

Urbanization in the 21st Century: Some challenges ahead

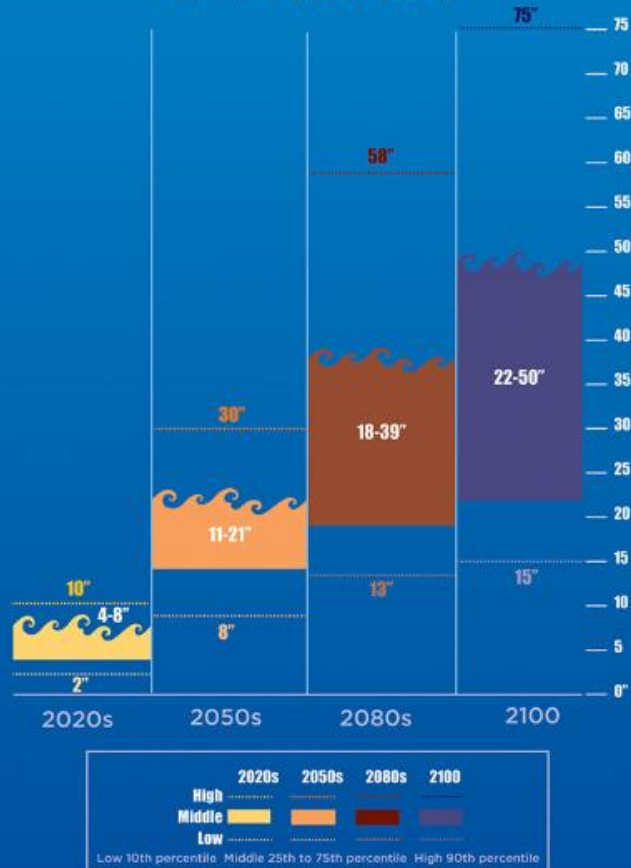
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Presentation prepared for
UN Population Division Expert Group Meeting
Session V on Urbanization and international mobility in an
increasingly interconnected world

Certainties in an Uncertain Century

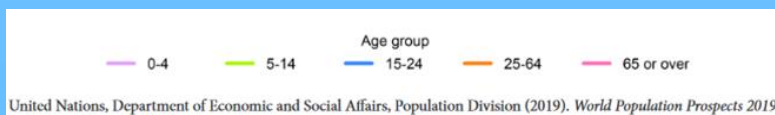
Sea level rise in New York City is very likely to accelerate as the century progresses

SEA LEVEL - MEAN ANNUAL CHANGES
Baseline (2000-2004)

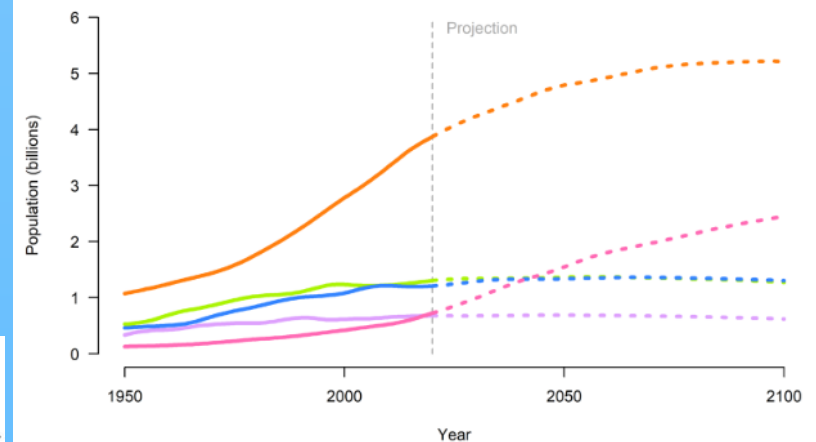


- Demographically
 - Urbanization
 - Aging
- Climate Change
 - Hotter (in most places)
 - More variability in weather
 - Sea levels will rise
 - More flood prone
 - Stormier
 - Drier

NPCC2 (2015)



Persons aged 65 years or over make up the fastest-growing age group

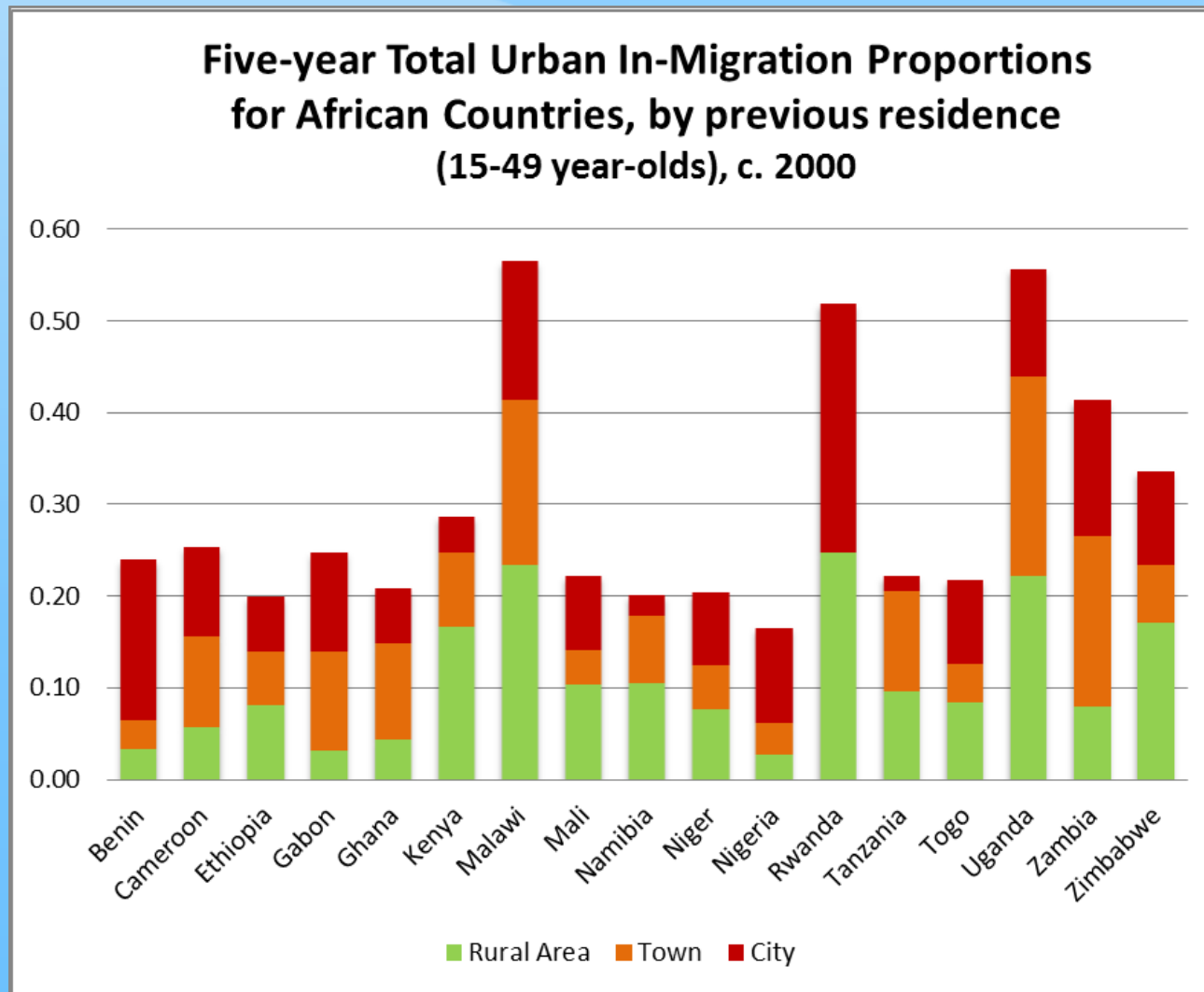


Urbanization

- Occurs in place
 - both vertically & horizontally
 - Yet we can't project spatial urban change
- Due to demographic and other factors
 - Yet we don't know the causes of future urban growth, in particular relative contributions of natural increase vs migration
- Relationship between cities and their surrounding areas & ...
- Roles of international vs domestic migration on city-growth unclear
 - Many cities are destinations for many migrants (particular from abroad) but are net senders of population to nearby locations

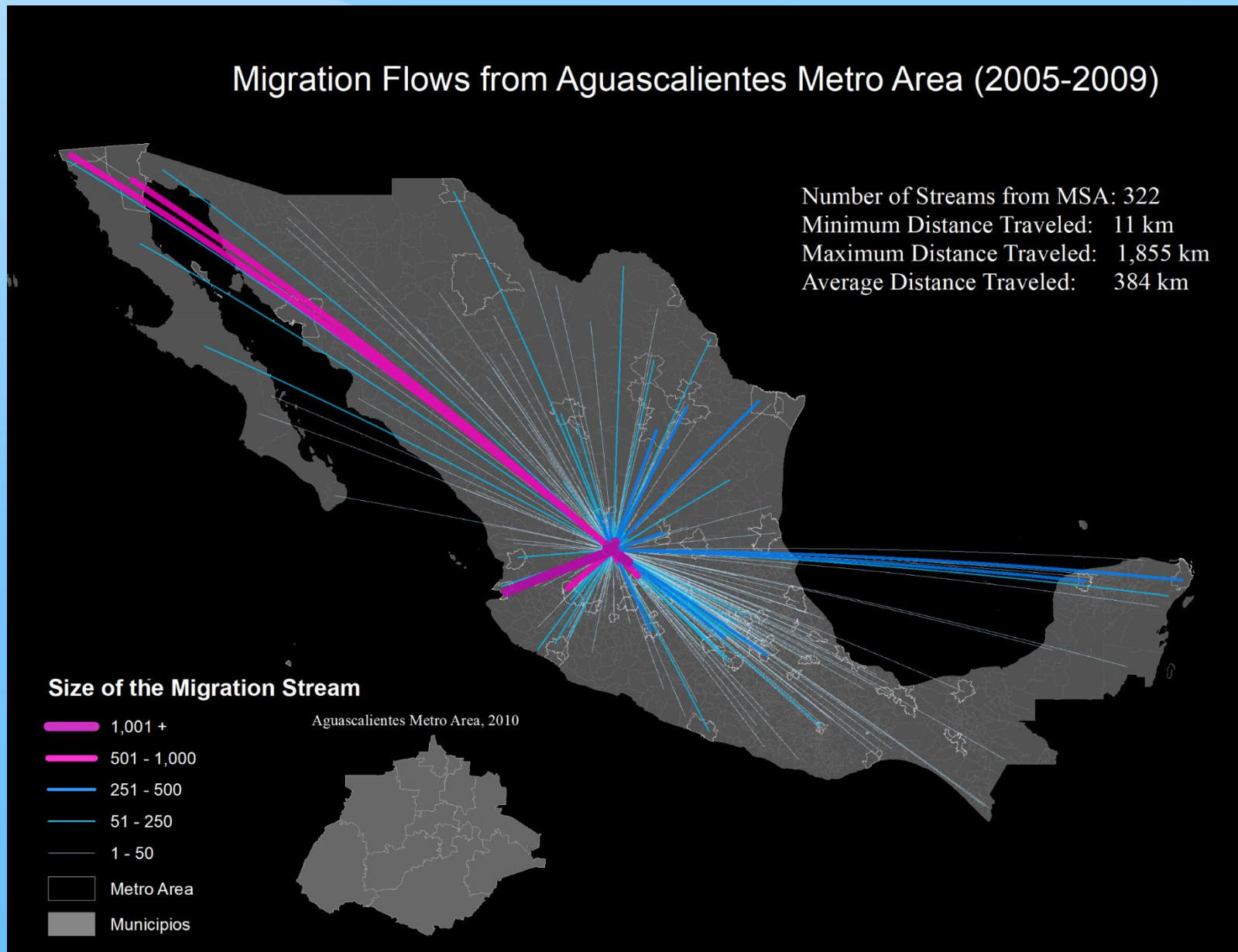


Migration to cities from where?



Source: Balk, Montgomery and Liu, 2012 (Using data from Demographic & Health Surveys (DHS))

Migration is a spatial process



Source: Jones, Riosmena, Simon, Balk, 2019

Summarizing that spatial process

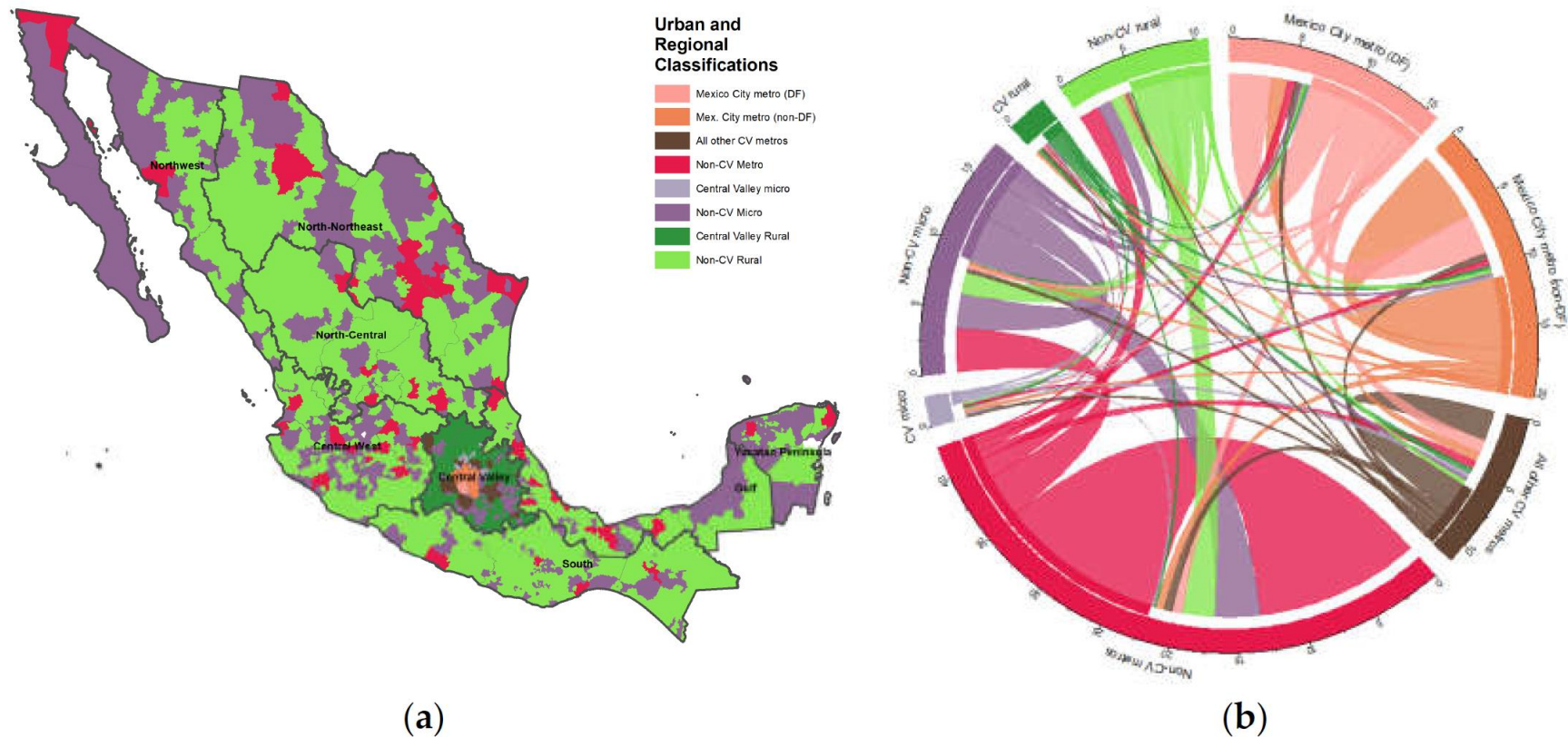


Figure 2. (a) Municipal classification map of Mexico and (b) flows of migrants between them, 2005-2009. Note: Base of the plot pertains to both region of origin (flows from part of base with no white gap) and destination (flows ending in part of the base with white gap). Size of flow indicated in 10,000s. Map generated using ArcGIS; Circplot generated using the *circlize* package in R.

Source: Jones, Riosmena, Simon, Balk, 2019

U-R dichotomy to a continuum

- At many spatial scales; and
- Over different time periods ...
 - Necessitating a multilevel framework to predict growth
- In a coupled socio-environmental system
 - That is, common suite of constraints and processes influence urban built-up (or land) and population change

Figure 1.1 From dichotomy to continuum: a portfolio of places

The simplified area economy



and a more realistic representation



Source: WDR 2009 team.

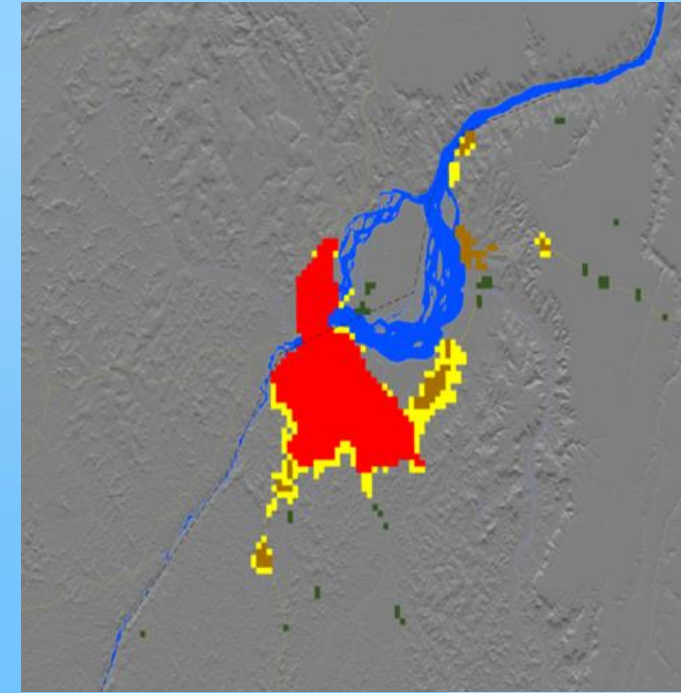
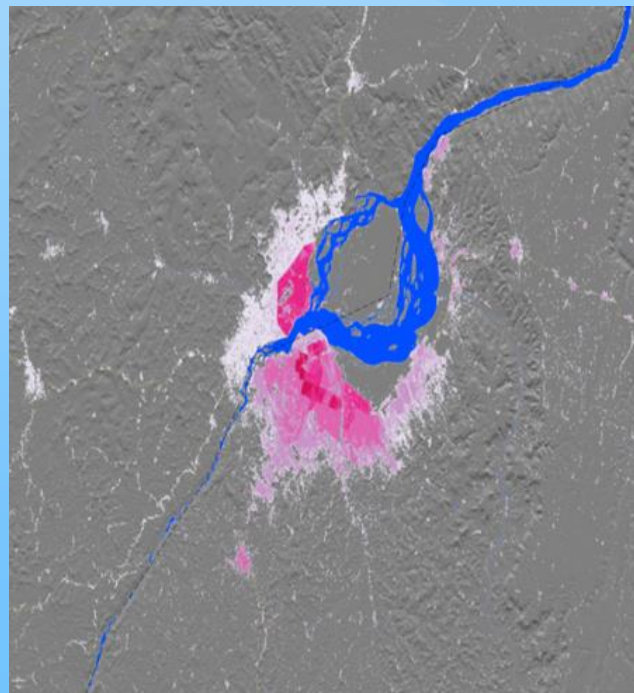
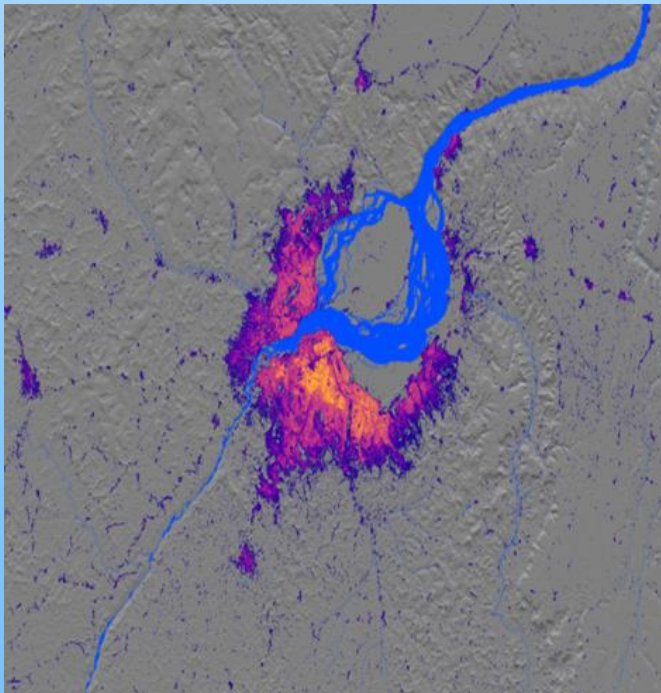


New ways of conceptualizing urban

Built-up (Sentinel-2) +

Population (GHS-Pop) =

Degree of Urbanisation



Satellite inputs (Landsat + Sentinel)

Modelled time-series from 1970s-present

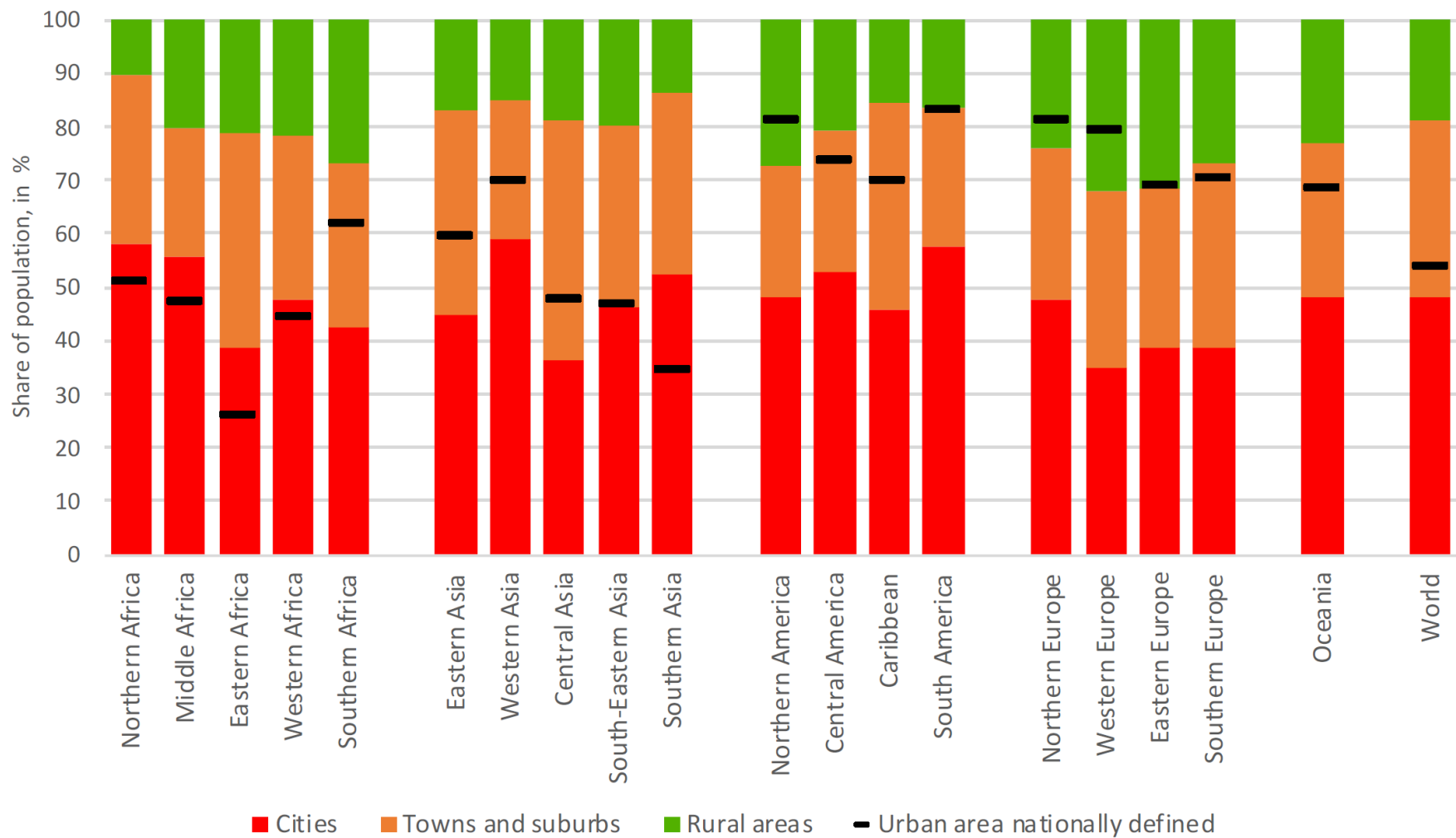
Population from censuses reallocated to built-up area

1990-present

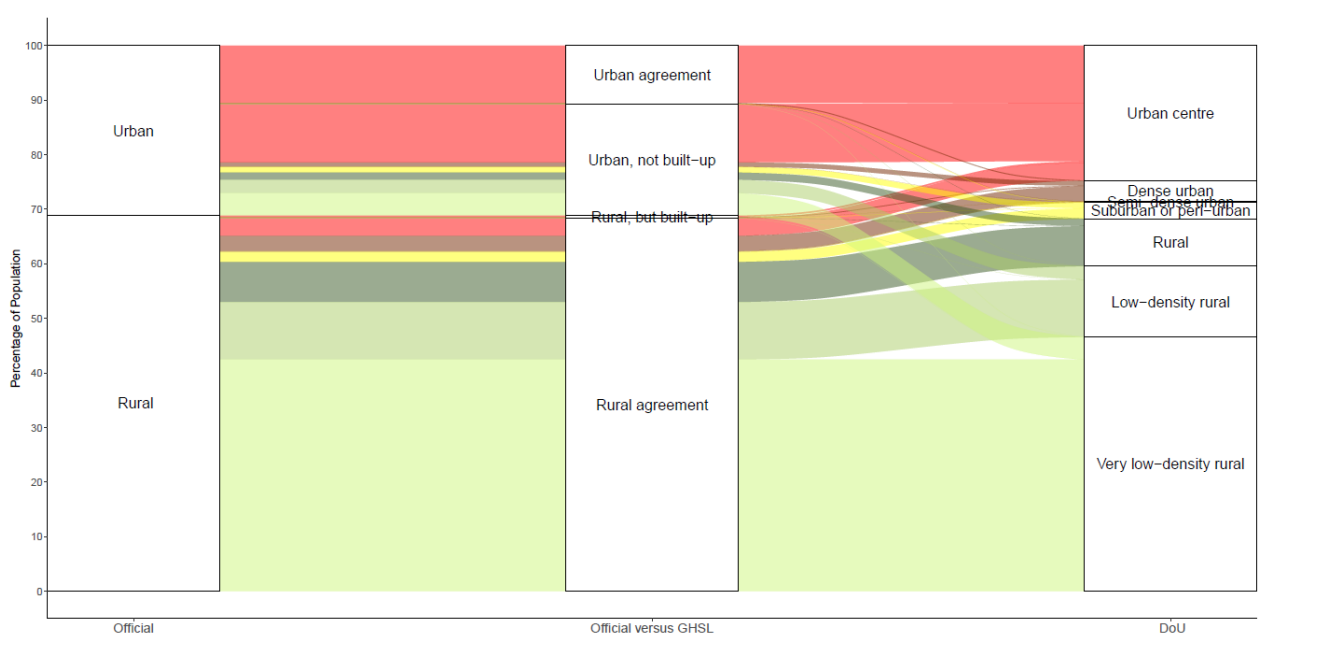
Rule-based reallocation of population into a continuum of rural-urban

New ways of conceptualizing urban

Degree of urbanisation and national defined urban areas, 2015



Agreement vs. work to be done



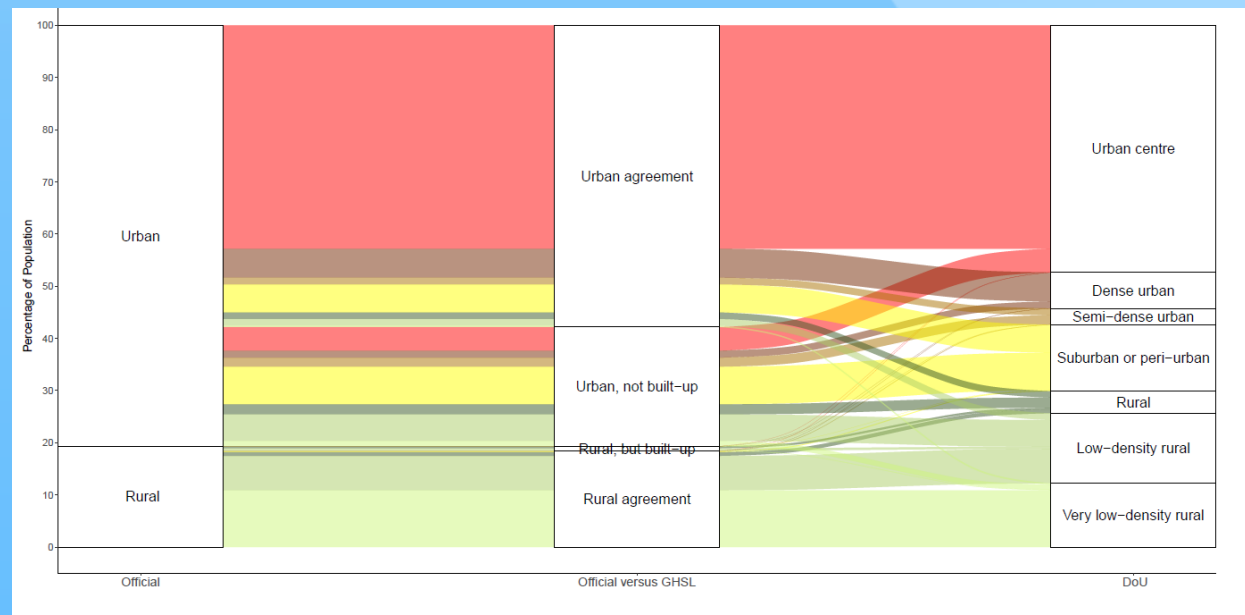
<< India

Cities (light red) tend to be built << t-up; rural areas (light green) tend to not be built-up

US (below)

Classification between cities (urban centres) and sparse rural areas are where the work remains.

- These areas are classified differently by NSO and DoU.
- These areas may not conform to a common set of functions
- These areas are changing.



Urban areas at risk

- We estimated for the first time that...

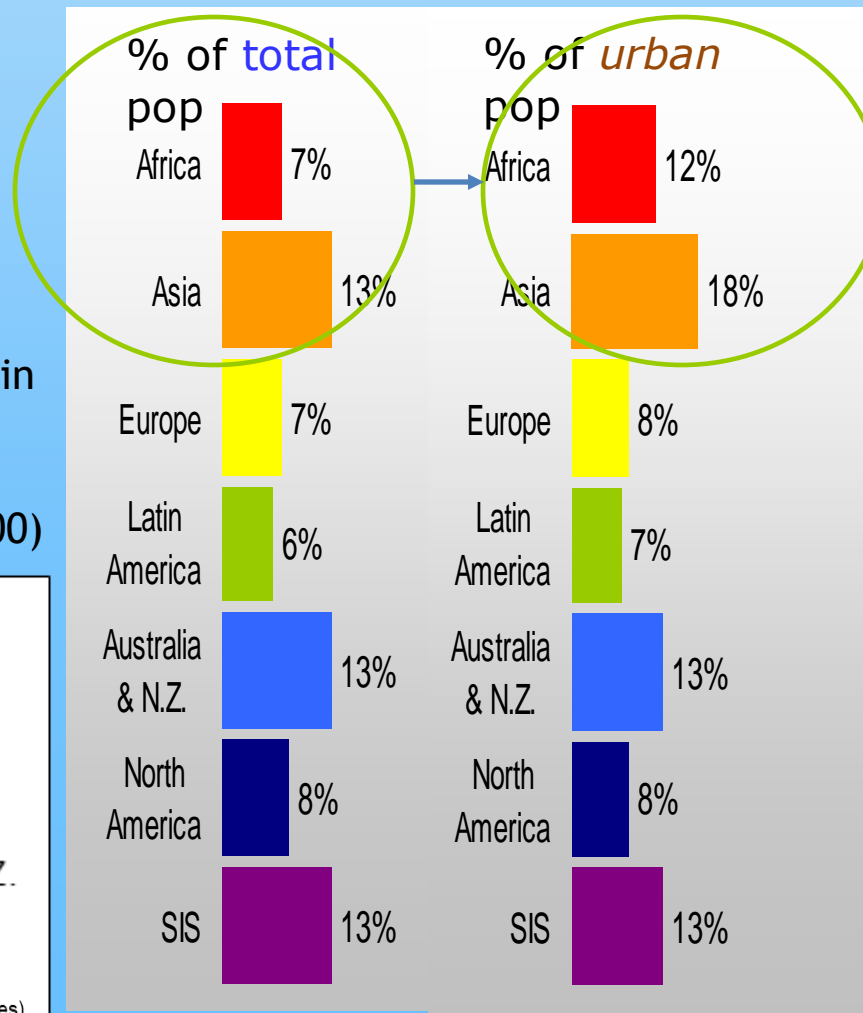
– **1:10** person lives in the **Low Elevation Coastal Zone (LECZ)**

- Most countries with any land area in the LECZ, have their largest city in it
- Small Island States and deltaic countries (and their cities) at much higher risk

– **1:8 urban person** lives in the LECZ

- City dwellers in **Africa** and **Asia** disproportionately at risk

– Most future population growth to take place in the cities and towns of Asia, Africa and LAC

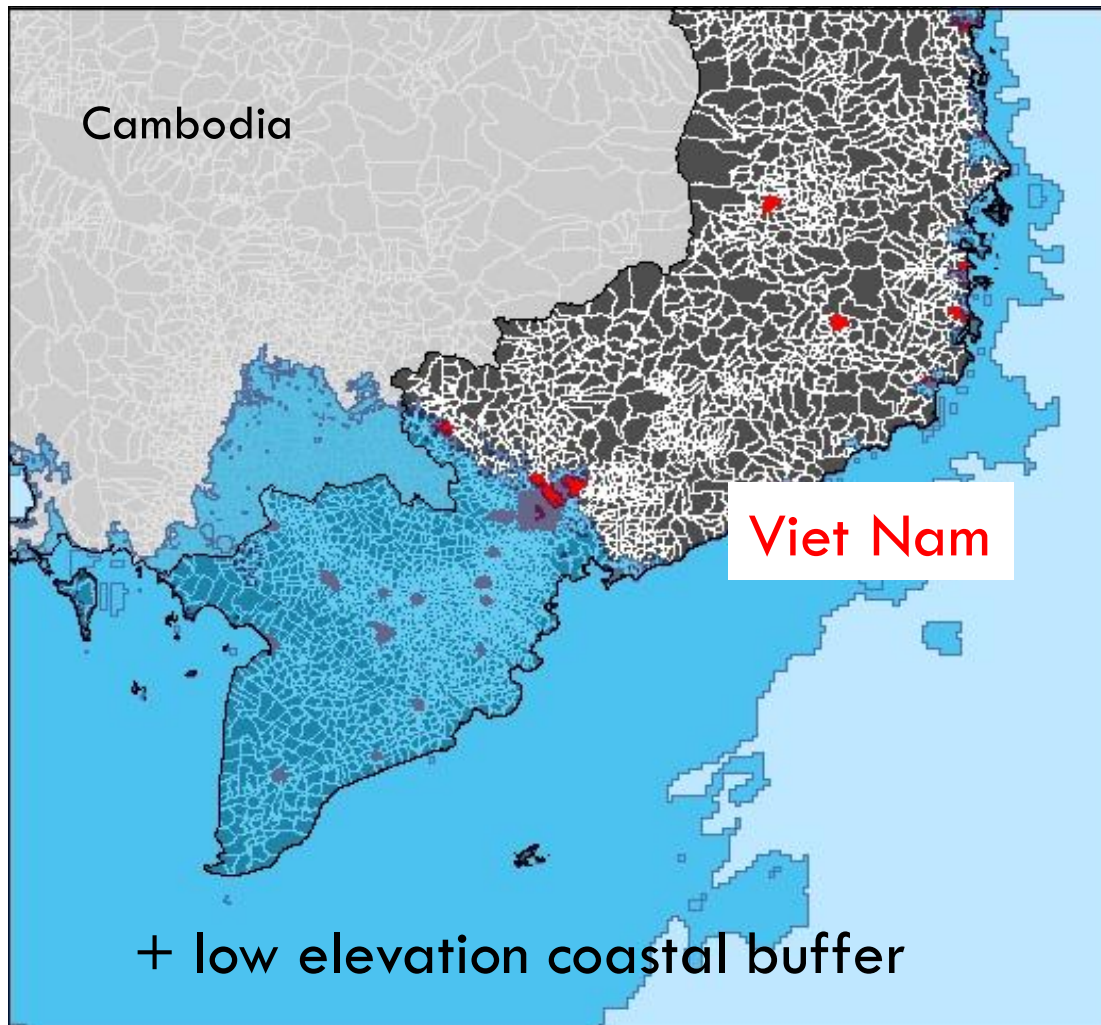


Persons living in the LECZ (millions), by continent (2000)

- Africa
- Asia
- Europe
- Latin America
- Australia & N. Z.
- North America
- SIS (Small Island States)

Source: McGranahan, Balk and Anderson (2007)

Simple method, but depends on the quality of the data: demographic + satellite data



Source: McGranahan, Balk and Anderson, 2007
(updated in MacManus et al. 2021)

- Population (census) data is reported in irregular administrative units
- Urban extents
 - Night-time lights based GRUMP shown here
- LECZ based on SRTM satellite data
 - 10m contiguous to seacoast
- Transform to a quadrilateral
- Create summary statistics based on spatial “zones”

Why Update? Improvement in underlying data & models

LECZ data and models

- Improvements in the spatial (horizontal and vertical) dimensions of Digital Elevation Model (DEM) data and modelling of its imperfections since 2000
- Allows for distinguishing two zones: 0-5m and 5-10m contiguous to coast

Population data and models

- Improvements in resolution of underlying census data
- Many new models of population distribution; some with time-series
- Allows for range of spatial population estimates, and change over time*

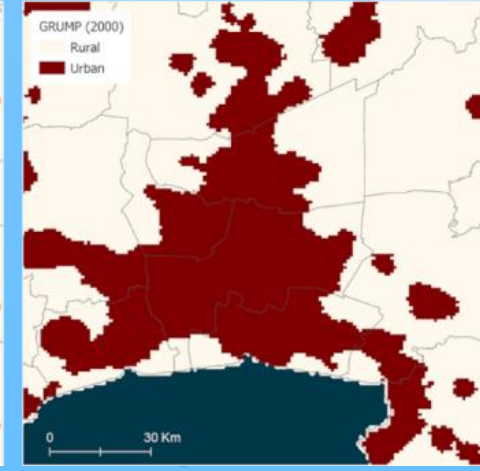
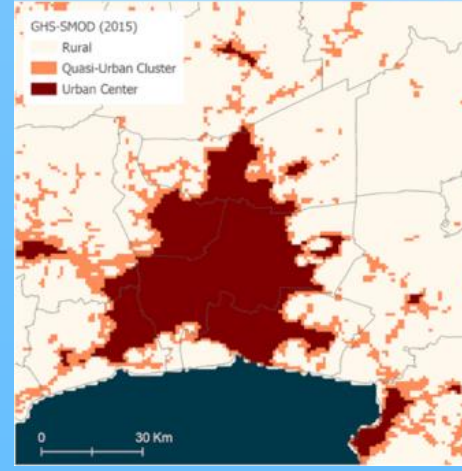
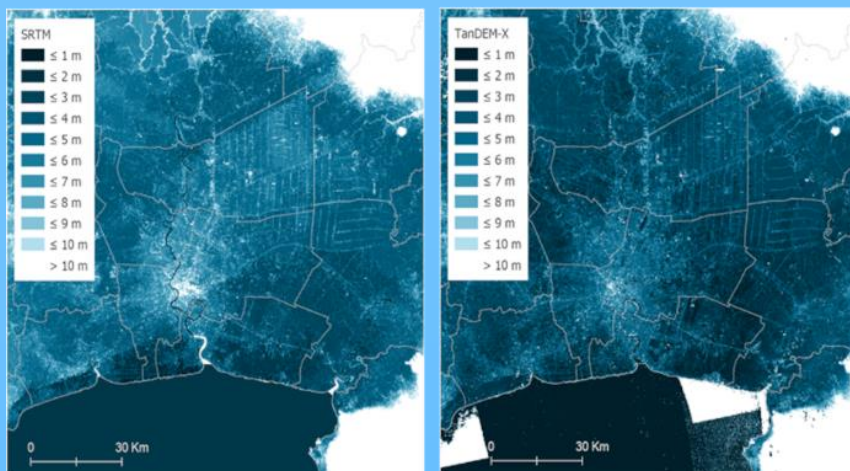
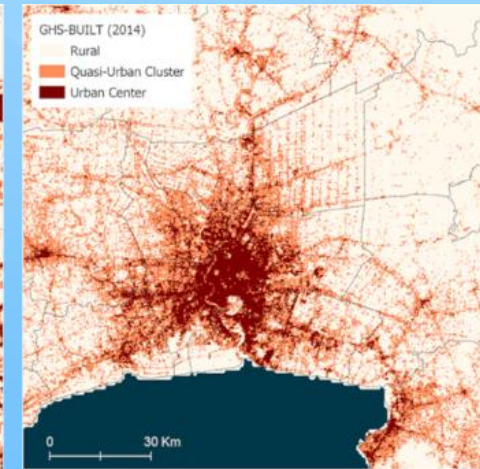
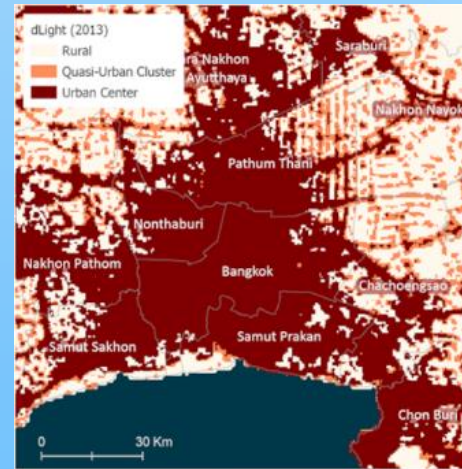
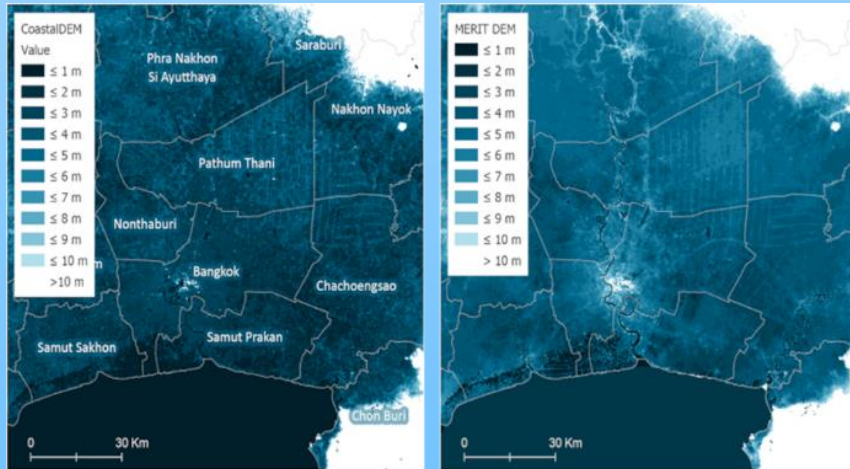
Urban-proxy data and models

- Big improvements and time-series since GRUMP; much progress in remote-sensing community since mid-2000
 - Opening up of Landsat archive, higher resolution satellites (sentinel) → settlement models
 - New class of lights data, and inter-comparisons over time
- Allow for distinguishing urban areas along a continuum:
 - Characterize the built-up and population density of locations;
 - and Comparison of different urban classification schema, and change over time*

* Temporal data can inform future projections

Many data choices (1)

- Elevation → LECZ
 - Coastal DEM, MERIT, SRTM, TanDEM-X
- Urban Construct
 - Night Lights-based, Settlement, Degree of Urbanization, GRUMP



Many data choices (2)

- Gridded Population Models

- GHS-POP

- 1990-2015

- GPW

- 1990-2015

- LandScan

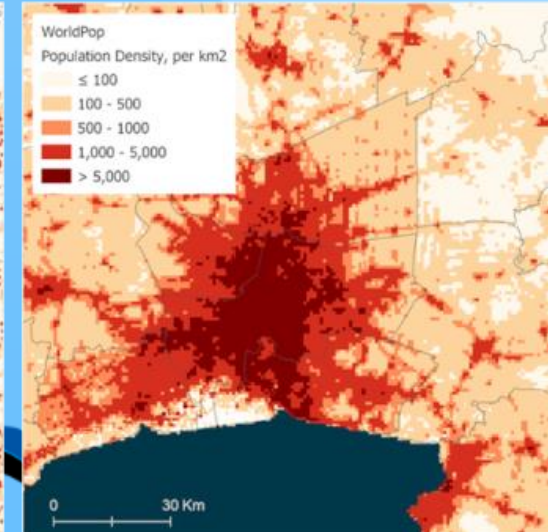
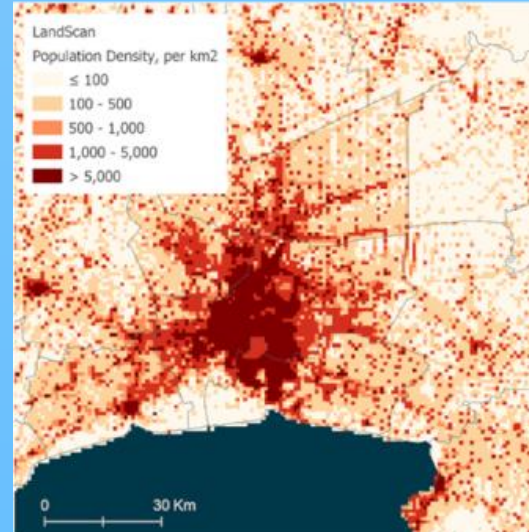
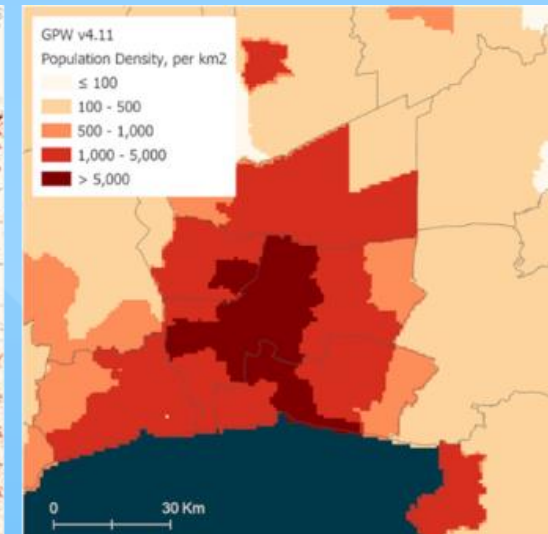
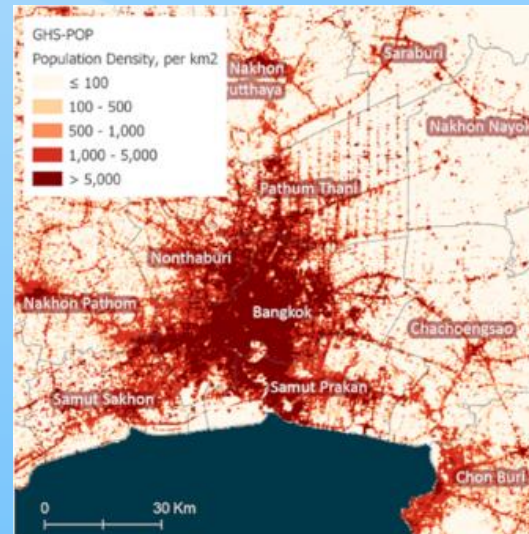
- 2000-2015
- Restricted use

- WorldPop

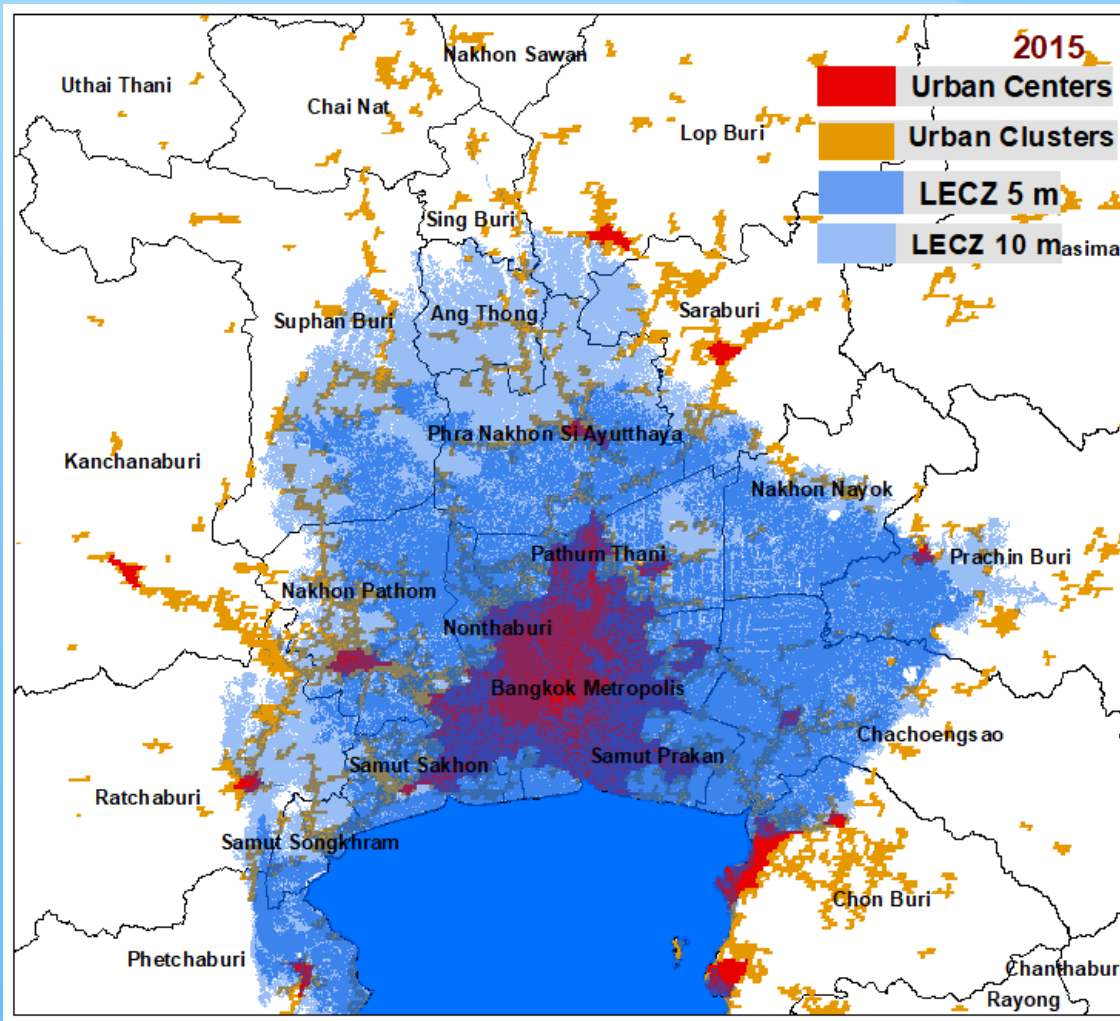
- Differ in:

- Underlying data
- Modelling inputs
- Modelling methods

See Leyk et al. 2019



Urbanization: Urban Centers & “Quasi-urban Clusters”



Technical details:

- Degree of Urbanization data
 - Based on landsat + sentinel
 - 1990-2000-2015
- Urban Classes
 - Urban Center
 - Pop density > 1,500/km² or population > 50,000
 - Quasi-urban Cluster
 - Pop density > 300/km² and population > 5000
- Method:
 - Reallocates GPW input data to GHSL built-up data based on contiguity and pop density rules

Data Source: “SMOD” Degree of Urbanization Grid (JRC, 2019);
also see Florczyk (2019)

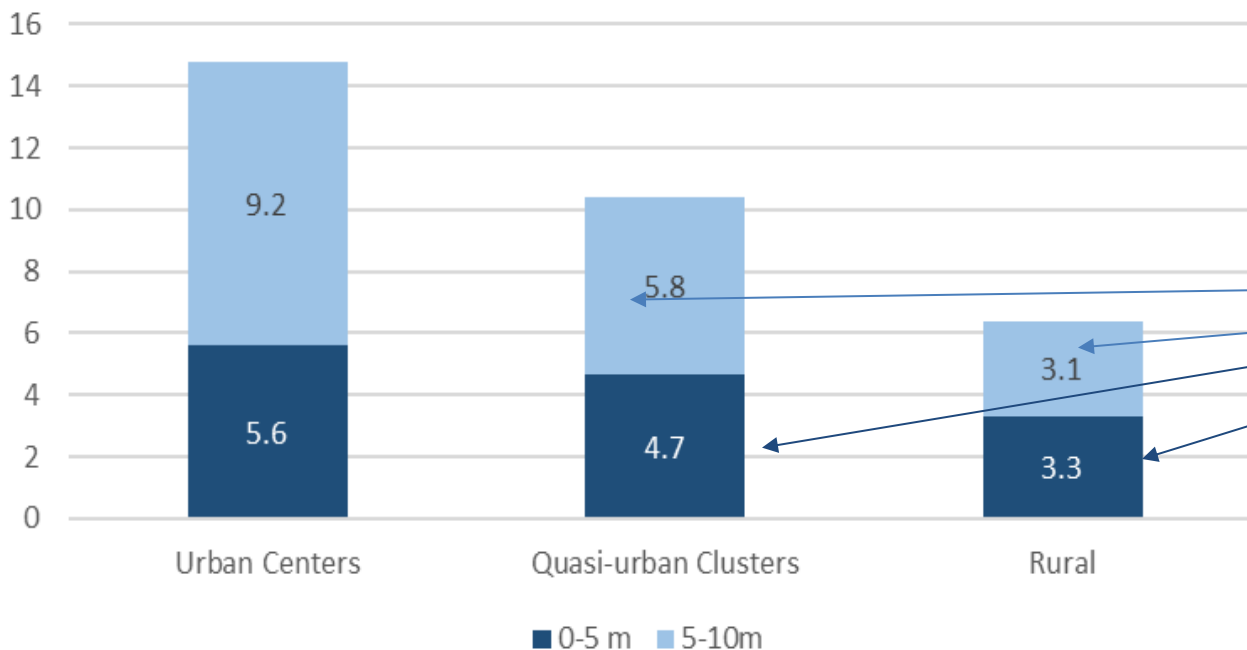
New results

- Confirming our original findings, new estimates place 10.5% of the global population (2000) in the LECZ (10.8%, 2015)

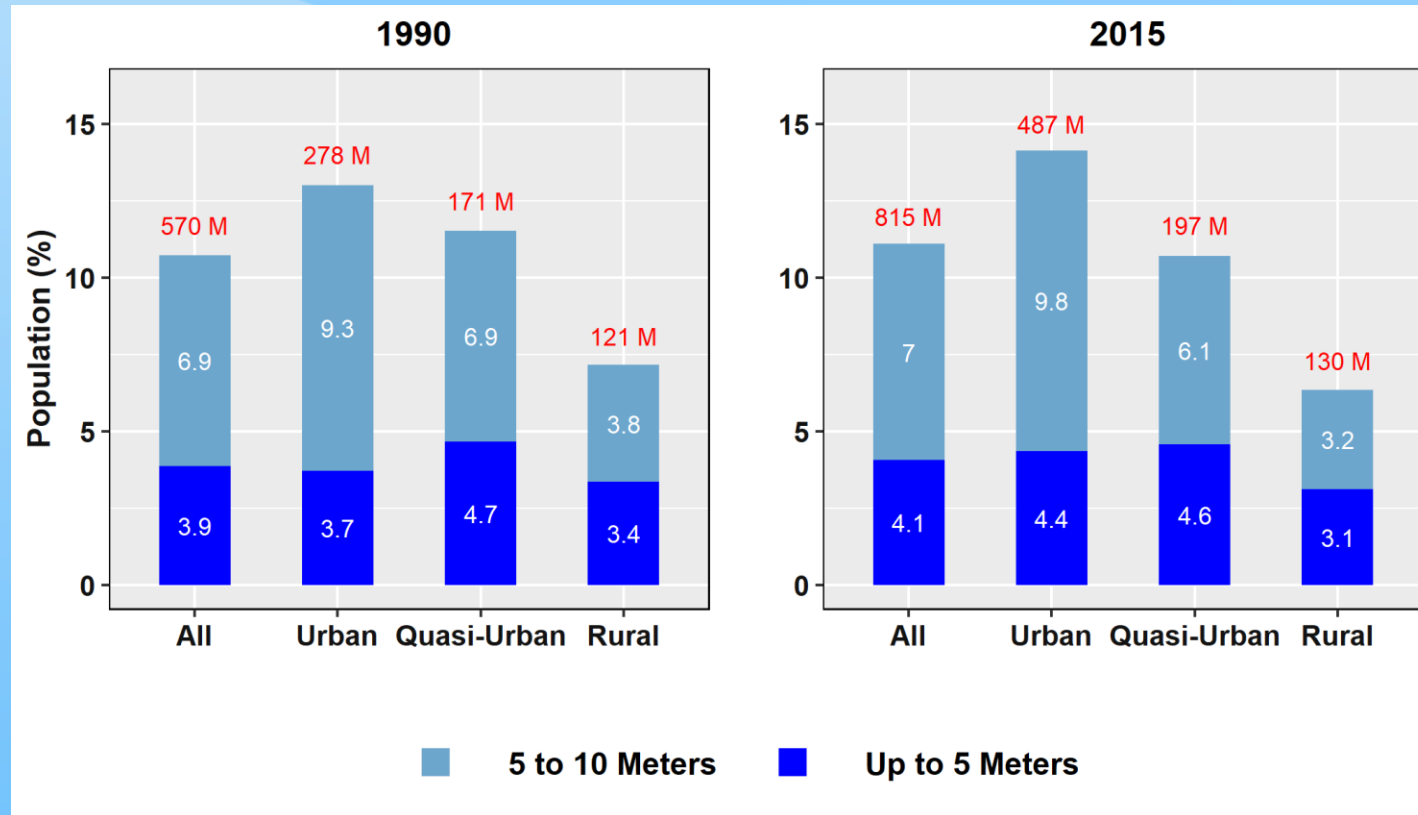
- But it places more urban residents in the LECZ
 - Nearly 15% of the population of Urban Centers and another 10.5% of persons living in Quasi-Urban Clusters

- The population of quasi-urban clusters and rural areas is nearly evenly split between 0-5m and 5-10m
- Whereas about one-third (and 105M persons) of Urban Center inhabitants live at this higher-risk

Proportion of Population in the LECZ, 2015

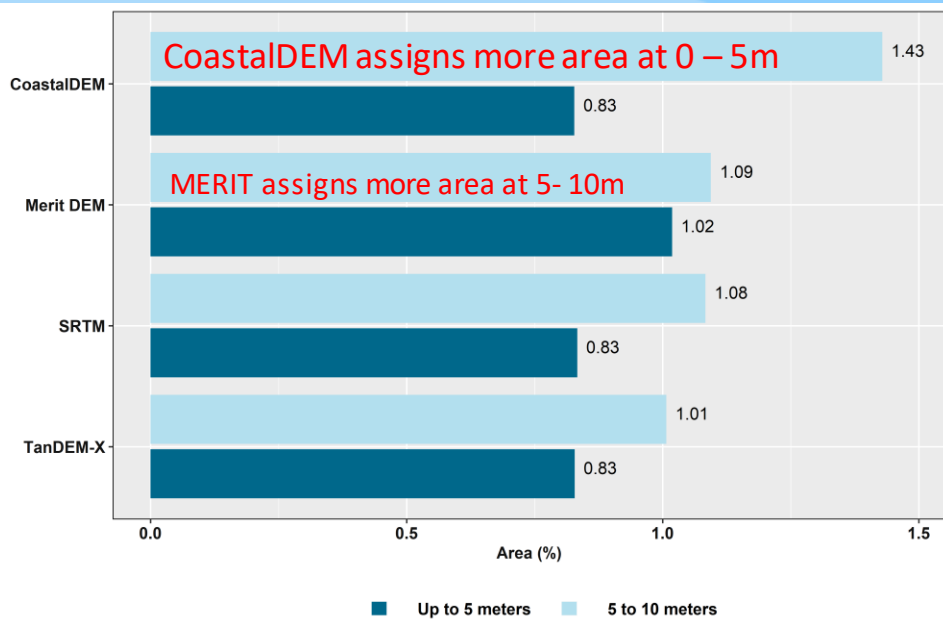


Changes over Time

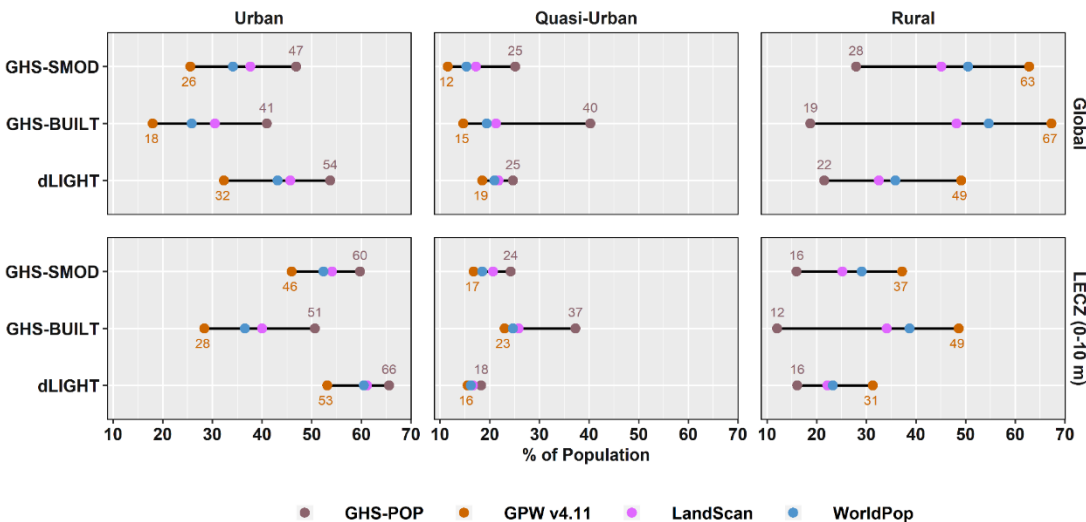
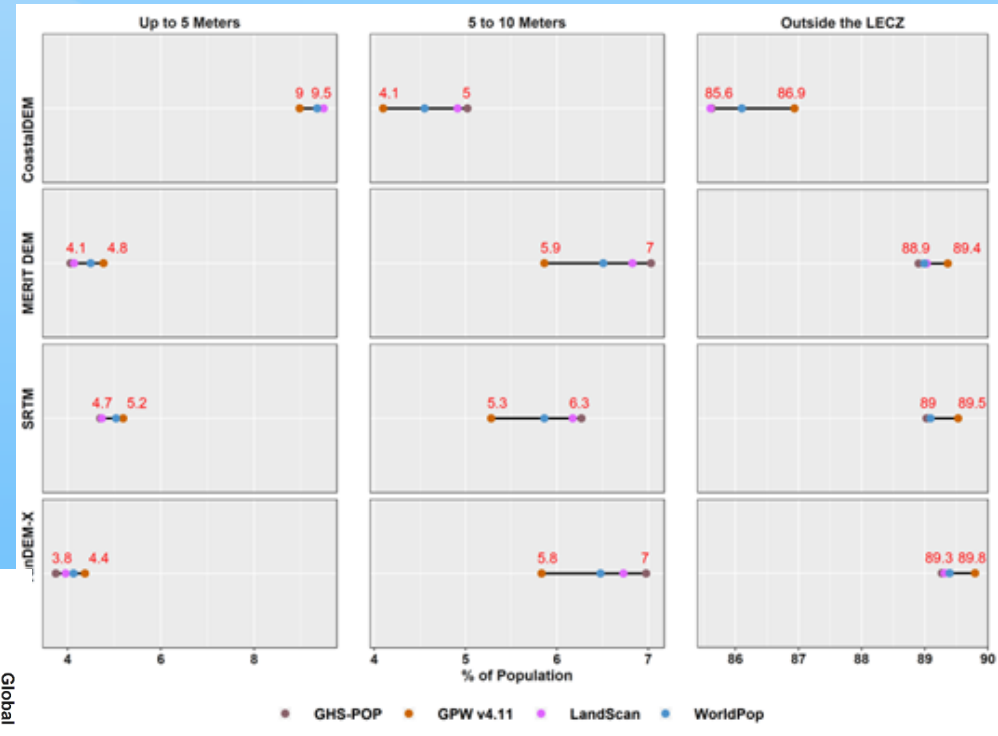


- Urban areas have experienced the greatest increase in population, from 1990-2015 but
- Urban areas within the LECZ have grown even faster than outside the LECZ
 - 75% increase in urban center pop in LECZ vs. 59% in urban centers outside of LECZ
 - Urban Center population in the 0-5m LECZ growth been fastest of all
 - Global averages driven by change in Asian cities

New Results: Sensitivity Analysis



- GPW most conservative and GHS-Pop most inclusive
- Estimates are more sensitive to the choice of DEM than Population



- GHS-POP concentrates more people in urban and quasi-urban
- GPW concentrates more people in rural
- Settlement estimates are highly sensitive to data source

Sensitivity Analysis: Data choices matter!

Data choices can lead to differences in estimates

- Large differences in estimates of potential SLR and coastal hazards
- While high agreement for urban centers and rural areas, but less so for the harder-to-classify areas (towns, peri-urban, sub-urban, etc)

Consistency in estimation

- Despite important differences, every source we evaluated shows that LECZs
 - are disproportionately urban
 - urban population in the LECZ is growing at a rate faster than we see outside of the LECZ

Fitness for use matters

- Depends on respective use cases
- Change over time?
- Better local data?

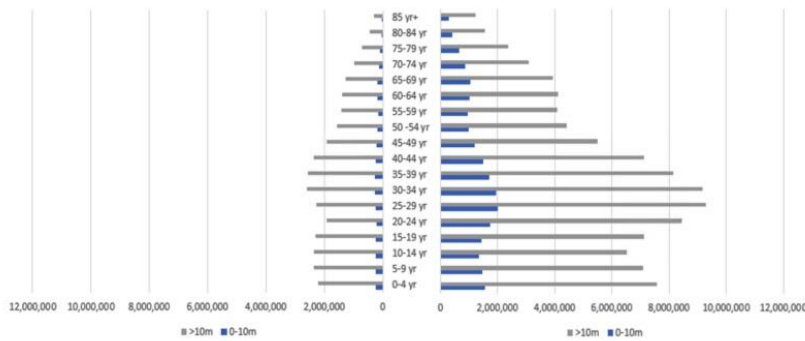
Exposures differ by vulnerability

Age & Urban/Rural

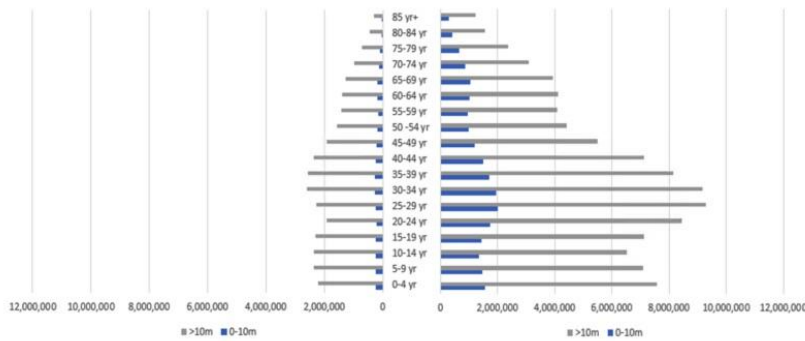
Race & Ethnicity

Housing Tenure

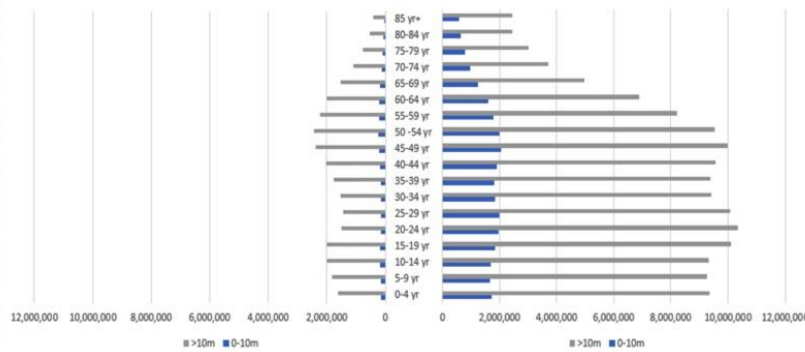
Rural Population in Coastal States, 1990



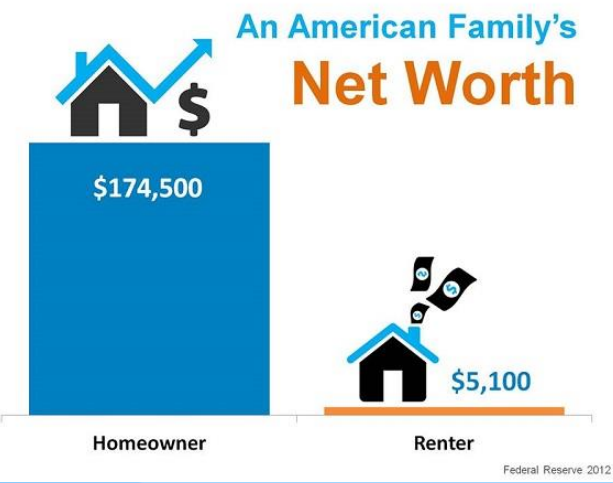
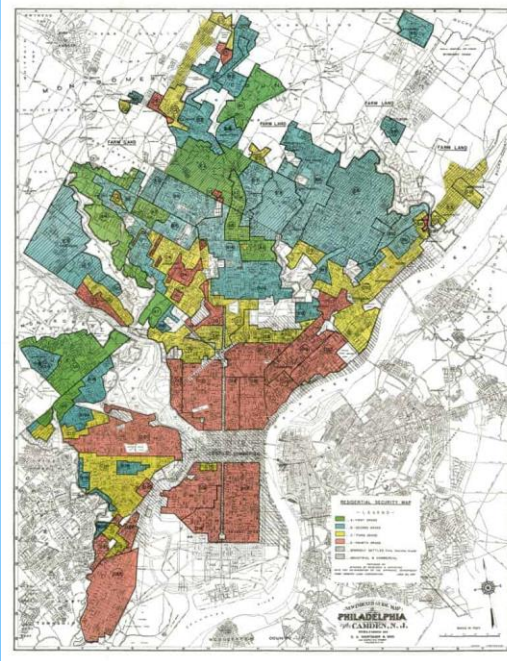
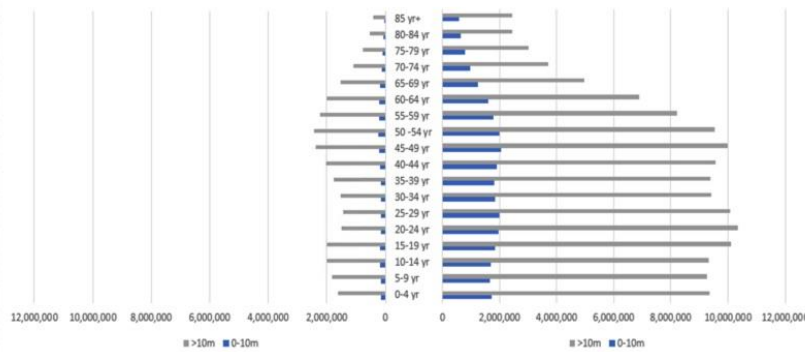
Urban Population in Coastal States, 1990



Rural Population in Coastal States, 2010



Urban Population in Coastal States, 2010



Vulnerabilities interact!

- In the US, exposure highly concentrated (to parts of 364/3100 counties) and 34 M persons.
- It is disproportionately to urban dwellers, and to communities of color, who are disproportionately residents of cities.
 - Blacks have the highest shares of population in both the urban and rural LECZ, with about 1 in 5 urban Black residents living in the LECZ.
 - Black and Hispanic householders are nearly twice as likely as Whites to live in urban renter-occupied housing in the LECZ.
- Residents of the LECZ are older.

Evidence from a decade+ of study

Data choices matter, but main finding agree:

- All evidence shows that the LECZ is disproportionately urban and
- In the past 25 years, cities have grown faster *inside* LECZ than outside, particularly in locations of high vulnerability like deltas and Florida. Local variability is notable:
 - Globally, this places Asian deltaic cities at very high risk
 - In the US, this places more communities of color at risk
- The LECZ is heterogenous – deltaic dominance in Asia, but not so in the US
- This research has and can (with extensions to) continue to inform planning decisions, future population projections and scenario development!

Causes of urban growth in the LECZ remain unanswered

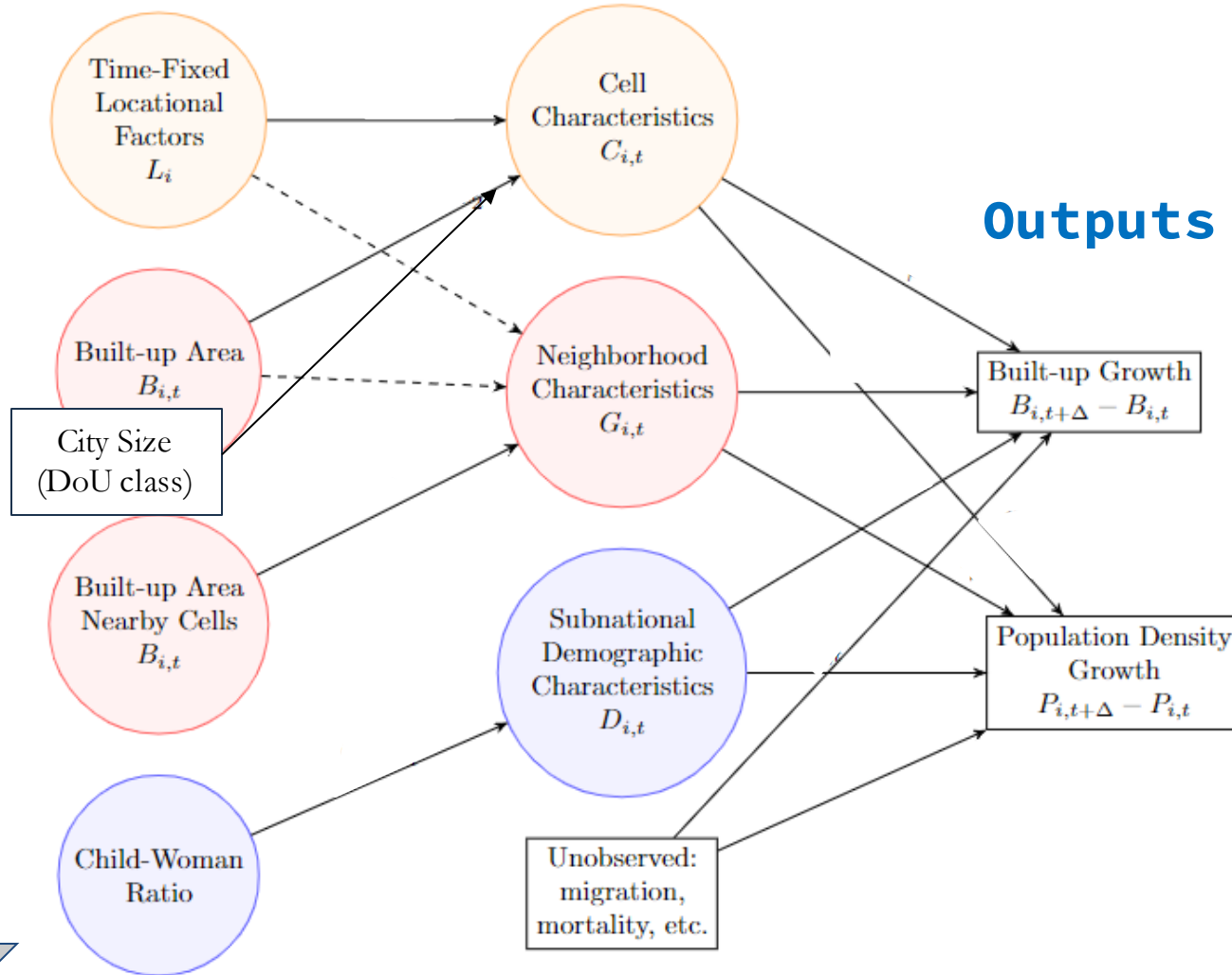
- Land expansion of existing cities or the emergence of new urban places?
- The role of migration vs. natural increase is unknown!

Answers would assist in climate adaptation and mitigation!

A new way of projecting & preparing for our urban future

Spatial Scale (fine to coarse)

Indicators



Fixed locational factors may include:

- Permanent Water
- Elevation
- Slope
- Aridity
- Coastal zones
- (Major Ports)

Neighborhood influences include distance gradients

One difference between the built-up and population density growth models is the addition of the city-size class for pop density growth

A collaboration of CUNY, Stony Brook, the Population Council & the University of Colorado Boulder. With funding from the European Commission, and partners at the Joint Research Center of the EC.



SUMMING UP!

Lessons for Policy & Research

Urban population growth is all but certain

- The form and **causes** of that growth much less certain
 - Including becoming a destination for those leaving climate-stress areas
- This places cities and their populations at risk of climate-hazards

Use approach with any spatially delineated hazard

- Heat or drought, wildfires, inland (pluvial) flooding, ...
- Notably, remote-sensing and environmental data are more and more available and easier to use
 - Measures of vulnerability and demographic change however come from censuses and surveys so we must be prepared to work with interdisciplinary methods and perspectives
- Some hazards are harder to study (storm paths) so think of new ways to capture this information

Enhance description and move beyond description

- National statistical office continue to improve and make available increasingly thematically, spatial data
 - But rich our data infrastructures are still primed on the 20th century. Time is now to update!
- Use place-based finding to help improve our understanding of causal processes behind vulnerability and the demographic components of change

Thank you!

- Works cited:
 - McGranahan et al. 2007
 - Climate Emergency: Urban Opportunity
 - <https://urbantransitions.global/en/publication/climate-emergency-urban-opportunity/>
 - MacManus et al. 2021
 - <https://essd.copernicus.org/articles/13/5747/2021/>
- Data and code (global study):
 - <http://www.ciesin.columbia.edu/data/lecz-urban-rural-population-land-area-estimates-v3/>
 - Delta summary data coming soon
- Contact: deborah.balk@baruch.cuny.edu

