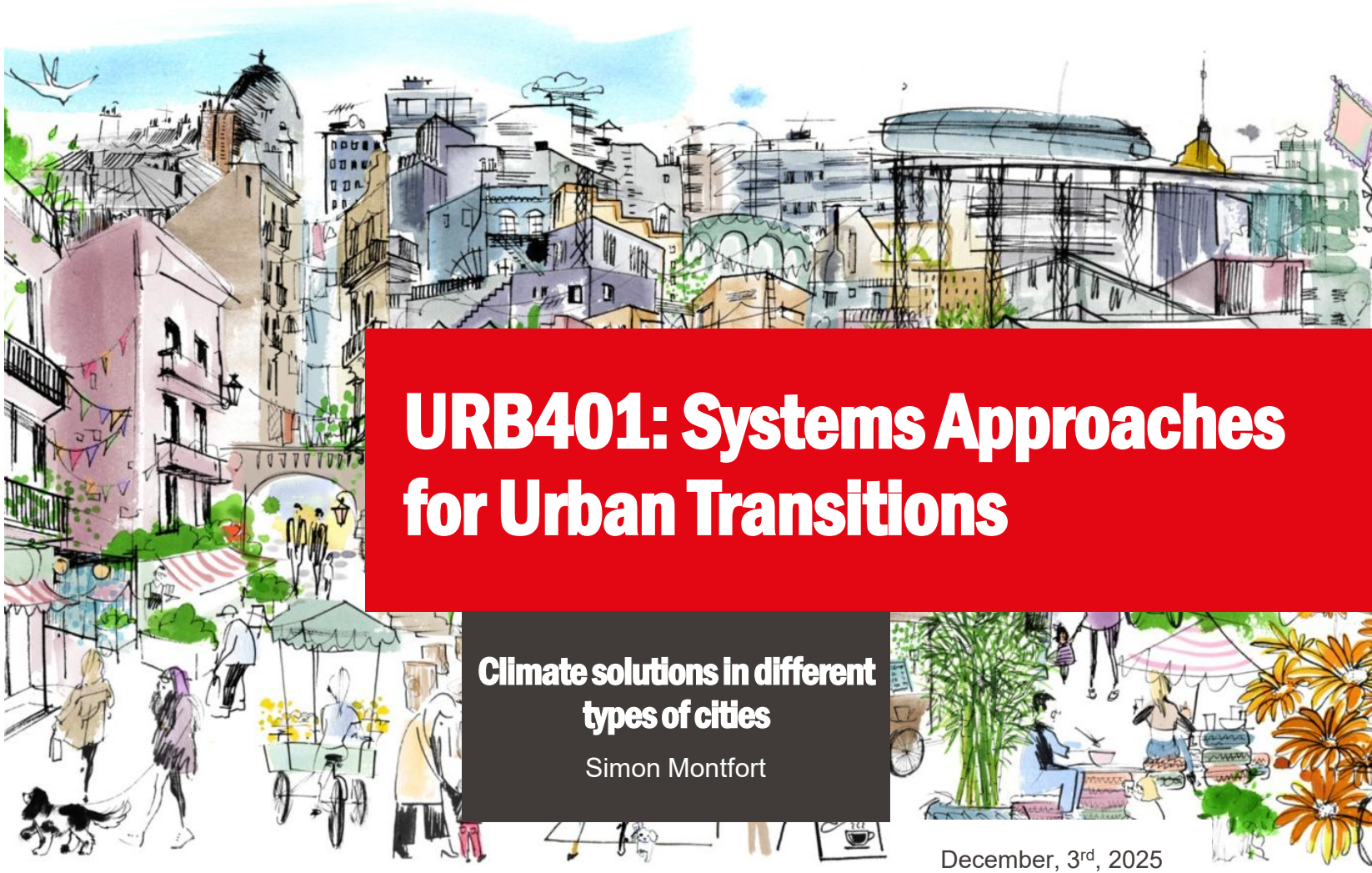


URB401: Systems Approaches for Urban Transitions

Climate solutions in different types of cities

Simon Montfort

December, 3rd, 2025

Courtesy of UN-Habitat and Global Utmaning

Course syllabus

Lectures 9:00-11:00
GC D0 386

Part	Week	Date	Teacher	Lecture
Part I: Urban transitions from a systems perspective	**1**	Sep 10	Hecher	Introduction to the course **Special guest:** Poetic transitions in the case of a historical architectural and urban design (Darius Karácsony)
	2	Sep 17	Hecher	Systems thinking for sustainable urban transitions
	3	Sep 24	Hecher	**Special guest:** Leverage points in the housing system (Anna Pagani)
	4	Oct 1	Binder	Transition research in urban systems
	5	Oct 8	Binder	Urban metaphors and urban metabolism
Part II: Social perspectives of urban transitions	**6**	Oct 15	Hecher	Social innovation and urban niches
	7	Oct 29	Hecher	Social acceptance in cities
Part III: Urban infrastructure and ecology in cities	**8**	Nov 5	Jessel	Multifunctional approaches through ecosystem services
	9	Nov 12	Jessel	Combining green-blue-grey infrastructures: Large-scale approaches (city level)
	10	Nov 19	Jessel	Combining green-blue-grey infrastructures: Small-scale approaches (building and neighborhood level)
Part IV: Policy and governance for urban transitions	**11**	Nov 26	Montfort	Multi-level embedding of cities: From global governance to scope for action in cities
	12	Dec 3	Montfort	Climate solutions in different types of cities
	13	Dec 10	All	**Special guest:** Urban transition processes in practice (Anton Sentic)
	14	Dec 17	All	Presentation City Lab projects

Outline

- What different kind of evidence synthesis methods exist?
- Why is evidence synthesis important for the IPCC?
- What is the current state of the evidence on climate solutions in cities?
- What are typologies?
- What climate solutions are needed in different types of cities?

Learning objectives

- Learn what evidence synthesis methodologies exist and how they differ.
- Learn about current approaches to understand climate solutions in cities.
- Learn what typologies are and how they can be used to understand urban research.
- Learn which climate solutions are needed in different types of cities.

International Arena: Special Report on Cities by the IPCC

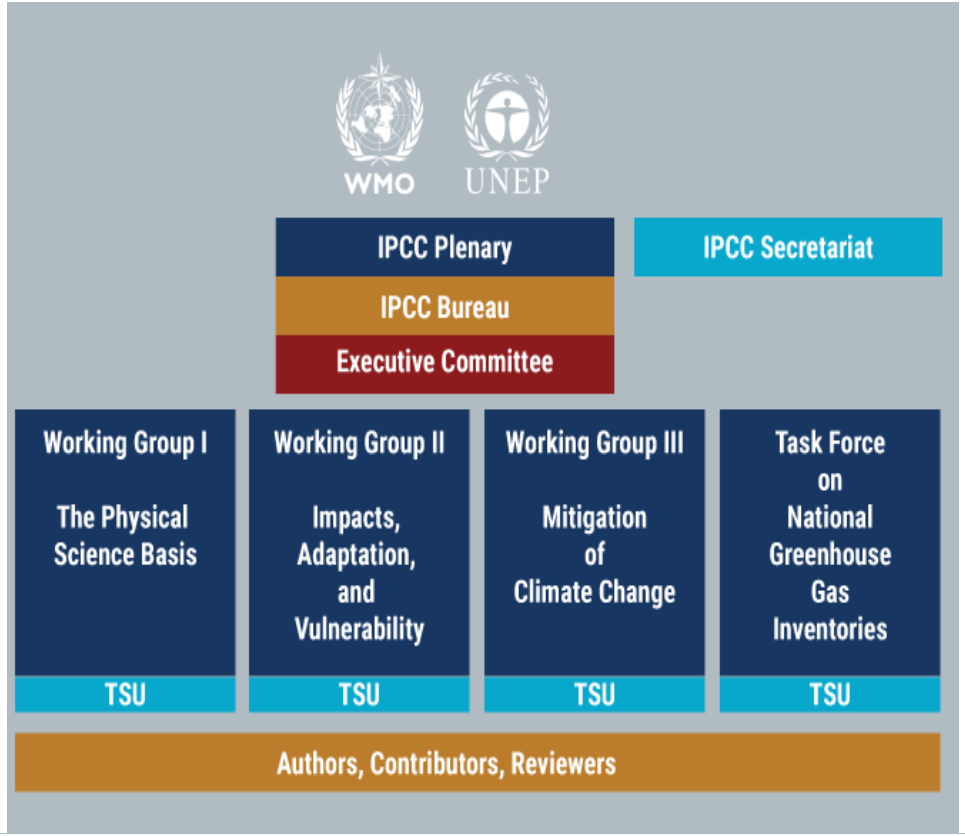
- The IPCC (Intergovernmental Panel on Climate Change) is the most authoritative organisation at the science policy interface.

https://www.youtube.com/watch?v=XP6rhcQUmOs

International Arena: Special Report on Cities by the IPCC

Plenary

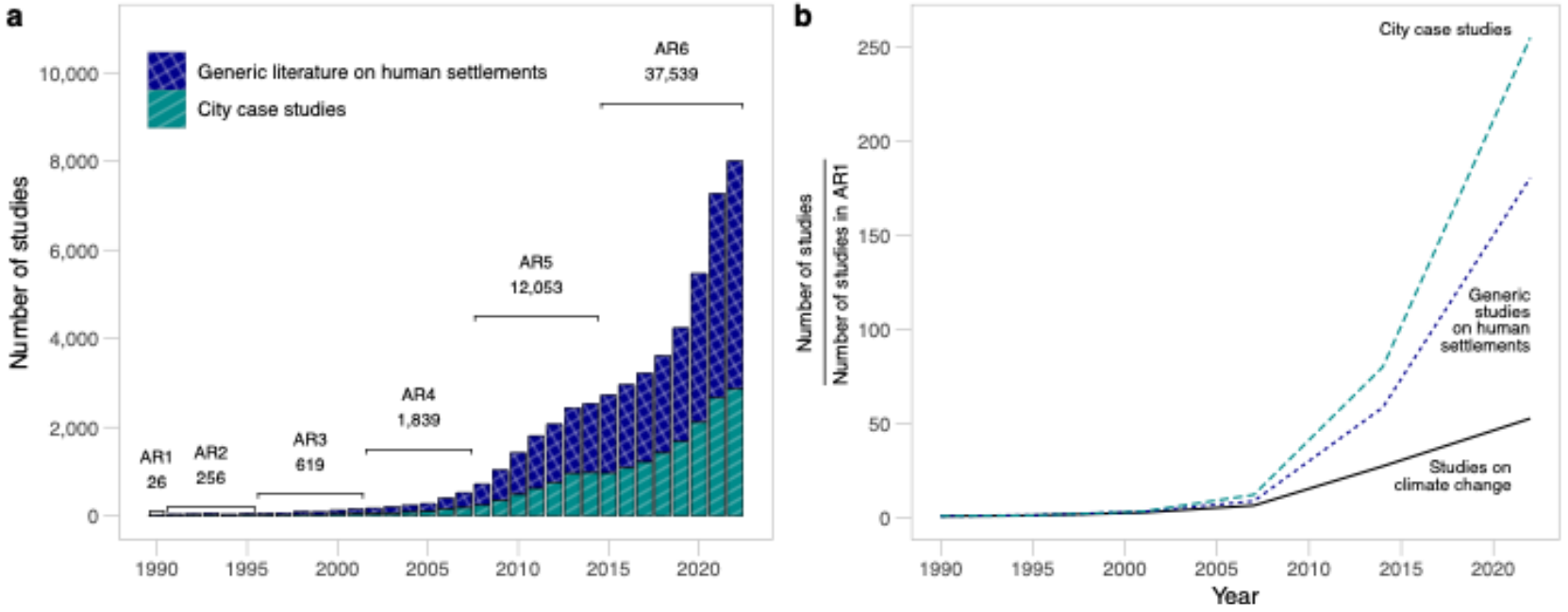
- **Sets overall direction:** Decides what reports the IPCC will produce and approves the work program.
- **Elects leadership:** Chooses the Chair and Bureau members who oversee report development.
- **Approves budget:** Manages funding and resource allocation.
- **Accepts reports:**
  - Approves *Summaries for Policymakers* **line-by-line**.
  - Accepts full chapters without editing their scientific content.



International Arena: IPCC

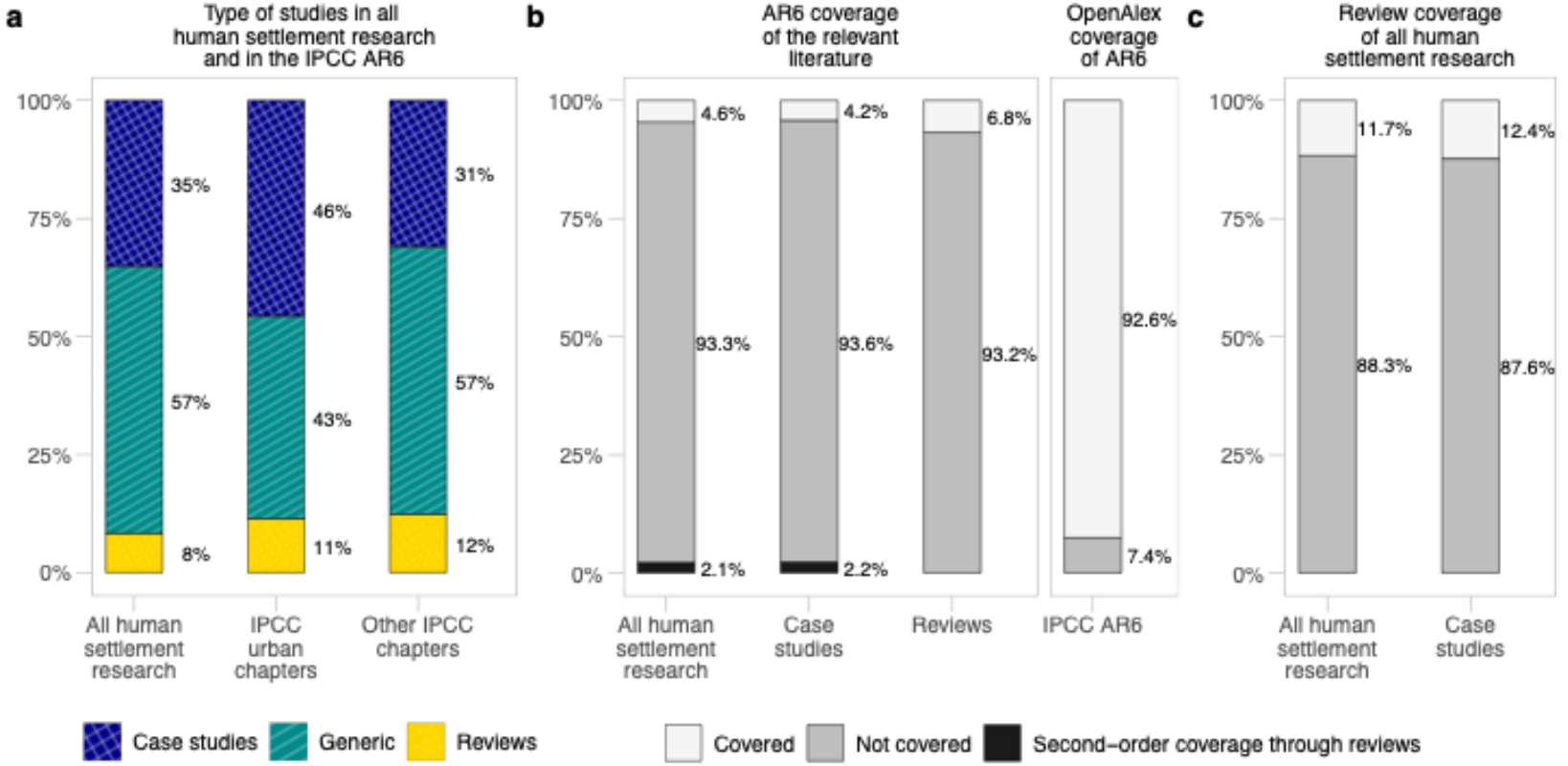
- Before Assessment Report 5, there was no focus on cities.
- The IPCC decided in April 2016 to include a special report in the AR7 cycle.
- Special Report (SR) on Cities:
  - Chapter 1: Cities in the context of climate change
  - Chapter 2: Cities in a changing climate: trends, challenges and opportunities
  - Chapter 3: Actions and solutions to reduce urban risks and emissions
  - Chapter 4: How to facilitate and accelerate change
  - Chapter 5: Solutions by city types and regions

Challenges for science assessments



Montfort, S., Callaghan, M., Creutzig, F., Lamb, W. F., Lu, C., Repke, T., ... & Minx, J. (2025). Systematic global stocktake of over 50,000 urban climate change studies. *Nature Cities*, 1-13.

Challenges for science assessments



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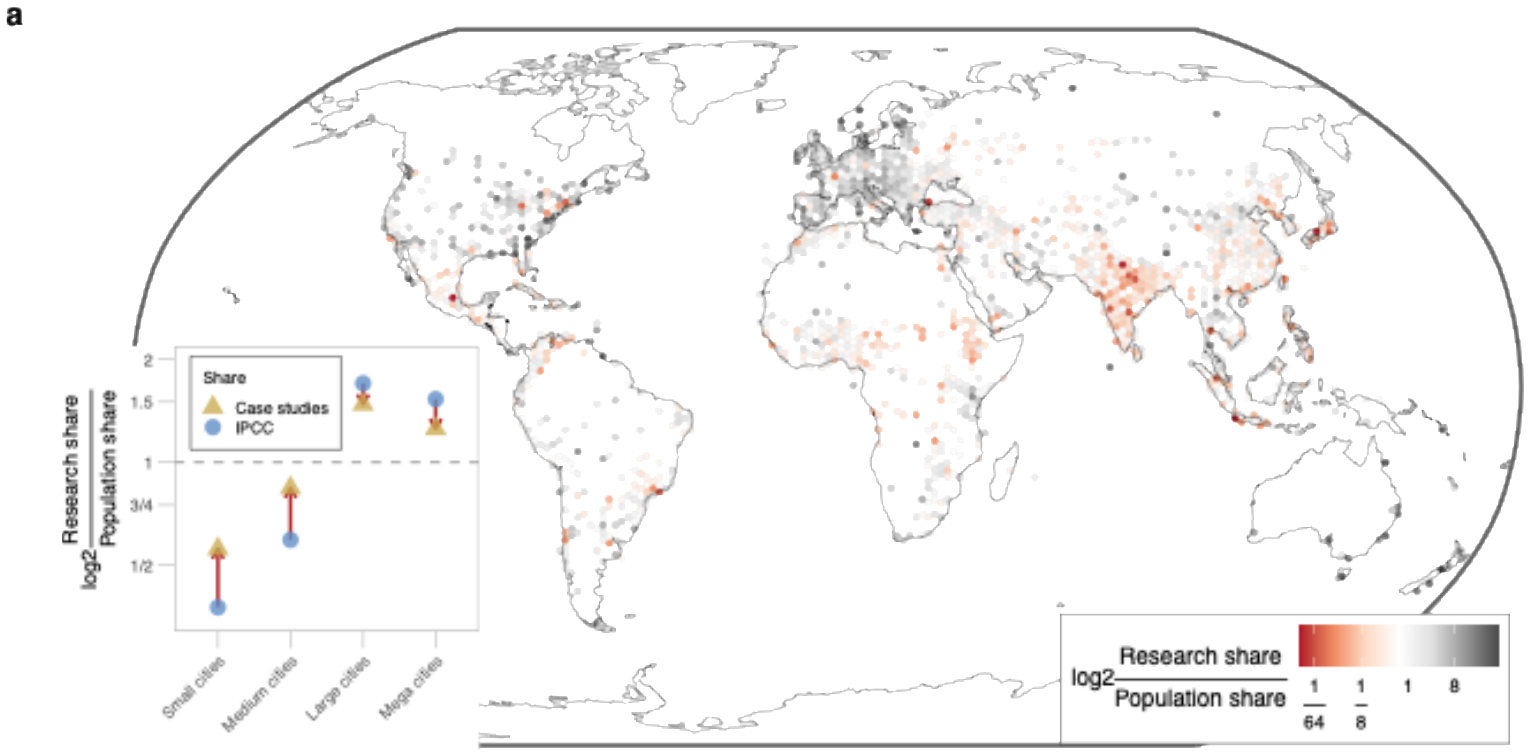
Challenges for science assessments



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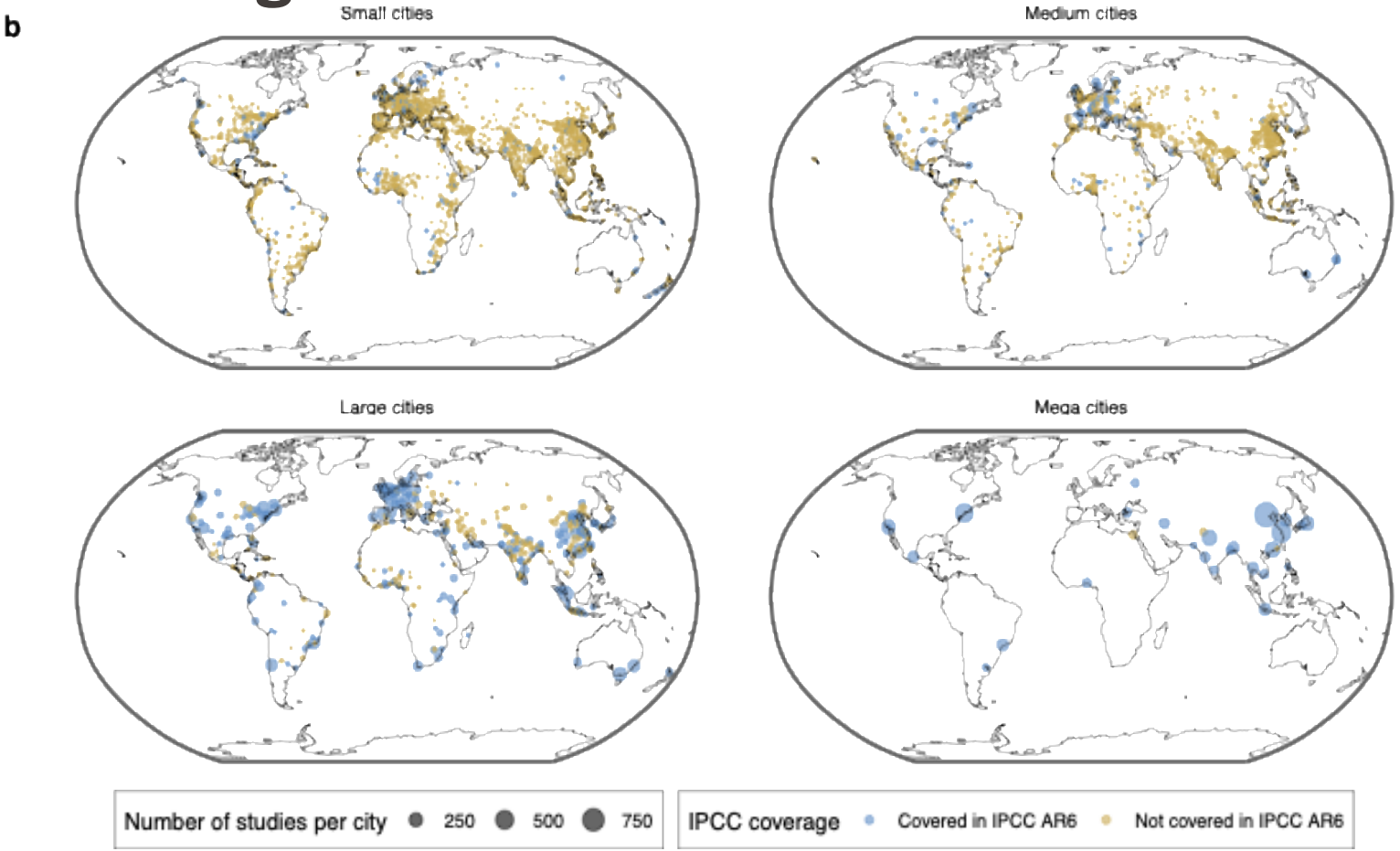

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Assessment gaps and possibilities

1. Urban form

1.1 Assess geospatial big data studies

1.2 Systematize case study insights on urban form

1.3 Explore changing dynamics of urban form

5.1 Framing: sustainability, health, and well-being

4. Data & AI

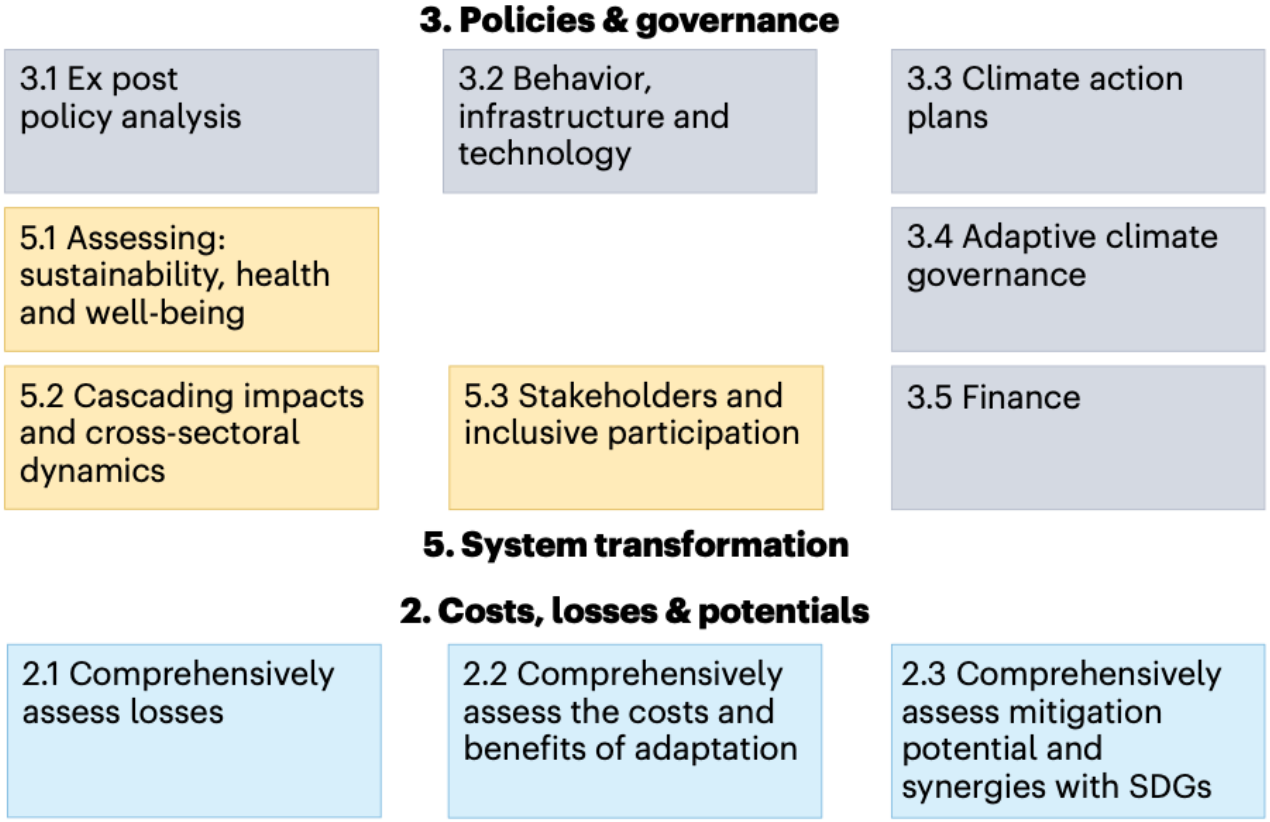
4.1 Monitoring

4.2 Computing spatially explicit solutions

4.3 Anticipatory data-driven governance

Creutzig, F., McPhearson, T., Bardhan, R., Belmin, C., Chow, W. T., Garschagen, M., ... & Ürge-Vorsatz, D. (2025). Bridging the scale between the local particular and the global universal in climate change assessments of cities. *Nature Cities*, 1-10.

Assessment gaps and possibilities



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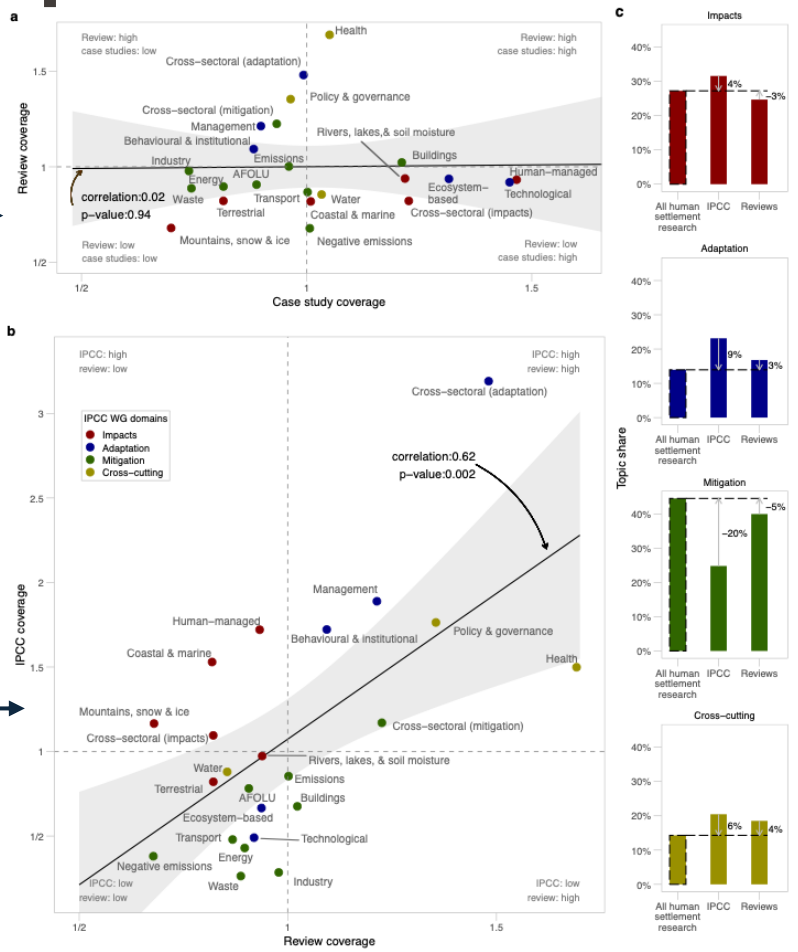
Assessment gaps and possibilities

Case studies are not well reviewed

The better reviewed a topic, the more likely it is to be covered in IPCC reports



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Evidence synthesis methods

BOX 1

Examples of knowledge synthesis methodologies

The landscape of knowledge synthesis is diverse and sometimes difficult to navigate. Below are examples of knowledge synthesis methodologies, which may combine or mix approaches to create a method tailored to the question. We include examples of 'mainstream' methodologies, along with those that emphasize the importance of working with diverse knowledges.

Systematic review. This involves systematically reviewing the literature to identify and appraise evidence for a specific and clearly articulated research question using predefined eligibility criteria for documents and explicitly outlined and reproducible methods[21]. This approach should be explicitly guided by a research question and assess the nature of the evidence, bias and confidence in the evidence when presenting findings. Systematic reviews are particularly useful within CCAs to provide an evidence base to inform climate policy and guide decision-making. For example: to what extent do livestock livelihood interventions reduce climate vulnerability among the ultra-poor?

Multi-evidence-base approach. This is a structured process that emphasizes the importance of bringing together diverse knowledges (Indigenous, local, scientific) on a particular topic or question, where a joint assessment of knowledge provides a starting point for further knowledge generation[44,52]. It has been used within used within the context of IPBES assessments. For example: how are changing ice conditions affecting the food systems of Indigenous communities in the Arctic?

Ford, J. D., Biesbroek, R., Ford, L. B., Creutzig, F., Haddaway, N., Harper, S., ... & Callaghan, M. (2025). Recommendations for producing knowledge syntheses to inform climate change assessments. *Nature Climate Change*, 1-11.

Evidence synthesis methods

Evidence map. This approach captures a group of methods (sometimes called a systematic map or scoping review) that are used to answer questions about the state of the knowledge on a particular topic and highlight knowledge clusters and gaps. Evidence maps do not seek to answer a specific research question, but rather to describe and characterize a knowledge base. Such reviews are particularly useful in providing CCAs with an overview of evidence and identifying knowledge gaps within a particular topic. For example: what is the nature of the evidence base on livestock transitions as an adaptation pathway?

Meta-analysis. Meta-analysis is a specific type of review that aims to answer a specific review question but uses statistical techniques to collectively analyse quantitative data across multiple studies[22]. Using particular techniques, meta-analysis pools data across several studies that are relatively homogeneous in terms of methods and data type. For example: does access to green space reduce mortality during heatwaves?

Meta-synthesis. This is a generalized term that reflects a range of qualitative approaches that can be used to synthesize insights from multiple qualitative studies to generate new insights and a deeper understanding of a particular topic or question (for example, case survey meta-analysis[78] and meta-ethnography[89,91]). For example: what are the main factors creating vulnerability to climate change among smallholder farmers?

Structured expert judgement. This is one approach to systematically aggregating expert opinions based on a set of metrics or questions, often using a scoring system, involving individuals with relevant knowledge or expertise on the topic and incorporating a broad range of information types and sources[93]. This approach has been used for issues where there is significant complexity, uncertainty and/or data gaps[28,29,94,95], and can include a diversity of experts including scientists, Indigenous knowledge holders, community representatives and decision makers. For example: what is the state of progress on climate change adaptation in coastal regions?

Oxford Martin Restatements. This is a structured process that aims to assess the scientific evidence base underlying key policy issues[96]. The Restatement process convenes an author group chosen to represent different scientific points of view on a contested topic. A first draft evidence summary is then prepared for the topic in question, which is then debated via correspondence until a consensus is achieved. A near final draft is then sent to diverse stakeholders for comment. Results comprise a series of evidence statements that are categorized according to the nature of the underlying information (for example, uncontentious, strongly supported and so on)[97]. For example: to what extent can economic development offset the impacts of climate change on malaria transmission in sub-Saharan Africa?

Ford, J. D., Biesbroek, R., Ford, L. B., Creutzig, F., Haddaway, N., Harper, S., ... & Callaghan, M. (2025). Recommendations for producing knowledge syntheses to inform climate change assessments. *Nature Climate Change*, 1-11.

Evidence synthesis methods

Rapid review. This type of review integrates key components of a systematic review but involves a simplification of the review process to allow for a more efficient and rapid review process. They involve simplifying review processes in areas with known likely impacts on the risk of bias, which should be clearly stated as caveats, and are suited to cases where the literature is rapidly evolving, decision makers need urgent advice and there are short policy windows and/or resource constraints[25,37]. For example: what is the effectiveness of carbon dioxide removal technologies for meeting emissions goals?

Realist review. This type of review seeks to understand why and how a policy/practice works, for whom and in what context it is effective or ineffective[21]. It focuses on systematically identifying the underlying mechanisms of an intervention, the contexts in which these

Knowledge dialogues. These platforms or forums seek to exchange knowledge and synthesize understanding on a particular topic or question through the process of communication and exchange between people, groups or communities that come from different backgrounds or cultures[48,49]. For example: can Indigenous peoples' agricultural knowledge and practices build resilience to climate change impacts?

Circle of experts. This involves bringing together a diverse group of specialists, practitioners and rights- and stakeholders to collaboratively synthesize knowledge on a particular topic or question; insights are shared and debated and areas of consensus and disagreement are identified. It is particularly well suited to bringing together Indigenous knowledge holders and representatives in an ethical space for authentic dialogue guided by traditional and ceremonial protocols (for example, refs. 50,51,98) with synthesized knowledge shared via videos, stories and reports. For example: what aspects of biodiversity in a specific location are most at risk from climate change?

Ford, J. D., Biesbroek, R., Ford, L. B., Creutzig, F., Haddaway, N., Harper, S., ... & Callaghan, M. (2025). Recommendations for producing knowledge syntheses to inform climate change assessments. *Nature Climate Change*, 1-11.

Importance of evidence synthesis for climate action

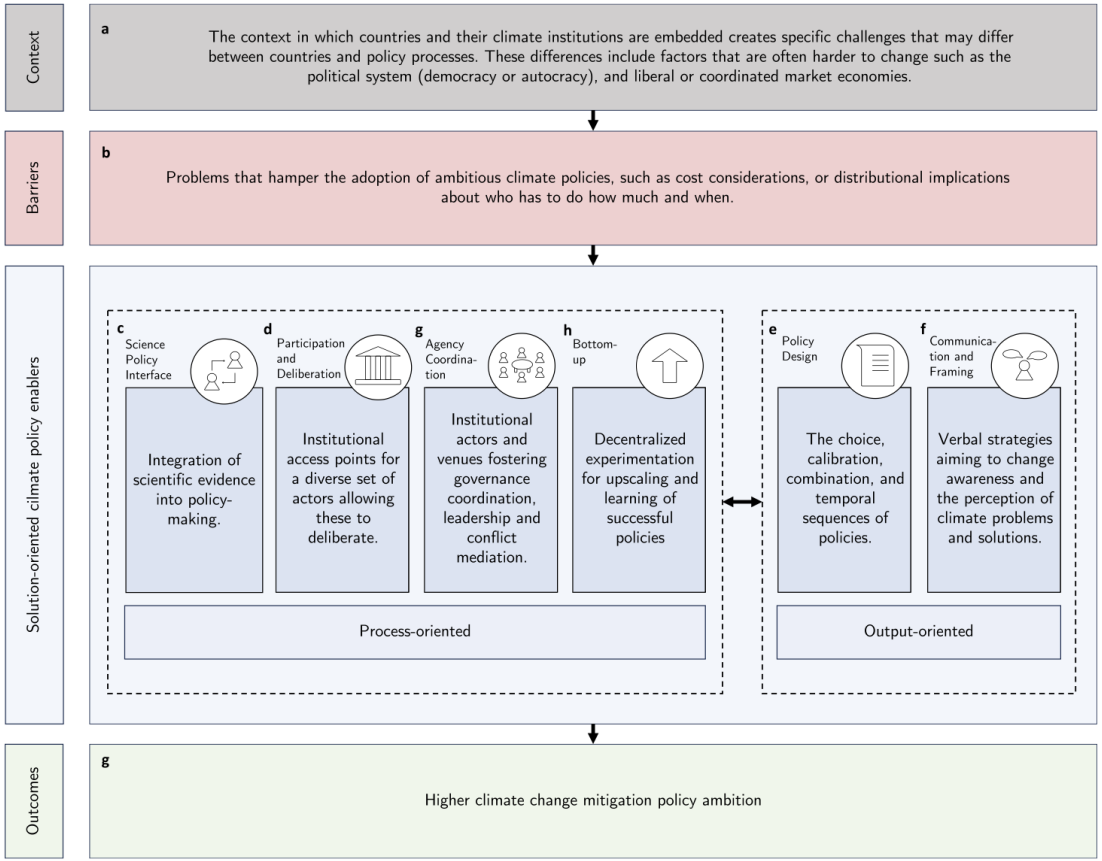


Fig. 1 | A solution-oriented framework of political enablers for higher climate change mitigation policy ambition. The key components include the context of the policy process (in panel **a**), the barriers (in **b**), the typology of political enablers (in **c**–**f**), and the outcome (in **g**).

Hecher, Binder, Jessel, Montfort

Montfort, S., Fesenfeld, L., Ingold, K., Lamb, W. F., & Andrijevic, M. (2025). Political enablers of ambitious climate policies: a framework and thematic review. *npj Climate Action*, *4*(1), 14.

Importance of evidence synthesis for climate action

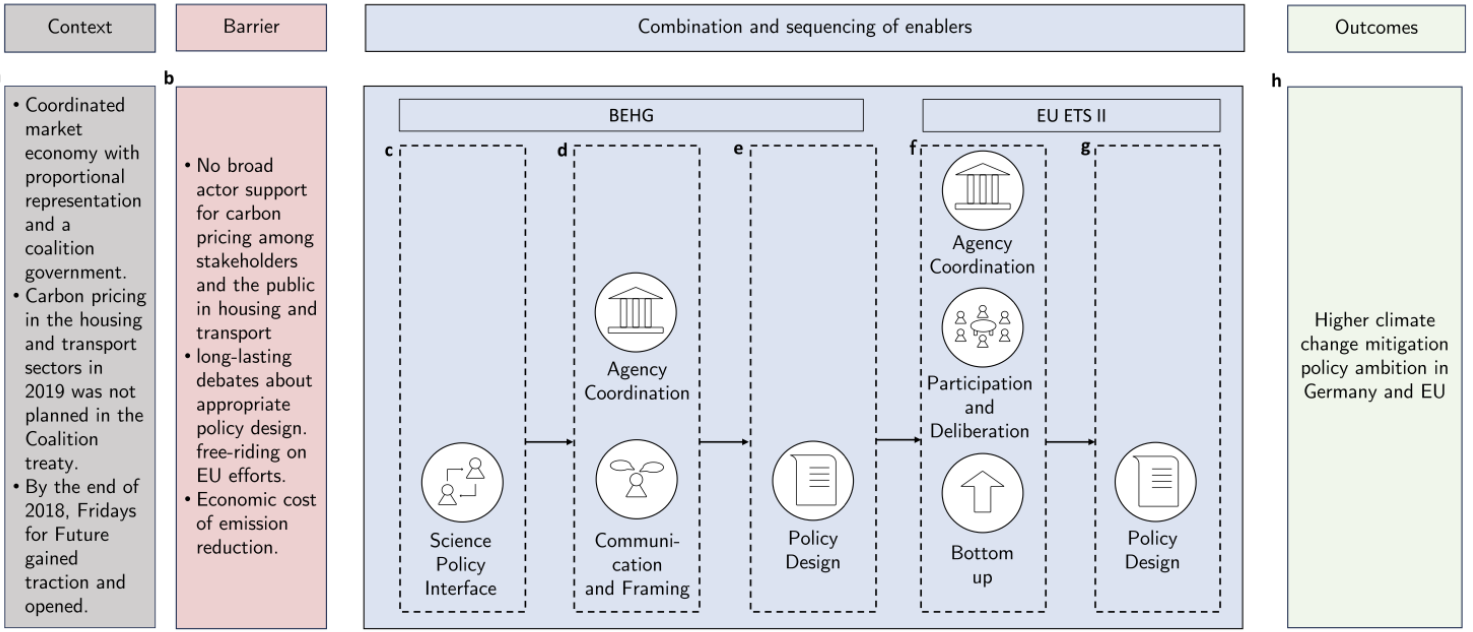
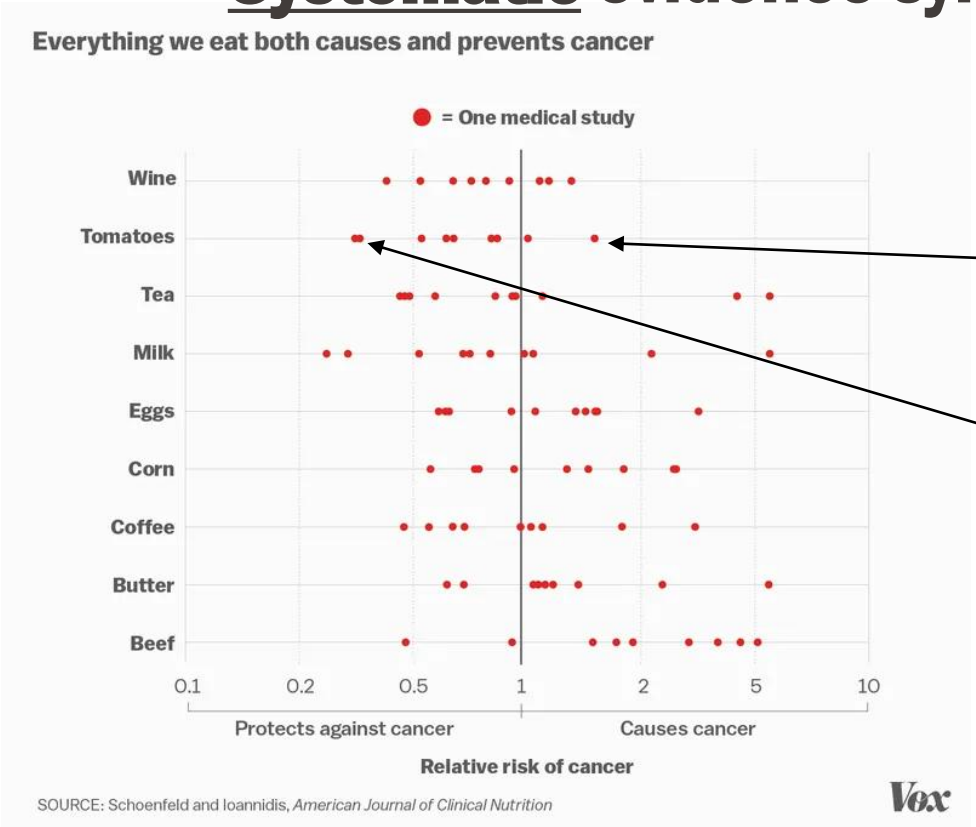
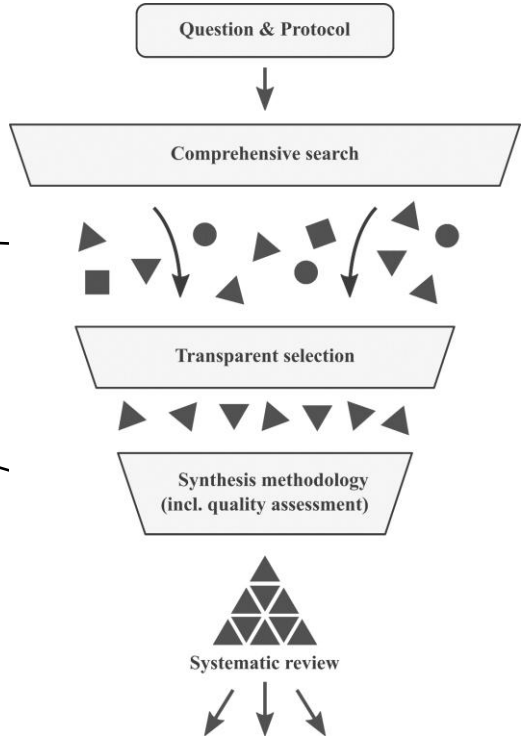


Fig. 2 | Case study illustration of the theoretical framework of political enablers. This illustrations shows the combination and sequencing of key solution-oriented enablers and how these fostered the introduction of the Fuel Emission Trading Act (BEHG) in Germany and the EU ETS II: the context (in panel **a**), the barriers (in **b**), the enablers (**c**–**g**), and the outcome (**h**).

Montfort, S., Fesenfeld, L., Ingold, K., Lamb, W. F., & Andrijevic, M. (2025). Political enablers of ambitious climate policies: a framework and thematic review. *npj Climate Action*, *4*(1), 14.

Systematic evidence synthesis methods





Hecher, Binder, Jessel, Montfort

Systematic evidence synthesis methods

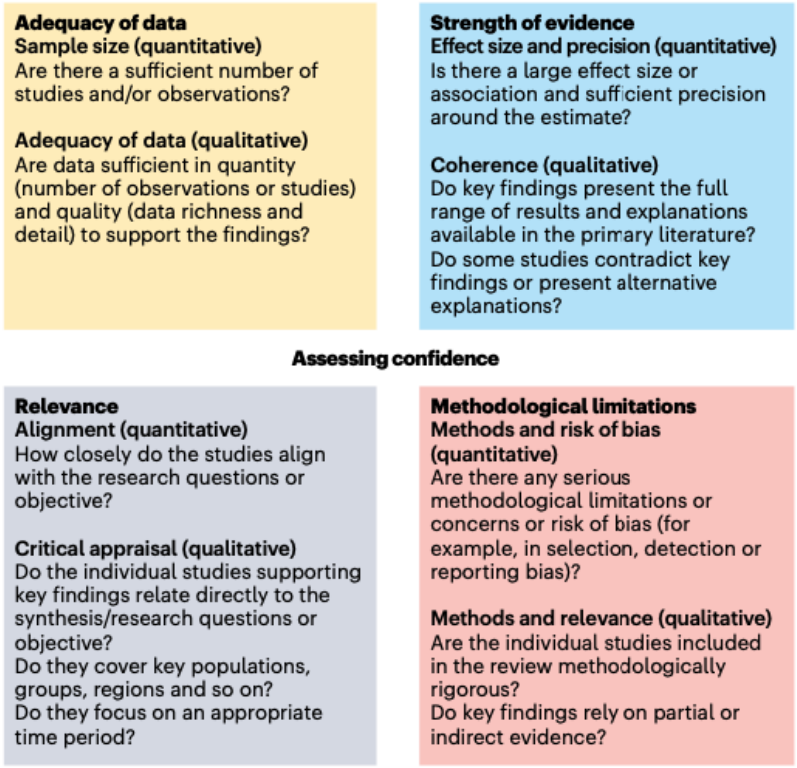
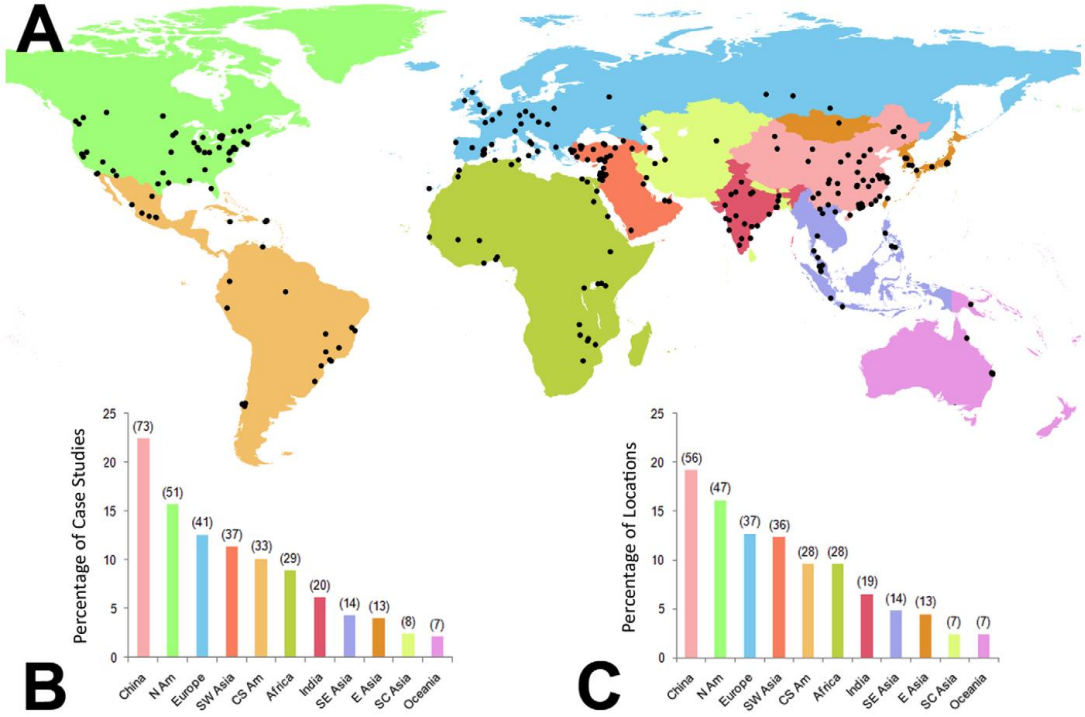


Fig. 3 | Key components for assessing confidence in evidence. Confidence can be assessed by drawing upon tools including GRADE-CERQual, the AACODS checklist (Authority, Accuracy, Coverage, Objectivity, Date, Significance) for grey literature and the mixed methods appraisal tool, among others.

Ford, J. D., Biesbroek, R., Ford, L. B., Creutzig, F., Haddaway, N., Harper, S., ... & Callaghan, M. (2025). Recommendations for producing knowledge syntheses to inform climate change assessments. *Nature Climate Change*, 1-11.

Climate challenges: land expansion



1.Study must quantify the urban area extent for at least in one point in time.
2.Study must quantify either the rate or amount of urban land expansion over a specific period of time.
3.Study area extent must be at city, metro, or regional scale (<100,000 km^2).
4.Study must not repeat the results presented in another paper

Figure 1. Geographical distribution of case studies and their locations. A, Locations of case studies. **B**, Studies by region. Numbers in parentheses are the number of case studies for each region. The total number of case studies is 326. **C**, Locations by region. Numbers in parentheses are the number of locations for each region. The total number of unique locations is 292. There are more case studies than geographic locations because there may be multiple case studies on a single location. The color-coding for the map corresponds to the bar charts.
doi:10.1371/journal.pone.0023777.g001

Seto, K. C., Fragkias, M., Güneralp, B., & Reilly, M. K. (2011). A meta-analysis of global urban land expansion. *PloS one*, *6*(8), e23777.

Climate challenges: land expansion

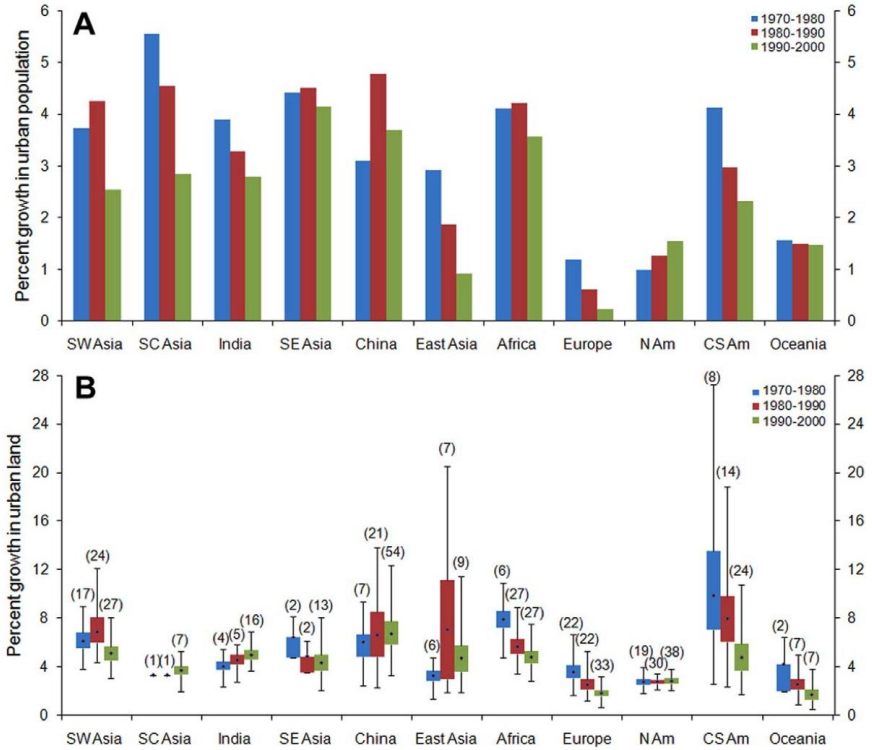


Figure 3. Comparison of two different urban growth measures by region and by decade. Annual rates of **A**, urban population change and **B**, urban land expansion. Population data are aggregated from individual countries to the geographic regions in the meta-analysis. Average annual rate of urban land change is based on the case studies in the meta-analysis. Box plots in **B** show the median, 1st and 3rd quartiles, minimum and maximum values of bootstrapped average annual rates of urban expansion by region.
doi:10.1371/journal.pone.0023777.g003

Seto, K. C., Fragkias, M., Güneralp, B., & Reilly, M. K. (2011). A meta-analysis of global urban land expansion. *PloS one*, *6*(8), e23777.

Climate solutions syntheses: Mobility/urban form

Vehicle miles travelled are reduced by densification

Vehicle hours travelled are reduced by densification

Table 2. Meta-Analysis Results for the Relationship between Density and Travel Variables

	Gross Residential/Population Density (Origin)		Gross Employment Density (Destination)	
VMT/VKT	N	#Studies	N	#Studies
	19839	3	3923	2
	Sig.	Sign	Sig.	Sign
	P<0.001	-	P<0.001	-
VHT	N	#Studies	N	#Studies
	2248	2	2248	2
	Sig.	Sign	Sig.	Sign
	P<0.001	-	NS	-
Vehicle Trips	N	#Studies	N	#Studies
	17616	2	2000	2
	Sig.	Sign	Sig.	Sign
	P<0.001	-	P<0.05	-
Vehicle Trips (non work)			N	#Studies
			864	2
			Sig.	Sign
			NS	-
Probability of Commuting by Automobile / Percent of Trips by Automobile	N	#Studies	N	#Studies
	73296	4	53650	2
	Sig.	Sign	Sig.	Sign
	P<0.001	-	P<0.001	-
Probability of Commuting by Transit / Percent of Trips by Transit	N	#Studies	N	#Studies
	35139	6	1017	2
	Sig.	Sign	Sig.	Sign
	P<0.001	+	P<0.001	+
Probability of Commuting by Walking / Percent of Trips by Walking	N	#Studies	N	#Studies
	21693	4	2083	2
	Sig.	Sign	Sig.	Sign
	P<0.001	+	P<0.01	+

NS – not significant at the 5 percent level

Leck, E. (2006). The impact of urban form on travel behavior: A meta-analysis. Berkeley Planning Journal, 19(1). Chicago

Climate solutions syntheses: Buildings

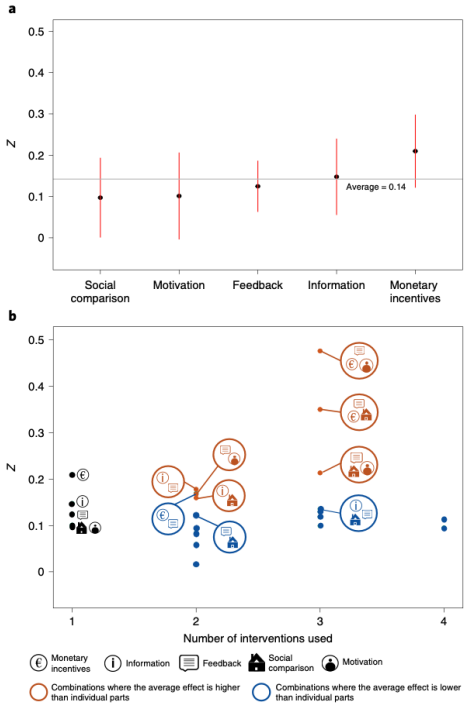


Fig. 2 | Estimated average effect size of different categories of reviewed interventions. a, The average effect size for individual interventions along with the corresponding 95% confidence interval. **b**, The average effect size for combinations of interventions. Only combinations with an average effect size that is statistically significant at the 5% level of significance are labelled. $Z > 0$ implies a reduction in energy consumption. The results are from a multilevel meta-regression model with interacted dummy variables for the five interventions. Only studies that employed randomization are included.

Intervention type	Intervention	Description
Monetary incentives	Critical peak pricing, seasonal pricing, time-of-use pricing, real-time pricing, rewards and rebates	Time-of-use pricing aligns the prices faced by households with the underlying cost of supply, which is higher during peak demand periods[43]. Other interventions reward consumers for reducing peak-period consumption. Households are expected to reduce consumption as long as the financial savings from reduced consumption outweigh the costs of shifting or reducing consumption[21].
Information	Home audits, tips, reminders	These policies focus on promoting energy-saving behaviour by reducing the information deficit faced by households with activities and actions that can help reduce energy consumption[17]. The information provided may be general advice like energy-saving tips and practices through workshops[44] and mass media campaigns[45] or tailored advice in the form of home audits[46].
Feedback	Historical, in-home displays	Feedback interventions are rooted in psychological research that posits that directing an individuals' attention to a feedback-standard gap that is relevant to the individuals can engender behavioural change[16]. Most experiments provide individuals information about their energy use, drawing comparison with their historical consumption. The effect of feedback seems to depend on its frequency, medium and duration[16,47].
Social comparison	Home energy reports, norms-based comparison	Households are benchmarked against the performance of their social group[20,48]. Norm-based communication has been widely adopted by utilities in the form of home energy reports[49], which seem to be effective in some cases even years after households received their initial reports[50].
Motivation	Commitment devices, goal setting, gamification	Social pressure has also been employed in the form of public pledges or commitments by households to practice energy-conserving behaviours[17]. Goal-setting interventions in which households commit to reducing energy consumption by a certain percentage over the course of the experiment are other commitment devices[18]. Some recent experiments have used web-based gamified platforms or mobile apps to induce behavioural change.

Fig. 1 | Typology of interventions in household energy consumption. Interventions in household energy consumption have been grouped in five categories for this analysis. The category 'monetary incentives' captures all interventions that involve a financial reward. Non-monetary interventions have been grouped into information, feedback, social norms and motivation[43–50].

Khanna, T. M., Baiocchi, G., Callaghan, M., Creutzig, F., Guias, H., Haddaway, N. R., ... & Minx, J. C. (2021). A multi-country meta-analysis on the role of behavioural change in reducing energy consumption and CO2 emissions in residential buildings. Nature Energy, 6(9), 925-932. Chicago

Climate solutions syntheses: Nature-based soluti

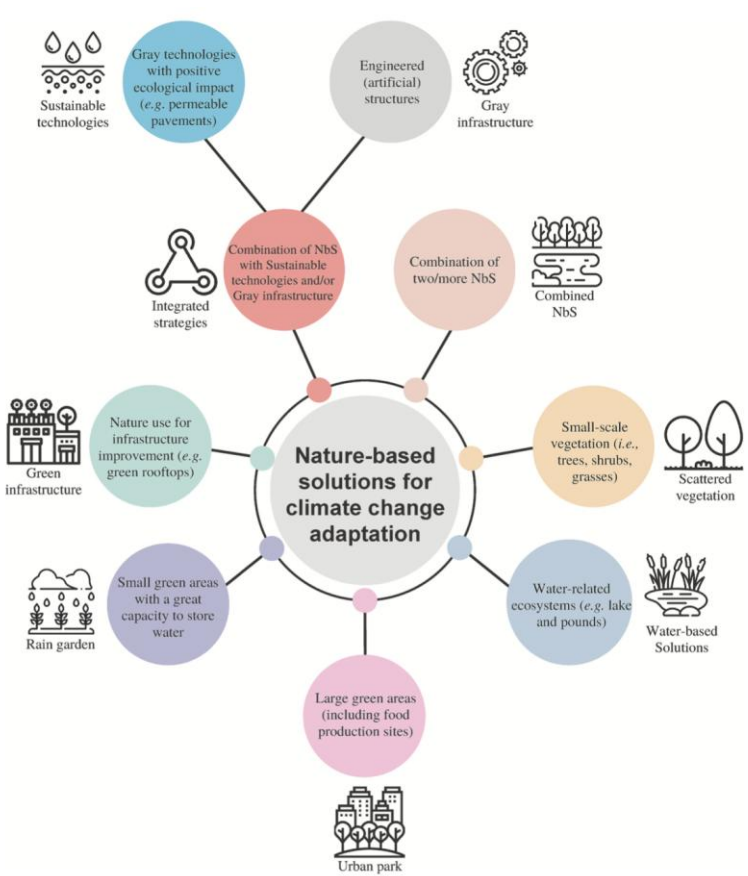


Fig. 2. Adaptation strategies focused on nature-based solutions (NbS) for climate change. NbS strategies are connected to the central gray circle, represented by icons with their definitions within the colored circles. The "integrated strategies" category combines elements of NbS and traditional strategies (*i.e.*, gray infrastructure and sustainable technologies) simultaneously, and thus, they are interconnected beyond the central circle.

Prado, H. A., Rodrigues, T., Manes, S., Kasecker, T., Vale, M. M., Scarano, F. R., & Pires, A. P. (2024). Designing nature to be a solution for climate change in cities: A meta-analysis. *Science of the Total Environment*, *954*, 176735.

Climate solutions syntheses: Nature-based

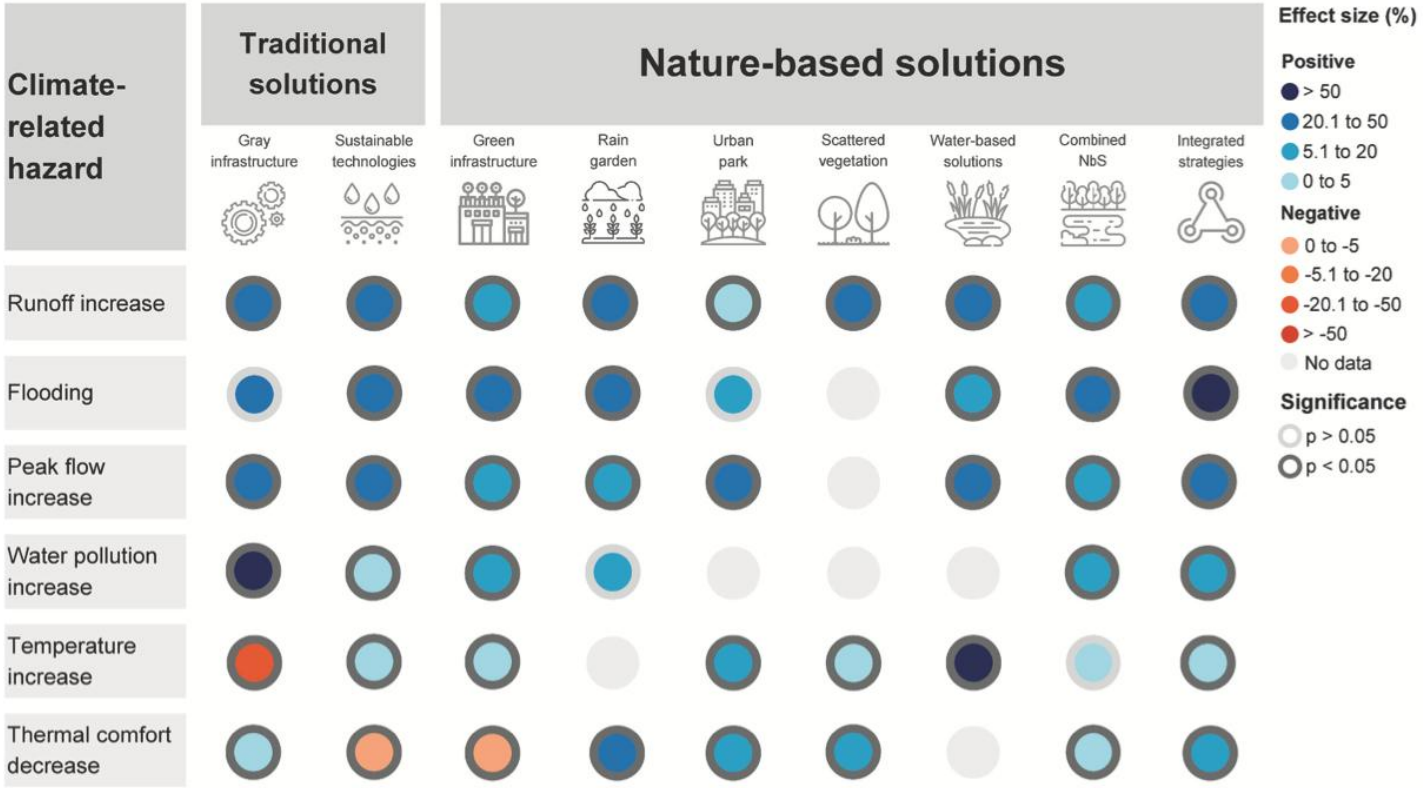


Fig. 3. Mean effect size (%) obtained for each adaptation strategy. Blue and orange inner circles represent the positive and negative impacts of the strategies, respectively. Darker colors represent stronger effects of each adaptation strategy. Significant impacts are presented considering a one-sample *t*-test (hypothetical mean equals zero) in the outer circles, where dark gray means significant effects while light gray non-significant effects ($p > .05$).

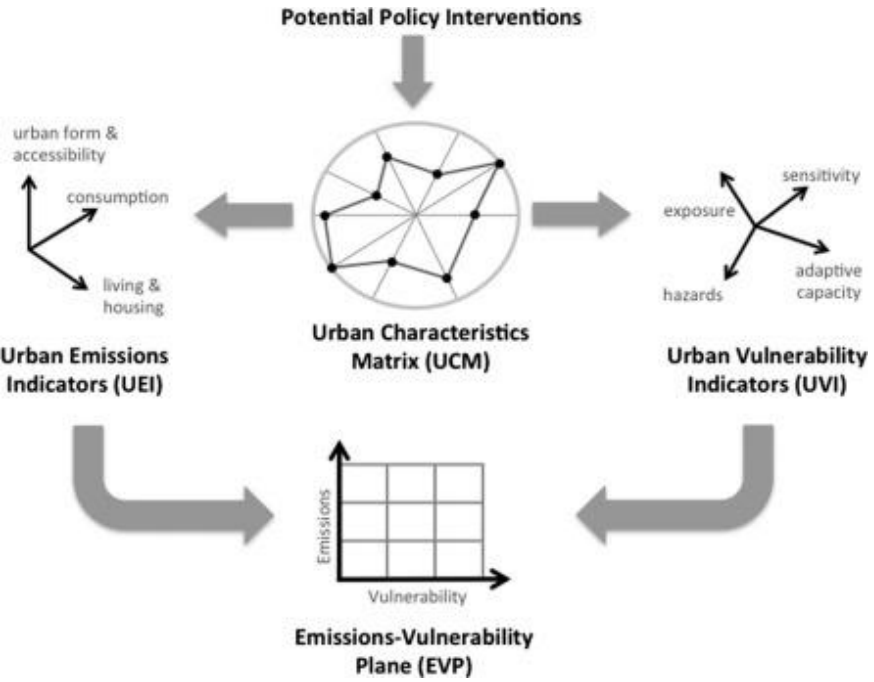
Prado, H. A., Rodrigues, T., Manes, S., Kasecker, T., Vale, M. M., Scarano, F. R., & Pires, A. P. (2024). Designing nature to be a solution for climate change in cities: A meta-analysis. *Science of the Total Environment*, *954*, 176735.

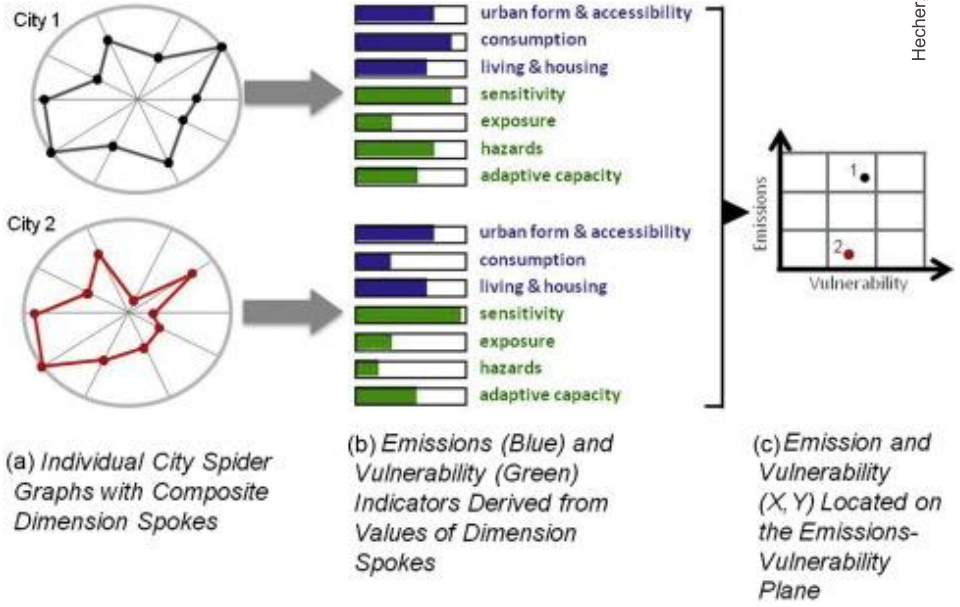
Urban typologies

Reveal patterns across diverse cases → identifying regularities
Simplify complexity by grouping recurring forms, functions, or behaviors
Clarify variation: show what differs *systematically* across contexts
Enable mechanism discovery: suggests underlying causal processes
Generate propositions by linking types to expected outcomes
Facilitate developing conceptual models, frameworks, and hypotheses
Build cumulative knowledge by connecting empirical cases to generalizable explanations
Guide empirical testing: types become units for prediction and evaluation

Doty, D. H., & Glick, W. H. (1994). Typologies as a unique form of theory building: Toward improved understanding and modeling. *Academy of management review*, *19*(2), 230-251.

Urban typologies





(a) *Individual City Spider Graphs with Composite Dimension Spokes*

(b) *Emissions (Blue) and Vulnerability (Green) Indicators Derived from Values of Dimension Spokes*

(c) *Emission and Vulnerability (X, Y) Located on the Emissions-Vulnerability Plane*

Solecki, W., Seto, K. C., Balk, D., Bigio, A., Boone, C. G., Creutzig, F., ... & Zwickel, T. (2015). A conceptual framework for an urban areas typology to integrate climate change mitigation and adaptation. *Urban Climate*, *14*, 116-137.

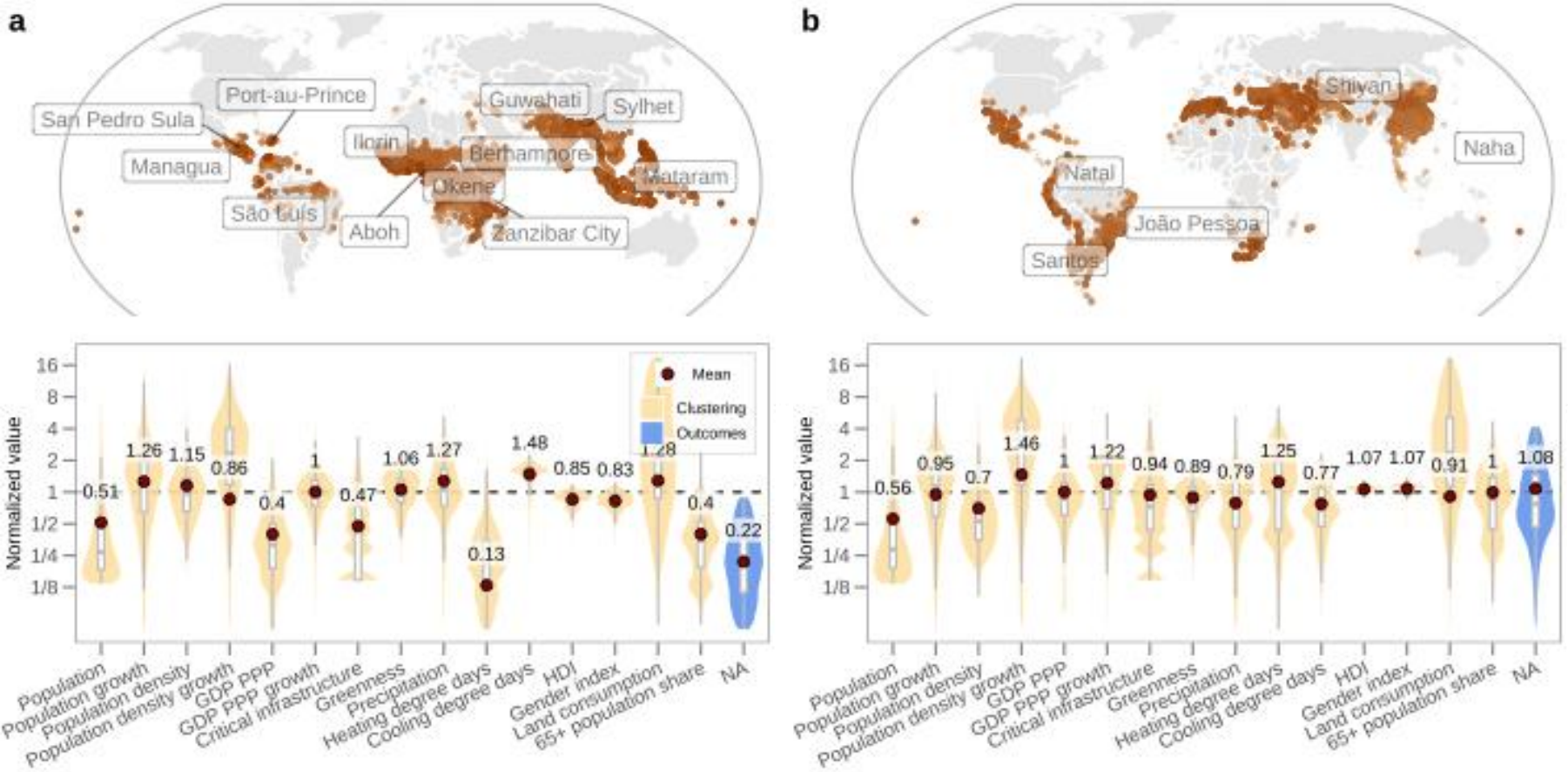
Urban typologies

With your neighbour,

- Like in your semester project, identify one non-European city (so it should be different than the one you chose for your project)
- Try to think about what the challenges and climate action needs, i.e., which specific solutions would protect people from climate change or allow the reduction of CO2 emissions

10 minutes

Urban typologies



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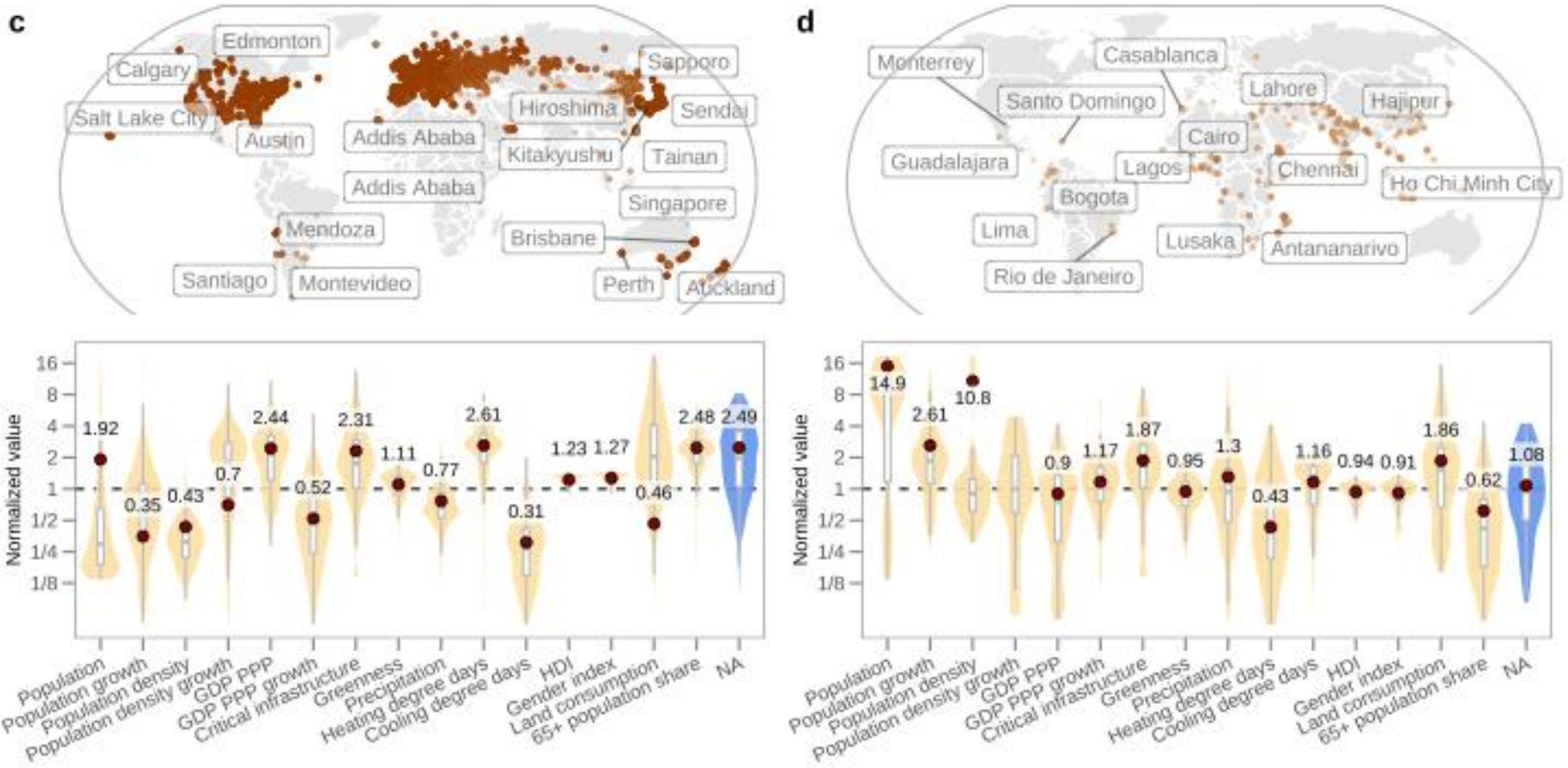
Urban typologies



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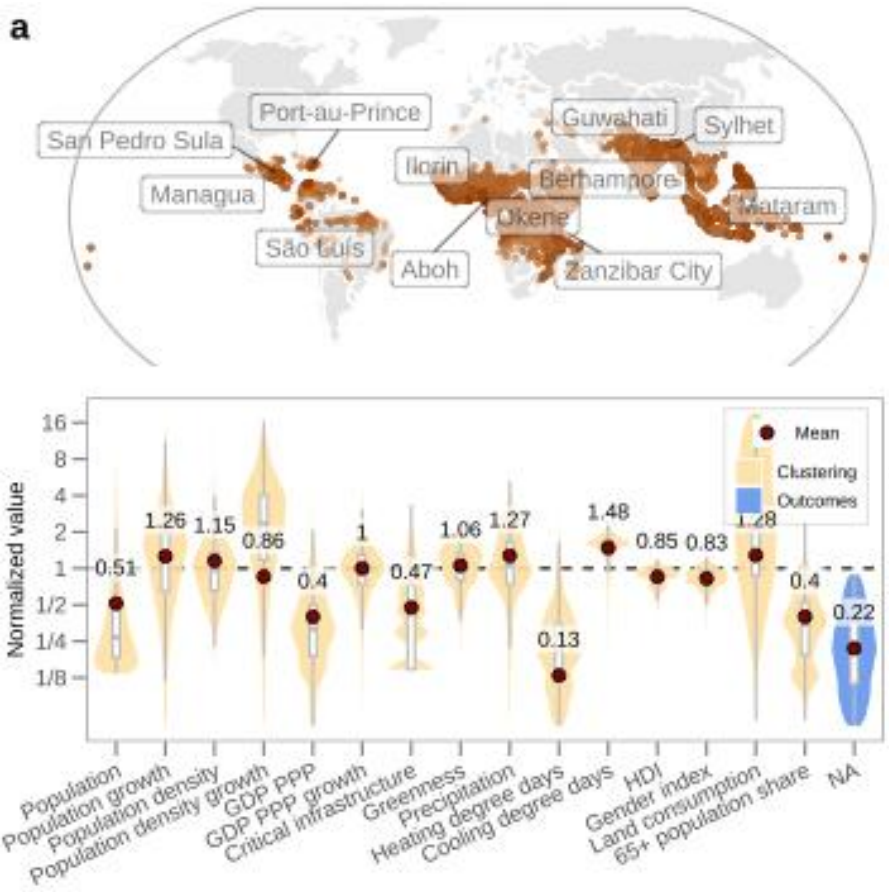
Urban typologies



Type 1: cities with development needs

- Smallest (population)
- Lowest GDP
- Lowest emissions
- Intermediary population growth
- Highest cooling, lowest heating needs

- Mostly concentrated in Central and South America, Africa, India, and Southeast Asia

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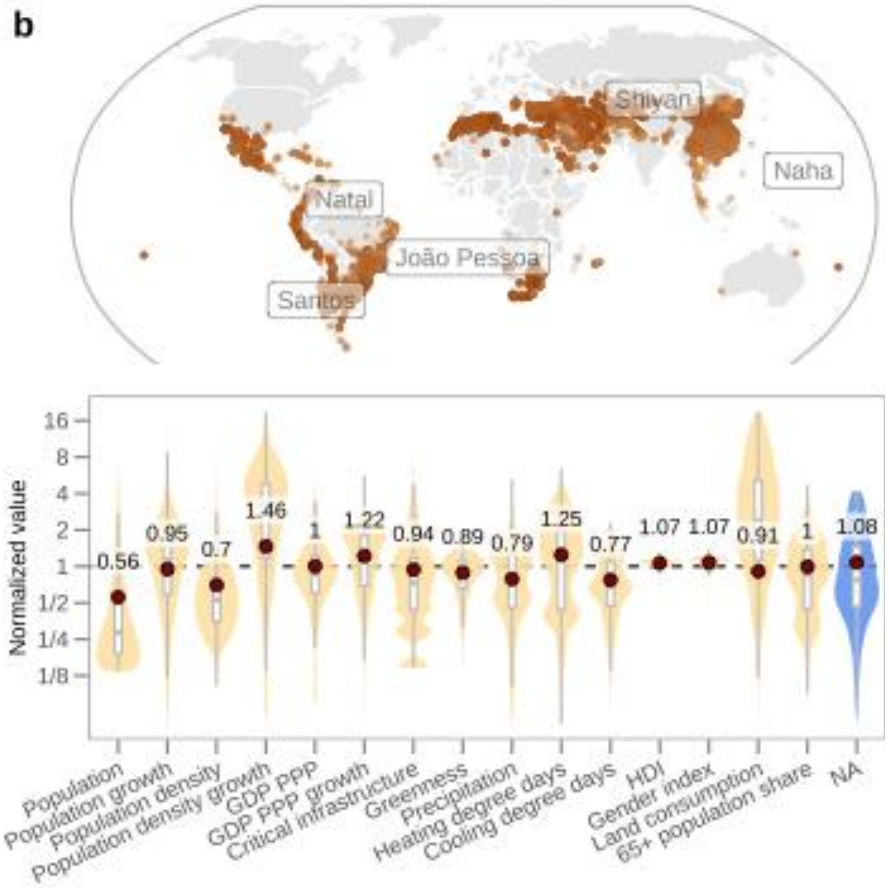
Urban typologies



Type 2: cities with urban planning and adaptation needs

- Rapidly expanding,
- significant GDP growth,
- relatively low population,
- sprawled development,
- low levels of critical infrastructure
- require cooling
- mostly subtropical

- Mostly developing country cities

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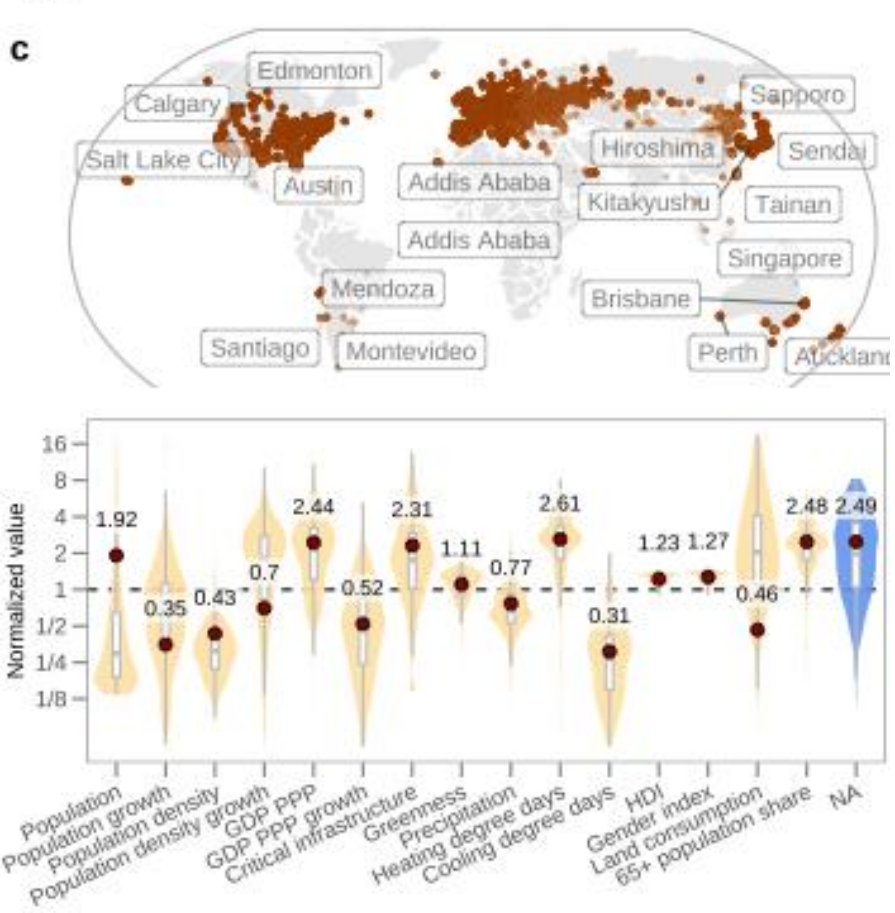
Urban typologies



Type 3: developed cities with mitigation needs

- Mostly wealthier, larger per capita emitters, low GDP growth, low density, little expansion; relatively
- high CO2 emissions; relatively high mean critical infrastructure, relatively high gender equality
- Largely cities in the global North- the majority of the urban population in Europe, Russia, North America, and some cities in South and Central America

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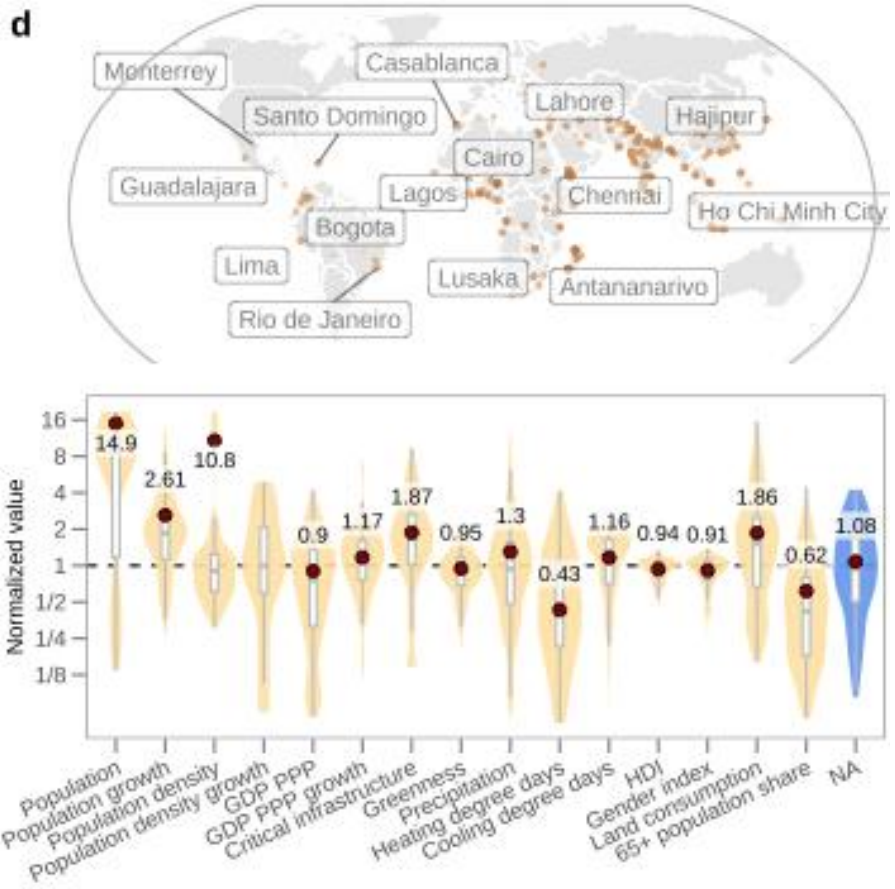
Urban typologies



Type 4: megacities with

- Mostly large/megacities with high density;
- High population growth, relatively high levels of critical infrastructure, and very high mean CO2 emissions
- Spread across regions, this group has high diversity depending on development levels (GDP). Developing country megacities have high cooling needs and a high proportion of the informal sector. Developed country megacities face challenges of both mitigation and adaptation
- Mostly concentrated in Central and South America, Africa, India, and Southeast Asia

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Urban typologies

Where do your cities sit in this typology?

You can check it out here: https://cities-explorer.eubucco.com

- Identify one important problem; what additional indicators do you need?
- Suggest a solution (i.e., action item)
- Identify a policy that could help solve the problem
- Think of the actors involved, the political multi-level governance system (last lecture)

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Urban typologies: Examples of how to use the typology

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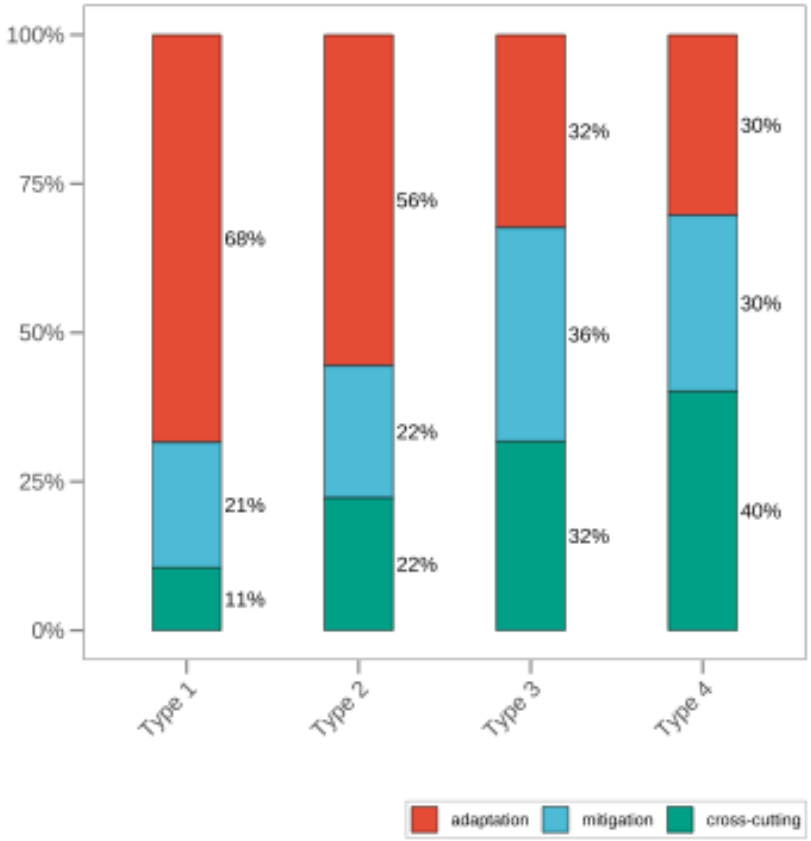
Urban typologies: Examples of how to use the typology



- Adaptation evidence decreases with development
- mitigation evidence increases
- cross-cutting evidence increases

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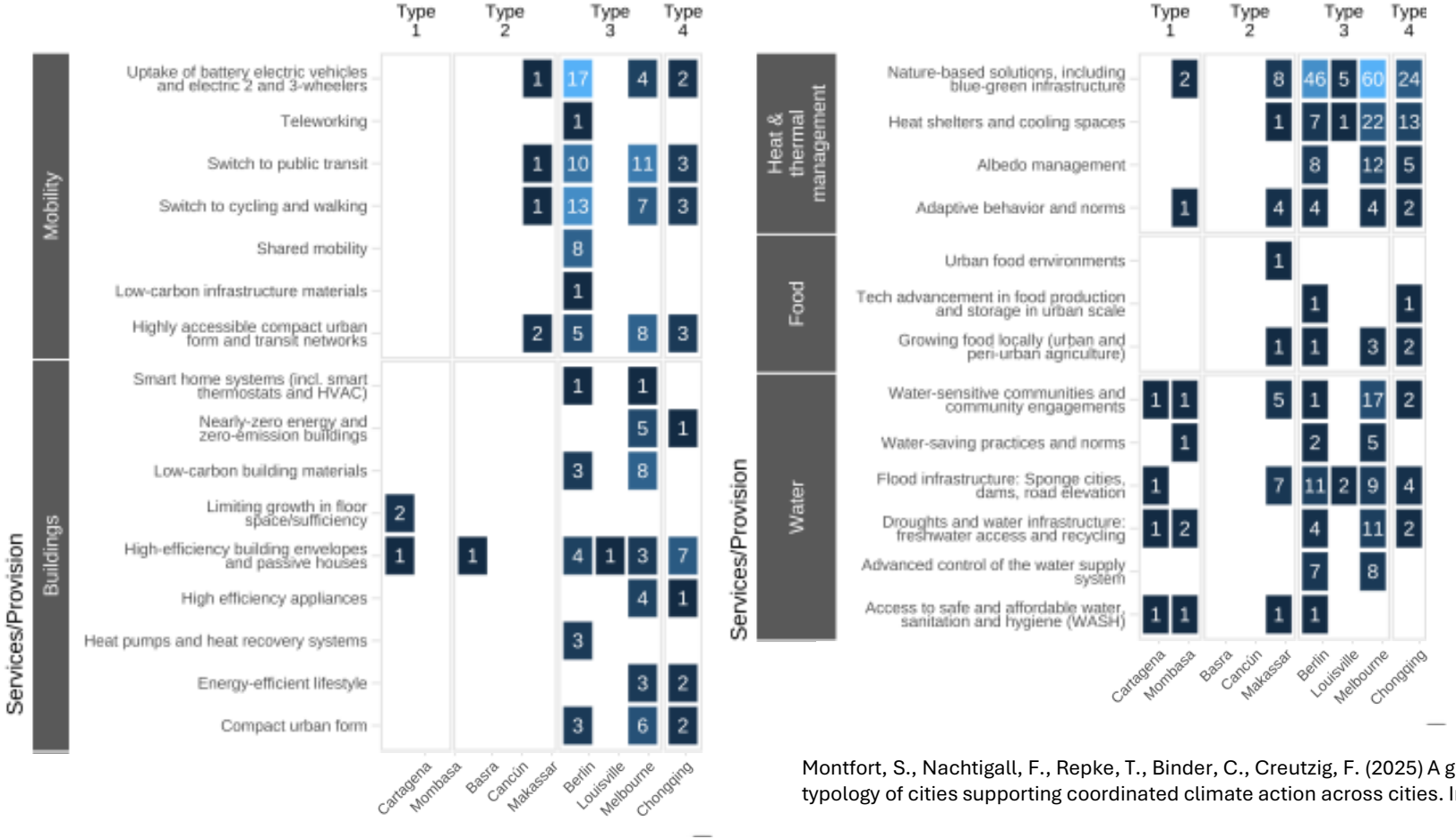
Urban typologies: Examples



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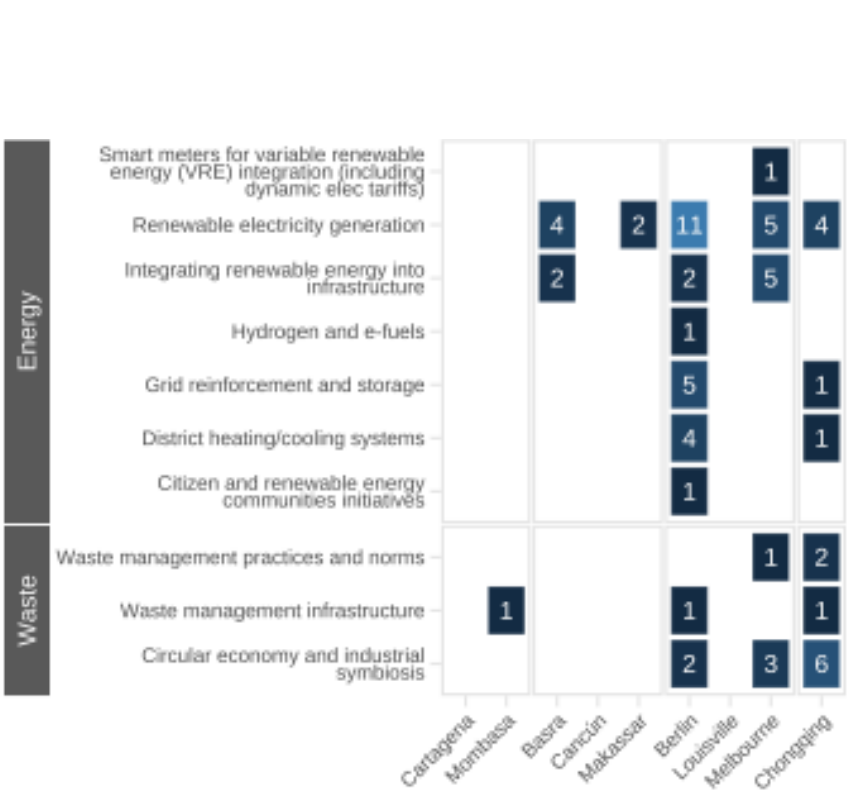
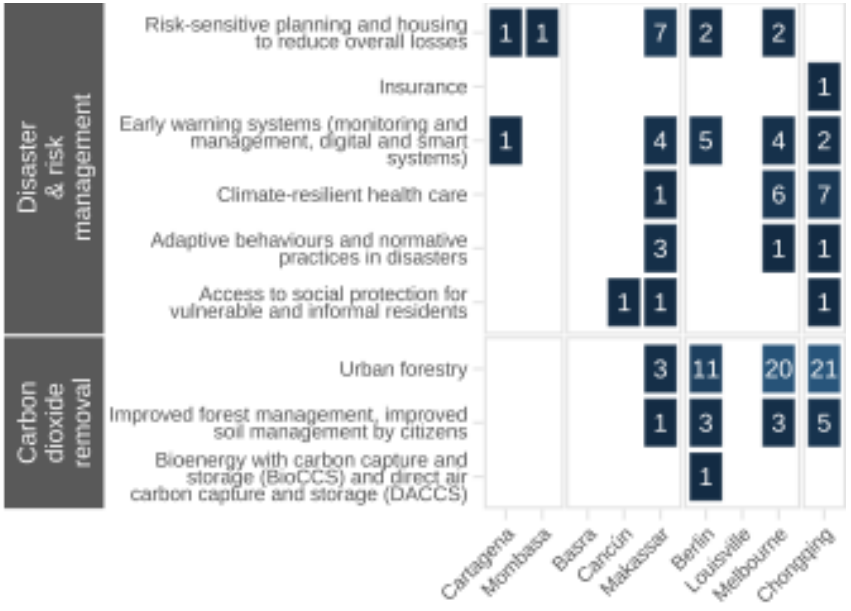
Urban typologies: Examples of how to use the typology





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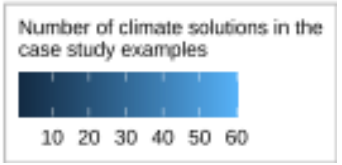

Key messages

- IPCC is grappling with the rapid growth
- Evidence synthesis methods are key for robust, policy-relevant insights
- Urban typologies can help
  - organizing the many heterogeneous place-specific studies across the world
  - Facilitate place-specific insights supported by examples
  - Facilitate learning from similar other cities
  - Can help identify climate action needs

Next time guest lecture: Dr. Anton Sentic

Urban transitions processes in practice: Lessons learned from Smart Cities and Urban Living Labs

December 13, 2025

Start 9:45

Contact

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