Identifying Entry Points for Adaptive Governance in Periurban Chennai (India): A multi-dimensional, multi-level, and multi-scalar approach

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ABSTRACT

Governing transitions has assumed increasing significance in managing change with respect to formidable challenges of upscaling and multilevel governance. In this respect, evidence from sustainability transitions research in India stipulates the need for institutional innovations that are suitable to the Indian context, which is characterised by a fuzzy field of 'speculative frontiers', and strong hierarchically structured, top-down governance mechanisms. Periurban regions pose both formidable challenges but may as well open up opportunities for innovative transformation. The paper presents a multi-scalar classification of the Chennai metropolitan region within the context of a multi-level governance system. By applying the *multi-dimensional* 'adaptive governance' framework that was developed during the Peri-cene research project, this paper seeks to contribute to the debates of formulating solution-oriented systemic interventions in transition governance by way of identifying 'adaptive development pathways' in a peri-urban region of a country of the Global South. Findings of the case study are presented with regards to the generic classificatory framework that was developed by the project partners for periurban regions and, in a similar way, applying the lens of 'adaptive governance' to understand and analyse dynamics of agency. While a number of barriers, bottlenecks and constraints of adaptive governance exist, there are also noteworthy indications of adaptive governance practices that demonstrate diverse potentials for enhancing this trend in a more strategic and conscientious manner.

Keywords: peri-urbanization, adaptive governance, sustainable transformation, climate change resilience, Global South, Chennai, India

Introduction

Chennai's growth story as an industrial hub and fourth-largest metropolitan agglomeration in India during the last few decades has led to significant urbanisation, drastically altering a complex land- and waterscape (Gajendran 2016, Homm and Bohle 2012) simultaneously making it vulnerable to multiple climate risks, as evidenced recently by the floods in 2015 (Arabindoo 2017). This was followed by a period of acute water scarcity in 2019, leaving the city to fluctuate between water abundance and scarcity, a condition that is expected to get worse. For centuries though, Chennai's hinterland ecology of natural and constructed water bodies has contributed to managing these types of risks that were inherent to its climatic landscape (Das 2009, Gopalakrishnan 2014, Schütt 2013). As the city expands and urbanizes into these hinterlands, our core question posed is: can the city develop adaptive pathways to address the twin challenges posed by rapid peri/urbanisation and climate risk?

Next to Manchester, the metropolitan region of Chennai is one of two selected in-depth case studies of the global Peri-Cene Project, which aims to explore the interactions between peri-urbanization and climate-environmental change, at local and global levels, and to co-design adaptive pathways towards peri-urban climate resilience. Within this research aim, this paper concentrates on the Chennai case study to ascertain the potentials of 'adaptive governance' in this periurban region of the Global South, critically engaging with scholarship related to 'Asian' or 'non-Western' theories of peri/urbanization (e.g. Gururani and Kennedy 2021, Wu and Keil 2020).

Governing transitions has assumed increasing significance in managing change with respect to formidable challenges of upscaling and multilevel governance (da Cruz et al. 2019, Kohler et al. 2019, Pierre 2019). In this respect, evidence from sustainability transitions research in India stipulates the need for institutional innovations that are suitable to the Indian context (Chebrolu and Dutta 2021), which is characterised by a fuzzy field of 'speculative frontiers' (Sood 2021), and strong hierarchically structured, top-down governance mechanisms (Resilient Chennai and Okapi 2019). By applying the *multi-dimensional* 'adaptive governance' framework that was developed during the Peri-cene project, this paper seeks to contribute to the debates of formulating solution-oriented systemic interventions in transition governance (Chaffin et al. 2014) in a country of the Global South. Such approach is embedded in an overall 'synergistics' model of collaborative engagement (Ravetz 2020) and experimentation (Fastenrath and Coenen 2021). It is also linked to the notion of 'adaptive development pathways', one of which identified in Chennai is envisioning an agroecological transformation of the metropolitan region (Volz and Woiwode 2022).

In conclusion, the research in Chennai points towards a highly dynamic situation of periurban and socio-economic, spatial change at multiple scales, levels and of multiple dimensions,

across various policy areas with a high pressure on policy makers and stakeholders of practice. While a number of barriers, bottlenecks and constraints of adaptive governance exist, there are also noteworthy indications of adaptive governance practices that demonstrate diverse potentials for enhancing this trend in a more strategic and conscientious manner.

The next section briefly outlines in broad strokes the methodology of the project, followed by sections of classifying the peri-urban region of Chennai and related climate change risks and projections. A fourth part then introduces the proposed adaptive governance framework. Based on this groundwork, key features of governance in Chennai are presented, followed by the identification of entry points for adaptive governance and a mapping of related, illustrative adaptive pathways.

Methodology

The foremost goal of the Pericene project is a global assessment of the periurban and its climate change risks and adaptation challenges. Two in-depth case studies focus on the 'Chennai region' (India) and the 'Manchester region' (UK). Each has a very different history, development pressures, socio-economic trends and climate risks.

Methodologically, the Chennai Region Case study approaches these objectives in the periurban space by identifying three scales — macro (bioregional), meso (landscape), and micro (neighbourhood) where these themes of peri/urbanisation and climate change entangle, creating both challenges and opportunities. Two of these spatial scales (macro, meso) are delineated along geo-hydrological boundaries of water basins, which are so defining for the human-ecology relationship of Chennai. Maps and images serve to show impacts of this growth and the fallout at three sites that are representative of each scale. This *multi-scale* perspective plays a role to tease out how various actors and stakeholders interact with each other and how they work within different *multi-level* governance arrangements at each scale. This approach of visualising these dynamic changes was complemented by field research and stakeholder interaction.

A comprehensive 'Policy Lab' was conducted online with researchers at 18 periurban sites globally. 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.

Accordingly, the first project phase focused on mapping and spatial analysis, followed by the design of adaptive pathways through these policy labs. In the context of Chennai, these steps and topics are covered:

1. identification and classification of the periurban in Chennai;
2. structures and institutions of governance in Chennai;
3. analysis and diagnosis of governance in Chennai deploying the adaptive governance framework;
4. results and moving towards transformative interventions: entry points for adaptive governance and connection to adaptive pathways.

What and where is the Chennai periurban?

Peri-urbanization can be seen as a process of being and becoming over time and space. In spite of the rapidly growing literature on the periurban, it remains an astonishing fuzzy concept characterised by manifold attributes such as 'peri-urban interface' (Adell 1999), the periphery (Gururani and Kennedy 2021), a 'transition zone' (Rakodi 1998), a 'hybrid zone' mixing rural and urban (Davis 2004), or similarly an 'in-between' city space (German "Zwischenstadt", Sieverts 1997), and yet, the periurban is still distinct from the city - separated by either agricultural land or open spaces (Oliveau 2005). As a result of continuous and increasing peri-urbanization, 'The metropolis as a new urban condition' and the related peculiarities of the periurban (Arabindoo 2009) have become viewed as a distinct phenomenon in its own right. However, it is not a static condition but rather "**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" (Webster 2002). Typically, the spatiality and localisation of the peri-urban is vague and varies depending on the specificity of the actual case or focus of interest, it may be indeed between cities reshaping rural areas and settlements, or on their edges, it may as well be a sort of continuum from the rural to the urban fringe, or a fragmented patchwork of peripheral development nodes across a region, as noted by Gururani and Kennedy (2021). This perspective aligns well with the notion of peri-urbanization in the Pericene project, which is a play with the 'new era' called Anthropocene that describes the global, anthropogenic phenomenon of urbanization of the 'rural'. Literature in this field on India is growing constantly, covering a range of topics from governance (Dupont 2007) and spatial development planning (Arif and Gupta 2020), social and political context (Arabindoo 2009), geographic implications (Oliveau 2005), economics (World Bank 2013), peri-urban dynamics and changes (Follmann et al. 2022) to infrastructure provision and the environment (Shaw 2005). In the context of the Global South, and in particular in India, "Land development in peripheral urban areas necessarily has to negotiate with the colonial and prereform structure of land tenure" (Wu and Keil 2020: 949). As these latter authors stress, investigating and conceptualizing peri-urbanisation in the Global South requires being "sensitive to the history and local context" (Wu and Keil 2020: 949).

One conception of the peri-urban is to employ ecological boundaries instead of administrative ones that are man-made and rendered porous through multiple processes such as urbanization. Based on previous research in the Chennai region that highlighted the interdependence of human settlements, livelihoods and water resources, a bioregional approach to identifying the regional limits was taken. Consequently, the Chennai region is defined based on the watershed area of four river-basins. For methodological-analytical reasons, this approach resulted in the identification of three scales a) macro/bioregional scale, b) meso/landscape scale, and c) micro/community/neighbourhood scale, where the themes of urbanisation and climate change converge and entangle, creating both challenges and opportunities. Essentially, these scales play a role in teasing out how various actors and stakeholders interact with each other and how they work within different governance arrangements at each scale. Furthermore, we distinguish four functional zones within this bioregion but outside the core city which is delineated by the administrative boundaries of the Greater Chennai Corporation (**Figure 1)**:

1. Ennore region in the north
2. Industrial corridor towards the southwest along the Bangalore highway
3. I.T. corridor stretching southward along the coast and immediate hinterland
4. Hinterland encompassing a large watershed region overlapping three states (Tamil Nadu, Karnataka, Andhra Pradesh)

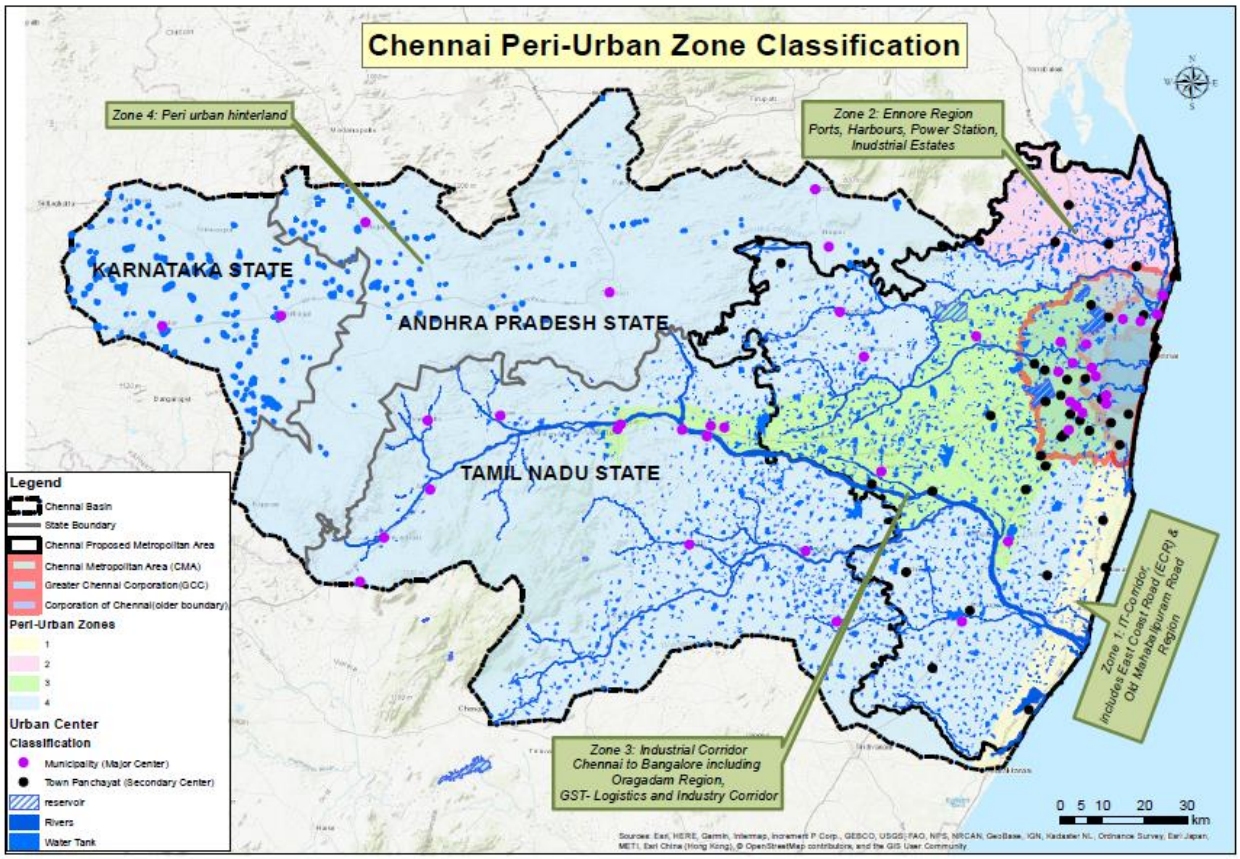


Figure 1: Chennai peri-urban region (© Periurban Initiative, Pericene Project)

The Peri-cene has used global mapping systems and local consultations to address the question – where is the peri-urban? This is especially complex in a dynamically urbanizing context such as the Chennai region with its many satellite towns, extended suburbs, urban greenspaces, water bodies and semi-rural hinterland with its rapidly changing population and evolving built environment indicators.

Overall, a relatively simple definition of the peri-urban based primarily on population data is shown in ***Figure 2***. It comprises all locations not in the grey urban areas, but inside the 60km radius; and yellow and green squares of between 50-300 p/km2, outside the 60km radius on the map. The data analysis resulted in a detailed framework that includes different peri-urban types as shown in ***Figure 2***, which refers to the mapping of 'Functional Urban Areas' (FUAs) (**Table 1**), calculated for the whole 200 x 200 sq.km shown in the map format. The calculation includes Greater Chennai, the proposed metropolitan area, and hinterlands of north and west of Chennai. Much of the open and peri-urban land area is both, inside and outside of the FUAs (functional urban areas). According to these data, the lower and higher density peri-urban, which together make up approx. 3.5% of the total population but 40% of the land area, combined an extraordinary population growth rate of 140% between 1990 and 2015, whereas the urban/suburban with more than 90% population and 50% land area saw a population increase of slightly more than 50%. In summary, while the most dynamic demographic change is taking place in the lower and higher density periurban, the largest absolute population increase is still occurring in the urban/suburban areas of Chennai.

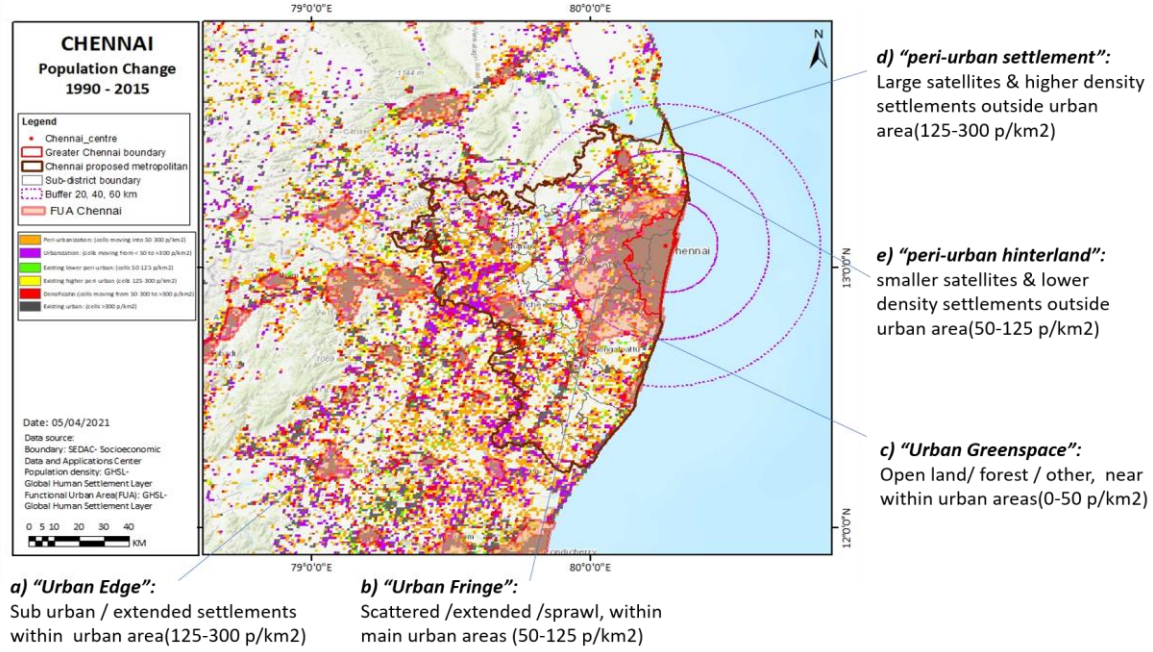


Figure 2: Peri-urban typology of the Chennai region (© Periurban Initiative, Pericene Project)

Table 1: Vital statistics summary of peri-urban classification

Peri-urban classes	Population/km	total land area 2015	population 2015 (in % to the total)	25yr change (%, base year 1990)	annual % change compound
Open land & peri-rural	< 50 p/km	9.40%	0.18	126.40%	3.32%
Lower density peri-urban	<125 p/km2	17.00%	0.88	141.00%	3.58%
Higher density peri-urban	<300 p/km2	22.10%	2.65	141.40%	3.59%
Urban & suburban	urban >300 p/km2	51.50%	96.29	52.30%	1.70%
Total	Total area	100%	100%	54.40%	1.75%

(© Periurban Initiative, Pericene Project)

Nexus of peri-urbanisation and climate change risks in the Chennai metropolitan region

The Chennai metropolitan region is one among the largest urban spaces in the world (Demographia 2021) and at the same time highly vulnerable to climate change. Driven by population growth and rapid land use change, the city region is expected to grow twice in its size by 2026 (Aithal and Ramachandra 2016). Economically, Chennai city is one amongst the fastest growing cities in the world according to Forbes (Kotkin 2012). The Chennai region predominantly receives its rain from the North Eastern Monsoon Rainfall (NEMR) (Rajeevan et al. 2012). The NEMR plays an important role in prediction of rainfall over regions in Tamil Nadu including Chennai, since NEMR is greatly influenced by large scale circulation in the pacific sea (Wang et al. 2018).

Topographically, Chennai is located on the highly exposed southeast coast of India on relatively low and flat coastal land. Three major rivers, the Adyar, Cooum, and Kosasthalaiyar, frequently inundate following even short periods of rain. The Climate Change Vulnerability Index of 2021 ranks Chennai the highest among large Indian cities in terms of exposure to climate change-related threats (Verisk Maplecroft 2021). Another study shows that Chennai is ranked the most socioeconomically vulnerable to climate change among the metropolitan cities in India (Malakar and Mishra 2017). The risk of flooding in Chennai is expected to worsen with climate change. Higher temperatures and more frequent droughts are expected to exacerbate water scarcity in the city.[1]

[1] More climate risk can be drawn from here: Chapter 3 https://www.environment.tn.gov.in/Document/tnsapcc/Chapter%203.pdf and Chapter 4 https://www.environment.tn.gov.in/Document/tnsapcc/Chapter%204.pdf of TNSAPCC 2.0

In the past decades, the city has experienced floods and drought due to climate change, and the recurrence has only increased in recent times. The future projections of climate conditions in the region are predicted to be on the rising trend, making the city region more vulnerable to risks of extreme events like floods and drought (table 2) (Jeganathan et al. 2021). Almost all extreme weather events in Chennai – flooding, droughts, cyclones - oscillate around water (Table 3). Chennai city reports recurrent flooding for the years 2006, 2007, 2008, 2010, 2015, and 2021 due to single day extreme rainfall (Jeganathan et al., 2021; Guhathakurta et al., 2011). The coastal area of about 27.79 sq.km is classified as highly vulnerable for erosion due to seven coastal factors, which includes sea level rise as one among them (Jeganathan et al., 2021), with the most severe scenario of sea level rise being projected of approx. 78 cm by 2100 (Ramachandran et al., 2017).

Table 2: Climate projections for Chennai region (TNSAPCC 2017, Jeganathan et al., 2021)

Climate variable	2020 (2010 - 2040)	2050 (2035 - 2065)	2080 (2065-2095)
Maximum Temperature (deg C)	1.0	2.0	3.1
Minimum Temperature (deg C)	1.1	2.2	3.2
Annual Rainfall (Percent change- %)	(2 - 7)	(1-4)	(4-9)

A review of papers on past occurrences of extreme climate events in the Chennai region revealed sparsely available information in such regards. Most of the studies are centered on the 2015 Chennai flood event, while other studies attempt to understand climate anomalies during the November - December month of 2015 (Arabindoo 2017, National Remote Sensing Centre 2016, Ramasamy et al. 2018). Nevertheless, a study by De et.al (2005) that reviewed extreme climate events in the country for the past century, reveals an increasing number of extreme events throughout the decades. In Tamil Nadu specifically, the number of heat waves and drought are observed to be increasing considerably and becoming more recurrent in nature. Although, Tamil nadu is experiencing more dry days compared to the past (Rajkumar et al. 2021; Dash and Mamgain 2011), the number of one day extreme precipitation events has been observed to have increased (Indian Meteorological Department). Similarly, in the case of cyclonic events, there has been an increasing number of cyclonic storms observed during the pre-monsoon and post monsoon seasons (Mishra 2014). The local warming of Bay of Bengal has shown to have much larger influence than rising Global temperatures, in triggering Extreme climate events in Chennai city (Krishnamurthy et al. 2018).

Table 3: Frequency of climate events in Chennai (Chennai Resilience Strategy, 2019)

Events	1985-2000	2000-2020 (current day)
Floods	3	8
Cyclone		7
Droughts		7
Heat Wave	4	6
Tsunami		1

Chennai city is known to be highly vulnerable to climate change (TNSAPCC 2017), predominantly though, the coastal regions are classified as very highly vulnerable zones. The state of the city's vulnerability is influenced by various factors. Firstly, its inherent topography results in less free runoff flow, secondly due to external conditions partly by climate change like surface temperature and rainfall, but mostly by human induced factors such as degradation of water bodies, improper solid waste system, under capacity drainage systems (Gupta and Nair 2011). In the past few decades, Chennai has grown physically (Gupta and Nair 2011), but the city also grew eight times in population between 1901 and 2001 due to the large influx of migrant population from Tamil Nadu and other parts of the country. This has also led to an increasing number of slum formation at the banks of water bodies and flood plain zones (Diwakar 2021). Floods were some of the major disasters that took place in the city in the past years due to heavy rains influenced by the warming and ultimately depression at the Bay of Bengal. Given the tremendous growth and lack of space in the city, even the smallest of floods create considerable damage. Although the trends of rainfall in Chennai have not increased or decreased in the century, the recurrent occurrence of single day extreme floods in the city comes down to following factors (Krishnamurthy et al., 2018; Gupta & Nair, 2011):

1. Drainage channels that are being blocked due to heavy encroachments.
2. Inadequacy of storm water drainage system and lack of proper maintenance of the drainage system.
3. Increasing land use changes open spaces to impervious surfaces.
4. Lack of coordination between institutional agencies involved.

Chennai region is predicted to experience more recurrent droughts in the future as the projection for rainfall is on a decreasing trend (Shankar et al. 2020). Preceded by failed monsoon in the years 2017 and 2018, the year 2019 was the driest for Chennai with a rainfall recorded around 10cm. The four reservoirs of Chennai city - Red Hills, Cholavaram, Poondi and Chembarabakkam - which provide potable water were heavily depleted leading to the declaration of “Day Zero”. An analysis (Praveen et al. 2016; Gupta and Nair 2011) on occurrence of drought events in South India reveals the influence of global climate on the

North-Eastern Monsoon during October to December, which was deficit hence leading to dry weather conditions. The risk of drought is exacerbated with other factors summarized below:

1. Increasing demand for Water with an increasing population.
2. Lack of ground water recharge mechanisms.
3. Encroachment and construction on water bodies deteriorating the integrity of Water bodies.
4. Decreased water holding capacity of water bodies.

In consequence of the aforesaid, the effects of climate change on Chennai's peri-urban region are twofold: firstly, in terms of the local conditions within the peri-urban areas, and secondly, the need to view the peri-urban as part of a whole city-region system (table 4).

Table 4: Effects of climate change on Chennai's periurban region (© Periurban Initiative, Pericene Project)

Local conditions within the periurban	Periurban as part of the whole city-region system
- Flooding and inundation of low-lying areas, especially new low-income housing agglomerations (partly a result of encroachments on water bodies) - Drought periods, with effects on ecosystems, landscape types and local farming. Agricultural lands being converted for non-agricultural purposes; especially towards speculative real-estate and water-supply economy. - Over-extraction of ground water coupled with sea-level rise causing salt water intrusion into coastal aquifers. - Extreme heat, which affects vulnerable social groups, in particular the elderly and outdoor workers. - In the coastal & estuary peri-urban areas of the various river basins (along the coast), sea level rise, coastal erosion and saline incursion is a growing problem.	- Water management in the peri-urban has a direct effect on the flood risk and exposure of downstream urban areas; - Landscape management in the peri-urban has an indirect effect on water: e.g., where upland land-use and ownership creates problems of storage & run-off; - Farming practices in the peri-urban create further problems of run-off, chemical pollution, soil erosion, clearance of natural areas etc. - The urban heat island effect may be alleviated by outward movement to the peri-urban, with increase in urban greenspace and decrease in density - Housing development in the peri-urban is a direct effect of urban pressure, and the need for natural capital and greenspace: however much new development is disruptive of landscape and water systems, increasing the flood risk downstream.

An Adaptive Governance Framework

Three research questions 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?

Adaptive governance has become a term for addressing and dealing with wicked problems such as climate change and other global (poly-)crises of socio-economic nature that render our future uncertain (Castán Broto 2019, Chaffin et al. 2014, Munaretto et al. 2014). It appears to be particularly suited for recognising and acknowledging the intertwined complexities of socio-ecological systems (Folke et al. 2005, Karpuzoglu et al. 2016). 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, cited in Winter and Karvonen 2022).

Adaptive governance may include various combinations of formal statutory government, market-based measures, collaboration, and informal actions. It is often seeking synergies across these combinations, systems, and levels. According to Ravetz (2020), adaptive governance is closely related to three modes of urban and regional governance. Mode 1 is a functional approach that involves command and control government, representing a traditional approach to governing that involves a strong central government with policies, regulations, and bureaucratic procedures. In contrast, 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, whereas Mode 3 can be characterised as ‘co-evolutionary’ emphasising 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.

Based on a review of literature on empirical studies of flood governance in peri-urban areas which underscores “a need to develop new modes of governance to address the inadequacy of structural measures, social and economic inequalities, and the uneven geographies of climate change” (Winter and Karvonen 2022), our colleagues developed the ELSA framework of adaptive governance to clarify four key principles and to provide a general tool to assess the adaptive governance characteristics in a particular place (Fig. 3). Moreover, this framework is complemented by five cross-cutting key dimensions characterising adaptive governance as collaborative, knowledge-based, contextual, emergent, and transformative (Winter and Karvonen, forthcoming?).

Figure 3: The ELSA Framework of Adaptive Governance for Climate Change Adaptation (copyright Peri-Cene Project; Karvonen and Winter 2022)

Accordingly, 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.

For the specific context in the Chennai case study, we apply a perspective of adaptive governance that is a) **multi-dimensional** by deploying this adaptive governance framework, b) **multi-level** considering local, intermediate and state governance levels, and c) **multi-scalar** applying the Pericene approach of the bio-regional (macro), landscape (medium) and community/neighbourhood (local) scales.

Key features of governance in Chennai

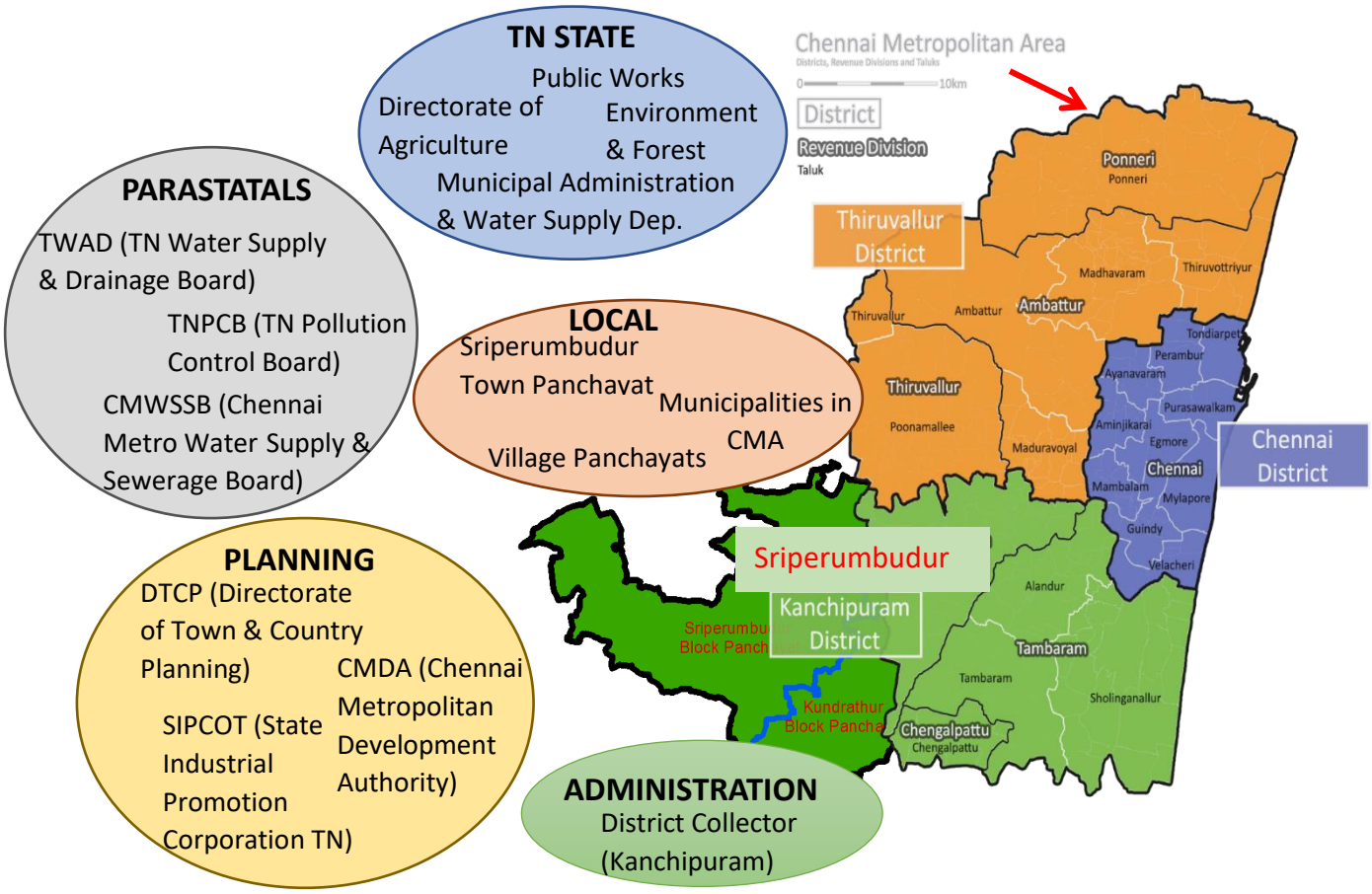
A recent in-depth study (Resilient Chennai and Okapi 2019) reveals the current state and challenges of metropolitan governance in Chennai, characterising it as:

a) polycentric,
b) multi-level (local, state, and national level),
c) multi-type (with nested, overlapping and fragmented jurisdictions),
d) multi-sectoral (various public and private organization, civil society and others), and
e) multi-functional (with units performing specific functions).

The plethora of government agencies and jurisdictions including parastatals poses a conundrum of inefficiency and often uncoordinated decision-making, frequently resulting in exacerbating or even generating additional disaster and climate risks. Notable is the existence

of the strong administrative, decentralized yet not devolved structure of the state with roots in the British, top-down, colonial government, versus the elected, democratic system of multi-level, constitutionally devolved role of rural and urban local bodies. Focusing on the administrative set up, Fig. 4 exemplifies various overlapping boundaries of the Chennai Metropolitan Area (CMA) which represents at the same time the Chennai Metropolitan Development Area. The Districts, as an element of the decentralized state administration, cut across the boundary of the Greater Chennai Corporation (not shown here; it is the local urban body with an elected assembly but smaller than CMA), while at the same time reach further into the hinterland thus encompassing the urban fringe and wider periurban region (exemplified by one of our case study areas Sriperumbudur in dark green). In addition to these various levels of administration, a multitude of planning and infrastructure related agencies are mandated to operate across these levels *outside* the mandates of rural and urban local bodies. The latter are rather one amongst many players than fully fledged self-governing local bodies, sitting under continuous control by the state government.

Fig. 4: Exemplary overview of Government administration in the Chennai metropolitan region (© Periurban Initiative, Pericene Project)



BOX 1: Case Study – Government Structures in Water Management, Sriperumbudur

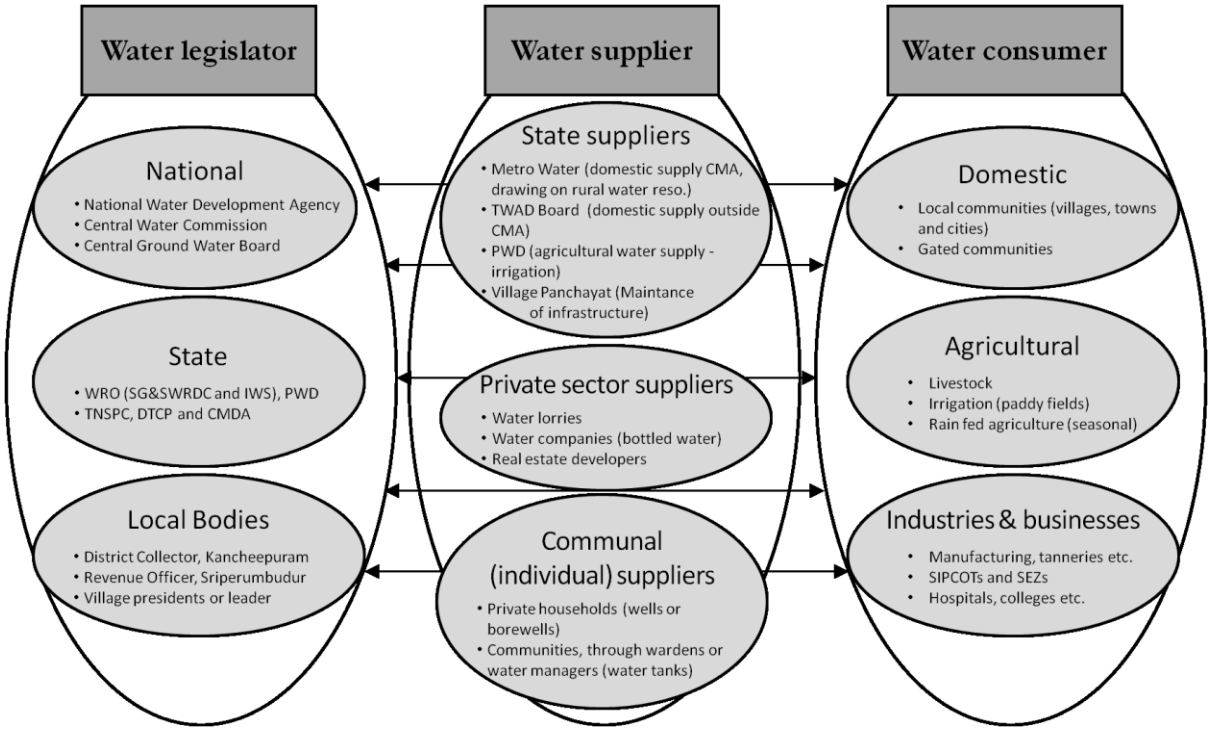
Sriperumbudur is one of the 385 Taluks within Tamil Nadu and comes under the Kancheepuram District. Within the Sriperumbudur Taluk there are 100 village panchayats, two panchayat unions and three town panchayats (Adelina ea. 2015). Those panchayats used to form the soul foundation of Indian society, as they represent the traditional community-based governance tool. These self-governing bodies have been eroded over the past 50 years and replaced by formal governance structure with little power (Palanithurai and Ragupa-thy 2008). The formal structures comprise an administrative body with a democratically elected panchayat president. The panchayat governing body utilises a warden system, which are partly found to be based on the traditional water management system (Palanithurai and Ragupathy 2008), whereby individuals are elected to represent the residents in their locality and report issues to the local government (AnanthPur 2004). Therefore, peri-urban regions are constituted of a three-tier governance system: the village panchayat, the panchayat union and the district panchayat. Sriperumbudur Taluk is thus divided into the Sriperumbudur and the Kandrathur block. Furthermore, Sriperumbudur Taluk falls partly under the jurisdiction of the CMDA and partly under the jurisdiction of the DTCP [Fig. 4]. Consequently, the supply of water is also split between the CMWSSB, supplying the CMDA area and the TWAD Board taking care of the rest of the Taluk. Furthermore, there are many other agents that are active…[Fig. 4 in this paper]

(adapted from John, R., 2015. Governance of periurban water resources: A case study of the discursive practices around sustainable water management in greater Chennai region, India. Master thesis, Freiburg University, p. 28)

Due to its significance, the water sector is a particular case in point to understand the administrative complexities, multitude of stakeholders and governance conditions in periurban Chennai, as the example of Sriperumbudur demonstrates (box 1; Fig. 5). Our research found that “Despite the seemingly clear division of tasks, there are many overlaps and conflicts between department’s obligations and tasks. The insufficient coordination between governing bodies and hence the unclear mandates lead to incoherent and non-holistic policy measures” (John 2015: 29).

Typically, ex-post analysis of each climate change induced disaster that affected Chennai has always critically raised concerns of the governance situation. Lack of coordination, working in silos, multiple agencies with overlapping activities and an obscure bureaucracy dominated by rigid systems combined with minimal civic engagement are but a few of many such weaknesses that crop up to present the state of governance. Adding to this are various other governance syndromes such as political fragmentation, widespread elite capture, unauthorised construction and encroachments, even though growing climate awareness is discernible, rigorous and committed implementation of policies is largely absent or sluggish.

Fig. 5: Actors in periurban water governance of Chennai



(Source: John 2015, p. 29)

Identification and characterisation of entry points for adaptive governance

For analytical rather than practical reasons, we characterise two dimensions of entry points for adaptive innovation. In reality though, these two are related and often interdependent:

1. *Thematic entry points*: traditional water management; peri/urban agroecology; eco-tourism as adaptive pathways;
2. *Institutional entry points*: windows of opportunity and niche innovations in formal and informal practices and institutional structures (such as organizational set up, relationships of agents/stakeholders, legal framework).

There are a number of recent examples of governance impulses in Chennai that were induced either through policies or calamities that occurred:

1) *Smart cities mission*: lauded as participatory, even though primarily a low level, weak type of participation close to tokenism (public feedback process via online mode, stakeholder consultations);
2) *Climate Change Action Plan Chennai 2022*: massive criticism about TN government's insensitivity to local constituencies (e.g. was not published in local language Tamil), only online feedback possible, and only for a two week time window (Roul 2022);
3) *73rd/74th CAA* (Constitutional Amendment Act), 1992, to devolve functional and fiscal self-governance to rural and urban local bodies: not fully implemented in Tamil Nadu

and across India (Gandhi and Pethe 2017)

4) *Post-tsunami 2004 response*: 'classic' disaster relief response through relocation of vulnerable communities (esp. fishing communities); World Bank funded; set up of an early warning system
5) *Post-flood 2015 response*: mostly technical-engineering solutions as immediate response (still ongoing works on storm water drainages, desilting, water body conservation); early warning system; relocation and resettlements of slum and squatter settlements; only in the aftermath the National Disaster Management Policy of 2005 was implemented that had been neglected until then;
6) *Current change in 2022*: approval given by Government of Tamil Nadu to enlarge the CMDA boundary five times from 1,189 sq.km to 5,904 sq.km, basically adding another 1,200 periurban villages to the city's planning region (The Hindu Bureau 2022).

In all these cases, institutional changes either happened in a prescribed manner (incorporating or changing statutory status of local rural/urban bodies as for the enlargement of the planning region), establishing entirely new institutions such as a State Disaster Management Authority (as per national law), or in a conventional manner such as the establishment of the Special Purpose Vehicle for the implementation of the Chennai Smart City projects. Bold experimentation to facilitate innovative procedures, mutual learning and co-creative knowledge production through participatory, more equal participation of stakeholders remains largely absent. Clearly, the undercurrent of planning and implementation processes is still adhering to an instrumental, result and output focused bureaucratic approach than a process-orientated multi-stakeholder notion. In contrast, the area with the potentially widest scope for institutional reform, the 73rd/74th CAA, has received only partial support from state governments.

In spite of this, we argue that peri-urban areas within the Chennai region are also providers of climate change adaptation functions. These will become particularly significant in the coming decades as the climate continues to change and extreme weather events are expected to become more frequent and intense. A notable example relates to opportunities of building on traditional water tank management measures for the implementation of the conservation and maintenance of water bodies (Mosse 1999). As our research shows, these have seen significant changes from locally decentralised to state level, more centralised infrastructures and governance over the course of a century (Haufe 2017). Other adaptation functions include the creation of food sovereign spaces to support local ecology conservation around water-bodies in a changing climate and offering livelihood opportunities to the landless local populations whilst ensuring their nutritional security. Strategies are needed to encourage and progress these opportunities.

Working to conserve and enhance the water management functionality of landscapes in the peri-urban hinterlands of the Chennai watershed can reduce flood risk in downstream urban areas and mitigate drought upstream, while also delivering benefits locally. However, this raises significant governance challenges that remain unaddressed or at best in proposal stage as the Chennai Metro Flood Management Committee (Roul 2021). Appropriate governance frameworks are needed, encompassing the wide range of sectors and stakeholder groups interested in the future of these areas. Current governance frameworks are fragmented both, spatially and sector-wise, and work in silos. However, emerging good practices can also be found. Thus, informal partnerships which exist with a mandate and role within more extensive institutional arrangements like independent third sector civil society, formal organizations that play an active role in informal partnerships (e.g., Meenavar Sangam/fishermen collectives; Water-Users Associations), or formal governance partnerships which bring together different levels and units of government like the Chennai River Water Restoration Trust. Taking clues from these instances and our analytical research findings on the situated conditions of peri-urbanization and the climate change risks identified for Chennai, we can roughly map potentials and requirements of adaptive governance and related adaptive future pathways:

- ***Adaptive governance***: integrated regional climate-wise planning: private sector & market integration: civil society governance.
- ***Adaptive pathways***: urban-rural linkages for ecosystems & livelihoods: agro-ecology & integrated food systems: integrated water & adaptation management: social grassroots innovations & community resilience.

Chennai: Adaptive Pathways at multiple scales

Adaptive pathways applicable to Chennai have been derived from the mapping of existing systems and diagnostic problem analysis during online Policy Lab workshops with research teams from all participating institutions in the Peri-cene project and eighteen additional periurban city regions. These are summarised for Chennai around the four core interfaces of the peri-urban, climate, society, and governance at two levels, firstly, a strategic meta-level of sorts defining four themes of 1. Peri-urban development syndromes (sprawl, extraction, waste), 2. Socio-climatic syndromes (controversy, division), 3. Socio-economic syndromes (inequality, exclusion), 4. Governance syndromes (defunded, captured, fragmented). Secondly, at a more topically specific level, syndromes and impacts describe specific issues such as divisive inequalities due to private residential enclaves, impact on land and ecosystems, or market governance open to corruption and elite capture (Fig. 6 top). Flipped around, positive potential synergies and pathways were constructed, again at a more strategic meta-level as well a topic-specific level of thematic synergies and pathways. At the strategic

level, the four identified pathways are 1. Synergistic peri-urban development and market transformation, 2. Synergistic socio-climatic consensus and capacity, 3. Synergistic peri-urban economic, social development and resilience, and 4. Synergistic governance and institutional development. Within the topic-specific synergies and pathways, water, flood and drought related pathways are the most crucial with high priority. Finally, the syndromes and mirrored pathways levels are also always interdepend as they are intrinsically intertwined; however, these interdependencies need to be closely investigated and understood from a socio-ecological systems perspective in order to design interventions that go beyond the cause-effect logic and to leverage on co-benefits and at systems level.

Subsequently, we briefly outline some such specific pathways that we identified based on the multi-scalar notion of intervention.

1. ***Social eco-innovation and micro-governance***

At the neighbourhood scale, use of a community gardening initiative to develop social capital amongst disenchanted youth groups and marginalized communities by providing a supplementary source of income and potentially rebuild and rekindle a lost sense of community and arrest social unrest within the community. This is already demonstrated in the village of Katchipattu near Sriperumbudur, in the industrial corridor.

2. ***Eco-tourism pathway***

At the peri-urban landscape scale on the southern peri-urban fringe of Chennai in the Muthukadu-Kovalam sub-basin, an earlier project '*Water as Leverage'* shows possibilities to intervene in a region that will continue to urbanise rapidly. Future policies could use design tools to incorporate nature-based designs of "blue-green" and "sponge-city concepts to avoid further social and ecological fragmentation and raise the potential for resilience at such a scale.

3. ***Agro-ecology pathway***

At the bio-regional scale there is an emerging agenda for food sovereign spaces in 'poramboke' lands ('commons' land attached to water bodies) thereby building climate resilience in the urban and peri-urban geographies involving local communities. This is also about greening the city's waterscapes with food-forests. This would mean re-imagining current food supply chains, shortening them, involving local, marginalised communities, alternative socio-economic models such as FPOs (farmer producer organizations) that will over time ensure food sovereignty and safeguard ecological assets. Agroecological approaches and transition to sustainable or non-conventional farming and food systems including peri/urban farming and horticulture have gained momentum in Chennai (Volz and Woiwode 2022) and other parts of India (references).

4. Bioregional water management pathway

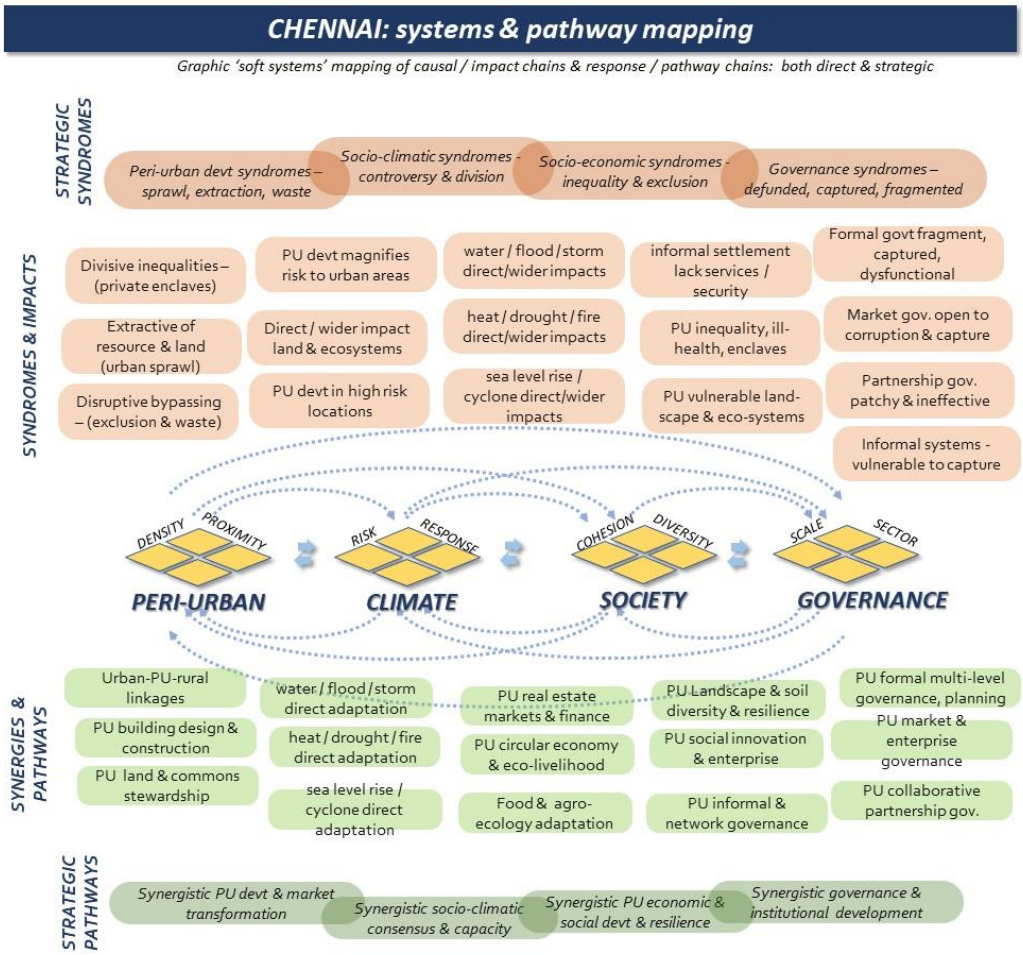
At the macro scale, we explored the idea of using the Chennai watershed (made up of the basins of four rivers that drain through Chennai) that cuts across adjacent state boundaries as well. We asked what conceptions might such a scale add to the discourse on the Peri-cene? However the proposed Chennai Metropolitan Area[2], four times the present area and covering three other districts, represents the diverse landscape and hence was chosen to represent the bio-regional scale. Yet, as other cases such as Ghaziabad near Delhi in India illustrate, "periurban waterscapes do not fit into existing urban or rural planning models because these same models largely fail to recognise the peri-urban interface as a distinct form of territorial development" (Mehta and Karpouzoglu 2015).

In that case, the peri-urban-climate agenda is subsumed in a larger and more uncontrollable dynamically shifting picture of power, conflict, turbulence and disruption. This shows up in practical cases, for instance, the Chennai adaptation agenda translates into practice with the clearing of informal settlements from the banks of the rivers and water bodies arguably for the management of flood defence. However, in a rather blunt and conventional way these residents are moved to peri-urban 'resettlement colonies', cut off from jobs and services and communities while at the same time adding to the disruption of water and ecosystems in the hinterland which contributes to such flooding.

Eventually, the potential for water management measures to sit as one of the pivotal elements of a broader flood-drought risk management response in the Chennai basin has risen up the agenda. Managing and restoring these traditional water-bodies encompasses a wide range of interventions: From restoring degraded reserve-forests upstream in the catchment areas to clearing the drainage channels, desilting the tanks, removing invasive species in the water-spread area, removing encroachments especially along the soft-edge, strengthening the bunds and associated infrastructure, addressing point and nonpoint pollution risks and preserving the natural ecology of the associated wetlands.

[2] Until October 2022 when the government order for the actual expansion was published, the proposed expansion of the Chennai Metropolitan Development Area was more than 8,000 sq.km. This is the area the research considered.

Figure 6: Systems and pathways mapping, Chennai



(Source: © Periurban Initiative, Pericene Project, design: Ravetz 2022)

Conclusion

This paper focused on the identification of possible entry points for generating an adaptive governance approach for sustainable, climate change responsive future development pathways for peri-urban Chennai. We discussed periurbanization within the specific context of Chennai, defining the peri-urban space from a bio-regional, ecological systems perspective as the watershed basin of the four major rivers that are important for the survival and economy of the metro-region. This is complemented by a zonal classification characterising various sub-regional areas within this peri-urban space, and considering the impact and consequences of disaster as well as projected climate change risks. We then presented an adaptive governance framework that was developed in the international collaboration research project. Based on these foundational sections, the existing governance structures of Chennai were discussed, followed by presenting the findings with respect to potentials and activities for adaptive governance and the concomitant notion of adaptive development pathways. This integrated

diagnostic and analytical approach we conceptualise as *multi-dimensional* (adaptive governance framework comprising of several normative features), *multi-level* (considering local, intermediate and state governance levels) and *multi-scalar* (bio-regional macro, landscape medium, community/neighbourhood local scale).

It is apparent that a key challenge in Chennai remains the transition from a predominantly top-down, strongly hierarchical, government-led and dominated type of governance to a more experimentally guided, co-creative and co-productive type of collaborative governance, which allows for climate change adaptation within a longer term perspective of transformative future development pathways:

> "The city probably needs to explore an innovative, 'adaptive governance' model. Adaptive governance, as a new model of cooperative or collaborative governance, is not confined to only climate change adaptation….It is a multi-tier and multi-layer cooperative and / or collaborative model beyond the strict control of techno-bureaucratic-consultant model. It is neither a fixed top-down nor a bottom-up approach. It is flexible as well as reflective, innovative and strategic. At best, the adaptive governance motto may include elements of co-imagine, co-initiate, co-design, co-learn, co-implement and co-evaluate all the 3 Ps (projects, programmes and policies) related to the city and beyond." (Roul 2021)

The implications of our research and ongoing dynamic changes, hence, highlight that 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.

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