

The Rising Tide:

Population Exposure and Change in Low-lying Coastal Areas across the Globe and in the United States

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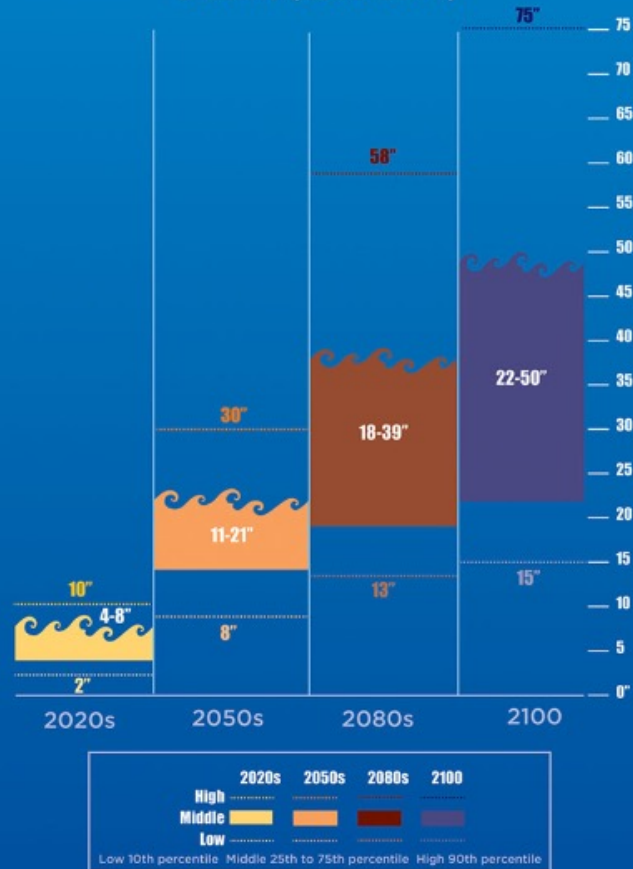
PROLOGUE: STUDY MOTIVATION

- Pressing questions
- Entering the policy discourse
 - First stop, the Intergovernmental Panel on Climate Change (IPCC)
- Retooling and blending methods and approaches
 - Using spatial methods in support of the description of population trends

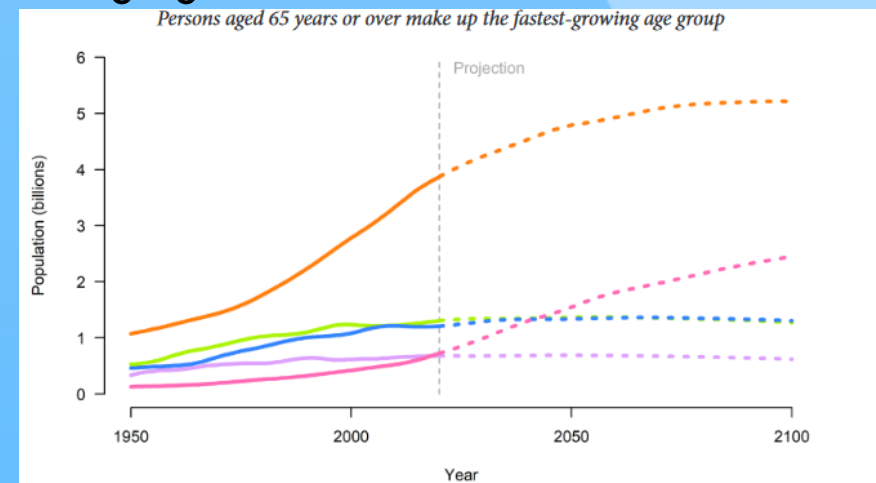
Certainties in an Uncertain Century

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

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



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



NPCC2 (2015)

Evolution of the IPCC Assessment Reports and attention to 'urban'

- AR3 (2001): Role of **population growth** important for understanding climate futures.
- **AR4 (2007)**: First mention of **human settlements** in the context of population exposure and adaptation frameworks, in connection with understanding seaward hazards. Small Island States.
- AR5 (2014): **Urban Areas** (Ch 8, WGII), Shared Socioeconomic Pathways (**SSPs**) framework
- SR1.5 (2018): What the IPCC Special Report on Global Warming of 1.5°C Means for Cities
- AR6 (2021-22):
 - WGII* (2022) **Chapter 6: Cities, settlements** & key infrastructure
 - WGIII** (2022) **Chapter 8: Urban systems and other settlements**
- AR7 (202?): Special Report on climate change and cities

* WGII = Impacts, Adaptation and Vulnerability

** WGIII = Mitigation of Climate Change

Key Messages from AR6

- In all cities and urban areas, the risk faced by people and assets from hazards associated with climate change has increased
- The number of people *expected* to live in urban areas highly exposed to climate change impacts has increased substantially
- Evidence from urban and rural settlements is unequivocal;
 - climate impacts are felt disproportionately in urban communities, with the most economically and socially marginalised being most affected
- Urban adaptation gaps exist in all world regions and for all hazard types, although exposure to the limits to adaptation is unevenly distributed.
 - Governance capacity, financial support and the legacy of past urban infrastructure investment constrain how all cities and settlements are able to adapt
- Global urbanisation offers a time-limited opportunity to work toward widespread and transformational adaptation and climate resilient development

Introducing the LECZ

- We estimated for the first time that...

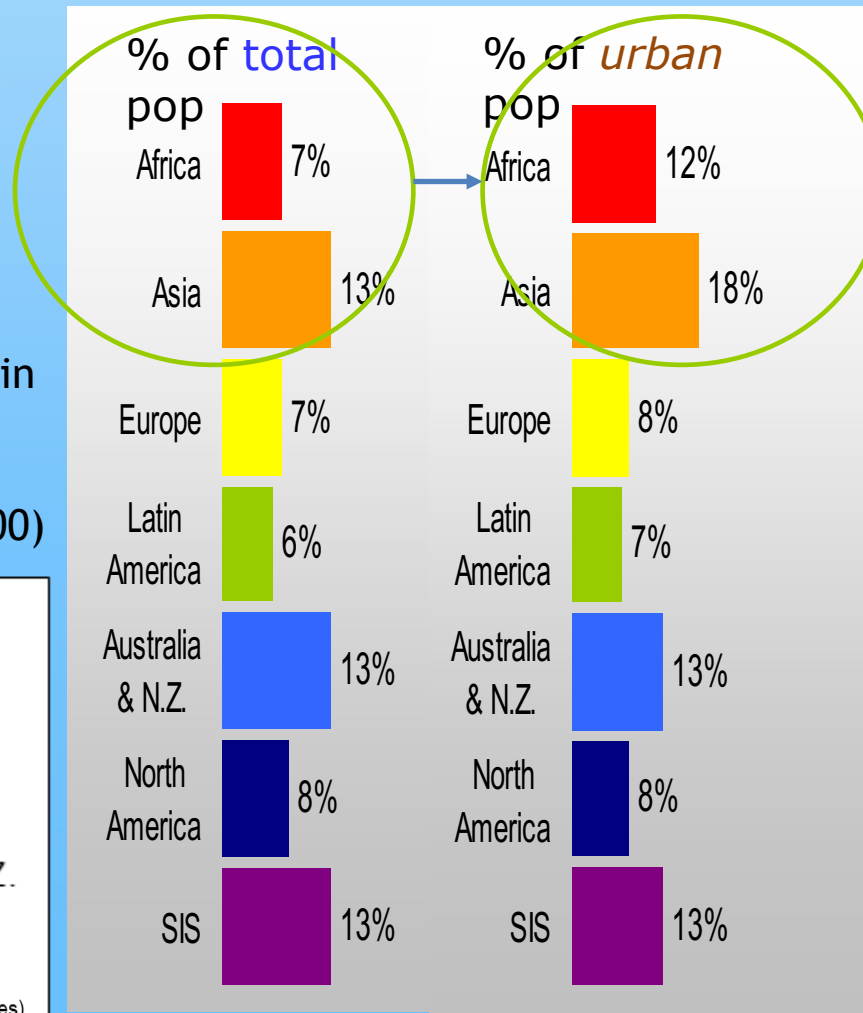
- **1:10** person lives in the **Low Elevation Coastal Zone (LECZ)**

- 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

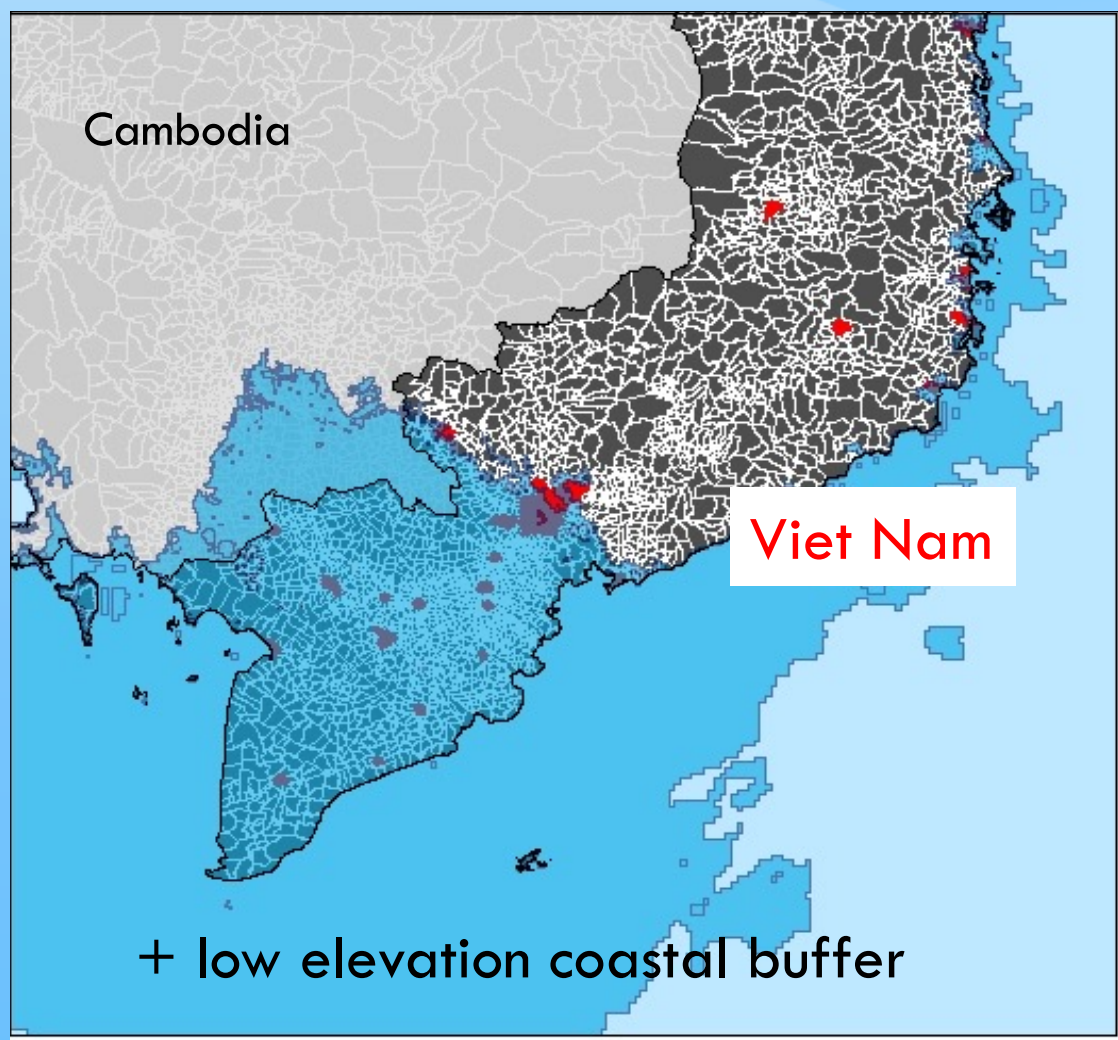


Persons living in the LECZ (millions), by continent (2000)

- 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



- Population (census) data is reported in irregular administrative units
 - Underlying spatial resolution varies by country and year
 - Transform to a quadrilateral grid (not shown)
 - Reallocation to grid ranges from lightly to heavily modelled
- To date, only population counts & density
 - Now, by modelled age & sex (2015)

Source: McGranahan, Balk and Anderson, 2007
(update in process, 2020)

Conclusions (c. 2007)

- The LECZ covers 2 per cent of the world's land area but contains 10 per cent of the world's population and 13 per cent of the world's urban population.
- A disproportionate number of the countries with a large share of their population in this zone are small island countries, but most of the countries with large populations in the zone are large countries with heavily populated delta regions.
- On average, the low-income countries have a higher share of their population living in the zone (14 per cent) than do OECD countries (10 per cent), with even greater disparities in the urban shares (21 per cent compared to 11 per cent).
- Almost two-thirds of urban settlements with populations greater than 5 million are situated, at least partly, in the zone.
- In some countries (most notably China), urbanization is driving a movement in population towards the coast.
- Reducing the risk of disasters related to climate change in coastal settlements will require a combination of mitigation, migration and settlement modification.

The rising tide: assessing the risks of climate change and human settlements in low elevation coastal zones

Gordon McGranahan, Deborah Balk, Bridget Anderson

First Published April 1, 2007 | Research Article

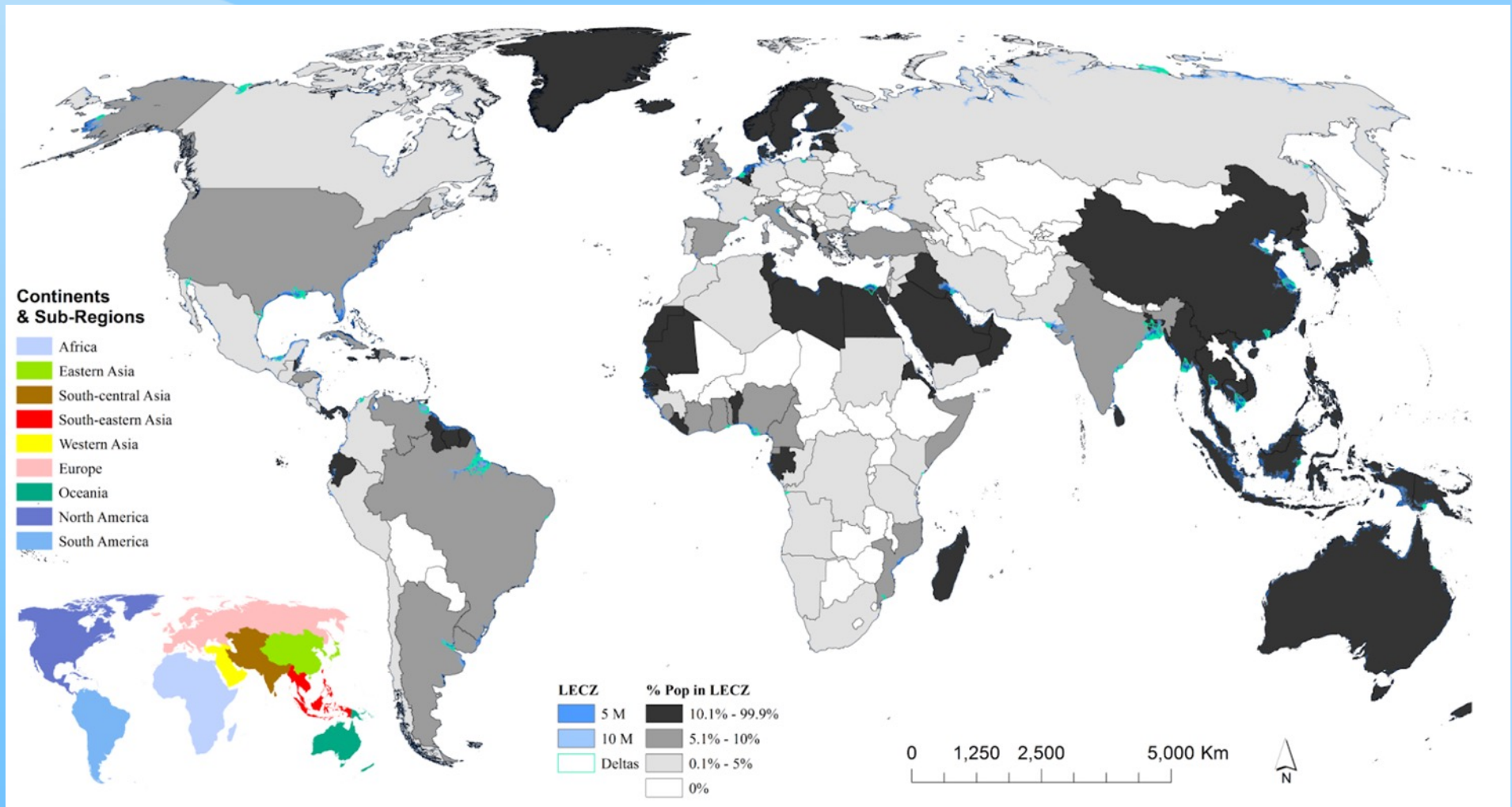
<https://doi.org/10.1177/0956247807076960>



Studies covered today

- Updated global estimates
- Decomposing the LECZ further into the deltaic and non-deltaic zones
- Focusing on the US coastal states

NEW GLOBAL ESTIMATES



Kytt MacManus, Deborah Balk, Hasim Engin, Gordon McGranahan, and Rya Inman, (2021) **Estimating population and urban areas at risk of coastal hazards, 1990–2015: how data choices matter**, [Earth Systems Science Data](#), 13, 5747–5801, 2021

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*

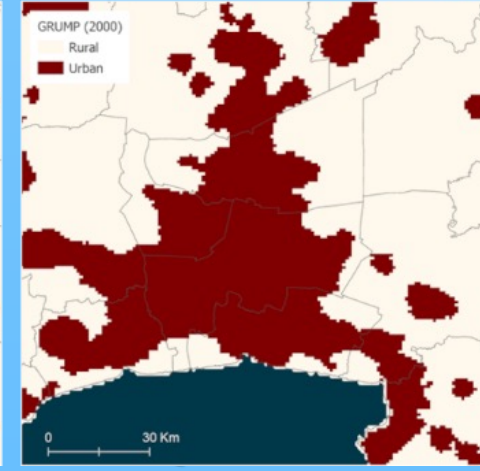
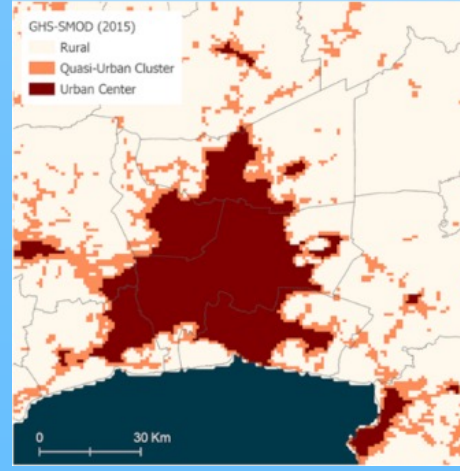
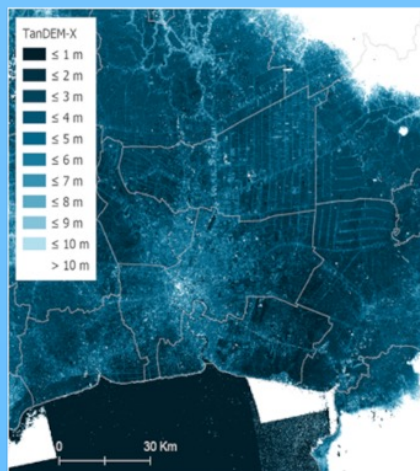
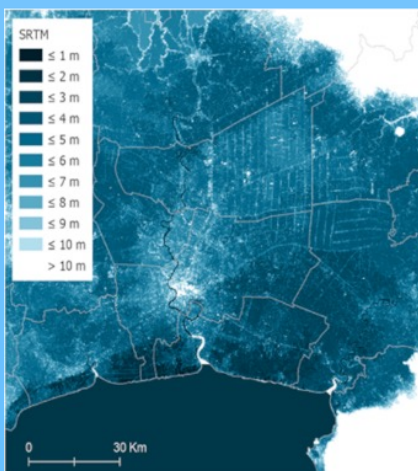
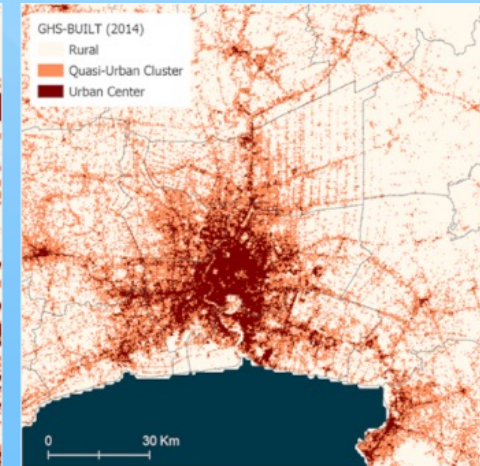
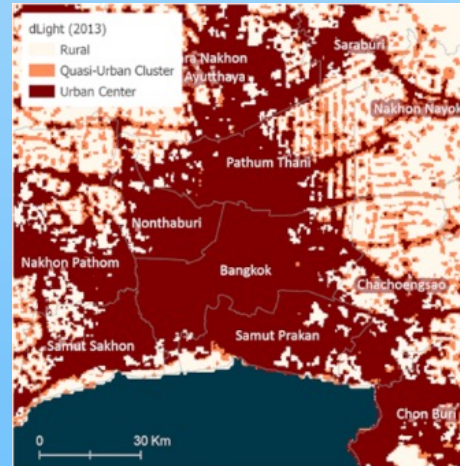
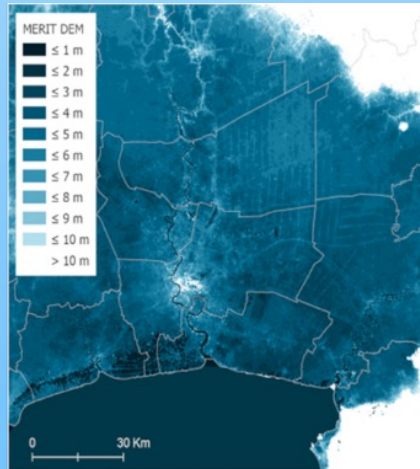
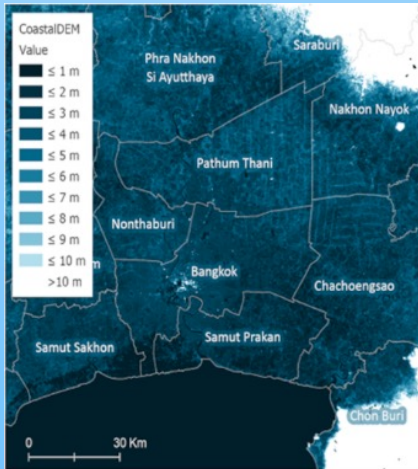
Urban-proxy data and models

- 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

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



Many data choices

- Gridded Population Models

- GHS-POP

- 1990-2015

- GPW

- 1990-2015

- LandScan

- 2000-2015

- Restricted use

- WorldPop

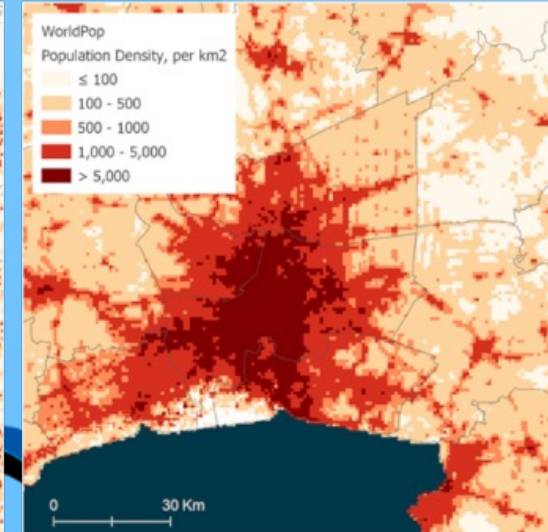
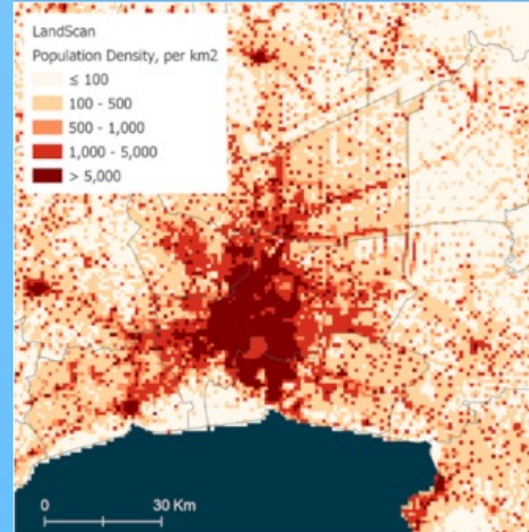
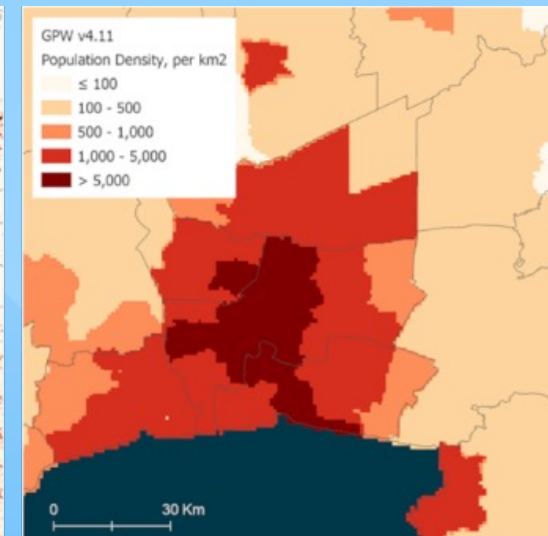
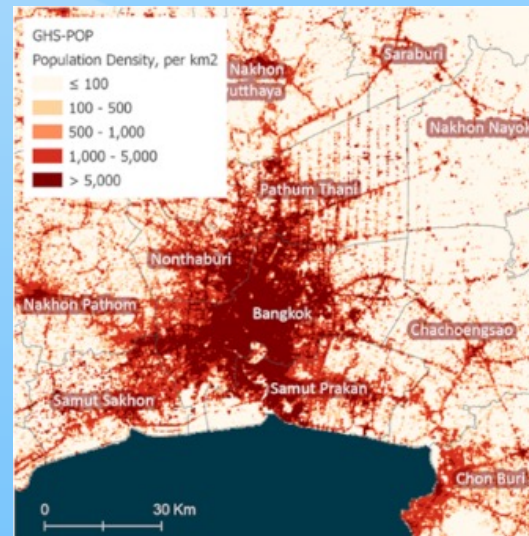
- Differ in:

- Underlying data

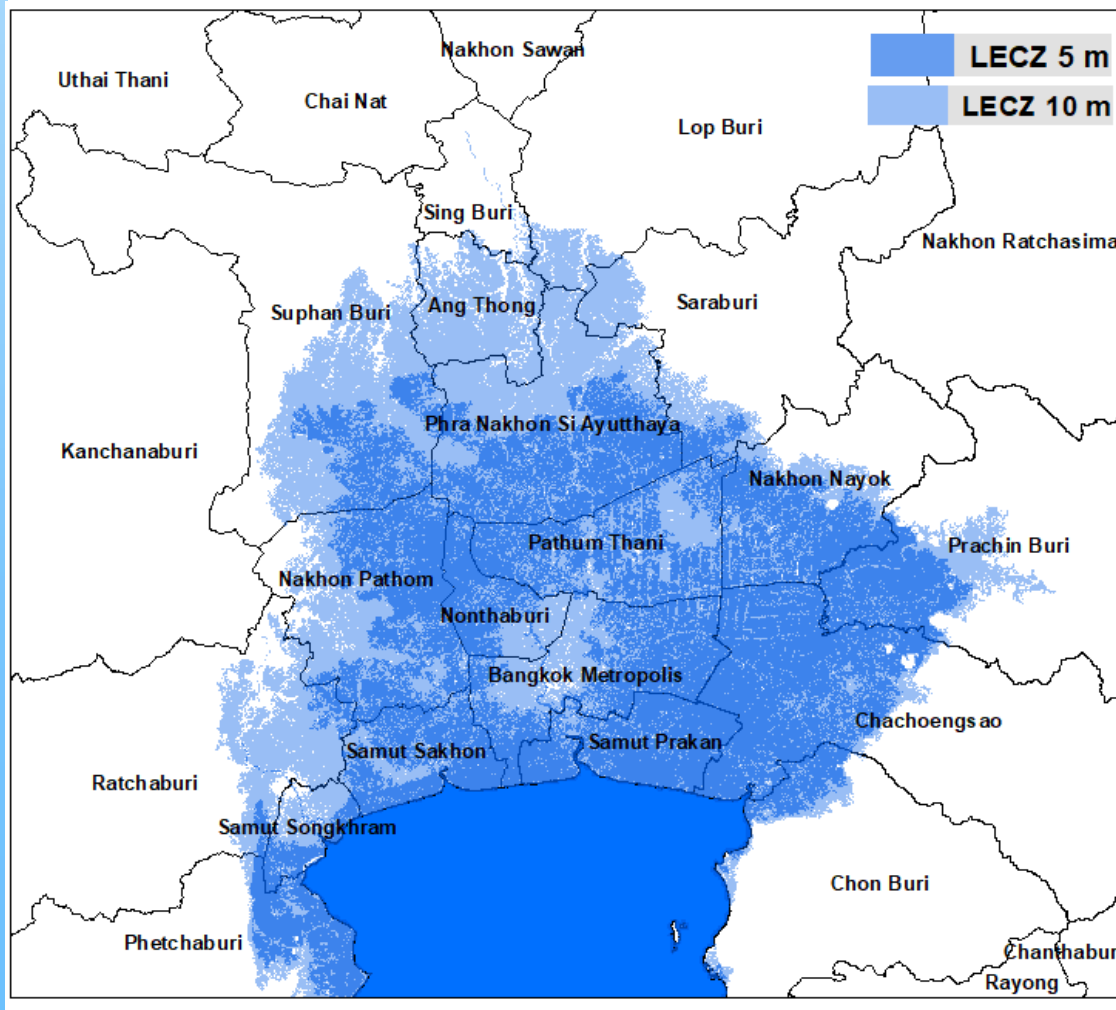
- Modelling inputs

- Modelling methods

See Leyk et al. 2019



LECZ: 0-5 vs. 5-10m

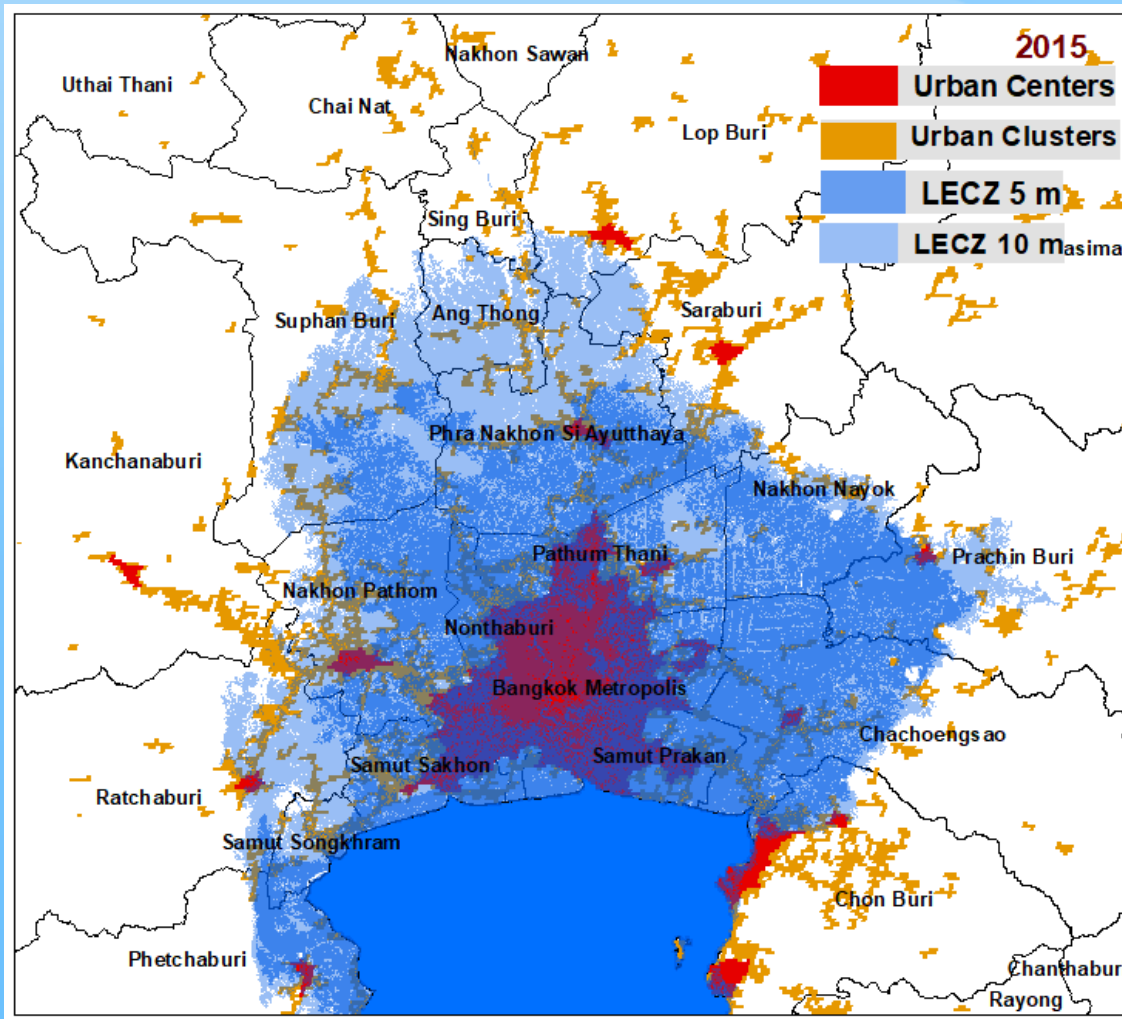


Technical details:

- SRTM 90m data, reconciled with coastlines
 - Only global data layer available for such measure
- Recent studies still caution against using SRTM-based data to consistently measure LECZ at elevations below 10m
 - Tension between policy & planning and the science
 - We treat our results here as suggestive but not definitive

Data Source: Low Elevation Coastal Zone, v3 CIESIN (2021)

Urbanization: Urban Centers & “Quasi-urban Clusters”



Technical details:

- Urban Classes

- Urban Center

- Pop density $> 1,500/\text{km}^2$
or population $> 50,000$

- Quasi-urban Cluster

- Pop density $> 300/\text{km}^2$
and population > 5000

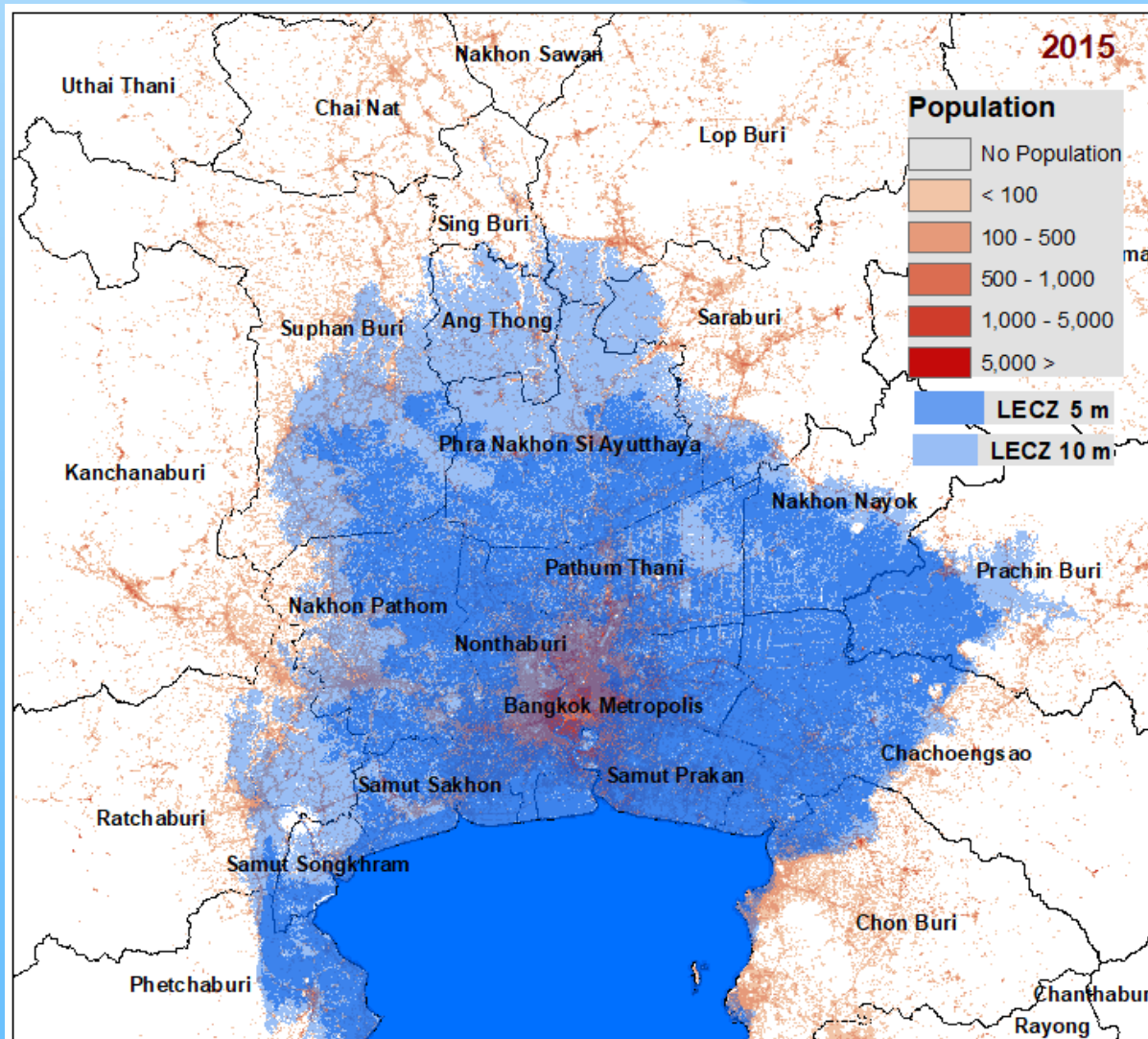
- 1990-2000-2015

- 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)

Population Distribution: 1990-2015



Technical details:

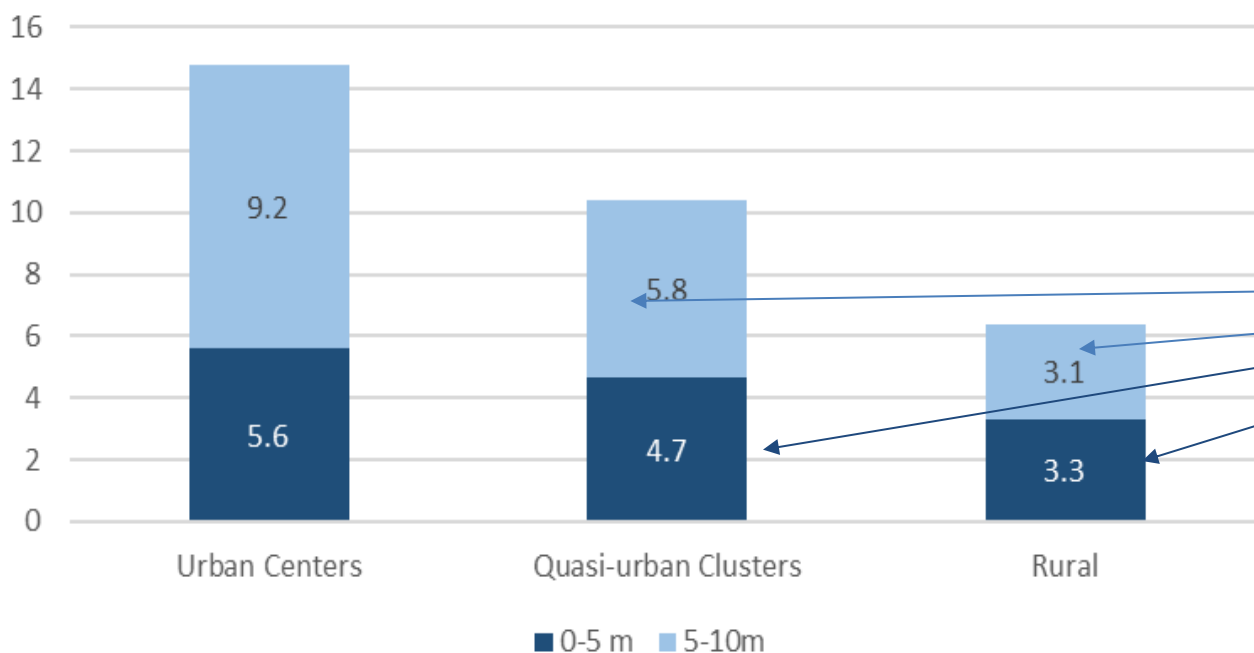
- **Gridded Population Model**
 - Uses Gridded Population of the World v4 inputs reallocated to built-up area based on the Global Human Settlement Layer (GHSL)
 - Consistent with *Degree of Urbanization* inputs
 - **Limitations**
 - Where GPW/Census inputs are coarse, possible over-allocation to built-up areas
 - Built-up detection is good but imperfect (more so in earlier years)

Data Source: GHS Population Grid (JRC and CIESIN, 2019)

What is Urban? Measurement Matters!

- Confirming our original findings, new estimates place 10.5% of the global population 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

Proportion of Population in the LECZ, 2015

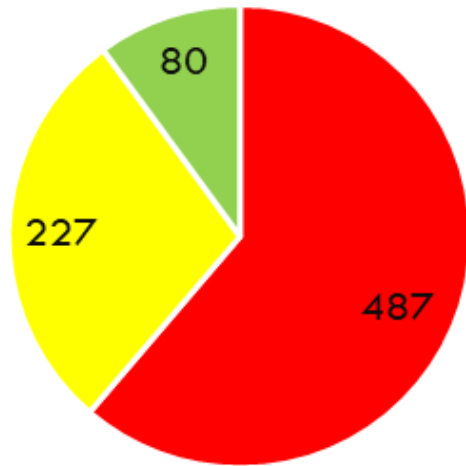


- The population of quasi-urban clusters and rural areas is nearly evenly split between 0-5m and 5-10m
- Whereas about one-third (and 105M persons) of Urban Center inhabitants live at this higher-risk

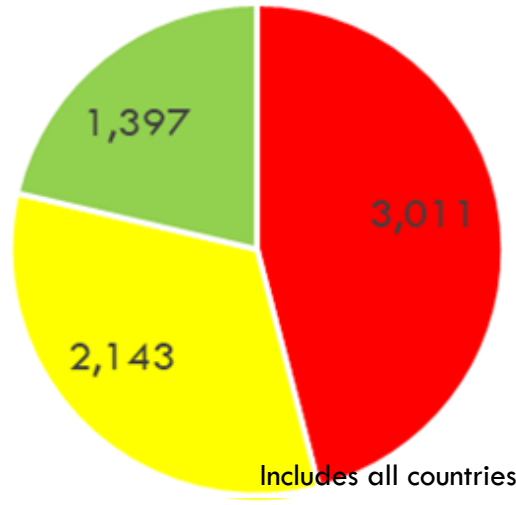
Distribution of Population & Land Area

Population (Millions)

Within the LECZ

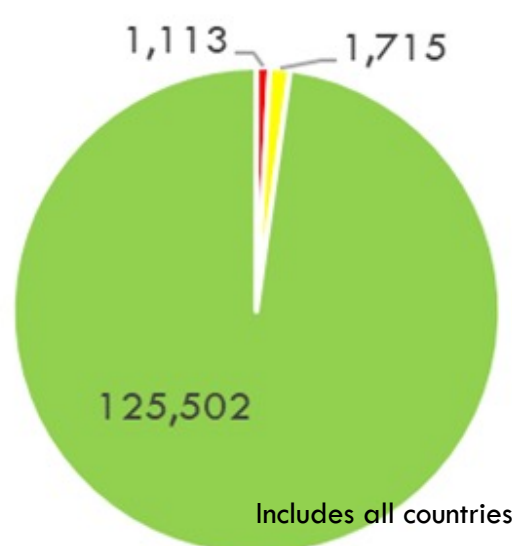
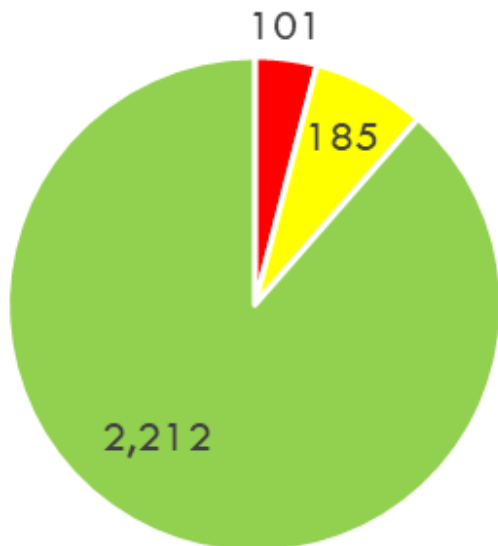


Beyond the LECZ



Urban Centers Quasi-urban Clusters Rural

Land Area (000 km²)

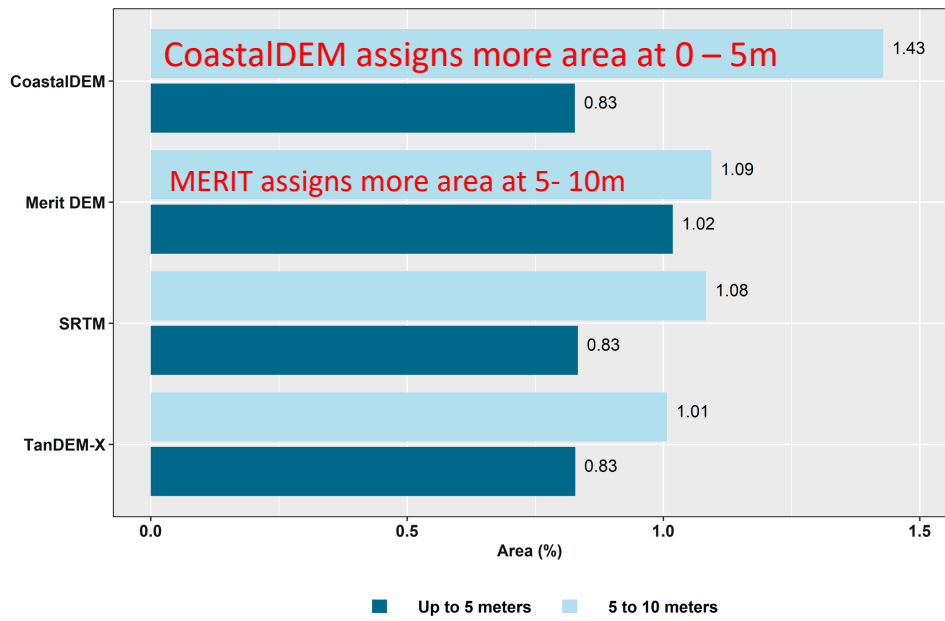


- 61% of the population of the LECZ lives in **Urban Centers** as compared to 47% beyond the LECZ
 - Slightly less than half live of those live in the 0-5m zone (not shown)
- 12% of land in the LECZ is an **Urban** or **Quasi-urban** area as compared to less than 2% of land beyond the LECZ
 - Fractions largely unchanged when including countries with no land area in LECZ
- Quasi-urban areas occupy more land and have more people than Urban area do everywhere

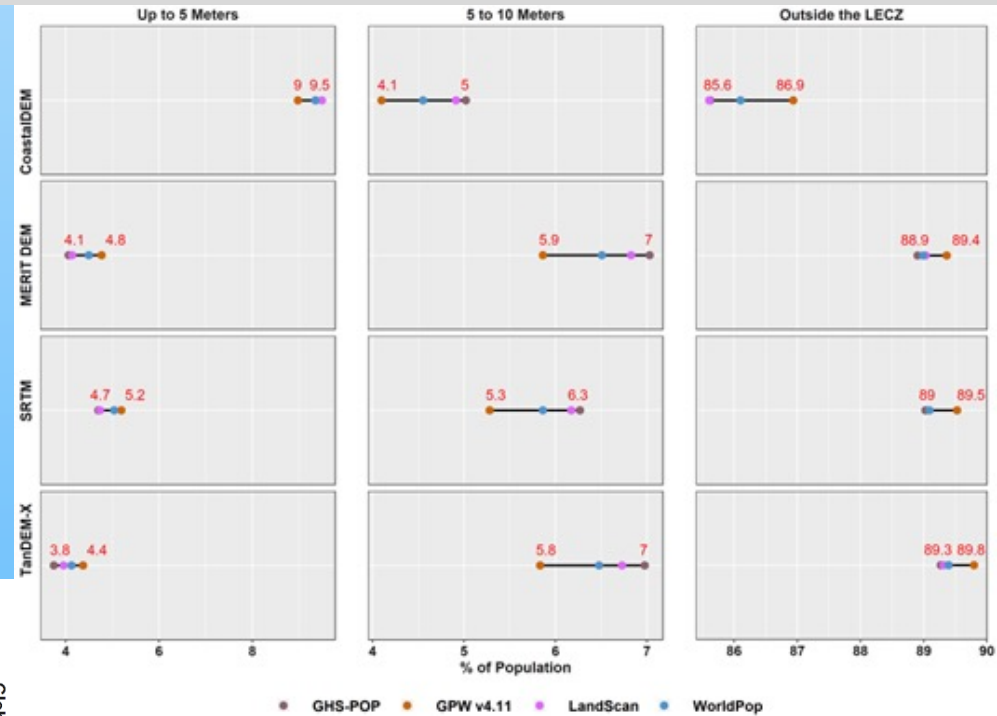
Population Density

- In 1990, the LECZ was nearly 6x more densely settled than land outside the LECZ
- With population growth faster in the LECZ, densities in 2015 were, on average higher in the LECZ
 - In the 5-10m portion of the LECZ and
 - In the urban centers of the those outside of it but this depends in part on the urban measurement used
- Likely causes:
 - LECZ's disproportionate urban nature combined with urban population growth
 - *In-situ* urbanization and expansion of urban land
 - Which may lower densities in such locations

Results in a Nutshell

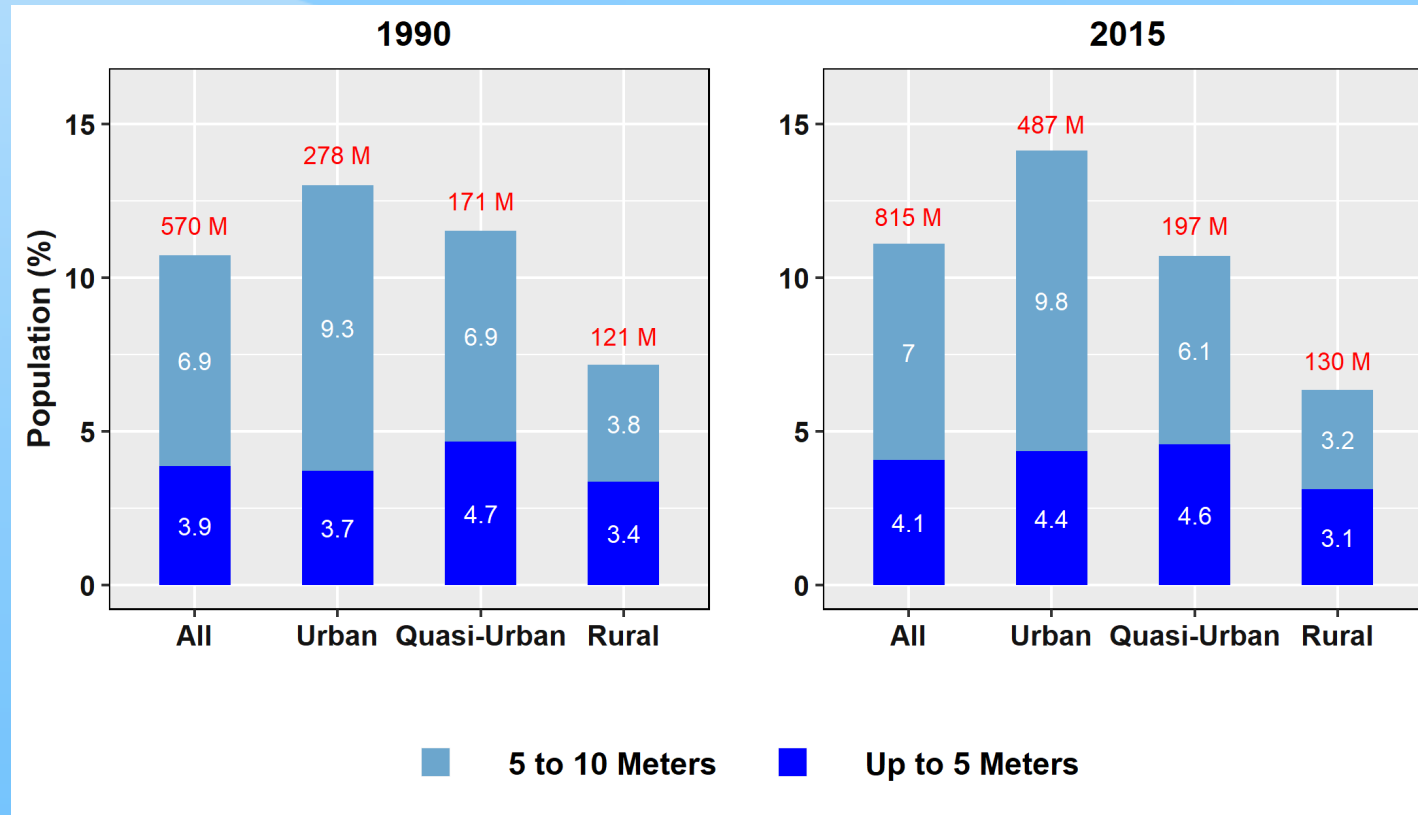


- GPW most conservative and GHS-Pop most inclusive
- Estimates are more sensitive to the choice of DEM than Population



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

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 (next)

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

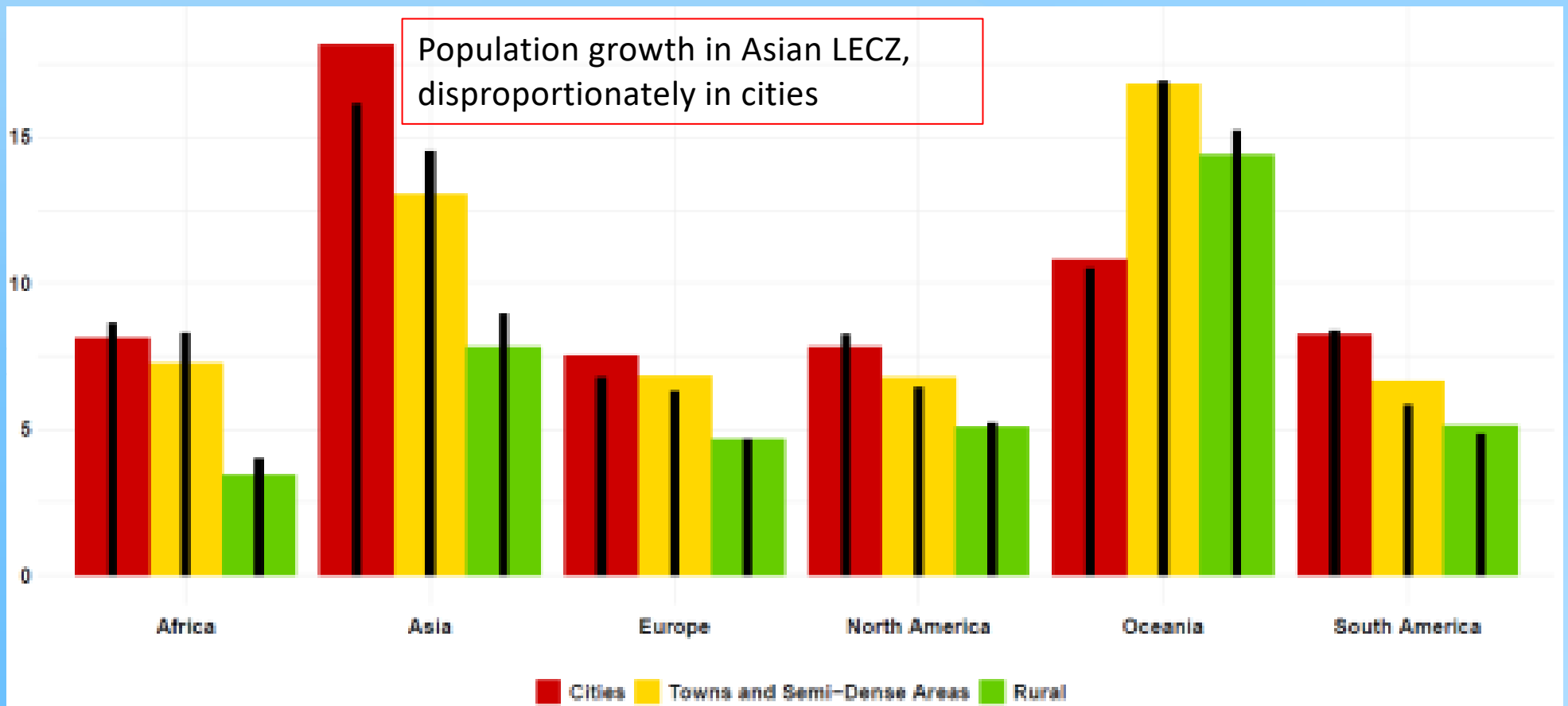
- Despite important differences, every source we evaluated shows that LECZs
 - are disproportionately urban
 - urban population in the LECZ is growing at a rate faster than we see outside of the LECZ

Fitness for use matters

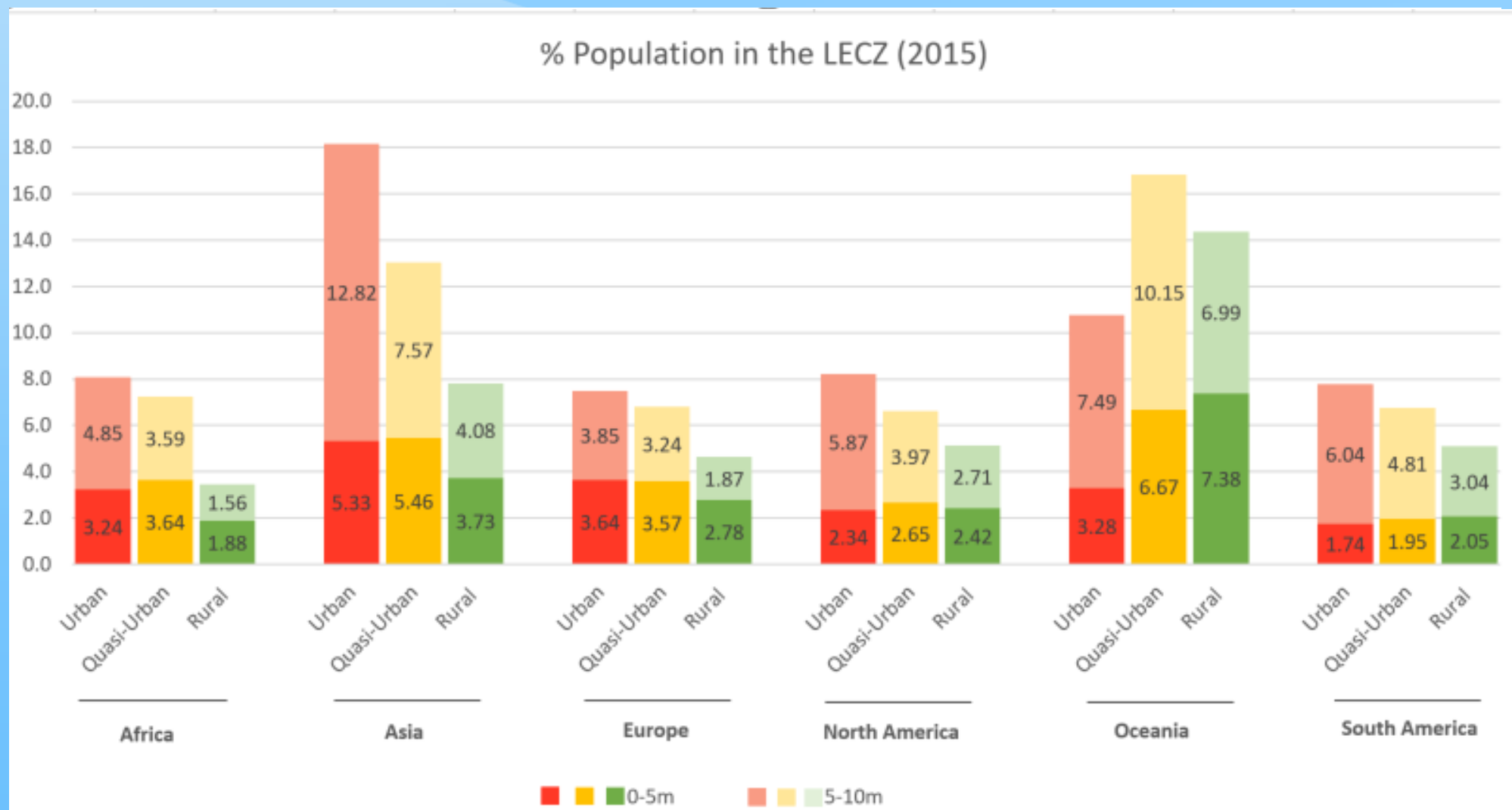
- Depends on respective use cases
- Change over time?
- Better local data?
- (see paper for full discussion)

Pop Change: Regional differences

% Population <10m LECZ, by urban continuum, 1990 (black bars) – 2015 (colored bars)



Continental view by LECZ zones



- Cities at risk everywhere, but especially in Asia's 0-5m LECZ
 - Many large cities – Bangkok, Dhaka, Kolkata, Saigon – are situated in Deltas.

“Top ten” countries at risk

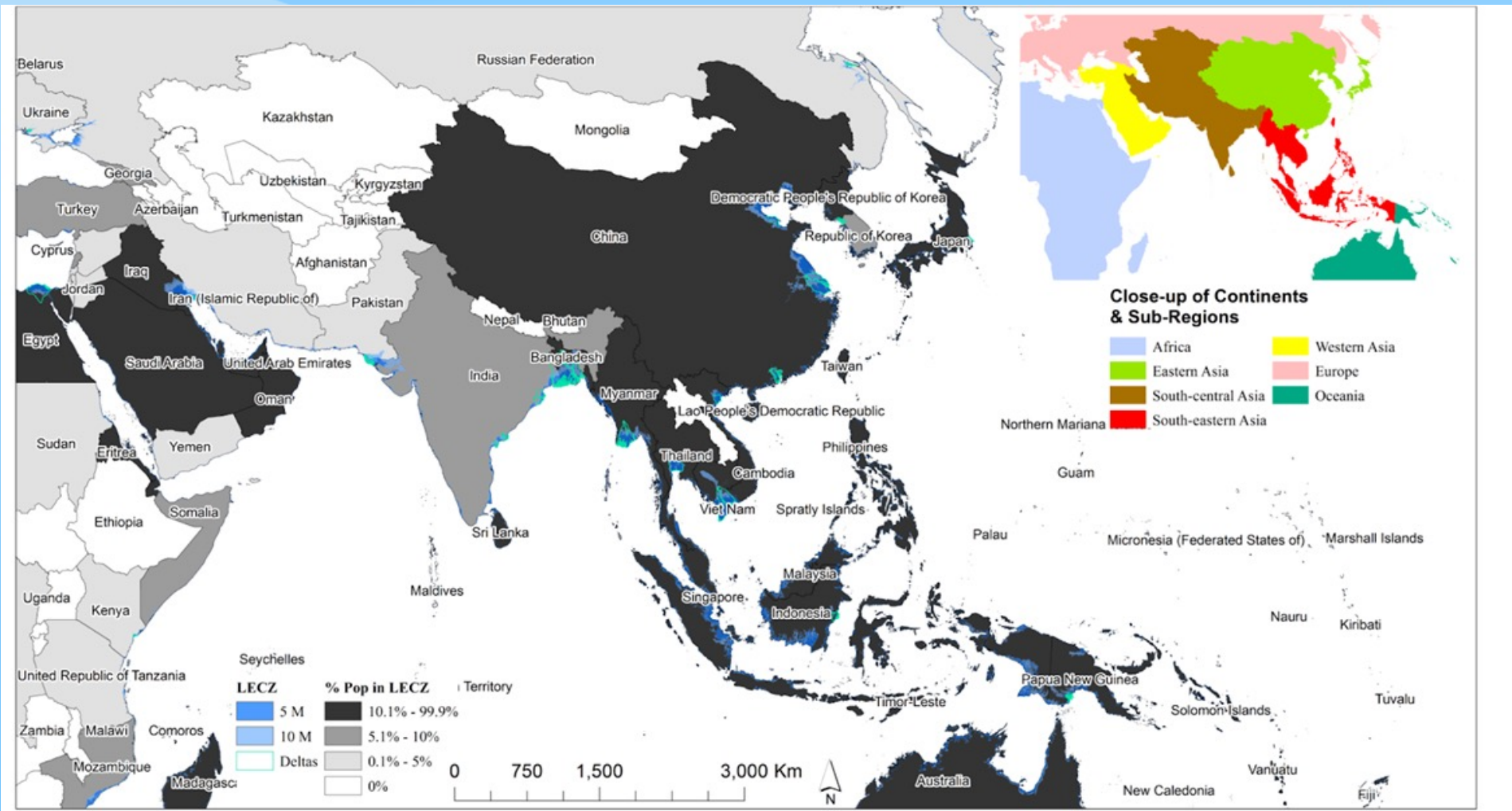
- Deltas at risk, particularly in Asia!
- Small Island States (SIS), too.

Total population (000s) living in Urban Centres and Quasi-Urban Clusters in the LECZ: Ranked by Population in Urban Centers				
Country (Rank)	in Urban Centers		in Urban Centers + Quasi-urban Clusters	
	Count	(%)	Count	(%)
China (1)	129,507	(23)	181,635	(17)
India (2)	55,216	(8)	70,827	(7)
Bangladesh (3)	40,912	(47)	62,875	(44)
Indonesia (4)	34,805	(24)	47,402	(23)
Japan (5)	26,593	(32)	33,446	(29)
Viet Nam (6)	23,871	(62)	44,556	(60)
United States of America (7)	17,607	(11)	23,027	(10)
Thailand (8)	16,811	(81)	21,460	(54)
Egypt (9)	14,200	(24)	25,579	(30)
Philippines (10)	12,998	(33)	19,038	(32)

Note: Countries with a total population of under 100,000 people, or smaller than 1,000 square kilometres were excluded from this list.

Ranked by share of population living in urban centres in the low elevation coastal zone				
Country (Rank)	in Urban Centers		in Urban Centers + Quasi-urban Clusters	
	Count	(%)	Count	(%)
Guyana (1)	226	100	447	95
Suriname (2)	201	100	356	97
Thailand (3)	16,811	81	21,460	54
Bahamas (4)	169	80	259	83
Netherlands (5)	6,027	77	9,731	70
Mauritania (6)	1,175	76		
Djibouti (7)	474	69	508	63
Liberia (8)	1,053	64		
Viet Nam (9)	23,871	62	44,556	60
United Arab Emirates (10)	3,875	57	4,407	53
French Guiana			141	69
Belize			152	58

FROM GLOBAL → REGIONAL



w/Gordon McGranahan, Sarah Colenbrander, Hasim Engin, Kytt MacManus (in review). **Is rapid urbanisation of deltas undermining adaptation to climate change long term? A global review of population and built-up area in risk-prone coastal areas**

Delta LECZ Study, 1990-2015

Differs from **global** study in that we add spatial data delineating major deltas

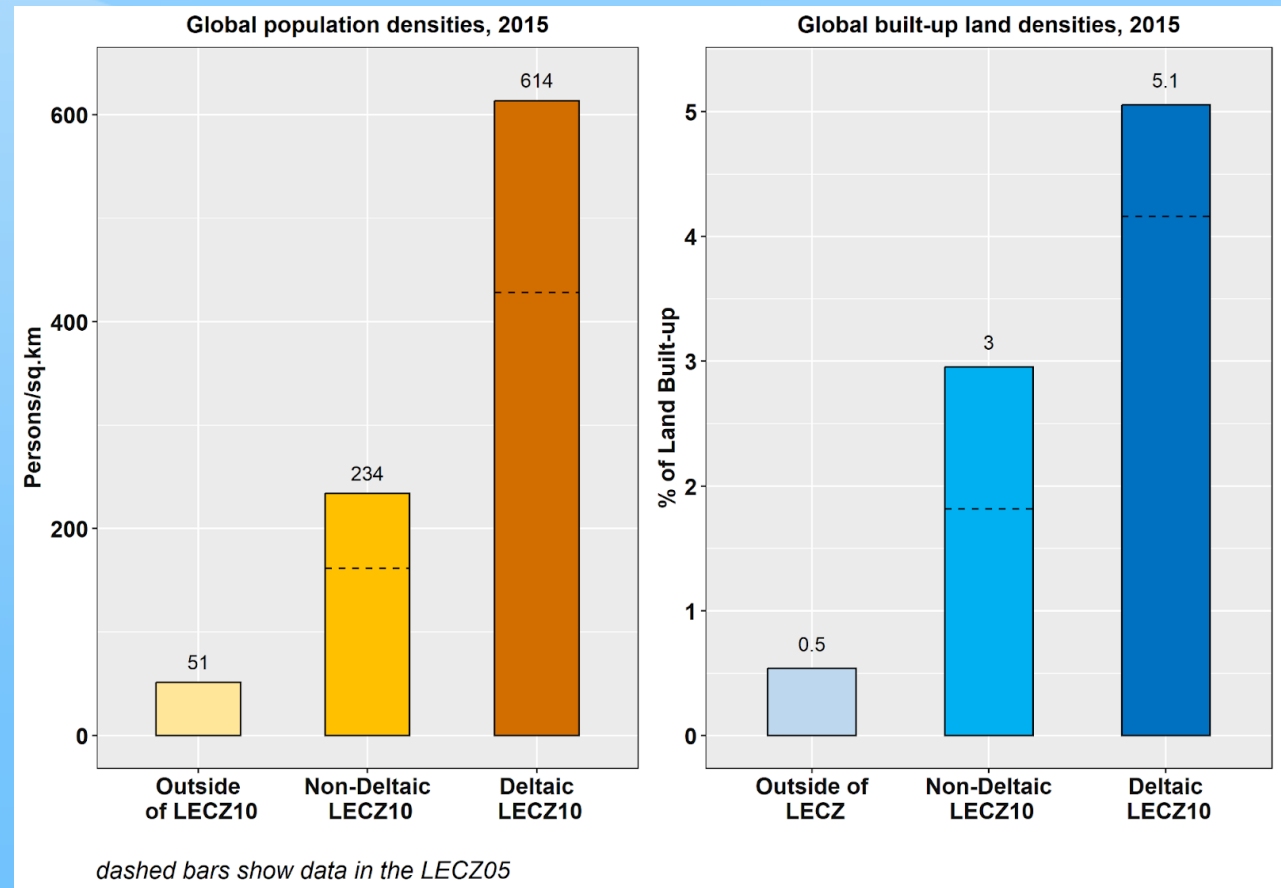
- Comparisons of LECZ in and out of deltas
 - + Delta data (Tessler et al., 2016)
- Necessitates a focus on Asia (and its subregions)

Differs from **prior studies of population in deltas**

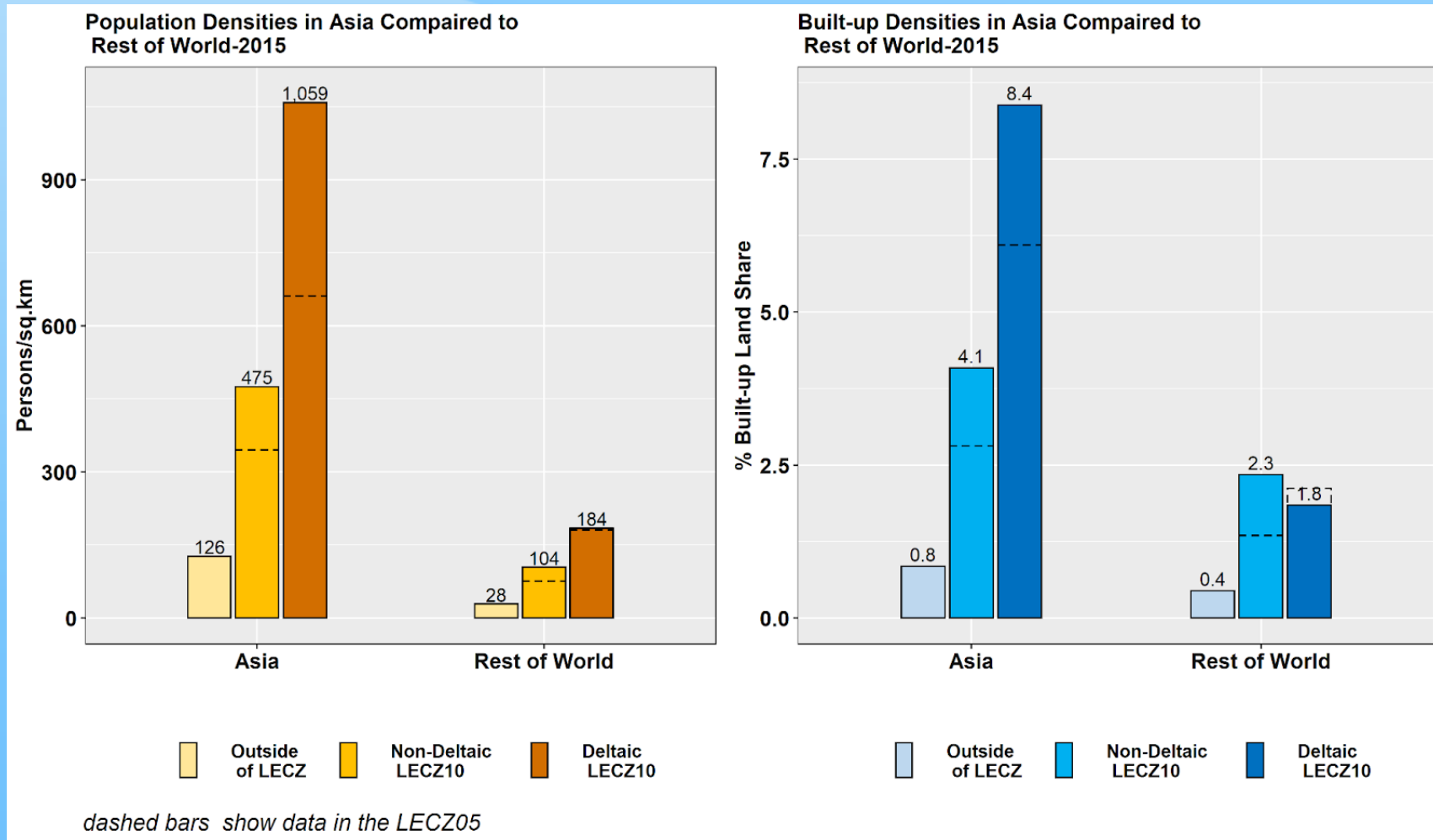
- By looking at change over time in population and built-characteristics and
- By looking exposures in LECZ overall (LECZ10 = 0-10m) vs higher risk zone (LECZ5 = 0-5m only)

Concentration of LECZ in Deltas

- Land in the deltaic LECZ10 was 2.6 times as densely populated as non-deltaic LECZ10 land in 2015
 - Non-deltaic LECZ10 land was 4.6 times as densely populated as land areas outside the LECZ10.
- The built-up densities display a similar pattern: the deltaic LECZ10 was 1.7 times as densely built-up as the non-deltaic LECZ10
 - non-deltaic LECZ10 6.0 times as densely built-up as outside the LECZ.
- Deltaic LECZ10 densities are regionally and locally (e.g. urban-rural) heterogeneous



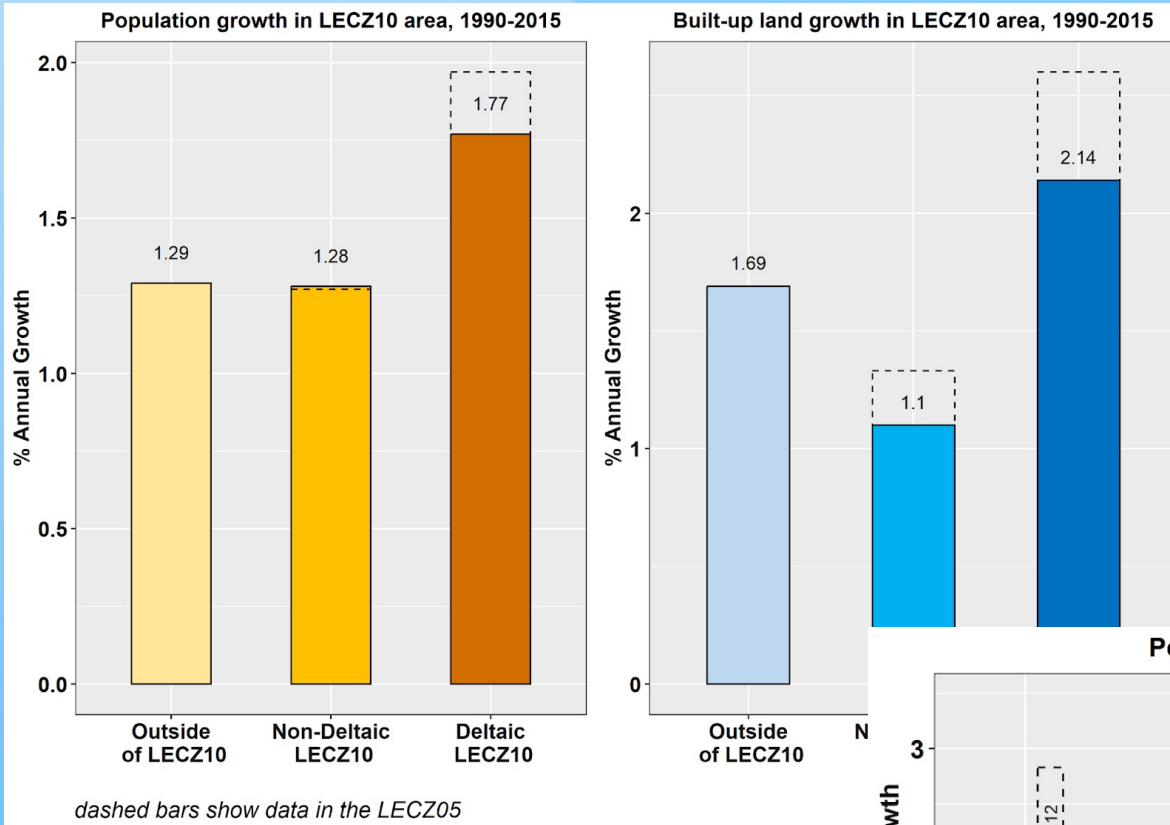
Concentrations in Asia



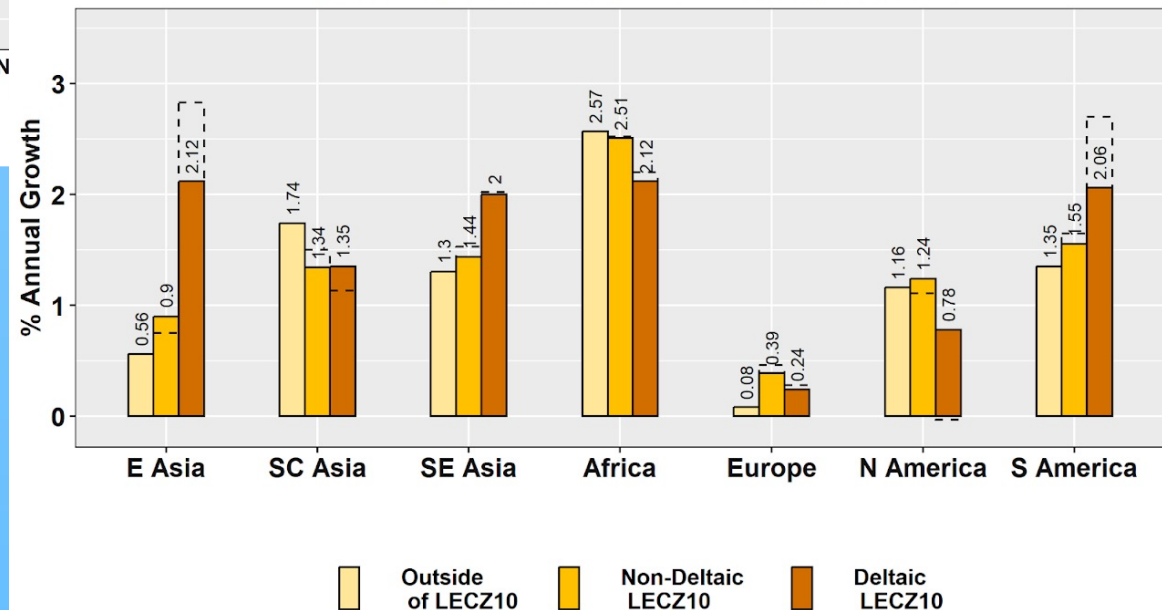
- Asia stands out with its far higher population densities
- Asia's population density outside the LECZ is 4.5 times as high as the rest of the world
 - Its non-deltaic LECZ10 density 4.6 times as high, and
 - Its deltaic LECZ10 density 5.8 times as high.
- In absolute terms, Asia's LECZ10 deltas have an average of 1,059 people per km² compared to just 184 people per km² in the deltaic LECZ10 elsewhere

Growth, 1990-2015

- Growth highest in the deltaic LECZ
 - Everywhere, but especially in the in the level of built-up in the LECZ05 in Asia (not shown)



Population growth rates in LECZ10/deltas, 1990-2015



- Growth higher in deltaic regions of E and SE Asia, both in population and built-up (not shown)

Key Take Aways

Unpacking the LECZ

- The LECZs and especially their deltas contain large concentrations of both population and built-up area.
- The LECZ10 accounts for just 2.1% of land but is home to 11.1% of the world's population (815 million people) and
- 11.7% of built-up area (or 91,000 km²)
- The deltaic LECZ10 accounts for only 0.35% of the world's land, but is home to 3.8% of the world's population (279 million people) and 3.0% of its built-up area (or 23,000 km²)
- Asia at greatest risk (and particular regions within Asia)

Urbanization in deltas

- Considerable variation within Asia, and the exceptionally high population and built-up densities in East Asia's deltaic LECZ10 suggest that both environmental pressures and risks are likely to be especially intense in this region, and it's growing urban areas
- Creates 'lock-in'
- Especially precarious because the urbanization may lead to 'sinking cities' confounding SLR processes underway from climate change

FROM REGIONAL → US → LOCAL



w/Daniela Tagtachian (in review) **Uneven Vulnerability: Characterizing population composition and change in the Low Elevation Coastal Zone in the United States with a climate justice lens, 1990-2020**

US LECZ Study, 1990-2020

Differs from **global** study in that we use 4 decades of census data, with a richer set of variables

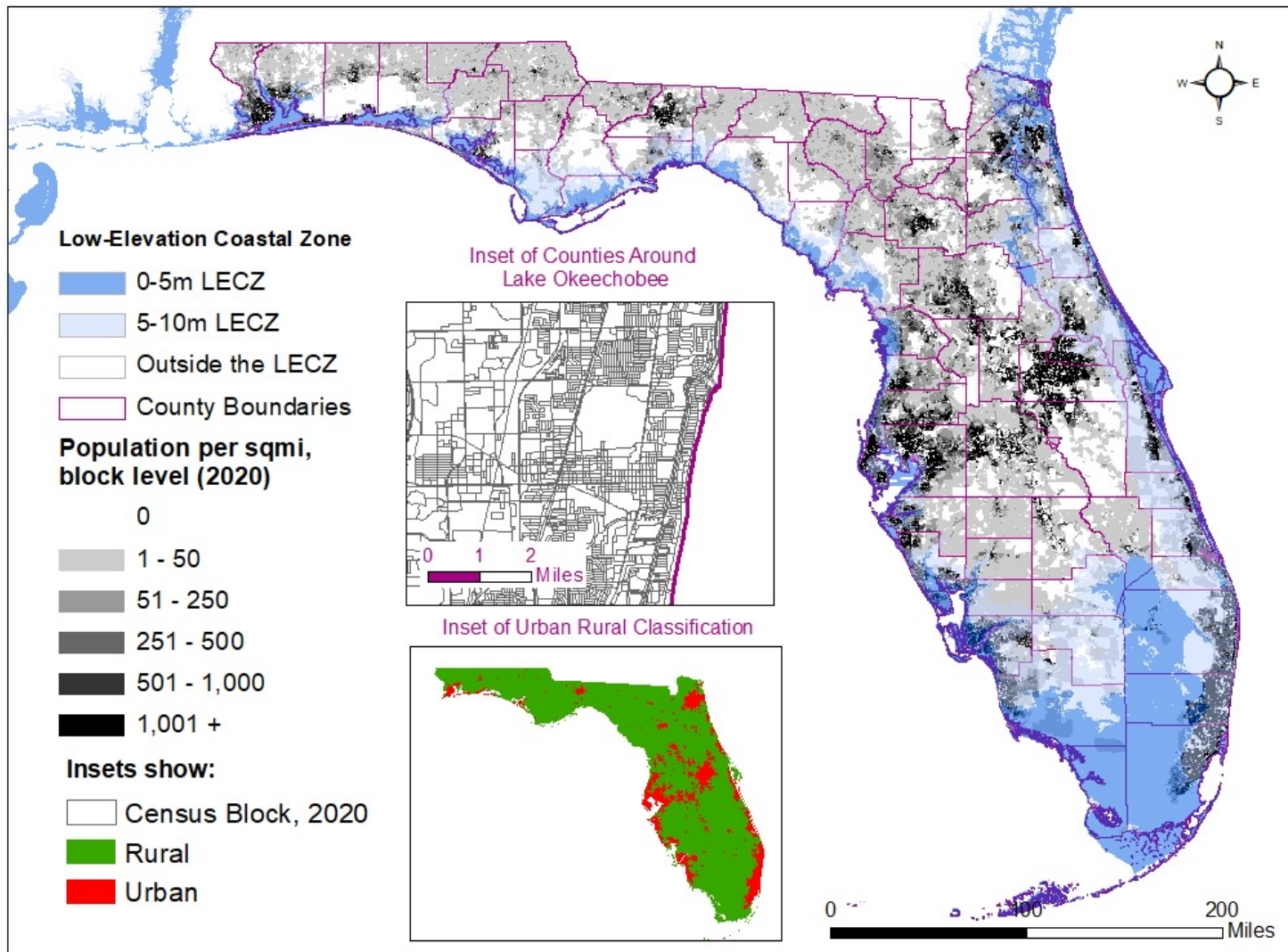
- Pop and land exposures, urban vs. rural +
- Age distribution, Race/Ethnicity, Housing Tenure

Differs from **prior studies in the US** (e.g., NOAA, Hauer) in that the finest spatial unit available in the census is used

- Coastal counties here defined as having any land area in the LECZ
- But census blocks (rather than tracts or counties) with any land area in the LECZ are then summarized to the county

Visualizing the data inputs

Low Elevation Coastal Zone Extent, County Boundaries, and Population Density (and block boundaries and Urban/Rural designation insets) (2020)

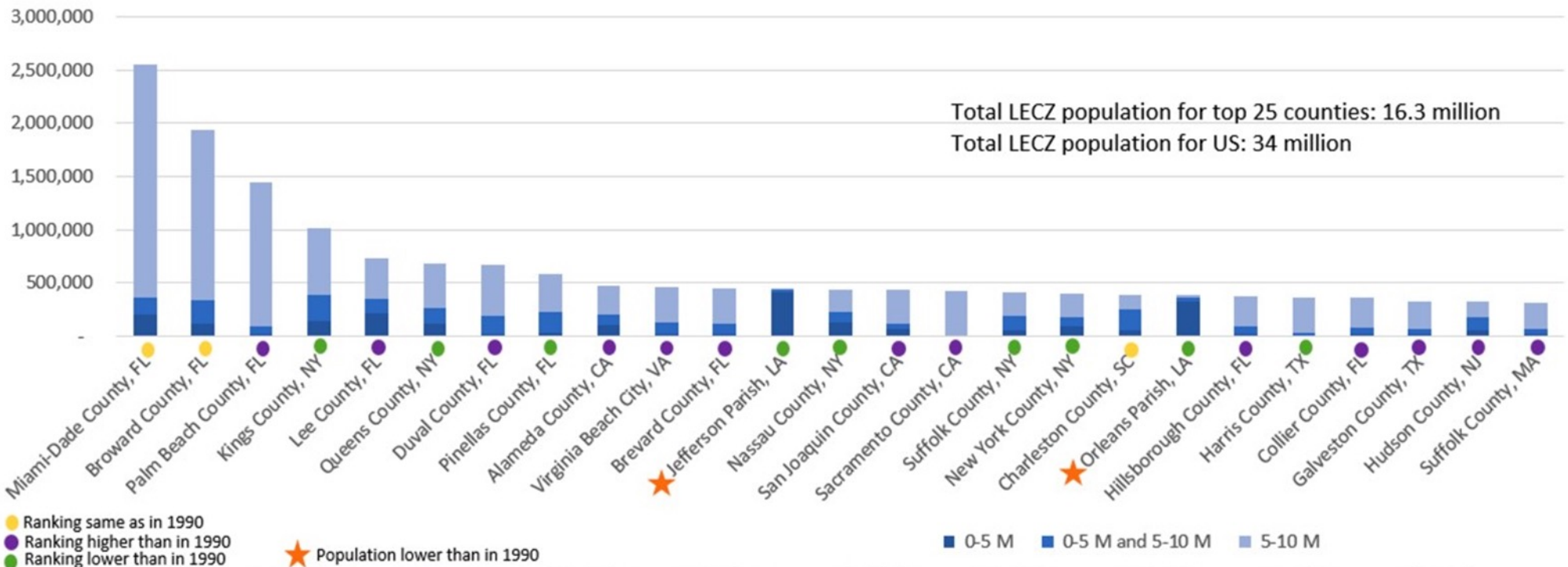


- Variables available at the block-level are limited
 - Change in measures over time limit them further
 - 2020 block data is limited to PL release

States and Counties at Risk

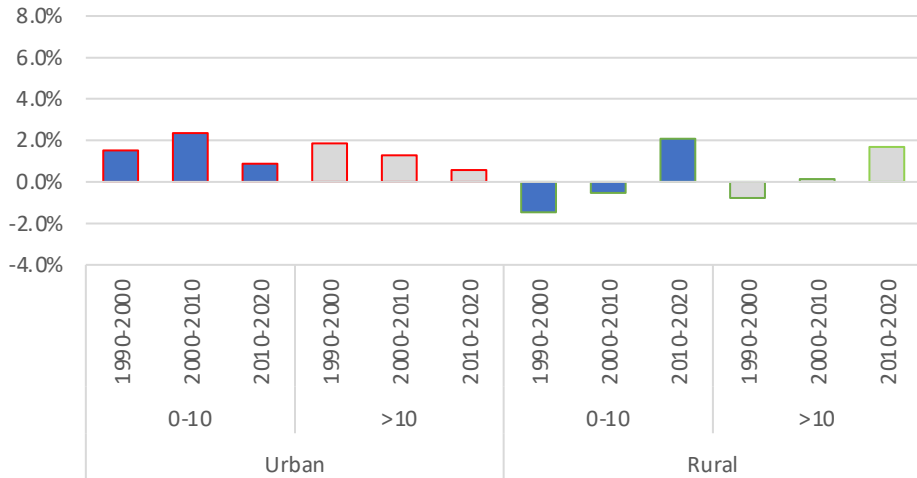
- Of the ~3,000 counties in the lower 48 states
 - 390 (~13%) have any land area in the LECZ, with more 34 million persons at risk (1:6 person).
 - Population exposure is even more concentrated with only 55% of the population exposure found in the top 25 counties.

Top 25 Counties - Population Exposure in the LECZ, 2020

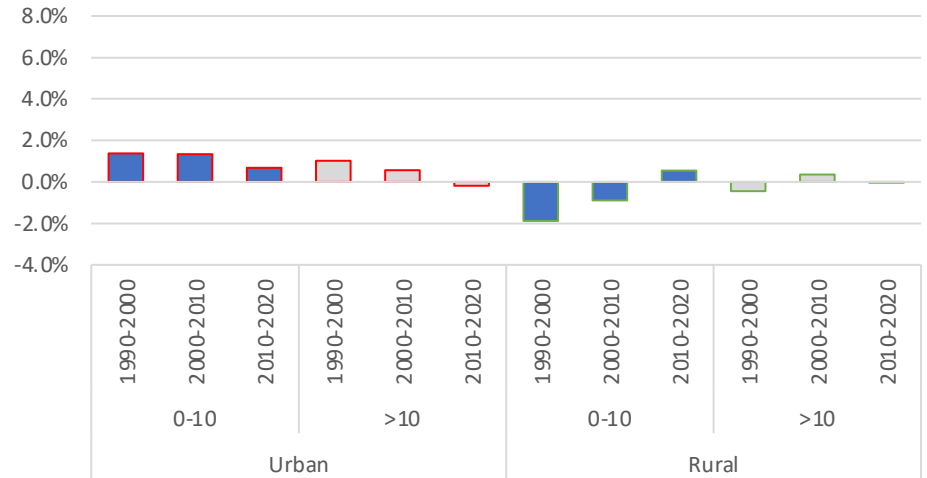


Change over time varies by state

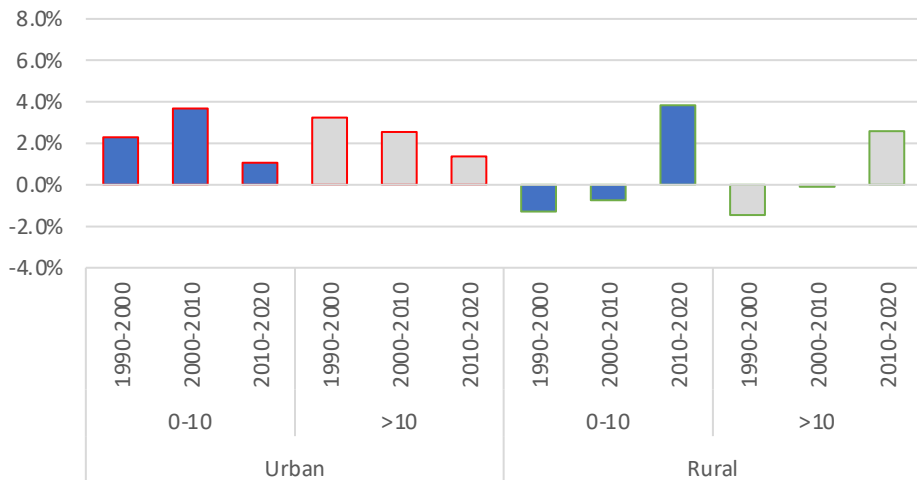
Total Population, Annual Growth Rate, 1990-2020



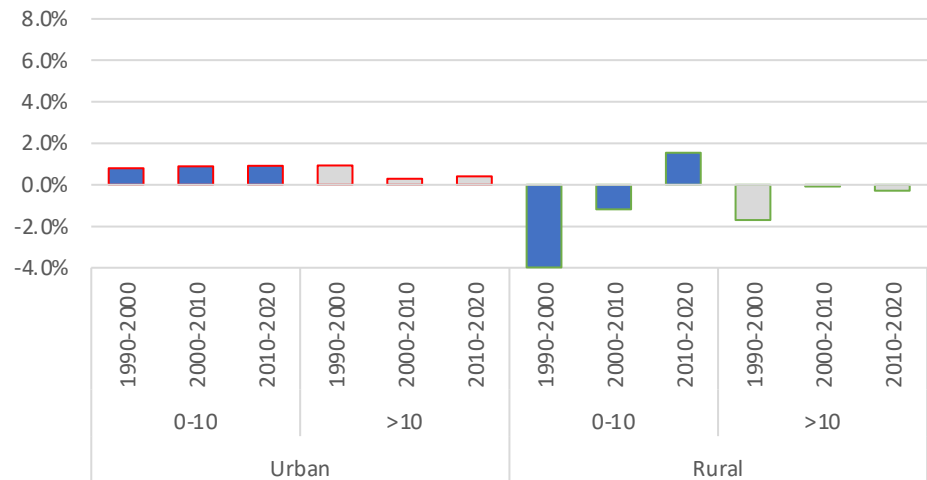
Louisiana Population, Annual Growth Rate



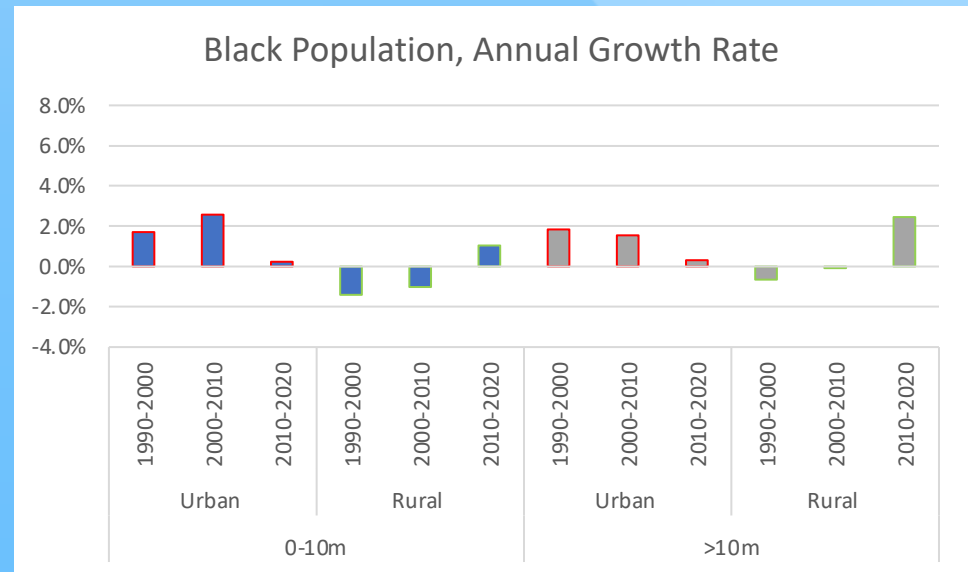
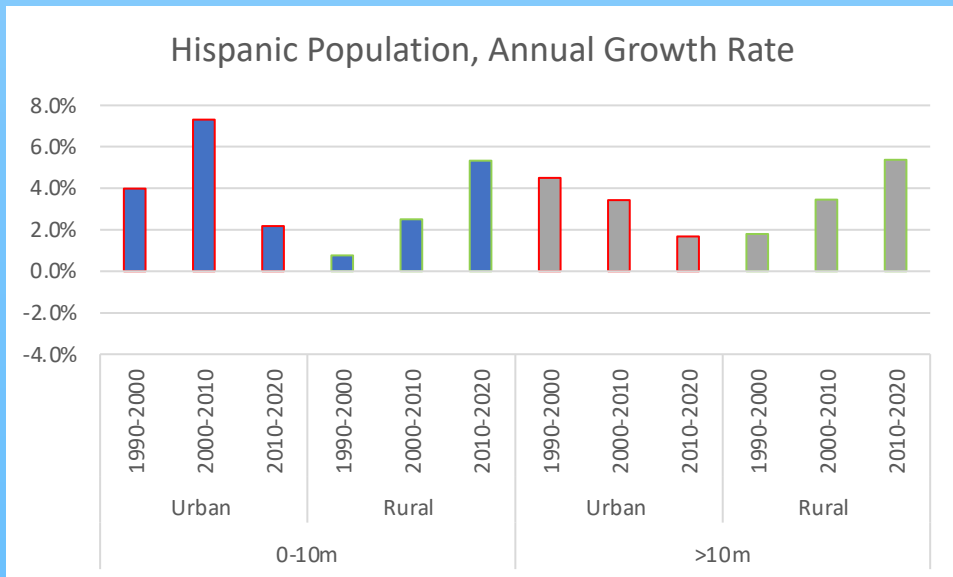
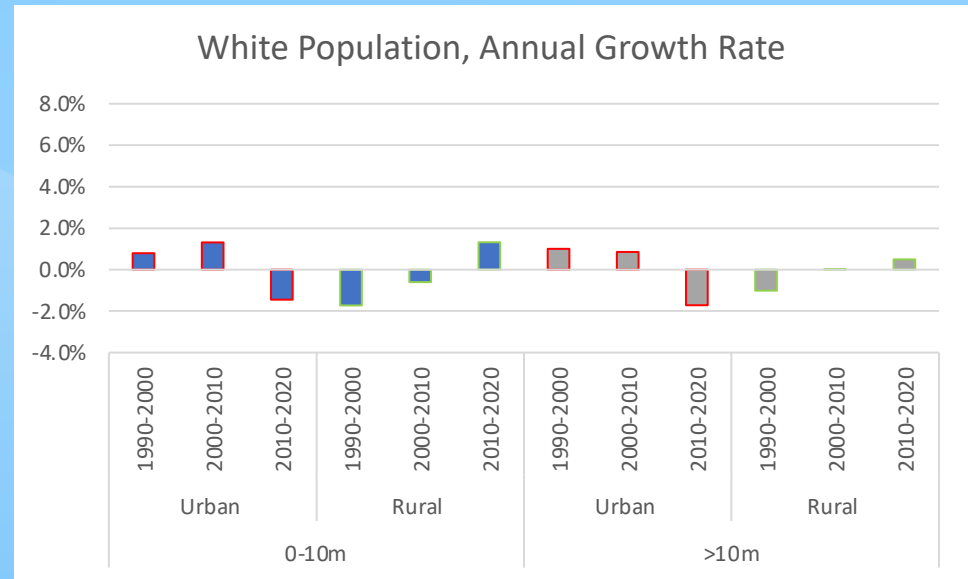
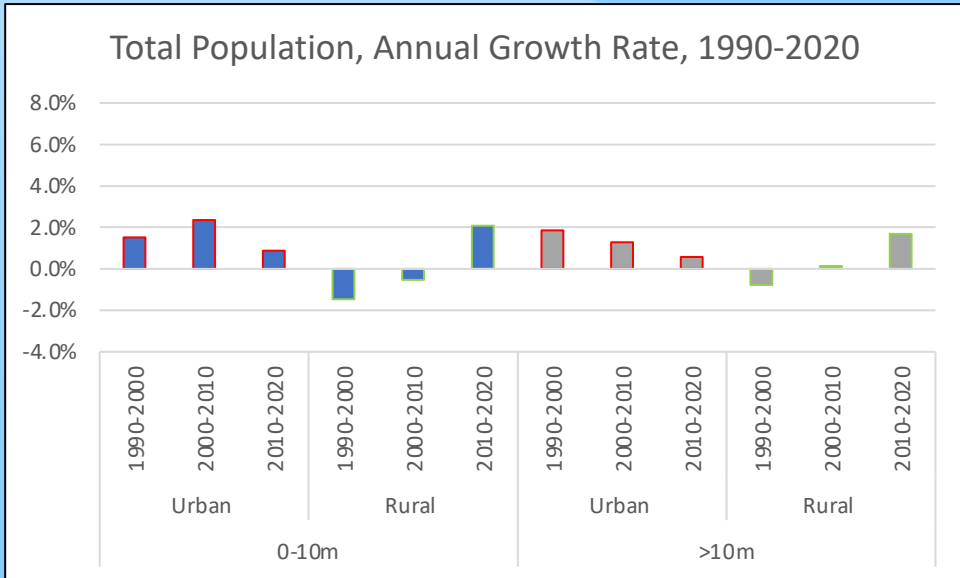
Florida Population, Annual Growth Rate



New York Population, Annual Growth Rate

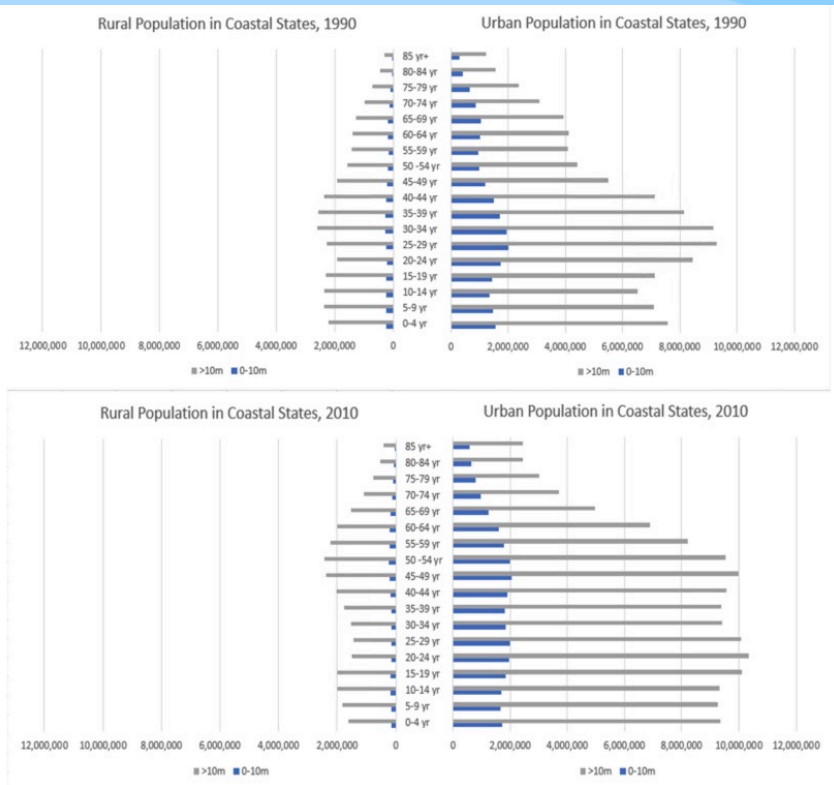


Change over time varies by race

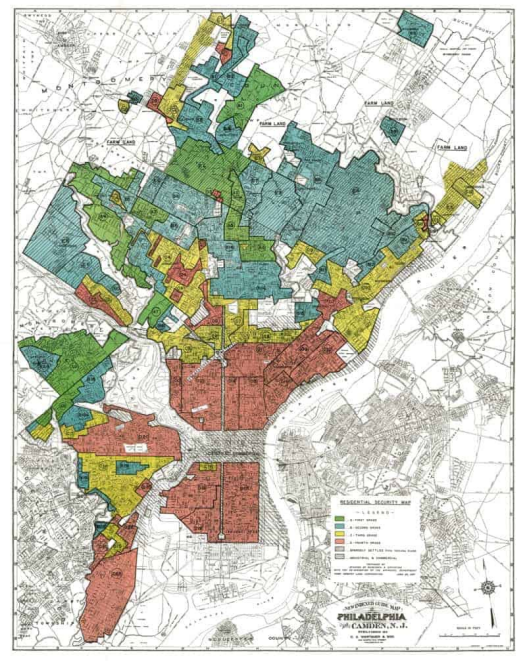


Exposures differ by vulnerability

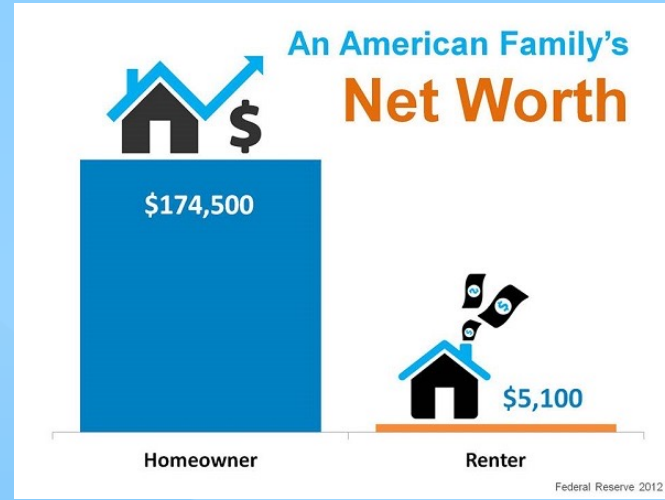
Age & Urban/Rural



Race & Ethnicity



Housing Tenure

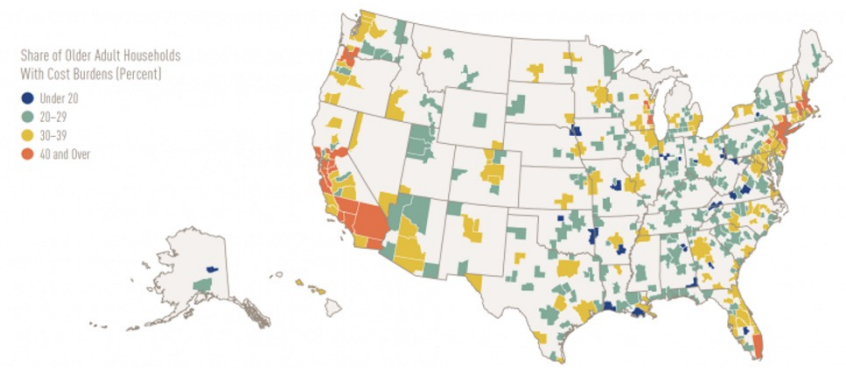


Vulnerabilities interact!

Other vulnerabilities include:

- Income/wealth, disabilities, English proficiency, certain occupational groups, social isolation/social networks, medical conditions, where people live/work, and so on...

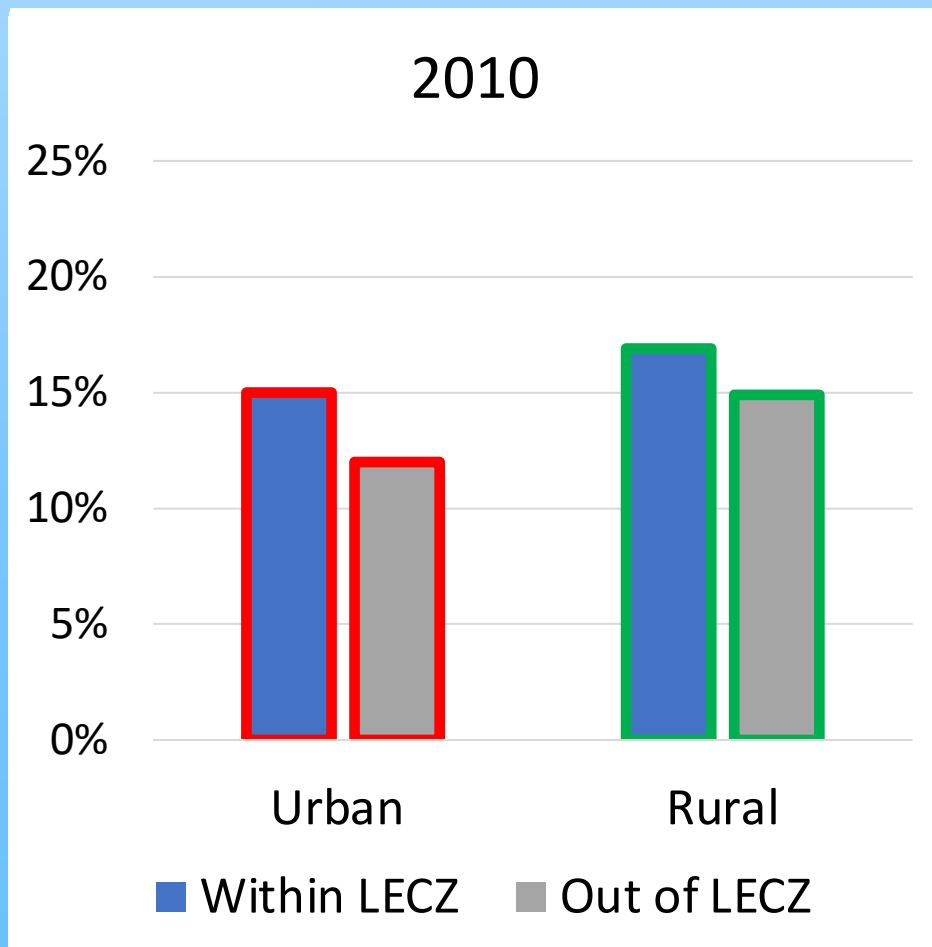
In Many Metros Across the Country, More than a Third of Older Households Are Cost Burdened



Notes: Data are for households headed by a person age 65 and over. Cost-burdened households pay more than 30 percent of income for housing. Households with zero or negative income are assumed to have cost burdens, while households paying no cash rent are assumed to be without burdens. Source: JCHS tabulations of US Census Bureau, 2017 American Community Survey 1-Year Estimates and Missouri Census Data Center data.

Percent of Population 65+

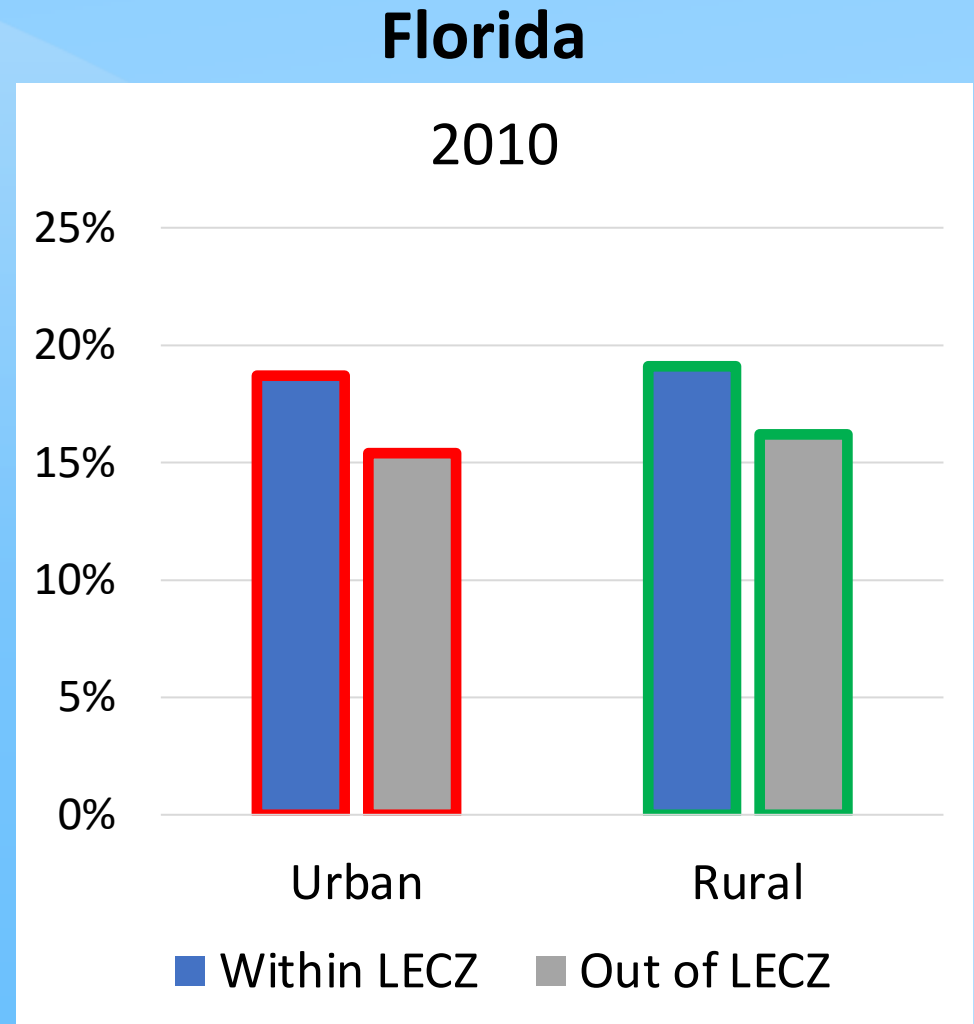
All Coastal States



- In 1990, one out of every 8 persons, averaging across all residents of coastal states, was over age 65.
 - From 1990-2010, we see an additional 6 million and small increase in the proportion 65+ to 12.9% in coastal states, on average (not shown in graph).
- Residents of the LECZ are older than average (14.6% in 1990, rising to 15.2% in 2010).
- This is true **urban** and **rural** areas.
 - 15% of urban residents in the LECZ are over age 65, vs. only about 12% outside it;
 - in 1990, 13.6% of the rural dwellers in the LECZ were over age 65 as compared to 12.1% outside of the LECZ;
 - by 2010 these shares had risen substantially, to 16.9% within the LECZ and nearly 15% outside of it.

Percent of Population 65+

- Florida has much higher shares of older adults -- over 18% statewide in 1990 – than elsewhere in the US (not shown).
 - While increasing by nearly 1 million older residents, the % of older adults decline to 17.3% of the state population in 2010.
- In 1990, 1:5 residents of the LECZ in Florida was over age 65, with even slightly higher proportions in the urban LECZ.
 - Like the statewide trend, these fractions declined somewhat by 2010 (while the population itself is rising).
- The annual growth rate of older adults (at 1.6% per year) is larger in Florida than elsewhere (1.3% for the coastal states average).



Race

- 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 (not shown below)
- Non-white (single race) populations are overrepresented in urban areas, both within and outside the LECZ

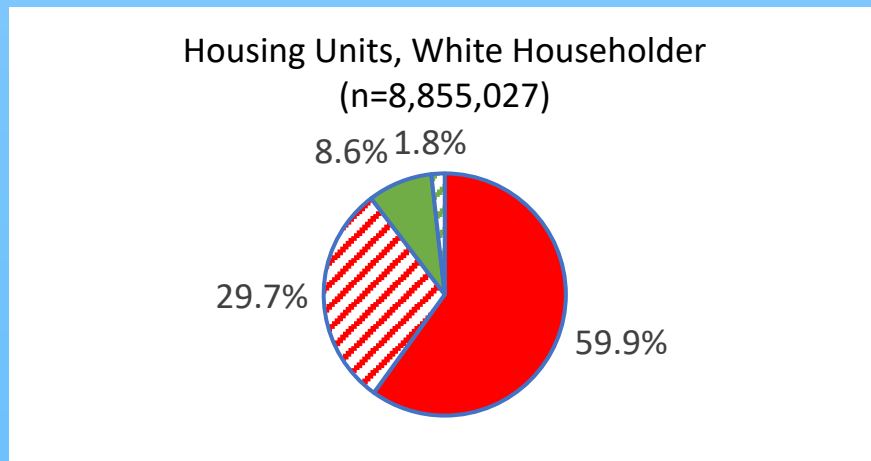
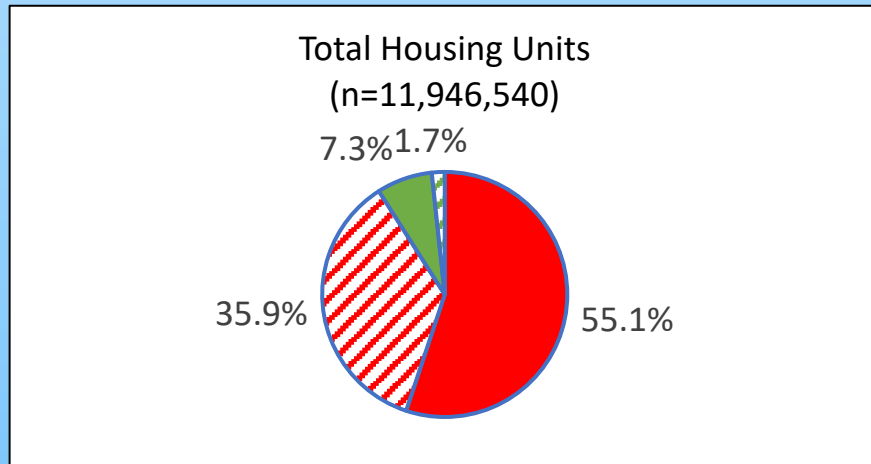
	1990				2020			
	Urban		Rural		Urban		Rural	
	0-10	>10	0-10	>10	0-10	>10	0-10	>10
Total Coastal Population	14.1%	64.1%	2.1%	19.7%	14.3%	68.1%	1.6%	16.0%
White Population	-0.4%	-2.6%	0.2%	2.7%	-0.6%	-5.3%	0.6%	5.4%
Black Population	3.4%	3.1%	-0.2%	-6.2%	2.5%	2.3%	-0.4%	-4.4%
Hispanic Population	1.3%	13.0%	-1.4%	-12.9%	0.8%	8.6%	-1.0%	-8.5%
Other Single Race	-3.6%	18.5%	-1.7%	-13.2%	-1.9%	12.0%	-1.1%	-9.1%
Two or More Races	-	-	-	-	2.8%	3.3%	-0.5%	-5.5%

Cells above list percentage point difference (positive highlighted in yellow) in share of subpopulation for a given year in urban/rural areas and within/outside the LECZ

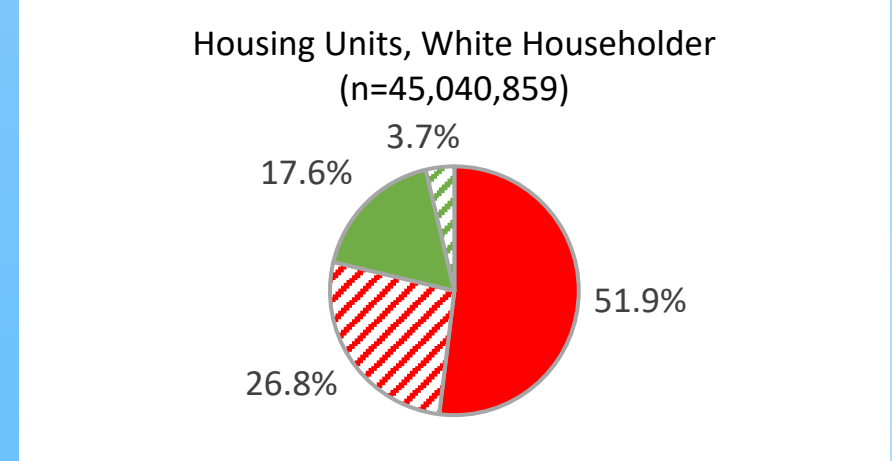
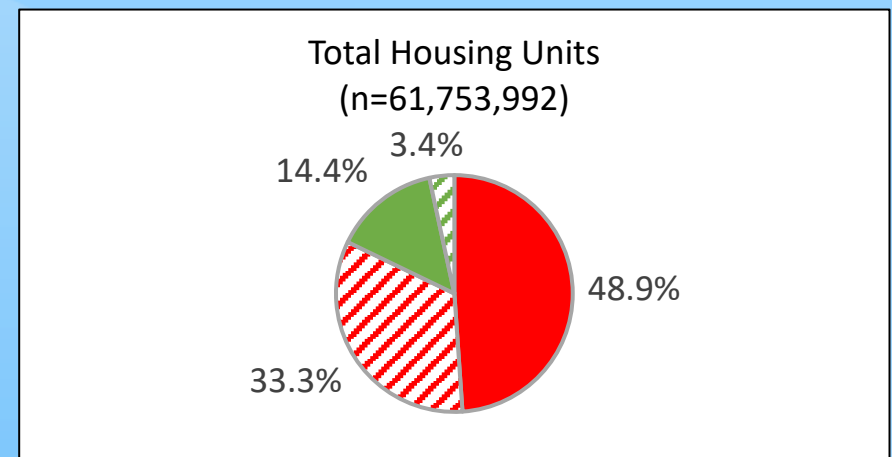
Housing Tenure

Housing Units Within and Outside LECZ by Race and Hispanic Origin, Housing Tenure, and Urban/Rural Classification, 2010

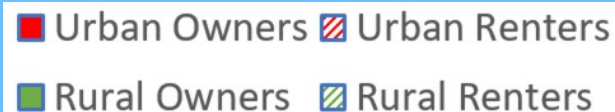
Within LECZ



Outside LECZ



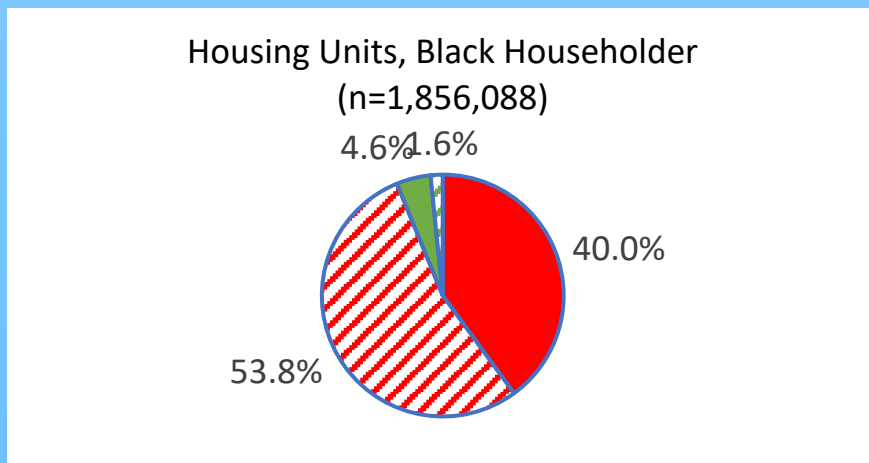
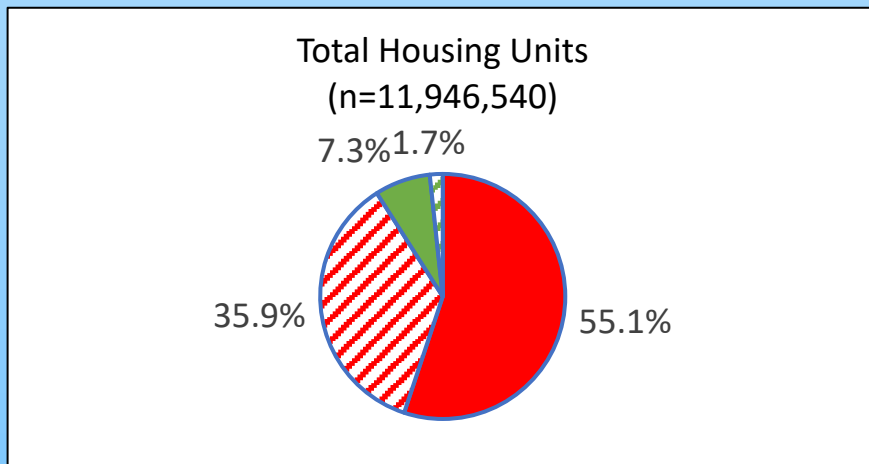
Whites are overrepresented **homeowners** in urban and rural places, within and outside the LECZ



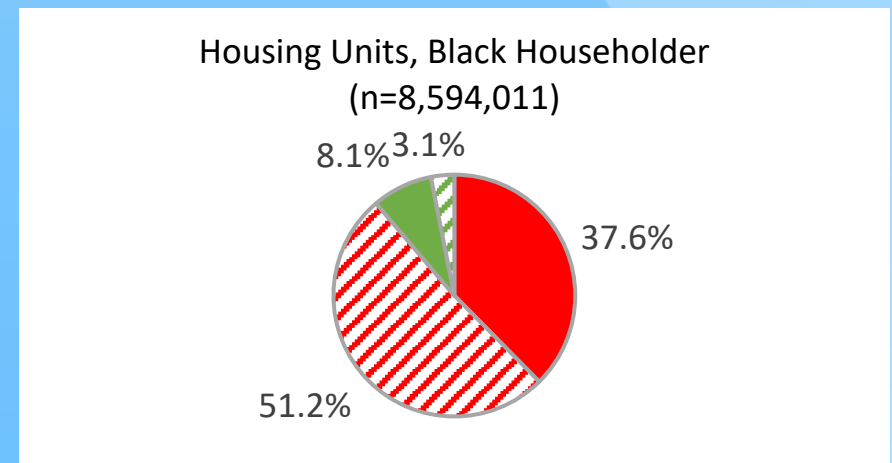
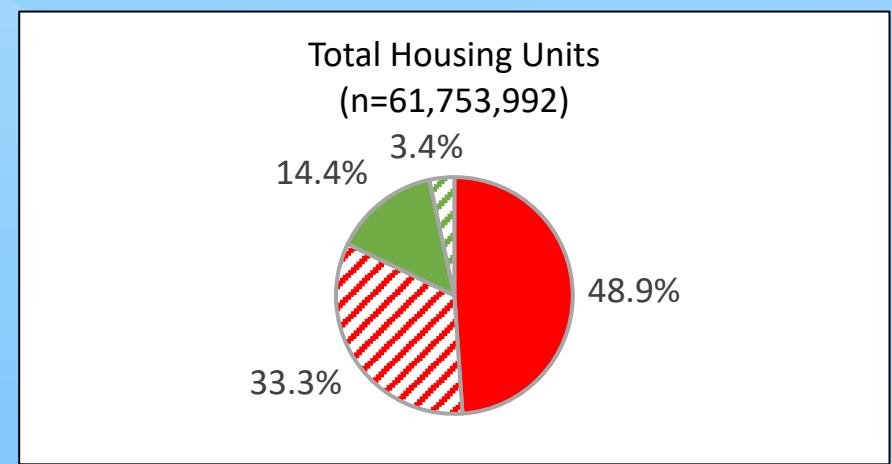
Housing Tenure

Housing Units Within and Outside LECZ by Race and Hispanic Origin, Housing Tenure, and Urban/Rural Classification, 2010

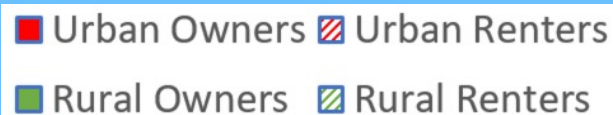
Within LECZ



Outside LECZ



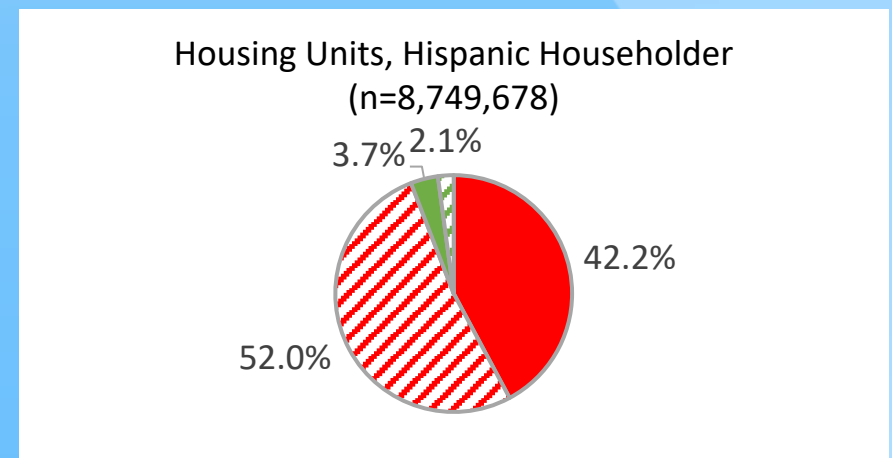
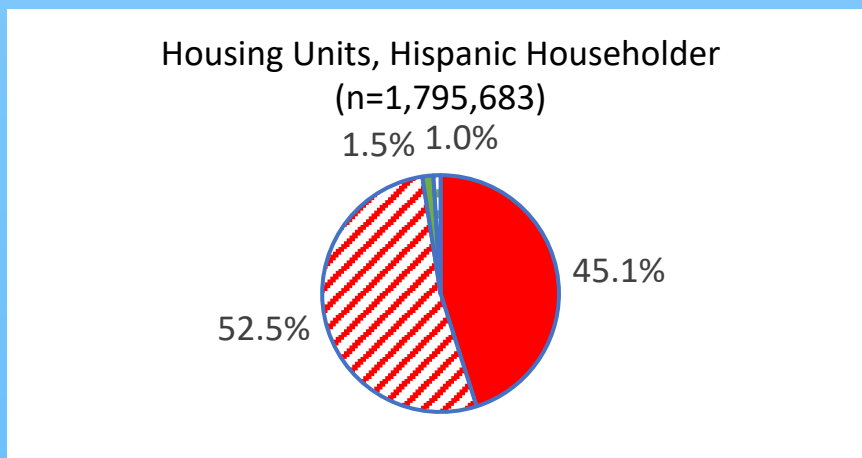
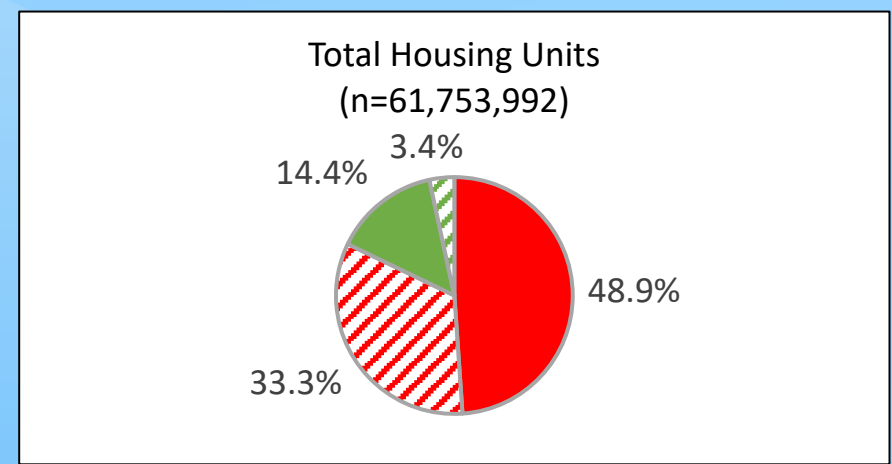
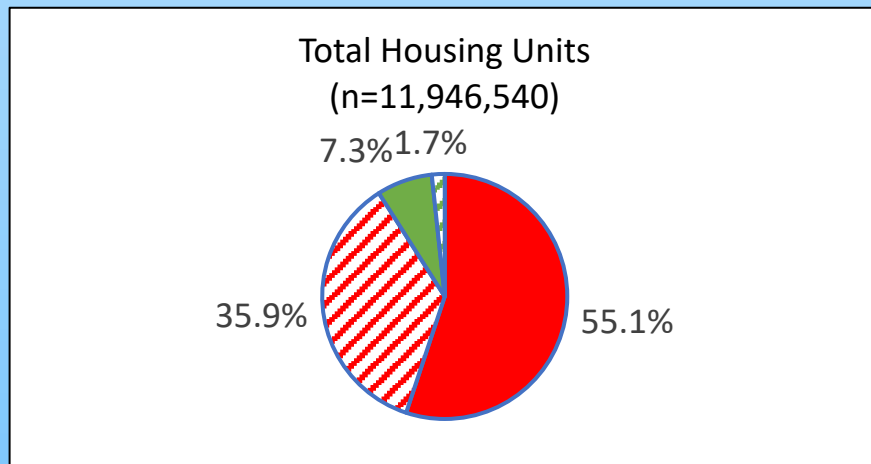
Blacks are overrepresented renters in urban places, within and outside the LECZ



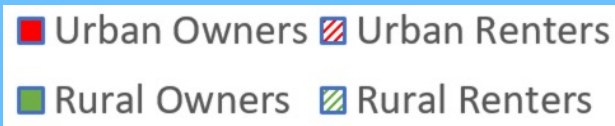
Housing Tenure

Housing Units Within and Outside LECZ by Race and Hispanic Origin, Housing Tenure, and Urban/Rural Classification, 2010

Within LECZ



Hispanics are overrepresented renters in urban places, within and outside the LECZ



Housing Tenure

Distribution of housing units by race and Hispanic origin of householder by housing tenure, within and outside the LECZ by urban/rural classification for coastal states, 2010

Housing Tenure	Race/Hispanic Origin	2010			
		Urban		Rural	
		0-10 M	> 10 M	0-10 M	> 10 M
Owner Occupied Housing Units	Total	8.93%	40.98%	1.19%	12.11%
	White	9.85%	43.41%	1.42%	14.69%
	Black	7.10%	30.93%	0.81%	6.64%
	Hispanic	7.68%	34.99%	0.26%	3.10%
Renter Occupied Housing Units	Total	5.81%	27.86%	0.27%	2.84%
	White	4.87%	22.37%	0.29%	3.09%
	Black	9.56%	42.10%	0.29%	2.56%
	Hispanic	8.93%	43.11%	0.16%	1.78%

When the data is disaggregated, we find that, for example, Black (1.96x) and Hispanic (1.83x) householders were almost twice as likely than Whites to live in urban renter-occupied housing units within the LECZ.

Housing Tenure (2010)

Homeowners

(Whites overrepresented)

- Almost 70% of White householders owned their home (inside and outside the LECZ),
- In comparison, only a little over 45% of Black and Hispanic households owned their home (inside and outside the LECZ)

Renters

(Blacks/Hispanics overrepresented)

- More than 50% of Black and Hispanics households were in renter-occupied units (inside and outside the LECZ),
- In comparison, only around 30% of Whites were in renter-occupied units (inside and outside the LECZ)

Why Housing Tenure Matters

- Climate change is augmenting and accelerating the affordable housing crisis.
 - While low-income residents are particularly vulnerable in areas that are prone to flooding or other coastal hazards,
 - Low-income homeowners and renters are likely to experience flooding, storms, and sea-level rise differently since **homeowners** (particularly middle and lower-income homeowners) **are likely to be less mobile and renters tend to have less equity.**

Lessons for Policy and Planning

Climate Planning needs to include social equity lens

- Race and ethnicity
- Urban and rural
- Housing
- Aging
- Interactions between these vulnerabilities

Social equity lens should include

- Climate justice principles: distributive, procedural, recognition, and intergenerational
- Inclusive planning from data collection to engagement with stakeholders

Lessons for Future Research

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 rich, spatial data
- Use place-based finding to help improve our understanding of causal processes behind vulnerability and the demographic components of change

Conclusions

Embrace the Main Research Finding

- All evidence shows that the LECZ is disproportionately urban (global and local) and
- In the past 25 years, cities have faster **growth** inside LECZ than outside, particularly in locations of high vulnerability like deltas and Florida. Local variability is notable:
 - Globally, this places Asia deltaic cities at very high risk
 - In the US, this places more communities of color at risk
- Research must 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!

Thanks to my collaborators

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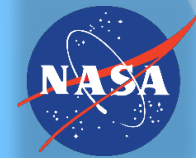
Kori Mascheck, CUNY

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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

