Ad Hoc Expert Meeting on

Climate Change Impacts and Adaptation: A Challenge for Global Ports

29 – 30 September 2011

Extreme Flood Events and Port Cities through the 21st Century: Implications of Climate Change and Other Drivers

Presentation by

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Extreme flood events and port cities through the 21st Century:
implications of climate change and other drivers

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Acknowledgements

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PLAN

- Introduction
- Key Questions
- Exposure Analysis
  - Global, National, and City Level
- Mitigation
- Adaptation and Risk
- Conclusions

Hamburg
1962

Netherlands
1953

New Orleans 2005

Coastal Urban Trends

Rising local and global risks

- Population
  - Growing coastal population (double global trends)
  - Urbanising coastal zone (new residents are urban)
  - Tourism, recreation and retirement
- Subsiding cities, especially in deltas
- Climate change and sea-level rise
- A reactive approach to adaptation

Key Questions

- What is the current and future exposure?
- What is the current coping capacity?
  - defences, warnings, disaster response, etc.
- What is present and future risk?
  - risk = probability x consequence
- What are our policy responses?
  - mitigation (source control)
  - adaptation (behavioural change)

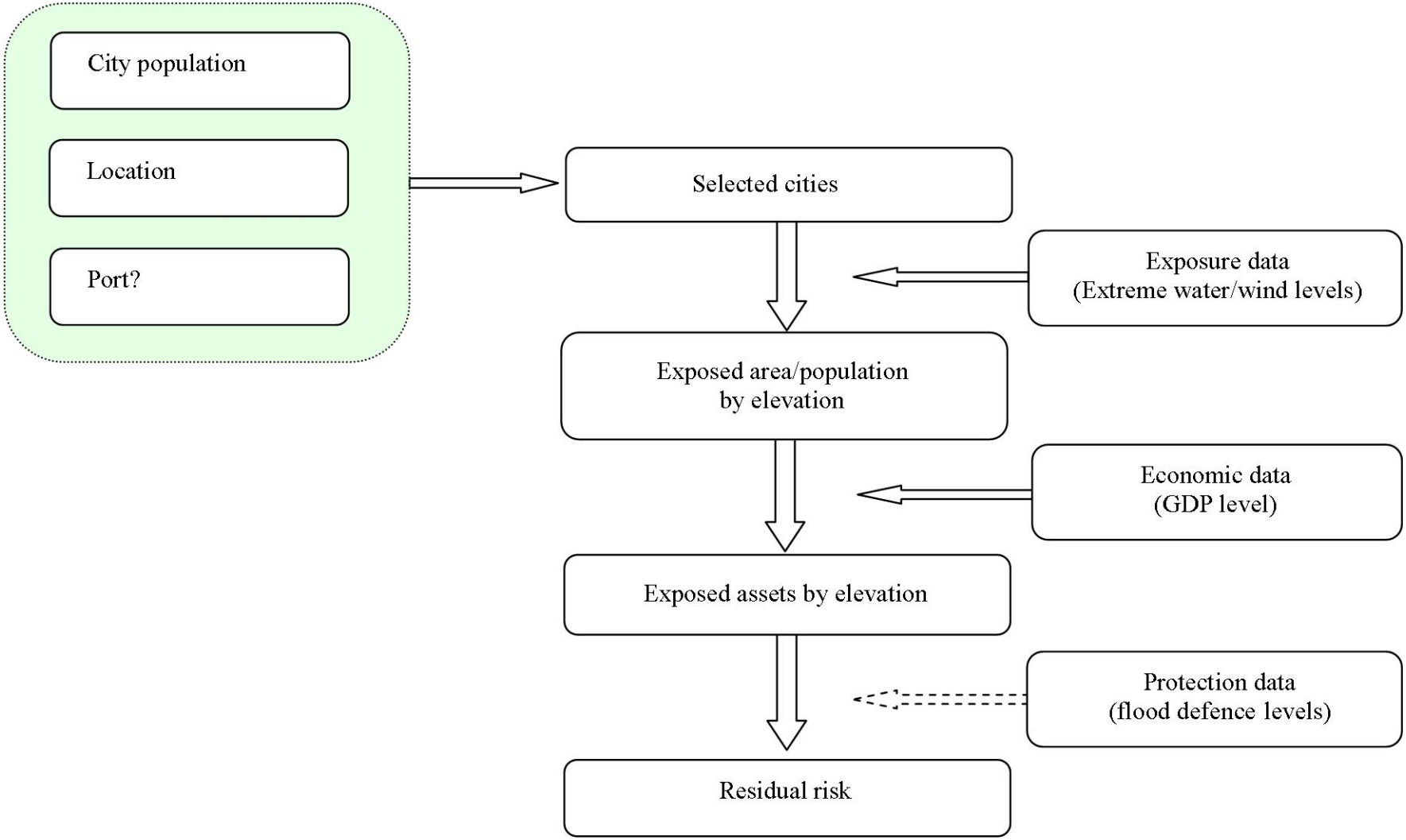
Exposure Analysis

For Baseline (2005) and the 2070s

- Focuses on the 1 in 100 year event in cities with > one million population in 2005
- Considers all the relevant drivers of flood exposure
  - Socio-economic (demographic, economic and urbanisation change)
  - human-induced subsidence
  - climate-induced sea-level rise
  - Storms, including climate change
- Considers high-end scenarios to bound potential changes.

Methodology

UN City database
Port databases



Scenarios

- Population, economic and urban growth
  - Single scenario from the OECD ENV-Linkages model
  - Assets linked to population and GDP/capita by a constant multiplier (5)
- Natural subsidence/uplift
  - From the DIVA database
- Global sea-level rise
  - 0.5 m rise -- after Rahmstorf (2007) -- larger than IPCC AR4 (2007)
- More intense storms and higher storm surges
  - Assumed increased intensity of 100-year storms consistent with IPCC (2007) -- tropical storms and selected extra-tropical storms
- Potential human-induced subsidence
  - Considered an average subsidence up to 0.5 m across the 100 year flood plain in all susceptible cities

Port City Locations

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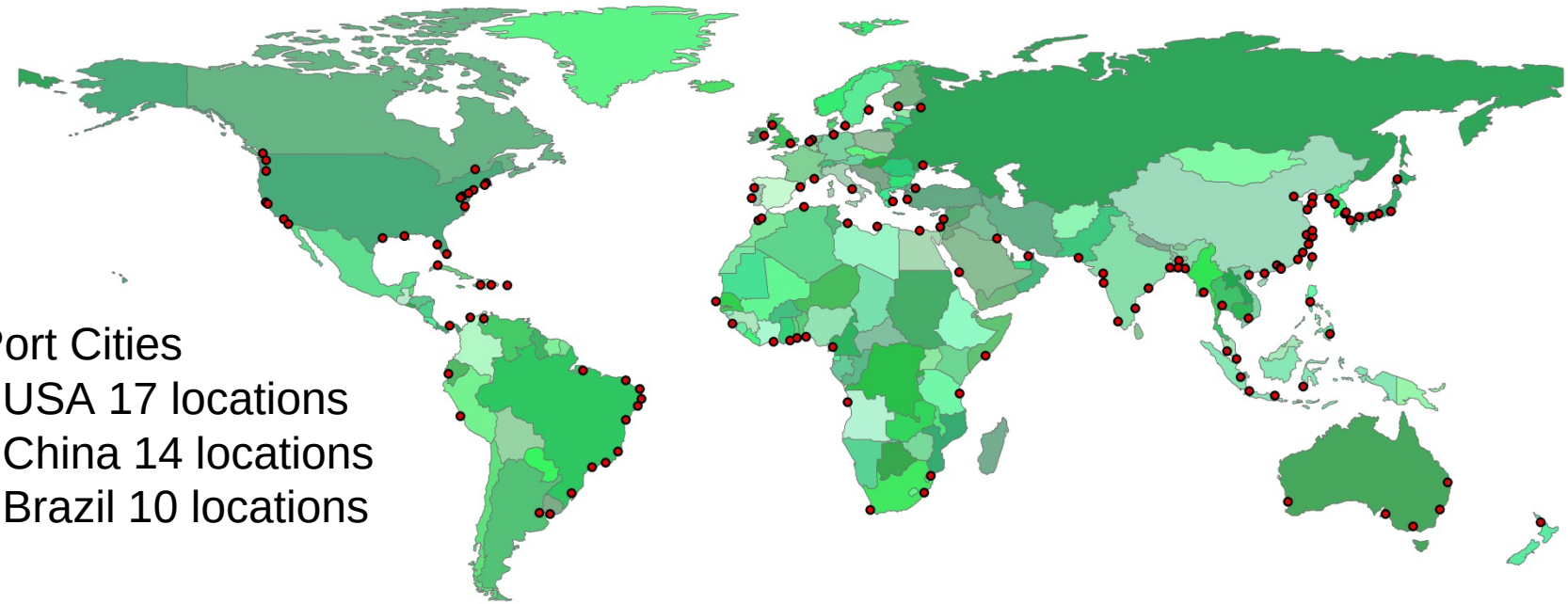
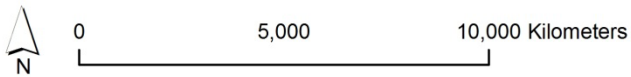
≥1 million population in 2005
136 locations

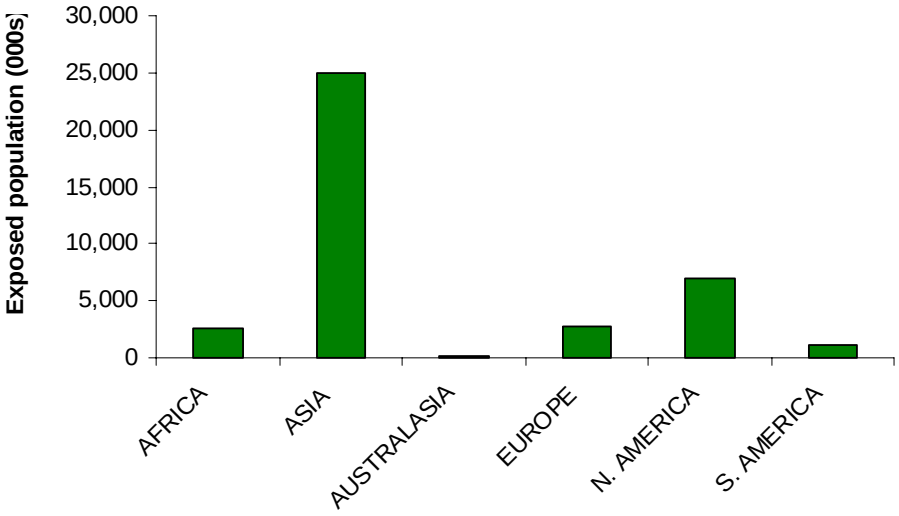


Port Cities
- USA 17 locations
- China 14 locations
- Brazil 10 locations



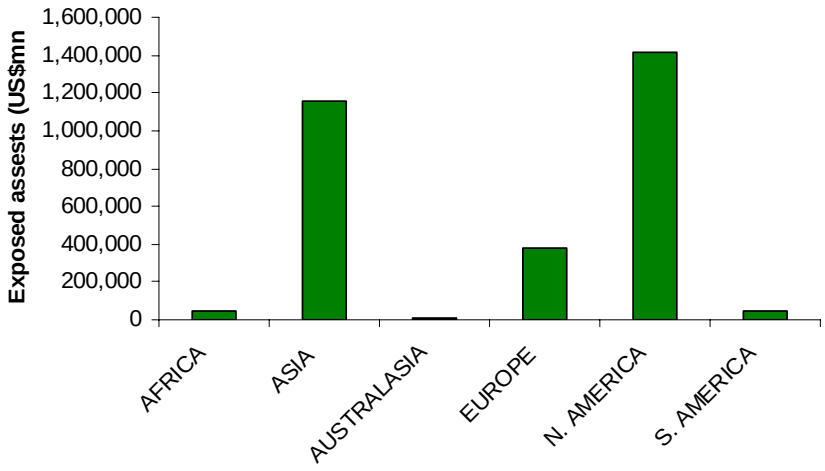
Key global results for the flood plain
- 40 million people
  - 0.6% of global population
  - (10% of port city population)
- US $3000 billion of assets
  - 5% of global GDP

Exposure by Continent
in 2005



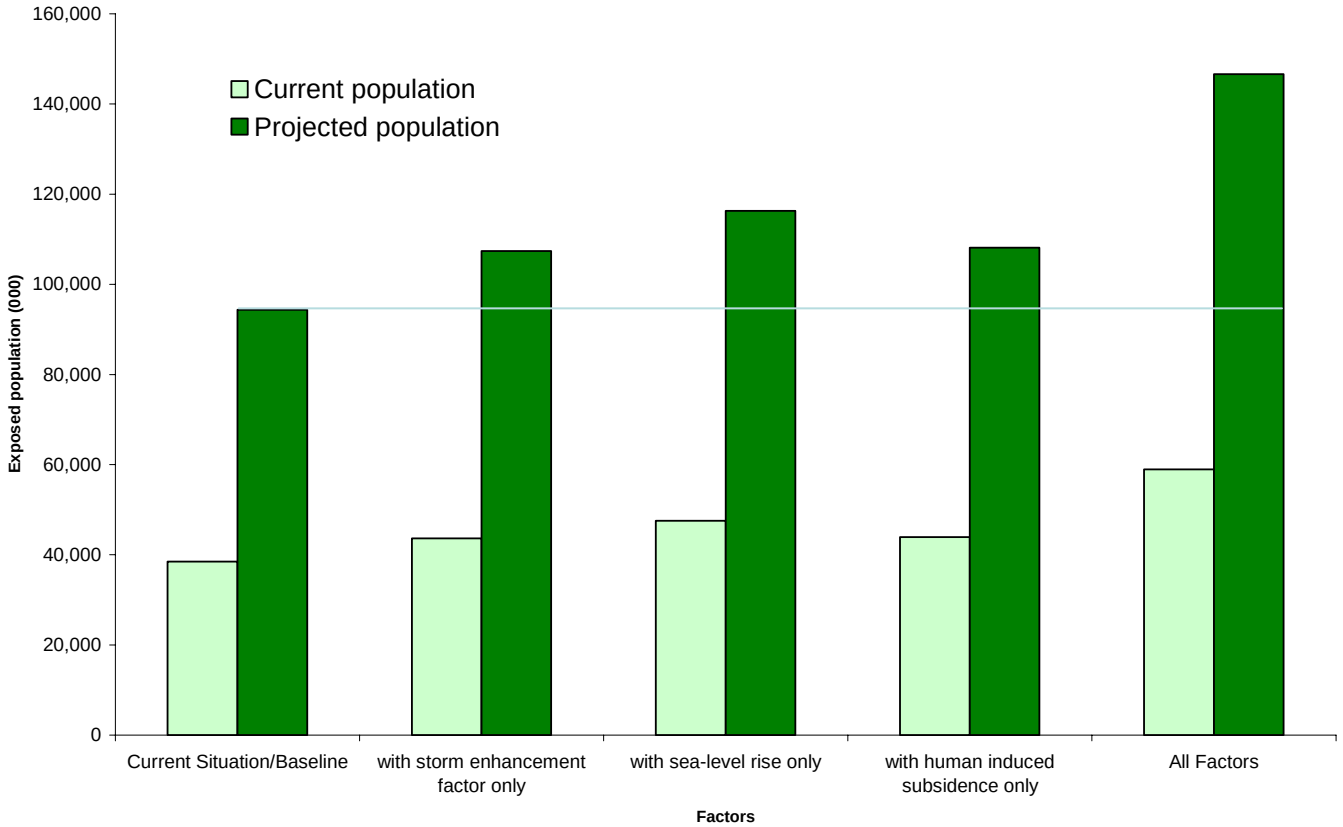
(a) Population

(b) Assets



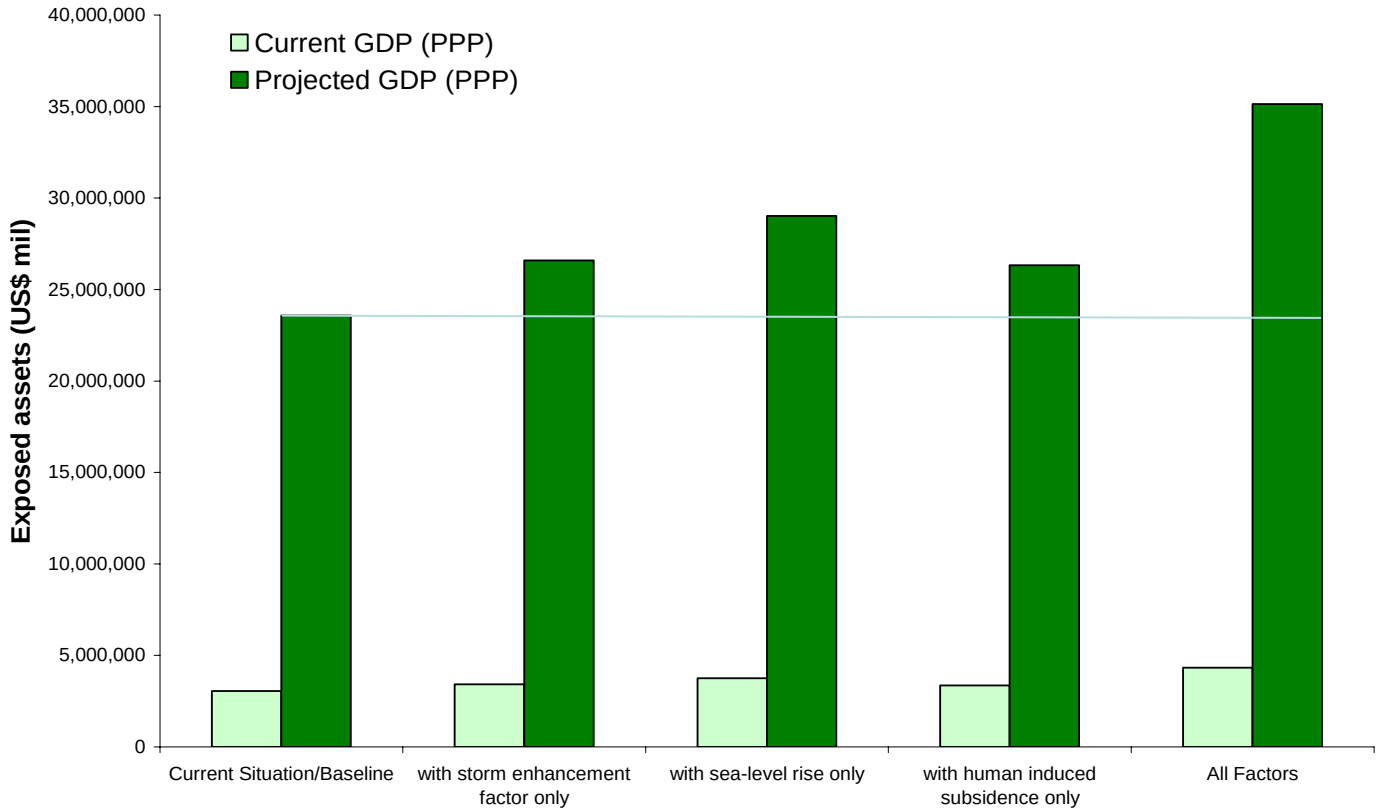
Global Population Exposure

Influence of different change factors: 2005 to 2070s



Global Asset Exposure

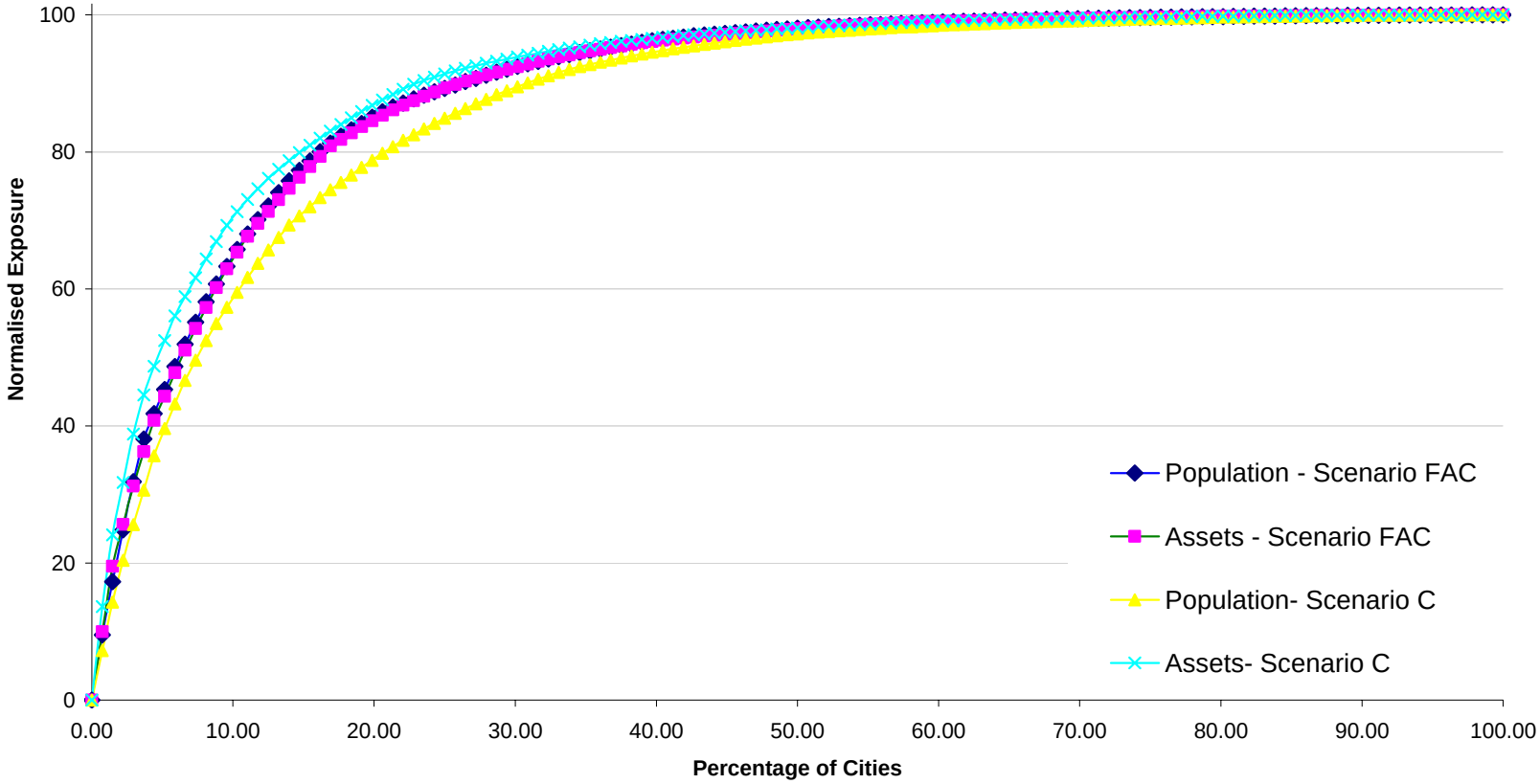
Influence of different change factors: 2005 to 2070s



Cumulative Global Exposure

Population and assets: 2005 and 2070s

Top 20 corresponds to 15 percentile



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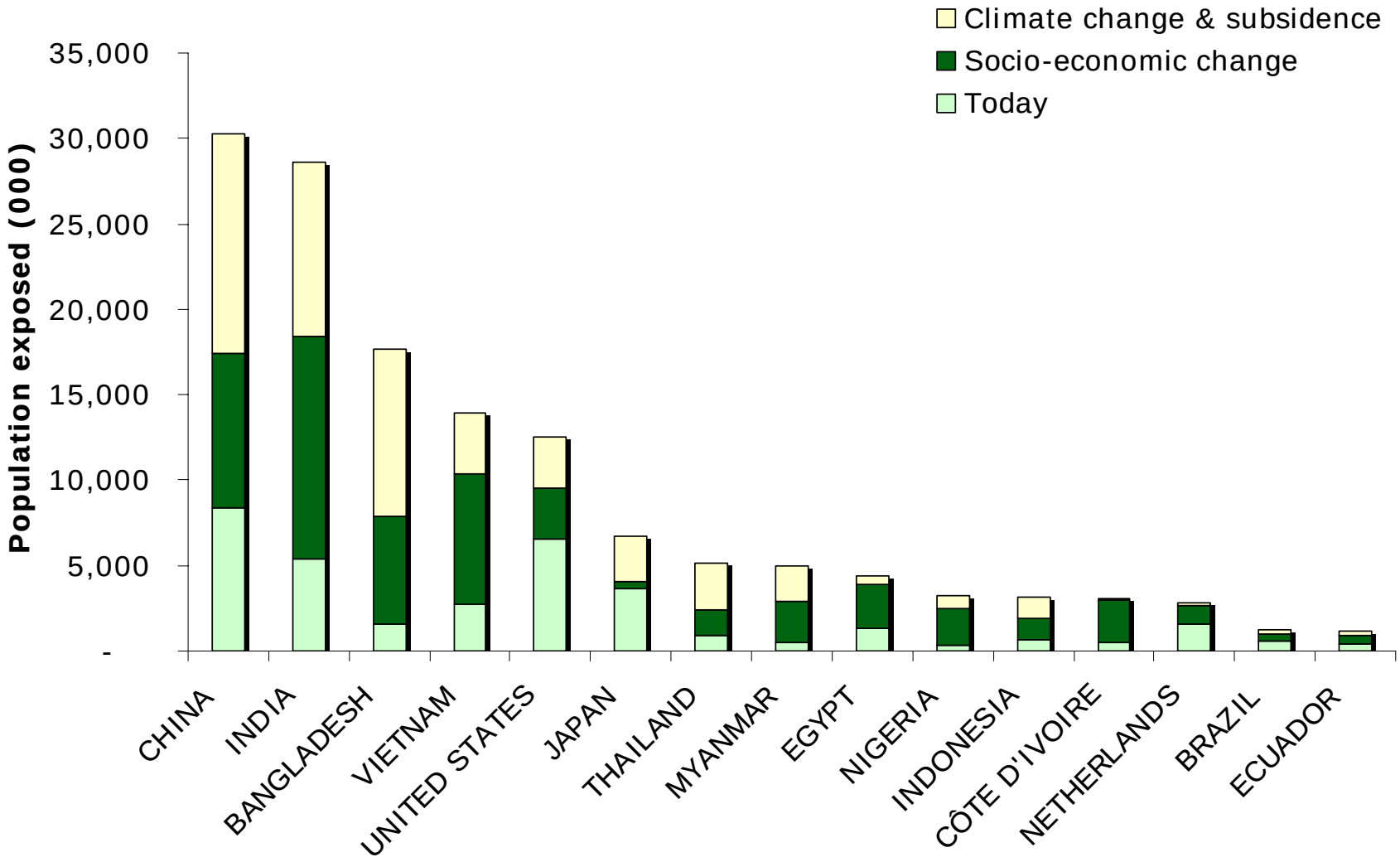
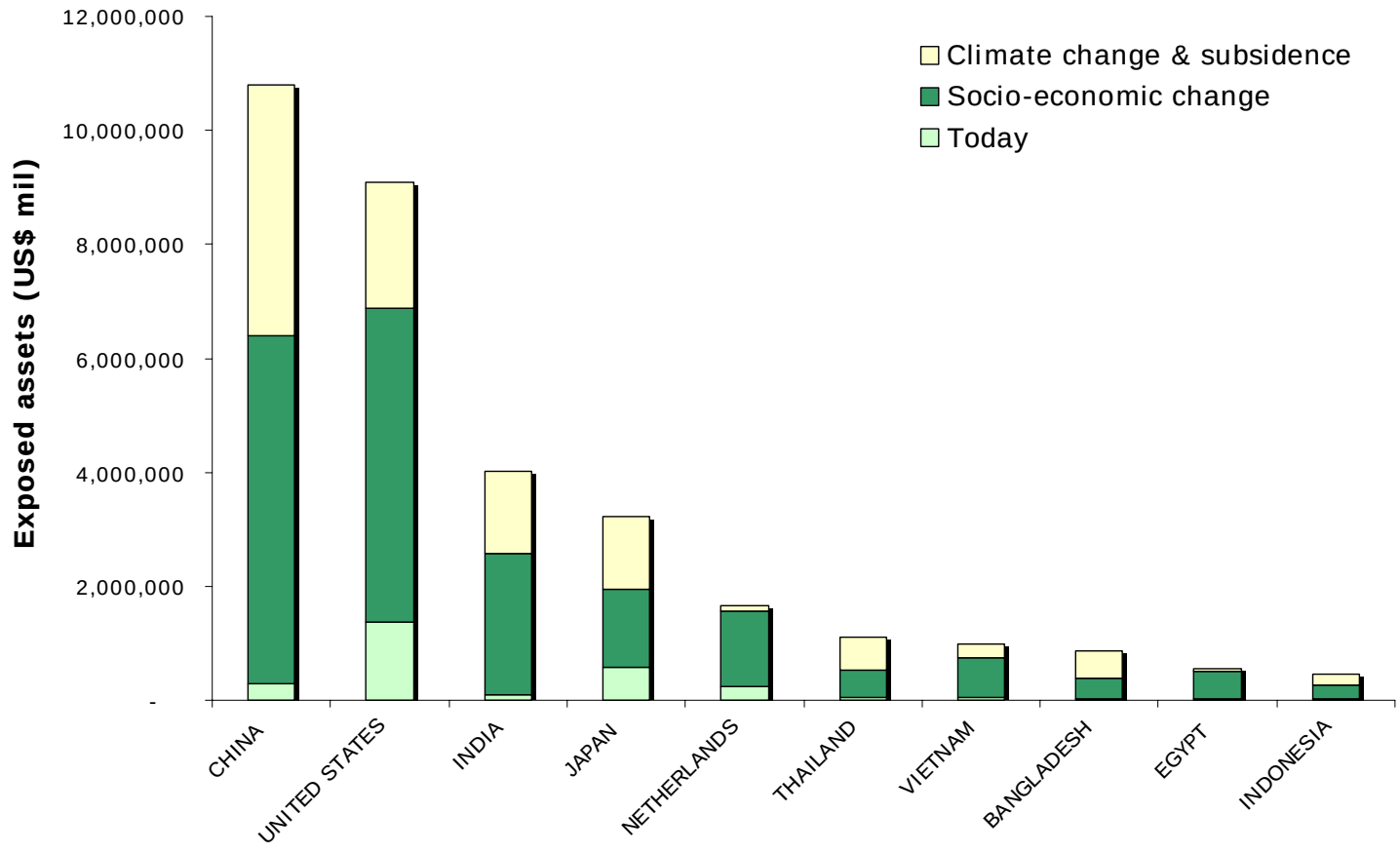
Population Exposed

Top 15 countries 2070s

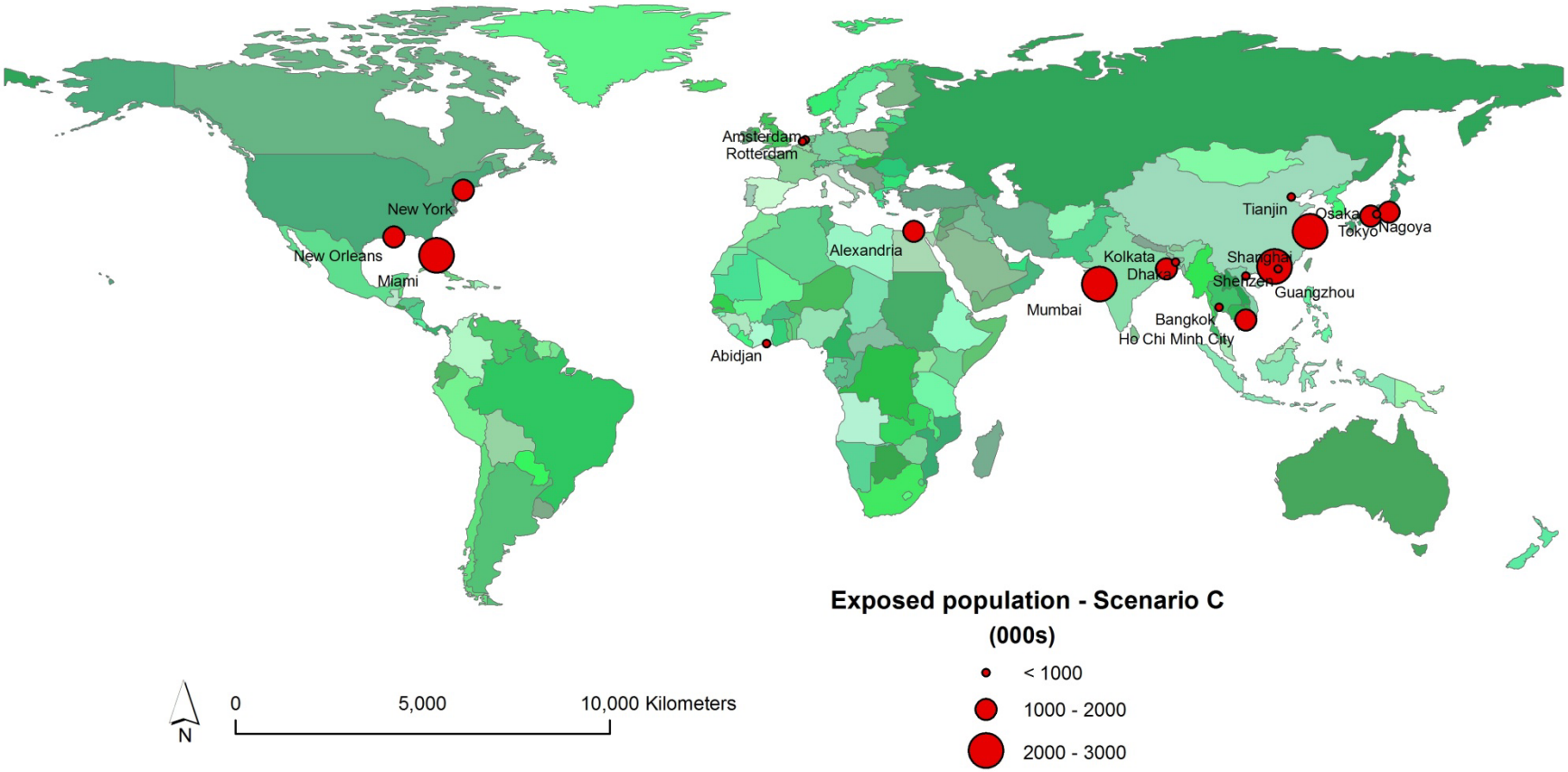


Assets Exposed

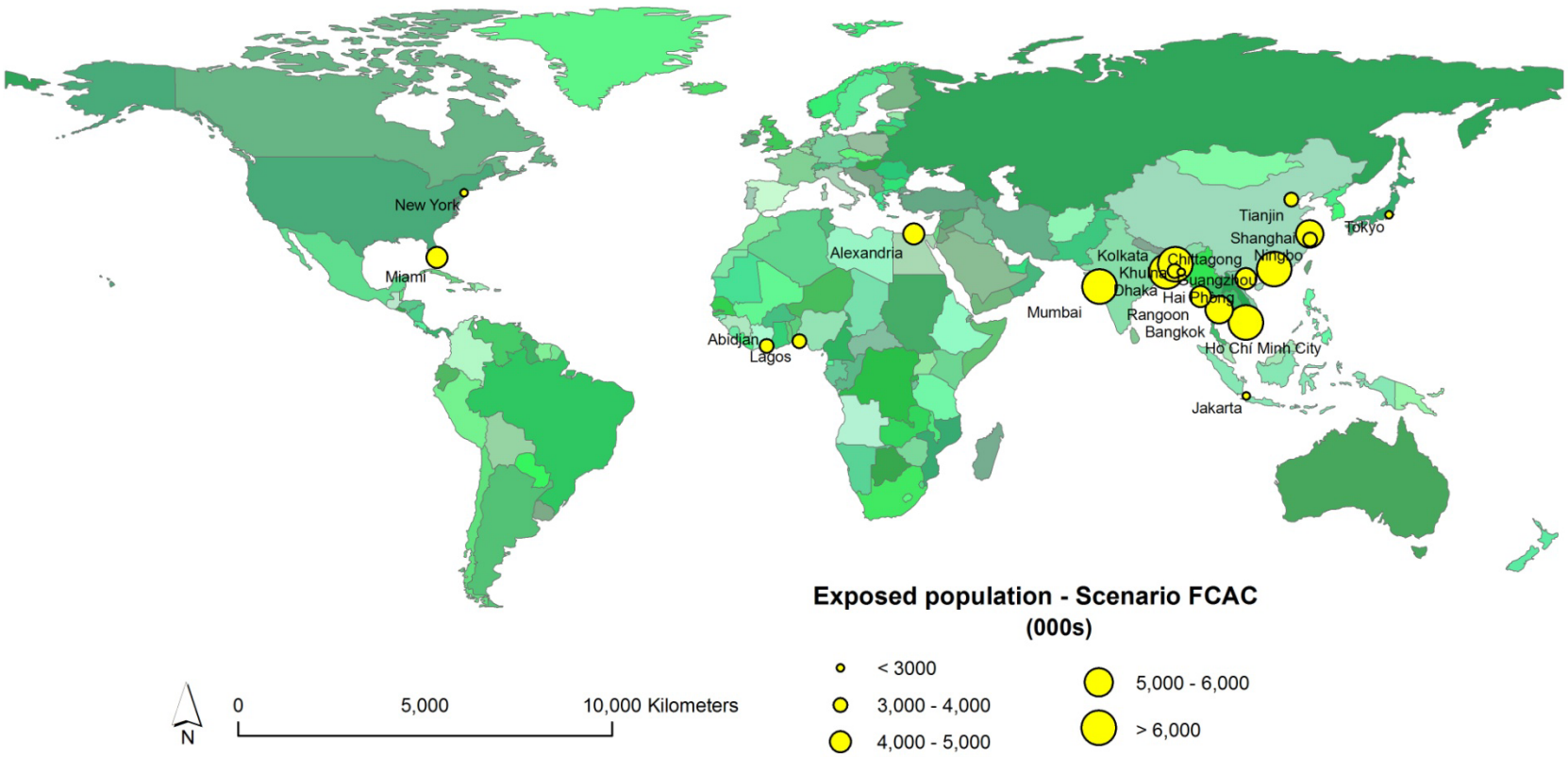
Top 10 countries 2070s



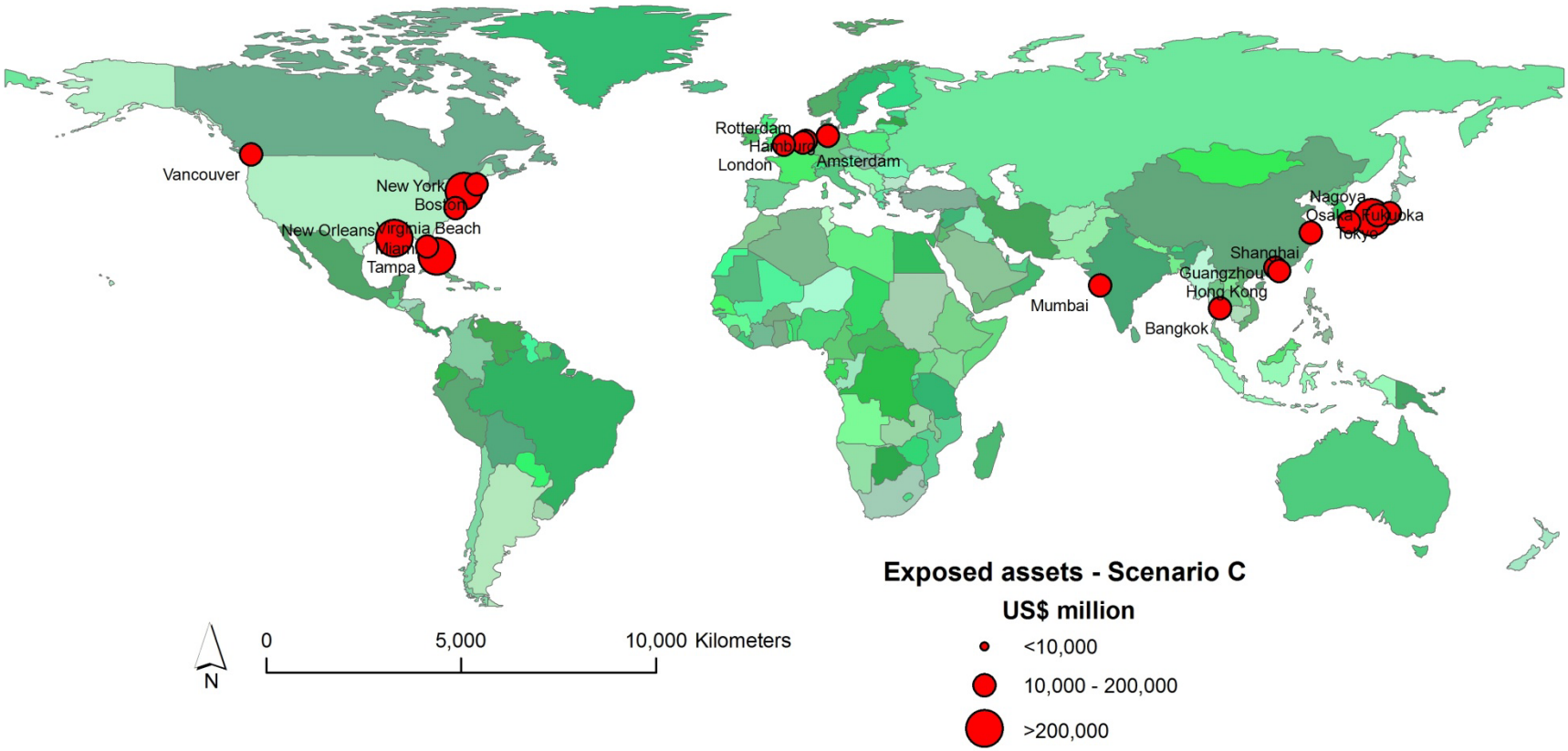
Exposed Population 2005
Top 20



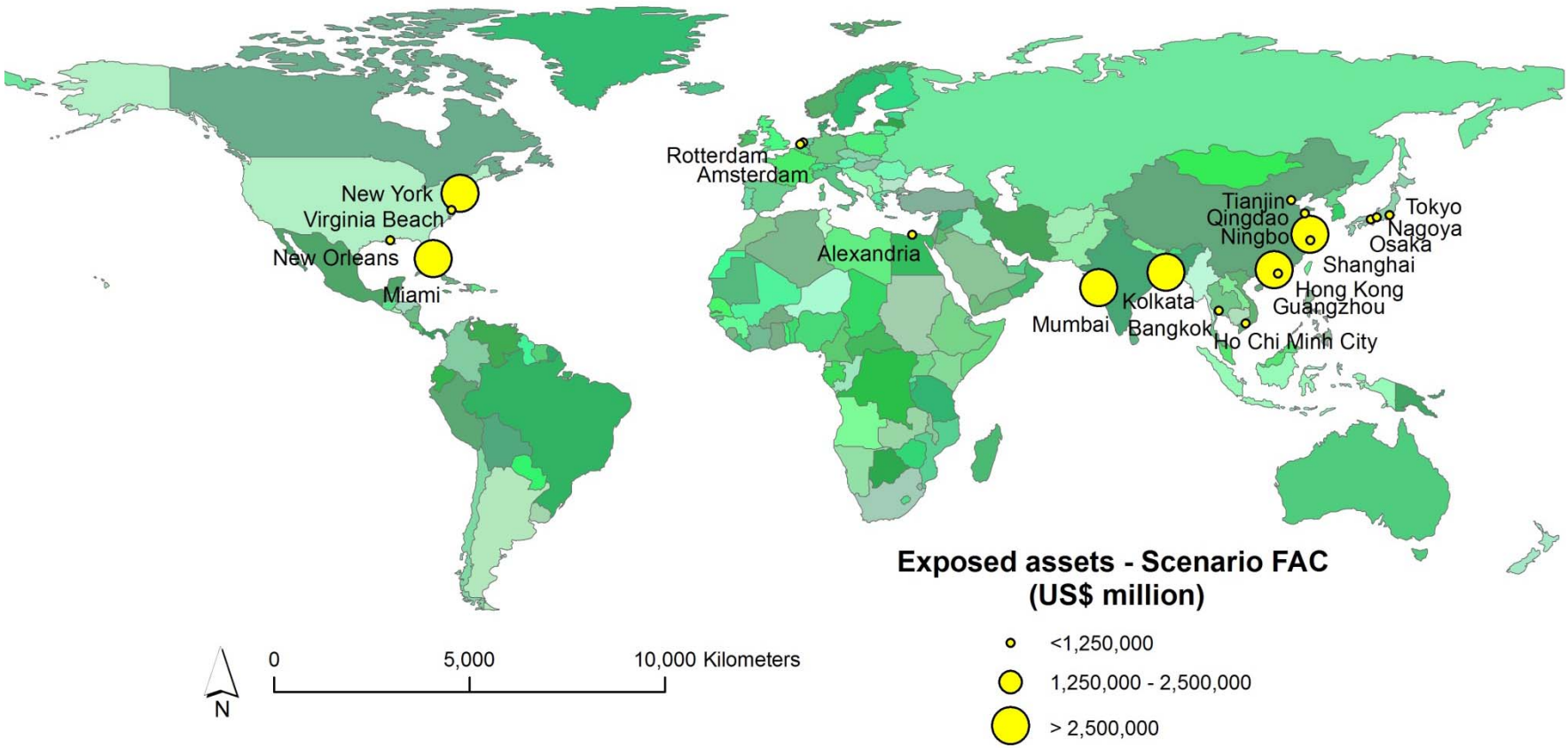
Exposed Population 2070s
Top 20



Exposed Assets 2005
Top 20



Exposed Assets 2070s
Top 20



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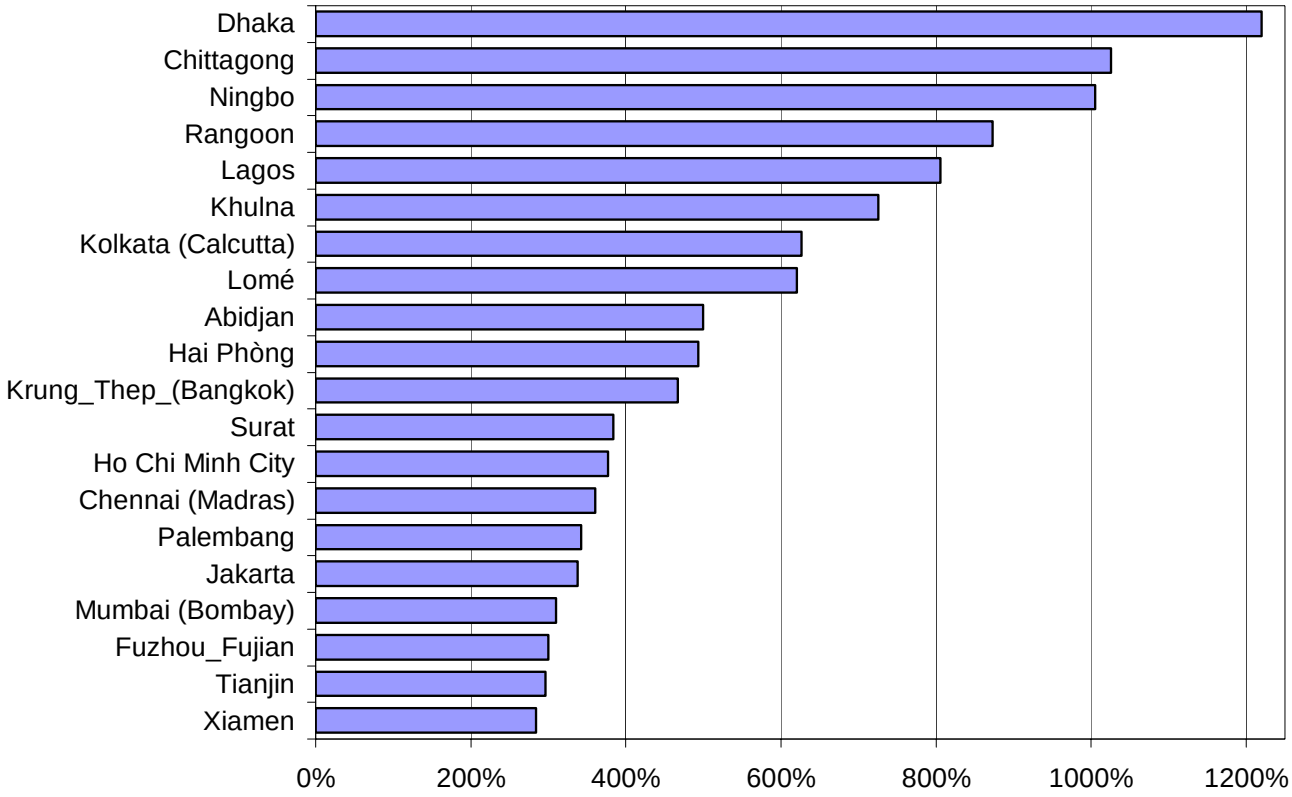
Most Rapid Growth in Exposed Population

(2005 to 2070s)

From the Top 50 cities in 2005



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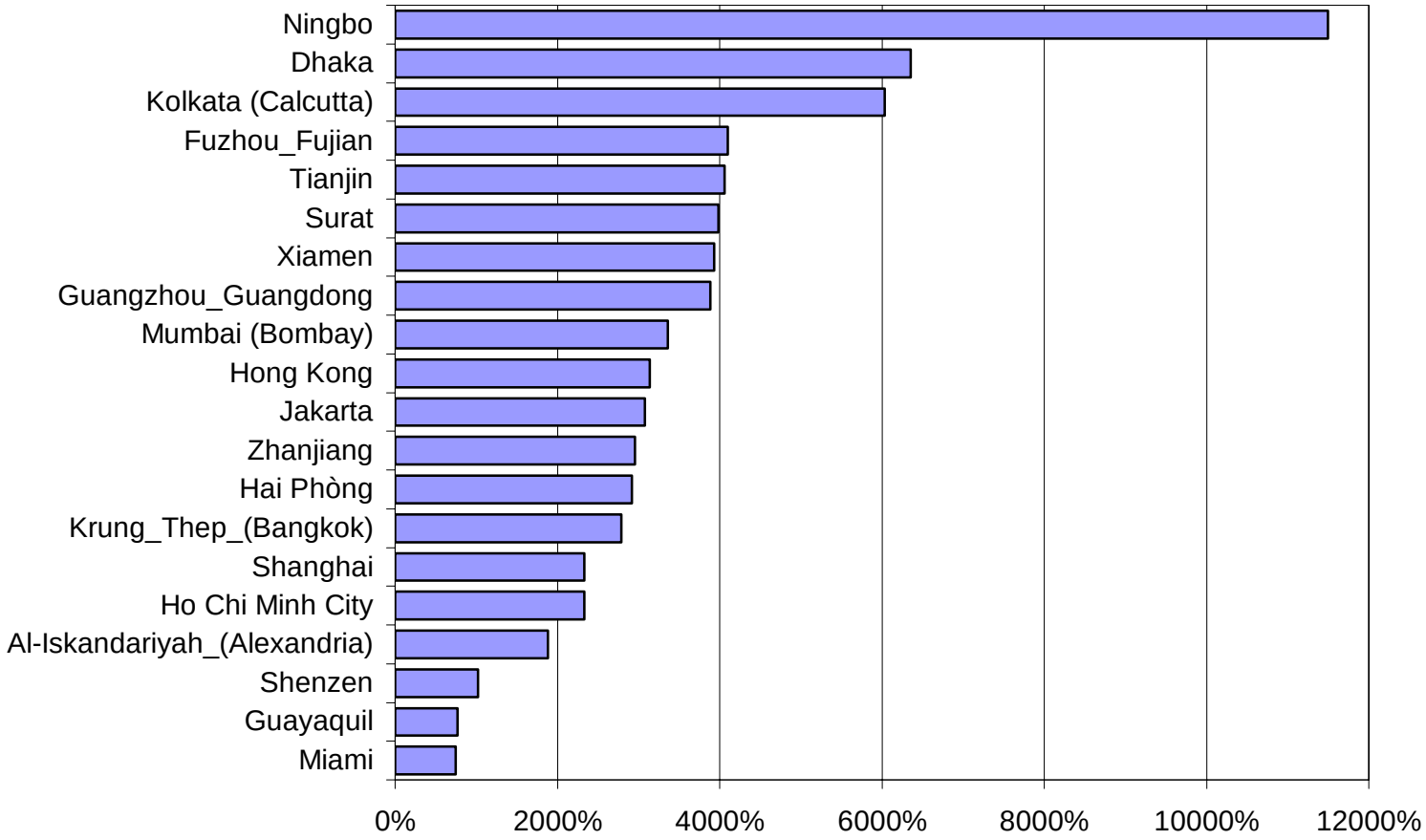
Most Rapid Growth in Exposed Assets

(2005 to 2070s)

From the Top 50 cities in 2005



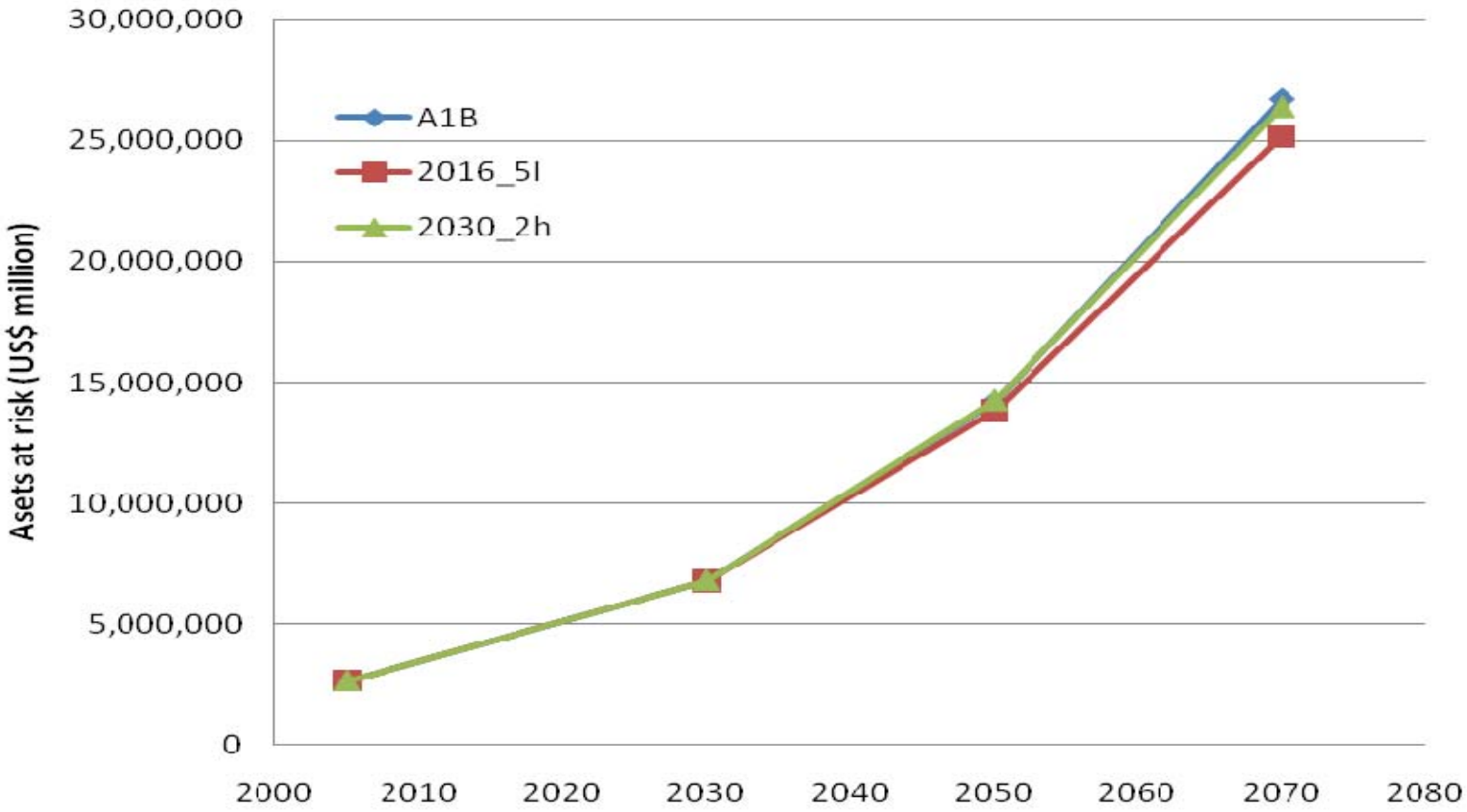
Climate Mitigation Analysis

Benefits of climate mitigation on climate change and sea-level rise

- Evaluate reduction in exposure in the 136 coastal cities due to global reduction of CO_2 emissions
- Climate projections from UK Met Office Hadley Centre
- Three climate scenarios (A1B SRES storyline)
  - Unmitigated
  - Peak emissions in 2016 with an annual reduction in CO_2 emissions of 5%
  - Peak emissions in 2030 with an annual reduction in CO_2 emissions of 2%
- Linked to storminess linearly
- Generated climate-induced sea-level projections – spatially variable
- Three urbanisation scenarios

Exposure reduction

due to climate mitigation



Additional benefit of mitigation in 2016 rather than 2030 is 1.2 x 10^6 US$ million

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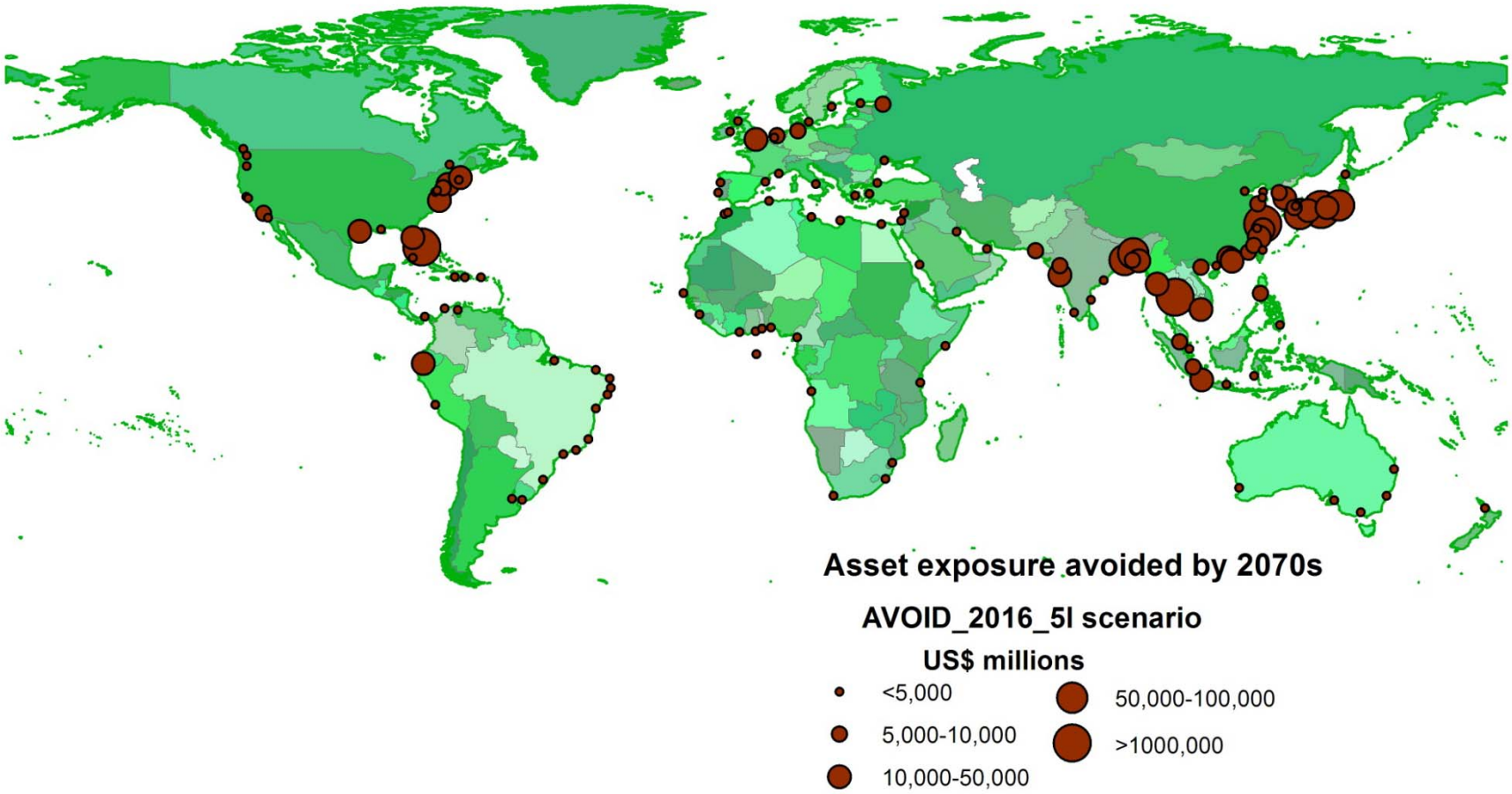
Benefits of climate mitigation



What about adaptation?

The Thames Barrier – London, UK

Sea wall - UK

Rock armour - Trinidad

Illustrative Protection Analysis 2005

City	Current Exposure		Approximate Protection Standard (Return period in years)	Annual Average Risk (Residual Risk)	
	Population (000)	Assets (US$ bil)		Population (000/yr)	Assets (US$ bil/yr)
London	397	60	1:1000	0.3	0.06
Shanghai	2,353	73	1:1000	2	0.07
Osaka	1,373	216	1:300	4.6	0.7
New York	1,540	320	1:100	15	3.2
Tokyo	1,110	174	1:1000	1	0.174
Amsterdam	839	128	1:10000	0.08	0.013
Rotterdam	752	115	1:10000	0.08	0.011
New Orleans	1124	234	1:200 (nominally)	5.1	1.168

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Cities In Low Income Countries

26 cities in 2005

Country	Agglomeration	Per capita GDP (PPP)	GDP Class	Exposed Population (000s) (Scenario C)
INDIA	Chennai	3,316	LOW	1
	Kochi	3,316	LOW	255
	Kolkata	3,316	LOW	844
	Mumbai	3,316	LOW	441
	Surat	3,316	LOW	11
	Visakhapatnam	3,316	LOW	519
ANGOLA	Luanda	2,829	LOW	22
VIETNAM	Hai Phòng	2,782	LOW	14
	Ho Chi Minh City	2,782	LOW	41
GHANA	Accra	2,601	LOW	1
PAKISTAN	Karachi	2,549	LOW	159
CAMEROON	Douala	2,284	LOW	94
BANGLADESH	Chittagong	1,998	LOW	1,929
	Dhaka	1,998	LOW	2,787
	Khulna	1,998	LOW	418
GUINEA	Conakry	1,986	LOW	25
SENEGAL	Dakar	1,914	LOW	61
DEM Republic of Korea	N'ampo	1,800	LOW	510
HAITI	Port-au-Prince	1,688	LOW	357
TOGO	Lomé	1,600	LOW	49
CÔTE D'IVOIRE	Abidjan	1,493	LOW	18
MYANMAR	Rangoon	1,417	LOW	9
MOZAMBIQUE	Maputo	1,335	LOW	119
NIGERIA	Lagos	1,188	LOW	36
UNITED REPUBLIC OF TANZANIA	Dar-es-Salaam	720	LOW	794
SOMALIA	Muqdisho_(Mogadishu)	600	LOW	1,931

Conclusions

- Exposure to coastal flooding is large and growing with multiple drivers at risk;
- Exposure is concentrated in a few cities;
- Flood risk and management is a dynamic problem requiring proactive assessment;
- Climate mitigation offers limited benefits by the 2070s: Subsidence mitigation offers bigger benefits;
- Hence adaptation is the key response in the next few decades;
- Adaptation is multi-faceted: protection, land use planning, building codes, warning and disaster response, etc.
- Promoting city exchange on proactive responses to growing flood risk would be useful;
- Next steps: A global risk assessment.

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Key Sources

- Nicholls, R.J., Hanson, S., Herweijer, C., Patmore, N., Hallegatte, S., Corfee-Morlot, J., Chateau, J., and Muir-Wood, R. (2008) Ranking Port Cities With High Exposure And Vulnerability To Climate Extremes: Exposure Estimates. OECD Environmental Working paper 1 (available at http://www.olis.oecd.org/olis/2007doc.nsf/linkto/env-wkp(2007)1)
- Hanson, Susan, Nicholls, Robert J., Hallegatte, Stephane and Corfee-Morlot, Jan, 2010 The effects of climate mitigation on the exposure of worlds large port cities to extreme coastal water levels. AVOID (Avoiding dangerous climate change) Report AV/WS2/D1/07. DECC/DEFRA, London UK
- Hanson , S.,· R. Nicholls, N. Ranger, S. Hallegatte, J. Corfee-Morlot, C. Herweijer, and J. Chateau (2011) A global ranking of port cities with high exposure to climate extremes, Climatic Change, 104:89–111.

More analysis will follow.

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