

Mapping Urban Population & Exposure to Climate-Related Risks:

The Brazilian Semiarid Region & Neighboring Coastal Zone

Deborah Balk

CUNY Institute for Demographic Research &
School of Public Affairs, Baruch College

Sandra R. Baptista

The Earth Institute at Columbia University,
Center for International Earth Science Information Network (CIESIN)

Mark R. Montgomery

Population Council & Department of Economics, Stony Brook University,
State University of New York

Donghwan Kim

Department of Economics, Stony Brook University,
State University of New York

ICID+18
2nd International Conference: Climate, Sustainability
and Development in Semi-arid Regions
August 16 - 20, 2010, Fortaleza - Ceará, Brazil



Research and data presented herein funded by:

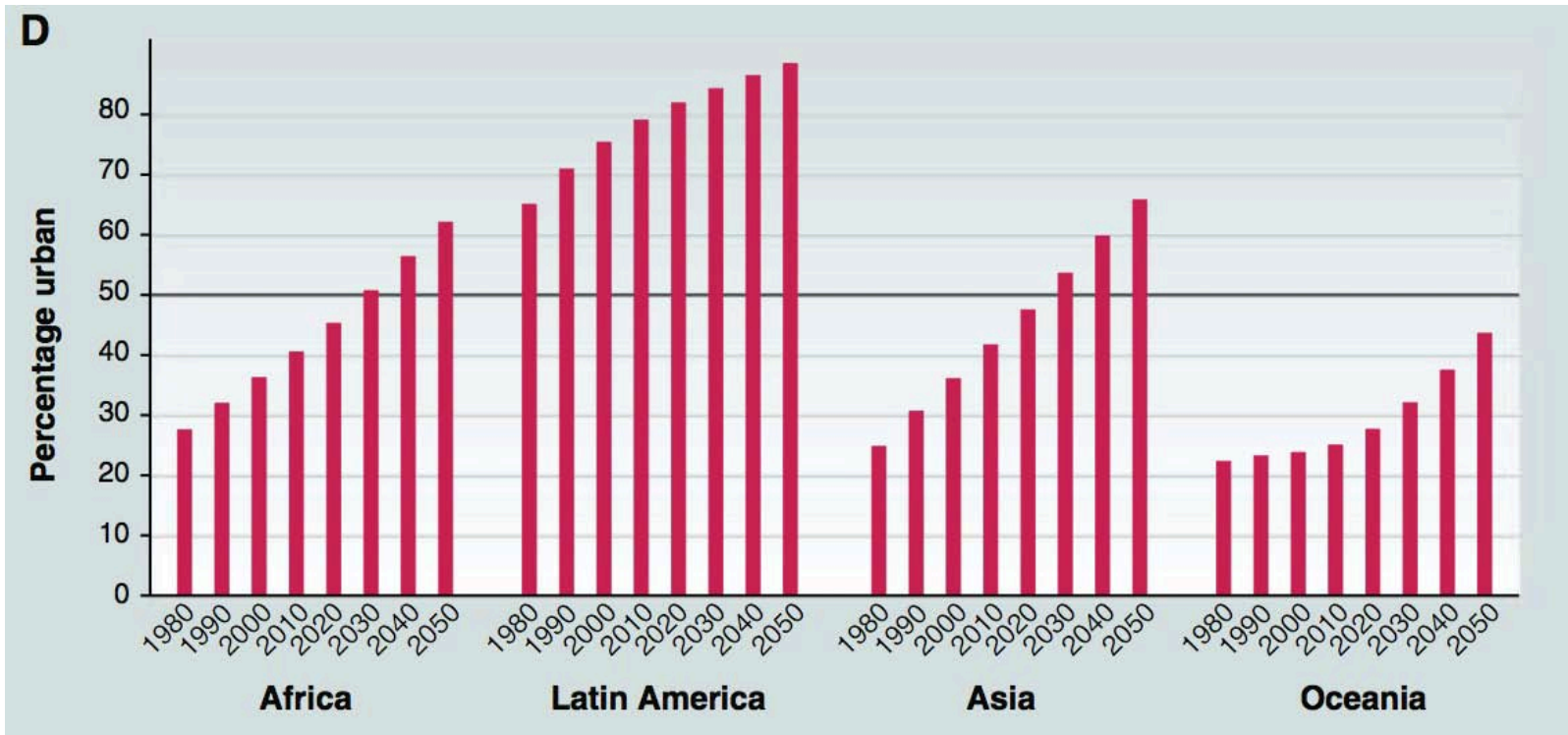
- National Institute of Child Health and Development (NICHD) awards R21 HD054846 and ARRA Supplement to the City University of New York, the Population Council and Columbia University.
- NASA (NAS5-03117) for the Continued Operation of the Socioeconomic Data and Applications Center (SEDAC) at CIESIN, Columbia University
- The Earth Institute Postdoctoral Research Fellowship
- International Institute for Environment and Development (IIED) with funding from the United Nations Fund for Population Activities
- USAID for funding to Macro International for the Demographic and Health Surveys

Collaborators:

- ❑ Gordon McGranahan, International Institute for Environment and Development
- ❑ Thomas Buettner & colleagues, United Nations Population Division
- ❑ Columbia University (including but not an exhaustive list)
 - Chris Small, Lamont-Doherty Earth Observatory
 - Robert S. Chen, Marc A. Levy, Alex de Sherbinin, Susana Adamo, Valentina Mara, Greg Yetman, Tricia Chai-Onn, Maria Elisa Lukang, Maria Muñiz (CIESIN)
 - Bridget Anderson, formerly of CIESIN (now NYC Dept of Sanitation)
- ❑ Many graduate students & research assistants

Global urbanization trends

Increasing percentage urban



Source: Montgomery, M.R. 2008. The urban transformation of the developing world. *Science* 319: 761–764.

Cities & urban population are NOT uniformly distributed

□ Coastal Zones

- Almost 2/3 of coastal population live in cities
- Coastal land is 16x more densely populated in urban than in rural areas
 - And rural areas in coastal zones are 3x more densely populated than in other ecosystems

□ Arid Zones

- More than $\frac{3}{4}$ of a billion urban dwellers – $\frac{1}{4}$ of all urbanites – live in drylands
 - More than 40% of all dryland residents live in cities

□ Coastal & Arid Zones present unique challenges with respect to climate change

Global Rural-Urban Mapping Project (GRUMP)

<http://sedac.ciesin.columbia.edu/gpw/>

Estimates of dryland & coastal urban population Using new data & methods

- We estimate
 - the *total* and *urban* population
 - the *total* and *urban* land area

- Of *drylands*

- Of a *low-elevation coastal zone (LECZ)*
 - i.e., a continuous buffer of 10 meters above sea-level contiguous to sea-coast

Dryland cities deserve more attention

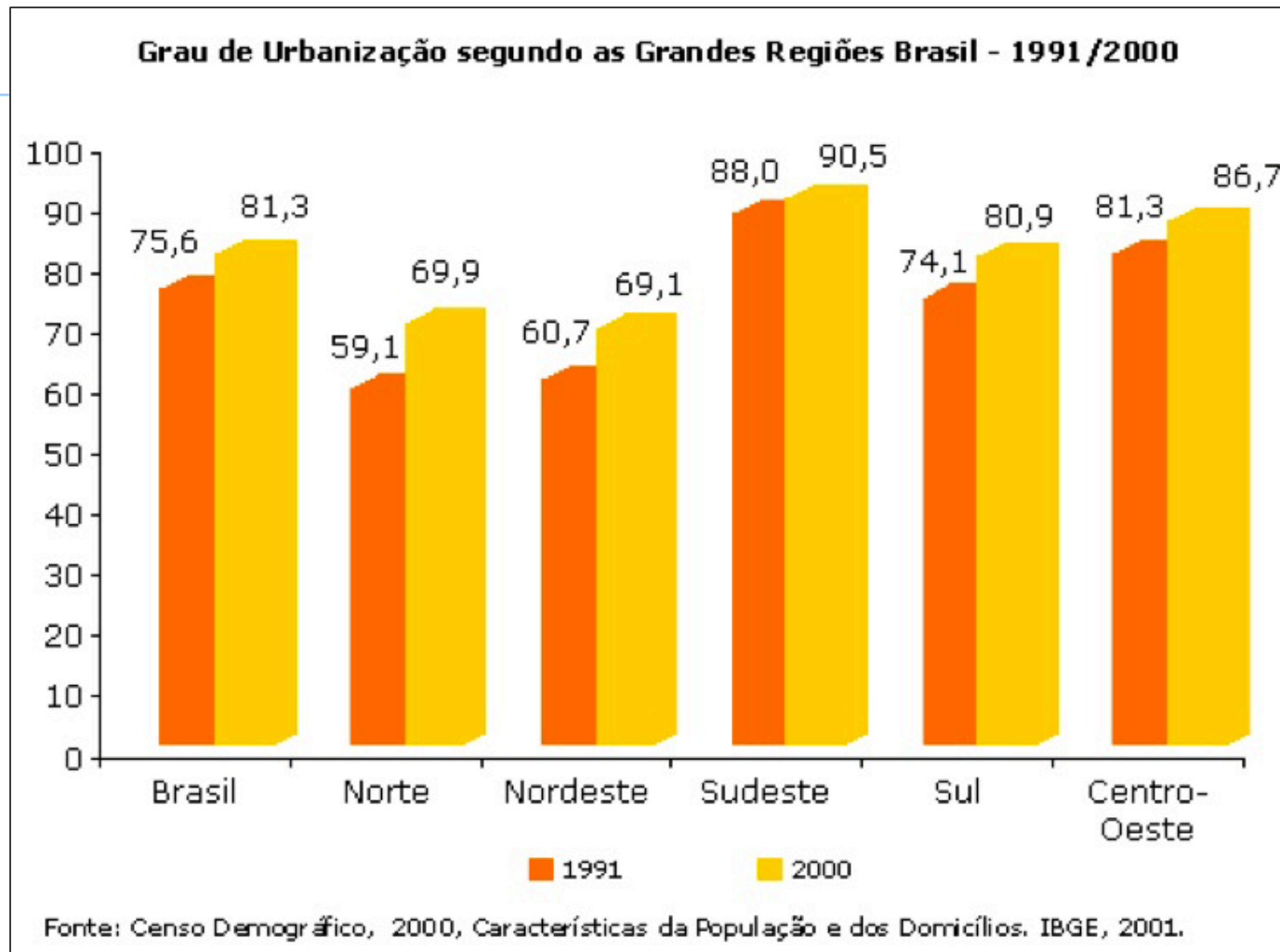
- The world's megacities (10M+) tend to be coastal, not arid
 - Megacities have gotten lots of attention
 - Small- to medium-sized cities in drylands have received less attention
- Yet, coastal and dryland vulnerabilities may be a lot alike
 - Warming, episodes of heavy rainfall & flooding are common future problems
- By improving spatial data addressing exposure, we can support vulnerability assessments and disaster risk reduction efforts
 - Develop strategies that coordinate interventions in urban and rural settlements, both coastal and inland

Distribution of South American urban population and land area in the drylands and 10m LECZ, by city-size ranges.

City population size in 2000, estimated using GRUMP methods.

South America	City Size	Number of Cities	Ecozone					
			Total	Dryland		LECZ		
			Population (000s)	Land Area (km ²)	Population (000s)	Land Area (km ²)	Population (000s)	Land Area (km ²)
	Less Than 100,000 persons	2,739	45,000	170,998	12,300	49,244	2,055	7,179
	100,000 - 500,000 persons	198	40,200	68,926	14,300	28,964	2,890	4,974
	500,000 - 1 million persons	28	19,900	23,257	6,220	6,627	1,946	1,956
	1 million persons +	34	111,000	71,677	25,500	20,234	10,800	5,844

Level of Urbanization in Brazil by Region



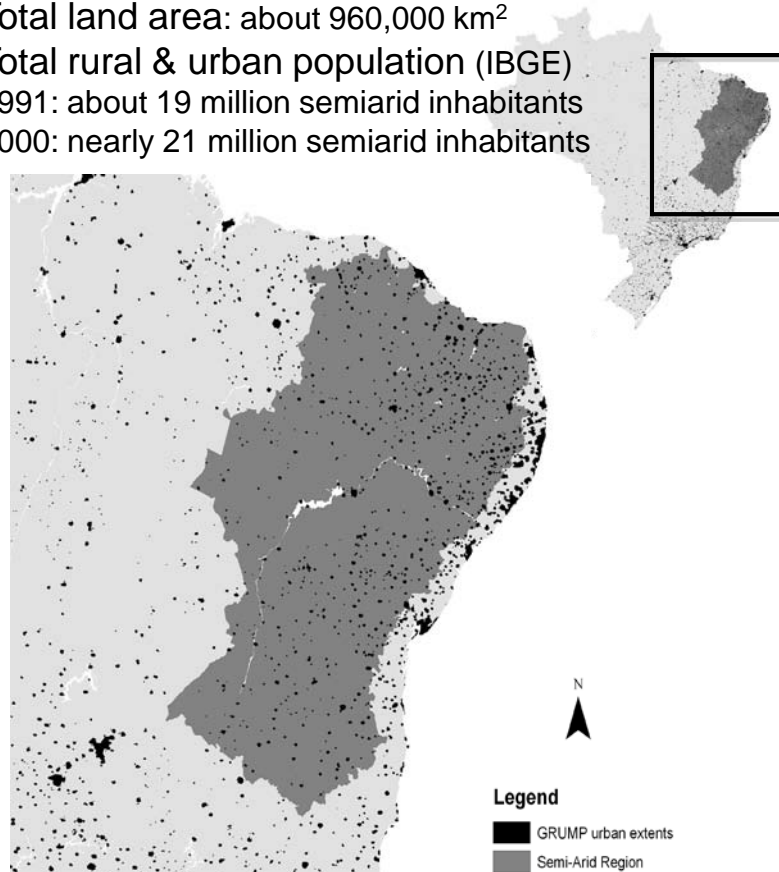
Source: <http://www.ibge.gov.br/>

Using GRUMP to analyze data on the drylands of Brazil

Delineation of Brazilian Semiarid
Ministério da Integração Nacional, Brazil, 2005

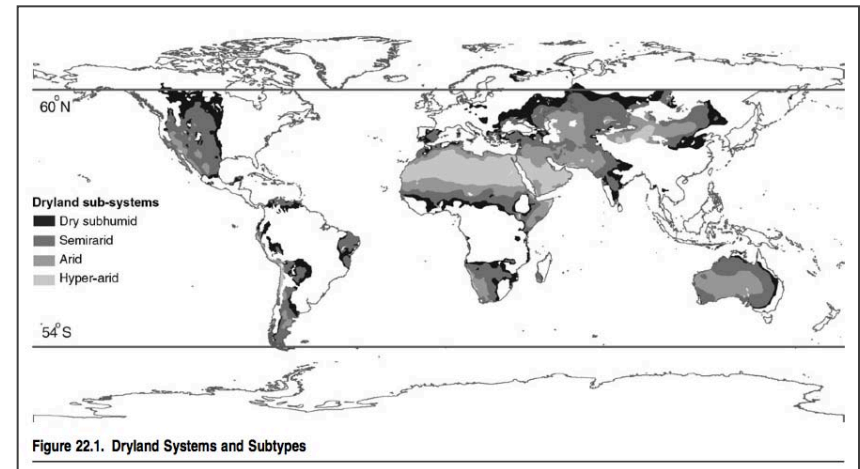
Total land area: about 960,000 km²

Total rural & urban population (IBGE)
1991: about 19 million semiarid inhabitants
2000: nearly 21 million semiarid inhabitants



*Semi-árido Brasileiro, Portaria N°89 do
Ministério da Integração Nacional, 16/3/2005
(Pereira Jr. 2007)*

Global Delineation of Drylands
Millennium Ecosystem Assessment



Distribution of population and land area of **Brazilian semiarid cities** with >20 thousand inhabitants, by city population size ranges, 1990 and 2000, estimated using GRUMP methods.

City Population Size	Number of Cities		Total Population (000s)		Total Area of Urban Extents (km ²)		Population Density (people/km ²)	
	1990	2000	1990	2000	1990	2000	1990	2000
20 000 – 50 000	47	62	1 505	1 969	4 700	5 700	320	345
50 001 – 100 000	5*	10**	335	622	800	1 300	419	478
100 001 – 250 000	7†	8††	1 036	1 351	1 500	1 700	691	795
250 001 – 500 000	2‡	2‡	677	785	800	800	846	981
> 500 000	1§	1§	2 144	2 695	1 100	1 100	1 949	2 450
TOTAL:	62	83	5 697	7 422	8 900	10 600	640	700

** Patos (PB), Paulo Afonso (AL), Santa Cruz do Capibaribe (PE), Irecê (BA), Iguatu (CE), Arcoverde (PE), Gravatá (PE), Picos (PI), Itapetinga (BA), Caicó (RN)

†† Petrolina (BA), Caruaru (PE), Vitória da Conquista (BA), Mossoró (RN), Arapiraca (AL), Garanhuns (PE), Jequié (BA), Sobral (CE)

‡ Campina Grande (PB) and Juazeiro do Norte (CE)

§ Fortaleza (CE)

Dryland & coastal risks in the same cities or states

Northeast Brazil, LECZ,
1990 & 2000

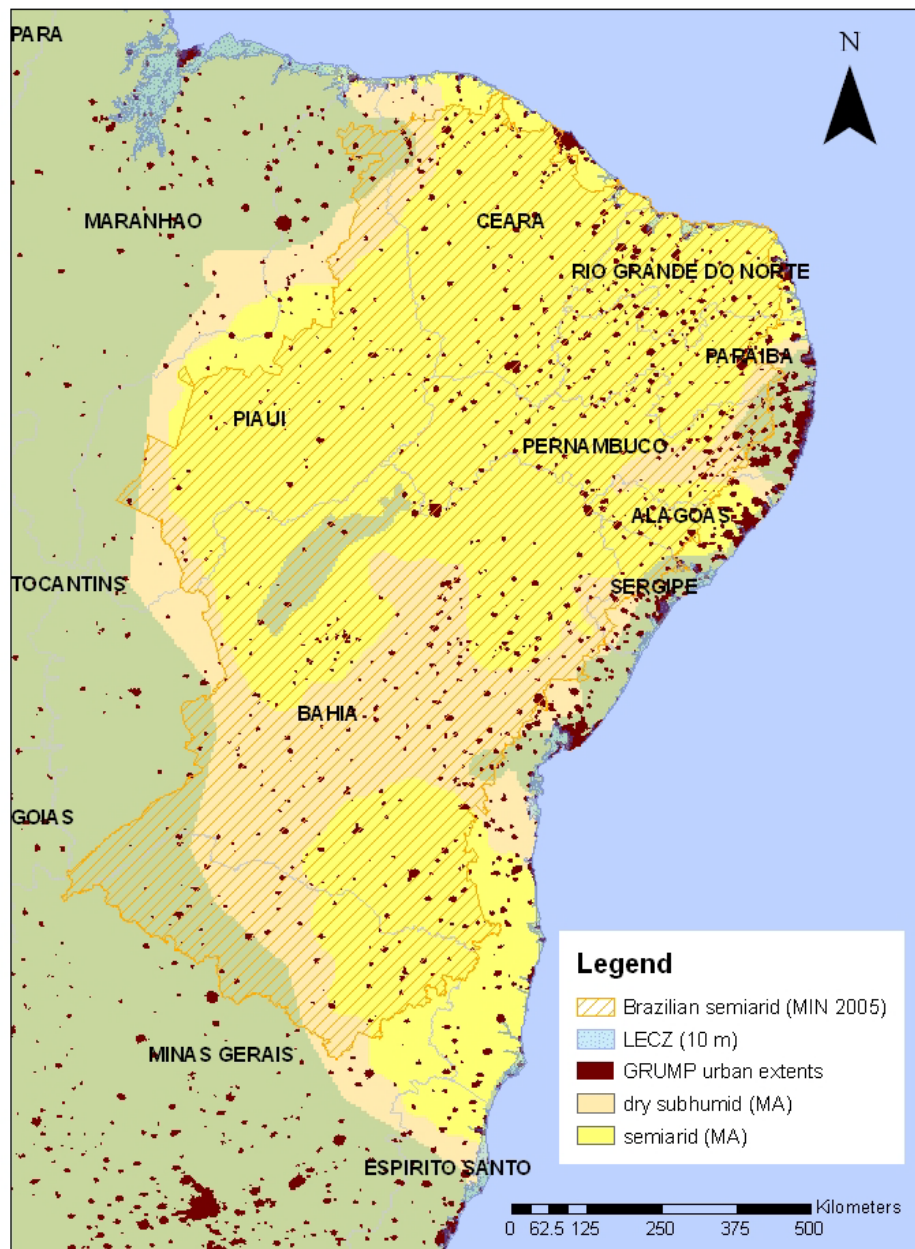
*Total area of urban extents in
10m LECZ of semiarid states:*
2,039 km²

- Bahia 491 km²
- Pernambuco 327 km²
- Sergipe 254 km²
- Paraíba 237 km²
- Ceará 216 km²
- R.G. do Norte 185 km²
- Piauí 182 km²
- Alagoas 147 km²

*Total population of urban extents
within Northeast's 10m LECZ*

1990: 2,285,000

2000: 2,740,000



“Semiarid” vs. “Drylands” of Brazil

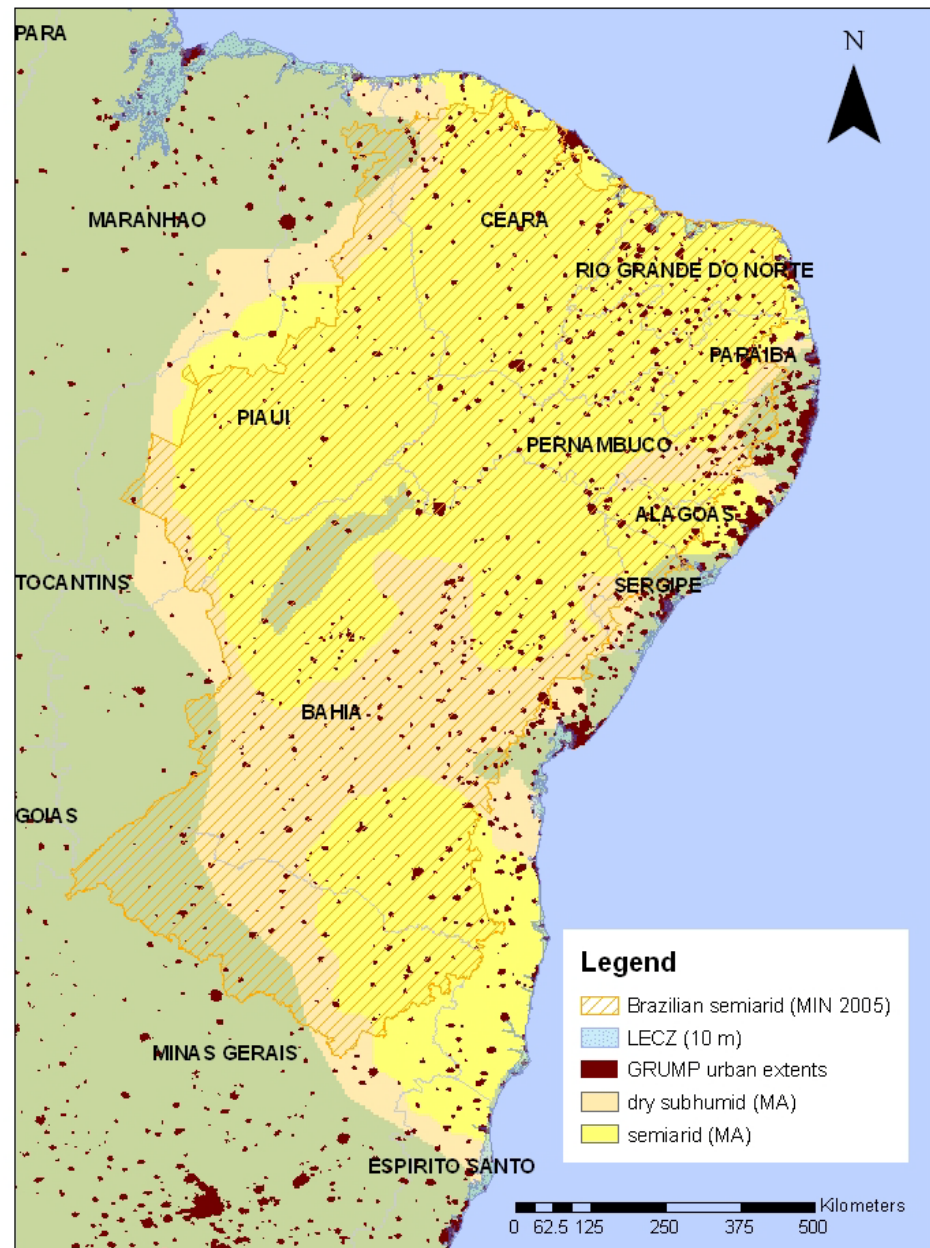
Area of urban extents in:

- the semiarid (MIN): **11,110 km²**
- the drylands (MA): **15,257 km²**

State	MIN (km ²)	MA (km ²)
Alagoas	590	1660
Bahia	3190	4800
Ceará	3060	3210
Minas Gerais	490	537
Paraíba	1080	1510
Pernambuco	1640	1340
Piauí	200	390
R.G. do Norte	860	1610
Sergipe	0	200

Total population of urban extents:

Year	MIN	MA
1990	6,545,000	8,458,000
2000	8,002,000	10,260,000



“Semiarid” vs. “Drylands” of Brazil

**40% to 50% of Brazil’s
dryland inhabitants
were living in cities in 2000**

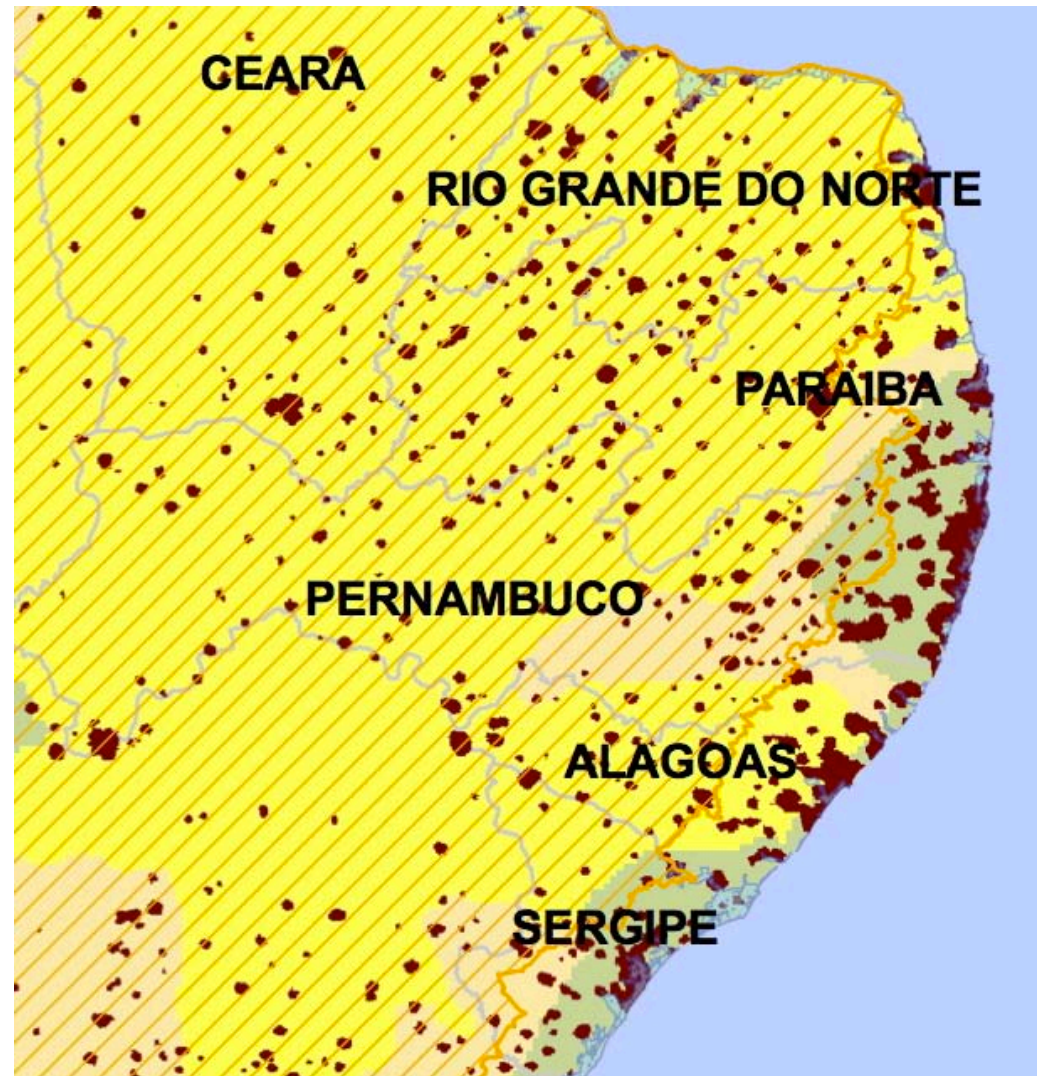
Area of urban extents in:

- the semiarid (MIN): **11,110 km²**
- the drylands (MA): **15,257 km²**

State	MIN (km ²)	MA (km ²)
Alagoas	590	1660
Bahia	3190	4800
Ceará	3060	3210
Minas Gerais	490	537
Paraíba	1080	1510
Pernambuco	1640	1340
Piauí	200	390
R.G. do Norte	860	1610
Sergipe	0	200

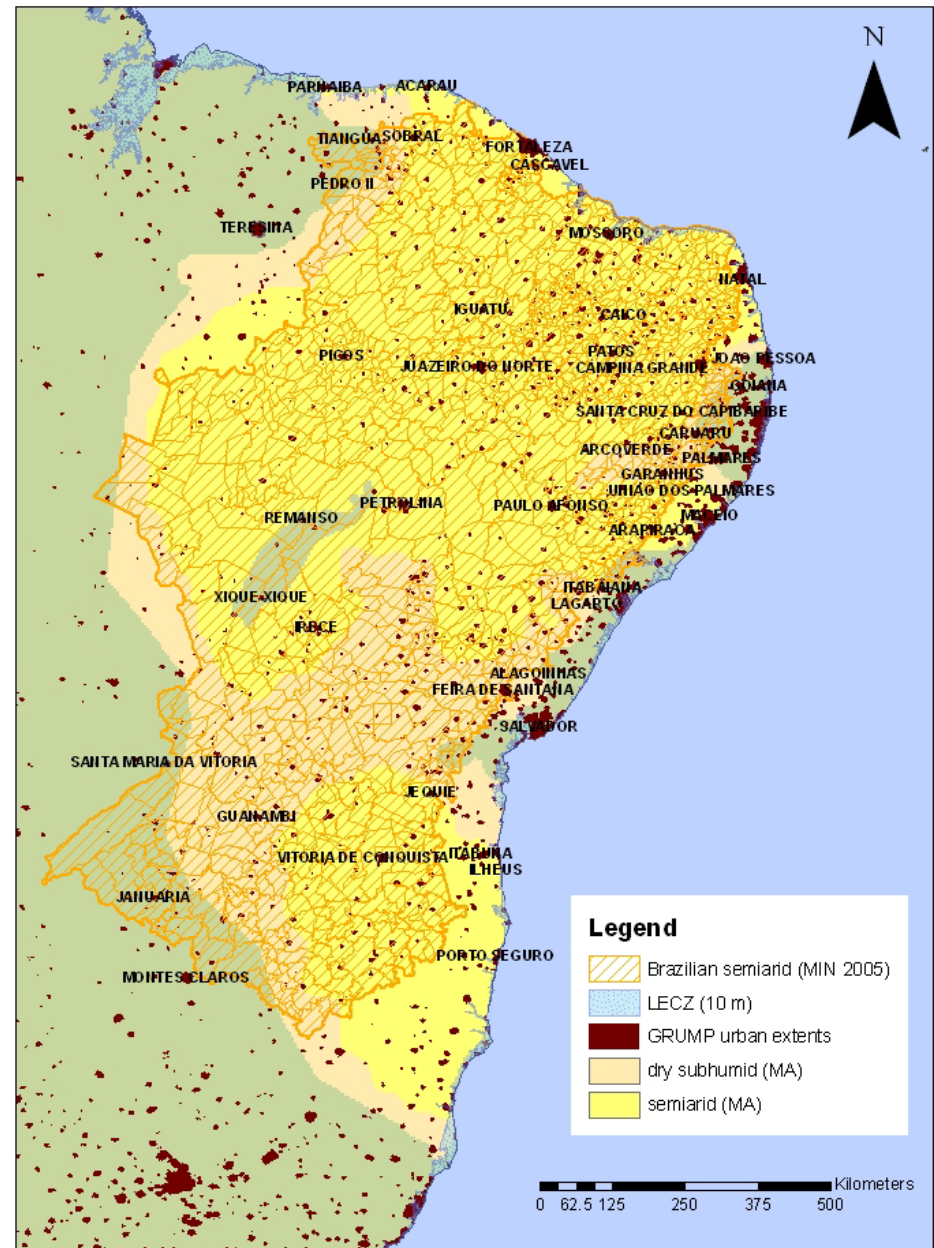
Total population of urban extents:

Year	MIN	MA
1990	6,545,000	8,458,000
2000	8,002,000	10,260,000



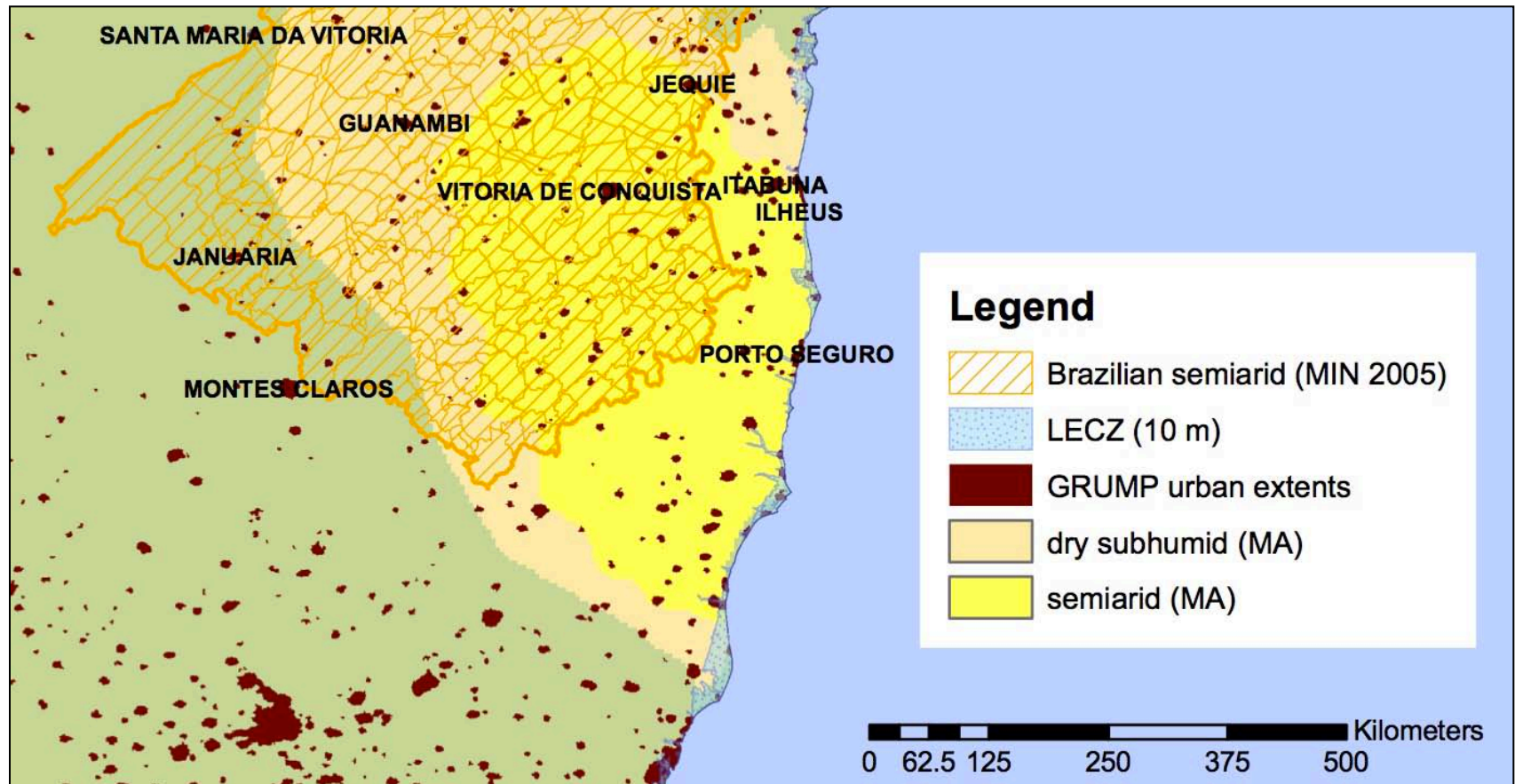
Brazilian dryland cities, top 5 ranked by total pop., 2000

- Fortaleza, CE
 - 1,070 km²
 - 2,695,000 inhabitants
- Feira de Santana, BA
 - 336 km²
 - 478,000 inhabitants
- Campina Grande, PB
 - 363 km²
 - 437,000 inhabitants
- Juazeiro do Norte, CE
 - 410 km²
 - 348,000 inhabitants
- Petrolina, BA
 - 363 km²
 - 232,000 inhabitants



Visualizing the method & data

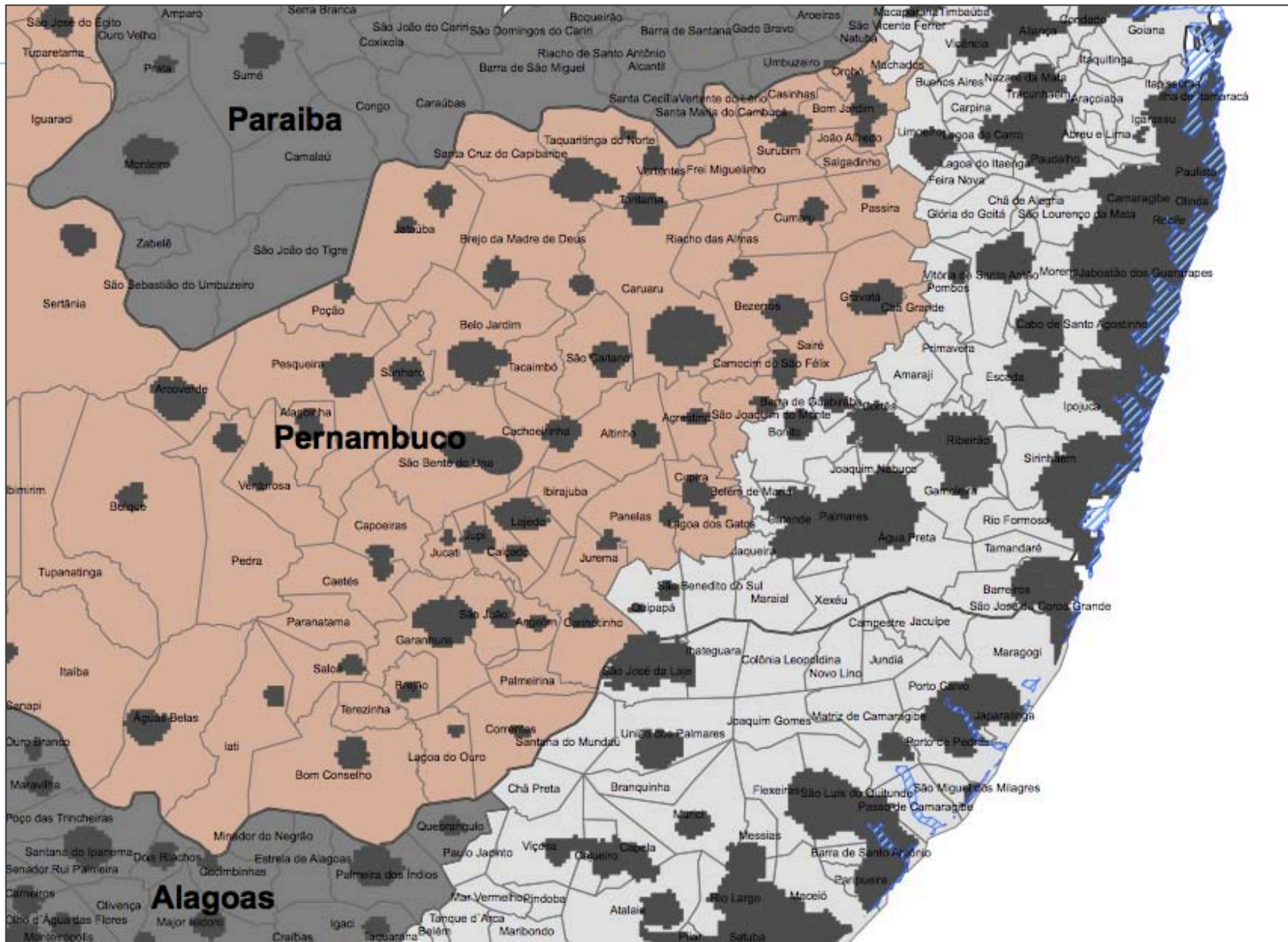
Brazilian Drylands



- Administrative boundaries (Brazilian Census -- IBGE)
- Urban extent boundaries (GRUMP -- CIESIN, et al.)
- Low elevation coastal zone buffer (SRTM, ISciences/NASA)

Visualizing the method & data: a closer look

Future work will integrate social and ecosystem data at finer resolutions



In Sum: what do we know?

- ❑ The world is increasingly urban
- ❑ The distribution of cities and urban population is uneven
 - More urban dwellers live in arid cities than in other ecozones
 - But, people who live in coastal zones are much more likely to live in cities
 - ❑ Coastal cities are much denser than arid cities
 - Most countries will need to adapt to climate change in more than one ecozone
- ❑ Climate change will exacerbate inequities
 - Cities have unique challenges & opportunities for climate change adaptation

Ongoing research needs

- *Where* will growth occur?
 - Forecasts of city growth are currently non-spatial
 - Will growth occur on the periphery of cities? In new cities? Vertically? In slums?
- What are the causes of city growth?
 - Natural increase or migration?
 - The composition of city growth—particularly of the poor
- *Where* precisely will climate change impacts will occur?
- How to address inequalities in both rural and urban areas?
 - Strengthen coordination of development interventions and adaptation measures in rural **and** urban settlements
 - Balance efforts for mitigation, necessary for long-term sustainability, and adaptation, to avert short and medium-term disasters

What can be done?

- Climate change is global, but adaptation is local
 - Effective adaptation requires a base of adequate infrastructure
 - Build local and national databases and capacity, such as:
 - Local expertise in spatial measurement of exposures and impacts (droughts, storms, floods, landslides)
 - In-country expertise in spatial uses of census data
 - Information on economic assets at risk
 - Partner with community organizations and NGOs
 - Not only can they supply knowledge to guide adaptation, they give the urban poor a voice
- Knowledge and spatial data infrastructures are essential for research and policy making alike
 - We cannot adapt to climate change without it!

**For more information about the
Global Rural-Urban Mapping Project (GRUMP) visit:
<http://sedac.ciesin.columbia.edu/gpw/>**

Or email:

Deborah Balk

deborah.balk@baruch.cuny.edu

Mark R. Montgomery

mmontgomery@popcouncil.org

Sandra R. Baptista

sandra.baptista@ciesin.columbia.edu

Obrigada / Thank you