Learning about urban climate solution from case studies

by William F. Lamb et al., 2019

Reporter:Lu Yang

2020/06/05

nature climate change

REVIEW ARTICLE

https://doi.org/10.1038/s41558-019-0440-x

Learning about urban climate solutions from case studies

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Climate mitigation research puts increasing emphasis on cities, but much more could be learned from urban case studies. The overall size, geographic scope and topic content of cases remains unknown, resulting in few attempts to synthesise the bottom-up evidence. Here, we use scientometric and machine-learning methods to produce a comprehensive map of the literature. Our database of approximately 4,000 case studies provides a wealth of evidence to search, compare and review. We find that cities in world regions with the highest future mitigation relevance are systematically underrepresented. A map of the evidence allows case studies to be matched with urban typologies in new and more ambitious forms of synthesis, bringing together traditionally separate strands of qualitative and quantitative urban research.

Outline

Background

- Urban Mitigation Solutions
- Systematic learning
- Case studies

Methods

- Literature scoping
- Identifying cases
- Topic modelling
- Future-looking case studies
- Systematic reviews

Results

- Case study bias towards large cities and the global North
- A topic map of urban mitigation case studies
- Three ways to learn from case study evidence
- Synthesizing urban typologies and case study evidence

Conclusions

Background

Urban Mitigation Solutions

- City-scale reforms in transportation, building design and urban form have substantial potential for reducing energy demand and achieving sustainability co-benefits.
- The key questions are:what works,for whom,under what conditions,and why?
- With no consistent epistemology, enormous variety in boundaries of analysis and a lack of formal research synthesis, urban mitigation solutions remain poorly understood.

Background

The Description of Case Studies

Advantage:

- A complementary strand of urban literature can be found in case studies: on individual city-scale reforms, as well as comparative studies across multiple urban settings.
- Revealing the contextual and contingent nature of urban policy-making.

Disadvantage:

- They remain under-represented in the scope of assessment literature on cities.
- A lack of rigorous literature selection procedures in assessments means that potentially relevant cases remain over-looked .
- The potential for coordination and mutual learning across epistemic communities has been neglected.

Background

Systematic learning

- Systematic learning hinges on aggregating information about individual cities.
- Recent work uses 'big data' and typologies to identify structural similarities and path dependencies of development.
- Groups of similar cities might draw from the same pool of solutions,or learn from early pioneers in climate policy.
- To make this strategy actionable,it will be critical to complement quantitative typologies with an understanding of underlying political and social conditions.

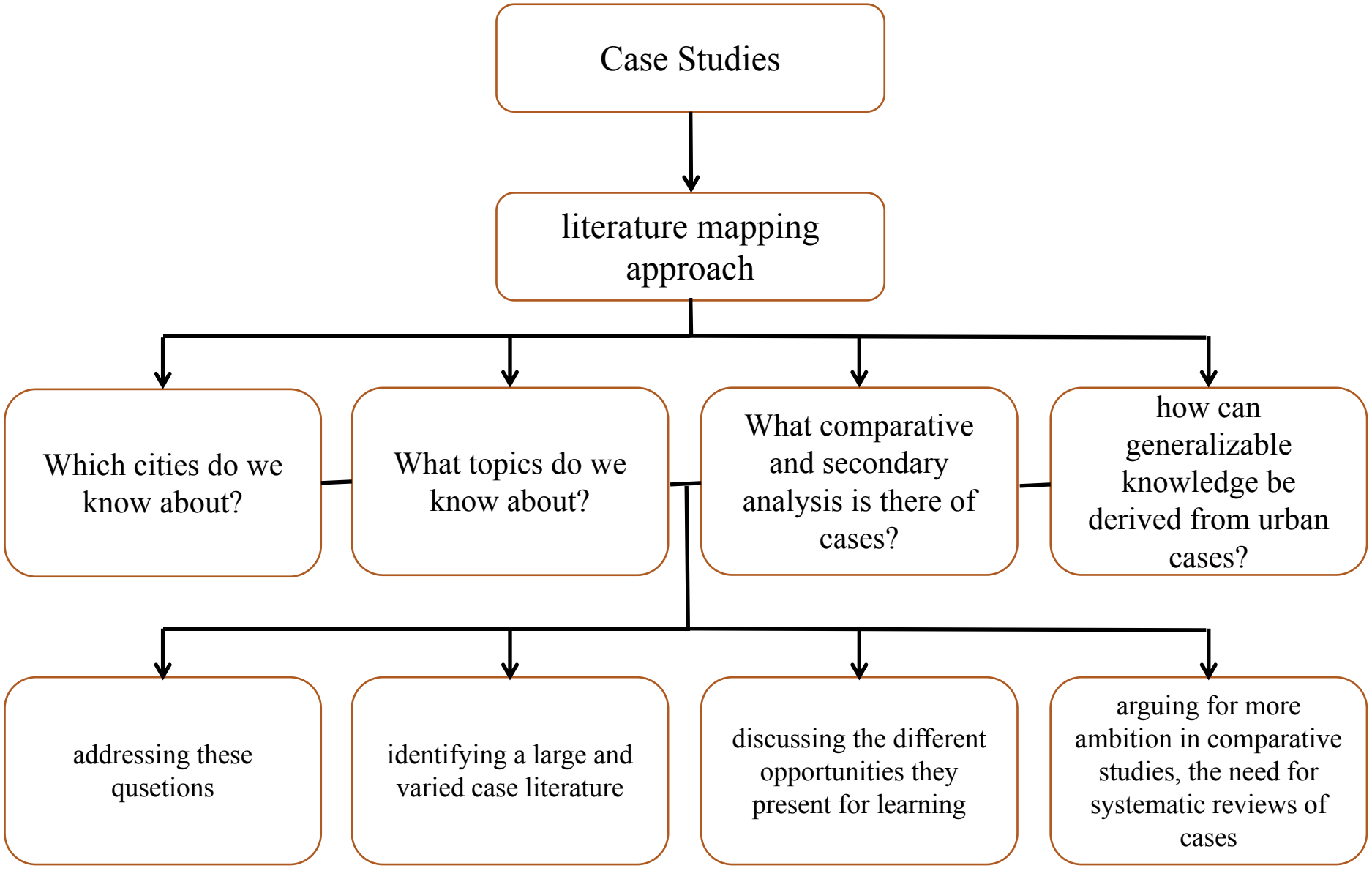
Background

Research Target

Research Method

Scientific Questions

Research Significance



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Methods

Literature scoping

Table 1 | Search query for urban climate mitigation literature

Urban synonyms	Mitigation synonyms
('urban*' OR 'municipal' OR 'city' OR 'cities' OR 'metropolitan')	('low carbon' OR 'decarboni*ation' OR (('energy' OR 'carbon' OR 'CO2' OR 'GHG' OR 'greenhouse gas' OR 'climat*') NEAR/3 'mitigation') OR (('energy' OR 'carbon' OR 'CO2' OR 'GHG' OR 'greenhouse gas') NEAR/3 ('reduc*' OR 'polic*' OR 'governance')))

The two strings are combined with an 'AND' operator and entered as a topic search in the Web of Science, and a title-abstract-keyword search in Scopus.

- As of October 2018 this search returned 15,027 documents.
- Their results are not fully comprehensive, since further databases are available (for example, Google Scholar) and relevant non-English language articles may exist.
- More in-depth studies, for example, systematic maps on specific topics or cities,could consider additional databases and non-peer reviewed sources.

Methods

Identifying cases

- To identify urban case studies we searched the abstracts of the 15,027 documents for city names.
- Used the Geonames database of geographic locations.
- Of the studies in the document set, 4,051 refer to a city in the abstract or title and 5565 case studies that mention names of multiple cities.
- Excluded conference proceedings, and the text ‘Paris Agreement’ and ‘Kyoto Protocol’ from abstracts.

Methods

Topic modelling

- Using the sklearn library in Python to process and produce a topic model from the 4,051 studies mentioning a city in the abstract.
- Important and subjective choices in the analysis are the number of topics to specify and the names given to the resulting topics.
- To analyse the prominence of topics within groups of papers , they sum their topic scores, selecting the top three for simplicity.
- To count publications on given topics, they assign a document-topic score threshold of 0.02.

Methods

Future-looking case studies and Systematic reviews

Future-looking case studies:

- To identify case studies with a future-looking orientation,we manually search for the following keywords within abstracts: ‘scenario’ OR ‘2020’ OR ‘2025’ OR ‘2030’ OR ‘2040’ OR ‘2045’ OR ‘2050’.
- A random selection and screening of these documents showed they were broadly in line with our expectations

Systematic reviews:

- To identify systematic reviews of the case study literature we manually search the original document set(10527 studies) for the following keywords: ‘meta-’ OR ‘systematic review’ OR ‘scoping’ OR ‘narrative review’ OR ‘qualitative comparative analysis’ OR ‘QCA’ OR ‘scientometric’ OR ‘synthesis’.
- The results are hand filtered to exclude non-urban, non-mitigation and non-review articles.

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Results

Case study bias towards large cities and the global North

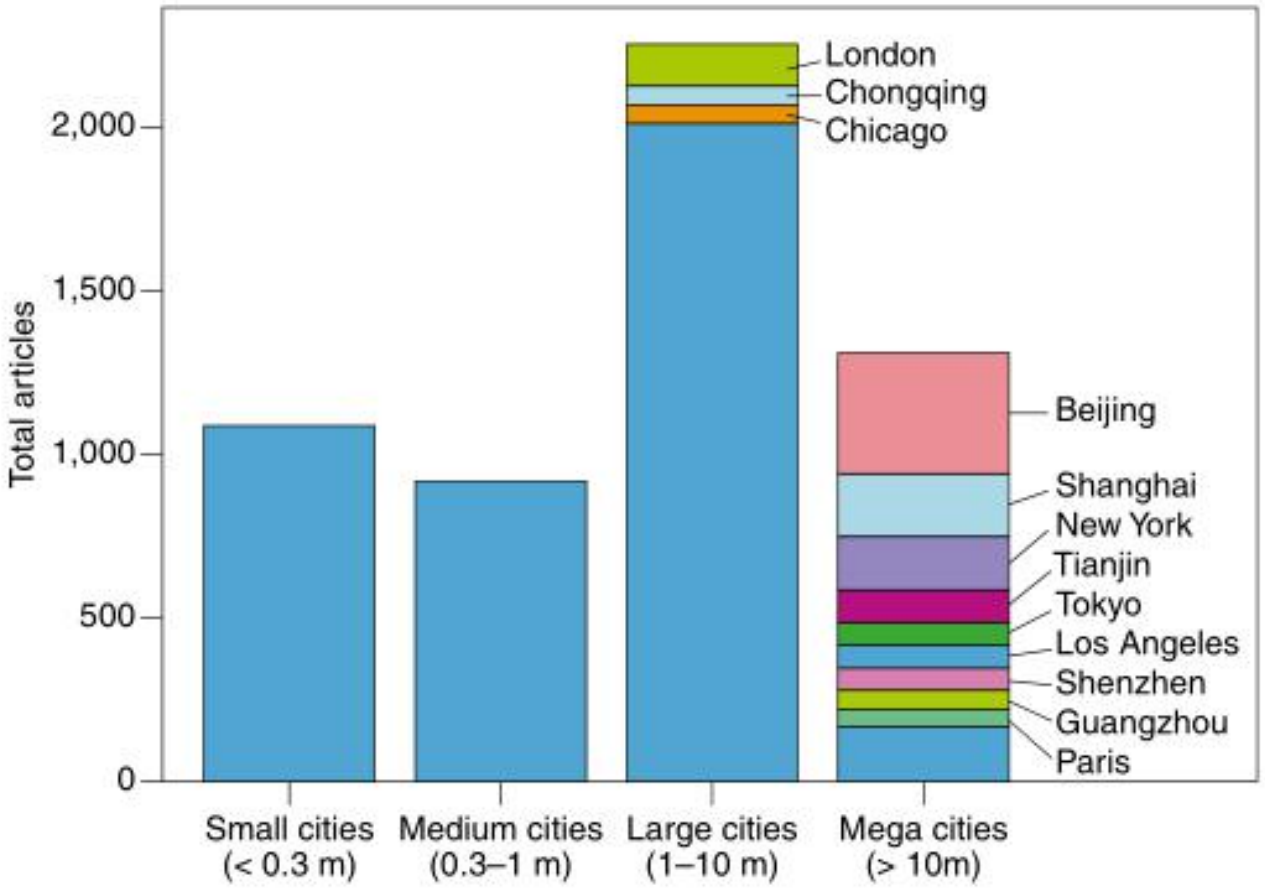


Fig. 1 | Number of urban climate mitigation case studies, grouped according to city size. The 12 most frequently studied cities are labelled. Population data from ref. [7], using agglomeration data where available.

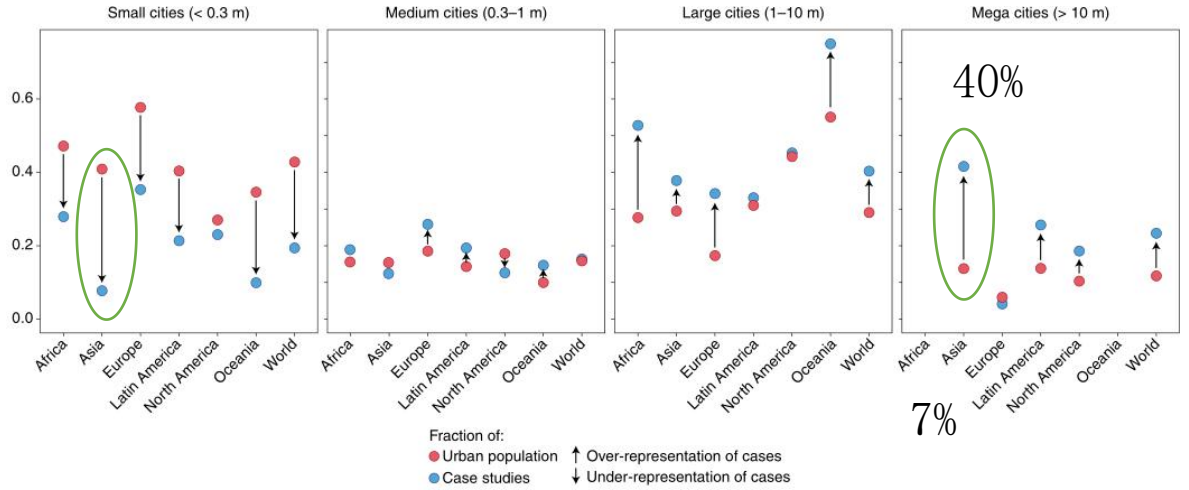
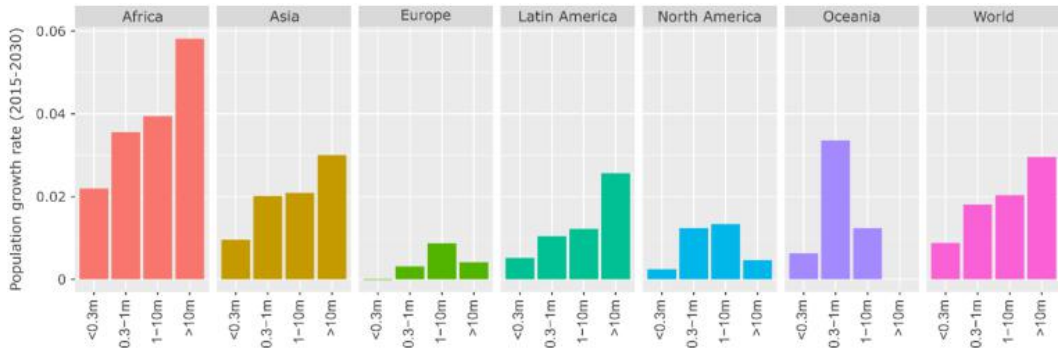


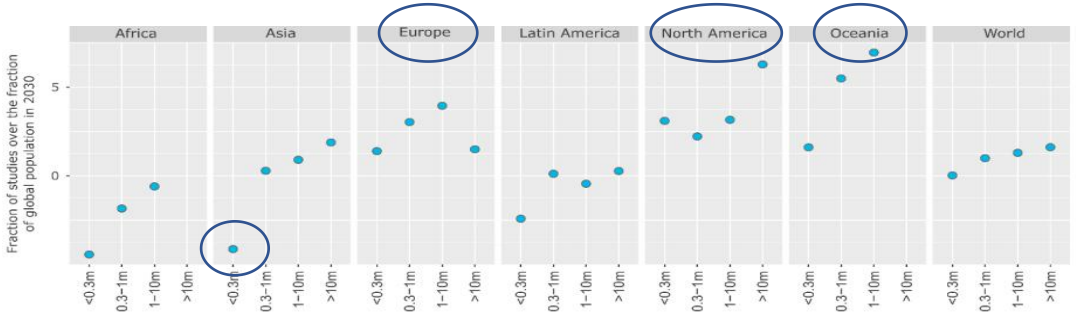
Fig. 2 | Size bias in urban mitigation case study research. Fractions of population and case studies are relative to regions. Population data and the United Nations Population Division regionalisation are from ref. [7], using agglomeration data where available.

The current unbalanced focus leaves smaller urban centres consistently under-represented in all regions apart from North America.

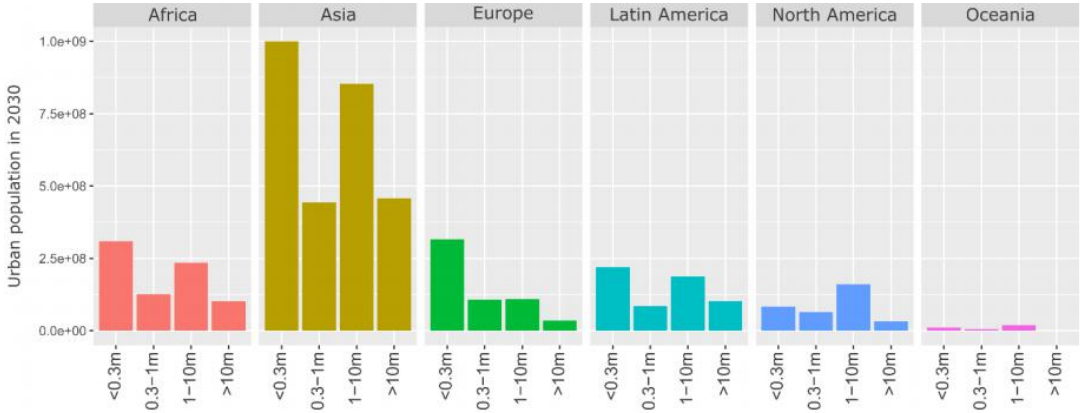
Results



Supplementary Figure 1: Projected population growth rate by region and city size, 2015-2030. *Population data from ref [1], using agglomeration data where available.*



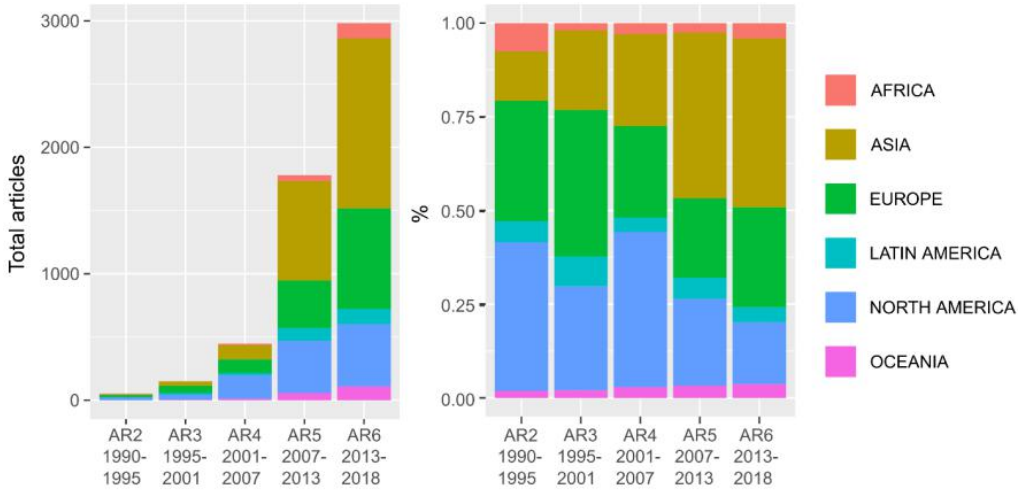
Supplementary Figure 2: The global distribution of urban case studies versus population size. *To normalise, where the numerator (% of global population in a region & city size) exceeds the denominator (% of case studies in a region & city size), we subtract the fraction from 2. Population data from ref [1], using agglomeration data where available.*



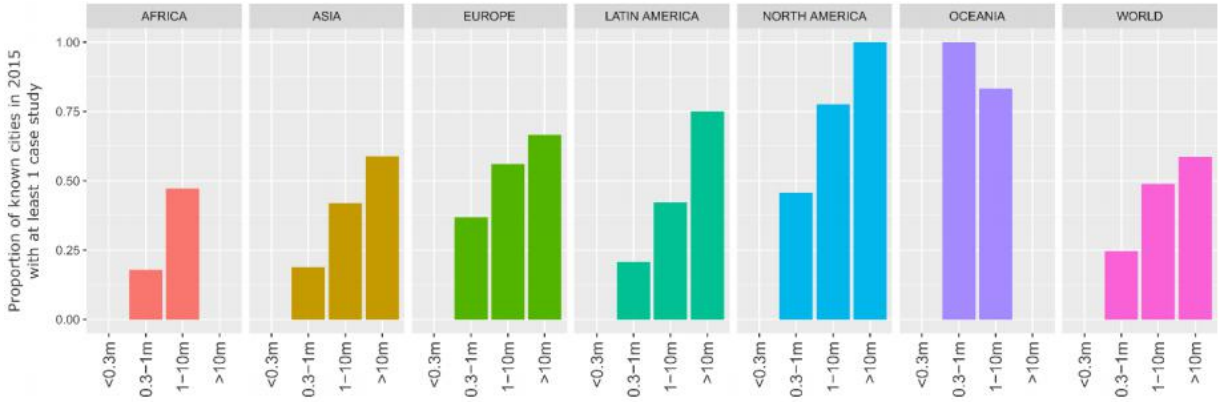
Supplementary Figure 3: Total urban population in 2030 by region and city size. *Population data from ref [1], using agglomeration data where available.*

- The world regions and city scales with most future relevance in terms of total urban population and growth dynamics are systematically under-represented in the literature.

Results



Supplementary Figure 4: Total articles and regional proportions of case study literature by IPCC Assessment Period



Supplementary Figure 5: Direct coverage of case studies. *Missing values due to absent data (small cities) and because there are no mega-cities in Africa and Oceania as of 2015. Population data from ref [1], using agglomeration data where available.*

- As a result, learning about solutions across a comprehensive set of contexts and scales requires major innovations in the synthesis of case study knowledge.

Results

a topic map of urban mitigation case studies

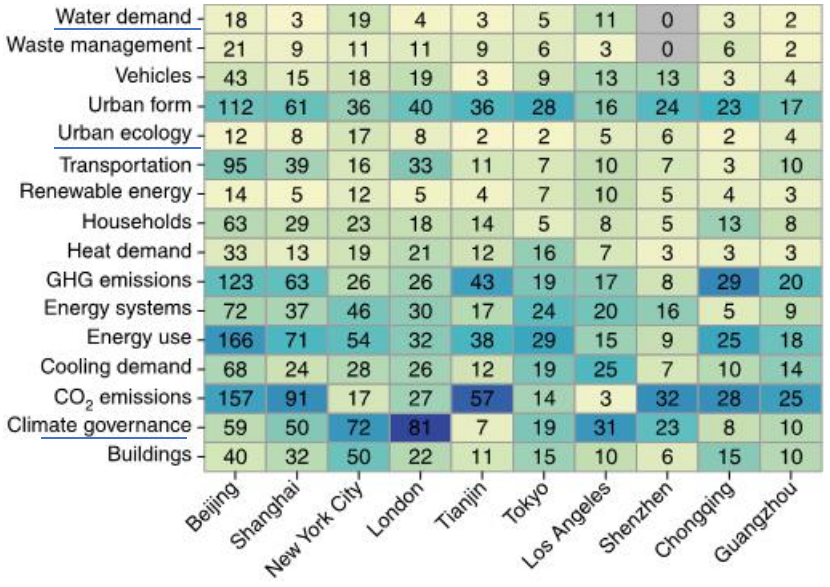


Fig. 4 | Number of mitigation studies by city and topic. Ten cities with

ID	Topic Name	Stemmed Keywords	Marginal Topic Distribution (%)
1	Climate governance	climat; chang; polici; local; govern	8.9
2	Energy use	energi; consumpt; effici; sector; renew	8.0
3	Energy systems	system; electr; power; cost; generat	7.4
4	Urban form	urban; land; area; model; ecolog	7.3
5	Buildings	build; energi; design; residenti; perform	6.8
6	CO2 emissions	carbon; emiss; industri; low; intens	6.7
7	GHG emissions	emiss; ghg; reduct; greenhous; gas	6.3
8	Cooling demand	air; temperatur; cool; roof; climat	6.3
9	Transportation	transport; traffic; travel; public; car	5.8
10	Vehicles	vehicl; fuel; electr; charg; drive	5.0
11	Households	household; incom; behavior; survey; resid	4.7
12	Waste management	wast; landfil; solid; recycl; manag	4.7
13	Heat demand	heat; district; thermal; pump; network	4.6
14	Water demand	water; suppli; treatment; manag; wastewat	4.3
15	Renewable energy	solar; radiat; energi; photovolta; collector	3.8
16	Urban ecology	tree; forest; benefit; speci; plant	3.4

Supplementary Table 1: List of topics and their keywords.

Results

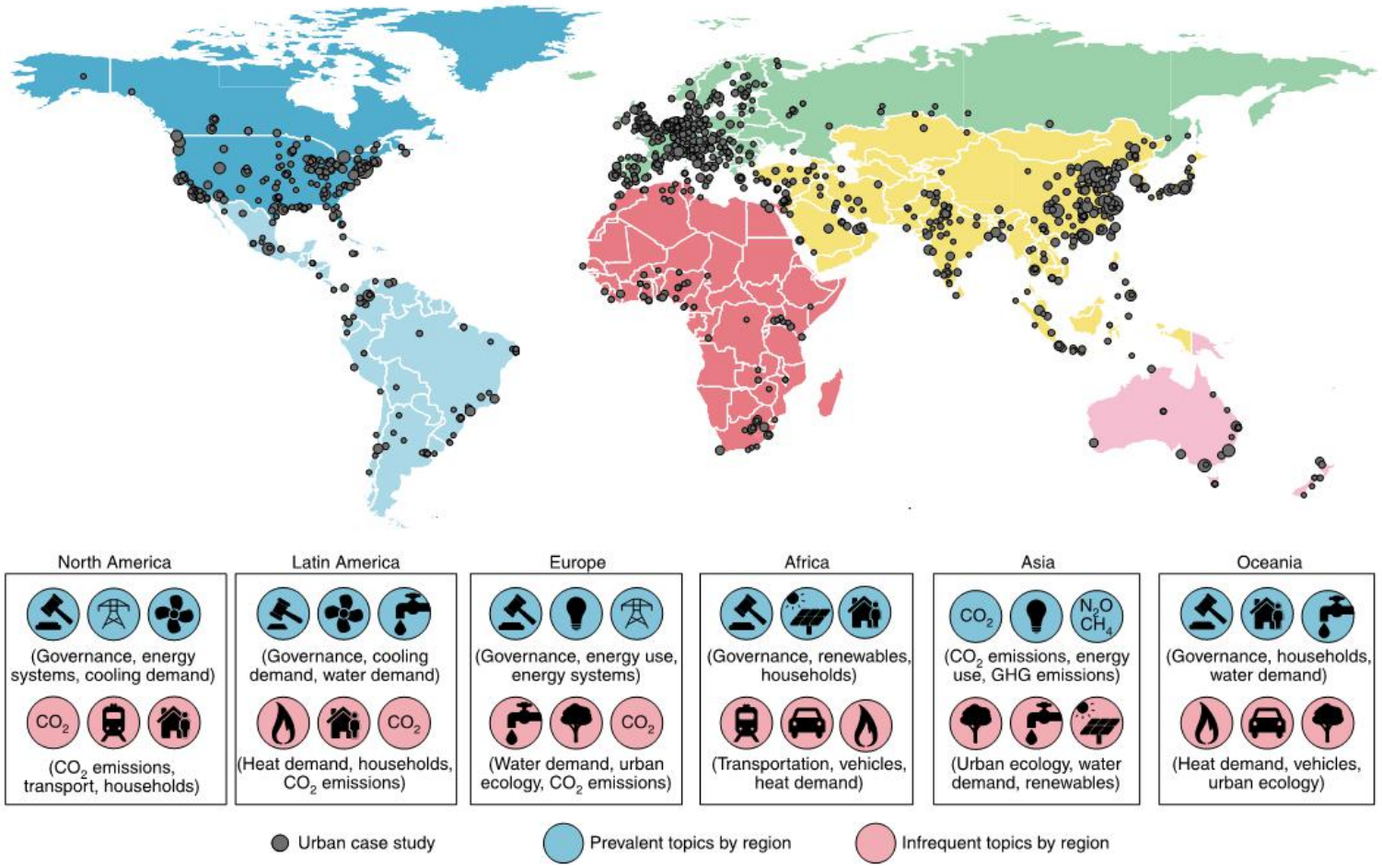


Fig. 3 | Global coverage of urban case studies. Cities are scaled by the number of identified case studies. For each region, the topic distribution of associated case studies is summed, and the highest/lowest scoring topics are shown (see Methods).

Results

Topic	Proportion (%)	Topic	Proportion
GHG emissions	9.6	Waste management	5.5
Climate governance	8.9	Vehicles	4.3
Energy consumption	8.3	Heat demand	3.9
Transportation	7.5	Renewable energy	3.8
Air pollution	7.5	Water demand	3.5
CO2 emissions	6.9	Urban ecology	2.9
Buildings	5.8	Cooling demand	2.7
Urban form	5.7	Households	2.6

Supplementary Table 4: Topic proportions of 'forward-looking' case studies

Region	No. case studies	No. 'forward-looking' studies	Proportion (%)
Africa	158	12	8
Asia	1934	335	17
Europe	1145	227	19
Latin America	206	37	18
North America	1054	131	12
Oceania	151	23	15

Supplementary Table 5: Regional coverage of 'forward-looking' case studies

- Overall, the topic mapping results suggest that prior regional biases in case study coverage are compounded by an uneven distribution of topics.
- Only a handful of urban cases in Africa can be found on issues that will likely have great importance in the coming decades,In contrast, some mega-cities already have well-developed literatures across a wide range of topics.

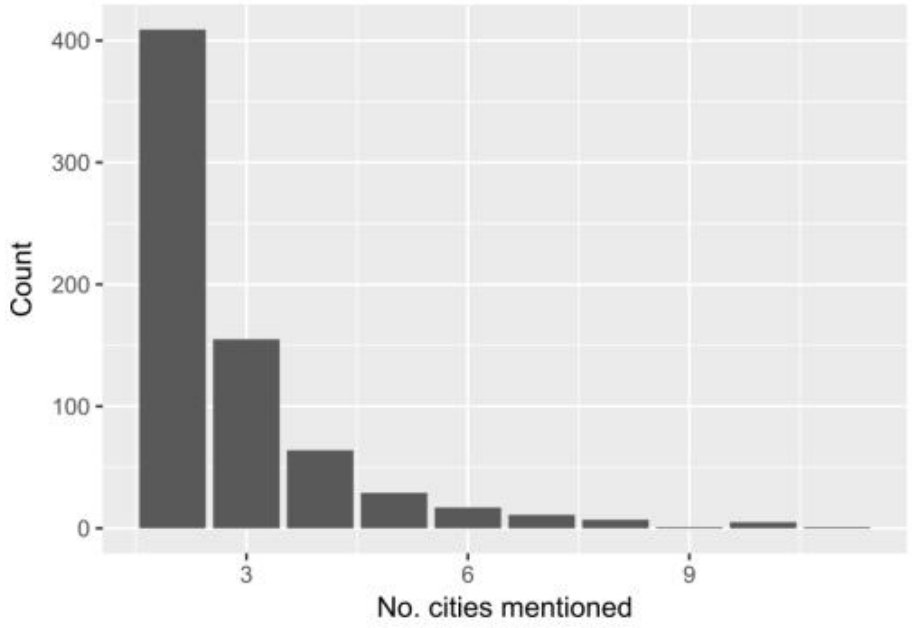
Results

three ways to learn from case study evidence-Individual cases

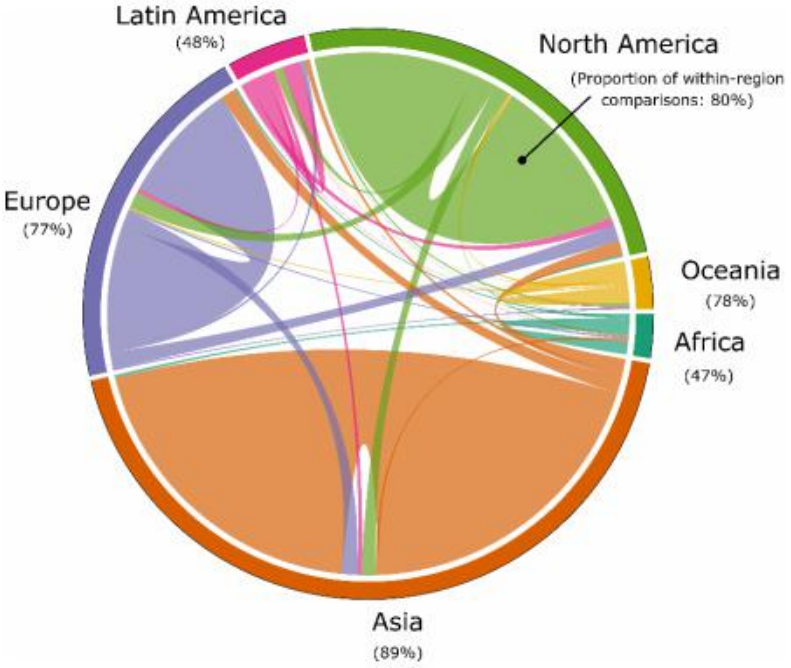
- Case studies attract scientists' fair share of epistemological debates.
- An example of careful case selection is the 'critical' case.
- When it comes to selecting case study locations, practical concerns matter too.
- Conducting case study research as a means to build expertise.
- Many benefits to be derived from individual cases, but also barriers to a wider project of learning.

Results

three ways to learn from case study evidence-Comparative cases



Supplementary Figure 6: Number of cities mentioned in comparative studies



Supplementary Figure 7: Inter and intra-regional comparative research on urban climate mitigation.

Results

three ways to learn from case study evidence-Reviews and assessments of cases

UCCRN

- A good example of the opportunities and challenges of learning from case study research.
- The case content is brought to the forefront, but is not synthesized across topics or locations.

While climate assessments increasingly assess the available literature on cities,learning appears limited as a crucial layer of evidence synthesis is missing.

Results

Synthesizing urban typologies and case study evidence

What is urban typologies?

Typology of cities

Cluster	1	2	3	4	5	6	7	8
Energy use (GJ/pop.)	64	67	21	76	201	103	106	148
GDP per capita (USD/pop.)	5,200	7,200	3,200	7,200	25,900	28,300	31,750	31,100
Fuel price (USD/litre)	0.9	1.0	1.1	1.0	0.8	0.9	1.4	1.4
Pop. density (pop/km²)	214	190	4,600	1,400	260	3,400	1,500	1,600
Heating degree days (15.5°C)	720	3,760	30	1,560	1,640	1,520	2,120	3,530

Quantitative/qualitative understanding of urban differences

Typology/case study cities

Kunming	Harbin	Ahmedabad	Beijing	Sydney	New York	London	Stockholm
Nanning	Lanzhou	Bengaluru	Shanghai	Dalian	Moscow	Tokyo	Oslo

Evidence synthesis meeting local needs

Fig. 5 | Bringing together case study evidence and typologies.

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Conclusions

- Despite many recent commentaries highlighting the manifold challenges(and opportunities) of an urban focus in climate mitigation , there has been little reflection on how to generate insights from cases using additional layers of mapping, comparison and synthesis.
- With computer-assisted methods, including scientometrics and computational linguistics, a comprehensive evidence map can be developed,and they substantiate claims of a North versus South bias in cases with a comprehensive sample of the literature , while going further to identify patterns of research that favour large cities and overworked topics (such as emissions accounting in Asia)
- Locating research efforts, stakeholder engagement and policy advocacy in growing cities and developing regions will be instrumental to avoiding lock-in and realising compact, low-carbon urban forms that can tackle the coming mitigation challenge.
- Their analysis reveals that juxtaposing evidence synthesis with quantitative city typologies can be a productive way forward to bring quantitative and qualitative research on cities and climate change solutions together.

Thank you for your time!