南京信息工程大学
Nanjing University of Information Science & Technology

A discussion on the paper "Building up or spreading out? Typologies of urban growth across 478 cities of 1 million+"

吕恒
南京信息工程大学
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LETTER

Building up or spreading out? Typologies of urban growth across 478 cities of 1 million+

Richa Mahtta[1,3], Anjali Mahendra[2] and Karen C Seto[1]

[1] School of Forestry and Environmental Studies, Yale University, New Haven, CT 06511, United States of America
[2] World Resources Institute, Ross Center for Sustainable Cities, Washington DC, 20002, United States of America
[3] Author to whom any correspondence should be addressed.

E-mail: richa.mahtta@yale.edu, anjali.mahendra@wri.org and karen.seto@yale.edu

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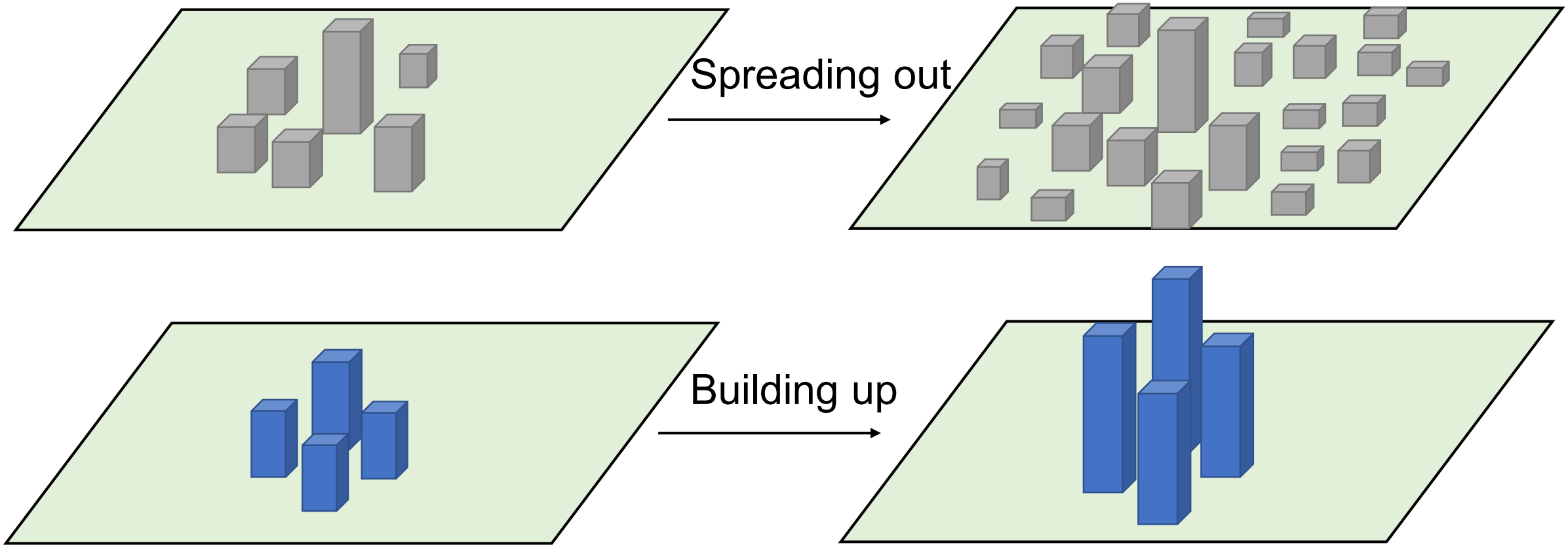
Outline

1. Background on Urban form
2. Datasets and Methods
3. Results and Discussion
4. Summary and Reflection

Background

What is Urban form?

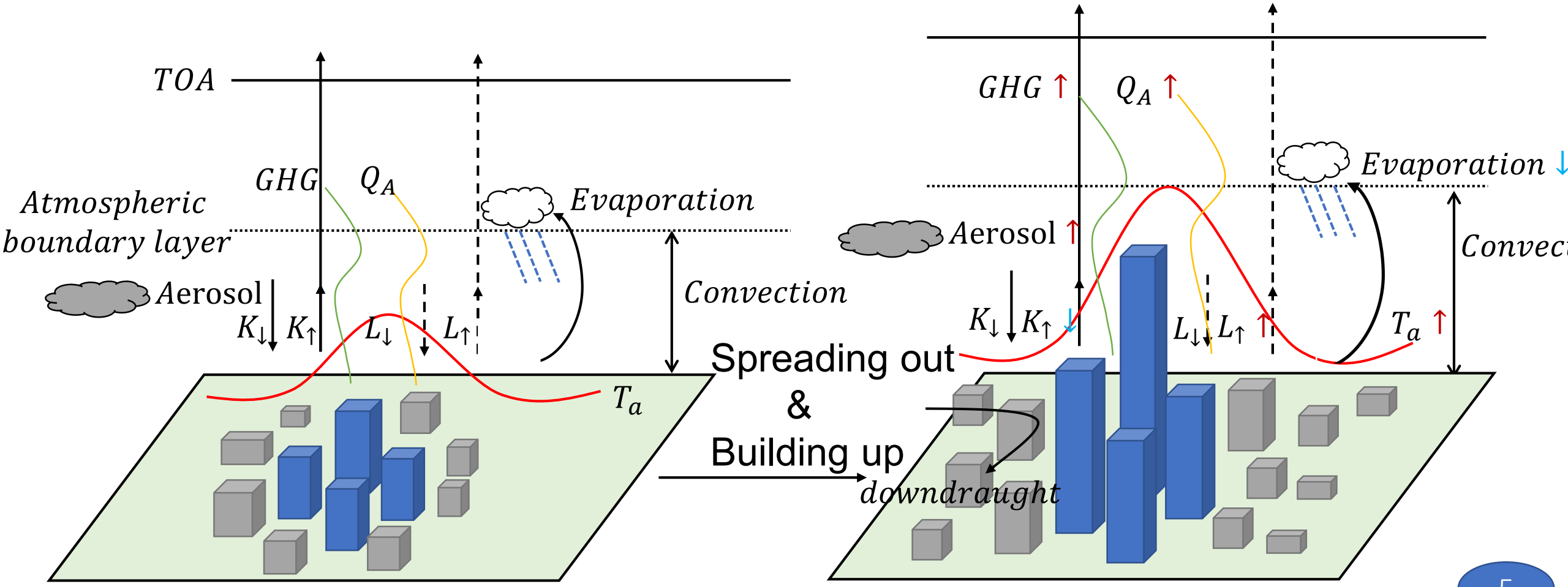


Background

Why Urban Form Matters?

Significance:

- Urban form(2-3D) has significant impacts on **environments**.



Background

Why Urban Form Matters?

Significance:

- Urban form(2-3D) has significant impacts on **environments**.
- Urban form is correlated with **energy demand.**
- Urban form is related to many aspects of **sustainability**.

Knowledge gap:

- Most of studies with remote sensing data (such as, LiDAR and SAR) have been limited in geographic scope to individual city or neighborhood case studies.

Background

What aspects of this paper merit our attention?

- The key trends in upward and outward urban growth across cities of our interest.
- The variables that reflect the upward and outward urban growth are applicable to urban climate effects or not.
- The typologies of urban growth that created is used to distinguish cities for research in different situations or not.
- Implications for urban sustainability.

Datasets and Methods

- The variables that reflect the area and height of urban:

Variable	Spatial resolution	Temporal resolution	Study Period	Source
GHSL(Percentage urban cover)	38m	Year(1975, 1990, 2000 and 2014)	2000 and 2014	Global Human Settlement Layer (GHSL) dataset
PR (Power-return-ratio)	4.45km	4-day	2001 and 2009	QuikSCAT SeaWinds microwave backscatter(Ku band,13.4GHz)
Population	-	-	2000 and 2015	Populated Places dataset(v 4.1.0) from Natural Earth

- Calculations:

  Outward growth: $\Delta GHSL_{(2014\text{-}2000)}$

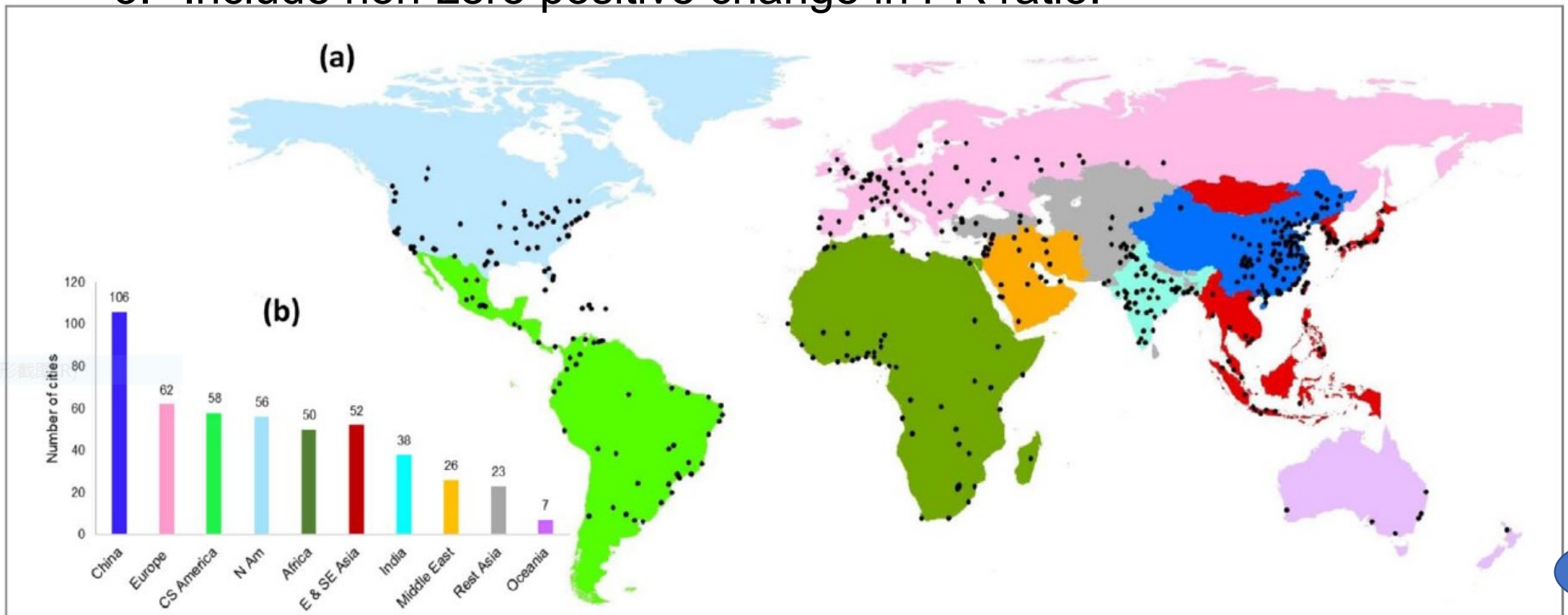
  Upward growth: ① σ^0_{dB} in dB $\rightarrow$ $10^{(\sigma^0_{dB}/10)}$(PR) ② $\Delta PR_{(2009\text{-}2001)}$

- Standardize the spatial resolution: 38m & 4.45km $\rightarrow$ 0.05° grid

- Research objects: cities of 1 million+

Datasets and Methods

- For each city: a 11×11 grid comprised of 121 pixels, and every pixel should
  1. Urban cover ≥ 20% in 2014 based on GHSL;
  2. Be connected to the largest patch comprising the central pixel of the city;
  3. Include non-zero positive change in PR ratio.



Datasets and Methods

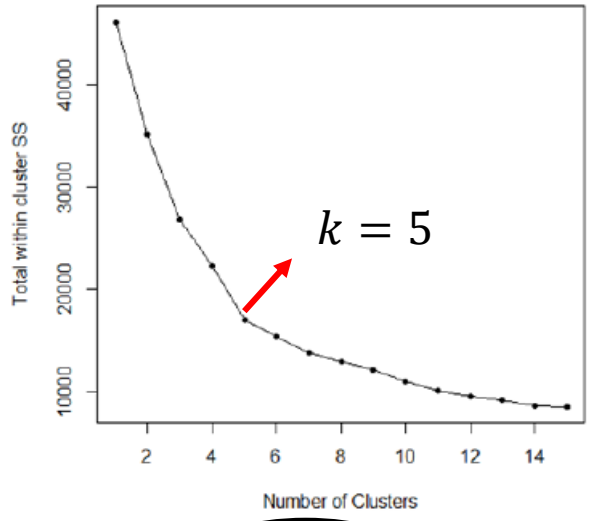
- Creating five Typologies of Urban growth:

To capture the Initial state

- $GHSL_{2000}$
- PR_{2001}

To capture the Change

- $\Delta GHSL_{(2014-2000)}$
- $\Delta PR_{(2009-2001)}$

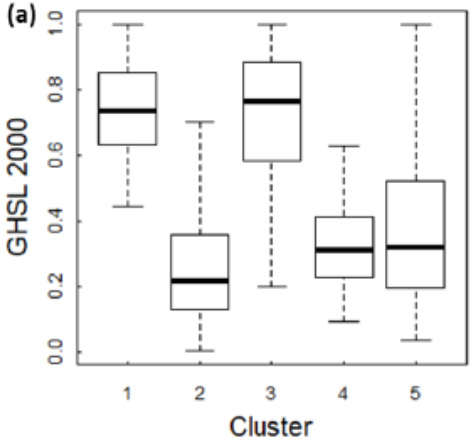


K-means cluster

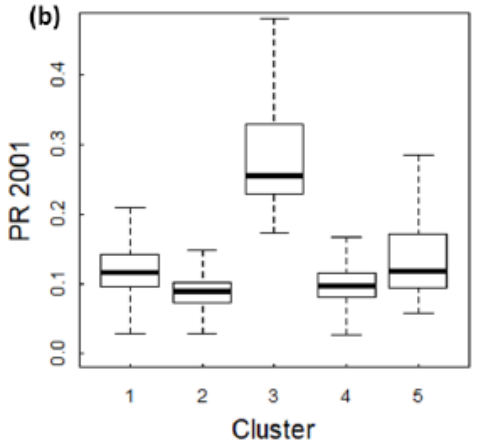
Typologies of urban growth:

- ***Stabilized***
- ***Outward***
- ***Mature upward***
- ***Budding outward***
- ***Upward and outward***

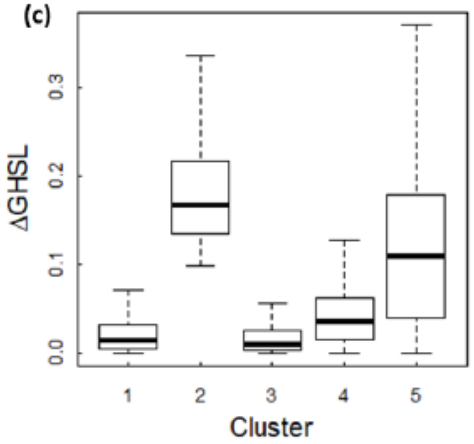
Initial horizontal extent



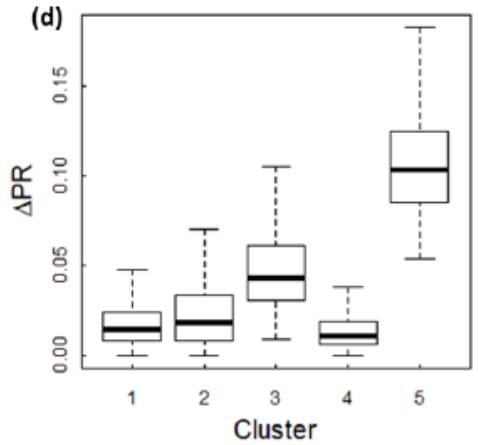
Initial vertical extent



change in horizontal extent



change in vertical extent

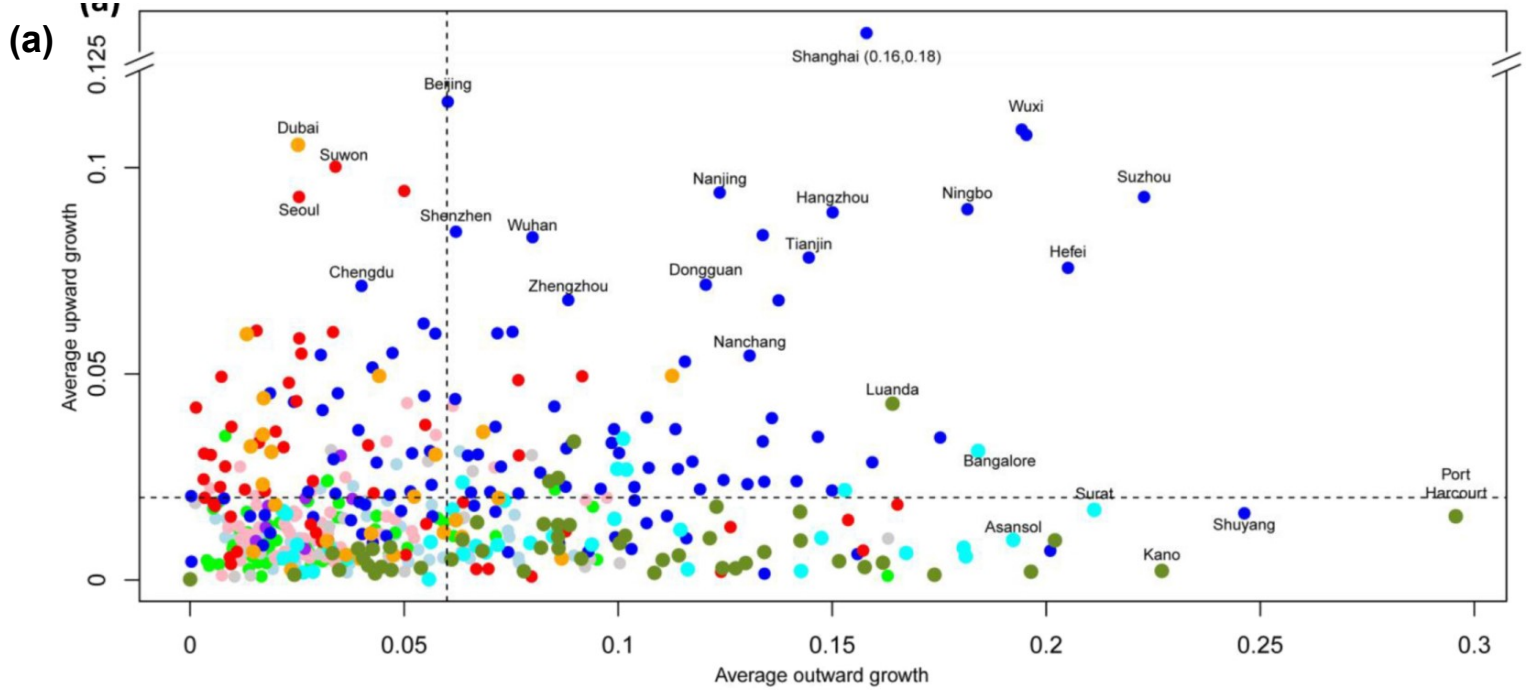


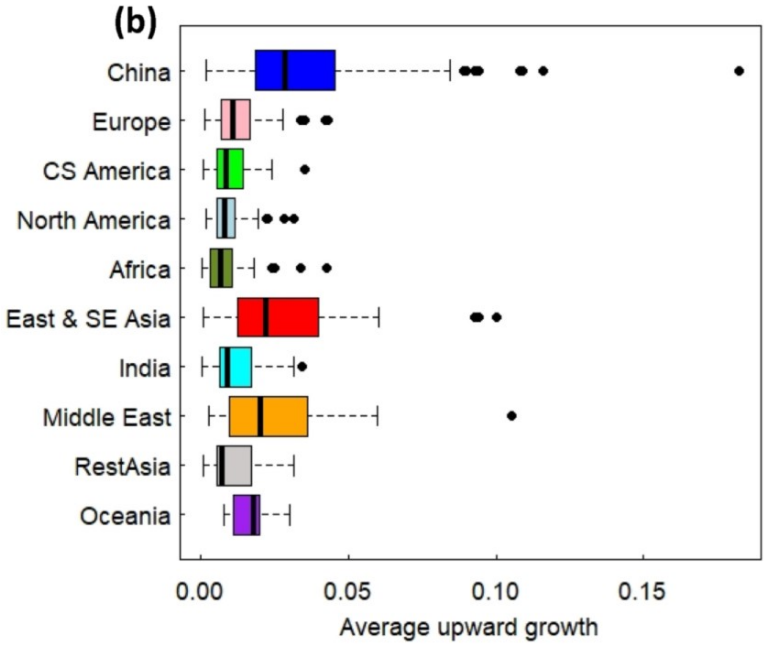
Urban growth typology	Initial Horizontal Extent	Initial Vertical Extent	Change in Horizontal Extent	Change in Vertical Extent
***Stabilized*(1)**	Very large	Medium	Very low	Low
***Outward* (2)**	Very small	Very small	Very high	Low
***Mature upward* (3)**	Very large	Very large	Very low	Moderate
***Budding outward* (4)**	Small	Small	Moderate	Very low
***Upward and outward* (5)**	Medium	Medium	Moderate	Very high

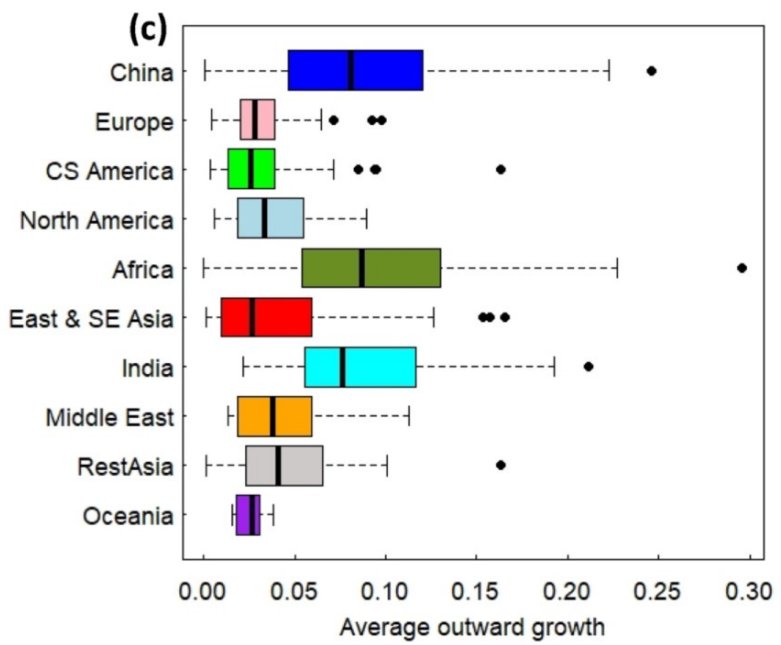
Results and Discussion

- Distinct urban growth patterns across geographies
- Five urban growth typologies
- Every city is comprised of multiple growth typologies
- Urban growth typologies vary by geography
- Mature upward typology shows highest population density
- Implication for urban sustainability

Distinct urban growth patterns across geographies

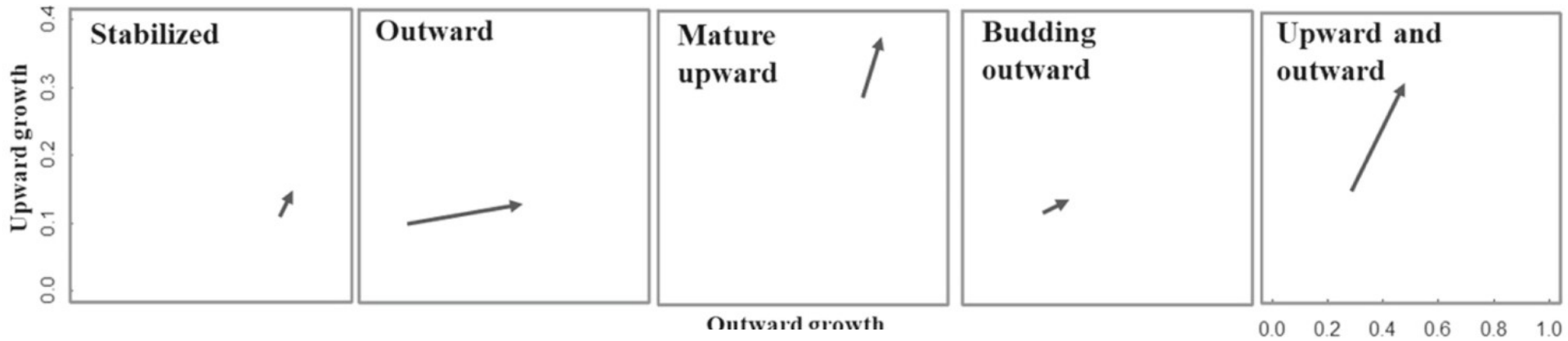


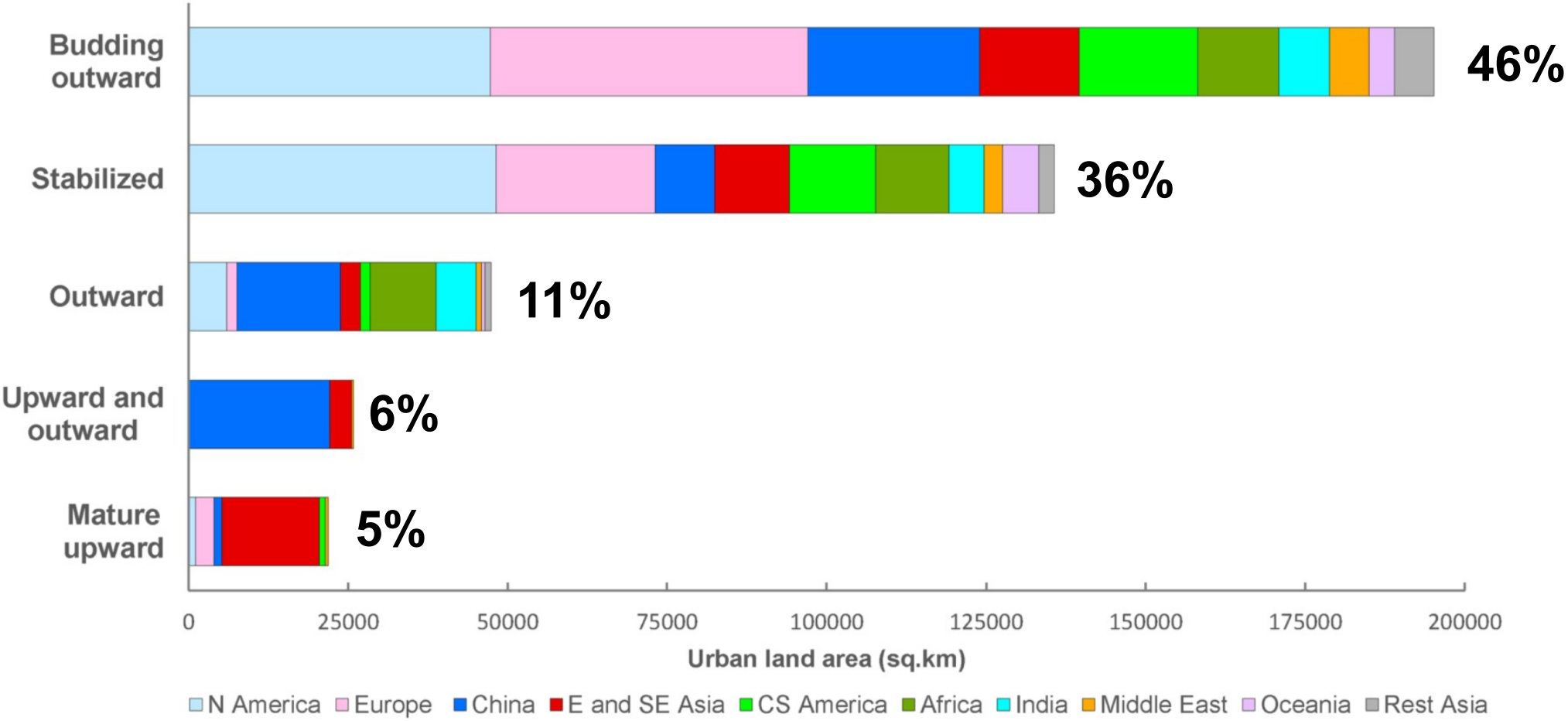




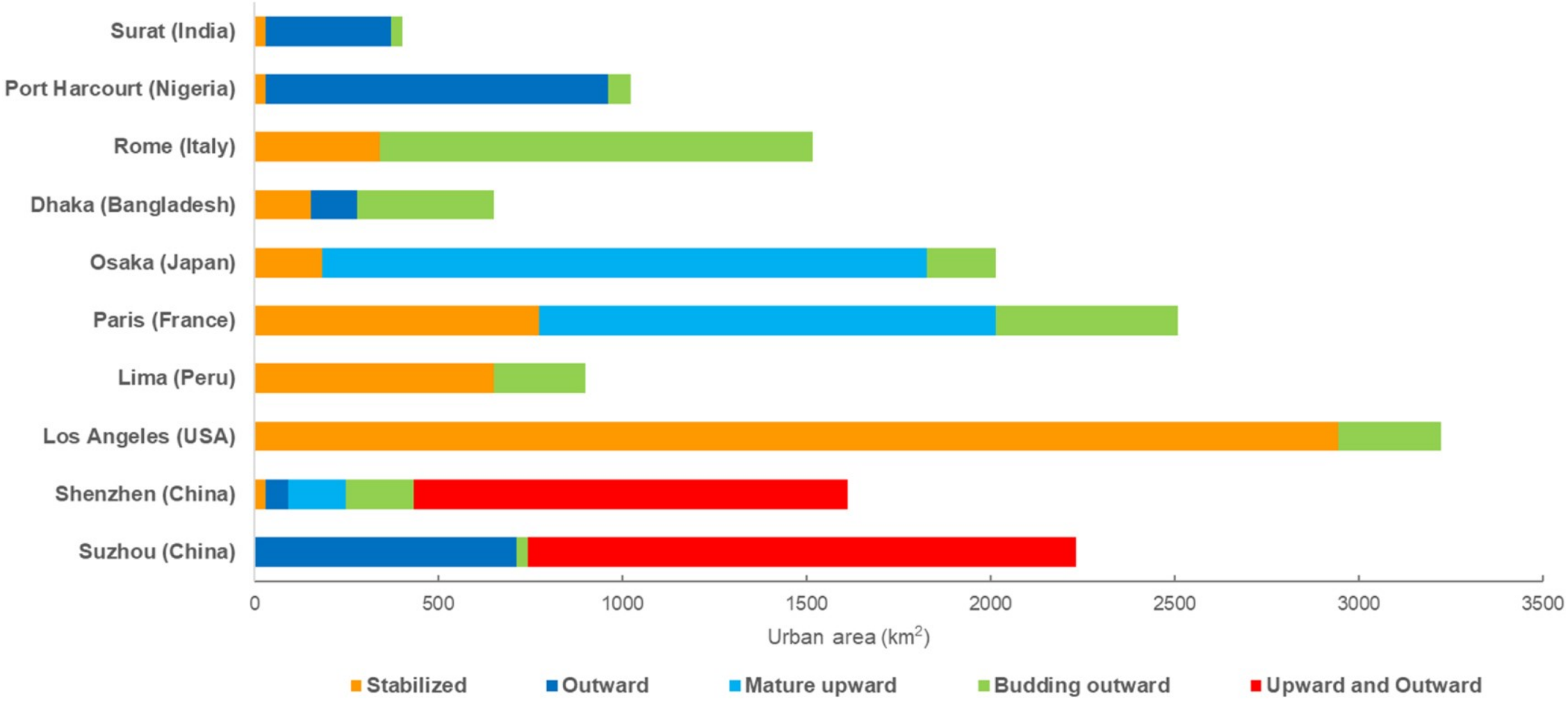
Geography	Main Urban growth patterns
China	Both upward and outward
CS America	less upward and outward
East & SE Asia	upward>outward
Middle East	upward>outward
India	upward<outward
Africa	upward<outward

Five urban growth typologies

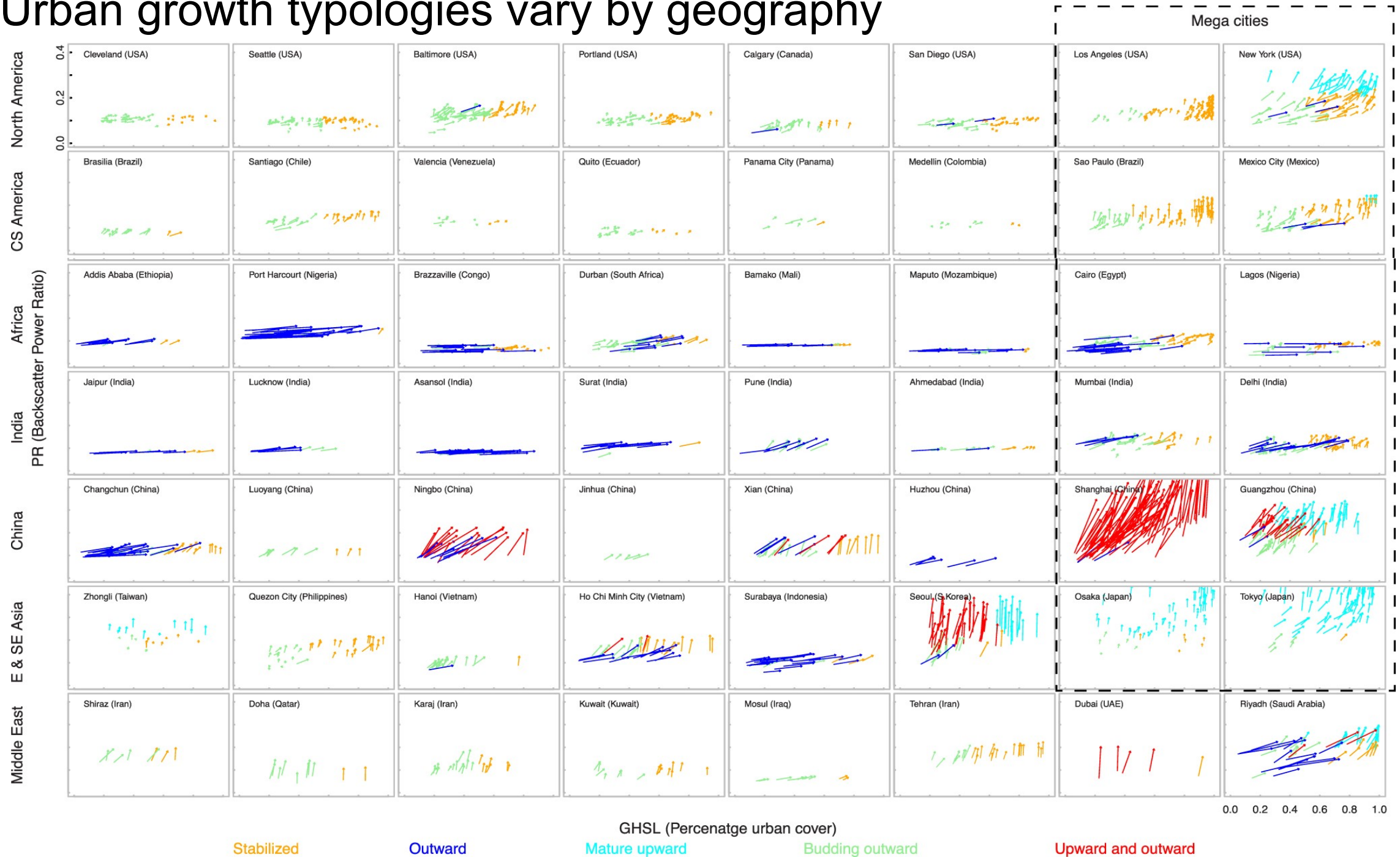




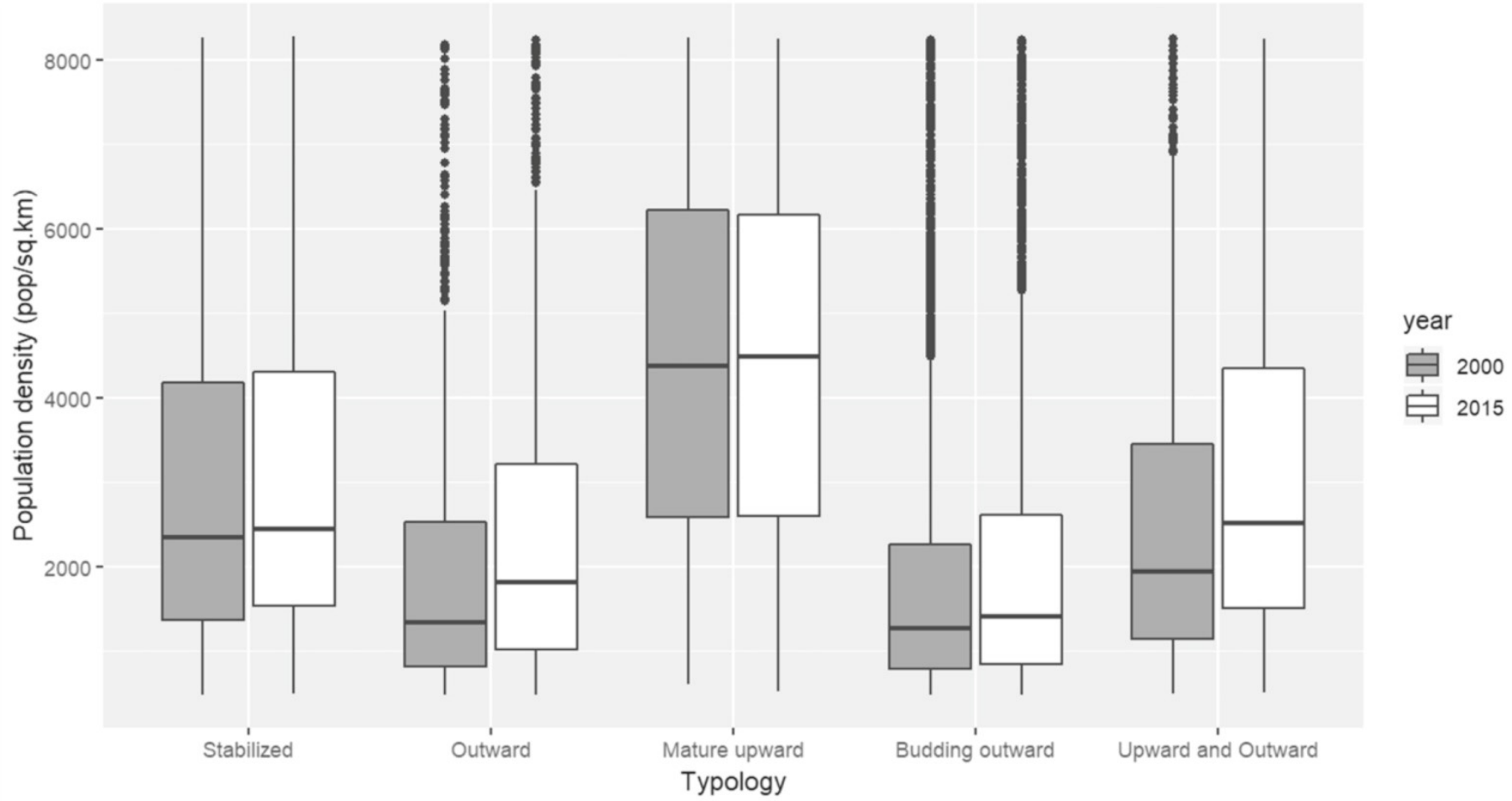
Every city is comprised of multiple growth typologies



Urban growth typologies vary by geography



Mature upward typology shows highest population density



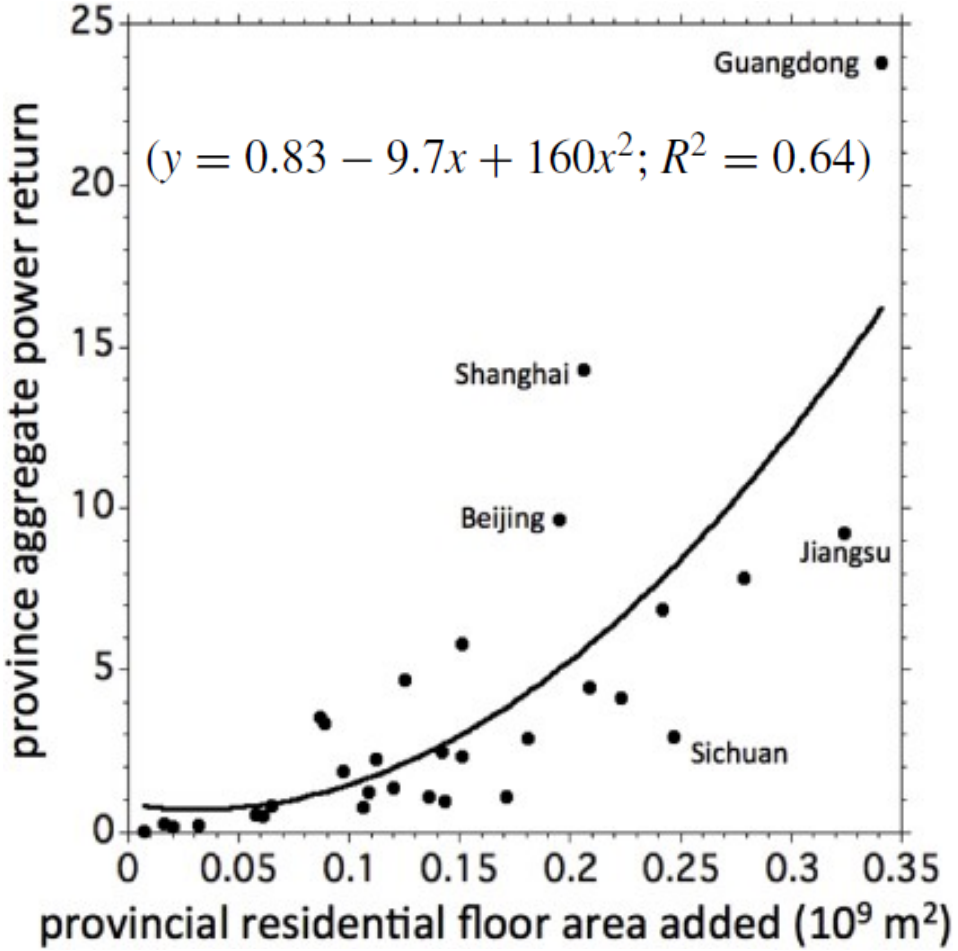
No. of pixels	4379	1531	707	6303	834
Mean pop density (2000)	4615	1973	6567	1789	3899
Mean pop density (2015)	5448	2988	7274	2166	5395

Implication for urban sustainability

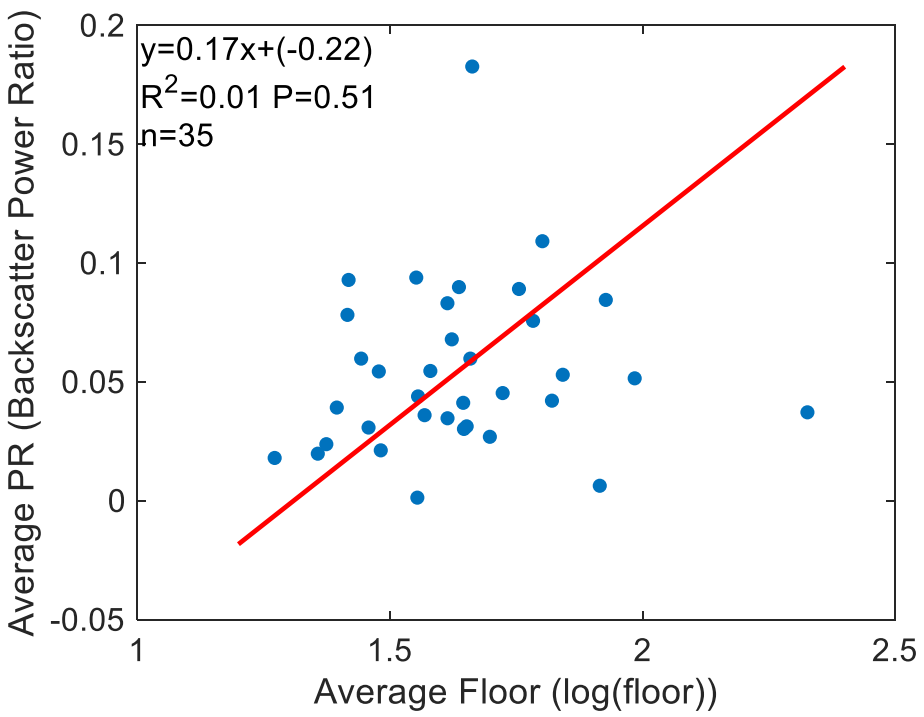
Results:	Implications:
Most of new urban land area is budding outward	Shape future patterns of urbanization
Different areas with a city undergo different types of urban growth	Differentiated strategies for different parts of a city.
Higher urban densities to be correlated with lower energy use	Reduce energy use

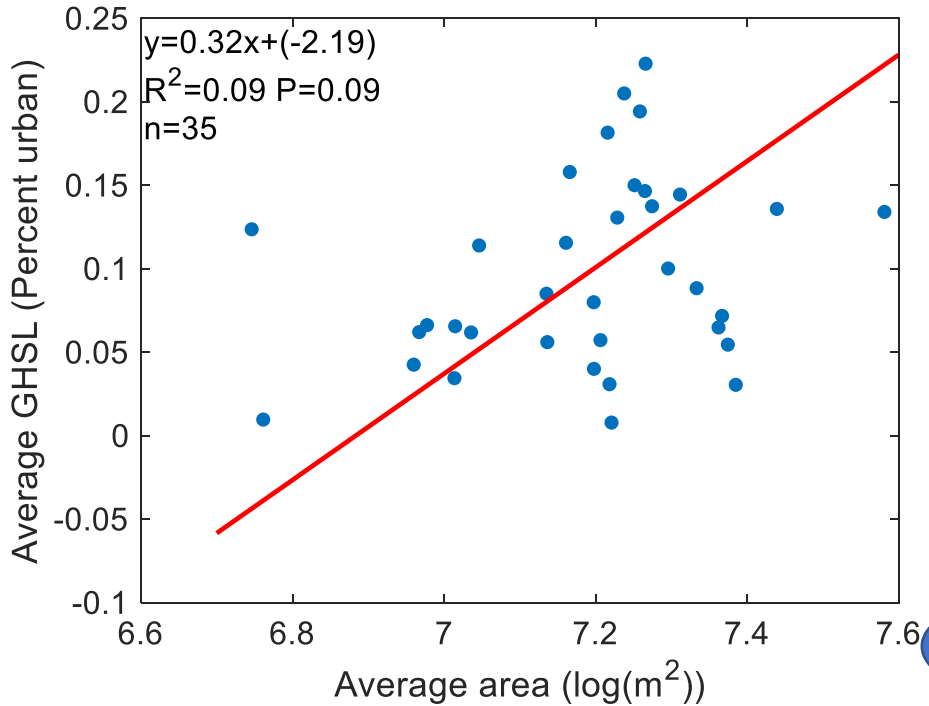
Summary and Reflection

- Compare the PR/GHSL with Floor/Area.



(Frolking et al., 2013)





Summary and Reflection

- This paper showed the key trends in upward and outward urban growth across cities of our interest and revealed previously undocumented recent and rapid changes in urban volumetric structure worldwide;
- Besides, cities are worldwide rapidly increasing their built-up infrastructure, with tremendous opportunity to shape emerging urban forms towards more sustainable outcomes;
- The typologies of urban growth that created could be used to distinguish cities for research in different situations.

Thanks for your attention!