A critical knowledge pathway to sustainable urban futures

AGCI Frontiers Workshop

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URBAN FUTURES

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www.ral.ucar.edu/csap/themes/urbanfutures

1. My research, AGCI and this group

2. Evolution of global change research, and

3. The future of global change research on

   - Urbanization, urban areas and carbon emissions/ climate risk

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Max Weber Lewis Munford, Norbert Elias

You !

Why urbanization if urban areas occupy less than 3% of Earth's land surface?

Urban population projections, by region (2010–2020)

Region	Proportion of total population living in urban areas (percent)			Urban population rate of change (percent change per year)	
	2010	2020	2030	2010–2020	2020–2030
World total	50.5	54.4	59.0	1.81	1.6
North America	82.1	84.6	86.7	1.16	0.92
Sub-Saharan Africa	37.2	42.2	47.9	3.51	3.17
Asia/Pacific	41.4	46.5	52.3	2.2	1.88
Latin America and the Caribbean	79.6	82.6	84.9	1.29	0.94

Romero Lankao and Gnatz (2011)
Data UN (2009) countries own reporting

1. Scale

Five-fold increase of urban populations (1950-2011)

In 2010, 3.5 billion urbanites;
by 2050, 5.5-6.5 billion

2. Speed

In 1900 we had twelve 1-5 million people cities

In 1950 there were 75 cities;

in 2011, 447

3. Location

Asia/Pacific and Africa

Small and medium cities (733 versus 15 large cities in 2000)

Challenges and opportunities

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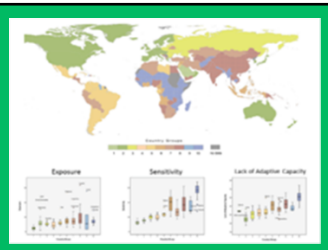
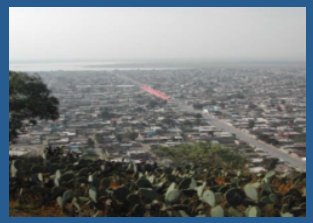
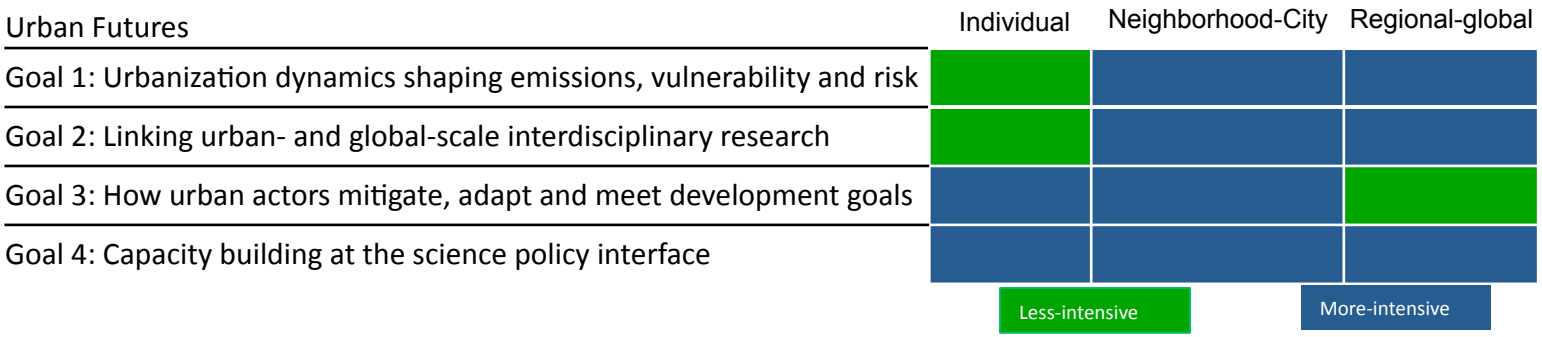
Regional to Global Scale		Urbanization dynamics shaping emissions, vulnerability & risk
Neighborhood to City Scale		Location, Infrastructure/ Built-environment, Socio-demographics, Policies & Governance
Individual and Household Scale		Individuals differential capacity to perceive and respond to risks



2. Evolution of global change research

- Independent lines of research have advanced our understanding of some of the processes involved

- But we have barely scratched the surface in our research efforts

NCAR

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1. What do physical, social and engineering sciences say about ..?

2. How urbanization, urban areas and carbon vary across space, time and scale?

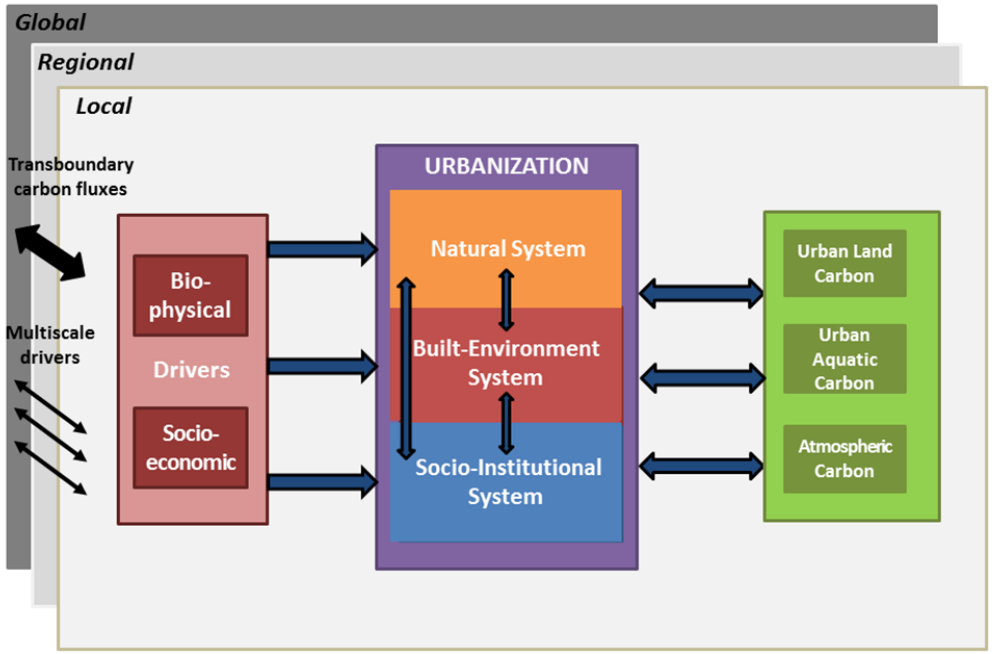
3. Major uncertainties

   – **2050: urban energy-related CO_2 = 9.6-11.2 PgC/yr (over ½ mean uptake by global terrestrial biosphere for 2000-2009)**

4. When and how urbanization and carbon emissions "lock in"?

5. What are the opportunities for altering urbanization towards lower carbon pathways?

Urbanization, urban areas & carbon: An integrated framework



Romero-Lankao (NCAR), K.R. Gurney (ASU), PK. Seto, (Yales) C. Kennedy (Toronto), N. Grimm (ASU), J. Ehleringer (Utah), P. Marcotullio (CUNY), S. Pincetl (UCLA), J.J. Feddema (Kansas), S. Hughes (EPA), M.V. Chester (ASU), L. Hutyra (Boston), J. Sperling (NCAR), D. Runfola (NCAR), Earth's Future (forthcoming)

Research on urbanization, urban areas and carbon

	Engineers/industrial ecologists	Social scientists	Physical scientists
Definition of **carbon**	An input (fossil fuels, renewables) or output (GHG)	A natural resource, waste or pollutant	The flow, flux or exchange of carbon among pools (fuels , biosphere, atmosphere)
Definition of **urban areas**	Metabolic systems entailing technical and socioeconomic processes	Spectrum ranging from "megacities" to smaller-scale urban settlements (e.g., towns)	Terrestrial areas dominated by impervious surfaces where land cover change has occurred
Selected **research questions**	What processes in urban metabolism threaten cities' sustainability?	How do demographics, affluence, economics, or institutions affect energy use and GHG emissions? What are the opportunities and barriers to transitions?	What are the urban anthropogenic carbon fluxes? How do they change in time & space? Can we attribute carbon fluxes by process, space & time?

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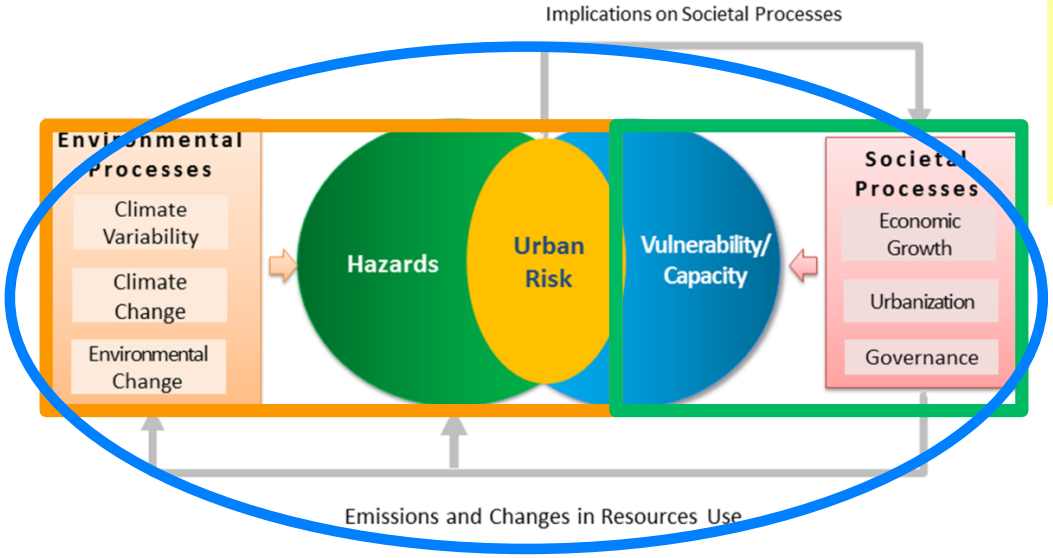
Determinants of urban vulnerability to temperature-hazards: evidence and agreement

Amount of Evidence	Low	Medium	High
Large	Gender: Female	Age (+) Education (-)	Magnitude (+)
Medium	Income Race: Non-African American Minorities	Population density (+) Poverty (+) Deprivation (+) Housing quality (~) Social isolation (~)	Timing (+) Pre-existing medical conditions (+) Acclimatization (-) Race: African American (+) Air conditioning (-)
Small	Housing density Social networks	Total population (~) Urban land use (+) Open space (~) Vegetation (-) Healthcare access (-)	Duration (+) Variance (+) Race: Non-white (~)
	Level of Agreement		

(1) Text color denotes categories of vulnerability dimensions. Green = Hazard; Yellow = Exposure; Red = Sensitivity; Blue = Adaptive capacity/adaptation (2) Symbols in parentheses = direction of relationship between vulnerability and outcome (medium or high level of agreement only) + positive relationship (increases vulnerability); - negative relationship (decreases vulnerability); ~ no relationship

What do we mean by urban population's vulnerability?



Urban outcome vulnerability top-down (88%)

- Natural hazards origins
- Vulnerability results from exposure to hazards, people's sensitivity & impacts

Inherent urban vulnerability bottom-up (6%)

- Political economy approach
- Focus on adaptive capacity and structural drivers of vulnerability

Urban resilience/integrated (6%)

- Multidisciplinary, integrated approach
- Focus on socio-ecological systems, adaptation, mechanisms

Romero-Lankao and Qin 2011
Romero-Lankao, Qin, Dickinson 2013

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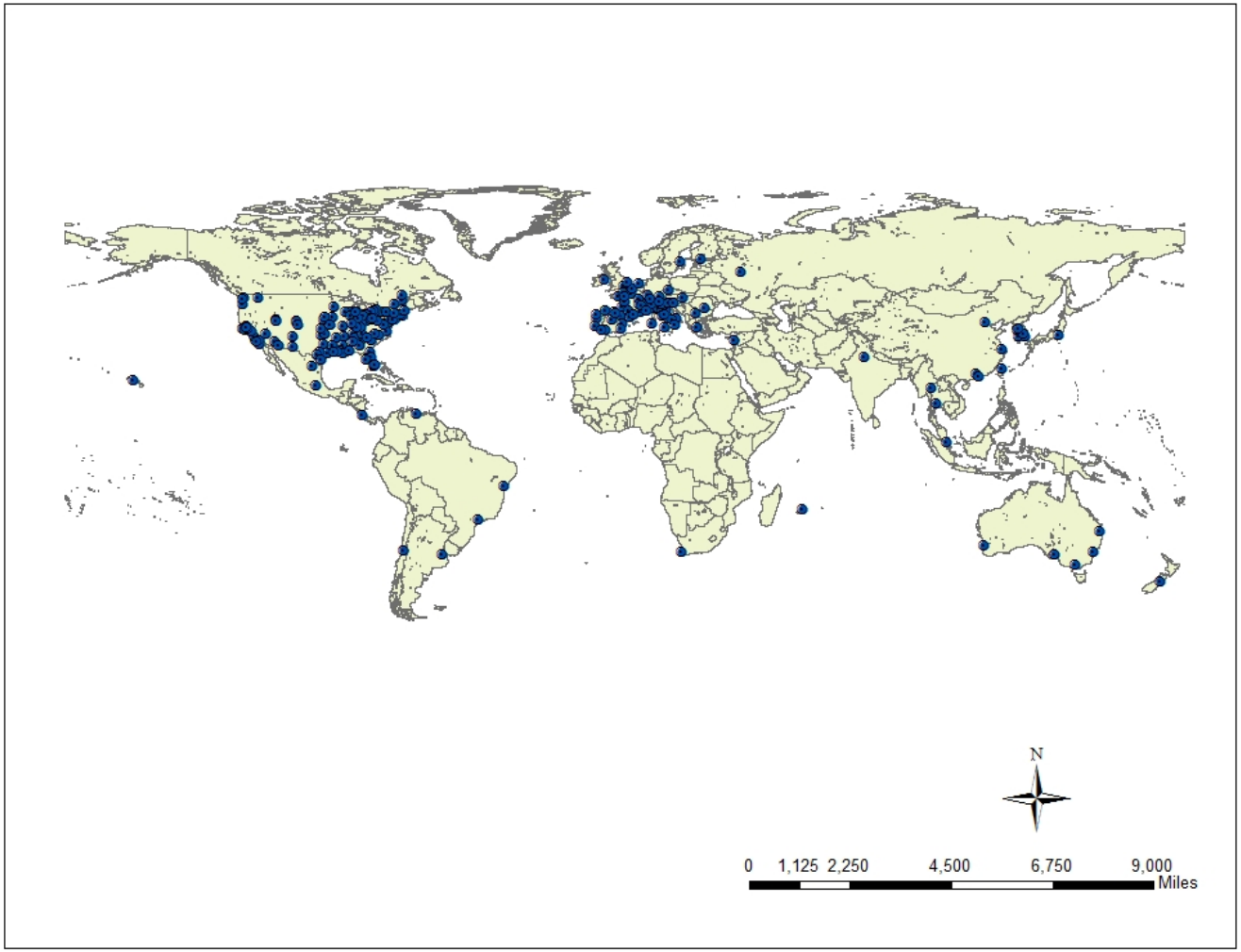
Population's Vulnerability to Temperature (224 cities)



Source: Patricia Romero Lankao, Hua Qin and Katie Dickinson 2012

3. **The future**

Approaches that complement & combine disciplinary domains into interdisciplinary, co-produced research

- Combines quantitative & qualitative methods
- Captures multiple scales
- Understand and fosters capacity

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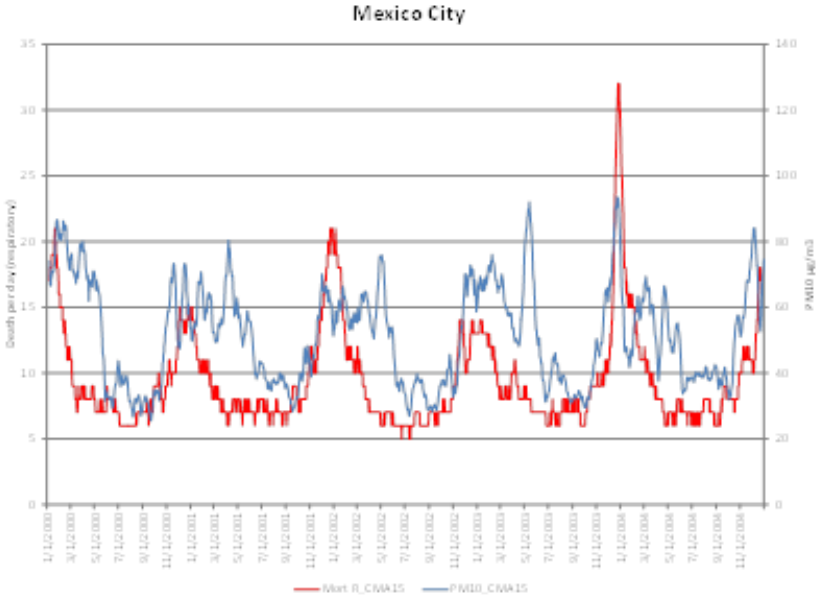
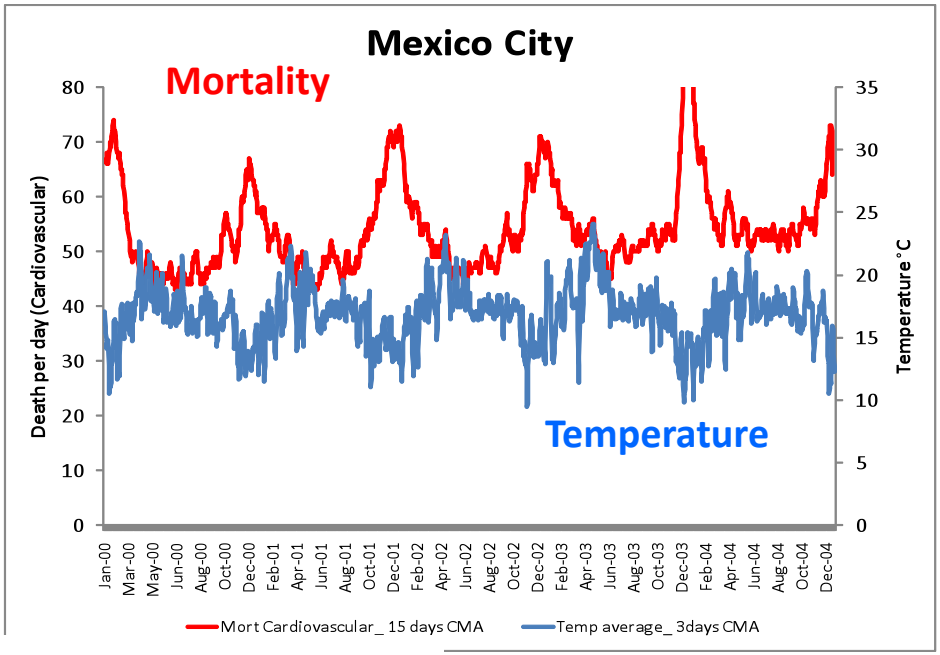
Why scale?

Issue of concern varies with the spatial, temporal, or analytical dimension used by scholars

Positive correlation between mortality and PM10



Negative yet different correlation between temperature and mortality

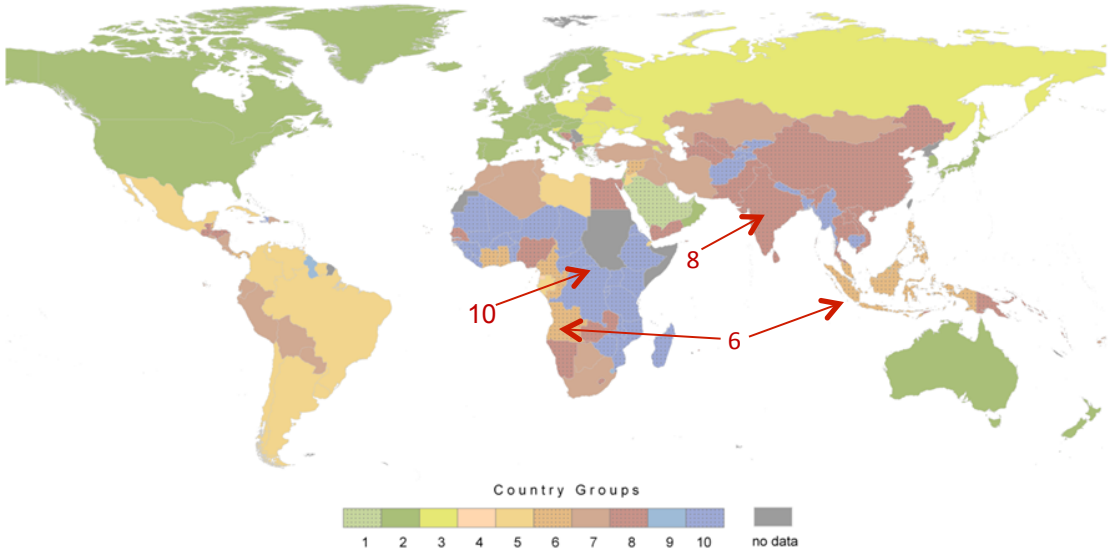


Time (~ 5 years)

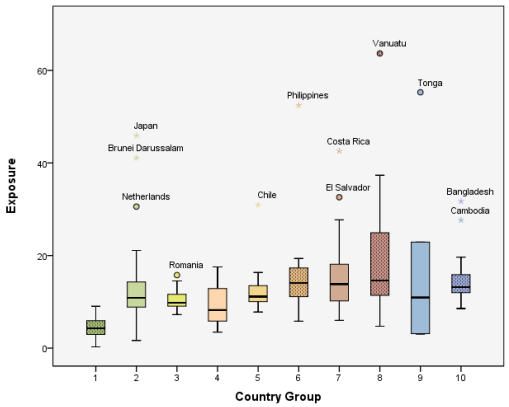
Source: Romero-Lankao, Qin, Borbor, et al., (2012) and (2013)

Dynamics of urbanization shaping vulnerability/capacity

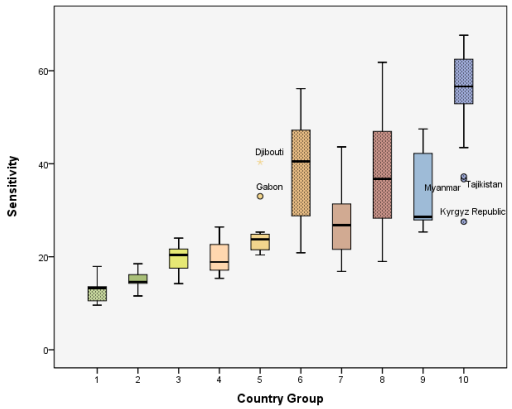
1. Not only exposure but also sensitivity and capacity
   - Urbanization and economic indicators to cluster countries
   - Cross-correlation of clusters with national-level normalized sub-indices of hazard exposure, sensitivity, and adaptive capacity (World Risk Index 2012)
2. Not only levels but also rates of urbanization influence vulnerability



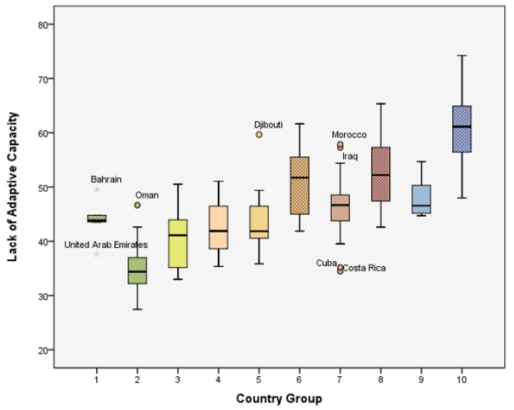
Exposure



Sensitivity



Lack of Adaptive capacity



Source: Garschagen and Romero-Lankao 2013 *Climatic Change*

Capacity and Adaptations vary across scale (Bogota, Buenos Aires, Mexico & Santiago)

- Risk-hazard and vulnerability assessment
- Integrating risk into territorial planning
- Addressing informality

- Community-based disaster response
- Infrastructure works
- Slum upgrading

- Move belongings to upper level, open windows
- Call emergency number
- House amenities
- Structural house modifications

- Economic growth
- Livelihood options
- Social fabric (crime and violence)
- Infrastructure
- Health, education, housing
- Land use planning, informality

- Social networks
- Water, sanitation
- Electricity
- "(In)formal status"

- Age, gender, education
- Medical conditions
- House quality
- Perceptions

Note: blue= determinants of vulnerability/adaptation capacity
black = actual adaptation actions

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Romero-Lankao (NCAR), Hughes (EPA), Hardoy (IIED), Qin (Missouri), Rosas-Huerta (UAM), Bórquez (Chile), Lampis (U. Colombia) (2014)

Integrate insights from social, physical and engineer sciences

1. Holistic concept of urbanization and relative weights of diverse features of urban systems on emissions & risk

2. Infrastructure couplings:
   - ❖ Emissions and resilience
   - ❖ Interdependencies within/across “hard” & “soft” infrastructures

3. Variations in emissions/risks within & across urban areas

4. Typologies of urban areas that include
   - ❖ Level of income, maturity, urban form, economic function,
   - ❖ Governance arrangements, geography

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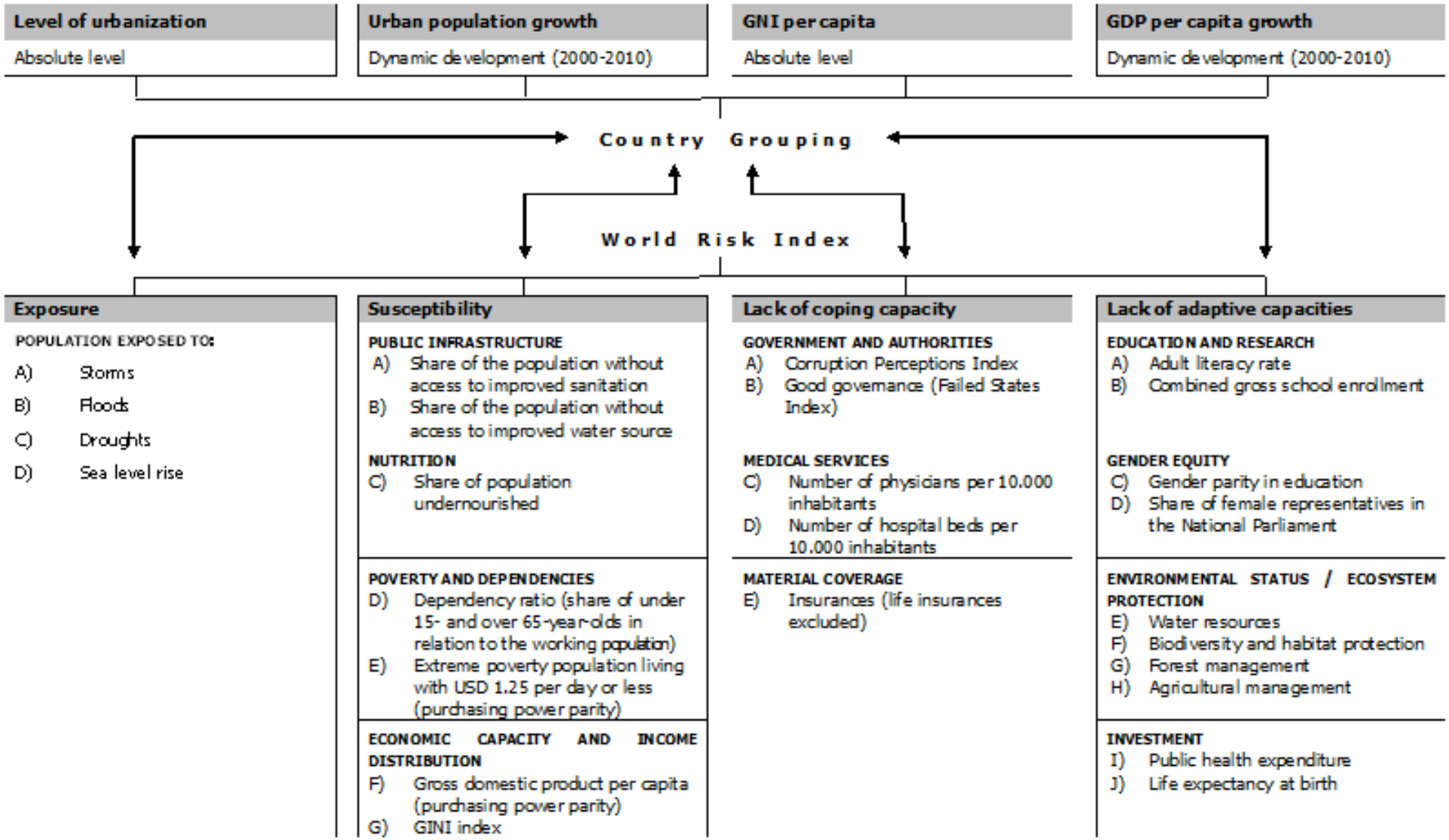
Interdisciplinary science where no domain can merely be and add-on to research agenda driven only from another domain (or vice versa)

Thank you!

Urban Futures at NCAR

http://www.ral.ucar.edu/staff/prlankao-staff.php

Indicators used for the country grouping and the World Risk Index



Source: own draft. World Risk Index indicators based on Welle et al. 2012