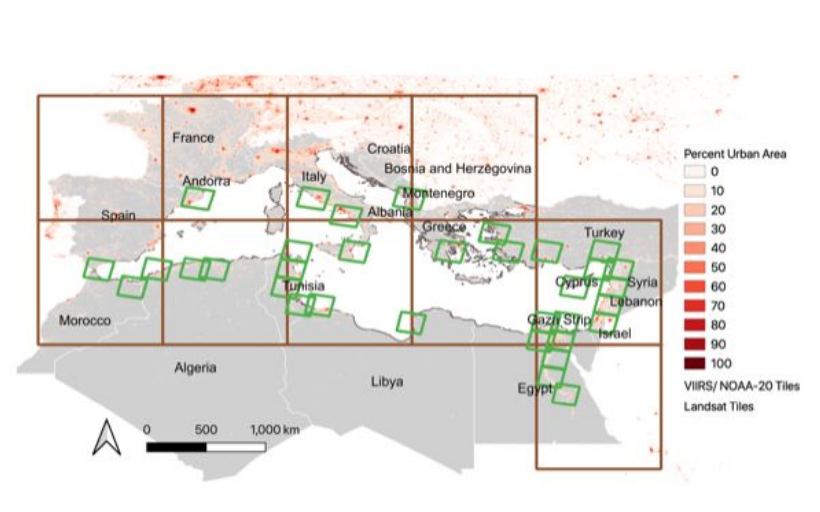

A multi-dimensional, Mediterranean assessment of urban land change for the evaluation of interconnected climate risks

Eleanor C Stokes (PI), NASA
Meredith Reba (Co-I),Yale University
Karen Chen (New PI), Yale University
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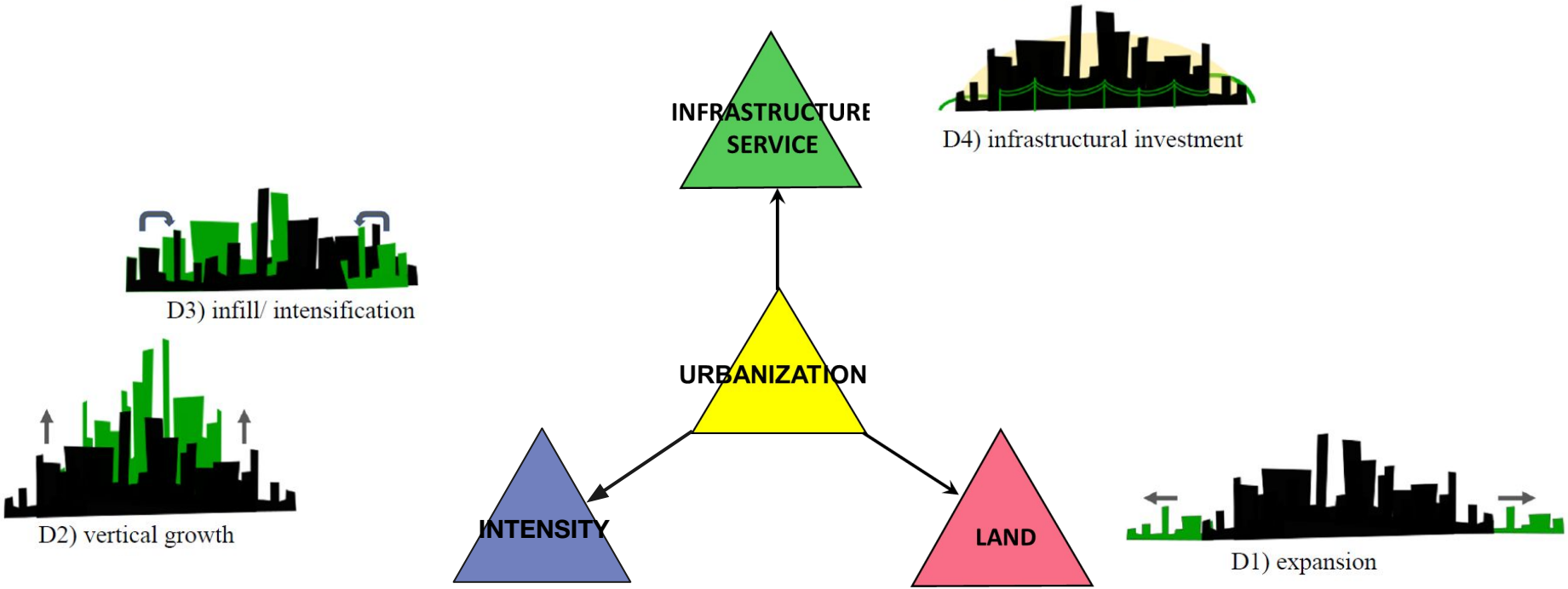
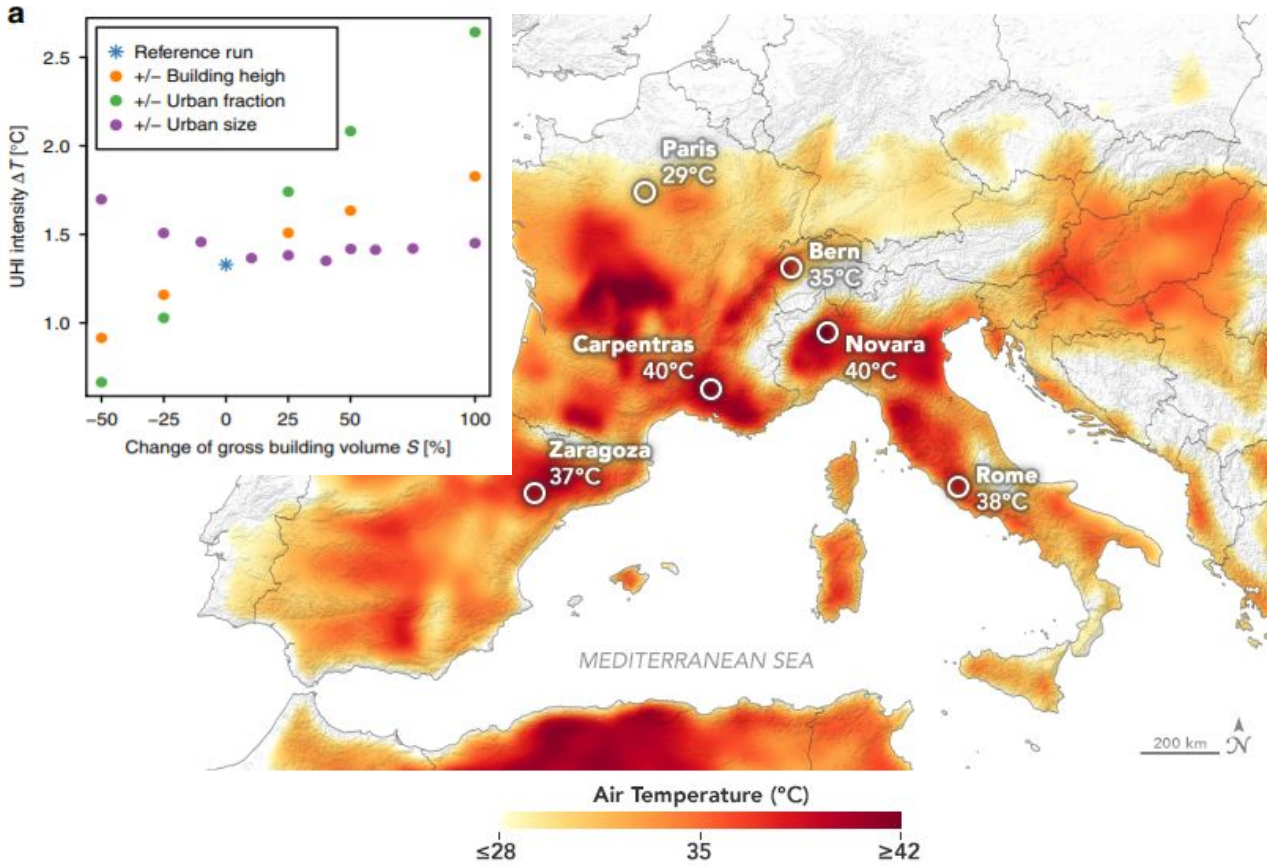
Yale School of the Environment

Yale Institute for Biospheric Studies

Multi-dimensional urbanization

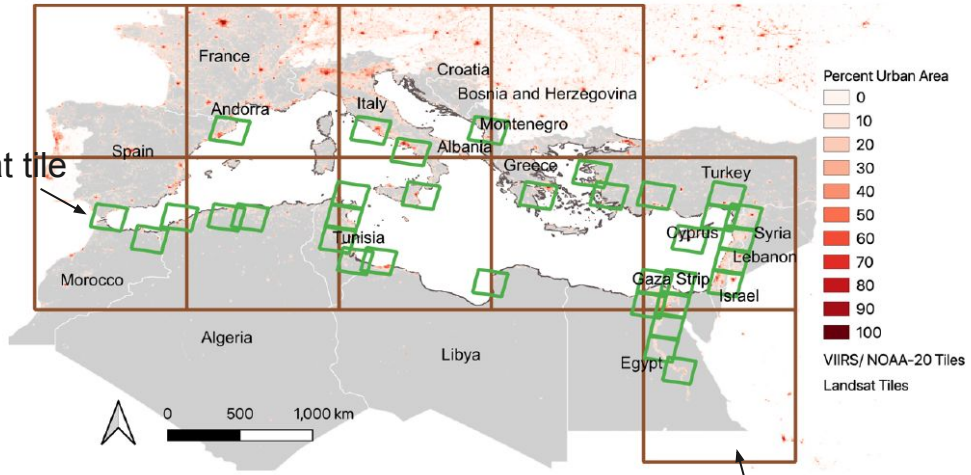


The morphology of the built environment affects heat intensity

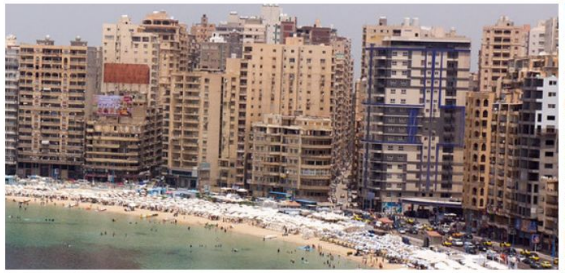


Partners:
Levent Genc, Turkey
Melis Inalpulat, Turkey
Nektarios Chrysoulakis, Greece
Dimitris Poursanidis, Greece

The Mediterranean region



Fethiye, Turkey



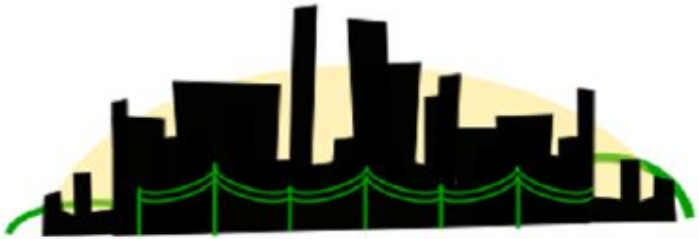
Alexandria, Egypt

Project goals

- Develop and apply methods for measuring multi-dimensional urbanization in the Mediterranean region:
    - Urban infrastructure investment
    - Infill / Intensification
    - 3D growth
- Understand interconnected climate risks

Dimension 1

Analyzing infrastructure investment by integrating night- and day-time urban maps



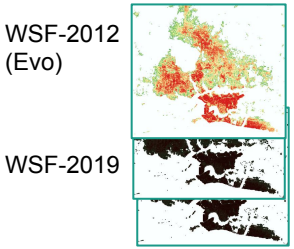
D4) infrastructural investment

Method

Data Resources

K-shape time series Clustering

Monthly Nighttime Lights (NTL) 2012-2022

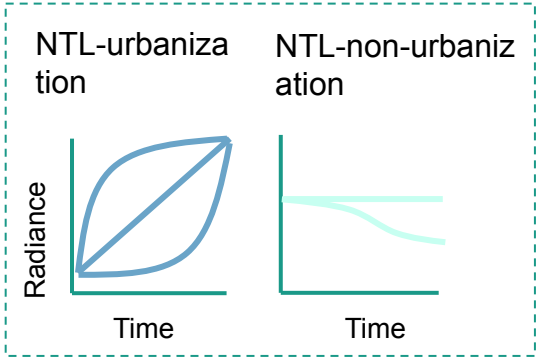


Aggregation

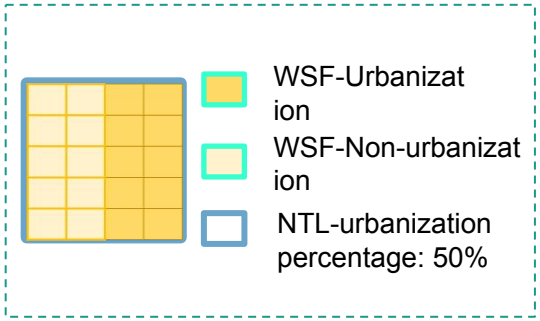
World Settlement Footprint (WSF)

Pre-Processing

Archetypes

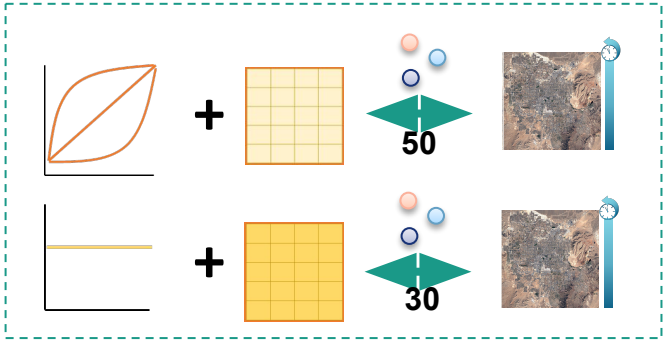


Urbanization Percentage



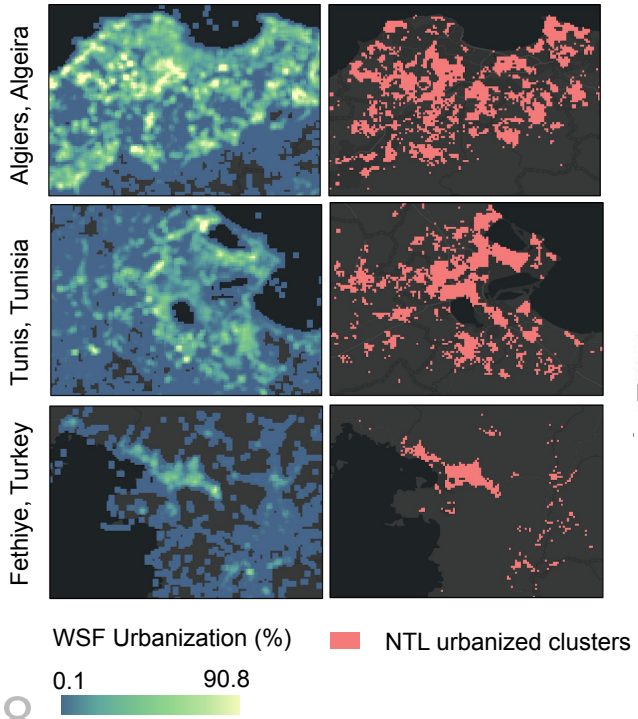
Night- and day-products disparity assessment

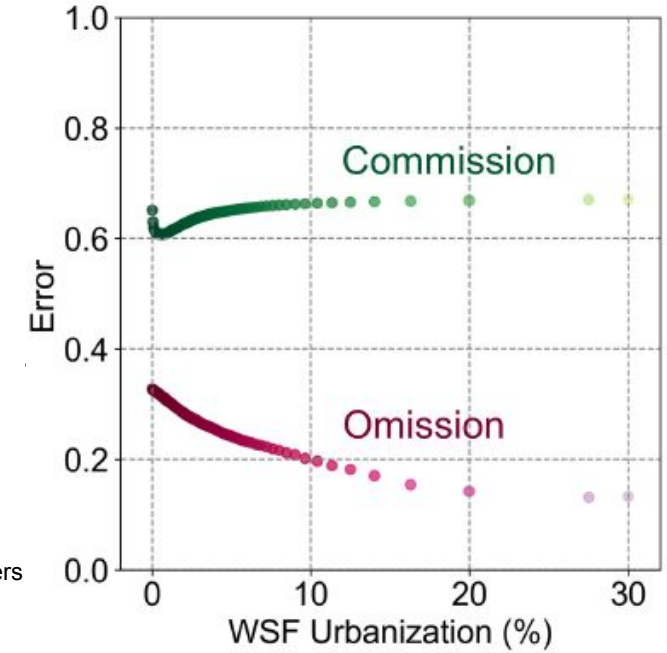
Comparison



Comparing NTL and WSF urbanization

	NTL: non-urbanization	NTL: Urbanization
WSF: Non- Urbanization	TN	FP
WSF: Urbanization	FN	TP

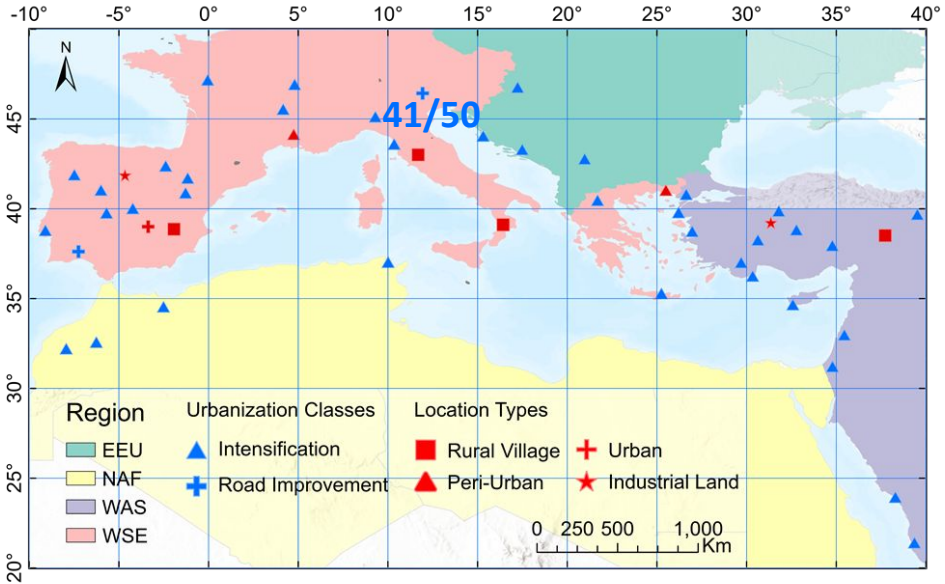


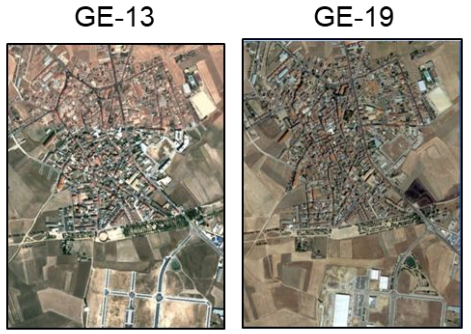


Commission error: Percentage of WSF-non-urbanization being identified as urbanization in the NTL profile

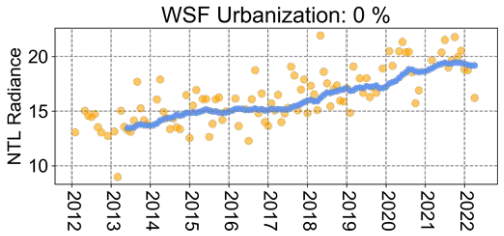
Omission error: Percentage of WSF-urbanization not being identified in the NTL profile

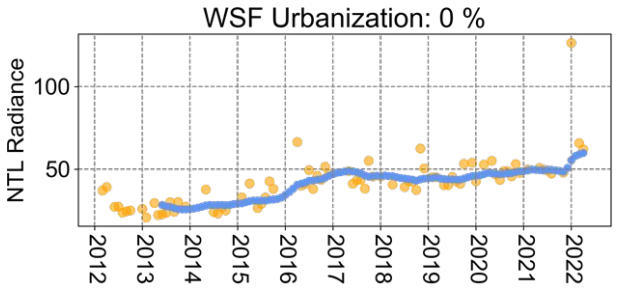
Disparity of urbanization



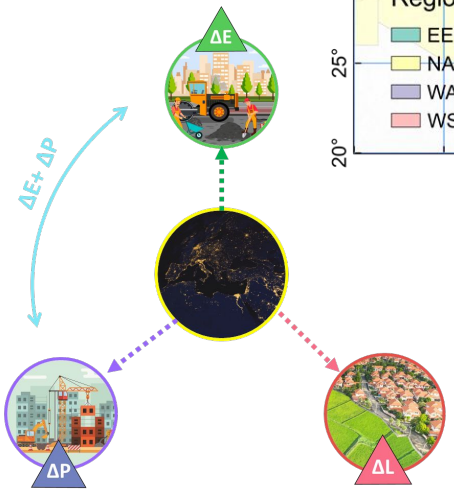


b1. Intensification





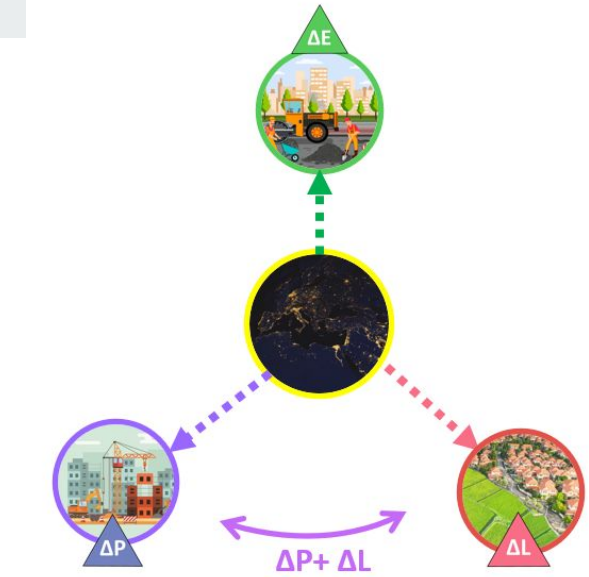
b2. Road Improvement

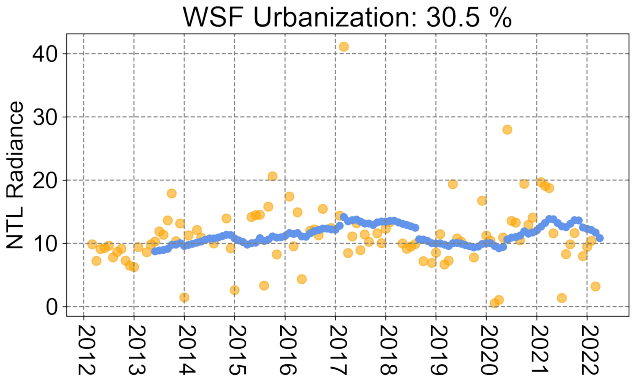


Disparity of non-urbanization

Dark Growth

Absent public lighting infrastructure (informal settlements)





Dimension 2

Subpixel estimate of urban land cover intensity and the identification of infill processes

D3) infill/ intensification

Landsat satellite image

Resolution: 30m
Revisiting: 16 days
1972 – to date

Commercial satellite image from Google Earth

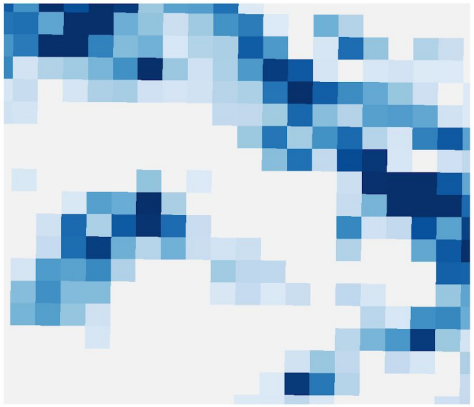
Resolution: 1m
Revisiting: months to years
Only updated images are freely available

Fractional urban land cover

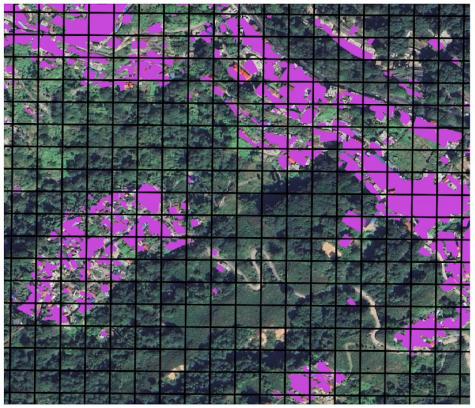
- Impervious surface
- 30 m x 30 m grids using Landsat
- 40 cities and towns, stratified by population, elevation, and country and natural land cover

(a) Google Earth image

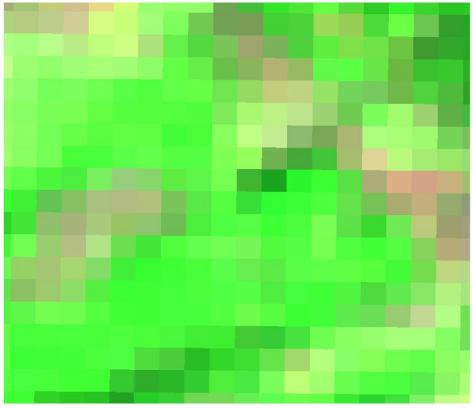
(c) Fractional data



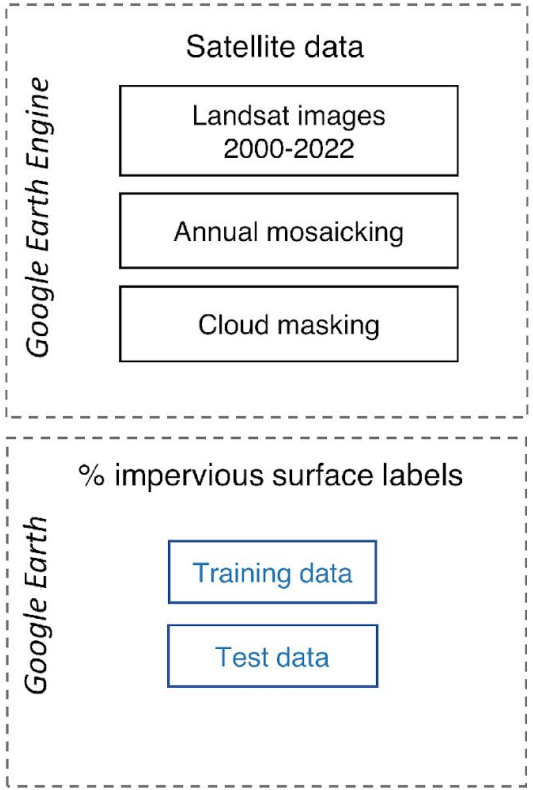
(b) Building footprint



(d) Landsat (SWIR-2, NIR, G)

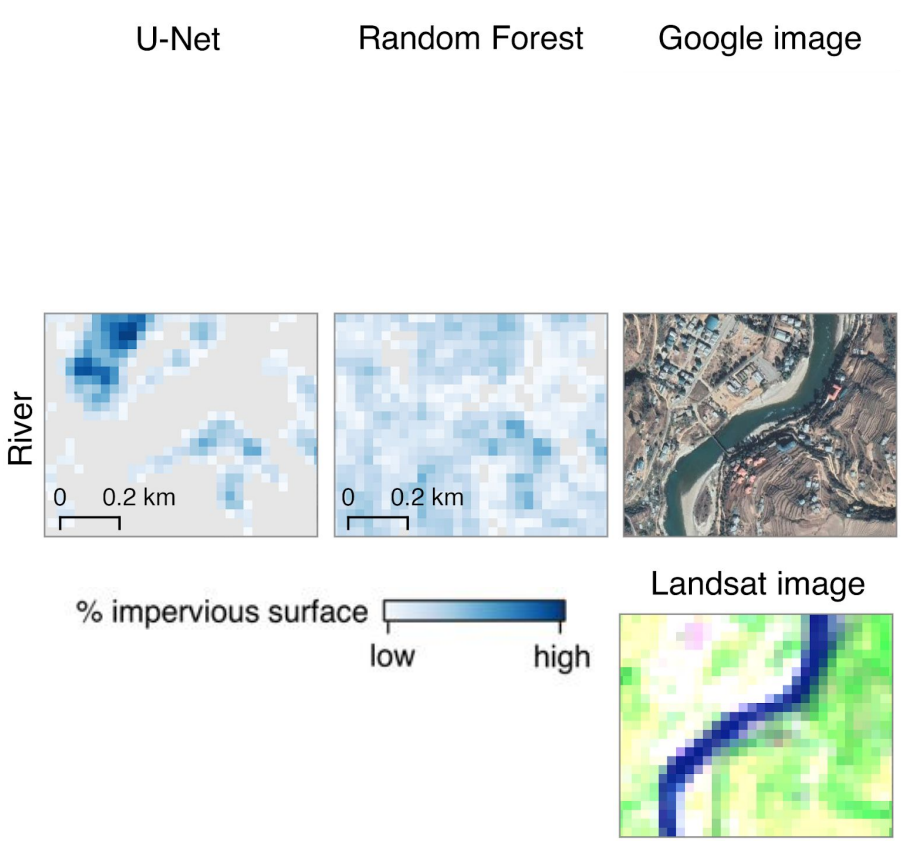


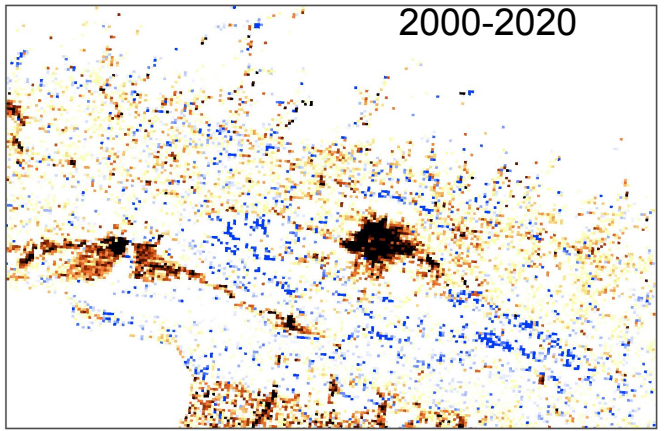
Datasets


Satellite data
Google Earth Engine
Landsat images
2000-2022
Annual mosaicking
Cloud masking
% impervious surface labels
Google Earth
Training data
Test data

Results – urban fraction

- Reduce false positives from spectrally similar land cover
- The U-Net + MS led to doubled accuracy for **small** settlements





Dimension 3

Identifying vertical growth using Landsat data

D2) vertical growth

Contents lists available at ScienceDirect

Remote Sensing of Environment

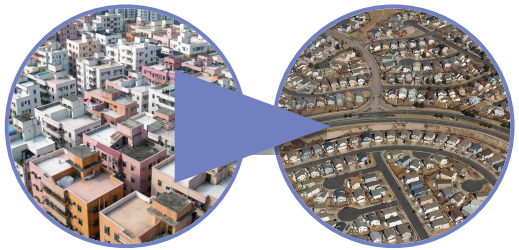
journal homepage: www.elsevier.com/locate/rse

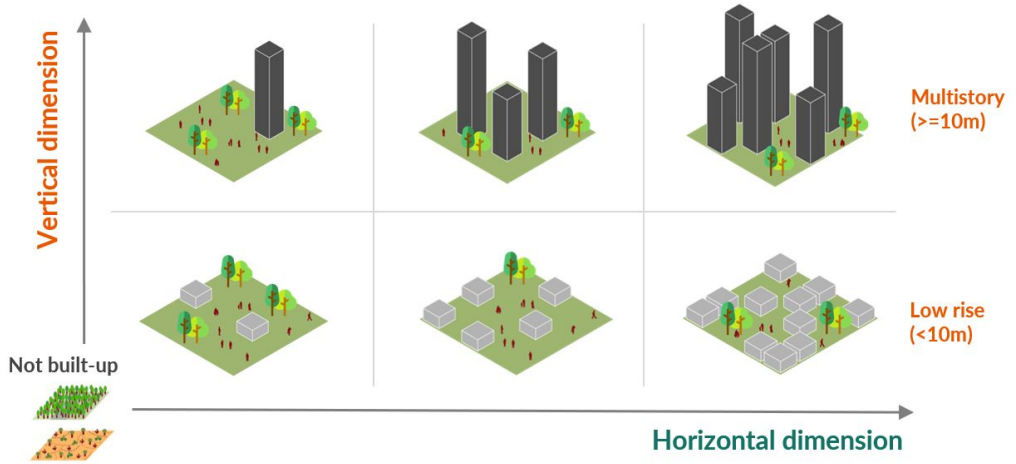
Mapping horizontal and vertical urban densification in Denmark with Landsat time-series from 1985 to 2018: A semantic segmentation solution

Tzu-Hsin Karen Chen[a,b,c,*], Chunping Qiu[d], Michael Schmitt[d,e], Xiao Xiang Zhu[d,e], Clive E. Sabel[a,b], Alexander V. Prishchepov[c]

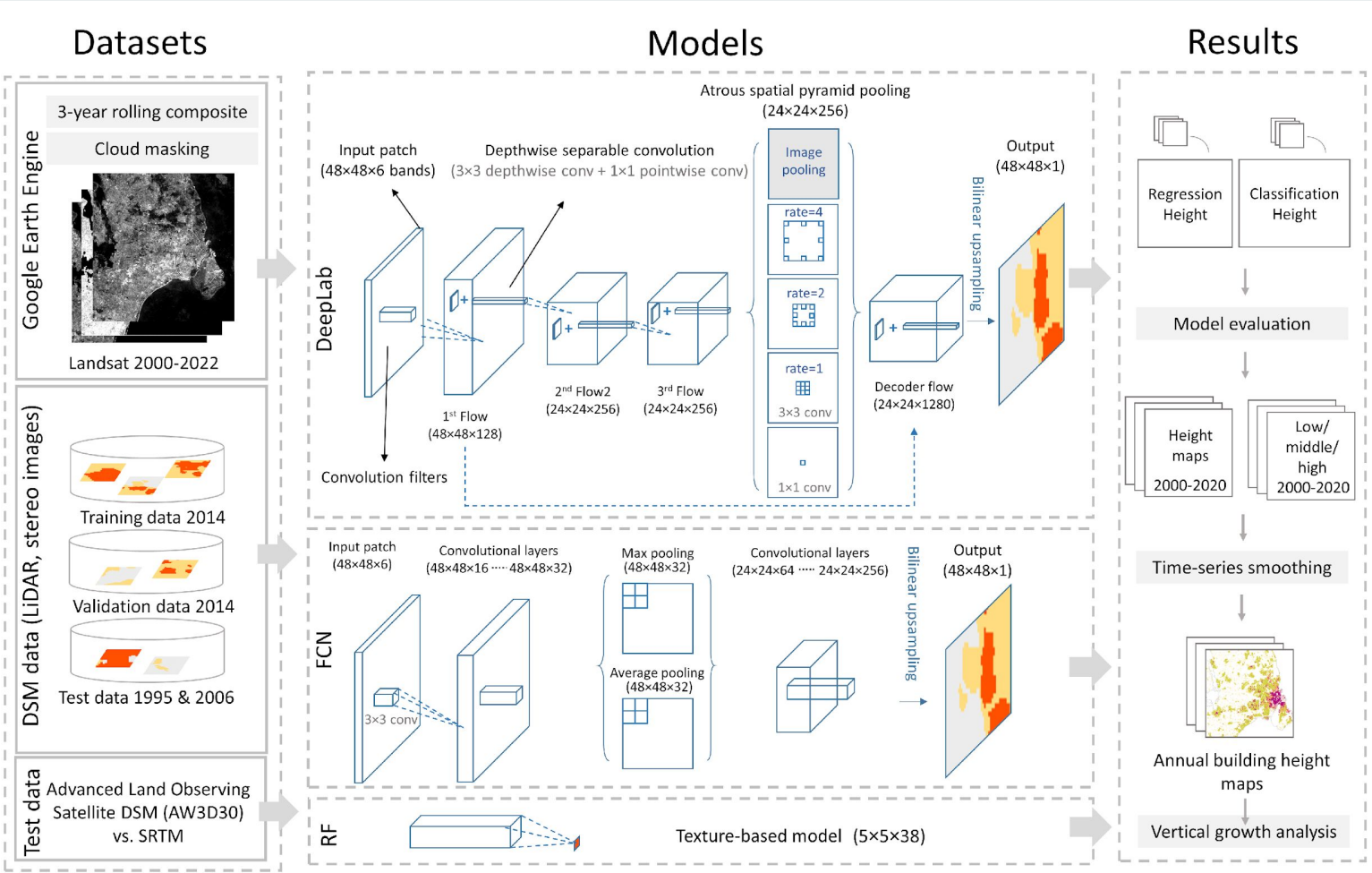
Vertical growth detection

- Common approaches:
  - Regression: Indicator using Sentinel-1 Ground Range Detected data
  - Classification: Local climate zones
- Research gap: time series height analysis
- Goal: validate and understand vertical growth in the Mediterranean region





(Chen et al. 2020, *Remote Sensing of Environment*)



Next?
Hotspots of urbanization-climate compound risks

- Heat waves
- Flooding risks
- Human health
- Biodiversity

JURSE 2023
Heraklion - Crete

Postdoc and PhD opportunities

Thank you ☺️

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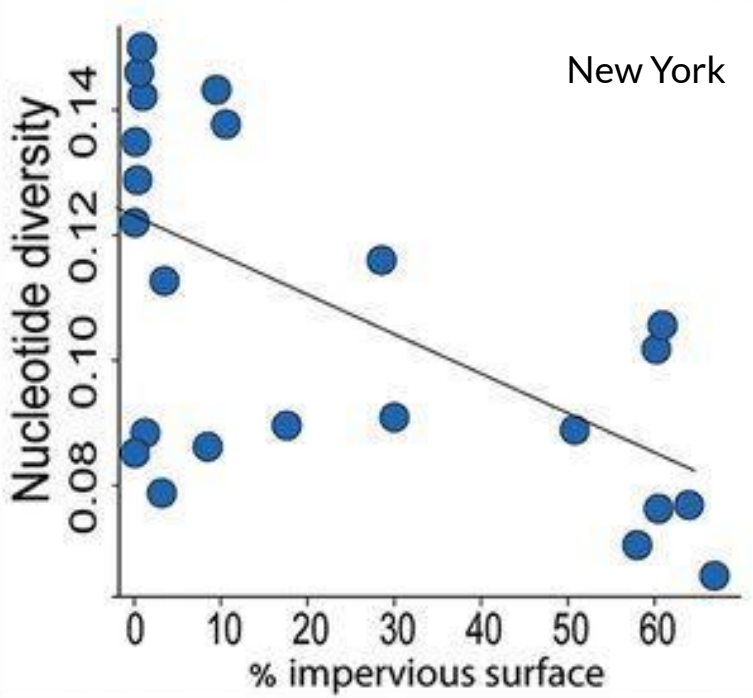
Dimitris Poursanidis

Supports:

Yale Institute for Biospheric Studies

Backup slides for Q&A

Biodiversity

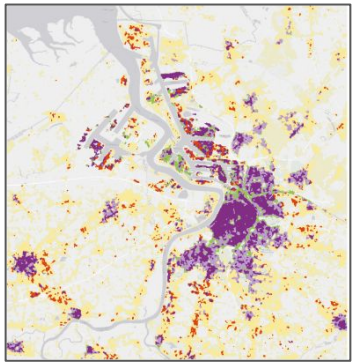


Climate Change

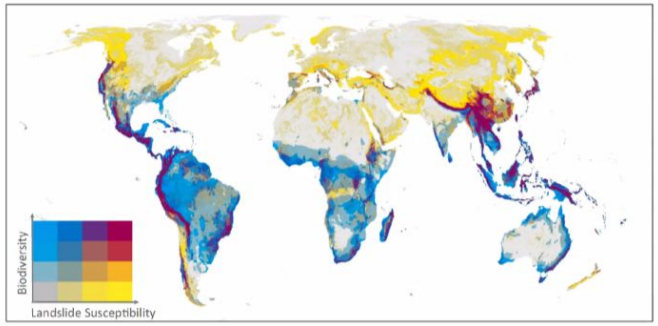
Biodiversity

Johnson et al., 2017, *Science*

Kibera, Nairobi © Johnny Miller/Thomson Reuters Foundation



Compact high
Compact low
Open high
Open low
Sparse high
Sparse low

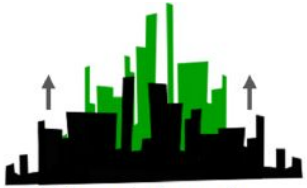


Machine learning & Land cover mapping

Urban time-series analysis

Intersecting climate risk

D1) expansion



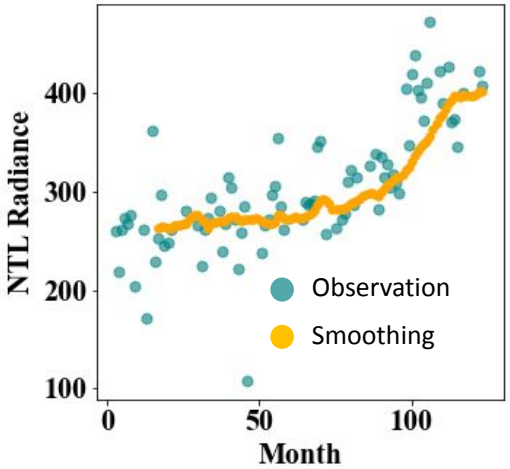
D2) vertical growth

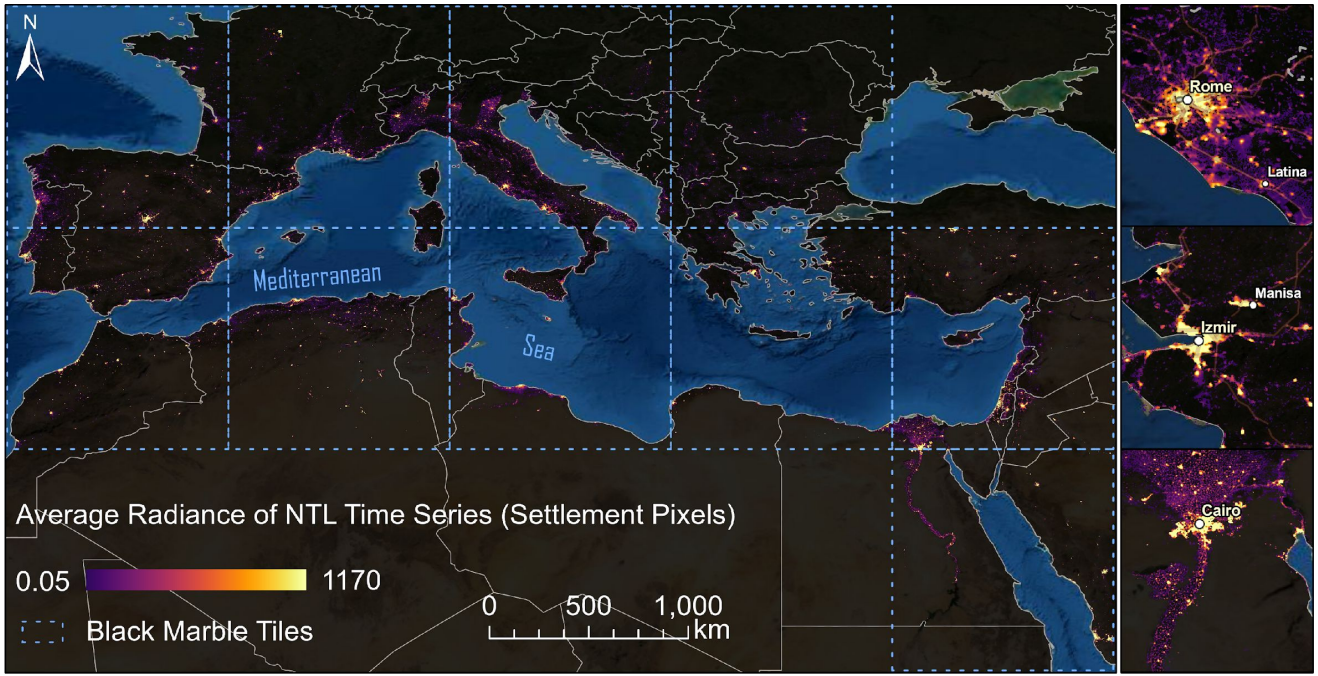
D3) infill/ intensification

D4) infrastructural investment

Materials and Study Area

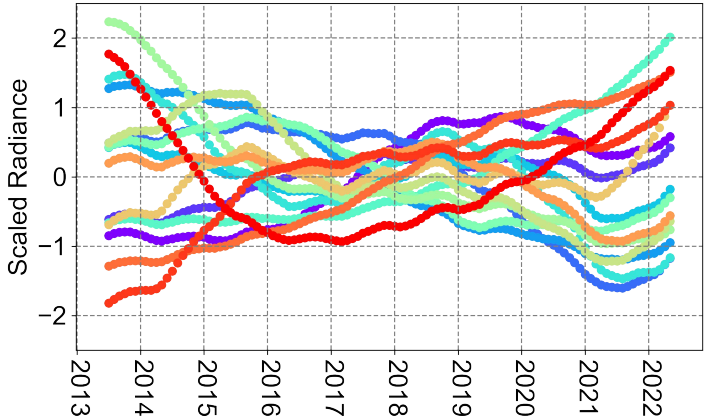
- Monthly **Black Marble NTL** dataset (2012-2022 April, 124 months) at Near-Nadir Angle
- Reliable urban NTL time-series (3 layers of quality control)
- Urban areas with E>0.59, ε>0.93
- 18-month smooth



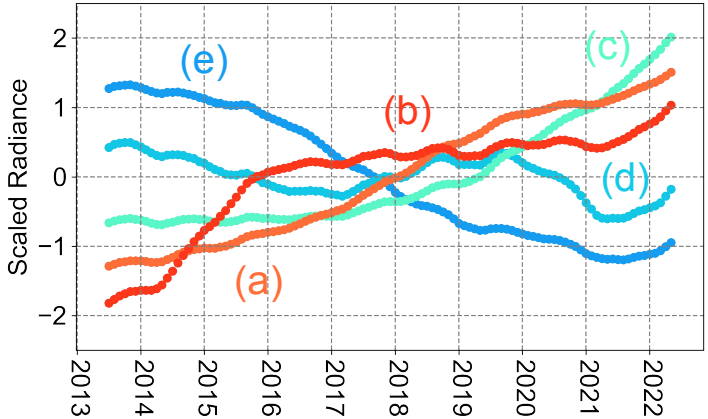


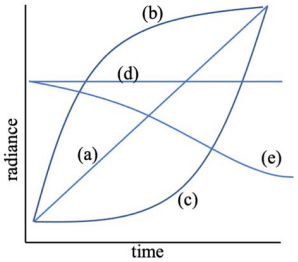
Clustering & Classification

15 clusters: mean values



Archetypes of infrastructure development





(a) constant infrastructure development (b) slowing infrastructure development (c) accelerating infrastructure development (d) no new development (e) deurbanization/declining infrastructure intensity and use.