




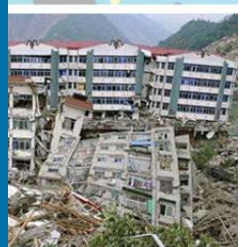

Ranking of the World's Cities Most Exposed to Coastal Flooding: Key Messages for Disaster Risk Management and Climate Change Adaptation

Key findings from a multi-institution OECD cities and climate change study

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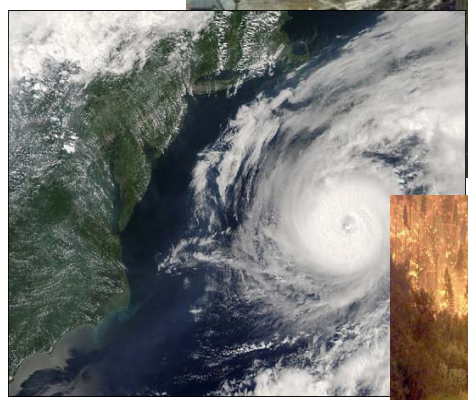
Risk Management Solutions (RMS)

Bringing Science to the Art of Underwriting™

Introduction to RMS

- The world's leading provider of products and services for the quantification and management of catastrophe risks.
- 20 years of experience in modelling catastrophe risks – mainly natural cats.
- Core client base – insurance industry
- Climate change practice set up in January 2008 to investigate:
  - The implications of climate change for the insurance and the catastrophe modelling industries.
  - How RMS' catastrophe risk expertise can be used to help decision-makers manage the risks from climate change.

100-year windspeeds for the Gulf and Atlantic coast states



The Project

- A project of the OECD cities and climate change work stream headed by Jan Corfee-Morlot:
  - Objectives on impacts & adaptation: *"to explore the local-scale risks of climate change and the benefits of climate policies with respect to urban infrastructure and populations"*
- Aims:
  - To examine the implications of climate change for the exposure of port cities to coastal flooding.
  - Pinpoint cities most reliant on adequate flood defences, and thus, where relevant adaptation is most crucial.

"Why port cities?"

➢ **Ranking of 136 port cities with a population >2m…**

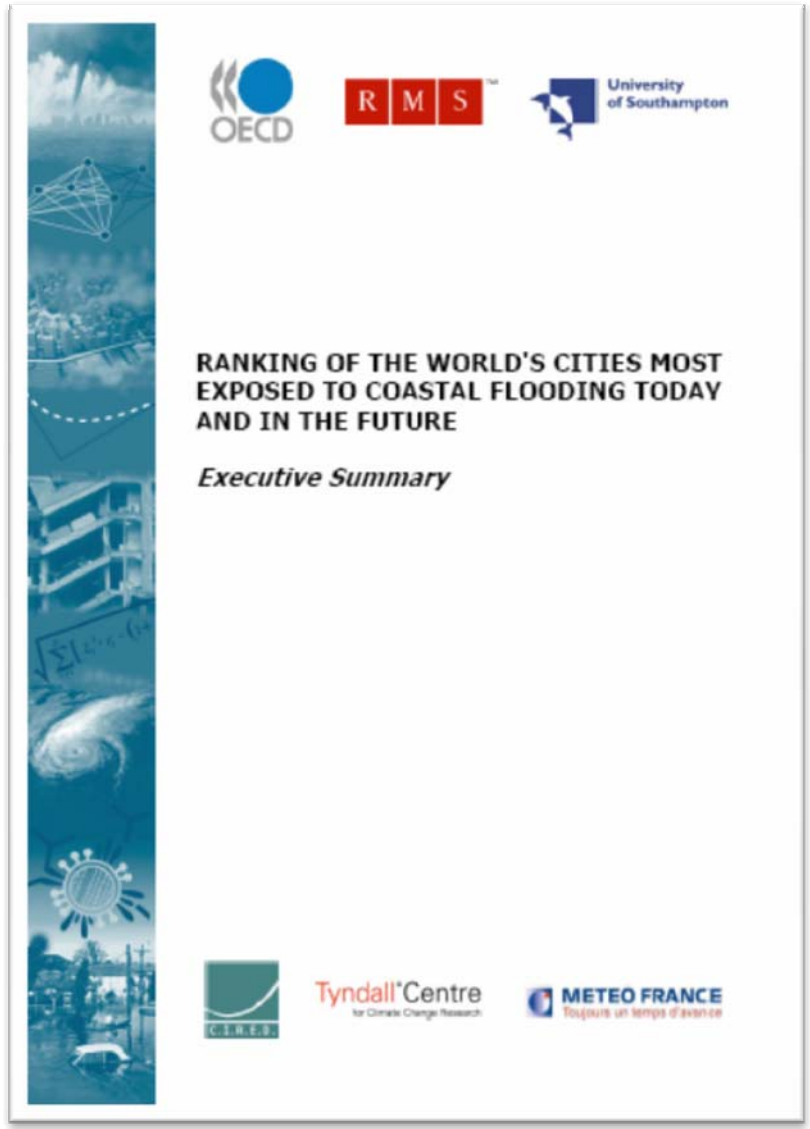
Coastal Flooding & Storm Surge

- Disaster risk management and climate change adaptation must go hand-in-hand
  - IPCC 2007 – First and most severe impacts of climate change will come from extreme events.
  - With climate change, expect rising sea levels and increased intensity of storms = rising storm surge hazard
  - Coastal development – long-term infrastructure developments therefore must take into account rising hazard.
  - Socioeconomic trends will aggravate climate change trends – rapid urbanisation, population growth and migration to coastal areas – today, **13 out of 20 most populated cities globally are coastal cities**.
  - Significant benefits possible through risk-informed urban development today – in both developed and developing world.

The Project

- Project required multi-disciplinary range of experts:
  - Robert Nicholls & Susan Hanson, University of Southampton, and the Tyndall Centre
  - Celine Herweijer, Nicola Patmore, Robert Muir-Wood & the RMS GIS Team, RMS
  - Stephané Hallegate, CIRED and METEO FRANCE
  - Jan Corfee-Morlot & Jean Chateau, OECD

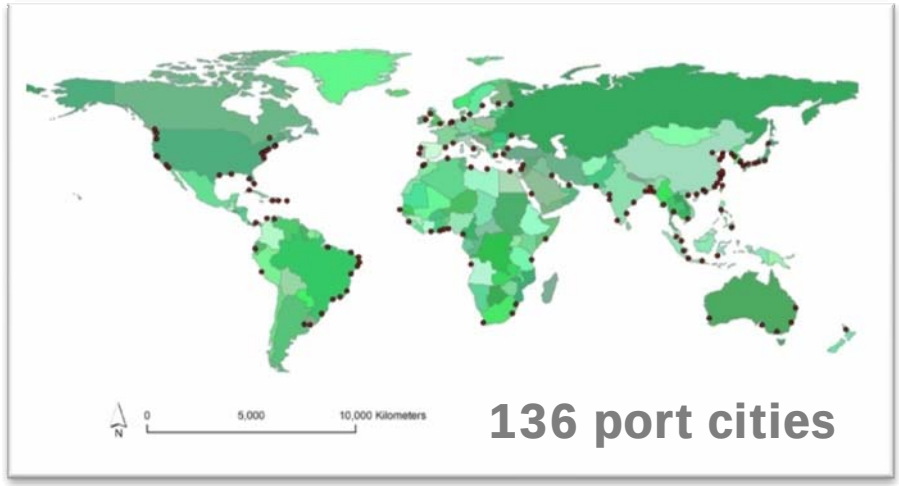
The full report can be accessed from: www.oecd.org/env/workingpapers.



Contents

- Presentation to discuss the findings of the study in terms of its key messages for Disaster Risk Management and Climate Change Adaptation – *focussing on benefits of risk-informed urban development planning*
  - Project methodology
  - The evolution of coastal flood exposure to the 2070s
  - The benefits of adaptation
  - Conclusions of the study

Project Methodology



Identify port cities with a population > 2m (in 2005)

Calculate population by elevation

Input SRTM elevation data and UN/Landscan population data

Calculate current and future exposed population

Input estimates of current and future (2070s) 1 in 100 year storm surge height
Input exposure growth scenario

Calculate current and future exposed assets

Input economic data

Project Methodology

- Drivers of change considered (2070s):
  - Natural subsidence/uplift (GIA (Peltier 2000) adjusted by natural subsidence in deltaic regions)
  - Potential human-induced subsidence (based on geology/morphology of the region)
  - Global sea level rise (0.5m based on Rahmstorf 2007)
  - More intense storms and higher storm surges (illustrative scenario of storm enhancement based on IPCC AR4)
  - Population and economic growth (based on forthcoming baseline projections from the OECD ENV-Linkages model)

Evolution of Coastal Flood Exposure

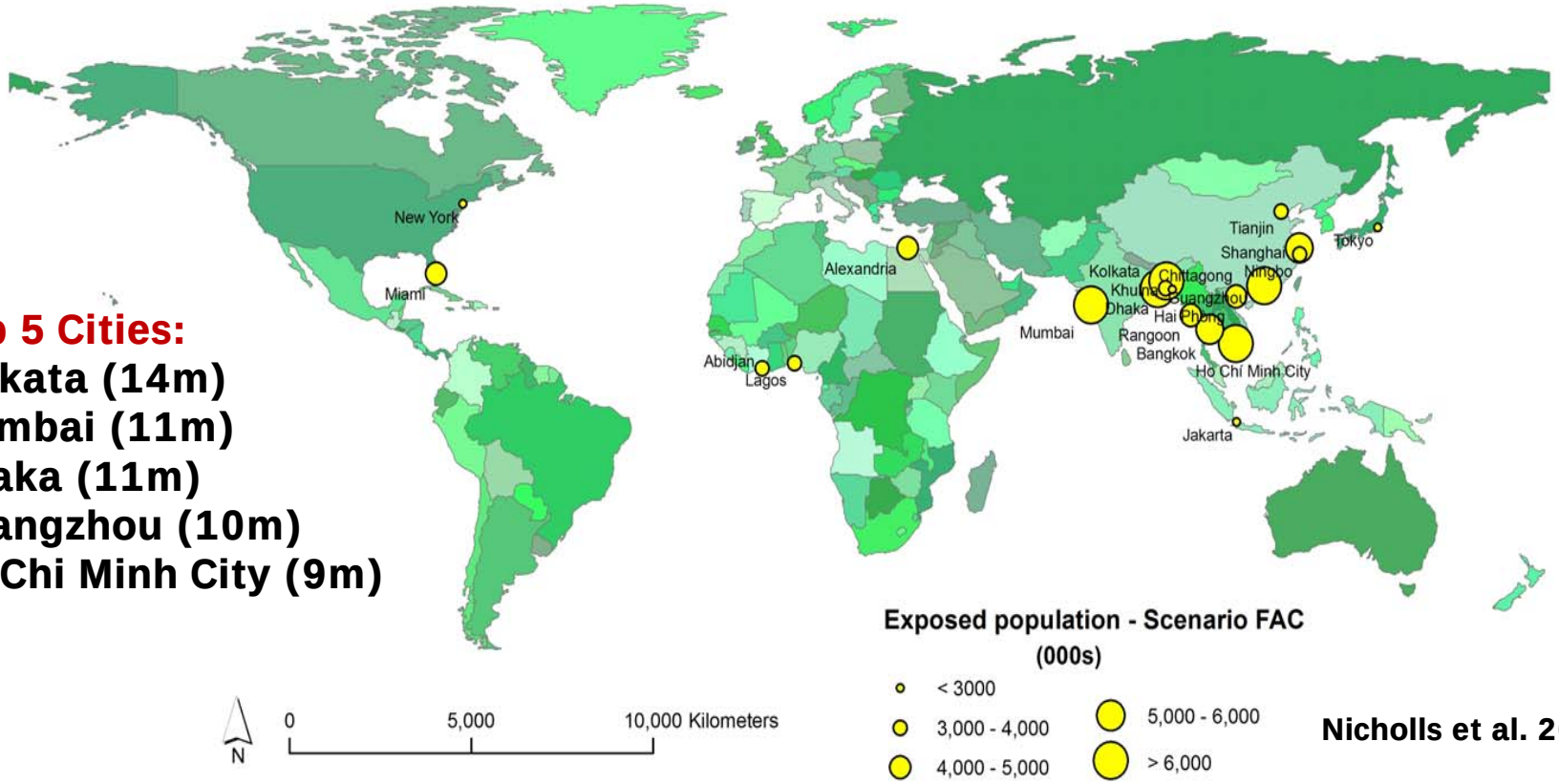
Summary of Key Findings: Risks

- By the 2070s, **more than 150 million people could be reliant on adequate and well maintained flood defences**; a threefold increase on current exposure
- **Total global asset exposure is expected to rise from $3,000 billion to $35,000 billion USD, a ten-fold increase**
- Over time, **the global exposure to coastal flooding will become increasingly concentrated in developing nations**; in particular, the rapidly growing Asian mega-cities
- The key driver of this increase in exposure is the **rapid population growth and urbanisation** expected over the coming decades; this is particularly evident in the developing nations of Asia.
  - Collectively, climate change and subsidence contribute approx. 1/3rd of the increase in exposure, with socio-economic growth (population growth, economic growth & urbanization) accounting for 2/3rds

Top 20 cities for 'exposed population' by 2070s

In 2070, 9 Asian cities are in the top 10, versus 5 in 2005

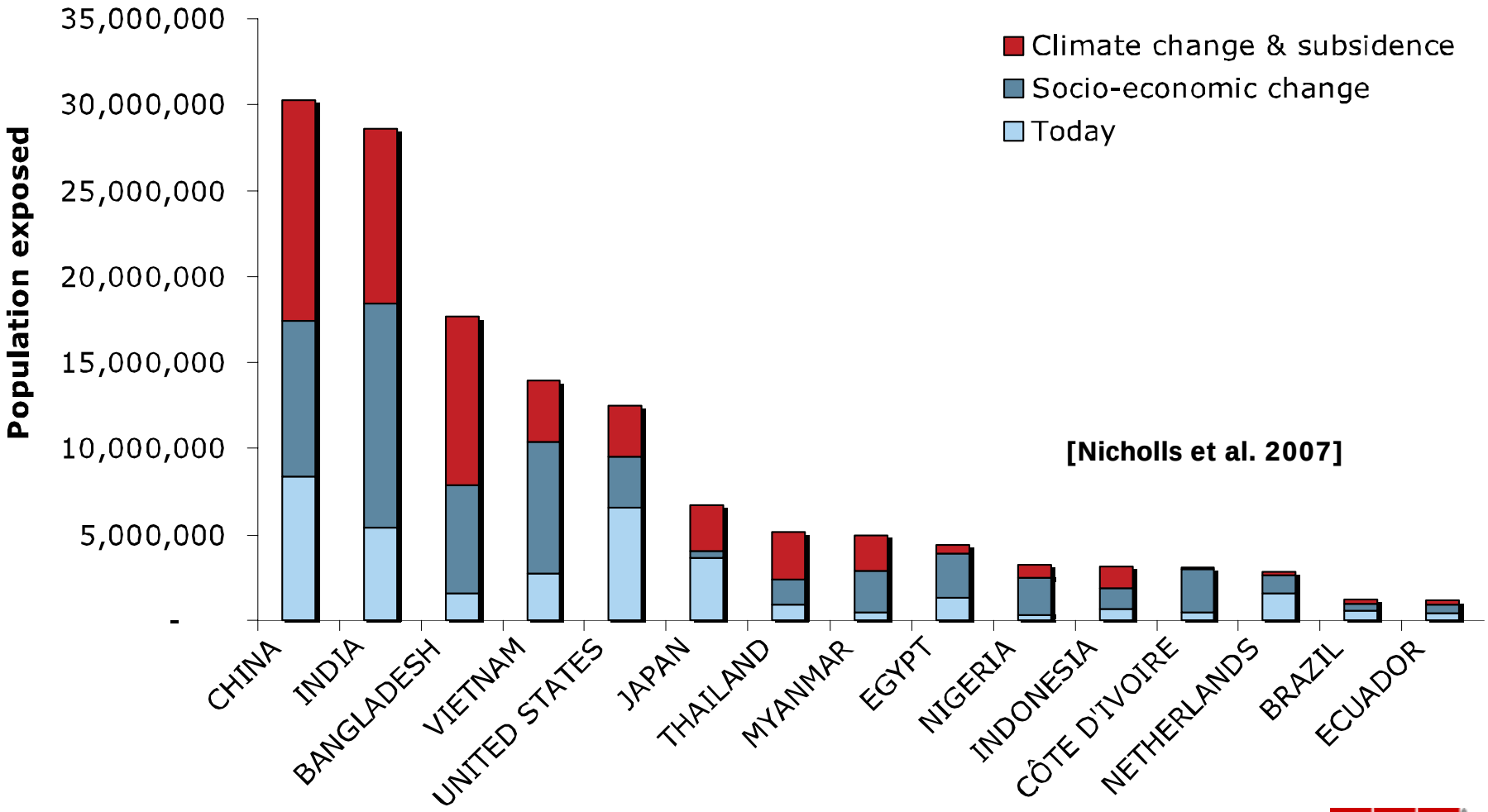
Top 5 Cities:
Kolkata (14m)
Mumbai (11m)
Dhaka (11m)
Guangzhou (10m)
Ho Chi Minh City (9m)



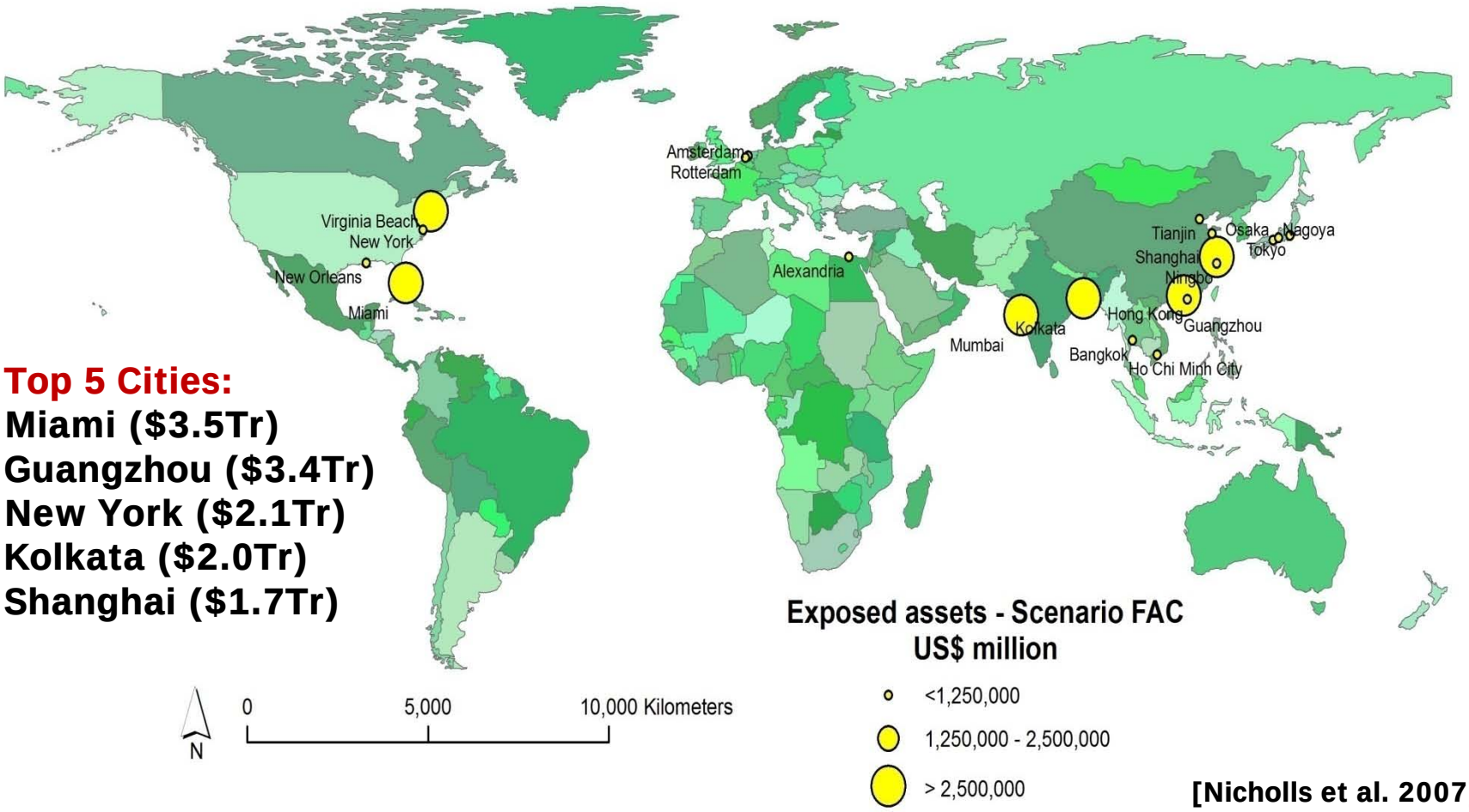
Nicholls et al. 2007

Cities with most rapid growth – African cities and 2nd – tier Asian Cities – e.g. Chittagong, Ningbo, Abidjan

Population exposure rankings by country: today and in the 2070s



Top 20 cities for ‘exposed assets’ by 2070s



Top 5 Cities:

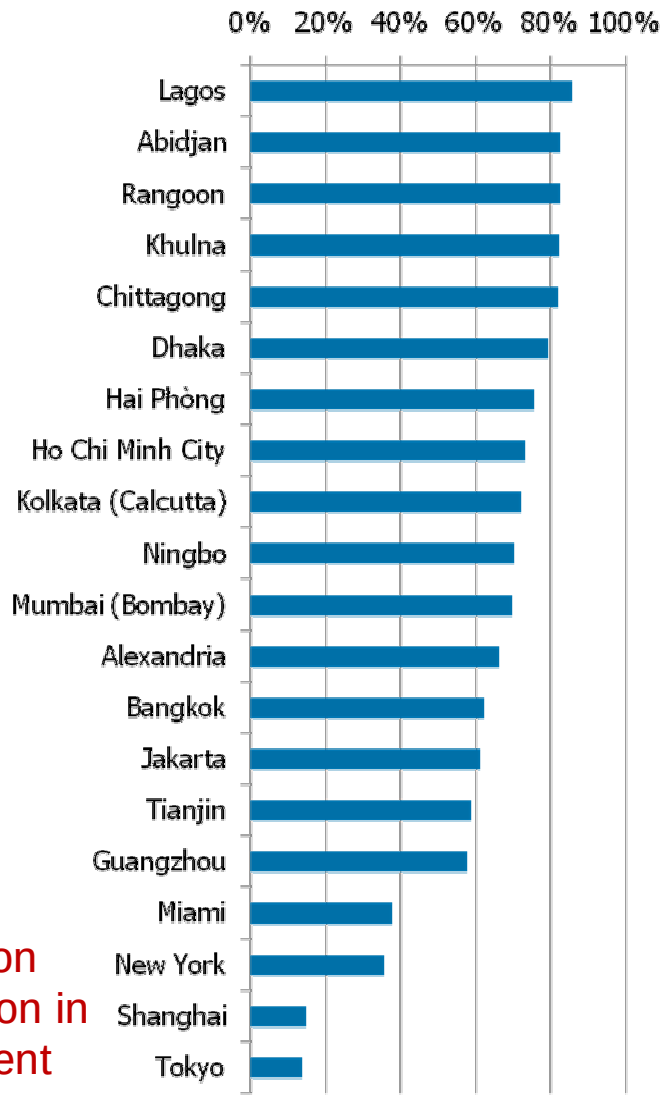
Miami ($3.5Tr)
Guangzhou ($3.4Tr)
New York ($2.1Tr)
Kolkata ($2.0Tr)
Shanghai ($1.7Tr)

[Nicholls et al. 2007]

Benefits of Adaptation

Estimates of the Benefits of Risk-Averse Land Planning Today

Region	Reduction in 2070s exposure assuming zero growth in high-hazard risk areas
Africa	80%
Asia	65%
Australasia	40%
Europe	30%
North America	30%
South America	45%



14 of the top 20 cities in terms of future population exposure could achieve more than a 60% reduction in future exposure through effective land management

Estimates of the Benefits of Avoiding Human-Induced Subsidence Today

Region	Reduction in 2070s exposure assuming no further human-induced subsidence
Africa	5%
Asia	15%
Australasia	0%
Europe	0%
North America	0%
South America	5%

Cities with the greatest potential benefit include:
Wenzhou ~ 50%
Ningbo ~45%
Guangzhou ~30%
Calcutta ~20%
Shanghai ~15%
Ho Chi Minh City ~10%

Key Messages

Rising hazard does not have to translate into rising risk

- The benefits of adaptation today are potentially great. Delaying action will result in locking-in future exposure and therefore, more costly future adaptation.
  - E.g. by implementing coastal risk management policies that prevent development in exposed areas (i.e. on today's 1 in 100 year coastal flood plain), **population exposed in the 2070s can be reduced by 60% and the assets exposed, by almost 90%.**
  - E.g. in South East Asia, future population exposure could be reduced by up to 20% by eliminating human processes that cause subsidence.
- The benefits can be particularly great in developing regions

Our findings underscore the urgent need for integration of disaster risk management and climate change adaptation into urban development planning

General Implications

- For each city, the demand and drivers of risk are different – this must be reflected in planning local adaptation strategies.
  - E.g. In many regions, economic and social development demand will drive continued developed in exposed areas.
  - In this case, risk reduction can be achieved through measures to increase resistance and resilience to flooding (e.g. hard defences).
  - However, resistance and resilience can not eliminate risk and urban development in exposed areas will increase residual risk.
- Adaptation must be informed by a detailed, location-specific risk assessment.
- There are significant benefits to be gained from taking into account the evolution of risk over the lifetime of the decision.