analysis by adaptive / ‘collective governance intelligence’

Organizational Qualities	Causal model / negative issues (Linear / Evolutionary)	Synergistic / adaptive model (Co-evolutionary / collective intelligence)
Deliberative governance <i>‘Deeper’ integration of policy agenda formation & competing values</i>	Linear problem-fixing, materialist, myopic	Deliberative / responsive
Multi-level governance: <i>‘Vertical’ multi integration of spatial / systems levels</i>	Command & control / power & conflict	Multi-level

Associative governance: <i>'Wider' integration of stakeholder interests & potentials</i>	Command & control / power & conflict	Associative / inclusive
Responsive governance <i>'Further' integration of policy & service value chains</i>	Fragmented & privatized services /infrastructure	Co-production, social learning
Collaborative governance <i>'Deeper' dynamics of informal / self-organized / co-creative actions</i>	Inequality, exploitation, corruption	Collaborative / creative

For each type of governance outlined in Table 5x, there are important questions to guide analysis. For *deliberative governance*, important questions are what types of expertise / knowledge are used? Is there an integrative (cross-sectoral) multi-hazard approach? For *multi-level governance*, important questions are whether there is top down or bottom up conflict or synergy? Does it respond to local needs and opportunities as well as anticipates global forces? Central to *associative governance* is a concern of how stakeholder conflicts are managed and how stakeholder synergies are formed and maintained? There are several concerns for *responsive governance*: is it responsive, innovative and knowledge-based? How is risk managed? Is there a sharing of costs and benefits? Finally, key questions for *collaborative governance* include: how are informal claims on land and resources managed? Is there negative informality or corruption? What positive kinds of informality can be seen?

Adaptive Governance Principles

In response to RQ2 (*What are the principles of effective 'adaptive' governance in peri-urban areas?*), we have identified four key principles for adaptive governance. The framework outlined in Figure xxx is designed to clarify the key principles of adaptive governance and provide a general tool to assess the adaptive governance characteristics in a particular place.

Figure 5xxx. *The ELSA Framework of Adaptive Governance for Climate Change Adaptation*



The engage principle is predicated on the shared understanding that broad stakeholder involvement is central to developing more adaptive approaches to governance. There is a range of types of engagement, from weak participation to strong deliberative and inclusive co-production (see Sarzynski 2015). It is closely related to concepts of collaboration, participation, representation, and engagement, and more recently is promoted through terms such as co-design, co-production, co-creation, and collaboratories. Engaging in adaptive governance involves activities that are inclusive, diverse, co-constructive, and empowering. There is a strong emphasis on the inclusion of local actors who have the responsibility and capacity to act, and results in new relationships between the state and civil society.

Learning and knowledge-sharing are important to adaptive governance, especially as different types of knowledges are considered from the various stakeholders that engagement brings. To identify and agree on climate change problems and solutions, stakeholders often learn together and produce local knowledge. This involves sharing existing knowledge as well as creating new knowledge through co-creation activities. From this perspective, knowledge is the lifeblood of engaged stakeholders and involves sharing, collecting, and deliberating on expert insights and local experiences to achieve a collective understanding of the problem at hand and potential ways to address them.

Adaptive governance maintains a situated perspective, one that is based on local contexts and place-based risks. Climate problems and solutions are customized to local contexts. Universal principles give way to a situated perspective that accounts for particular material, cultural, social and political conditions. The focus on context acknowledges that climate impacts are unevenly distributed and adaptive governance needs to recognise and align with contextually specific factors. Such a customized, situated perspective recognizes the importance of place and difference as key to understanding climate risks as well as developing and implementing potential responses

The act principle is based on the notion that adaptive governance initiatives tend to be experimental and entrepreneurial. These experiments allow for learning, 'failure', and flexibility. Perhaps the most important aspect of experimentation for climate adaptation is the processes of 'learning by doing' and acting in the face of uncertainty. Such experiments tend to be short term and multiple rather than emphasising best practices and standardised approaches.

The purpose of the framework is not to offer a definitive, finalised structure for adaptive governance but rather to synthesise the findings of recent research into a simple and useful analytic tool. How these key principles of engaging, learning, situating, and acting play out in different contexts will continue to inform the emergence of new modes of governance that can engage with climate adaptation.

Multi-level Institutional Pathways

In this section, we address RQ3 on pathways that may involve multiple organizations, sectors and programs: *Which kinds of pathways could lead towards adaptive governance?* The following seven adaptive pathways offer a framework at the multi-level governance scale to better understand opportunities for adaptive governance in the peri-urban.

- An **ecological pathway** offers an integrated approach to ecosystems, which is anticipatory (forward looking), precautionary, and multi-functional. Current policies focus on climate adaptation and building resilience. Integrated climate models that look for creative solutions and consider short and long-term time scales is an emerging policy model for this pathway.
- An **economic pathway** takes an entrepreneurial approach, with service models, benefit-cost balance, resource stewardship and long-term investment. Ecosystems services is a conventional

model for this pathway, with emerging models engaging with social return on investments, eco-enterprise, and stake-owning and crowd sourcing.

- A **territorial pathway** integrates boundaries, scales, and bio-regions. Current policies engage with multi-level governance, and emerging policies are engaging with more active territorial definitions such as eco-neighbourhoods.
- A **social pathway** incorporates a wider set of stakeholders in the community that aims to be transparent, participatory, and inclusive. Social well-being is a common policy model, with more networked learning and deliberative models emerging.
- A **political pathway** focuses on collaborative partnership activities that are transparent and involve active leadership. Current policy models engage with accountability and public participation. Participatory budgeting, round table governance, and 'champion' leadership models are emerging.
- A **functional pathway** requires technical skills and capacities for functional efficiency, effectiveness, and policy efficacy. Conventional models rely on information and spatial mapping platforms. Emerging policy models include foresight, deliberative evaluation, and collaborative regulation.
- An **institutional pathway** is one where organizations and regulatory frameworks are multi-functional, multi-sector, or multi-level. Current policy models focus on policy evaluation, whereas emerging models turning towards design thinking and innovation.

These pathway governance types then provide the building blocks for the combined 'adaptive pathways' as seen in Chapter 4 (see also the full list in the Annex).

6 CONCLUSIONS

The intersection of climate change and the peri-urban will most probably grow in the coming years, even if all the global climate policies were fully agreed and put into action immediately.

The Peri-cene is the first to focus on this intersection, but hopefully not the last.

- We aimed to open up this agenda, for larger projects to follow.
- We aimed to demonstrate innovation in research: combining technical analysis, socio-political analysis, spatial mapping, and the creative engagement of stakeholders to design forward pathways,
- We aimed to set up and run a Policy Lab of city-regions around the world, with institutional partners such as the UN Habitat. In the event this was much disrupted by the pandemic and lockdown, so that all meetings were online, with added challenges for creative thinking.
- We aimed to provide a balance of analysis of problems and synthesis of forward pathways, for both academics and policy-makers.
-

Project aims and propositions

Peri-Cene explores the links between peri-urbanisation and climate risk / resilience, at scales from global to local. The overall aim is: *To explore the interactions between peri-urbanisation and climate risk, at local and global levels, in order to co-design adaptive pathways towards more sustainable and resilient forms of peri-urbanisation.*

Three propositions helped to shape the research: each has been validated with a range of evidence.

- peri-urbanisation is a major contribution to climate change, ecosystems degradation, and urban vulnerability and risk;
- peri-urbanisation has potential for alternative forms, which lead towards environmental sustainability and resilience;
- new forms of adaptive, collaborative and entrepreneurial governance, with policy innovation and social / economic innovation, are needed to realize these alternatives.

6.1 Recommendations to policy

From the 25 pathways in the 'global menu', some strategic recommendations stand out.

Peri-urban policy:

- Ensure that peri-urban development patterns and infrastructures are integrated with the city-region, linked with urban and rural, socially inclusive, economically connected and ecologically resilient.

Climate adaptation policy:

- Longer term planning and investment for 'transformative adaptation' across all climate effects: -
- Riverine flooding and storms
- Drought, wildfire and extreme heat
- Sea level rise and hurricanes / cyclones

- Indirect impacts on ecosystems, food systems, landscapes

Socio-economic resilience policy

- Ecological resilience of landscapes, soils, ecosystems
- Technical resilience of critical infrastructure
- Economic resilience of enterprises, jobs and livelihoods
- Social and cultural resilience of housing, communities, cultures

Adaptive governance policy

- formal government is integrated and collaborative: multi-level, multi-sector and multi-actor.
- Market-led governance (green markets, quotas, finance etc) is robust and responsible
- Collaborative governance with a wider circle of stakeholders is inclusive and associative
- Informal / grassroots actions / social innovations are valued and included

Implications for SDGs

The Peri-cene is designed around three key SDGs, and focuses on the inter-dependencies between them: Goal 11: *(Make cities inclusive, safe, resilient and sustainable)*: Goal 13: *(Take urgent action to combat climate change and its impacts)*: Goal 15: *(Protect, restore and promote sustainable use of terrestrial ecosystems)*. The key linkages include:

- peri-urbanization is framed as the interactions of (11) Cities, with (15) Land-use and ecosystems:
- peri-urban climate risk / resilience is focused on the interactions of (11) Cities, with (13) Climate change
- The urban-rural nexus and environment-climate resilience is focused on the interactions of (13) Climate change, with (15) Land-use and ecosystems.

Other Goals are also relevant: poverty, food security, water, energy, economic development, infrastructure, inequality, inclusive societies, accountable institutions, and cross-cutting issues.



Implications for Urban-Rural Linkages

The UN Urban-Rural Linkages (URL) program sets out a territorial agenda: the Peri-cene then contributes to that with a peri-urban perspective. This highlights the reality of large and growing areas around the world, which are neither fully urban or rural, but some new combination or new entity. The pathways here are focused on this peri-urban space, often messy and dynamic, problematic but also full of opportunities.

We can assess the adaptive pathways in this report from the viewpoint of the URL 10 Guiding Principles: ‘*Locally grounded interventions, Integrated governance, Spatially and Functionally integrated, Financially Inclusive, Balanced partnership, Human rights-based, Do no harm and provide social protection, Environmentally sensitive, Participatory engagement, and Data driven and evidence-based.*’

All of these are relevant in some way to the adaptive pathways in this report. For the URL Compendium, the ‘best practice’ format looks for - outline of the project, challenges to be addressed, beneficiaries, context, process, solutions, results, impact and lessons learned. For the Peri-cene, the pathways here aim to complement the URL examples, with a strategic and transformative approach:



- Adaptive pathways ‘upstream’, can enable & mobilize many practical URL examples ‘downstream’;
- Adaptive pathways as strategic items, can also help to understand the bigger picture and the factors of success (or failure) of practical URL examples.

6.2 Recommendations to research

The Peri-cene and similar projects show how adaptation / resilience research often struggles with fundamental gaps on the science-policy interface. Successful adaptation may depend both on physical actions, and on linkages with social-economic agendas – an ‘*adaptation gap*’. There is always a *scale gap*, between top-down generalizations, and the grounded granularity of particular cases. Adaptive pathways have to work not only as if ‘other things being equal’ (the economist’s *ceterus paribus*), but in dynamic change or a ‘*flux gap*’. And finally the issues of climate change and its responses are increasingly divisive, showing deeper stakeholder conflicts, or ‘*worldview gaps*’.

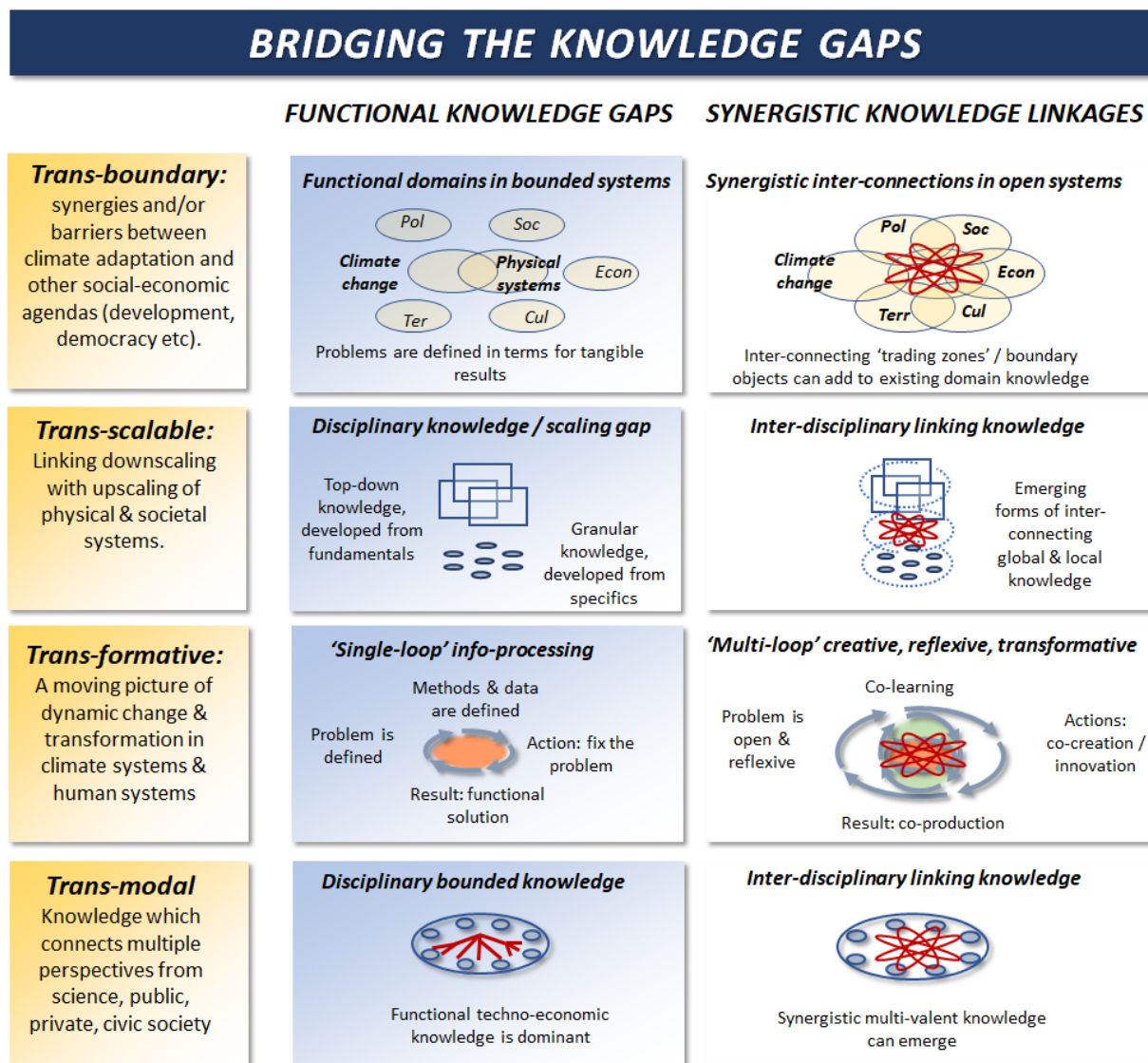
These gaps can be summed as four key meta-research questions -

- Q1 - trans-boundary questions and the ‘adaptation gap’;
- Q2 - trans-scalar questions of linking top-down with localized knowledge - the ‘scale gap’;
- Q3 - trans-formation questions of dynamic change all around, with a ‘flux gap’;
- Q4 - trans-modal questions of multiple conflicting perspectives, or a ‘worldview gap’.

For example, the Peri-cene project calls for *trans-boundary* connections between urban and social problems: *trans-scalar* mapping of global-local space: *trans-formation* of urban / ecological systems: and *trans-worldview* understanding of corruption and elite capture. The resulting ‘*adaptive pathways*’ aim towards a ‘*collective adaptive intelligence*’, with capacity for learning and collaboration, which can start to bridge these gaps.

Each kind of gap and potential pathway can be explored with a graphical mapping format, (either online / onsite) (Figure xxx). This reflects the ‘*trans-boundary, transformative, trans-modal*’ scope of synergistic knowledge, and its potential for ‘*collective adaptive intelligence*’.

Figure xxx: Synergistic knowledge scope



6.3 Next steps

To follow




7 ANNEX:


7.1 Global menu of adaptive pathways

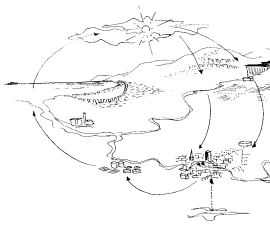




This is a first global menu of adaptive pathways, arranged by the Peri-cene cause-effect model. Nearly all the pathways here may be relevant in some way to each city location, but some more than others. Some may appear more practical than others, due to the geographic, political, economic and social situation: some are relevant for the shorter term, others for the longer term. Each pathway includes for work in progress on 3 tracks:

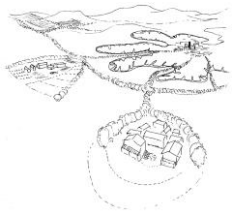


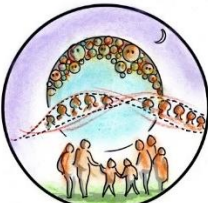
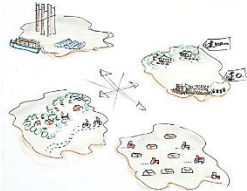

- Analysis: further technical description where needed
- Sources: scientific references where possible
- Examples: applications around the world, with best practice examples where possible.


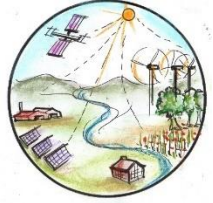



This version includes for thumbnail illustrations, for visual thinking and open communication.


PERI-URBAN PATHWAYS	•	•
<i>urban-rural linkages in the peri-urban</i>	<ul style="list-style-type: none"> • Urban & rural areas are highly inter-dependent, in resources, infrastructure, housing, travel, leisure, ecosystems services etc. The peri-urban adds another dimension to that mix. The aim of the 'PURL' is to maximize opportunities and minimize negative impacts on each kind of territory. 'Sprawl repair' & similar ideas aim to mobilize the local synergies wherever possible. 	 <ul style="list-style-type: none"> •
<i>peri-urban building design & form</i>	<ul style="list-style-type: none"> • Typical urban patterns & building forms show huge variety: but there is an globalized model of gated communities with single houses or serviced apartments. For both lower / middle / higher income housing, there are low impact design, eco-design and eco-building forms and construction methods, which can enable climate-wise adaptive pathways. 	 <ul style="list-style-type: none"> •
<i>peri-urban stewardship of land & commons</i>	<ul style="list-style-type: none"> • Many peri-urban territories include large areas of leftover 'lost space', and much of this (in some countries) is in common / public ownership. The community based stewardship of marginal land on edges or corridors, can be a powerful way to generate social synergies, e.g. by local food democracy, which can then manage ecosystems for resilience and adaptive capacity. 	 <ul style="list-style-type: none"> •

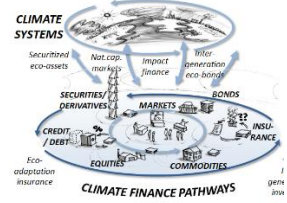
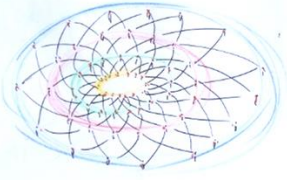
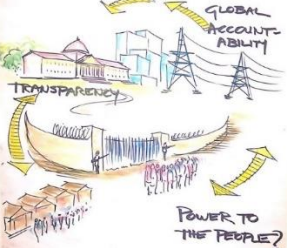
<p>Peri-urban infrastructure, airports, industrial zones etc</p>	<ul style="list-style-type: none"> • Large facilities in the peri-urban can cause disruption & depletion – or, contribute to positive transformation of the peri-urban as a zone of diversity, local-global linkages, and socio-ecological resilience. Airports, major roads or industrial plants can be designed as green corridors with built in adaptation capacity. 	
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<p>CLIMATIC PATHWAYS</p>		
<p>water / flood / storm adaptation</p>	<ul style="list-style-type: none"> • Short term: we need ways to manage rising floodwaters and extreme events, via SUDS, walls, canals, basins etc. • Longer term: (in some areas) we need to rethink – where are the settlements, what kind of forms & surroundings, how can low impact eco-design manage a transformation towards a water-friendly co-existence. 	
<p>heat / drought / fire adaptation</p>	<ul style="list-style-type: none"> • Short term: arid zone water management in buildings and land: fire defence via forest breaks and natural fire cycle management. • Longer term: (in some areas) we need to rethink – where are the settlements, what kind of forms & surroundings, how can low impact eco-design manage a transformation towards a drought / fire-friendly co-existence. • For extreme heat, a growing agenda for building eco-design, social welfare, health & safety, adaptation of livelihoods etc. 	<p>WUI Administration at Various Scales</p>  <ul style="list-style-type: none"> • (source: Duerksen et al 2011)
<p>sea level rise / cyclone adaptation</p>	<ul style="list-style-type: none"> • Short term: sea defences, adaptation of coastal livelihoods. Also how to cyclone-proof buildings, infrastructure, ecosystems where possible. • Longer term: (in some areas) we need to rethink – where are the settlements & infrastructure, can they be defended, managed retreat or whole relocation. For cyclones etc, replanting of mangroves, dunes & coastal ecosystems 	
<p>agro-ecology & food democracy</p>	<ul style="list-style-type: none"> • Agro-ecology may be the most important pathway: first by challenging the chemical-intensive industrial production of global agri-business, and its disruption / depletion of ecosystems & adaptive capacity. Then it aims to rethink the relations of producers, markets and the ecosystems resilience in a changing climate. With the dimension of 'food democracy' it can mobilize social / cooperative enterprise on a large scale, which then fits with the adaptive pathways for landscape, soil, water, local livelihoods etc. 	<p>GLOBAL SYNERGIES</p>  <p>LOCAL SYNERGIES</p> 

RESILIENCE - ECOLOGICAL		
ecosystems conservation	<ul style="list-style-type: none"> • Direct local conservation of ecosystems is one way to ensure the survival and management of at least the selected areas. A wide range of policies goes from national parks, bio-reserves, SSSIs and Ramsar sites, all the way to local/regional designations for forests, soils, wetlands, wildlife etc. The peri-urban is then a vital part of the wider connectivity of urban & rural green infrastructure. 	 <ul style="list-style-type: none"> •
landscape diversity & resilience	<ul style="list-style-type: none"> • A wider agenda is for sustainable / adaptive / resilient landscapes, soils, forests, water bodies & wetlands etc, both within / without formal designations. Policies for forestry, farming, infrastructure, housing, business, leisure & tourism etc, can steer towards adaptive planning & design for the surroundings of housing, industry, farming etc. These may be strengthened by eco-systems markets, green finance, carbon offsets etc. 	 <ul style="list-style-type: none"> •
RESILIENCE - SOCIAL		
social innovation enterprise & networks	<ul style="list-style-type: none"> • Within the flux & disruption of peri-urban expansion & particularly in climate related disasters & extreme events, existing or new residents can self organize for mutual aid. This may include new forms of social care, community based services, social livelihoods, grassroots & networked infrastructure. Much of this is hardly on the official policy radar, so there is great potential on both sides. 	 <ul style="list-style-type: none"> •
<ul style="list-style-type: none"> • demographic shifts & new forms of eco-housing 	<ul style="list-style-type: none"> • While much peri-urban expansion is in middle-upper income suburbs & gated communities, some areas see an influx of alternative lifestyle, ex-urban small-holders, local eco-entrepreneurs etc. This bring new opportunities for co-housing, housing with small-holdings, low impact development etc. This can change the social mix & increase the local diversity & resilience. 	 <ul style="list-style-type: none"> •
RESILIENCE ECONOMIC		
peri-urban real estate markets, insurance	<ul style="list-style-type: none"> • Climate change brings a major rethink in the insurance industry, which now calculates the cost / benefit of adaptation as (global average) 7:1 net positive. Such principles can then feed into the real estate market, via green finance and the concept of 'positive insurance', which is re-invested to reduce risks & increase resilience. 	 <ul style="list-style-type: none"> •
ecosystems markets & green finance	<ul style="list-style-type: none"> • From the 'Economics of Ecosystems & Biodiversity' agenda, there are many variations in different countries. Payment for ecosystem services, local carbon markets, green / long finance, developer contributions, precautionary bonds / escrow accounts, and social return on investment are some of the options. 	 <ul style="list-style-type: none"> •

<p>circular economy & eco-livelihood</p>	<ul style="list-style-type: none"> The practical question is how can businesses invest and create jobs from these peri-urban 'climate-wise' transitions and pathways. The peri-urban can be a vital part of a city-region circular economy, with a continuous flow of re-use recycling & recovery. This may include shift from mainstream business models, towards cooperative, mutual or similar forms of social-eco business. These can then work in sectors such as food & forestry, biodiversity & ecosystems, education & health, leisure & well-being of all kinds. 	
<p>RESILIENCE - TECHNOLOGY</p>		
<p>distributed / networked infrastructure & services</p>	<ul style="list-style-type: none"> Energy and water technologies see rapid innovation in local distributed harvesting, storage, conversions etc. These can enable further peri-urban off-grid expansion: they can also enable climate-proofing of development with practical alternatives to centralized / intensive infrastructure. 	
<p>digital platforms & monitoring</p>	<ul style="list-style-type: none"> A digital approach sees potential to enhance climate adaptation, flood defence, ecosystems management & markets. Indicators & metrics for systems change, adaptation and resilience can be defined & monitored by local stakeholders in combination with experts. 	
<p>RESILIENCE - CULTURAL</p>		
<p>indigenous & first people knowledge</p>	<ul style="list-style-type: none"> There is growing awareness of the vital knowledge of indigenous & first peoples, for such challenges as drought periods, water harvesting, ecosystems management, forest fires, agro-ecology, coastal management, and nature based solutions of many kinds. 	
<p>culture of foresight, learning & participation in civil society</p>	<ul style="list-style-type: none"> This cross-cutting agenda can be a pre-condition for many other pathways: adaptive / collaborative governance, ecosystems management, social mutual aid etc. Governments can support this with open access information, learning hubs & platforms, open policy evaluation, participatory budgeting & decision paths, futures / foresight projects, with further links to education & public services. 	

<p>GOVERNANCE PATHWAYS</p>		
<p>Multi-level governance, integrated planning</p>	<ul style="list-style-type: none"> A wider peri-urban expansion and metro-scape transition calls for a regional strategic level of government, regulation and planning. With the peri-urban spilling over administrative boundaries & between urban & rural, there is particular need for the peri-urban agenda to be a focus of integration, vertical & horizontal. 	

<p>Market-led governance, finance & enterprise</p>	<ul style="list-style-type: none"> Beyond the limits of formal government, market led approaches may enable innovation, forward investment, enterprise of all kinds. Ecosystems markets, green finance, impact investment, or social return on investment may bridge the gap between ecological social & economic values. Public services and public procurement can also have a powerful effect, such as local / organic food policies or ecosystems reinvestment. 	 <p>CLIMATE FINANCE PATHWAYS</p>
<p>Collaborative governance, civil partnerships</p>	<ul style="list-style-type: none"> As the peri-urban agenda crosses many boundaries & involves many sectors, new forms of civil society partnerships, networks, forums, dialogues can emerge. These may be based on water catchments, bio-regions, or terrestrial eco-regions, as well as economic zones, commuting patterns etc. Government can enable these with round table structures, deliberative processes, core subsidies, rules for transparency & accountability. 	
<p>Radical governance, grassroots networks</p>	<ul style="list-style-type: none"> Emerging forms of radical ecological democracy & the 'pluriverse': these are beginning to show real alternatives to the mainstream top-down neo-liberal consensus on development & livelihood. The peri-urban can be host to many creative variations on agro-ecology, local livelihoods, grassroots self-help, social mutual aid, stewardship of the commons etc. 	

7.2 Practical guide: P-CAT

The Peri-cene has developed the Peri-urban Analysis Tool (P-CAT), as an online system which provides a local application of a global spatial dataset.

The current link is <https://nenpintoresearch.wixsite.com/temp-pcat>

The P-CAT sets out common archetypes of representative of global peri-urbanisation, ranging from. These archetypes will be overlaid on the climatic – biome types and the associated risk layers. The P-CAT tool will draw on existing global and local datasets such as the JRC's Global Human Settlement Layer (GHSL). The results will be ground-truthed in two case studies in Chennai, India and Greater Manchester, UK.

On the P-CAT you can:

Visualise spatial data for the PERI-CENE 21 partner cities in the P-CAT City Visualisers. Contribute with geospatial data for each of the PERI-CENE 21 partner cities in the P-CAT City Surveys

Follow the PERI-CENE analyses and findings in the P-CAT Analyses

P-CAT City Visualisers

You can find our City Visualisers for all the PERI-CENE partner cities in the map below. Hover over the placeholder to find the relevant link.

These visualisers include spatial information about population distributions, built-up areas and degree of urbanisation based on the global dataset Global Human Settlement Layer produced by the European Union Joint Research Centre.

The visualiser has basic tools to select the layers, measure and identify features.

Attribution of the datasets can be found on each visualiser in the top right corner.

P-CAT City Surveys

Stakeholders and citizens can contribute to the discussion about peri-urbanisation by adding geospatial data to our datasets, using the City Surveys for the city of their interest.

Click on the link of the city of your interest in the map and follow the instructions.

You will add one piece of information at a time, and you can add as many inputs as you want, responding to the survey once per contribution.

P-CAT Analyses: Story maps, dashboards and other tools

The story maps offer a unique insight on the peri-urban geography and history, combining narrative with dynamic spatial mapping. See the samples:

Chennai - <https://storymaps.arcgis.com/stories/839e3c209e064a4a934169e6b6cc3dda>

Manchester - <https://storymaps.arcgis.com/stories/a27be6007e974e63986c140188258b59>

7.3 Practical guide: Pathways tool

The counterpart to the spatial analysis is the Synergistic Toolkit, for exploring and co-creating the synthesis, with possible solutions or at least 'pathways' towards them. This uses visual thinking and system mapping as the primary means to explore the deeper and wider situation: first in the problems, and then in the responses / opportunities / solutions. This section is a brief outline and example.

Each of the 12 steps has a visual thinking template, with 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 6 of these templates. 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.

Here is a worked example with summary outputs (shown as vignettes) from each step.

Systems (baseline) mapping

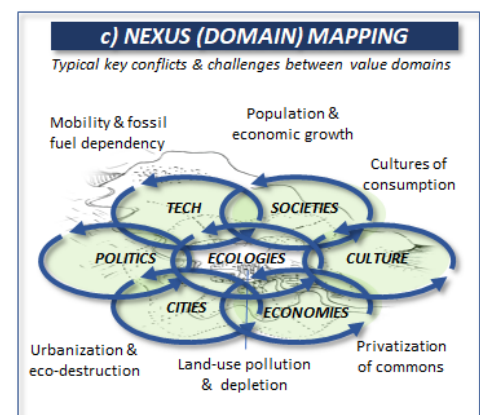
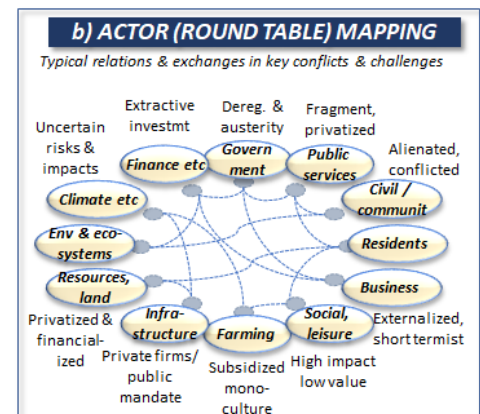
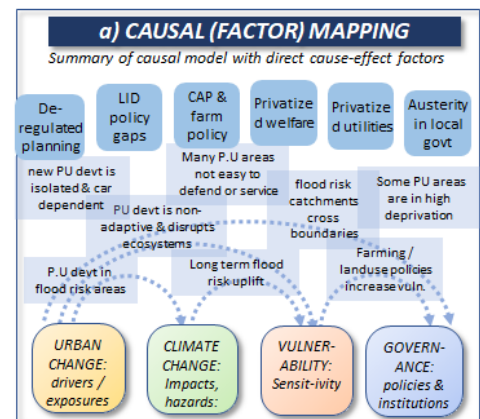
Step (a) This is a summary of the above 'causal model'. The main direct surface-level problems are shown in the middle of the diagram: some more structural problems are shown above. In summary,

- *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) the nexus / domain mapping covers 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.



Synergy (opportunity) mapping

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

h) 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) '**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.

j) 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:

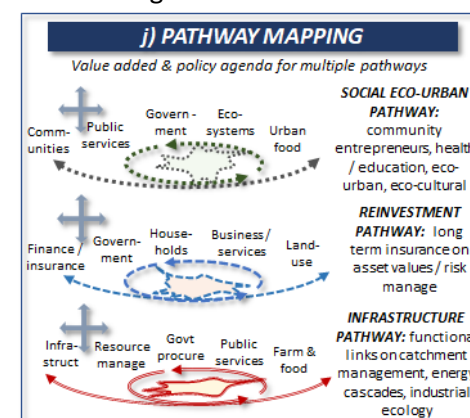
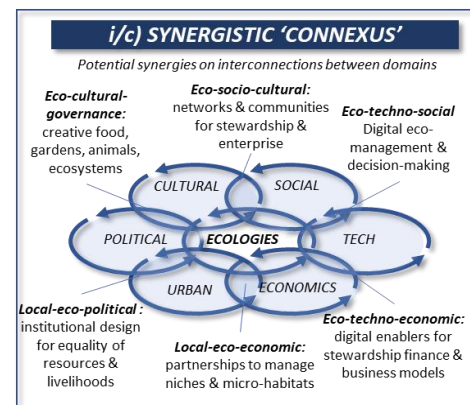
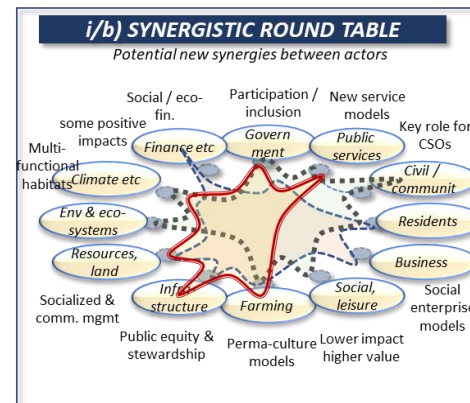
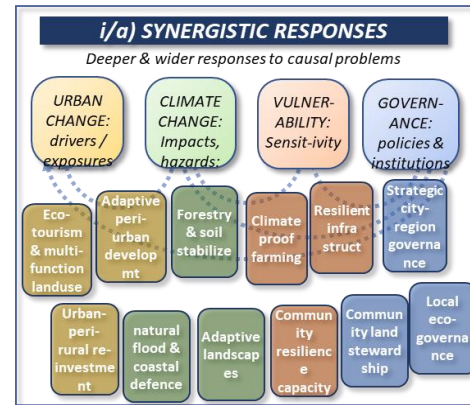
- **Eco-socio-cultural synergies:** networks & communities for stewardship & enterprise;

- **Eco-techno-social synergies:** Digital eco-management & decision-making.

Strategy (pathways) mapping

k) 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 Pennine 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.



7.4 Glossary

(draft version from D1-1)

Spatial review terms

PERI-URBAN CONCEPT	TYPICAL DEFINITIONS
CARCERAL CITY / POST-METROPOLIS:	...a new flexible, information-rich, postfordist economy; the globalization of capital, labor, and culture; and the complementary revolution in ICT...
EX-URBIA / EX-URBS : Counter-urbanization concepts:	[...] as a particular form of amenity-driven sprawl at times reaching into the global countryside with profound effects.
'NON-PLACE' Socio-cultural experience concepts:	a landscape of 'non-places': transient, artificial, anonymous and alienated
EDGE CITY	New urban development hubs with rapid decentralization of urban functions
GREEN BELT POLICIES	A <i>greenbelt</i> is a policy and land use zone designation used in land use planning to retain areas of largely undeveloped, wild, or agricultural land surrounding or neighboring urban areas.
ECOSYSTEMS SERVICES	'Ecosystem services can be defined as services provided by the natural environment that benefit people'.
'PERI-URBAN ZONE' (Residential density concept:	Discontinuous built development, containing settlements of less than 20,000, with an average density of at least 40 persons per km ² (averaged over 1km ² cells)
'RURAL-URBAN FRINGE' : Spatial gradient / interface concept:	' [...] that zone of transition which begins with the edge of the fully built-up urban area and becomes progressively more rural whilst remaining a clear mix of urban and rural land uses and influences before giving away to the wider countryside'.
'URBAN SPRAWL' : as a system concept:	'unplanned incremental urban development, characterised by a low density mix of land uses on the urban fringe': 'Low density, scattered urban development, without systematic large scale or regional public land-use planning':
'URBAN SPRAWL' : as a spatial definition	'low values in one or more of eight measures: density, continuity, concentration, clustering, centrality, nuclearity, mix of uses, and proximity
FUNCTIONAL URBAN REGION / AREA :	'an urban core and the area around it that is economically integrated with the centre, e.g. the local labour market.
'AEROTROPOLIS'	Specialized / globalized transit hub: also applies to retail or leisure malls, business or science parks etc.
PERI-URBAN AREA: Urban-rural linkage concept:	Parts of a city that appear to be quite rural but are in reality strongly linked functionally to the city in its daily activities.
PERI-URBAN-ISATION PROCESS	a process in which rural areas located on the outskirts of established cities become more urban in character, in physical, economic, and social terms, often in piecemeal fashion.
URBAN FRINGE	... transition zone between the built-up area and the countryside... interface between the consolidated urban and rural regions: a zone of mixed land uses with competition between them.
TRANSPORT EFFECTS	Automobile dependency is the concept that some city layouts cause automobiles to be favoured over alternate forms of transportation, such as bicycles, public transit, and walking, in a reinforcing feedback loop

Climate risk review terms

CLIMATE ISSUES	Example definitions
Climate change risk	“the potential for consequences where something of value is at stake and where the outcome is uncertain, recognizing the diversity of values.”
Climate vulnerability	“characteristics of human or social-ecological systems exposed to hazardous climatic (droughts, floods, etc.) or non-climatic events and trends (increasing temperature, sea level rise)
Climate change adaptation	‘process of adjustment by societies and natural systems to the actual or anticipated effects of climate change’
Climate change resilience	‘the capacity of social, economic, and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and transformation’

Adaptive governance terms

ADAPTIVE GOVERNANCE	TYPICAL DEFINITIONS
Governance	a distributed activity “involving a multitude of variegated public and private actors and relationships that operate through multiscale and multiactor networks”
Adaptive climate governance	“decision-making systems comprising formal and informal institutions and social networks that are able to adapt in the face of uncertainty”
Collaborative Governance	“A governing arrangement where one or more public agencies directly engage non-state stakeholders in a collective decision-making process that is formal, consensus-oriented, and deliberative and that aims to make or implement public policy or manage public programs or assets.”
Multi-level governance	Type I as the “dispersion of authority to a limited number of non-overlapping jurisdictions at a limited number of levels”. Type II “pictures a complex, fluid, patchwork of innumerable, overlapping jurisdictions”.
Urban Climate Governance	“the ways in which public, private, and civil society actors and institutions articulate climate goals, exercise influence and authority, and manage urban climate planning and implementation processes” where “central to the institutionalization of urban climate action is the development of regulations, policies, codes, and support programs”
Adaptive capacity	“the ability to respond to challenges through learning, managing risk and impacts, and developing new knowledge and devising effective approaches”
Deliberate Transformations	“The shifts called for may include a combination of technological innovations, institutional reforms, behavioural shifts and cultural changes; they often involve the questioning of values, the challenging of assumptions, and the capacity to closely examine fixed beliefs, identities and stereotypes ... to be successful they typically require changes to entrenched systems maintained and protected by powerful interests.”
Public participation	“securing the active involvement of a broad range of stakeholders in decision-making and action”
Climate governance experiments	“primarily engaged in <i>explicitly</i> making <i>rules</i> that shape how communities respond to climate change ... initiatives with a conscious intention to create/shape/alter behavior by setting up rules (broadly conceived as including principles, norms, standards, and practices) for a community of implementers (whoever and whatever they may be) to follow”

7.5 Citations

¹ Fischer, Meissner, Mix et al 2018