Scientific Capacity Building for Climate Impact and Vulnerability Assessments (SCBCIA)

FINAL REPORT

Climate Change Vulnerability Assessment and Urban Development Planning for Asian Coastal Cities (CIA2009-01-SNIDVONGS)

茨城大学 Ibaraki University

EAST-WEST CENTER

Southeast Asia START Regional Center

Making a Difference

Scientific Capacity Building & Enhancement for Sustainable Development in Developing Countries

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OVERVIEW OF PROJECT WORK AND OUTCOMES

Non-technical summary

This second 'Cities at Risk' workshop builds on the first held in 2009 in Bangkok, and specifically addressed the limited capacity to carry out risk and vulnerability assessments in coastal Asian cities. The workshop brought together over 40 participants including academics, urban planners/government representatives, and experts in disaster management.

The workshop clarified the current information/knowledge gaps and challenges, and identified future research opportunities for addressing climate change related risks and vulnerability assessments in Bangkok, Ho Chi Minh City, Jakarta, Manila and Mumbai. Key findings distilled from the workshop were grouped into three categories - 'assessment of climate change related risk', 'information/knowledge management', and 'governance'. Some 25 specific observations and recommendations for future research were identified.

Two major projects are anticipated to commence in 2011, thereby offering the opportunity to address the identified gaps in information/knowledge faced by the cities. These projects demonstrate how the cities at risk workshops are encouraging communication and generating collaboration in addressing the impact of climate change on cities in Asia and beyond.

Objectives

This workshop addressed the limited capacity to carry out risk and vulnerability assessments in most coastal Asian cities. Workshop objectives included:

a) helping develop capacity on the part of urban planners, managers, and researchers in climate change vulnerability assessment and application to urban development planning and governance;

b) promoting locally-led vulnerability research in Asian coastal cities linked to user needs;

c) helping develop partnerships between researchers, planners, and policy makers, and to develop communities of knowledge for vulnerability assessment in each participating city.

Amount received and number years supported

The workshop was funded by the Asia-Pacific Network for Global Change Research (APN) and Ibaraki University, Japan. The total amount of funds received for this activity was 50,000 USD; this comprised an APN Grant of US $45,000 for one year (15 Dec 2009 – 14 Dec 2010), and Ibaraki University provided co-sponsorship of 5,000 USD. The APN support was under the Scientific Capacity Building and Enhancement for Sustainable Development in Developing Countries Programme (CAPaBLE)/Scientific Capacity Building for Climate Impact and Vulnerability Assessment (SCBCIA).

Activity undertaken

The workshop, held from 22-28 August 2010 in Nakhon Pathom, Thailand, brought together over 40 participants including academics, urban planners and officials, and experts in disaster management (Participants, Appendix 4). The workshop comprised presentations from City Teams, expert presentations, training sessions (including socio-economic vulnerability analysis, and GIS data preparation for estimating flood and inundation areas); and a field excursion to see at first hand the issues facing Samut Sakhon, a city and province located to the south of Bangkok that is at increasing risk from extreme flooding.

The workshop builds on the first 'Cities at Risk' workshop held 26-28 February 2009 in Bangkok (*Developing Adaptive Capacity for Climate Change in Asia's Coastal Mega Cities*[1]), and findings from

1 First Cities at Risk Workshop report available at: http://www.apn-gcr.org

recent studies of Asian cities supported by the Asian Development Bank (ADB), World Bank, and Japan International Cooperation Agency (JICA). The first workshop aimed to become the catalyst to encourage a series of follow-on activities for developing adaptive capacities in coastal megacities of Asia, specifically calling for various future activities including training exercises, development of resource materials, and visioning for young scientists and practitioners, including a Cities at Risk II (CAR II) workshop within two years. Importantly, it also recommended a focus on integrated socio-economic vulnerability assessments rather than downscaling of impact assessments. This workshop (CAR II) aims to raise awareness and improve capacity to assess climate change related risk and vulnerability in five Asian coastal megacities – Bangkok, Ho Chi Minh City, Jakarta, Manila, and Mumbai.

The workshop was hosted and co-organised by the Southeast ASIA START Regional Centre (SEA START RC) of Chulalongkorn University and the East-West Centre, Hawaii.

Results

The workshop clarified the current information/knowledge gaps and identified future research opportunities for addressing climate change related risks and vulnerability in Bangkok, HCMC, Jakarta, Manila and Mumbai. The City Reports (submitted prior to the workshop), City Report Presentations (Day 2), Research Proposal presentations (Day 5) and abstracts (submitted post-workshop) were used as core sources of information for distilling and organizing findings, in addition to the training sessions and discussions. Key information/knowledge gaps and proposed research identified by the cities were identified as follows:

Category 1: Assessment of climate change related risks (hazards and socio-economic vulnerabilities)

1. Improve stakeholder perception of risk
    - acknowledging the vulnerability of the poor to the impact of climate change
2. Better define urban hazard factors
3. Assess the risk to water and food security, including
    - consumption, water quality, sanitation, waste management, agriculture, and aquatic systems
4. Address lack of baseline climate data, including
    - temperature, sea level, and social impact (see socio-economic vulnerabilities below)
5. Conduct health risk assessments, including
    - assessing link between climate change and health impacts
6. Recognize the importance of green space in moderating air temperature and flood prevention
7. Recognize the potential future impact of coastal erosion
8. Conduct socio-economic vulnerability assessments
    - addressing limited information on social aspects of vulnerability
    - integrating existing studies to better understand the current situation
    - refining/identifying measures of risk
    - developing measures of social vulnerability
    - mapping vulnerabilities
    - integrating exposure, places, sectors, activities, individuals, households, social groups, communities, livelihoods into assessments
    - understanding how urban and rural areas are linked by migration
    - assessing the vulnerability of marginal groups/informal sector

Category 2: Information/knowledge management

9. Address provision of an information/knowledge management system, including
    - lack of a central information system, poor data collection and storage
    - an interdisciplinary approach to development is needed

10. Address limited availability of geographic information
11. Address integration of geographic information with socio-economic data
12. Address lack of GIS and mapping tools, and understanding of their application
13. Ensure access to information by stakeholders
14. Develop materials for information dissemination and target the most vulnerable communities
    - make better use of mass media
15. Expand capacity building activities, including
    - developing a course on urban development and climate change
    - integrating climate risk content into other courses (e.g., engineering)
    - deliver stakeholder workshops
16. Recognize limitations of existing early warning systems

Category 3: Governance

17. Recognize the need for an institutional linking mechanism
18. Build capacity for city officials
19. Address lack of coordination between government agencies, NGOs, and the private sector
20. Assess the role of civil society groups in urban governance
21. Address deficiency of existing planning instruments in incorporating climate change risk and vulnerability
22. Address development and enforcement of land use regulations and building and sanitation codes
23. Address vulnerability of marginal groups, including
    - invisibility in plans/assessments
    - inadequate dissemination of information to the poor
24. Investigate potential of climate-induced migration of population
25. Address challenges to allocating funds for climate change related risks and vulnerabilities, including
    - availability and commitment
    - project-based and donor-driven support
    - raising of funds through fees paid by the local community
    - sustainability of initiatives

Relevance to APN's Science and Policy Agenda

The second Cities at Risk workshop is in accordance with the aims and activities of the CAPaBLE programme, which addresses scientific capacity development for sustainable development, science-policy interfacing, awareness raising and dissemination activities[2]. Specifically, the workshop provided a forum to share experiences, lessons learned and information relevant to climate change risk assessments in Asian coastal megacities and the identification of potential future opportunities for research and regional cooperation.

Self evaluation

The workshop proved very effective and productive for participants and organisers. Training sessions delivered by experts from Ibaraki University, United Nations University Institute for Environment and Human Security, and Pacific Disaster Center were particularly well received by participants who were actively involved with various practical and exercise activities. Key outputs of the meeting were the identification of potential future research opportunities and further development of city research networks.

2 CAPaBLE activities: http://www.apn-gcr.org/newAPN/activities/capable.htm

Notably, two proposed projects addressing climate change risk and adaptation are anticipated to commence in the near future, offering the potential for further collaboration with workshop participants (see section below).

Potential for further work

Two major projects are anticipated to commence in 2011, thereby offering the opportunity to address the above gaps in information/knowledge and challenges faced by the cities. These projects demonstrate how the Cities at Risk workshops, are promoting communication and collaboration in addressing the impact of climate change on cities in Asia and beyond. In summary, the two upcoming projects:

- APN funded project - *Enhancing adaptation to climate change by integrating climate risk into long-term development plans and disaster management.*
- project funded by International Development Research Centre (of Canada) and the Canadian Research Tri-Councils (Natural Sciences and Engineering, Social Sciences, Health Research) - *Coastal Cities at Risk (CCaR): Building Adaptive Capacity for Managing Climate Change in Coastal Megacities.*

Publications

A paper presenting a synthesis of the findings from the workshop is under preparation. It will highlight issues of risk assessment, information/knowledge management, and governance and planning issues in relation to coastal Asian megacities.

Acknowledgments

We would like to acknowledge our gratitude to workshop sponsors (Asia-Pacific Network for Global Change Research and Ibaraki University), co-organisers (Southeast Asia START Regional Centre of Chulalongkorn University, and East-West Center), collaborators and participants.

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TECHNICAL REPORT

Table of Contents

1.0 Introduction

The workshop expands on the first 'Cities at Risk' workshop held 26-28 February 2009 in Bangkok (*Developing Adaptive Capacity for Climate Change in Asia's Coastal Mega Cities*[1]) and findings from recent studies of Asian cities supported by the ADB, World Bank, and JICA. The first workshop initiated a series of follow-on activities for developing adaptive capacities in coastal megacities of Asia, specifically calling for various future activities including training exercises, development of resource materials, and visioning for young scientists and practitioners, including a Cities at Risk II (CAR II) workshop within two years. A focus on integrated socio-economic vulnerability assessments rather than downscaling of impact assessments was also recommended. This workshop (CAR II) aims to raise awareness and improve capacity to assess climate change related risk and vulnerability in five Asian coastal megacities – Bangkok, Ho Chi Minh City, Jakarta, Manila, and Mumbai.

1 First Cities at Risk Workshop report available at: http://www.apn-gcr.org

The workshop was funded by the Asia-Pacific Network for Global Change Research (APN) and Ibaraki University, Japan. The total amount of funds received for this activity was 50,000 USD. This comprised an APN Grant of US $45,000 for one year (15 Dec 2009 – 14 Dec 2010), and Ibaraki University provided co-sponsorship of 5000 USD. The APN support was under the Scientific Capacity Building and Enhancement for Sustainable Development in Developing Countries Programme (CAPaBLE) focused activity on 'Scientific Capacity Building for Climate Impact and Vulnerability Assessment (SCBCIA)'.

The workshop was hosted by the Southeast ASIA START Regional Centre (SEA START RC) of Chulalongkorn University and co-organised with the East West Centre, Hawaii.

2.0 Methodology

2.1 Pre-workshop activity: Preparation of City Reports

Prior to the workshop, groups of researchers and urban planning practitioners representing each city at the workshop (hereafter referred to as 'City Teams') – Bangkok, Ho Chi Minh City (HCMC), Jakarta, Manila and Mumbai – were invited to prepare a 'City Report' on 'Climate Change Vulnerability Assessment and Urban Development Planning' for their home city. These reports represented a key source of information for better understanding current efforts in integrating climate risk and vulnerability into development and planning in each of the five cities and for better identifying future research and capacity building activities. The guidelines for preparing the City Reports (full details in Appendix 1) suggested a range topics to be addressed, as follows:

- Current perception of climate change related risk (such as *floods, water and food supply, land losses, air quality, heat stress, disease outbreaks, etc.*) and social/economic vulnerability (such as *poverty, investment, capital and opportunity losses, social conflicts and divides, genders, justice, etc.*) in your city, e.g., how do they perceive the differences and linkages between weather/climate risks and social/economic vulnerability?
    - Among general public
    - Among urban officials, city managers
- Have various climate risks to your city have been assessed and/or mapped, and if so do they take into account possible effects of current and future climate changes?
- Have social/economic vulnerability to climate related risks been assessed and/or mapped, how, by whom, details?
- Have the climate risks and vulnerability of city been communicated to the public, and how?
- Is there an existing urban GIS information base that may be used for climate risk and vulnerability assessment? What is included?
- Which agencies and institutions (e.g., government, non government, business, academic, civil society, etc.) in the city have roles in risk and vulnerability assessments, communicating such assessments to public and managing for information and knowledge about climate change? Their skill level and capacities needed?
- Is there an urban master plan? When was it completed? Does urban master plan take into account future risk to climate change?
- Have and how building codes, land use regulations, sanitation codes, etc. been enforced?
- Is there an early warning system? Evacuation or emergency response plans for various types of weather and climate related disasters? How effective are they?
- Level and effectiveness of public funding and commitment to respond to climate related risks and vulnerability?
- Governance and social justice issues, institutional, jurisdictional and social conflicts, etc. that may worsen climate related issues?

2.2 Workshop structure

The workshop, held from 22-28 August 2010 in Nakhon Pathom, Thailand, brought together over 40 participants including academics, urban planners/government representatives, and experts in disaster management (Participants, Appendix 4). The workshop included presentations from City Teams, expert presentations, training sessions (including socio-economic vulnerability analysis, and GIS data preparation for estimating flood and inundation areas); and a field excursion to see at first hand the issues facing Samut Sakhon, a city and province located to the south of Bangkok that is at increasing risk from floods.

2.3 Approach to synthesis

In order to identify gaps in information/knowledge and future research/capacity building needs, pertinent information was extracted from the City Reports (submitted prior to the workshop), City Report Presentations (Day 2), Research Proposal presentations (Day 6) and abstracts (submitted post-workshop). City Teams were requested post-workshop to prepare one page abstracts based on the City Reports and presentations under three main categories - 'assessment of climate change related risks', 'information/knowledge management', and governance' (Appendix 2). Additional outputs from the training sessions and discussions are reported in the Results and Discussion section and/or Summary of Proceedings (Appendix 5).

Content from the above documents were initially distilled into two tables (Tables I and II, Appendix 3) to help clarify the key issues. Table I essentially captures a present day understanding of climate risk assessment and current adaptation efforts for each city, based on extracting pertinent elements from the City Report and City Report Presentations (Day 2). Table II clarifies future research topics and activities, and is compiled from the Research Proposal presentations (Day 6) and abstracts. While both tables categorize information into the three broad sections, as requested for drafting the abstract, they have been further refined in Table I in an attempt to allow a more detailed comparison between cities, plus an additional fourth category is added on 'knowledge status/research gaps'. All content in these tables and the *Results and Discussion* section is referenced back to the workshop documents and presentations.

Extracted information in Table I was compiled into the following four main categories where possible in order to better understand the capacity for assessing climate risk and its application to urban development planning and governance in the five megacities.

Category 1: Assessment of climate change related risks (hazards and socio-economic vulnerabilities)

- Projections of extreme risk to cities
- Perception of risk
- Substantive reports (key references cited in Table I)
- Assessment of hazards (categorized by individual hazard where possible)
  - flooding
  - drought/salt water intrusion (impacting city water and food security)
  - heat stress
  - public health (disease)
  - coastal erosion
- Assessment of socio-economic vulnerability

Category 2: Information/knowledge management systems and communication

- Urban GIS information systems, decision support systems, early warning systems* (overlap with category 3 below), websites, metadatabases

- Communication – to all stakeholders (e.g., public, government officials)/capacity building

Category 3: Governance and planning
- Agencies responsible for adaptation efforts
- Current planning instruments
  - Extent of integrating adaptation measures?
- Disaster response plans/early warning system*
- Provision/enforcement of land use regulations/building codes

Category 4: Knowledge status/research gaps

Extracted information in Table II is presented under the three original categories, with a fourth – 'proposed partners' – indicating possible future institutional research collaboration.

3.0 Results & Discussion

3.1 Category 1: Assessment of climate change related risks (hazards and socio-economic vulnerabilities)

3.1.1 Projections of extreme risk to cities

All five cities represented at the workshop, Bangkok, Ho Chi Minh City (HCMC), Jakarta, Manila and Mumbai are at extreme risk from climate change. The possible scale of future disruption faced by city populations was clearly highlighted in the the City Reports. Projections of millions of people displaced by floods in Bangkok (UNEP Bangkok Assessment Report 2009; cited in Bangkok City Report, p12) or 12 per cent of the population in HCMC with 1m inundation (Carew-Reid 2007; cited in HCMC Report, p14), and massive infrastructure damage by extreme weather events (OECD study cited in Mumbai City Report, p15) were described.

> … sea-level rises, cyclones and storm surges could have a devastating impact on a large urban centre like Mumbai, which falls into a low elevation coastal zone (LECZ) (Mumbai City Report, p16).

3.1.2 Perception of risk

The perception of risk by the various stakeholders in the five cities appears variable. It was identified as one of the 'critical gaps both at national and local level' (HCMC Report p13). Recent intense weather events are increasing awareness of the public to the threat posed by climate change (Manila City Report, Part3, p1), and while there appears to be a limited awareness in the Jakarta public, the issues are well known and discussed in the scientific community (Jakarta City Report, p11). Furthermore, big business developers in the northern coastal area of Jakarta already appear to have anticipated flood risk by building canals and drainage systems (Jakarta City Report, p15). The vulnerability of the poor to the effects of climate change is also recognized by the Jakarta city government (Jakarta City Report, p5), but elsewhere marginalized groups are not properly addressed in climate risk assessments (Bangkok City Report Presentation, s17). However, the Bangkok Team reported that following the 2009 pre-Copenhagen meeting in Bangkok 'some level of sensitisation to climate change and disasters has already been initiated in the mainstream media which built on the effects of the 2004 Boxing Day tsunami' (Bangkok Abstract).

> With their extreme experiences of typhoons and floods in recent years like Typhoon Milenyo, Pepeng and Ondoy, the residents of Metro Manila have heightened sense of awareness of climate change related risks (Manila City Report, Part3, p6).

3.1.3 Assessment of potential hazards

Assessments of climate change related risk have predominantly focused on the physical impacts of hazards, whereas information on social aspects of vulnerability remain limited. In addition to the City Report, City Report Presentation, and Research Proposals, key hazards and vulnerabilities were identified on Day 3 as part of the exercise session on socio-economic vulnerability assessment; outputs from the latter are summarized below in Tables 1 and 2 below.

Flooding

Flooding can be a function of one or more factors, including absolute sea level rise, precipitation, storm surge and land subsidence, and has been assessed in a variety of studies. For instance, northern Jakarta is reported to be vulnerable to both sea level rise and flood water from its rivers (Jakarta City Report, p7) and outlying areas of Bangkok are subsiding (up to 30 mm annually) thereby exacerbating flooding (Bangkok City Report, p9). Dr Snidvongs also commented that a one meter sea level rise by the end of the century is projected for Bangkok, as reported in a World Bank report. Moreover, in addition to the physical hazards identified in Table 1, the impact of impervious surfaces and storm water runoff and inundation damage caused by man-made structures preventing drainage from floodplains after localized rainfall (Bangkok City Report, p9), demonstrates how urbanisation and development have increased the possible impact of flooding.

Bangkok	HCMC	Jakarta	Manila	Mumbai
Flooding	Flooding (duration and frequency) - diseases (water-related) - damage/asset loss	Flood	Extreme rainfall (severe flooding)	Flooding due to heavy precipitation
Coastal erosion	High tidal surge	Inundation	Intense typhoons (severe flooding)	Landslides
Land subsidence	Land subsidence	Landslide	Earthquakes	Sea level rise
Salt intrusion		Disease outbreak (dengue, diarrhea)	Subsidence/ landslides	Storm surges /cyclones
Excessive groundwater withdrawal		Pollution	Sea level rise	Earthquake
Storm surge		Twister	Storm surges	
Rise of temperature (heat island and heat wave)		Earthquake		

TABLE 1. HAZARDS AS IDENTIFIED BY CITY TEAMS DURING DAY 3 TRAINING SESSION.

Flooding has been assessed to various extents with vulnerable flood-prone areas identified (e.g., Manila City Report, p19; Jakarta City Report, p7; Bangkok City Report, p2), and sea level rise has been studied recently using satellite TOPEX measurements (HCMC Report Presentation, s12). However, gaps in baseline data such as rising sea water, air temperature, and social impacts were noted (Jakarta City Report, p21). Future proposed research includes studying the subsidence and stability of reclaimed land (Mumbai Research Proposal, s15; Mumbai Abstract), and more broadly defining urban hazard factors (Bangkok Research Proposal, s6).

Drought/saltwater intrusion

City water supplies and food production were identified as other areas of concern. Drought (Mumbai City Report, p17), unreliable river flows (Bangkok City Report, p10), salt water intrusion (HCMC Report, p14), uncontrolled groundwater extraction (Jakarta City Report, p20), together with increasing populations and industry and contamination of supplies (Bangkok City Report, p9-10) all pose threats to the provision of adequate water services. According to Boer et al. (2007; cited in Jakarta City Report, p8), 'between 2010 and 2015 the country is predicted to experience a major clean water shortage, and this is expected to occur mainly in urban areas'. Decreases in crop productivity and aquatic ecosystems are expected in light of increased saltwater intrusion into the Mekong (HCMC Report, p14). The need to assess the risk to water and food security and their input into decision support systems for national planning and local governance was identified (Manila City Report, Part3, p5). Water is addressed in proposed research on urban infrastructure by the the Bangkok Team (Bangkok Research Proposal, s8), asking: 'What is the climate impact on fresh water quality? How does it impact on water consumption? Who is most affected?'

…due to the uncontrolled extraction of fresh groundwater, some freshwater in the north part of Jakarta are mixed with sea water making it unfit for drinking (Jakarta City Report, p20).

Baseline climate related data is lacking in some cities. Historical and projected temperatures and rainfall have been mapped in the Philippines (Manila City Report, Part3, p2). In contrast, studies on climate change were described as 'sorely lacking' in Jakarta together with a lack of available baseline data such as air temperature and sea water level (Jakarta City Report, p21). The need for more research on climate was mirrored by the Mumbai Team, proposing research to focus on intra-seasonal monsoon variability (Mumbai City Report, p24), and the Manila Team, advising that 'climate with the associated geophysical and ecological risk to food, water and energy security as well as health need to be assessed' (Manila City Report, Part3, p5).

Heat stress

Projected increases in temperature were mentioned in all City Reports. Studies were cited that suggested rising maximum and minimum temperatures. It was commented that losing green space was influencing the heat island effect (Efendy, 2007; cited in Jakarta City Report, pp7-8). The importance of urban green space in moderating air temperature and the impact of automobile density was reported to be an important cause of the heat island effect (Jakarta City Report pp7-8). On Day 5, the issue of greens pace was also noted in measures for climate change adaptation by Jakarta (i.e., increasing green area, upper stream reforestation, and mangrove conservation) and by Bangkok (mangroves) (see Appendix 5).

… a 50% reduction in urban green space would bring air temperature to rise between 0.4 to 1.8C and automobile density is found to be the most important cause of urban heat island in Jakarta (Sobry Efendy, 2007; cited in Jakarta City Report, pp7-8).

Disease

Vector-borne and water-borne diseases pose another climate related risk to communities. Increases in vector-borne diseases (dengue fever and malaria) were mentioned by several cities (Bangkok City Report, p5; HCMC Report, p14; Mumbai City Report, p16) and water-borne diseases (diarrhea, cholera, typhoid) by Mumbai (Mumbai City Report, p16). Public health was reported as a key concern in flooded areas (HCMC City Presentation, s24), and that 'pollution of river in addition to hygiene issues after floods should be seriously taken into consideration, especially for groups of the poor who are living along the river channel and workers who are living in low standard residential areas' (HCMC Report, p27). Future information needs on health impacts was noted (Mumbai Abstract), and more specifically with regard to: 'establishing the link between climate variability and health impacts; assessing the vulnerability of the city to water-borne and vector-borne diseases; sensitizing city stakeholders including health professionals, public health administrators, municipal officials and citizens' groups to health risks of climate change' (Mumbai City Report, p24). The Manila Team likewise raised the need for future health risk assessment (Manila City Report, Part3, p5).

> Another important climate risk for Indian cities, in particular Mumbai, is the onset of water-borne diseases (diarrhea, cholera and typhoid) and vector-borne diseases (malaria and dengue) (Mumbai City Report, p16)

<u>Coastal erosion</u>

The importance of coastal erosion was highlighted by several cities including Bangkok, HCMC, and Mumbai. It was reported that more than 1 million people could be impacted by coastal erosion and land loss in the Mekong Delta by 2050 (IPCC 2007; cited in HCMC Report, p8), and that Bangkok was especially at risk (OECD 2007; cited in Bangkok City Report, p11).

3.1.4 Assessment of socio-economic vulnerabilities

Understanding socio-economic vulnerabilities to climate change was recognized as a critical knowledge gap by all City Teams. For instance, existing vulnerability assessments 'focused mainly on the physical or the climatic aspects of vulnerability and little attention is given to non-climate factors that exacerbate an individual or household's vulnerability' (Bangkok Abstract). Similarly, the Jakarta Team reported that 'risks related to the impact of climate impact on people have experienced much less attention ... studies [on] coping strategies and adaptation to these disasters are few and far between' (Jakarta Abstract). The need to address the research gap was reiterated by the HCMC Team, calling for a 'comprehensive research study on climate change vulnerability of the city … to understand which future strategies and adaptation measures need to be built up for sustainable urban development', and specifically mentioning a 'socio-economic assessment of riverine communities in HCMC … as a primer for assessing the vulnerability of these communities to climate change in HCMC' (HCMC Abstract). In Indonesia, 'officially, assessment and mapping on social/economic vulnerability has not been done', with most assessments focusing on vulnerability to conflict or economic issues (Jakarta City Report, p9). However, the National Bureau of Statistics has been examining the development of a social vulnerability index (Jakarta City Report, p9). A summary of vulnerabilities, including socio-economic, was additionally identified by City Teams during the Day 3 training session (see Table 2 below of participant outputs).

> The most vulnerable section is the slum dwellers and squatter communities that comprise more than half of the total residents. Therefore, it is critical for the city to assess the vulnerabilities and devise adaptation and mitigation mechanism to cope with future climate risks (Mumbai Abstract).

Bangkok	• Discussion focused on healthcare
HCMC	• Infrastructure (transport/road, drainage, water supply, public facilities) • Production (agricultural practices, industry, aquaculture, services (tourism, trading)) • Health (outbreak diseases, infectious disease) • Social impacts

Jakarta	• Poverty • Elderly • Weak governance (capacity building, corruption, limited information • Low level land • Lack of enforcement • Lack of budget • Lack of awareness
Manila	• High incidence of poor people living in hazard-prone areas • High population density (exposure) • High number of poor people without access to basic services • Sub-standard buildings and infrastructure due to weak implementation of regulations • Haphazard zoning / land use plans and implementation
Mumbai	• Physical (reclamation, low lying, congestion, poor drainage) • Economic and social (high population density, informal sector, land use pattern, access to resources, poverty)

TABLE 2. VULNERABILITIES AS IDENTIFIED BY CITY TEAMS DURING DAY 3 TRAINING SESSION

All city teams proposed conducting socio-economic vulnerability assessments to address current shortcomings in knowledge. More specifically, issues to be addressed included:

- Integrating existing studies to better understand the current situation (Bangkok Research Proposal, s13; Manila City Report, Part3, p5),

- Refining/identifying measures of risk (Manila Research Proposal, s3; Mumbai Research Proposal s13),

- Developing measures of social vulnerability, such as macro and micro social vulnerability indicators (SoVI) (Jakarta Research Proposal, s9), climate disaster resilience index (Bangkok Research Proposal, s13), and a quantifiable profile of socio-economic vulnerabilities (HCMC Research Proposal, s21).

> … what seems to be lacking in the BMR is the identification of the vulnerable groups so that a more proactive and differentiated intervention can be crafted (Bangkok Abstract).

- Mapping vulnerabilities (HCMC Research Proposal, s21; Jakarta Abstract; Mumbai Research Proposal, s14). Mapping of socio-economic vulnerabilities was proposed for visualizing climate risk. To date, limited and uncoordinated assessment/mapping has been reported (Manila City Report Presentation, s35; HCHC Abstract). The Jakarta Team highlighted that there is 'an urgent need to combine physical as well as socio-economic data to construct vulnerability mapping that can provide a holistic assessment of climate change impact' (Jakarta Abstract). Furthermore, the collection of remotely sensed LIDAR data is planned by the Department of Spatial Planning, and this could be used for climate risk and vulnerability analysis (Jakarta City Report Presentation, s11). Expected results from developing an adaptation plan for Jakarta, includes a multi-hazard risk map and ranking (Jakarta Research Proposal, s17). Similarly, HCNC calls for the creation of risk maps of vulnerable communities in Thu Doc and Can Gio areas of HCMC (HCMC Research Proposal, s21). The use of ArcGIS was suggested for mapping (Jakarta Presentation).

- Integrating exposure, places, sectors, activities, individuals, households, social groups, communities, livelihoods into assessments (Bangkok City Report, p5)

- Learning how urban and rural areas are linked by migration and the threshold at which migration due to climate-induced change is triggered (Bangkok City Report, p7)

- Assessing the vulnerability of marginal groups/informal sector (Bangkok Research Proposal, s11-12; Mumbai Abstract). The Bangkok Team proposed the following research objectives -

  a) to identify the major CC hazards facing vulnerable groups;

  b) to link the future well being of vulnerable groups to impacts of climate change and extreme weather events;

  c) to link planned adaptation strategies with existing autonomous adaptation strategies.

- The cultural aspect should be expressed in future research (issue raised during the HCMC presentation).

- Use available household data (e.g., SUSENAS / PODES / SAKERNAS / 2010 Population census data (comment from Jakarta Team during Jakarta Presentation)

- Need to consider the dynamic nature of vulnerability (comment by Dr. Virji during the Jakarta Presentation)

3.2 Category 2: Information/knowledge management

Category 2 focuses on the development of information/knowledge management systems for sharing data and information (e.g., through creation of urban GIS databases, decision support tools, early warning systems), and their access and content dissemination to stakeholders. The aim of an information/knowledge management system is to facilitate access to relevant data and information for stakeholders, for example, by centralizing storage in a single location.

<u>Information/knowledge management systems</u>

Development and implementation of information/knowledge management systems appears limited across all cities. The HCMC Team reported that there was 'no unified information centre and poor data collection and storage' (HCMC Report, p30). Furthermore, there was 'a lack of GIS or mapping tools for climate risk and vulnerability assessment' (HCMC Abstract). Likewise, the Mumbai Team highlighted the need 'to compile information regarding different climate-related risks' and 'assess how and where different models & tools can be applied to look at changes in hazards, exposure & vulnerability' (Mumbai Abstract). The Bangkok Team reported that while GIS and maps on various coastal risks and hazards are available from government departments, ministries and international development organisations in Bangkok, to date the only climate change specific mapping for Bangkok was conducted by Panya Consultants (2009) (Bangkok Abstract); data/maps in meteorology, hydrology, land subsidence, erosion, hazard, and coastal change are currently held in four different government departments (Bangkok City Report Presentation, s5).

Jakarta has limited geographic information located at provincial and national agencies, which is used for urban planning but not integrated with socio-economic data (Jakarta City Report, p12). Furthermore, 'the lack of available data also makes it difficult to conduct any meaningful assessment of the climactic conditions in Jakarta, such as long time series data on rainfall, baseline data on tides, the daily measurement of temperatures, etc.' (Jakarta City Report, p12). The Manila Team reported that 'aside from thematic layers from the Manila Observatory ... there is also the Metro Manila Earthquake Impact Reduction Study (MMEIRS) in the form of a GIS, which may contain related information on exposure and vulnerability (Manila City Report, Part3, p2). The latter is also reported to be accessible to local government units (Manila City Report, Part3, p2).

Access and dissemination of information

In addition to limited information resources, stakeholder access and communication were also identified as issues of concern. The HCMC Team noted that 'in the area of disaster management especially climate change impacts such as food, salt water intrusions, drought, it is very difficult to access information and despite public debates demanding more transparency there has been little progress' (HCMC City Report, p30). They further reported that 'important information is only available through informal channels' and there are 'few mechanisms for citizens to access all useful information of water management, flood prevention, and pollution control (HCMC City Report, p30). This was similarly articulated by the Manila Team, who saw developing an information system and its access as a main issue to address (Manila City Report Presentation, s42), noting the 'dire need to develop materials for information dissemination in the popular media' (Manila Abstract). The importance of effectively communicating research to government and targeting information to the most vulnerable communities were issues raised by the Jakarta Team. The latter group reported:

An interdisciplinary approach is needed to create an information and knowledge base to help identify, develop and implement effective responses to reduce vulnerability and enhance adaptive capacity (Patwardhan et al. 2009; cited in Mumbai City Report, p21).

> the public have been informed on the climate risks and vulnerability through the mass media and seminars. The main problem is that the method of delivery as well as the target audience has not been properly addressed. As an example, campaign on the impact of climate change has not been done on those vulnerable to the risks such as the poor and other groups. The main climate risk campaign is still limited to the high government circles and academics (Jakarta Abstract).

Concerns about existing early warning systems were expressed. For example, 'Metro Manila's flood warning system (Effective Flood Control Operation System or EFCOS) under MMDA has not been utilized effectively as seen during Typhoon Ondoy (Ketsana)' (Manila Abstract). An early warning system has also been implemented in Jakarta, but according to the Jakarta Team, it has been designed for flooding caused by heavy rainfall rather than sea level rise (Jakarta City Report, p17). However, as noted by the Jakarta Team 'these efforts are more of reactive measures rather than proactive measures to tackle the problem of climate change' (Jakarta City Report, p20).

At the city level, the Bangkok 5-year Action Plan for Climate Change identifies communication among different sectors. This strategy could lay ground for the integrated framework (Bangkok City Report, p1).

The above limitations regarding systems, access and dissemination of information were reflected in proposed future research. The Manila Team proposed 'information architecture and infrastructure for integrated risk analysis' as one approach for their research, and more specifically development of dynamic risk assessment and decision-support framework/tools (Manila Research Proposal, s10, 5). The Jakarta Team's Research Proposal addressed raising awareness of the public on the vulnerability to climate change (Proposal I)(s9), and in their third proposal described developing a comprehensive course on 'Urban Development and Climate Change' (s33). Likewise, the Manila Research Proposal included risk and vulnerability communication and education, and integration into curricula (s10). Stakeholder workshops were proposed by the Mumbai Team to help in 'creating a mechanism for integrating post event recovery strategy with long-term development plans leading to reduction in vulnerability and enhancement of adaptive capacity of the cities at risk' (s19). Dr. Virji described as 'critically important' the development of a risk management course incorporating climate. The Mumbai Team noted that there are a number of disaster management and climate change programmes, but they are driven by those with engineering backgrounds, hence the usual focus on infrastructure fixes, so there is a need to look at science curricula in engineering courses.

Topics in the Jakarta Team's proposed course on 'Urban Development and Climate Change': urbanization and urban development in developing countries; coastal cities and small island development; climate change; sea level rise, land subsidence, flooding, inundation, heat, storm surge; vulnerability, risks and socioeconomic implications; prediction and mapping; data and information; mitigation and adaptation, land use and spatial planning, disaster management, infrastructure development; and governance (Jakarta Research Proposal, s33)

3.3 Category 3: Governance and planning

The section addresses a range of governance-related matters including: institutional coordination/linkage; the role of civil society groups; deficiencies in existing city plans; land use regulations, building and sanitation codes; vulnerability of marginal groups; and challenges to funding.

The need for an institutional linking mechanism for climate risk related planning was highlighted. The latter was raised in meetings in Bangkok by some agencies including the Bangkok Metropolitan Administration (Bangkok City Report, p1). In Jakarta, there is no single organisation that manages issues related to climate change risk, and 'it appears that most government agencies, NGOs, and the private sector conduct their own activities to cope with climate change without coordinating with each other' (Jakarta City Report, p13). The Jakarta City Team also commented that compared to the national level, city level officials have less understanding of climate change adaptation issues. Similarly in HCMC, it was commented that there was no single responsible metropolitan administration, and cooperation among government agencies and stakeholders is unsatisfactory (HCMC Presentation). The Mumbai Team identified two research areas to address this issue including: 'identifying and defining specific roles of public and private stakeholders in adaptation', and 'capacity building in institutions to strengthen adaptation decision-making' (Mumbai City Report, p23). The role of civil society groups in urban governance was raised in the presentation by the Bangkok Team. The latter specifically asked (Research Proposal, s8) - 'how civil-society groups play a role in adapting to uncertainties? What are factors influencing their success?

The Plans only solves the current issues of urban development (land use, public works and infrastructure) and are not integrated with the scenarios of climate change and the prediction of sea level rise (HCMC Presentation, s21; 'Plans' refers to the Regional and Master Plans)

There are no particular agencies or institution in Jakarta which oversees account risk and vulnerability assessments, managing climate change knowledge, or disseminating the climate related information to the general public (Jakarta City Report, p13).

What are their challenges?'

Existing planning instruments are deficient with regard to incorporating climate change risk and vulnerability. For instance, it was reported that the Metro Manila Development Authority (MMDA) had created several master/development plans, with the most recent integrated into the National Medium-Term Development Plan, but that 'these plans have not systematically incorporated climate change risks and the socio-economic vulnerability of the metropolis to climate changes' (Manila Abstract). Similarly, the Bangkok 5-year Action Plan for Climate Change incorporated strategies concerning development and disaster preparedness, but 'according to the preliminary reviews, the plan paid little discourse on vulnerability reduction' (Bangkok City Report, p1). Regarding the Greater Mumbai Disaster Management Action Plan (DMAP), 'no specific attention is given to adaptation strategies which may be more important in the short to medium-term to deal with the climate risks of flooding, storms and cyclones' (Mumbai City Report, p17). Understanding the gaps in existing urban plans at different scales was identified by Bangkok as an issue requiring future inspection (Research Proposal, s7), and in their second research proposal, the Jakarta Team proposed developing an 'Adaptation Plan for Climate Change' for their city (Research Proposal, s17). In order to mainstream adaptation into planning, the Mumbai Team proposed two research activities - 'identifying contexts such as disaster management or infrastructure development activities for mainstreaming adaptation into current planning and policies', and 'carrying out policy oriented studies to understand where such integration is possible.'

In general, LGUs are unable to enforce laws and ordinances (Manila City Report, Part3, p4; 'LGUs' refers to Local Government Units)

Integrating climate risk into land use regulations and building and sanitation codes was another key governance issue raised in the workshop. Zoning regulations are currently being drafted by the Jakarta Government, for which the Jakarta Team noted the opportunity for integrating climate risk assessment into the regulations (Jakarta City Report, p16). However, big business developers in the northern coastal area of Jakarta already appear to have anticipated flood risk by building canals and drainage systems (Jakarta City Report, p15). The Manila Team reported that 'it cannot be determined whether these are adequate or whether these have been enforced', further adding that a 'JICA study projected a high number of casualties if a strong intensity earthquake hit Metro Manila because of poor regulation and enforcing of building related laws and codes as well as in the compliance of requirements for business permits' (Manila City Report, Part3, pp3-4). The challenge of enforcement was echoed by the the Jakarta Team (Jakarta Abstract), noting that 'the real problems are enforcing these regulations on the public', where 'most effort has only been partly successful'. One of the expected outcomes from proposed research by the HCMC Team is to develop building codes for low-lying areas (HCMC Research Proposal, s21); the importance of which is evident with respect to proposed new developments on flood-prone land (HCMC City Report, p27).

Addressing the vulnerability of marginal groups was identified as another critical issue. Slums are not included on Mumbai's developmental plans, and the Mumbai Team reported that this 'deliberately induced invisibility of slums pushes its dwellers to multiple forms of displacements' (Mumbai City Report, p10). According to the Bangkok Team, 'marginalized groups and informality are currently viewed by the general public as non-climate issue, and hence not only ignored by city planning but also perceived as a non-climate factor for risk assessment, that could also exacerbate sector and community vulnerability' (Bangkok City Report Presentation, s17). Inadequate dissemination of information to the poor was criticized by the Jakarta Team, reporting that a 'campaign on the impact of climate change has not been done on those vulnerable to the risks such as the poor and other groups', with the main climate risk campaign 'still limited to the high government circles and academics' (Jakarta Abstract). Issues addressing marginal groups were considered in research activities proposed by Bangkok (Bangkok Research Proposal, s11-12), and Mumbai (Mumbai Abstract; Mumbai Research Proposal, s13); for more details see above section on assessment of socio-economic vulnerabilities.

Climate-induced migration of population was raised by the Bangkok and Mumbai Teams. The former expressed the need to understand how urban and rural areas are linked by migration and the threshold at which migration due to climate impact is triggered (Bangkok City Report, p7). For example, migration may be in response to falling agriculture production, closed factories, industry relocation, and interruption to the transport network. The latter commented that migrations from surrounding areas into the city might be triggered by drought becoming more frequent (Mumbai City Report, p17).

Public funding and commitment to respond to climate related risks and vulnerability has been mostly project-based and donor-driven. Thus, sustainability and progress of these initiatives are a major concern for most stakeholders (Manila Abstract)

Allocating and disbursing funds and sustainability of initiatives were other challenges discussed. The Jakarta Team reported that there 'is currently no information on public funding and commitment on climate change', though according to the Jakarta City Government Medium Term Development Plan (2007-2012) 'some sort of funding must be available and there should also be commitment' (Jakarta City Report, p17). The problem of funding being largely project-based and donor-driven was also noted (Manila Abstract), and is further complicated in Manila as the National Disaster Coordinating Council (NDCC) does not have control of its own regular budget to disburse (Manila City Report, Part3, p5). In HCMC, research into climate risks and impacts has been supported by domestic and international organisations (HCMC Report, p20), and the city is permitted to raise funds for flood and storm prevention through fees paid by the local community (HCMC Report, p28). In Thailand, the parliament is currently considering how to institutionalize and fund climate change adaptation activities (Bangkok Abstract). The need to better integrate projects into ongoing programmes and initiatives was also commented by the Mumbai Team.

4.0 Conclusions

The workshop identified current information/knowledge gaps and future research opportunities for addressing climate change related risks and vulnerability in Bangkok, HCMC, Jakarta, Manila and Mumbai. As previously noted, the City Reports (submitted prior to the workshop), City Report Presentations (Day 2), Research Proposal presentations (Day 5) and abstracts (submitted post-workshop) were used as core sources of information for distilling and organizing findings, in addition to the training sessions and discussions. Key information/knowledge gaps and proposed research identified by the cities are summarized as follows:

Category 1: Assessment of climate change related risks (hazards and socio-economic vulnerabilities)

1. Improve stakeholder perception of risk
    - acknowledging the vulnerability of the poor to the impact of climate change
2. Better define urban hazard factors
3. Assess the risk to water and food security, including
    - consumption, water quality, sanitation, waste management, agriculture, aquatic systems
4. Address lack of baseline climate data, including
    - temperature, sea level, and social impact (see item 8 below on socio-economic vulnerabilities)
5. Conduct health risk assessments, including
    - assessing link between climate change and health impacts

6. Recognize the importance of green space in moderating air temperature and flood prevention
7. Recognize the potential future impact of coastal erosion
8. Conduct socio-economic vulnerability assessments
   - addressing limited information on social aspects of vulnerability
   - integrating existing studies to better understand the current situation
   - refining/identifying measures of risk
   - developing measures of social vulnerability
   - mapping vulnerabilities
   - integrating exposure, places, sectors, activities, individuals, households, social groups, communities, livelihoods into assessments
   - understanding how urban and rural areas are linked by migration
   - assessing the vulnerability of marginal groups/informal sector

<u>Category 2:</u> Information/knowledge management

9. Address provision of an information/knowledge management system, including
   - lack of a central information system, poor data collection and storage
   - an interdisciplinary approach to development is needed
10. Address limited availability of geographic information
11. Address integration of geographic information with socio-economic data
12. Address lack of GIS and mapping tools, and understanding of their application
13. Ensure access to information by stakeholders
14. Develop materials for information dissemination and target the most vulnerable communities
   - make better use of mass media
15. Expand capacity building activities, including
   - developing a course on urban development and climate change
   - integrating climate risk content into other courses (e.g., engineering)
   - stakeholder workshops
16. Recognize limitations of existing early warning systems

<u>Category 3</u>: Governance

17. Address the need for an institutional linking mechanism
18. Address the lack of coordination between government agencies, NGOs, and the private sector
19. Build capacity for city officials
20. Assess the role of civil society groups in urban governance
21. Address deficiencies in existing planning instruments in incorporating climate change risk and vulnerability
22. Address development and enforcement of land use regulations and building and sanitation codes
23. Address vulnerability of marginal groups, including
   - invisibility in plans/assessments
   - inadequate dissemination of information to the poor
24. Investigate potential for climate-induced migration of population
25. Address challenges to allocating funds for climate change related risks and vulnerabilities, including
   - availability and commitment
   - project-based and donor-driven support
   - raising of funds through fees paid by the local community
   - sustainability of initiatives

5.0 Future Directions

5.1 Research networks

Potential future city research networks were identified by HCMC, Jakarta and Mumbai in their Research Proposals (see Table II, Appendix 3), and the Bangkok Team referred to to the need to build an institutional community towards the research. Furthermore, an upcoming Research Conference (CAR II) is planned for Taipei in 2011 (Dr. Roland Fuchs, Day 1 Opening session).

5.2 Proposed projects

Two major projects are anticipated to commence in 2011, thereby offering the opportunity to address the above gaps in information/knowledge and challenges faced by the cities. These projects demonstrate how the Cities at Risk workshops, the first of which was held in February 2009, are promoting communication and collaboration in addressing the impact of climate change on cities in Asia and beyond.

1. An APN funded project titled - *Enhancing adaptation to climate change by integrating climate risk into long-term development plans and disaster management.* The study will include a comparative analysis of Bangkok, Manila and Mumbai in order to identify policy implications for managing risk, adaptation strategies, and development planning. More details on the study are included in the Mumbai abstract (Appendix 2).

2. A project funded by International Development Research Centre (of Canada) and the Canadian Research Tri-Councils (Natural Sciences and Engineering, Social Sciences, Health Research) - *Coastal Cities at Risk (CCaR): Building Adaptive Capacity for Managing Climate Change in Coastal Megacities.* The overall objective is to 'develop the knowledge base and enhance the capacity of megacities to successfully adapt to and when necessary cope with risks posed by the effects of climate change, including sea level rise, in the context of urban growth and development' (Gordon Bean, Presentation Day 6). The cities of Bangkok, Lagos, Manila and Vancouver were selected for the study, with workshops involving other cities, including HCMC, Mumbai and Jakarta. Approval for the five-year project is anticipated in January 2011, becoming operational in April 2011.

References

1. City Reports (collated in Appendix 6)

Bangkok City Report

Hutanuwatr K (2010) A Preliminary Review on Frameworks for Thai Climate Risk and Approaches in Social/ Economic Vulnerability Assessment in Bangkok.

Yila JO (2010) Gender Perspective on Climate Change Risk and Vulnerability.

Salamanca A (2010) Climate Change and Migration.

Marome WA, Suwanarit A, Tiampayothorn R, Chenvidyakarn T (2010) Urban Development Perspective on Climate Change Risk and Vulnerability: Landscape Urbanism, Landuse Plan and Informality Economy and Settlement.

HCMC Report

Vo Le Phu, Le Anh Duc, Dang Van Khoa, Lam Vu Thanh Noi (2010) Climate Change Vulnerability Assessment and Urban Development Planning in Ho Chi Minh City, Vietnam.

Jakarta City Report

Surbakti IM, Idroes IC, Simarmata HA, Firman T (2010) Jakarta City Report. Information related to Climate Change in Jakarta City.

Manila City Report

Porio E, Loyzaga AY, Vicente C, Perez R, Narisma G, Olaguer D, Muto M, Cartagena R (2010) Climate Change Related Risks and Adaptation Potential in Metro Manila.

Mumbai City Report

Patankar A, Patwardhan A, Andharia J, Lakhani V (2010) Mumbai City Report.

2. City Report Presentations (collated in Appendix 7)

3. City Research Proposals (collated in Appendix 8)

Appendix 1: City Report Guidelines

International Workshop

Climate Change Vulnerability Assessment and Urban Development Planning for Asian Coastal Cities

Rose Garden Sampran Riverside, Nakorn Pathom, Thailand,

22-28 August 2010

The City Report is critical for participants, mentors, and resource persons of the workshop to discuss the knowledge status and research gaps of each participating city. It will also be the important justification for research activities that each city team will propose for financial support from international research networks on urban development and climate change over years to come.

Suggested topics to be included in the City Report are

- Current perception of climate change related risk (such as *floods, water and food supply, land losses, air quality, heat stress, disease outbreaks, etc.*) and social/economic vulnerability (such as *poverty, investment, capital and opportunity losses, social conflicts and divides, genders, justice, etc.*) in your city, e.g., how do they perceive on the differences and linkages between weather/climate risks and social/economic vulnerability?
    - among general public
    - among urban officials, city managers
- Have various climate risks to your city been assessed and/or mapped, and if so do they take into account possible effects of current and future climate changes?
- Have social/economic vulnerability to climate related risks been assessed and/or mapped, how, by whom, details?
- Have climate risks and vulnerability of the city been communicated to the public, and how?
- Is there an existing urban GIS information base that may be used for climate risk and vulnerability assessment? What is included?
- Which agencies and institutions (e.g., government, non government, business, academic, civil society, etc.) in the city have roles in risk and vulnerability assessments, communicating such assessments to the public and managing information and knowledge about climate change? Their skill level and capacities needed?
- Is there an urban master plan? When was it completed? Does the urban master plan take into account future risk to climate change?
- Have and how building codes, land use regulations, sanitation codes, etc. been enforced?
- Is there an early warning system? Evacuation or emergency response plans for various types of weather and climate related disasters? How effective are they?
- Level and effectiveness of public funding and commitment to respond to climate related risks and vulnerability?
- Governance and social justice issues, institutional, jurisdictional and social conflicts, etc. that may worsen climate related issues?

Instructions

1. One report will be submitted by each city team and every member of the team is expected to contribute.
2. These topics are only for suggestions, each city team may identify or add other topics that they feel relevant to climate and development issues in their city.
3. We do not expect an intensive technical review of each topic but rather a general overview of the status, gaps and opportunity that may be further developed in to a research framework for each city team to carry out.
4. The total length of each city report is about 20-25 A4 pages.
5. Please identify clearly on who, among the team members, contribute to which parts of the report so that further questions/comments can be appropriately directed to that person.
6. Please submit the first draft of city report by *August 8th 2010* in electronic form to pasita@start.or.th

Appendix 2: Abstracts submitted by City Teams

1. Bangkok City Report Abstract

A number of assessments have identified the coastal areas of the Bangkok Metropolitan Region (BMR) as vulnerable to the risks resulting from or associated with climate change and extreme weather events. These risks include sea-level rise, coastal erosion and flooding. These assessments were carried out under the auspices of various government ministries and bilateral and multilateral development agencies. To an extent, the climate change related vulnerabilities of the BMR are also covered in the national assessments for the whole Kingdom. As a result of these assessments, issues related to climate change were heavily discussed in the Thailand 11th National Economic and Social Development planning and various action plans were formulated to mitigate the root causes of climate change such as the Bangkok Metropolitan Administration's Global Warming Action Plan and efforts are underway to plan for adaptation to the impacts of climate induced variability and the increasing frequency of extreme weather events. Thailand's Parliament is also now debating on how to institutionalise and fund climate change adaptation activities and infrastructure.

The conduct of a pre-Copenhagen meeting in Bangkok in 2009 has substantially raised awareness on climate change. The media has covered this event and several locally based initiatives have sprung up as a result to deal with future disasters. Thus, some level of sensitisation to climate change and disasters has already been initiated in the mainstream media which built on the effects of the 2004 Boxing Day tsunami which hit Southern Thailand with devastating impact. But whether the level of awareness crystallise by these events sufficiently leads to concrete action is another thing.

GIS and maps on various coastal risks and hazards are also available with various government departments and ministries in Thailand and international development organisations based in Bangkok. The only climate change specific mapping to date for Bangkok is carried out by Panya Consultants with funding from the World Bank.

Despite all these assessments, what seems to be lacking in the BMR is the identification of the vulnerable groups so that a more proactive and differentiated intervention can be crafted. Furthermore, it appears that most assessments of the BMR's vulnerability used mapping, ranking and quantifiable indicators which tend to treat vulnerability as attributes, in other words as objects, rather than understanding the underlying social, economic, political and geographical processes underpinning climate change vulnerabilities because these approaches lack the process dimension, relied heavily on available database, limited by rigidity and subjectivity in indicator selection and weightings, and insensitivity to context-based vulnerability. Also, existing vulnerability assessments focused mainly on the physical or the climatic aspects of vulnerability and little attention is given to non-climate factors that exacerbate an individual or household's vulnerability. Finally, the scale and interdependence of climate risks and vulnerabilities with other social and economic factors are not given adequate attention in existing assessments. Places and communities which are likely to be affected by climate change and extreme weather events are treated as undifferentiated and independent.

In terms of governance, existing compartmentalised, rigid and politicised bureaucratic structure is likely to hamper effective implementation of measures to adapt to climate change and extreme weather events. For instance, the efficiency and effectiveness of existing jurisdictional and authority structure of the Bangkok Metropolitan Authority and the provinces in the BMR, represented by the Ministry of Interior, will be called into question whether this is the best way to provide for and implement a coherent and sensible climate change adaptation plan.

2. Ho Chi Minh City Report Abstract

Ho Chi Minh City (HCMC) is a biggest city and the largest economical, cultural and scientific center in Vietnam. Though the city accounts for 0.6% of Vietnam's total area and 8.3% of the country's total population, it has witnessed a remarkable economic growth, evidenced by GDP growth rate with more than 10% since 2000. The city faces many serious issues due to rapid development: congestion, inadequate infrastructure and housing, sprawling and uncontrolled expansion. In addition, recent environmental changes resulting from emerging global climate change continue to threaten the city. Sustainable development of the economy and urban expansion of HCMC will be significantly affected by long term consequences of climate change and environment-related factors.

A recent World Bank report showed that Vietnam is one of the top five countries affected by climate change, effects which include rising sea-level, temperature fluctuation and extreme weather phenomena. The report showed that a projected 1-meter rise in sea level would affect about 5 percent of Vietnam's land area, 11 percent of the population, 7 percent of agriculture and reduce the country's GDP by 10 percent. More importantly, HCMC is one of the top 10 southern provinces in Vietnam that will be drastically affected by a 1 meter rise in sea level. As the largest urban area in the Mekong Delta, HCMC will be inundated with 43% of its total area, and more than 660,000 people (about 12% of the City's population) will face displacement.

In-order to report city's risk to climatic threats many papers and research projects explore the current climate of the city and forecast the climatic hazards such as severe storms, storm surges, and tidal flooding. Studies show with only 40%–45% of HCMC's land at 0-1 m elevation, 15%–20% at 1–2 m elevation, and a even smaller percentile land above 4m elevation. HCMC is most vulnerable to a rise in sea level. Despite such crucial studies, there remained a lack of GIS or mapping tools for climate risk and vulnerability assessment.

In 2008, the national government responded with the National Target Program (NTP). NTP utilizes a framework generated by the Ministry of Natural Resources and Environment (MoNRE) which includes key policies for responding to climate change in the country. Accordingly, the HCMC municipality has established the Department of Natural Resources and Environment (DoNRE) as the agency responsible for studying and advising the city government to conduct activities in climate change adaptation. An Action Implementation Strategy has been recently issued on seeking prevention and mitigation measures for the city by 2020.

Unfortunately, these measures are difficult to implement within terms of the MoNRE policies. The most important issue comes from the collaboration of the urban planning sector with other sectors. Urban development of HCMC is anchored at two major plans: the Regional Plan and Master Plan which were recently approved by the government in May 2008 and Jan 2010 respectively. However, these plans have not been integrated with the predicted rise in sea level that is clearly indicated by climate change scenarios of MoNRE. They only address the current issues of urban development (land use, public works and infrastructure) that serve population growth. Climate change policy is limited to the national and city level, hereby preventing the implementation of climate change policy at the community level.

A comprehensive research study on climate change vulnerability of the city is necessary to understand which future strategies and adaptation measures need to be built up for sustainable urban development. Therefore, a socio-economic assessment of riverine communities in HCMC is proposed as a primer for assessing the vulnerability of these communities to climate change in HCMC. Two riverside communities in HCMC, Hiep Binh Chanh ward - Thu Duc district (inner urban area) and Can Gio district (coastal urban district), will be examined for the magnitude of impact of climate change on social and economic aspects daily life. According to Vietnam National climate change scenarios, these areas will be the most vulnerable and are most at risk to a rise in sea level and coastal flooding.

3. Jakarta City Report Abstract

The city of Jakarta is one of the most vulnerable cities to climate change impact. There is a general perception on the dangers of natural disasters, such as flooding, disease outbreaks, rising sea water. Whether or not they agree that climate change is occurring and increasing the frequency of these disasters is still unclear. Officials as well as the academic circle also agree on the impact of these disasters. Mitigation programs and the setting up of disasters centers among others are proof enough that there recognition that disasters are occurring more and more. The only problem is whether the cause of these disasters is man-made or due to climate change is still debated among officials and academics.

Various climate risks, mainly regarding flood in Jakarta have been assessed. However, these assessments are limited to the physical aspect of climate change impact. Risks related to the impact of climate impact on people have experienced much less attention. There are studies on the effect of flood and rising sea water. However, studies coping strategies and adaptation to these disasters are few and far between. Limited efforts are also being done to assess and map these socio-economic impacts of climate change.

The public have been informed on the climate risks and vulnerability through the mass media and seminars. The main problem is that the method of delivery as well as the target audience has not been properly addressed. As an example, campaign on the impact of climate change has not been done on those vulnerable to the risks such as the poor and other groups. The main climate risk campaign is still limited to the high government circles and academics.

The current GIS maps on Jakarta climate risk assessment do have spatial data for the physical aspect of vulnerability. The maps have not been integrated with the socio-economic aspects of vulnerability. Thus, there is an urgent need to combine physical as well as socio-economic data to construct vulnerability mapping that can provide a holistic assessment of climate change impact.

The local government has not been unaware of the implications o climate change. There are various local government bodies which are responsible for disaster management in Jakarta. There is an urban master plan that takes into account disaster scenarios such as flood and rising sea water. There are also mitigation programs as well as regulations and building codes in place. However, the real problems are enforcing these regulations on the public. Most effort has only been partly successful.

4. Manila City Report Abstract[1]

Perception of Climate Change Related Risks. In a recent national survey[2], majority of Filipinos (52 percent) had a wide knowledge of climate change, especially the big changes in climate during the past three years (62 percent). After recent climate extreme experiences like Typhoon Ondoy (Ketsana), Metro Manila residents now have a heightened sense of awareness of climate change related risks. While aware of its severe consequences on their lives, they have not been systematically oriented/educated nor have their capabilities been systematically built to respond or

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[1] This abstract was prepared by Emma Porio, Celine May Vicente and Antonia Y. Loyzaga with inputs from Ronald Cartagena and Megumi Muto

[2] Pulse Asia 2010 Survey on Climate Change.

adapt to these risks and hazards. In like manner, government agency officials and barangay officials coordinating disaster responses are very ill-equipped to respond to these hazards and risks as demonstrated during Typhoons Ondoy in September 2009.

But among city officials and managers, this high awareness/knowledge has not been translated to concrete assessments and mapping/inventory of risks and its links to social-economic vulnerability. At most, these risks have been incorporated, albeit unevenly, through poverty assessments, social services inventory for vulnerable populations, and disaster management plans of local government units. Meanwhile, uncoordinated assessments of climate change related risks (including GIS databases) have been done by research institutes (e.g., Manila Observatory), universities (University of the Philippines), government agencies (e.g., PAG-ASA or the Philippine Atmospheric Geophysical and Astronomical Services Administration, Department of Environment and Natural Resources, Metro Manila Development Authority) and a few local government units (Makati City, Marikina City) in partnership with some overseas development agencies (ODA). There has been no systematic climate-related risk assessment and mapping done but since Metro Manila consists of 17 municipalities and cities which are interconnected by the same rivers, watersheds and drainage ways, a Metro-wide risk assessment and mitigation/adaptation plan is badly needed. Meanwhile, the 2010 National Climate Change Framework need to be operationalized at city/local/provincial levels.

Information/Knowledge Management. Metro Manila Development Authority has drawn several master/development plans, with the most recent incorporated to the National Medium- Term Development Plan (2010-2014). But these plans have not systematically incorporated climate change risks and the socio-economic vulnerability of the metropolis to climate changes. PAGASA is the government agency designated to provide hazard warnings (sometimes inaccurate) which are relayed to LGUs and schools. Metro Manila's flood warning system (Effective Flood Control Operation System or EFCOS) under MMDA has not been utilized effectively as seen during Typhoon Ondoy (Ketsana). Most LGUs have disaster response teams for emergency situations but often these cannot cope when the need rises during typhoons and extreme rainfall bringing floods.

There have been some limited attempts to communicate climate risks and vulnerability to the public through radio/TV programs (e.g. Climate Change Challenge, Kalikasan-Kaunlaran). There is a dire need to develop materials for information dissemination in the popular media.

Public funding and commitment to respond to climate related risks and vulnerability has been mostly project-based and donor-driven. Thus, sustainability and progress of these initiatives are a major concern for most stakeholders.

5. Mumbai City Report Abstract

Mumbai is one of the largest megacities in the world and is home to more than 13.4 million people. It is the financial capital of India with a large commercial and trading base. The city plays host to a number of industries, multinational companies and important financial institutions. It is also an important international sea port on the western coast and strategic from defense perspective. Mumbai has a large coastline, which has been reclaimed for development purposes. The geographical location of the city and its physical, economic and social characteristics make the city more vulnerable to the threats posed by climate risks, such as, sea level rises, storms, floods and coastal erosion. The most vulnerable section is the slum dwellers and squatter communities that comprise more than half of the total residents. Therefore, it is critical for the city to assess the vulnerabilities and devise adaptation and mitigation mechanism to cope with future climate risks.

Studies carried out over the past decade indicate that Mumbai is likely to be highly vulnerable to climate change with majority of its population living on the flood prone and reclaimed land.

Estimates suggest that the average annual temperatures in the city would increase by 1.75°C and 1.25°C respectively in the A2 (business as usual) and B2 (sustainability) scenario. Mumbai is also predicted to have an average annual decrease in precipitation of 2% and an increase of 2% for the A2 and B2 scenario respectively. The most damaging scenario for the city is the predicted sea-level rise of 50cm by 2050. Further, the city is ranked 2nd in terms of population exposure to future climate conditions by 2080. The city is also expected to have a high exposure to coastal flood risk in the 2070s. However, exposure will not necessarily translate into impact if effective adaptation and risk management strategies are in place. However, for a city like Mumbai with far lower standards of adaptation and risk management or flood defenses, the impacts of extreme weather events are likely to be large in future with huge costs.

In the aftermath of the unprecedented Mumbai floods of July 2005, Government of India enacted the Disaster Management Act. In Maharashtra, the state government accordingly prepared the Greater Mumbai Disaster Management Action Plan (DMAP) in 2007. Under this plan, the risks and vulnerabilities associated with floods, earthquakes, landslides, cyclones, etc., have been identified. The Plan envisages specific relief and mitigation measures in terms of infrastructure improvement, contingency plan and changes in land-use policies and planning. The Plan identifies important stakeholders, such as, various departments of the local authority, MCGM, engaged in storm water drainage systems, early warning systems and public health, police and fire brigade, NGOs and communities.

There are, however, a number of research gaps and challenges that need to be addressed for Mumbai in immediate future in order to reduce climate vulnerabilities and build city resilience. These can broadly be classified into three categories: Information, Assessment and Knowledge. There is a need to compile information regarding different climate-related risks. We further need to assess how and where different models & tools can be applied to look at changes in hazards, exposure & vulnerability. We also need to build on the fundamental knowledge about topics where there is inadequate understanding, e.g., health impacts of climate change, intra-seasonal variability in the monsoon, studies of subsidence and stability of reclaimed lands, etc. Further, the city administration and other stakeholders need specific strategies and an integrated approach to build resilience of the city to climate risks.

The proposed APN funded project titled 'Enhancing adaptation to climate change by integrating climate risk into long-term development plans and disaster management' will evaluate the immediate to medium-term post-disaster recovery and response scenario in the aftermath of flooding caused by heavy intensity precipitation in three Asian cities – Mumbai, Bangkok and Manila. In each of the three target cities, this exercise will include analysis of secondary data pertaining to the flooding events, the resultant physical, economic, environmental and social impacts, the response measures undertaken and their benefits for climate change adaptation. The comparative analysis of the three cities will bring out the policy implications for risk management, adaptation strategies, city resilience and development planning in the long run. The project further seeks to integrate post event recovery strategy with investment and development plans through stakeholder workshops that would lead to long term reduction in vulnerability and enhancement of adaptive capacity. The methodology evolved to document and analyze the impacts of flooding events and the resultant analysis will be shared with the policy makers and other stakeholders including the scientific and research community through the in-country consultation and information dissemination workshops held in the three cities to enable them to draw relevant lessons.

Appendix 3: Tables summarizing key content extracted from City Reports, City Report Presentations, and Research Proposal Presentations

Two tables summarizing the current status of information/knowledge and future research proposals on climate change related risk assessments and application to urban development planning and governance in five Asian megacities

Table I: Current status of information/knowledge on climate change related risk assessments and application to urban development planning and governance in five Asian megacities

Table II: Proposed research on climate change related risk assessments and application to urban development planning and governance in five Asian megacities

Content presented in the tables was extracted from the City Reports, City Report Presentations (Day2) (**Table I**) and the Research Proposal Presentations (Day 6) (**Table II**).

[see PDF files on enclosed CD]

Appendix 4: Participants list

City Team Members (26)
Bangkok 10
Ho Chi Minh 4
Jakarta 4
Manila 5
Mumbai 3

Bangkok

Name	Education	Affiliation/Home base	Expertise/Interest	Contact
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Ho Chi Minh

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Jakarta

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Manila

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Mumbai

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Resource persons

Name	Home base	Affiliation	Contact	Lesson in Charge
Dr. Anond Snidvongs	Bangkok	Director/ SEA-START Regional Center	Email: anond@start.or.th	1. Workshop introduction and overview 2. Field Trip 3. Wrap-up
Dr. Roland Fuchs	Honolulu	Senior Fellow/ East-West Center	Email: fuchsr@eastwestcenter.org Tel: (808) 944-7518	1. Workshop introduction and overview 2. Wrap-up
Dr. Hassan Virji	Washington DC	Director/ International START Secretariat	Email: hvirji@start.org Tel: +1 202 462 2213 Fax: +1 202 457 5859	Visioning and participatory process as a tool for developing stakeholder partnerships and strategies to deal with multiple stresses
Dr. Christina Finch	Maui Hawaii	Senior Risk Assessment Analyst /Pacific Disaster Center	Email: cfinch@pdc.org	Socioeconomic vulnerability assessment
Dr. Stanley Goosby	Maui Hawaii	Chief Scientist/ Pacific Disaster Center	Email: sgoosby@pdc.org	Socioeconomic vulnerability assessment
Antonia Loyzaga	Manila	Executive Director, Manila Observatory/ Manila	Email: aloyzaga@observatory.ph	Supplementary comments
Dr. Joern Birkmann	Bonn	Head/ Vulnerability Assessment, Risk Management & Adaptive Planning Section	Email: birkmann@ehs.unu.edu	Integrating risk and vulnerability assessment with spatial planning

Name	Home base	Affiliation	Contact	Lesson in Charge
		United Nations University Institute for Environment and Human Security		
Dr. Hiromune Yokoki	Tokyo	Associate Professor/ Ibaraki University/ Tokyo	Email: yokoki@mx.ibaraki.ac.jp	Assessing hazards and risk associated with climate change including downscaling of climate models
Dr. Yuji Kuwahara	Tokyo	Associate Professor/ Ibaraki University/ Tokyo	Email: kuwahara@mx.ibaraki.ac.jp	Assessing hazards and risk associated with climate change including downscaling of climate models

Observers

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Appendix 5: Workshop Program and Summary of Proceedings

5.1 Workshop Programme

Day 1: Sunday 22 August 2010

Suvarnabhumi International Airport

Rose Garden Riverside

08.00 – 18.00	Arrival Registration
19.00 – 21.00	Reception dinner

Day 2: Monday 23 August 2010

Rose Garden Riverside

09.00 – 09.40	**Opening Session** Workshop in the context of a longer term collaborative research activity *Dr. Anond Snidvongs, SEA-START Regional Center* *Dr. Roland Fuchs, East-West Center*
09.40 – 10.00	Tea and coffee break
10.00 – 12.10	**City team introduction and city report presentation** (15 minutes for presentation and 10 minutes for discussion) • Bangkok • Ho Chi Minh • Jakarta • Manila • Mumbai
12.10 – 13.30	Lunch
13.30 – 14.40	**Visioning and participatory process as a tool for developing stakeholder partnerships and strategies to deal with multiple stresses** [this presentation moved to Friday 27 August at 330pm] *Dr. Hassan Virji, International START Secretariat*
14.40 – 15.00	Tea and Coffee Break
15.00 – 16.00	**Estimation of future flood and inundation risks due to climate change at downstream regions of major rivers in Japan** *Dr. Hiromune Yokoki, Ibaraki University*
16.00 – 16.30	***Data preparation and process for estimating flood and inundation areas*** *Dr. Yuji Kuwahara, Ibaraki University*

Day 3: Tuesday 24 August 2010

Rose Garden Riverside

08.30 – 09.00	Review of Day 2
09.00 – 10.30	**Risk Assessment of river flood on GIS (Practice)** (continued from 23 August) Dr. Hiromune Yokoki, Ibaraki University Dr. Yuji Kuwahara, Ibaraki University
10.30 – 10. 50	Tea and coffee break

10.50 – 11.50	**Methodology to link GIS flood maps and socio-economic data: case of Metro Manila** *Dr. Megumi Muto, Research Fellow, JICA Research Institute,* *Dr. Tran Thi Viet Nga, Hanoi University of Civil Engineering*
11.50 – 13.00	Lunch
13.00 – 16.00	**Socioeconomic vulnerability assessment** Overview of disaster risk reduction terminology Demonstration examples of risk assessment (American Samoa, Marikina City) Focus on characteristics of vulnerability Audience participation/discussion breaks for applicability in host cities *Dr. Christina Finch, Pacific Disaster Center* *Dr. Stanley Goosby, Pacific Disaster Center* * Tea and coffee break is arranged where appropriate
16.00 – 17.00	**Brief summary of climate change vulnerability and adaptation of Samut Sakhon Municipal Area : Case study for field trip** *Dr. Anond Snidvongs, SEA-START Regional Center*

Day 4: Wednesday 25 August 2010
Fieldtrip
Samut Sakhon

09.00 – 10.00	Depart Rose Garden Riverside
10.00 – 12.00	**<u>Sight Seeing # 1</u>** Khok Kham, Muang District, Samut Sakhon Province Visit to Eastern Mahachai Coastline Natural Resources Conservation Center and related areas
12.00 – 13.30	Lunch
13.30 – 15.00	**<u>Sight Seeing # 2</u>** Visit to Mahachai municipal area
15.00 – 17.00	**<u>Sight Seeing # 3</u>** Tha Chalom, Muang District, Samut Sakhon Province A case study of people-based involvement in coping with flooding *Mr. Samran Klinard, Chairman of People-based Participation*
17.00	Back to Rose Garden Riverside

Day 5: Thursday 26 August 2010
Rose Garden Riverside

08.30 – 09.00	Review of Day 3
09.00 – 12.00	**Socioeconomic vulnerability assessment** (continued from 24 August) • GIS and demographic data; place-based research • Overview of methodology for the Social Vulnerability Index (SoVI) • Demonstration of SoVI examples and analysis (US County and Hurricane Katrina) • Audience participation/discussion breaks for applicability in host cities

	Dr. Christina Finch, Pacific Disaster Center *Dr. Stanley Goosby, Pacific Disaster Center* * Tea and coffee break is arranged where appropriate
12.00 – 13.00	Lunch
13.00 – 14.00	**Vulnerability as the entry point to link disaster risk reduction and climate change adaptation for adaptive urban governance** (Part I) *Dr. Joern Birkmann, United Nations University Institute for Environment and Human Security*
14.00 – 14.20	Tea and coffee break
14.20 – 16.20	**Vulnerability as the entry point to link disaster risk reduction and climate change adaptation for adaptive urban governance** (Part II: Exercise and development of a questionnaire and criteria for adaptive urban governance) *Dr. Joern Birkmann, United Nations University Institute for Environment and Human Security*

Day 6: Friday 27 August 2010
Rose Garden Riverside

08.30 – 09.00	Review of Day 5
	APN recent global change research and capacity building activities in the Asia-Pacific region *Ms Perlyn Pulhin, Asia-Pacific Network for Global Change Research (APN)*
09.00 – 12.00	**Presentation: City team work plans for future research** (40 minutes for presentation and 10 minutes for discussion) • Mumbai • Jakarta • Ho Chi Minh * Tea and coffee break is arranged where appropriate
12.00 – 13.00	Lunch
13.00 – 14.40	**Presentation: City team work plans for future research** (continued) • Manila • Bangkok
14.40 -15.00	Tea and coffee break
15.00 – 16.00	**Closing Session** *Dr. Anond Snidvongs, SEA-START Regional Center* *Dr. Roland Fuchs, East-West Center*
19.00 – 21.00	Farewell dinner

Day 7: Saturday 28 August 2010
Rose Garden Riverside
Suvarnabhumi International Airport

09.00 – 18.00	Departure

5.2 Summary of Proceedings

Day 2

The workshop was opened by Dr. Anond Snidvongs (Southeast Asia START Regional Centre) and Dr. Roland Fuchs (East-West Centre) introducing the workshop in the context of longer-term collaborative research activities.

Dr. Fuchs delivered a presentation on the background to the Cities at Risk Initiative. The latter highlighted coastal vulnerabilities in light of global change; the Keeling Curve; social and environmental disruption from global warming; projected global temperature increases by 2100; dangerous warming consequences; strategic retreat; sinking deltas; and impact zones using Vietnam as a case study. Social vulnerability assessments were discussed, including 'what if' scenarios; assessing and monitoring social and spatial inequalities in impacts and recovery; and vulnerability of Asian coastal cities. The Cities at Risk project objective is to 'help develop capacity of Asian coastal cities to better cope with risks posed by the combined effects of sea level rise, climate change, and urban growth and development.' Key recommendations from the first Cities at Risk workshop, included:

1) move from conventional downscaling impact assessments to integrative socio-economic vulnerability assessments;
2) prioritize need for training urban planners in climate change risk and vulnerability assessment;
3) create urban “communities of knowledge” involving researchers, planners and urban officials.

Future activities of the Cities at Risk project were identified, including: 'locally generated research in context of international projects; research conference (CAR II Taipei 2011); publications, including policy papers.' It was noted that there were about 3000 papers on urban adaptation, and is a growing area of interest. Dr. Fuchs emphasized that through this initiative, participants have the opportunity to make a real difference to people's lives.

Dr. Snidvongs discussed the link between science and policy making, and how the workshop is a contribution to the Cites at Risk project, with APN the major sponsor of the workshop, plus the important contribution from Ibaraki University. Pre-workshop activities were also described including the establishment of City Teams; Dhaka and Shanghai teams were unable to attend on this occasion. It was noted that the City Reports are for sharing among the Cities at Risk network, and the important outcome of workshop will be a roadmap or workplan over 3, 4 or 5 years of what each team plans to accomplish.

Dr. Hassan Virji (Director, International START Secretariat) discussed future research opportunities including the IDRC/Canadian Research Council proposal, noting that there were 12 proposals and that six will be selected. The study will focus on four cities - Bangkok, Manila, Lagos, and Vancouver.

The remaining sessions of the day focused on City Team presentations of their City Reports (refer to the section 3 in this report for outputs from the City Team presentations), and commencement of the GIS session by Dr. Hiromune Yokoki (Ibaraki University). Dr. Yokoki's presentation (*Estimation of future flood and inundation risks due to climate change at downstream regions of major rivers in Japan)* was divided into two parts, the first describing flood and inundation simulation, covering the concept and method, examples (Chikugo river), and indexes of risk; and the second giving examples of hazard maps. It was noted in the discussion that all households in Japan receive copies of hazard maps.

The presentation by Dr. Hassan Virji on *Visioning and participatory process: Developing stakeholder partnerships and strategies* was moved to Day 6 at 330pm.

Day 3

Day 3 continued with the GIS theme that commenced the previous afternoon, with the practical session - *Data preparation and process for estimating flood and inundation area*s. Each City Team worked separately on their own workstation using ESRI ArcGIS, led through the practical session by Dr. Yuji Kuwahara from Ibaraki University. The aim of the session was for the participants to gain an insight into the technical aspects of estimating flood and inundation areas using GIS. The process comprised four major steps including sourcing data (pre-downloaded for participants), pre-processing of input data, flood simulation, and overlaying data. Useful sources of data included: GTOP030 – digital elevation data – 1km resolution; ASTER GDEM – 30m resolution; SRTM 90m Digital Elevation data; GLCF; www.maproom – roads, boundary data – but 20 years old; iscgm.org – to download elevation, land use, vegetation, boundary, elevation – 1km resolution.

The next step of linking flood maps to socio-economic data was presented by Dr. Megumi Muto, Research Fellow, JICA Research Institute (*JICA-WB-ADB Joint Study: Climate Risks and Adaptation in Asian Coastal Mega-Cities (The Case of Metro Manila*)), and Dr. Tran Thi Viet Nga, Hanoi University of Civil Engineering (*Infected Risk Assessment with Exposure to Pathogens in the Flood Water Case of City of Manila*). The conclusions and future directions of work summarized from Dr. Muto's presentation:

> costs of damage will be substantial in Asian coastal megacities; urban plans and flood protection infrastructure need to take climate risks into consideration; need to address other non-climate factors such as improved management of canals and drains; and the potential cross-fertilization with disaster risk reduction community.

The way forward for future research was noted by Dr. Tran as requiring comprehensive investigations into human behavior during flooding episodes, inundation water quality, and the natural and socio-economic status of the area.

In the afternoon, the workshop moved into the topic of social vulnerability assessment, with presentations from Dr. Stanley Goosby and Dr. Christina Finch from the Pacific Disaster Center. The session provided an overview of disaster risk reduction terminology, demonstration examples of risk assessment, characteristics of vulnerability, and with opportunities for participants to address issues to their home cities. Participant outputs from the training session components on city hazards and vulnerabilities are presented in Tables 1 and 2 as follows.

Bangkok	**HCMC**	**Jakarta**	**Manila**	**Mumbai**
Flooding	Flooding (duration and frequency) - diseases (water-related) - damage/asset loss	Flood	Extreme rainfall (severe flooding)	Flooding due to heavy precipitation
Coastal erosion	High tidal surge	Inundation	Intense typhoons (severe flooding)	Landslides

Bangkok	HCMC	Jakarta	Manila	Mumbai
Land subsidence	Land subsidence	Landslide	Earthquakes	Sea level rise
Salt intrusion		Disease outbreak (dengue, diarrhea)	Subsidence/ landslides	Storm surges /cyclones
Excessive groundwater withdrawal		Pollution	Sea level rise	Earthquake
Storm surge		Twister	Storm surges	
Rise of temperature (heat island and heat wave)		Earthquake		

TABLE 1. HAZARDS AS IDENTIFIED BY CITY TEAMS DURING DAY 3 TRAINING SESSION.

Bangkok	• Discussion focused on healthcare
HCMC	• Infrastructure (transport/road, drainage, water supply, public facilities) • Production (agricultural practices, industry, aquaculture, services (tourism, trading)) • Health (outbreak diseases, infectious disease) • Social impacts
Jakarta	• Poverty • Elderly • Weak governance (capacity building, corruption, limited information) • Low level land • Lack of enforcement • Lack of budget • Lack of awareness
Manila	• High incidence of poor people living in hazard-prone areas • High population density (exposure) • High number of poor people without access to basic services • Sub-standard buildings and infrastructure due to weak implementation of regulations • Haphazard zoning / land use plans and implementation
Mumbai	• Physical (reclamation, low lying, congestion, poor drainage) • Economic and social (high population density, informal sector, land use pattern, access to resources, poverty)

TABLE 2. VULNERABILITIES AS IDENTIFIED BY CITY TEAMS DURING DAY 3 TRAINING SESSION

Day 4

A field trip to Samut Sakhon Province was organised for Day 4, to see at first hand issues faced by the local communities to potential future climate risks. In the morning, participants visited the Marine and Coastal Resources Research Center (under the Department of Marine and Coastal Resources), where an extensive area of mangroves has been planted for coastal protection (see photos below), and in the afternoon Tha Chalom, Muang District, to understand the impact of flooding on the local urban population. Dr. Snidvongs led the field trip, providing an account of vulnerability and adaptation for the Samut Sakhon area and giving participants the opportunity to meet with community leaders at each site: Mr. Vorapol Doundlomchan from the the Khok-Kham community (Photo 2), and Mr. Sumran Klinard, the previous Tha Chalom community leader (Photo 6, next page).

Photo 1: Marine and Coastal Resources Research Center (Samut Sakhon)

Photo 2: Dr. Anond Snidvongs and Mr. Vorapol Doundlomchan from the the Khok-Kham community

Photo 3: Mangrove coastal protection at the Marine and Coastal Resources Research Centre (Samut Sahkon)

Photo 4: Local community area regularly impacted by flooding (Samut Sakhon)

Photo 5: Mr. Vorapol Doundlomchan talking to the workshop participants

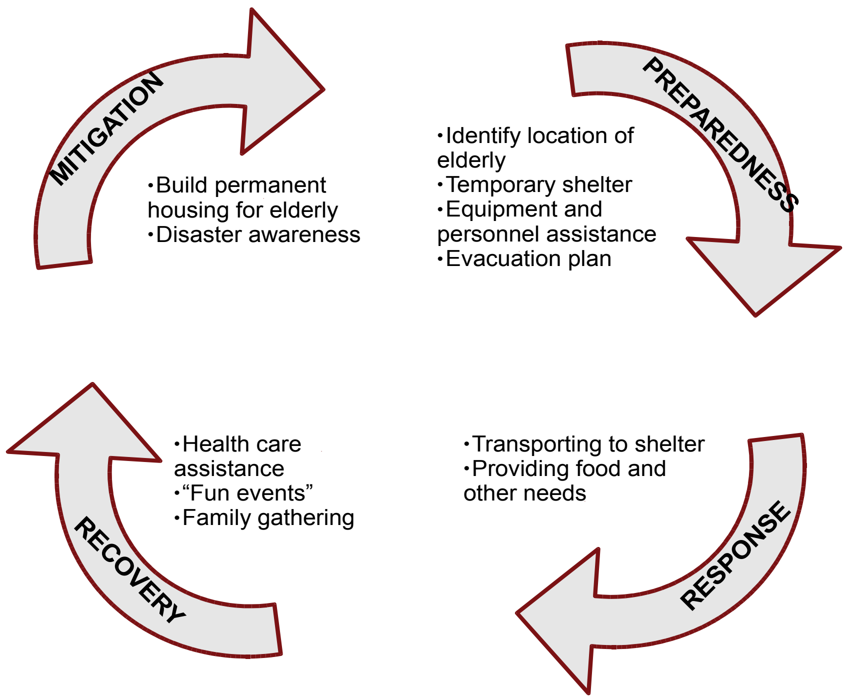
Photo 6: Dr. Anond Snidvongs and Mr. Sumran Klinard (the previous Tha Chalom community leader)

Day 5

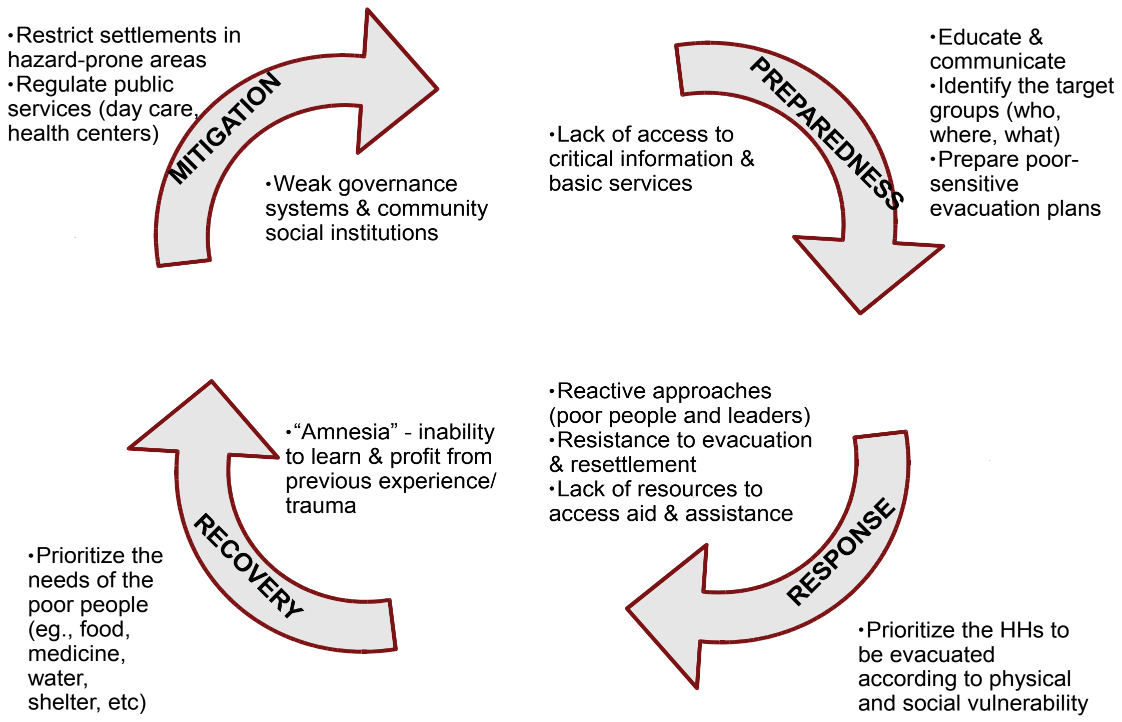
Day 5 continued with the social vulnerability assessment led by Dr. Goosby and Dr. Finch, focusing on GIS and demographic data, an overview of the Social Vulnerability Index (SoVI), demonstration of SoVI examples, and with opportunities for audience participation. During this session, emergency management cycles were drafted by the City Teams as illustrated below.

Emergency management cycles

JAKARTA TEAM — AGE (ELDERLY)

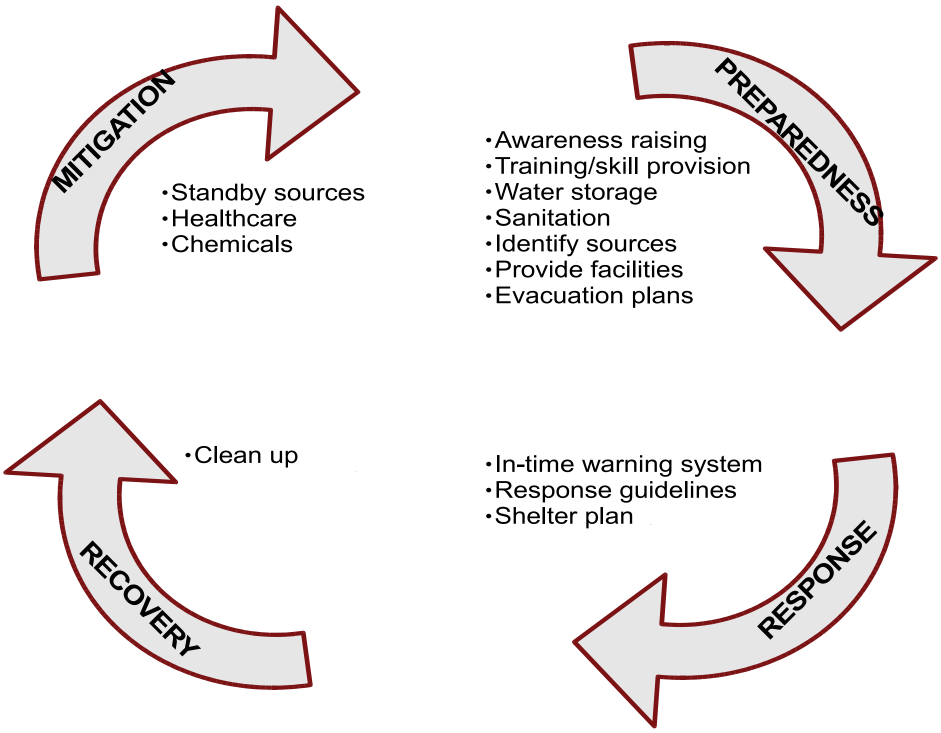


MANILA TEAM — POVERTY



HCMC TEAM

EDUCATION - FLOODING



BANGKOK TEAM

HEALTHCARE
(physical, mental disability)

- Handicap
- ♀ health
- Intellectual disability (information access)
- Access to healthcare
- Specialised recovery plan
- Re-construction (design for all)
- Job security + income
- Increase capacity of social institution (temples, schools)

- Infrastructure / design for all
- Evacuation plan
- Training the healthcare professionals / caretaker
  +
  the handicap (education)
- Proper equipment / tools (equal access)
- Affordable technology + equipment
-
- Sanitation for ♀ & children

- **PREPAREDNESS**
- **RESPONSE**
- **RECOVERY**
- **MITIGATION**

In the afternoon of Day 5, Dr. Joern Birkmann, from the United Nations University Institute for Environment and Human Security, gave a presentation on *Vulnerability assessment as the entry point to link disaster risk reduction and climate change adaptation for adaptive urban governance,* which included examples from the north (London) and south (Vietnam). The challenges for adaptive urban governance were summarized as the scale-dimension, normative-dimension, knowledge-dimension, and access-dimension. Subsequently, group work was assigned to participants to develop a questionnaire and criteria for adaptive urban governance. The detailed outputs from the City Teams are summarized as follows.

Ho Chi Minh City Team

1. Adaptation goals

Developing feasible strategies and adaptive capacity for minimizing CC impacts.

2. Measures

a) Define visions and objectives for adapting with CC
b) Identify major risks/vulnerability
c) Classify/categorize structural and non-structural measures of adaptation strategy.
d) Enhance HMR and governance system (decision-making process)

3. Evaluate

a) Adaptation strategies

- multi-sector policies
- multi-sector cooperation
- participatory approach

b) Adaptation measures

- feasibility of eco-socio
- technical feasibility
- effective reductions in damages/vulnerability

4. Questionnaire / criteria

- accountability
- transparency
- decentralize
- effectiveness
- participatory approach system

Jakarta

Questionnaire
Goals:

1. To reduce flooding areas
2. To reduce victims

Measures
1.1 Flood canals
1.2 Polder (embankment)
1.3 Dykes + sea wall
1.4 Mangrove conservation
1.5 Public education (i.e., waste disposal)
1.6 Upper stream reforestation
1.7 Increasing green area

2.1 Early warning system
2.2 Evacuation plan
2.3 Improvement of public awareness (CSO, NGO)(i.e., learning center)
2.4 Preparing rescue equipment
2.5 Zoning regulation enforcement
2.6 Building code enforcement

Key performance indicators
1. Decreased flooding areas gradually
2. Reduced number of victims significantly

Q1.1 Size of flood canals?
Area of coverage?
Operation and maintenance?
Q1.2 Number and location of polder?
Area of coverage?
O & M

Q1.3 Who are target group?
Methods of education?

Manila
Target: Decision-makers in MMDA and LGUs
MMDA: Metro-Manila Development Authority
LGU: Local Government Units

1. What are the major hazards/extreme events that you experience?
Climate/weather-related (e.g., extreme rainfall)
Geophysical (e.g., floods)
2. What are your adaptation goals
3. What have been the impacts of adaptation strategies to the cities (e.g., flood management in Kamanava)
4. What are the challenges and barriers to adaptation in the respective cities (e.g., institutional, political, economic, social, cultural)?
5. What are the existing and accessible data baselines/benchmarks for decision-making and monitoring?
6. What is the decision-support system?

Mumbai
Questions for local government/admins:
1. Is Mumbai vulnerable to regular extreme weather events of flooding due to heavy precipitation and how frequent would such events potentially be/ occur (readiness/ awareness)
2. If yes, has vulnerability / risk mapping been done for the city?
3. Are the potential vulnerabilities/risks articulated in an action plan?
4. What are the potential physical/social/eco vulnerabilities?
5. Are these communicated to the local admin depts?
6. Who is responsible for undertaking rescue/recovery operations?
7. Have the roles of different stakeholders been closely identified? If so, what are their roles?
8. What are the coping/adaptation strategies proposed/implemented by the local administration
9. Are these strategies regularly reviewed and does any feedback mechanism exist for evaluation/ revision?

10. How are stakeholders, particularly NGOs, community organisations and common people involved in formulation / revision of adaptation strategies.
11. Are the strategies focused on the city alone or due consideration is given to the urban, peri-urban areas surrounding the city?
12. Is there any exchange of information or participation of the local authorities in surrounding areas to formulate mitigation/adaptation strategies.
13. Is adaptation mainstreamed into development plan for the city? What is the time horizon of such a plan?
14. How are the strategies or the development plan inclusive of such strategies dealing with the most vulnerable/marginalized communities (slum dwellers/squatter communities).

Questions to the community:
1. What is your perception of vulnerabilities to weather events?
2. Which vulnerabilities can you identify in terms of physical location, built environment, livelihoods and health?
3. How have you coped in the past?
4. Outline your coping/adaptation strategies (local knowledge)
5. How would you perceive your relationship with local admin/elected representative?
6. Have you received timely help in the past? (rescue, relief, rehabilitation and developmental support)
7. What are the major vulnerabilities (eco and social) faced by your community which affect your coping strengths?
8. What kind of support (monetary/non-monetary) do you expect from your local administration to help you cope better?

Bangkok
FLOODING (→ SLR – Coastal community)

Protect:
1. Lives
2. Infrastructure
3. Livelihood
4. Cultural identity

Measures:		
Policy	**Physical**	**Social**
Evacuation and recovery plan Building codes Land use planning Early warning system	Dykes Canals Mangroves Sand sausages Sea walls Retentions Drainage system	Public awareness Relocation Re-settlement Strengthen community institutions

How to measure?
Define risks
Measure the impacts of the measures?

Day 6

Day 6 commenced with the presentation by Ms Perlyn Pulhin, from the Asia-Pacific Network for Global Change Research (APN), describing APN's global change research and capacity building activities in the Asia-Pacific region. An account of APN's history, membership, and major activities (ARCP, CAPaBLE, Science-policy linkages) were given. Types of activities eligible for ARCP funding includes new research addressing key knowledge gaps, synthesis/analysis of existing research, and generation of policy products (e.g., climate models, impact assessments). CAPaBLE funding supports activities addressing capacity development, scientific policy, raising awareness, and dissemination activities. APN supported projects under the *Scientific Capacity Building for Impact and Vulnerability Assessments* programme includes the initiative supporting this workshop - *Cities at Risk - Developing Adaptive Capacity for Climate Change in Asia's Coastal Mega Cities* .

Subsequently, City Teams gave presentations on their plans for future research. Key outputs from this section are presented in section 3 and Table II in Appendix 3.

In the afternoon, a presentation on *Visioning and participatory process* was given by Dr. Hassan Virji. Sustainable adaptation and the Bangkok visioning exercise were discussed, highlighting outcomes including a 'mobilized and active civil society process in Bangkok led by the Bangkok Forum' and 11 city representatives (from Manila, Hanoi and Bangkok) trained as knowledge facilitators. The IDRC/Research Council (Canada) proposal was also discussed, identifying key issues including investigating CC drivers and development context; action research effort; resilience focus; and the three track approach – visioning-development, resilience framework, and strategic partnering context.

The latter proposal was further elaborated by Dr. Gordon McBean (Director/ Policy Studies, Institute for Catastrophic Loss Reduction, Departments of Geography and Political Science, Social Sciences Centre, University of Western Ontario). The proposed project - *Coastal Cities at Risk (CCaR): Building Adaptive Capacity for Managing Climate Change in Coastal Megacities* - is a five year project with the overall objective 'to develop the knowledge base and enhance the capacity of mega-cities to successfully adapt to and when necessary cope with risks posed by the effects of climate change, including sea level rise, in the context of urban growth and development.' Four cities were selected for the study - Bangkok, Lagos, Manila and Vancouver – with opportunities for other cities to participate at workshops. Key research themes include: 'characterization of vulnerability and risk; characterization of hazards; understanding decision making; city system dynamics risk simulator; response strategies leading to knowledge-based actions; knowledge transfer and capacity building.' The decision on project approval will be made in January 2011, with April 2011 the likely start date.

Closing Session

Dr. Snidvongs and Dr. Fuchs thanked the participants, presenters, sponsors and staff for making this such a successful workshop. Dr. Fuchs reiterated how the participants of the Cities at Risk programme could really make a difference with regard to improving the management of climate change impact, highlighting the limited work in this urban field and future research opportunities such as the substantial project supported by the IDRC/Canadian Research Tri-Councils.

Participants of Cities at Risk Workshop, Nakhon Pathom, 22-28 August 2010

Appendix 6: City Reports

[see PDF files on enclosed CD]

Bangkok City Report

Hutanuwatr K (2010) A Preliminary Review on Frameworks for Thai Climate Risk and Approaches in Social/ Economic Vulnerability Assessment in Bangkok.

Yila JO (2010) Gender Perspective on Climate Change Risk and Vulnerability.

Salamanca A (2010) Climate Change and Migration.

Marome WA, Suwanarit A, Tiampayothorn R, Chenvidyakarn T (2010) Urban Development Perspective on Climate Change Risk and Vulnerability: Landscape Urbanism, Landuse Plan and Informality Economy and Settlement.

HCMC Report

Vo Le Phu, Le Anh Duc, Dang Van Khoa, Lam Vu Thanh Noi (2010) Climate Change Vulnerability Assessment and Urban Development Planning in Ho Chi Minh City, Vietnam.

Jakarta City Team

Surbakti IM, Idroes IC, Simarmata HA, Firman T (2010) Jakarta City Report. Information related to Climate Change in Jakarta City.

Manila City Report

Porio E, Loyzaga AY, Vicente C, Perez R, Narisma G, Olaguer D, Muto M, Cartagena R (2010) Climate Change Related Risks and Adaptation Potential in Metro Manila.

Mumbai City Report

Patankar A, Patwardhan A, Andharia J, Lakhani V (2010) Mumbai City Report.

Appendix 7: City Report Presentations

[see PDF files on enclosed CD]

Appendix 8: City Research Proposal Presentations

[see PDF files on enclosed CD]

Appendix 9: Funding sources outside the APN

Contribution from Ibaraki University:	5,000 USD
Funding from APN:	45,000 USD
Total support:	50,000 USD

Appendix 10: Glossary of Terms

ADB: Asian Development Bank
APN: Asia-Pacific Network for Global Change Research
BMA: Bangkok Metropolitan Administration
BMR: Bangkok Metropolitan Region
CAPaBLE: Scientific Capacity Building and Enhancement for Sustainable Development in Developing Countries programme (APN)
CAR II: Cities at Risk workshop II
CC: Climate Change
EWC: East West Center
GIS: Geographic Information System
HCMC: Ho Chi Minh City
IPCC: Intergovernmental Panel on Climate Change
JICA: Japan International Cooperation Agency
LGUs: Local Government Units (Manila)
LIDAR: Light Detection and Ranging
MMDA: Metro-Manila Development Authority
NDCC: National Disaster Coordinating Council (Philippines)
OECD: Organisation for Economic Co-operation and Development
SEA START RC: Southeast Asia START Regional Center
SLR: Sea level rise
START: global change SysTem for Analysis, Research and Training

A Preliminary Review on Frameworks for Thai Climate Risk and Approaches in Social/Economic Vulnerability Assessment in Bangkok

Prepared by Khanin Hutanuwatr, Ph.D.

"Governance and social justice issues, institutional, jurisdictional and social conflicts, etc. that may worsening climate related issues?"

Issues in integrated framework and inter-institutional and jurisdictional links

For the last five years, literature in the field of disasters indicates the pressing needs for integrating three domains of research and policy communities: climate change adaptation, disaster-risk/ vulnerability reduction, and development (e.g. Mercer, 2010, Label, 2009; Parnell et al., 2007; Schipper and Pelling, 2006). The three domains are highly related but conventionally work separately in many cases (Thomalla et al. 2006). The separation of the three domains may worsen climate-related issues. Institutional linkage is one of the key challenges for such integration.

At the national policy level, there are integrated efforts, but we do not know much at the city level. Climate change is now one of key components of the Thai National Social and Economic Development Plan in which staff from Department of Disaster Prevention and Mitigation serves the committee of the climate change adaptation planning. However, it is unclear to what extent the adaptation plan takes vulnerability perspective into account. It is argued that the field of vulnerability can be significant contribution from disaster research communities to investigate human dimension of climate change (Ford et al. 2010; Helmer and Hilhorst, 2006). The lack of vulnerability perspective in efforts for climate change adaptation may miss the opportunity to address issues at their root causes (Thomalla, et al. 2006).

At the city level, the Bangkok 5-year Action Plan for Climate Change identifies communication among different sectors. This strategy could lay ground for the integrated framework. Other strategies of the plan are involved with development and disaster preparedness, but according to the preliminary reviews, the plan paid little discourse on vulnerability reduction (EEPSEA, 2008; BMA, GLF, and UNEP, 2009).

Despites the above efforts, the issues of inter-institutional links were raised in meetings regarding climate change and planning observed in Bangkok during 2010 by a few agencies, including those under Bangkok Metropolitan Administration. The need for inter-institutional linking mechanism for climatic related planning was identified. This is consistent with the literature indicating that institutional structure is one of the key challenges for the integrated framework (Schipper and Pelling 2006).

For general public, Bangkok may have unique characteristics of collaborating and coordinating culture. Some evidences demonstrate the potential of ad-hoc, urgent, and short-term collective actions regardless of scale such as the city-clean up activities in down town areas after recent political crash. However, it is said that long-term commitment can be critically challenging. This may impact the nature of inter-institutional collaborative efforts. Other factors such as communication culture, perception of collaborative projects, and skills required for teamwork may be additional explanatory attributes.

Interestingly, National Food Insecurity and Vulnerability Information and Mapping System (FIVIMS) Thailand located in Bangkok is able to run the inter-agency network to conduct food insecurity assessment. The network is called The Inter-Agency Working Group on Food Insecurity and Vulnerability Mapping Systems (IAWG-FIVIMS). It can be an interesting model for lessons learned.

"*Have social/economic vulnerability to climate related risks have been assessed and/or mapped, how, by whom, details?*"

There are studies related to social and economic vulnerability to climate related risk. They vary in frameworks and methods initiated by different agencies as summarized in Table 1.

Table 1. Studies related to social/economic vulnerability to climate risk in Bangkok

	Key assessment concepts	**Results**	**Agencies**
FIVIMS, Thailand (FIVIMS Thailand, 2004)	ADDATI software, using 37 indicators such as GNP, household income, food price index, volume of food production, under weight population etc.	Bangkok Metropolitan Region is least vulnerable to food security compared to the whole country while most vulnerable provinces are mostly located in the north-east and the north regions.	FAO, UN National FIVIMS Secretarial Center for Agricultural Information, Office of Agricultural Economics, Ministry of Agriculture and Cooperatives
EEPSEA's assessment (Anshory Yusuf and Franciso , 2009)	UNIPCC framework Overall vulnerability= f(multiple hazard map*human and ecological sensitivity*adaptive capacity) Human sensitivity= population density Adaptive capacity= socio-economics, technology, and infrastructure Socio-economics= f (Human Index*Poverty Incidence*Income Inequality) Human Index= f (Standard of living*longevity*Education) Weight is assigned by experts' opinions	Bangkok is : medium-high climate-vulnerability, high multiple climate hazards, high human sensitivity, and high adaptive capacity	EEPSEA
Flood Vulnerability to the rise of sea level (Dutta, 2007)	scenario approach. Impacts= f (loss function* Scenario of inundation) Loss Function= f(Scenario of urbanization* socio-economic database)	The results show in the form of percentage of impact areas regarding to 3 inundation scenarios.	Monash University, Australia

The World Bank Climate Change Impact and Adaptation Study for Bangkok Metropolitant Region Panya Consultant Co. Ltd. 2009)	Unclear methods Most focuses are on physical aspects, but one dimension is on "in-come losses"	Daily wage earners in condensed communities located in low-elevation areas are identified of vulnerable groups for losses of income. Spatial distribution of these vulnerable groups are provided.	Private consultant firm. The World Bank

EEPSEA's assessment and FIVIMS applied multi-geographical approach at national and multi-national scales. This approach usually aimed at comparing and ranking level of vulnerability across geographical scale. While flood vulnerability assessment is conducted at the city scale, it seems to aim at identifying threshold and spatial impacts.

According to Eakin and Luer (2006)'s classification of vulnerability assessment of socio-environmental systems, it appears that most assessments of Bangkok's vulnerability applied mapping, ranking and comparing vulnerability approach relying on quantifiable indicators. This approach tended to treat vulnerability as attributes rather than underlying social process. Objectivity and availability of database of these measures are among key preferences of this approach. Challenges in this approach are the lack of process dimension, limitation from relying on available database, comprehensiveness of indicators, subjectivity in indicators selected, and the rigidity of weight assignment, and insensitivity to context-base vulnerability (Hutanuwatr, 2009;Eakin and Luer, 2006; Turner et al. 2003). It is not surprising that in Economic and Social Survey of Asia and the Pacific 2008, for example, United Nations vulnerability index are subjected for improvement such as the inclusion of wars and political unrest into its framework (UNESCAP, 2008).

While there are only a few vulnerability studies on process-oriented, qualitative and place-based approach (if any), studies on marginal groups such as informal sectors or slum dwellers in Bangkok (e.g. Nirathron, 2009) can inform vulnerability studies in this approach. However, the link to climate-related risk is needed.

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Gender Perspective on Climate Change Risk and Vulnerability

Prepared by Jummai O. Yila

"*Have social/economic vulnerability to climate related risks have been assessed and/or mapped, how, by whom, details?*"

A variety of technical studies have been undertaken that outline likely impact scenarios, (ONEP, 2008; World Bank, 2008; World Bank, 2007; World Bank, 2008b; World Bank, 2006; Institute of Development Studies, 2007; Greenpeace, 2006; BMA, 2007). The main potential impacts and vulnerability identified in these studies are:

> (i) Mean temperature increase 3-3.5% by 2100 about one million people will be affected by a 30 year flood in 2050. Of these, one-third (330,000) will be affected by half meter flooding for at least a week.
>
> (ii) Buildings will be the most affected structures. More than one million buildings might be damaged by such a flood, causing over $3 billion USD damage (2008 prices).
>
> (iii) Water supply, sanitation, public health, energy, and transportation infrastructure will be minimally affected. This is both because much key infrastructure is in protected areas (the core city), and many systems, particularly those built since the 1995 flood, are designed to withstand significant flooding. For example, MRTA subway stations are raised and the new Suvarnabhumi International Airport international airport, despite being on land that was below sea level twenty years ago, was constructed on land fill raising its elevation several meters.
>
> (iv) There would likely be significant increases in diseases and accidents associated with flooding and temperature rise, of special concern is dengue fever, but other risks include salmonellosis, electrocution, drowning, etc.

Knowledge status and research gaps:

Exposure unit Places, sectors, activities, Individuals, households, social groups, communities, livelihoods are not factored in these assessment

"Current perception of climate change related risk (such as floods, water and food supply, land losses, air quality, heat stress, disease outbreaks, etc.) and social/economic vulnerability (such as poverty, investment, capital and opportunity losses, social conflicts and divides, genders, justice, etc.) in your city, e.g., how do they perceive on the differences and linkages between weather/climate risks and social/economic vulnerability?"

- ***Among general public***
- ***Among urban officials, city managers***

As per the current perception of climate change and related risk, it seems there has been an over emphasis on flood related risk than any other both among the general public and the urban officials/city managers. Among the general public however, especially within natural resource dependence communities, flood is perceived as part of the natural cycle where tolerance and acceptance level is very high, hence shaping behavior and coping strategies

For gender and justice issues, most vulnerability assessment focused mainly on physical and/climatic aspects of vulnerability, little attention or studies give consideration to the non climate factors that exacerbate individual or household vulnerability which if ignored in city planning would render successful planning or policy problematic.

Secondly, Bangkok/Thailand national assessment did not capture the influence of processes operating on all these scales. There is an inevitable tension as vulnerability is best defined at a point, at a particular location in space or within the community, and any aggregation to the national level can result in a loss of information, for example how people and places are affected differently, what explains differential capacities to cope and adapt and the causes and consequences of differential susceptibility?

Therefore vulnerability is moderated by existing inequities in resource distribution and access, the control individuals can exert over choices and opportunities, and historical patterns of social domination and marginalization

Climate Change and Migration

Prepared by Albert Salamanca, PhD

Among the issues related to the social impacts of climate change, migration and other forms of mobilities are the some of the least understood and discussed. Bangkok's economy has, for a long time, been dependent on labour sourced out from the countryside. The industries located in coastal provinces Chonburi, Samut Prakarn, and Samut Sakorn, which are also vulnerable places to the impacts of climate change, rely heavily on labour supply coming from adjacent provinces and the northeast. Through remittances, the economic well-being of these provinces has been sustained. Any disruption, therefore, on the demand of labour and a reduction in income possibly through the closure of factories, decline in profit and transfer of industrial production elsewhere will have material impacts on the households dependent on these remittances.

Another aspect wherein coastal urban areas may be affected by climate-induced vulnerabilities is through the movement of people displaced from provinces where farming productivity declines due to weather disturbances such as prolong drought. These people in search of a better income will seek opportunities in the city thereby increasing the ranks of the unemployed and burdening social services. Moreover, the impact of climate change on workers who commute daily to work in these provinces need to be assessed. The severity of extreme weather events driven by climate change may affect their pattern of work and living when transport infrastructures are disrupted. This will have costly implications also to companies who rely on this labour as work stoppages due to absence will affect their productivity.

On a related matter, some of the attractions for companies to locate in the Eastern Seaboard are the benefits expatriate staff receive in terms of proximity to international schools for their kids, hospitals, entertainment venues, restaurants, and other business support services, to name a few. Such proximity is underpinned by mobility. That is, the ability to reach these places within a reasonable duration. Climate-induced variability can potentially alter the attractiveness of the BMR for international companies to base their operation here by limiting access to these services. Roads may be blocked due to flooding or congestion will become an everyday reality.

We, therefore, need to understand how urban and rural areas are linked by migration and the 'tipping-point' with which migration due to climate-induced variability is activated as a livelihood strategy. We also need to understand how other forms of mobilities may be affected. We need to ask what lessons can we learn from existing anticipatory, autonomous, and planned adaptation mechanisms to adjust to extant natural hazards in coastal urban regions in the BMR. Given these lessons, how do we infer future adaptation mechanisms to the increasing severity, frequency and exposure to natural hazards caused by climate change.

Urban Development Perspective on Climate Change Risk and Vulnerability: Landscape Urbanism, Landuse Plan and Informality Economy and Settlement

Prepared By Wijitbusaba Ann Marome, PhD, Asan Suwanarit, Rachaniporn Tiampayothorn, Torwong Chenvidyakarn, PhD

"Have various climate risks to your city have been assessed and/or mapped, and if so do they take into account possible effects of current and future climate changes?"

Climate change related risk	Assessment	Mapped	Agency and Institution
1. Floods	<u>Rain water</u> Faced with seasonal monsoon rains and daily tidal fluctuations, greater Bangkok now faces the threat of catastrophic flooding each year. From May to October the combination of elevated river flow from the Chao Phraya basin and rapid local runoff often puts many sections of the city and its environs under water. And when a high tide slows the flow of the river, it is impossible to drain the city without the help of floodwalls and pumping stations. <u>River flow, tidal surge, and sudden torrential rain</u> have prompted some to refer to Bangkok as "the city of three waters." (i) <u>Rising seawater + Land subsidence</u> The city also suffers from land subsidence, caused by over-pumping of groundwater and the thick soft clay on which the city is built. Each year, parts of the city sink by 5-10 mm and by as much as 30 mm in outlying southeastern and southwestern areas. This subsidence, when combined with a rising sea level could leave Bangkok under 50-100cm of water by 2025. (ii)	Statistic: Meteorological data of Bangkok metropolis Map: Land subsidence rate of Bangkok in 2002 (a) and in 1981 by Phien-wej et al., 2006. (iv)	Dept. of Meteorological

	The simulated outcomes of the flood model used in the study indicate that almost 55 per cent of Bangkok would be affected by floods if the mean sea level were to rise by 50cm, and 72 per cent of the city would be affected if the mean sea level were to rise by 100cm. (iv) The maximum subsidence is now occurring in outlying areas of Bangkok in the southeastern and southwestern industrial zones, where the phenomenon is taking place at the alarming rate of 30 mm per year. Land subsidence not only causes damage directly, but it also intensifies the impacts of flooding while threatening human life and property. In the Chao Phraya River delta, the risk factors are greater than in most other coastal cities due to land subsidence. (iv) The shortened time lag from a torrential rainfall to flooding is a result of the increased number of impermeable areas in this catchment basin. A concentration of flood flow waters and the transmission of the peak of flood discharge has been accelerated and aggravated flood disaster. (V) Inundation damage is also caused by local rainfall in the plain. Man-made structures, such as roads, dikes and irrigation equipments prevent in the lower plain from draining away. These conditions account for increase in flood-prone areas. (V)		
2. Water supply	Most of Bangkok's water supply (91%) comes from the Chao Phraya and Mae Klong rivers. <u>Climate change will affect the flow of waters</u> in the two rivers, affecting the city's water supply. Increasing demand for water as temperatures rise, from households and industries may further exacerbate this projected change in water supply. Since Bangkok is expected to continue to grow over the next 10 years, the problems of		

	water supply and contamination of both surface and ground waters may worsen. (ii) The Metropolitan Waterworks Authority (MWA) supplies about 4.65 million cubic metres (Mm3) of purified water per day to residential, industrial and commercial users in Bangkok, using surface water withdrawn from the Chao Phraya and Mae Klong rivers. This represents 91 per cent of the city's total demand (BMA, 2006); the remaining 9 per cent (about 0.5 Mm3/day) is met by extraction of water from deep wells (Polprasert C., 2007). (iv) The effects of global warming have caused the river flows in Thailand to be unreliable, with too high or too low flow rates during the rainy and dry seasons, respectively. Increasing demand may further exacerbate the projected changes in water supply. (iv)		
3. Heat island	The change in land use effects to Bangkok's temperature to be higher than the suburb by 2ºC. From 1956 –1997 the Bangkok's lowest temperature increased by 2ºC. (iii) Bangkok and its suburbs are already experiencing more severe and frequent flooding and more days with temperatures above 30ºC. (ii) A study by the Department of Meteorology on the variations in maximum and minimum temperatures in Bangkok during the previous 10 years, compared with long-term averages, found that from 1991 to 2000 the maximum average temperature in the summer months was significantly higher than the long-term average. Conversely, the lowest temperatures in the winter months were warmer than the long-term average (Department of Meteorology, 2008). (iv)	Statistic: Meteorological data of Bangkok metropolis	Dept. of Meteorological

	Figure 2.2 clearly illustrates that the observed annual mean temperatures in Thailand between 1981 and 2007 are increasing. Overall, the temperature rises demonstrate an upward trend during the same period. Annual mean minimum and maximum temperatures from 1951 to 2005 are shown in figures 2.3 and 2.4, which also show a rising trend. (iv) In urban Bangkok, the number of days exceeding 35 C is rising (see figure 2.9). The impacts of climate change on Bangkok have thus become increasingly visible and have been the subject of serious concern among residents since 1967, as they experience increasingly hotter weather (Department of Meteorology, 2008). (iv)	Statistic: Meteorological data of Bangkok metropolis, 2008. Statistic: Meteorological data of Bangkok metropolis	Dept. of Meteorological Dept. of Meteorological
4. High salinity in river			
5. Coastal erosion	Thailand’s long coastline (a total of 2,615 km) makes it especially vulnerable to the effects of climate change. In this regard, the country’s capital and major port are especially at risk. A recent study ranking the cities of the world most exposed to coastal flooding today and in the future provide interesting insights into this vulnerability (OECD, 2007). The analysis indicates that by the 2070s almost all (90 per cent) of the total asset exposure of large port cities will be concentrated in only eight countries, one of which is Thailand (see figure 1.2). Thailand ranks sixth in terms of the severity of the projected effects. (iv)		

Initiative/ Plan for mitigation

1. Such policy dimensions are being integrated into the country's economic and social development plans. The first to undergo this process was the Seventh National Economic and Social Development Plan, covering the period 1992-1996 (MOSTE, 2000). These principles have also been incorporated into Thailand's environmental policies and plans. Currently, the Office of Natural Resources and Environmental Policy and Planning, under the Ministry of Natural Resources and Environment, is in the process of drafting a strategy to address climate change issues as they relate to Thailand. The strategy will outline the mechanisms and measures that will have to be undertaken by various agencies of the Government. Such measures will include those for reducing greenhouse gas emissions and enabling the country to adapt to the adverse impacts of climate change. These measures will be in addition to those incorporated within the country's five-year plans. (iv)

2. The Bangkok Declaration on the Cooperation of Alleviating the Global Warming. 36 Organizations jointly signed the Bangkok Declaration on the Cooperation of Alleviating the Global Warming on 9 May 2007 at the United Nations Conference Centre, Bangkok. (iii)

3. The Bangkok Metropolitan Administration has adopted the Action Plan on Global Warming Mitigation 2007-2012, which calls for it to: expand mass transit and improve traffic systems; promote the use of renewable energy; improve electricity consumption efficiency; improve solid waste management and wastewater treatment efficiency; and expand park areas. The Action Plan is aimed at bringing about a reduction in Bangkok's greenhouse gas emissions over a period of five years that will be15 percent below the levels currently projected for 2012. (iv)

Initiative/ Plan for adaptation

1. According to the report, approximately 900,000 people in Bangkok are currently at risk from flood events, and that number would increase to more than 5 million by 2070. The economic losses to the infrastructure that would be caused by such floods is estimated to be $39 billion currently, but are expected to grow to a staggering $1.1 trillion by 2070 (OECD, 2007). Although flood protection projects were established and improved after the two previous devastating flood events (Bangkok Metropolitan Administration, 2004), Bangkok is still at increasing risk of flooding, due partly to the effects of global warming and partly to rapid urban development. (iv)

2. The main flood barriers for Bangkok are dykes and walls built along the Chao Phraya River. However, land subsidence negates the efficiency of the city's flood defenses because the high-point of the dykes gradually sinks as the ground beneath these defenses subsides. Land subsidence also dramatically affects the efficiency of the sewer system and underground pipes built to rapidly eliminate rainwater, a situation which tends to aggravate the flooding of urban areas during the monsoon season and periods of very high tides. Further, it makes more difficult the process of draining the low lying areas of the city that are sinking, leading to the formation of stagnant water after flooding. (iv)

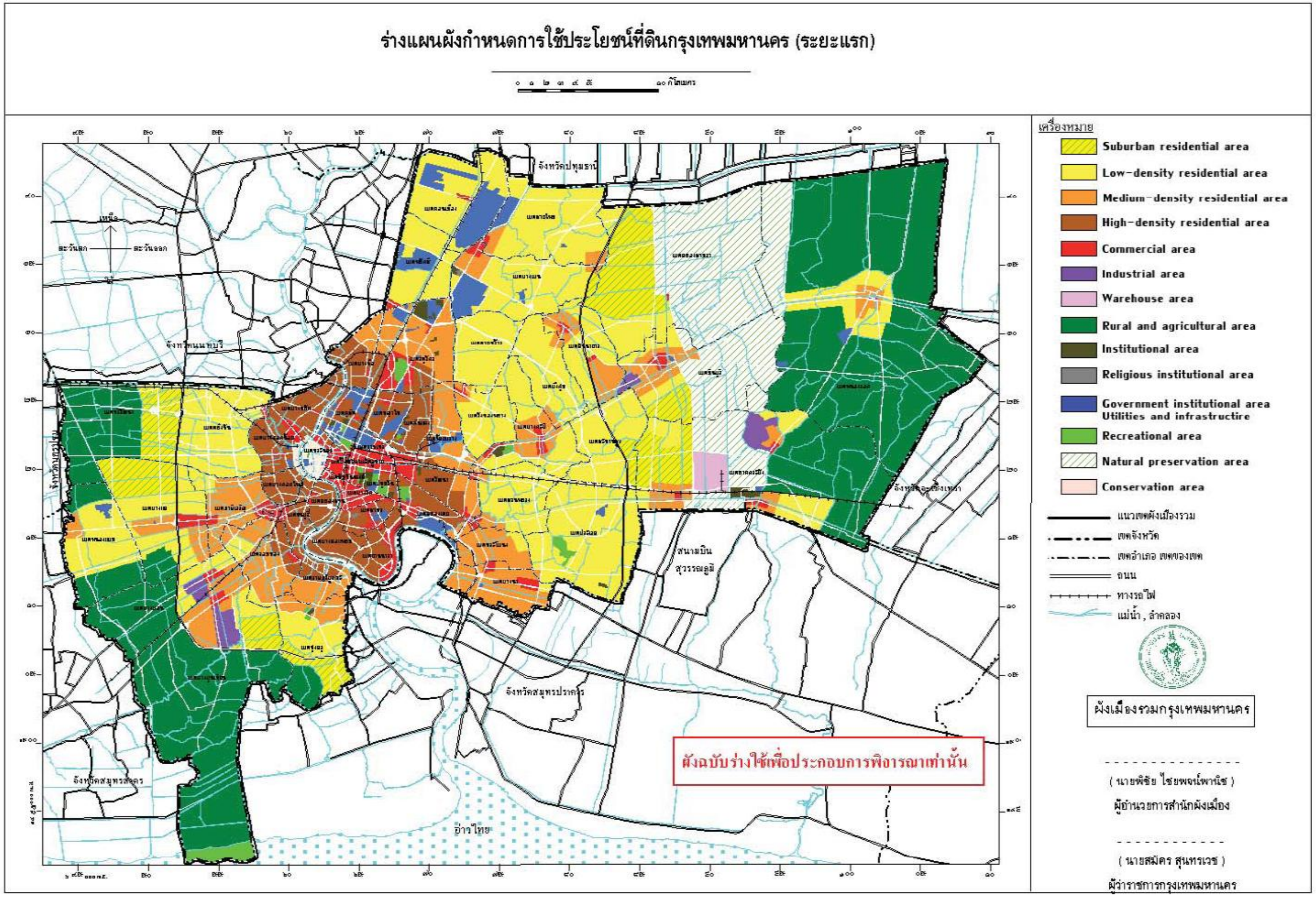
3. Since Bangkok is expected to continue to grow over the next 10 years, the problems of water supply and contamination of both surface and ground waters will also be exacerbated. By the end of the current century, increasing temperatures are expected to boost the demand for water for agricultural purposes between 2 and 13 times in the lower and medium warming ranges, respectively, as well as the demand for water for household purposes (California Environmental Protection Ageney). Some options that could be considered if Bangkok is to achieve a sustainable supply of water might include: the harvesting of rainwater, decentralizing the wastewater management system, increasing stakeholder participation and raising awareness among consumers about water issues (Polpraset C, 2007). (iv)

Notes:

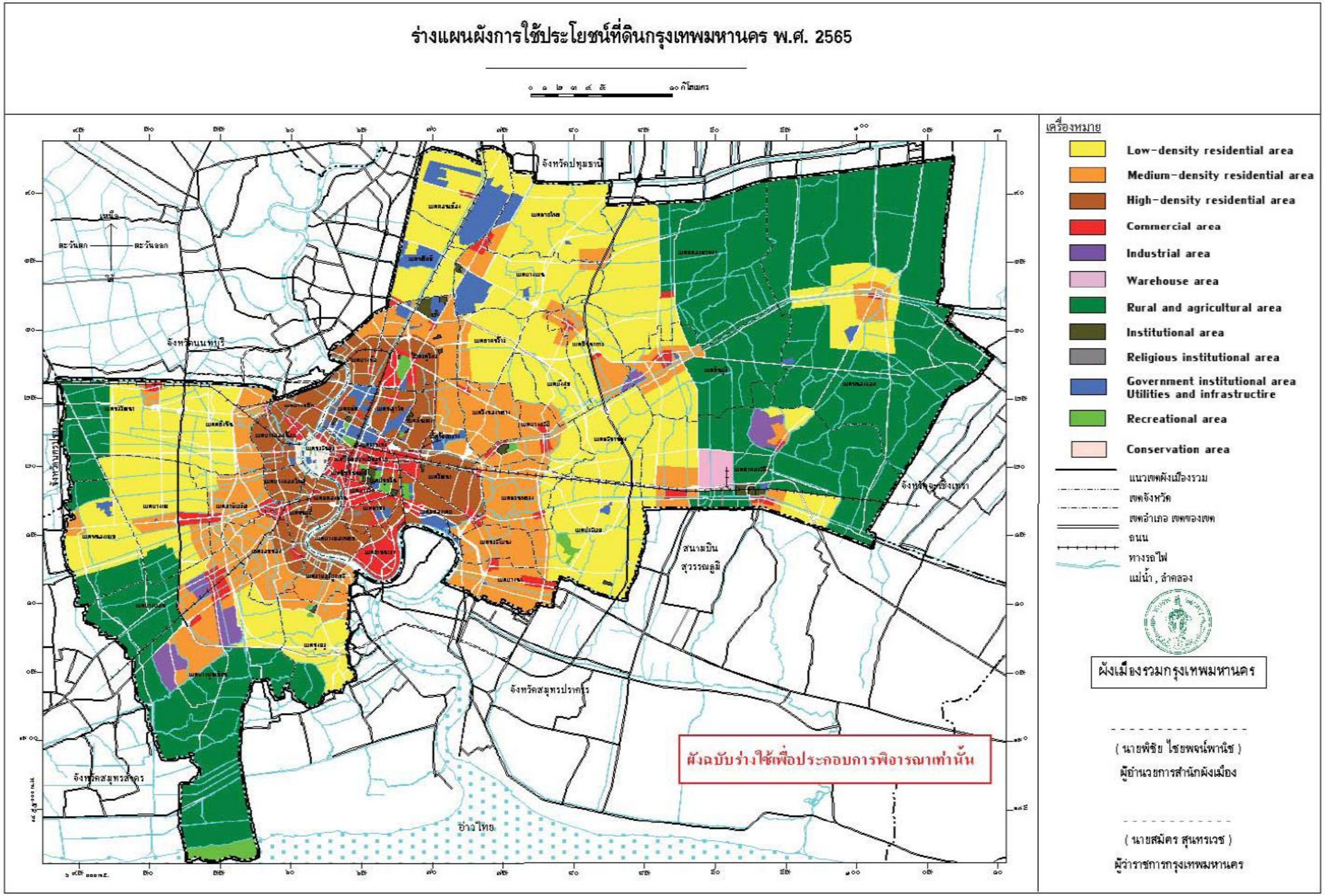
i. Brian McGrath and Danai Thaitakoo, "Changing Landscape, Changing Climate: Bangkok and the Chao Phraya River Delta," in Place.
ii. UNEP, Regional Office for Asia and the Pacific.
iii. Porntep Techapaibul, Deputy Governor of Bangkok, Climate Change Mitigation in Bangkok, September 25,2009
iv. UNEP, Bangkok Assessment Report 2009.
v. Shigeko Haruyama, Geomorphology of the central plain of Thailand and its relationship with recent flood conditions, GEO Journal, Springer Netherlands

“Is there an existing urban GIS information base that may be used for climate risk and vulnerability assessment? What is included?”
“Is there an urban master plan? When it was completed? Does urban master plan take into account future risk to climate change?”

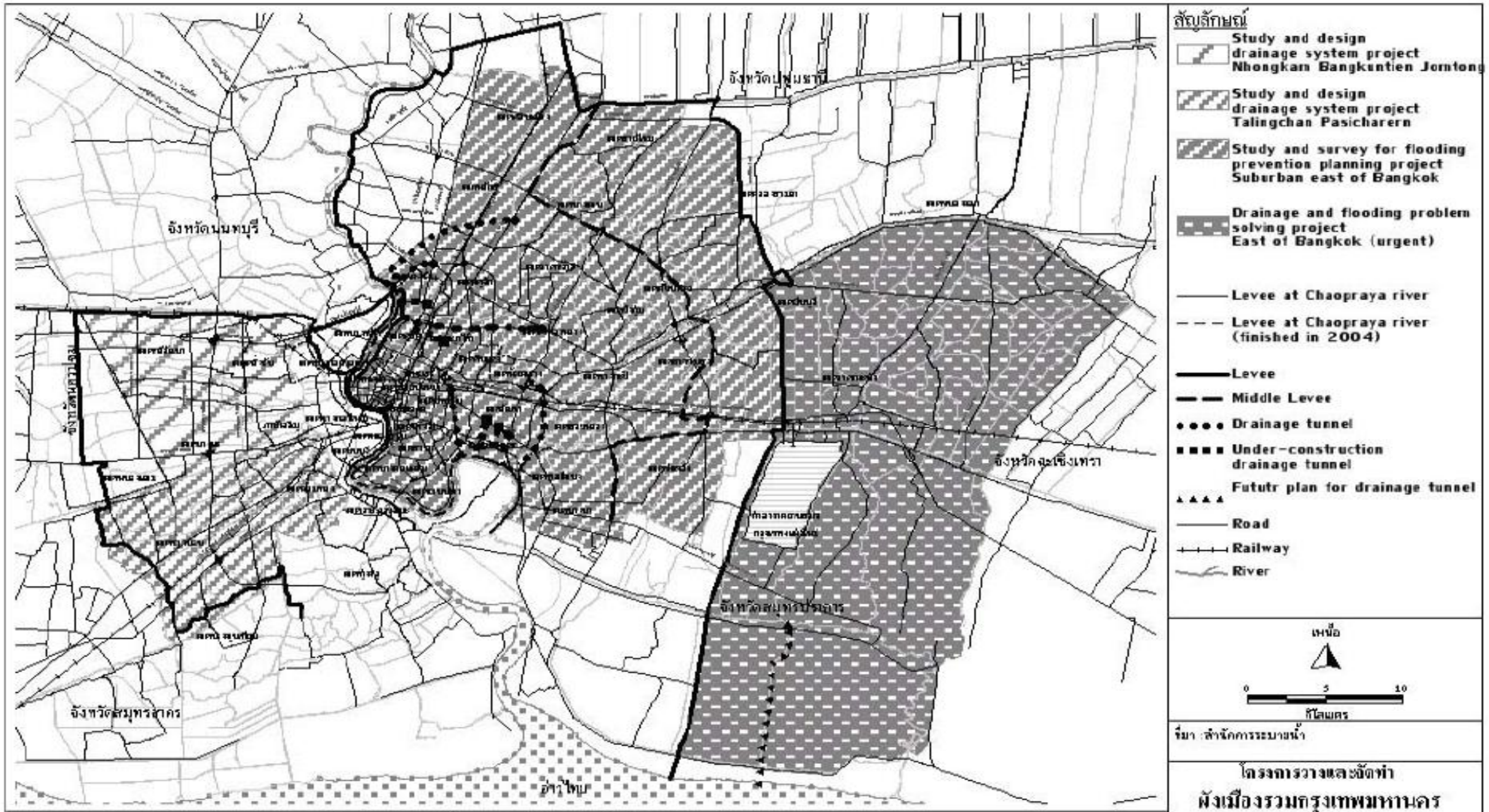
A Preliminary Review on Bangkok Master Plan (2nd revision) and its Climate Related Factor



Bangkok Comprehensive Plan (first phase)



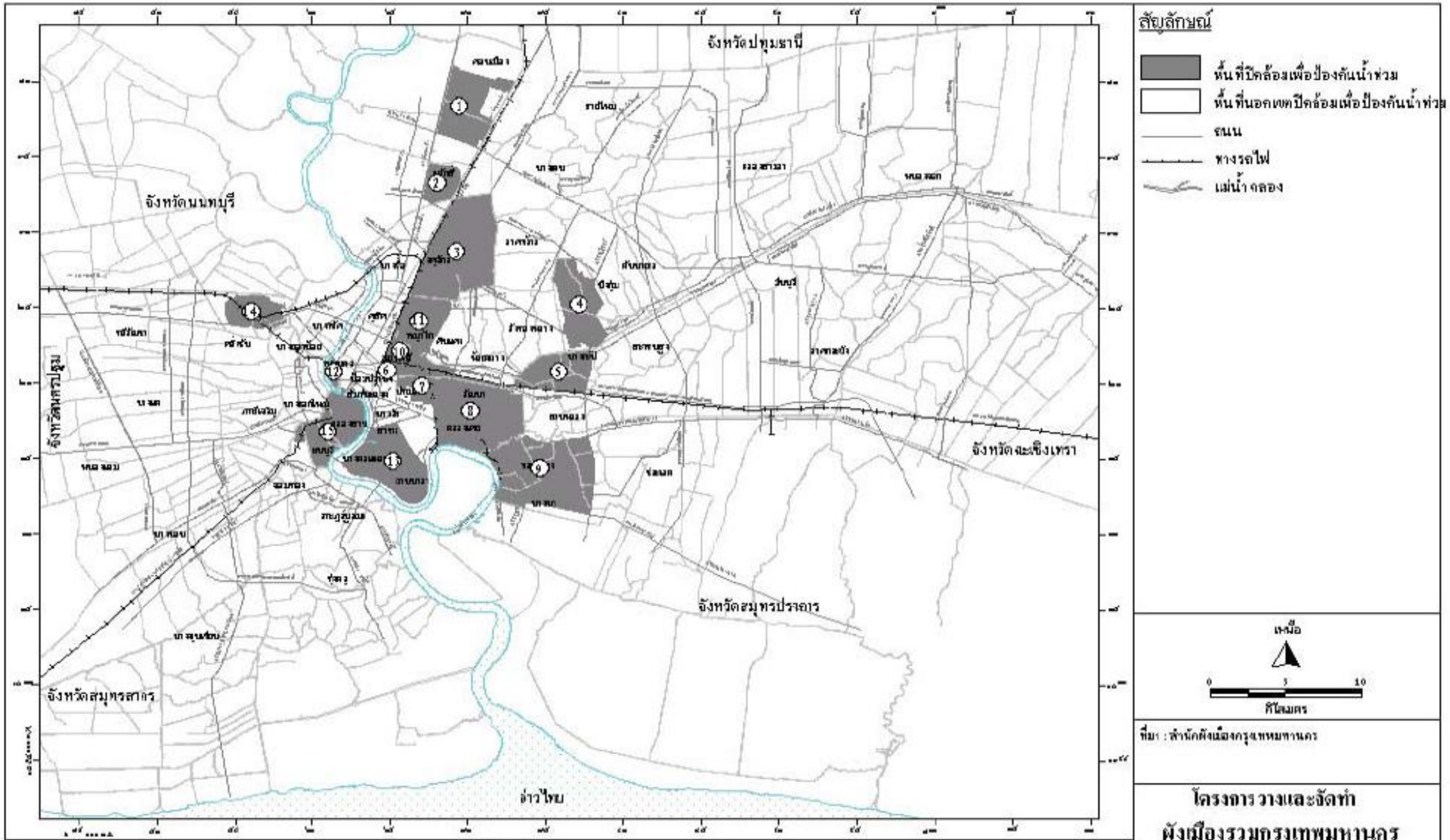
Bangkok Comprehensive Plan in 2022



แผนที่ 5.1 แสดงโครงการป้องกันน้ำท่วมของกรุงเทพมหานคร

บริษัท กรุงเทพธนาคม จำกัด

Map of Flooding prevention projects for Bangkok

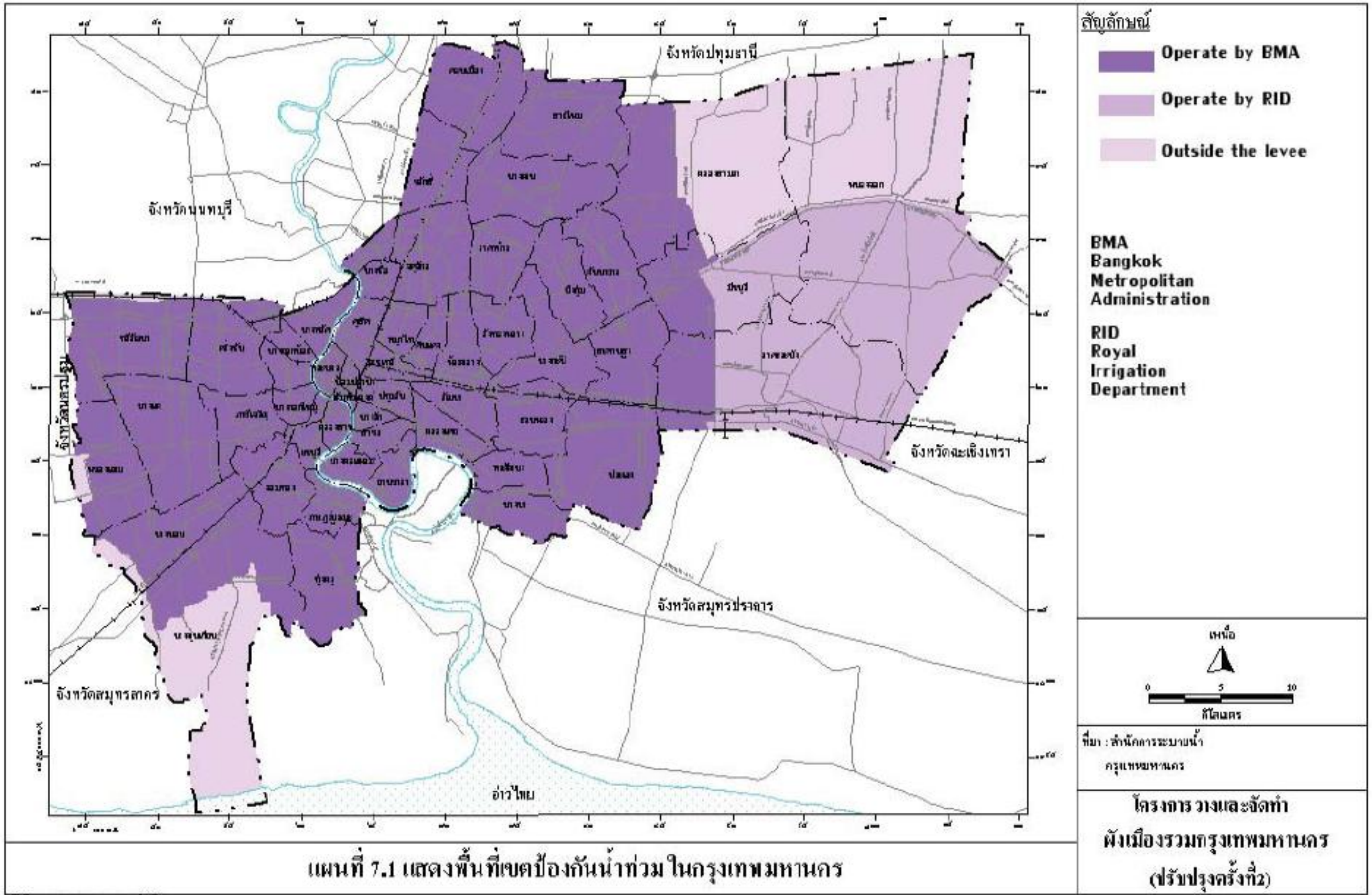


แผนที่ 5.2 แสดงพื้นที่ปิดล้อมเพื่อป้องกันน้ำท่วม

โครงการวางและจัดทำ
ผังเมืองรวมกรุงเทพมหานคร
(ปรับปรุงครั้งที่2)

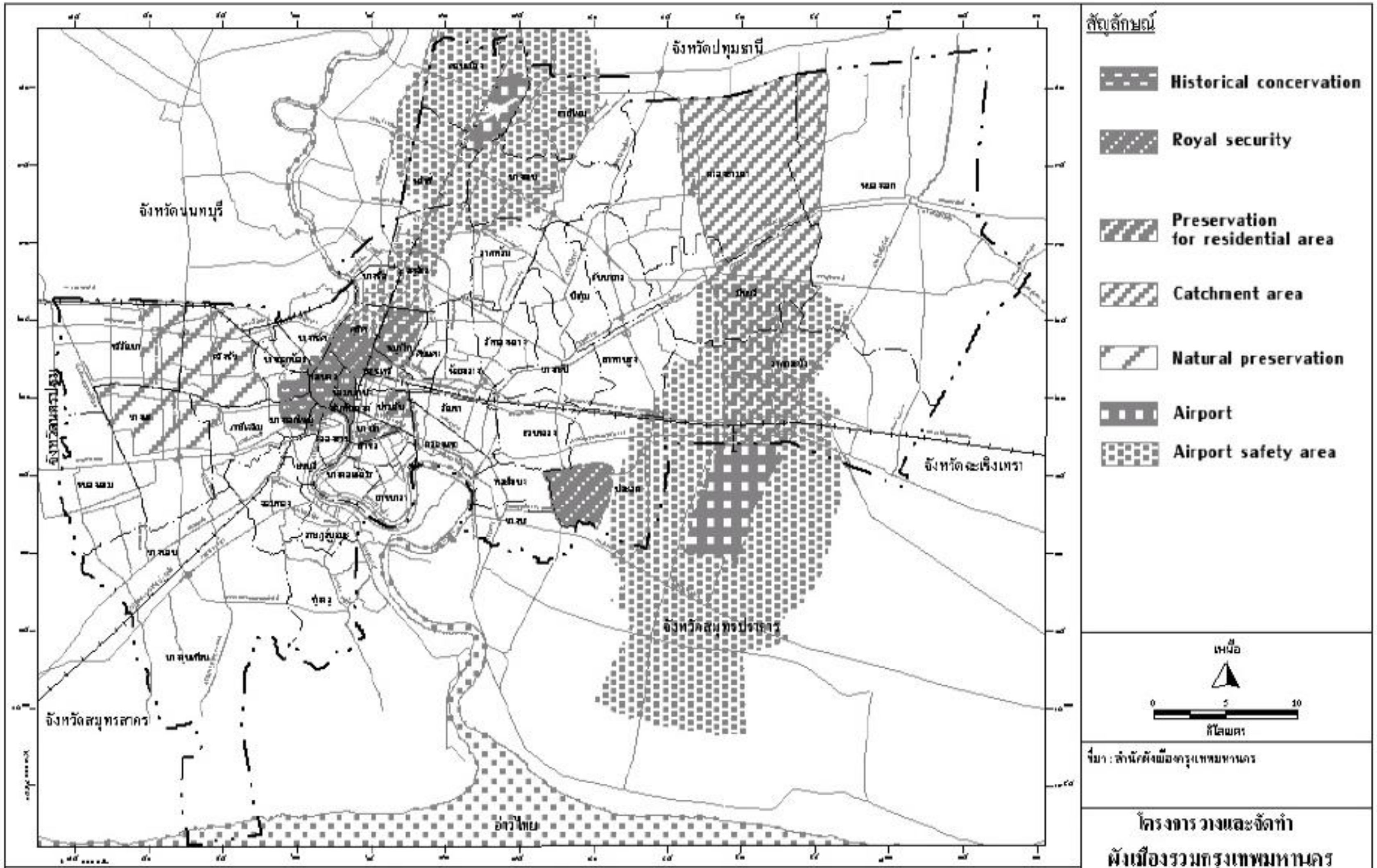
บริษัท กรุงเทพธนาคม จำกัด

Map of Enclosure area for flooding prevention



บริษัท กรุงเทพธนาคม จำกัด

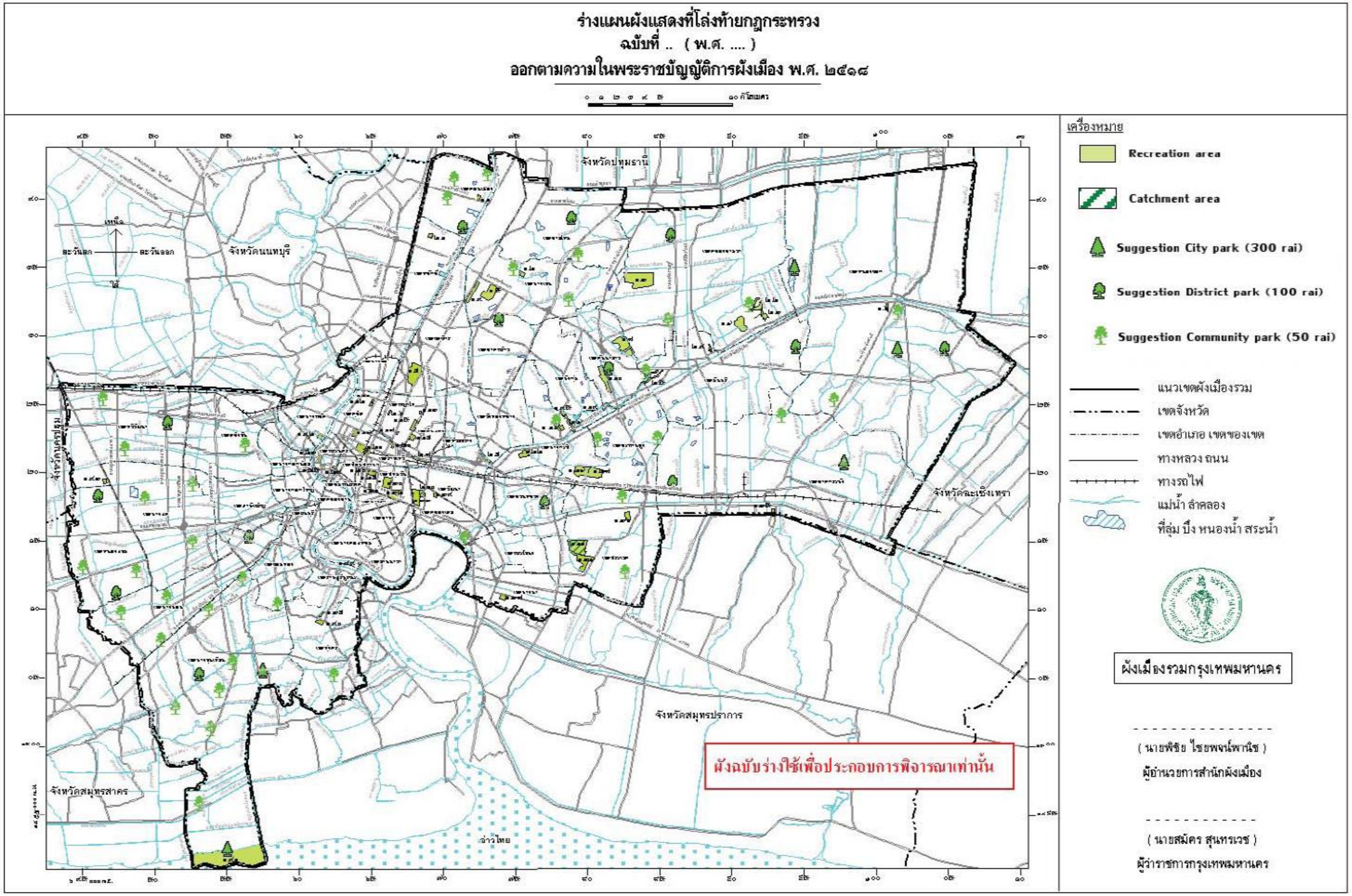
Map of flooding prevention area in Bangkok



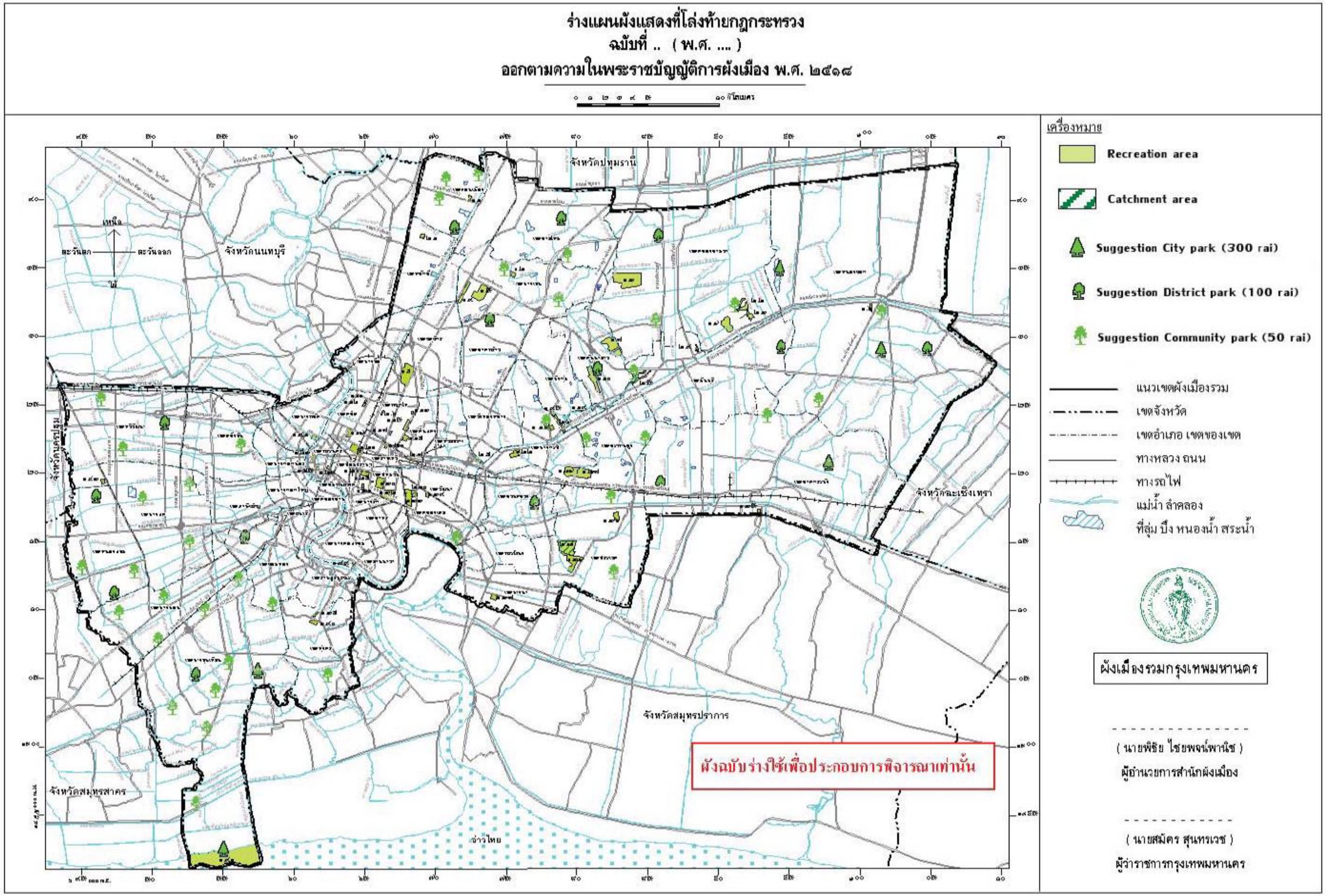
แผนที่ 7.10 แสดงบริเวณที่มีข้อจำกัดการพัฒนาเมือง

บริษัท กรุงเทพธนาคม จำกัด

Map of restriction in urban development area

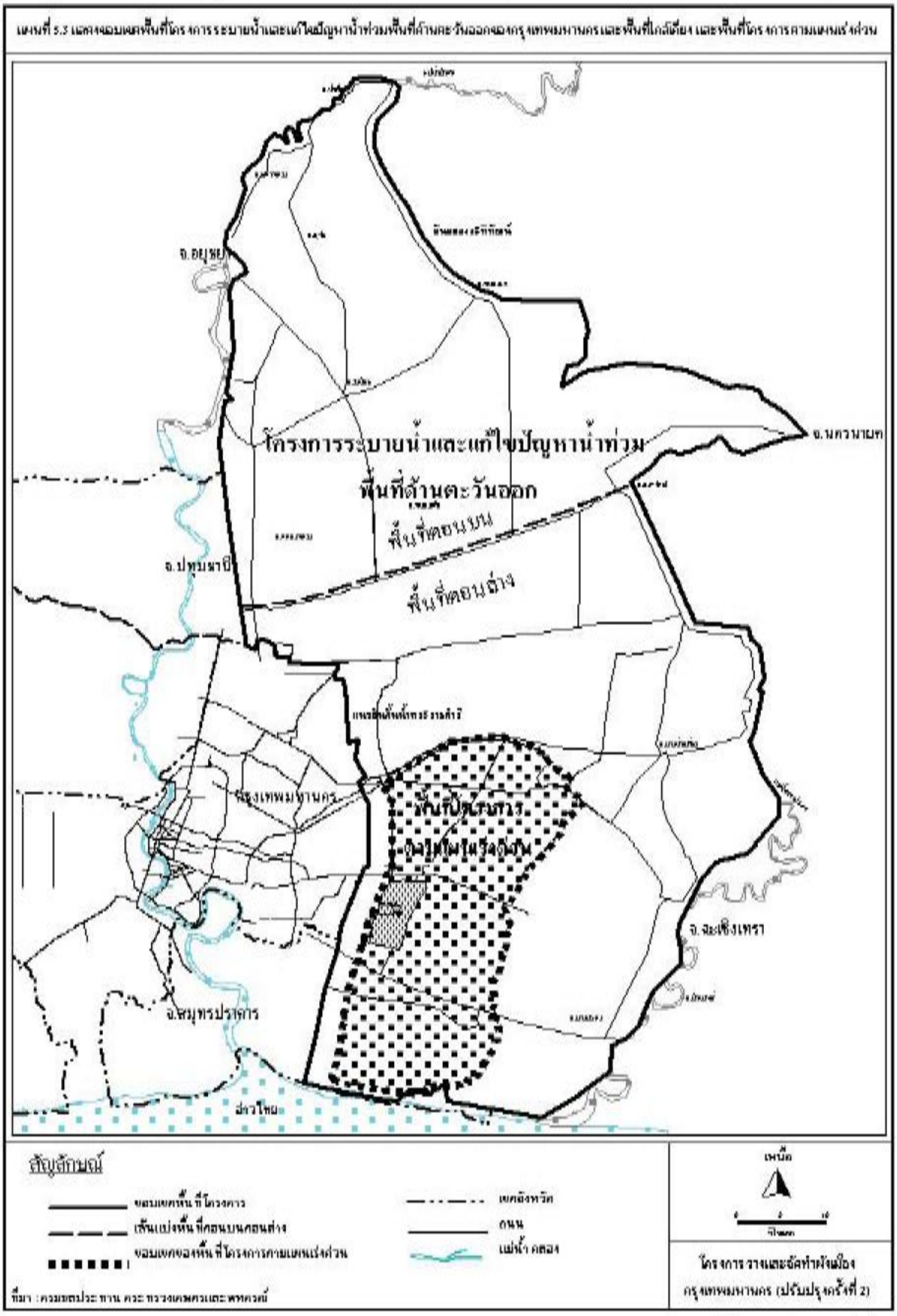


Map of Open space in Bangkok (draft version)



Map of Open space in Bangkok (draft version)

Map of Flooding prevention and drainage project for the east of Bangkok



บริษัท กรุงเทพธนาคม จำกัด

Flooding problems

1) Natural causes
   - Rain water that fall within the field or Water for agriculture in the vicinity of the north and the east of Bangkok. This will flow into the area protected by flood slope of the ground level.
   - Water from the Northern area along the Chao Phraya River in October and November.
   - Strom search and the sea-level fluctuations which affect the water-level fluctuations in Chaoprayariver in October and December.
2) Physical condition causes
   - City Growth
   - Drainage system
   - Land subsidence

Flooding prevention

1) Operate by Bangkok Metropolitan Administration

1.1) Prevent flooding from outside which caused by sea water.

- Construct the levee in Bangkok area along almost all of Bangkok western area and the east line along the Chao Phraya River in Nonthaburi province.
- Construct the levee along the Chao Phraya River, Klong Bangkoknoi and Klong Mahasawat to prevent flooding, which caused the water from northern area and strom search with the length of the current 86 kilometers.

1.2) Prevent flooding from inner area which caused by rain water and drainage system.

- Construct the tunnel to optimize the drainage system and the drainage of flood detention area to the Chao Phraya River directly. There are 4 existing tunnels which are Klong Bangken, Klong Bangsue, Klong Chong-non-sri and Klong Prakanhong.
- Provide catchment area to improve the current drainage Bangkok to accommodate rainfall.
- Create sub-system of enclosed-area in high- densisty communities with flood vulnerability within the line of Bangkok's levee to prevent and resolve the spatial area. 15 areas are on the current operation with the total area of 168.06 square kilometers.

2) Operate by Royal Irrigation Department
   - Responsible for the area outside the levee's line, including Khlong Sam Wa, Min Buri, Nong Chok, Ladkrabang, Samut Prakan province and in the Chao Phraya River area. The current operation is to drain from the east of Bangkok over the sea through Samut Prakan with the several installations of large pumping station in Samut Prakan.

"Current perception of climate change related risk (such as floods, water and food supply, land losses, air quality, heat stress, disease outbreaks, etc.) and social/economic vulnerability (such as poverty, investment, capital and opportunity losses, social conflicts and divides, genders, justice, etc.) in your city, e.g., how do they perceive on the differences and linkages between weather/climate risks and social/economic vulnerability?"

- ***Among general public***
- ***Among urban officials, city managers***

Informality Risk and Assessment

The study of climate change and related risk has been heavily studied on flood related risk. Informality which is one of the dominant characteristic of Bangkok Urbanism has been largely ignored. For informality issues, this report is aimed to focus on 1) informal economy and 2) informal settlement which is currently viewed by the general public as non-climate issue, and hence not only ignored by city planning but also perceived as a non-climate factor for risk assessment, that could also exacerbate sector and community vulnerability. The review, hence, aims review a current knowledge on informality of Bangkok. The ensuing question is what would be the risk and vulnerability on informal economy and settlement.

<u>Bangkok Economy and Uneven Development</u>

Bangkok, the capital of Thailand since 1782, marked the beginning of the current Chakkri Dynasty. Nowadays, Bangkok covers an area of 1,443.85 square kilometres. According to the National Statistics Office (NSO) in 2008[1], Bangkok's total population was 5,710,883 (2,988,570 are women and 2,722,313 are men) with 2,207,453 households. Between 1883 and 1913, Bangkok's population expanded from 169,000 to over 365,000 people, a growth rate far in excess of the average population growth in the Kingdom. By 1937, Bangkok was 15 times larger than the second-largest urban settlement of Thailand, Chiang Mai (Askew, 2002: 37). Bangkok remains disproportionately larger than Chiang Mai and as a result, Bangkok has manifested more dominant and exaggerated elements in economy, society and culture compared to other urban areas in Thailand (Baker and Phongpaichit, 2005: 204). The urbanisation of Thailand, especially Bangkok, can be explored through its economic boom.

Bangkok's demographic change is part and parcel of the rise of urbanism in Bangkok. It has been usually estimated that about 15 percent of Thailand's population resides in the greater Bangkok metropolitan area (Hewison, 1996: 149). The Table below shows population trends in Bangkok from 1985 to 2006 relative to those in Thailand as a whole.

Demographic changes of the population in Bangkok and Thailand as a whole, 1985-1986, 1995-1996, and 2005-2006

Regions	Demographic change								
	1985-1986			**1995-1996**			**2005-2006**		
	Birth rate*	Death rate	Growth rate	Birth rate	Death rate	Growth rate	Birth rate	Death rate	Growth rate
Thailand	23.87	6.44	1.74	17.90	6.02	1.19	10.85	6.76	0.66
Bangkok	18.92	3.84	1.51	14.24	3.92	1.03	8.63	4.23	0.65

*Note: Birth and death rates represent figures per 1,000 persons while growth rates represent figures per 100 persons.

[1] In comparison to the whole Kingdom, in 2008, Thailand had a population of 63,389,730 (32,133,861 are women, whereas 31,255,869 were men)
http://www.dopa.go.th/xstat/p5010_01.html, 29.01.09, 14.15

However, the above population numbers are still considered to be quite low. The urbanisation of Bangkok and the currently available data are likely to be underestimated. This is partly because the way data was collected, based on household registrations[2]. Even so, the increasing number of Bangkok's population can not be ignored (ibid: 149).

The increasing population in Bangkok can also be further explored from the angle of urban migration. As discussed in Chapter 4, government policy has been encouraging foreign investment and industrial development through taxation and the provision of cheap labour. Since the decline of the agricultural section in the rural areas, the returns from agricultural production was too small for household reproduction, and the money from Bangkok became a necessity for the reproduction of rural villages. At the same time, government policy ensured that the surplus labour from the agricultural sector would be absorbed into the industrial one. Hence, female and male workers migrated in search of wage-work in Bangkok (Korff, 1989: 16).

Number of migrants (X 1,000) moving to Bangkok (from regions of origin, 1974-1992)

From	**1974**	**1976**	**1978**	**1981**	**1982**	**1988**	**1992**
North-eastern	24.6	24.9	44.3	53.2	36.4	48.6	155.5 (51.4%)
North	7.7	7.4	10.3	17.0	14.7	19.6	68.6 (22.7%)
South	4.9	6.7	6.3	10.0	9.0	7.8	18.3 (6.0%)
Central	32.8	28.2	32.3	41.8	33.6	32.8	60.2 (19.9%)
Total	70.6	67.7	93.8	122.9	94.0	108.8	302.6 (100.%)
Male	35.9	31.7	38.9	48.6	39.1	41.4	152.9
Female	34.8	36.0	55.8	74.2	54.8	68.3	149.7
M:F	1.03	0.88	0.68	0.65	0.71	0.61	1.02

Source: The National Statistics Office, 1992 (*adapted from* Tantiwiramanond & Pandey, 1997: 104)

The number of female and male migrants moving from different regions of the country to Bangkok increased from 70,600 persons in 1974 to 302,600 persons in 1992. The largest portion came from the poorest region, the North-eastern region. Moreover, the trend of female migrants outnumbering male migrants continued until the early 1990s. In 1992, more women (64,300 women) at the young age of 10-19 years migrated to Bangkok compared to men (47,700 men). However, at the older age range of 20-34, more men (72,400) migrated to Bangkok compared to women (57,500 women). In sum, female migrants comprised about 4.7% of Bangkok's population, whereas male migrants comprised at 4.9%. As previously discussed, female migrant workers were mostly employed in services and sales. Male migrant workers were employed in the technical and transportation fields (Tantiwiramanond and Pandey: 103-104). As a consequence of government policy being focused on urbanisation, the disparity of Thailand's productivity between the urban areas, especially Bangkok, and the rural areas is apparent, as shown in the Table below.

Regional productivity of Thailand in 1989

Region	**% of population**	**% of GDP**
Bangkok	16.0	48.2
Central	16.8	18.4
Northeast	34.6	12.9
North	19.4	11.4
South	13.2	9.1

Source: The Thailand Development Research Institute, 1992 (*adapted from* Hewison, 1996: 147)

[2] A household registration is an official household census where the address, location and ownership information of a house, including the name and relationships of all members of that household are officially listed. (www.dopa.go.th 30.03.09 10.00)

Such industrialisation also contributed to the rising middle class in Bangkok. The middle class continued to be the main beneficiary of this income and wealth concentration in Bangkok. There is still a large disparity between the lower status and the upper one. The Table below presents the socioeconomic status of the population in Thailand in different regions in 1990.

Socioeconomic status (SES) in Thailand, 1990

SES[3]	**Bangkok (%)**	**Other urban areas (%)**	**Rural areas (%)**
Lower	55.1	69.6	78.6
Middle	28.3	20.5	13.1
Upper	16.6	9.9	8.3

Source: Ogilvy & Mather, 1991 (*adapted from* Hewison, 1996: 150)

Urban dwellers have received the greatest benefits as a result of the increasing wealth of the upper and middle classes in the urban area, especially in Bangkok, which amounted to about double of that in the rural areas. Almost half of Bangkok's income earners are considered to belong to the middle or higher classes. This is also reflected in their spending patterns. In 1989, an average of one in three of Bangkok's residents owned a vehicle. At that time, the rate of vehicles purchased per month, which steadily increased, averaged at 12,000 vehicles. The spending power of Bangkok's residents increased rapidly by 17% between 1988 and 1989 (Hewison, 1996: 151, 153). Yet even though the number of the population considered to be in the lower classes in Bangkok was smaller than that of other urban and rural areas, they still comprised more than half of Bangkok's residents. In this way, not only was the disparity between the urban and the rural areas apparent, but also that within Bangkok.

With respect to the aforementioned uneven development between Bangkok and the rural areas, it is apparent that Bangkok provided a variety of jobs for the middle classes as well as cheap labour. Even so, social stratification in the rural areas was small compared to that of Bangkok, where the disparity between the urban rich and the urban poor could not be ignored. Bangkok was the place where the mass media, government departments, and business were located. As a result, Bangkok also had to deal with the heterogeneity and complexity of the working population in Bangkok (Korff, 1989: 16, 22).

<u>Gendered Political Economy and Informal Sector: An Exemplification of Bangkok Uneven Development</u>

(Perceived) non-climate issues

- migrant workers dominate the sector
- poor condition of work and cheap labour
- reserve army of workforce
- gendered issues: from a comparative perspective, working women in Thailand have suffered less discrimination than women in many other parts of Asia. Thai women have always worked. Women represent more than half of the Thai population and have always shared productive work with their men.
- Women are attracted to informal sector

[3] A relative measure of a person's economic and social position against others, based on income, education and occupation. (www.nida.or.th)

Industry expansion in Thailand during 1960-1990

Sectors	1960	1970	1980	1990
Agricultural, % GDP	39.8	28.3	23.2	12.4
Agricultural, % exports	90.5	70.3	58.3	22.6
Agricultural, % labour force	82.4	79.3	72.5	66.5
Industry, % GDP	18.2	25.3	28.4	39.2
Industry, % exports	1.0	15.0	32.0	63.0
Industry, % labour force	4.2	5.8	7.7	11.2
Services, % GDP	42.0	46.4	46.4	48.4
Services, % labour force	13.4	14.9	19.8	22.3
GDP per capita (constant 1990 US dollars)	$100	$195	$688	$1,200
Annual growth rate		7.9%	6.9%	5.4%

Source: *adapted from* Slagter (2000: 36)

This striking picture underscores that fundamental change had taken place in the Thai economy by the end of 1980s. There was rapid growth in manufacturing, whereas the percentage of GDP and exports of agriculture had relatively declined (ibid: 36). Ever since the 1980s, the value of manufacturing exports has been much greater than that of agricultural exports. In this period, Thailand also attracted labour from the agricultural sector to the non-agricultural sectors and the population shifted from the rural to the urban areas (Kanda, 2000: 382).

Percentage of total employment by industry, 1980 and 1989

Industry	1980		1989	
	Women (%)	Men (%)	Women (%)	Men (%)
Agriculture	74.1	67.8	56.2	57.8
Mining	0.1	0.2	0.1	0.2
Manufacturing	7.1	8.7	14.1	11.0
Construction	0.6	3.2	1.2	6.2
Electricity	0.1	0.5	0.1	0.7
Commerce	9.1	7.4	14.2	9.6
Transport	0.3	3.6	0.6	4.2
Service	8.2	8.6	13.4	10.1
Other	0.0	0.0	0.1	0.1
Total number (thousands)	10,657.4	11,866.3	11,909.0	15,363.5

Source: National Statistical Office of Prime Minister, May 1989 (*adapted from* Phananiramai, 1996: 281)

Since the working population in agriculture had declined, manufacturing, commerce and the service sectors absorbed approximately 8 percent of the total work force. More importantly, this development had a significant impact on the expansion of the number of female industrial workers. In 1980, female workers out-proportioned male workers in agriculture and commerce, whereas in 1989 they did so in manufacturing, commerce and the service sectors (ibid: 281). Most industries were located in Bangkok and its vicinity and all factories employed female labour which contributed significantly to national income (Attavavutichai, 1992: 55). Such big and small factories, workshops and joint-venture companies, as in the period of accelerating industrialisation, provided a big increase of employment for female labour in Thailand. The most important of these industries were textiles, gem polishing, footwear and simple electronic components which were all export oriented. Conversely, the growth of these industries crucially depended on female labour force (Falkus, 2000: 182). The female labour intensive industries generated 47.7 percent of GDP in 1989 (Phananiramai, 1996: 282).

Percentage share of employment by economic sector, 1990-1998

Year	**Agriculture**			**Manufacturing**			**Construction**			**Transport**			**Service**		
	Female	Male	Total	Female	Male	Total	Female	Male	Total	Female	Male	Total	Female	Male	Total
1990	30.3	33.7	64.0	5.1	5.1	10.2	0.6	2.8	3.4	0.2	2.1	2.3	10.4	9.7	20.2
1991	27.9	32.4	60.3	5.6	5.5	11.1	0.6	3.2	3.8	0.3	2.4	2.7	11.5	10.6	22.1
1992	34.6	14.2	48.8	9.0	8.5	17.5	4.3	3.6	7.9	0.2	1.0	1.2	13.1	14.6	27.7
1993	26.2	30.5	56.7	6.0	6.3	12.3	0.8	3.9	4.7	0.3	2.5	2.8	6.0	5.4	11.4
1994	26.2	29.8	56.0	6.6	6.0	12.6	0.9	4.3	5.2	0.3	2.5	2.8	6.3	5.7	12.0
1995	24.3	27.7	52.0	6.7	6.8	13.5	1.0	4.7	5.7	0.3	2.1	2.4	6.3	6.3	12.6
1996	23.1	26.9	50.0	6.4	7.0	13.4	1.3	5.4	6.7	0.3	2.7	3.0	6.6	6.1	12.7
1997	23.3	27.0	50.3	6.2	6.7	12.9	1.3	4.8	6.1	0.3	2.6	2.9	6.8	6.3	13.1
1998	19.2	30.8	50.0	7.4	7.2	14.6	1.1	6.2	7.3	0.2	2.0	2.2	5.7	6.2	11.9

Source: National Statistic Survey (*adapted from* Kanda, 2000: 381)

Working women were likely to dominate men in the agricultural, manufacturing and service sectors, whereas they were poorly represented in transport and construction (ibid: 381-382). As in the 1970s-1980s, the reason that the manufacturing and service sectors prefered female workers was partly because women were seen as being more likely to put up with low pay, short-term employment, repetitive, and labour-intensive work than men. As Elson and Pearson (1981) argue, as in other countries in the global South women are attractive to employers. Global factories reproduce similar models of organisation where women's low pay and authority is concentrated, whereas men occupy most of the supervisory and managerial ranks (Elson and Pearson, 1981: 98-99)

Besides as factory workers, women in urban areas are also prominent in trade and professional jobs. The merchant culture of the Sino-Thai population that was instrumental in establishing Bangkok in early twentieth century capitalism still remains an important part of business expansion in Bangkok and neighbouring regions today (Reynolds, 1998: 117). In the professional area, Thai women are active, often in senior positions, as teachers, nurses, and more recently as doctors. Thailand also has a slightly higher proportion of women serving in clerical (1.8% of women, 1.6% of men) and sales positions (6.7% of women and 4.5% of men) (Thomson and Bhongsvej, 1995: 60). Furthermore, in the areas of business ownership and management there is also a high degree of female activity. Thai women have long held the right to own and manage property and are often engaged in business activities on their own account. Much female economic activity, however, is carried out behind the scenes. Hence, women own-account workers only constituted 10% whereas 23.5% were men in the 1998 national statistic (Kanda, 2000: 382). Such perceptions reflect women's traditional role as the rear leg of an elephant, avoiding women as leaders in the past. "Men have prestige built into their manhood and recognized by their superior religious status with which women, by definition, cannot compete." (Ward, 1963: 97 *quoted in* Springer *et al*, 1981: 727) The percentage of employment distribution by work status and gender from 1993-1998 demonstrated that in almost every work status, government, private, and own-account worker, male employment was higher than that of female. Many formal institutions, for example religion and the political arena, continue to be dominated by males. Moreover, professional women have lower positions and are paid less than men. As modernisation occurs, occupations tend to become structured along institutional lines. When these occupations become important sources of status, men and women find themselves in direct competition. The result is a decline of female equality, which traditionally has been based mainly on participation outside formal institutions (Kanda, 2000: 378-384; Springer *et al*, 1981: 727). Although Thai women have traditionally participated actively in family and economic life, such freedom and equality with males has not been carried over into modem occupations since the 1970s.

Not only did the female work force face limited employment, but their work conditions were also poorer compared to that of the male work force. Nearly all Thai women factory workers were paid less than the legal minimum wage and they worked long hours, often more than 50 hours a week (Falkus, 2000: 185). Although legislation provides equal rights for men and women, including equal pay for work of equal value, women accounted for 46 percent of the labour force but earned only 37 percent of income in 1999. Most women earn only half of the men's income in all non-professional jobs, including manufacturing services and management (Thomson and Bhongsvej, 1995: 60-61).

Women provide cheap labour because they are paid less than their marginal product which leads to excess profit. For example, in the garment industry, which was dominant in 1990s, the majority of workers were paid piece-rates. Hence, the prevalence of piece-rate, subcontracting and female employment were favoured. Paying piece-rates was a way to avoid minimum wage and other government labour legislation. Costs could then be minimised. In some cases, it seemed that women workers could combine factory and service sector employment with household activities such as family responsibilities provided that they were a flexible and undemanding work force (Falkus, 2000: 185).

In 1997, Thailand faced an economic crisis[4] after a period of economic boom when the benefits of growth trickled down to most Thais and improved economic well-being substantially. Prior to the crisis, the population of the poor decreased from 57% in 1962/63 to 33% in 1975/76 and to 14% in 1992 (Santrisart, 2005: 138). As presented in Table 4-3, Thailand saw significant increases in per capita incomes from about 18,000 baht in 1980 to 30,000 baht in 1990. However, even then, the benefits of economic growth were not equally distributed. In 1990, most of the rural working population (79%) earned less than 4,000 baht/month, whereas more than half of the working population in Bangkok (57%) and those in other urban areas (51%) earned more than 8,000 baht/month (Hewison, 1996: 146-147). With the onset of the Thai economic crisis, the incidence of poverty significantly increased as a result of the crisis, from 11.4% in 1996 to 12.9% in 1998 (Phongpaichit and Baker, 2000: 96). The Thai economic crisis seriously worsened the living conditions of the poor. It also raised local prices of commodities, deteriorated social services provided by the state and led to a decrease in income and output. The resultant costs and responsibilities were transferred to women who maintained the daily routine of household tasks (Surivasarn *et al*, 2003: 10-11). The impact of the economic crisis on employment resulted in reverse migration of unemployed former workers from the non-farming sectors from Bangkok to the farming-sectors of other regions. As a consequence, there was an increase in underemployment in the agricultural sector. It should be noted that most of the reverse female and male migrants were from the construction sector whereas new migrants from the central and northern parts of the country still came to Bangkok. More importantly, the crisis strongly affected employed persons under 30 years of age and those with under primary level education, whereas employment was increased by one million in 1998 for those with secondary and higher education

[4] Due to the dominant policies of export orientation and foreign investment in the 1980s to 1990s, most foreign capital inflows were in the form of short-term and speculative investment. The rapid economic growth and large amount of foreign investment was encouraged by a fixed foreign exchange rate in the 1990s. Such investment looked for quick profits in niche markets which then created a volatile investment environment. In 1996, this resulted in a downturn of external demand which decreased the value of exports. Consequently, the cost of imports was raised and in 1997 Thailand was forced to float the Thai currency (*Baht*) due to an exhaustion of foreign exchange reserves. The sudden devaluation of the Thai Baht increased foreign debts and hence led to the Thai economic crisis (Suriyasarn *et al*, 2003: 9).

(Sarntisart, 2005: 154-155). More women were unemployed than men. They were also less likely than men to be offered training or re-training. Women labourers could not progress at work because they received no training and lacked the knowledge to deal with the technology used in the workplace (UNIFEM, 1998: 4). Service sector employment rose during the crisis years, from 1997 to 1999. Service sectors such as tourism, entertainment and hospitality attracted women. They increasingly entered the services and informal sectors to mitigate the effects of crisis (Surivasarn *et al*, 2003: 10-11). Because of the above constraints and longstanding poor work conditions of women, they continued to work in poor conditions. Not only were most of the women are laid off, but they also had less chance of being re-hired by formal sectors and remained in informal and service sectors.

With respect to informal workers[5], there were 4.4 million female workers in the informal sector in 1997. Women are also attracted to the informal sector because of it provides for easy entry, is labour intensive, usually small scale with low cost, and requires technology utilizing only low skills or less formal education. Because of the co-existence of their economic and domestic roles, women could compromise between family obligations and income earning by adapting both to their own circumstances (Kanda, 2000: 383-384). With respect to women entrepreneurs in Thailand engaged in family run enterprises, specific data is not readily collected from the national census on labour force. However, it is apparent that wives and daughters have been involved not only in family businesses but also engaged in business activity on their own to supplement the family income. Especially in urban areas, female traders are almost double in number than male traders. However, there are problems encountered in advancing women in the informal sectors. These include lack of market information, limited access to credit, inadequate linkage with technological resources, inadequate support services, too much competition, lack of health and child care facilities and lack of professional business and financial management skills (Aganon, 2000: 9).

Informal Settlement: An Exemplification of Spatial Uneven Development

The economic developments of Thailand, urbanisation, and the changing socioeconomic characteristics of her cities have also led to uneven spatial development in Bangkok. Nowadays, Bangkok is one of the world's most cosmopolitan cities. It is dominated by the manufacturing production of multinational corporations, commercial sectors, financial sectors, the tourism industry and the service sectors. It also represents the centre of the economy, political life, and Thai society richly articulated in such areas such as culture, fashion and lifestyle (Askew, 2002: 227). However, like many other developing cities, Bangkok's spatial development has been uneven.

Residential types of low and lower-middle income settlements:

- riverside or canal squatter settlement
- apartment block
- rent room

(perceived) non-climate issues

- settle on public land, hence lack of land tenure security
- deprived space/area, hence facing poor sanitation and quality of life

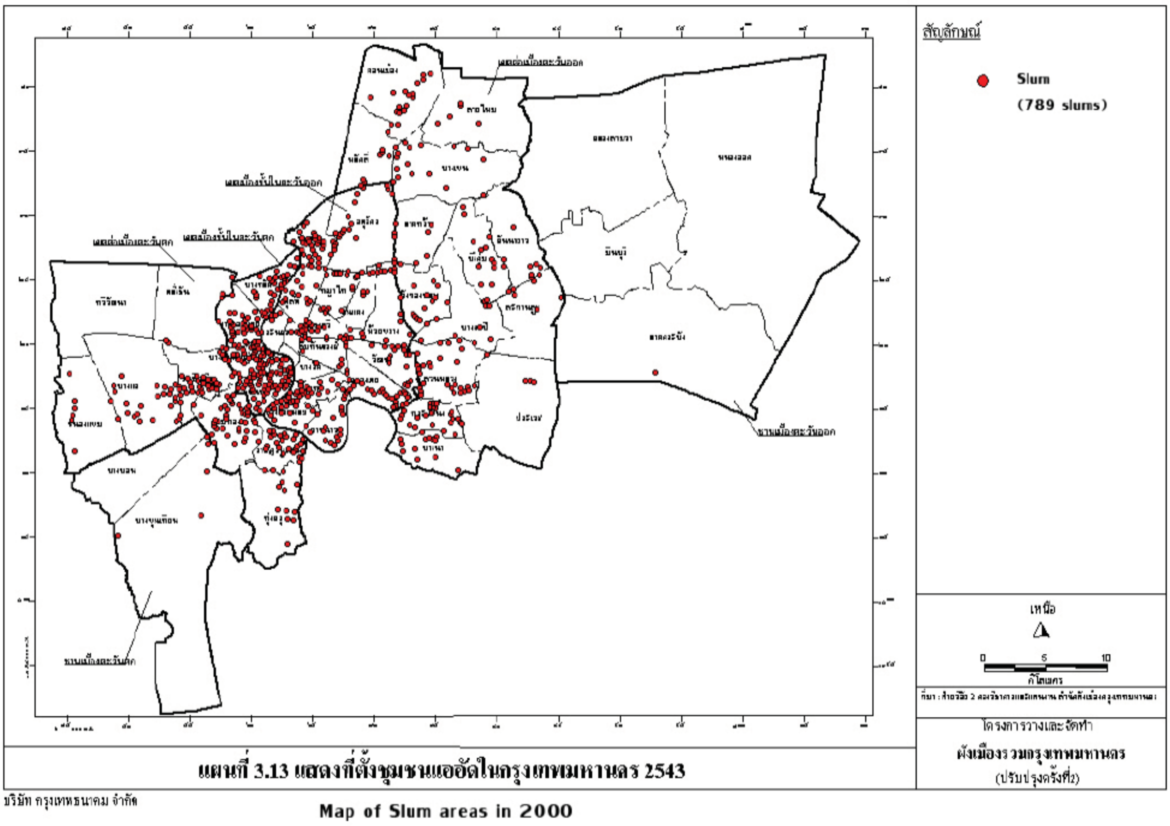
[5] "The informal sector includes such activities as domestic work in other households, traditional handicraft production and manufacturing of export goods and small-scale enterprises with less than 10 workers." (Kanda: 2000: 383-389)

"Is there an existing urban GIS information base that may be used for climate risk and vulnerability assessment? What is included?"

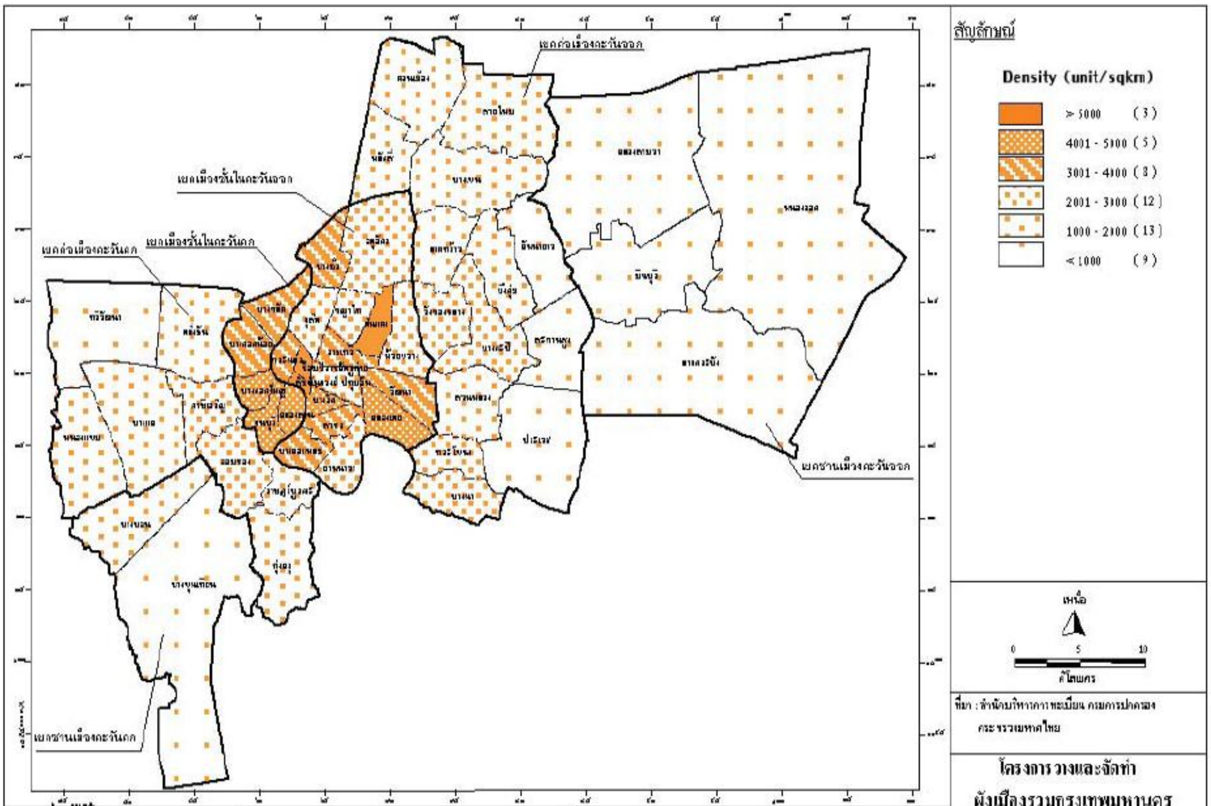
During the economic downturn in 1997, even though there was a low rate of urbanisation, economic performance actually improved in a manner. Bangkok's residents living in the core were able to adjust and inner city, urban areas provided significant opportunities for them. Hence, the already available complexity and heterogeneity of *Soi*s in inner Bangkok absorbed excess labourers, especially in the informal sectors. Consequently, the physical structure of Bangkok's inner core became comprised of tourists, hospitality and retail zones, financial districts, government areas and informal business sectors— mixed land use (ESCAP, 2005: 125)

Even though a policy of decentralisation of Bangkok has been implemented, it failed due to the low level of job dispersion. Employers continue to commute to inner Bangkok for work. This pattern occurs partly because almost all land in Bangkok is privately held. Hence new housing has been developed on the periphery and there is no affordable land for the construction of public housing to bring people closer to their workplace (Punpuing, 1993: 8,9). Hence, the inner core still absorbs residents and commuters, and creates multiple land use patterns. There are layers of labour markets and uses in the economies and ecologies of the inner Bangkok which operate with relative autonomy from the luxury condominium inhabitants. These include services for people working in both formal and informal sector and living locally, such as dressmakers, hairdressers, laundries, and etc.

The following three maps done by BMA suggest the characteristic of low-income settlement which is clustered along the Chao Praya River and juxtaposed the business district, especially the large shopping mall in the urban core.



Map of Slum areas in 2000

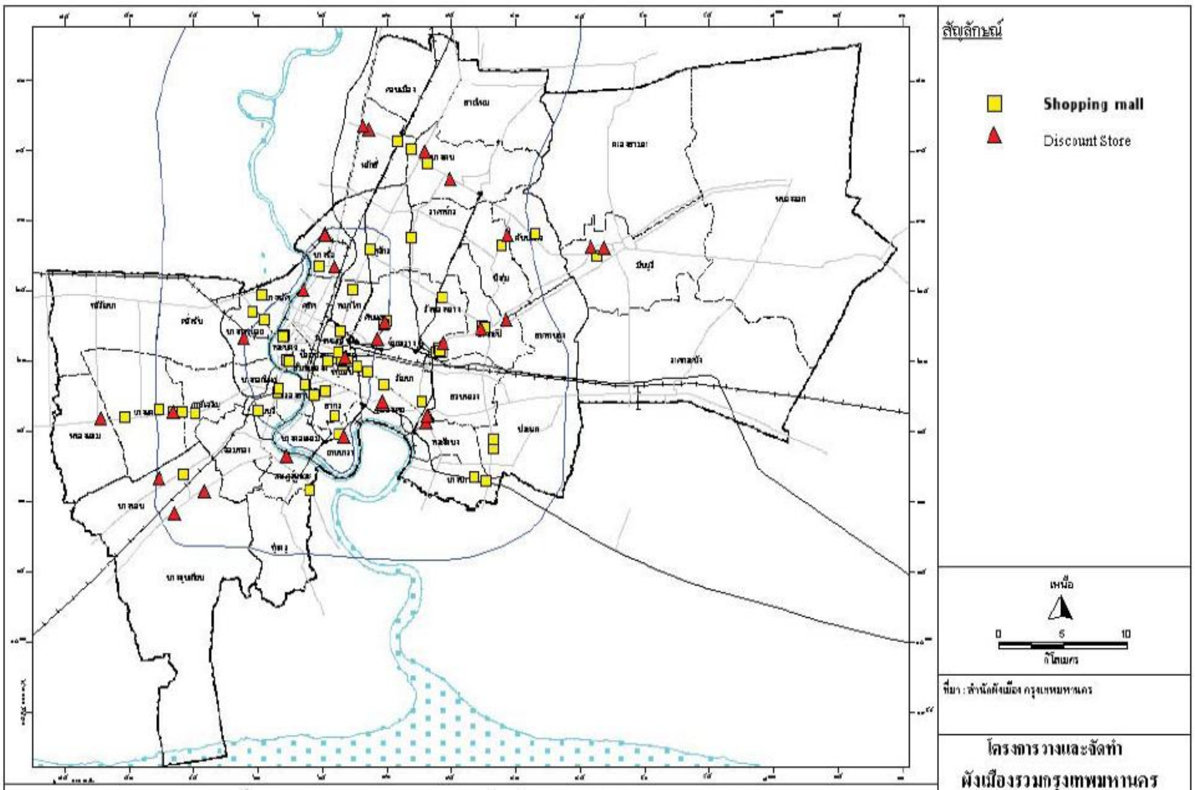


แผนที่ 3.3 แสดงการกระจายความหนาแน่นของที่พักอาศัย พ.ศ. 2543

โครงการวางและจัดทำ ผังเมืองรวมกรุงเทพมหานคร (ปรับปรุงครั้งที่2)

บริษัท กรุงเทพธนาคม จำกัด

Map of Residential density in 2000

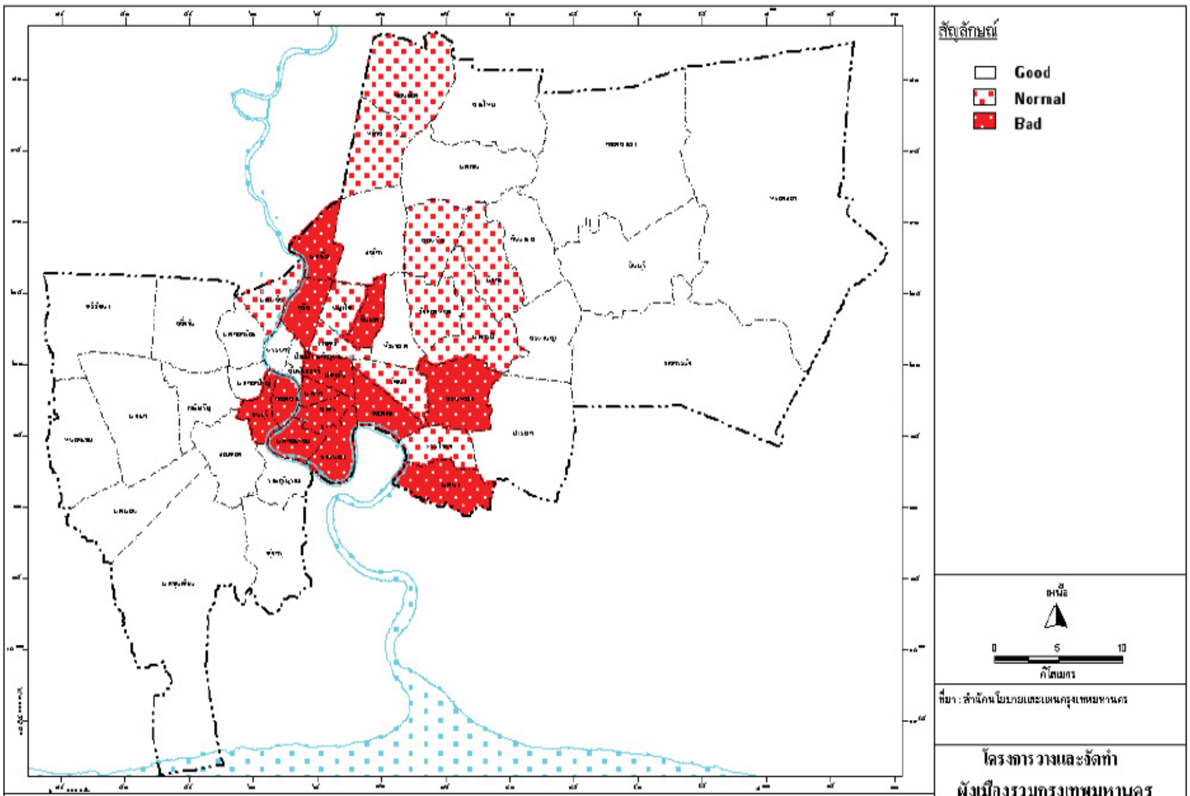


แผนที่ 3.12 แสดงการกระจายตัวของห้างค้าปลีกขนาดใหญ่ในกรุงเทพมหานคร

โครงการวางและจัดทำ ผังเมืองรวมกรุงเทพมหานคร (ปรับปรุงครั้งที่2)

บริษัท กรุงเทพธนาคม จำกัด

Map of large retail store in Bangkok



แผนที่ 5.4 แสดงคุณภาพน้ำในคลองต่างๆ ของกรุงเทพมหานคร ปี พ.ศ. 2543

บริษัท กรุงเทพธนาคม จำกัด

Map of Water quality in Bangkok in 2000

Bangkok City Team Report

International workshop
Climate Change Vulnerability Assessment and Urban Development Planning for Asian Coastal Cities

22-28 August 2010
Rose Garden, Bangkok
Thailand

CITY REPORT ON

CLIMATE CHANGE VULNERABILITY ASSESSMENT AND URBAN DEVELOPMENT PLANNING IN HO CHI MINH CITY, VIETNAM

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"Climate Change Vulnerability Assessment and Urban Development Planning for Asian Coastal Cities"

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List of Members' Assignment

Main parts	Member's Assignment
1.1. Urban Context of Ho Chi Minh City	Nguyen Anh Duc
1.2. Perception of Climate Change among Stakeholders	Le Vo Phu
2. Existing Knowledge of Climate Change Impacts in Ho Chi Minh City	Le Vo Phu Lam Vu Thanh Noi
3. Institutional Capacity and Policy Respond to Climate Change	Le Vo Phu Dang Van Khoa
4. Urban Development in the Context of Climate Change in Ho Chi Minh City	Nguyen Anh Duc
5.Climate Change and Urban Governance in Ho Chi Minh City	Lam Vu Thanh Noi

TABLE OF CONTENT

ABBREVIATION

ADB	: Asian Development Bank
CC	: Climate change
DONRE	: Department of Natural Resources and Environment (City and Provincial Level)
GDP	: Gross Domestic Production
GoV	: Government of Vietnam
HCMC	: Ho Chi Minh City
HFSPA	: HCMC Flood and Storm Prevention Agency
ICEM	:International Central for Environmental Management
IPCC	: Intergovernmental Panel on Climate Change
LMB	: Lower Mekong Basin
MRC	: Mekong River Commission
MOC	: Ministry of Construction
MONRE	: Ministry of Natural Resources and Environment
NTP	: National Target Plan
PC	: People’s Committee
SFEZ	: Southern Focal Economic Zone
UNFCCC	: United Nations Framework Convention on Climate Change

LIST OF TABLES

LIST OF FIGURES

CLIMATE CHANGE VULNERABILITY ASSESSMENT AND URBAN PLANNING IN HO CHI MINH CITY, VIETNAM

1. Background

Ho Chi Minh City, a biggest city of Vietnam, has undergone a rapid growth of urbanization and industrialization over the past decades. The City accounts for 0.6% of Vietnam's total area and 8.3% of the country's total population. However, it is a lion share of Vietnam's GDP growth over the last ten years (Vo, 2008).

The renovation policy in 1986 triggered the so-called 'industrialization and modernization' process which created momentum and impetus for social transformation and radical economic development in Vietnam (O'Rourke 2004). Not surprisingly, HCMC has witnessed a remarkable economic growth, evidenced by GDP growth rate with more than 10% since 2000 (People's Committee of Ho Chi Minh City, 2006).

Its population has doubled over 25 years from 2.5 million in 1975 to 5.17 million people in 2000. By 2005, the urban population increased to 6.2 million, and increased up 7.1 million by 2009 (Ho Chi Minh City Statistical Office, 2007). As a result, HCMC is one of the most dynamic urbanized areas in the Southeast Asian region with rapid recent economic growth and is predicted to become the largest urban agglomeration in Vietnam (Bolay et al., 1997; Gubry and Le, 2002).

However, this exponent growth is under enormous threat of recent emerging global environmental change in which climate change is one of most threatened factors. Sustainable development of the economy and urban expansion in growth poles of Ho Chi Minh City and Hanoi will be significantly affected by long term consequences of climate change and climate related vulnerabilities (Chaudhry and Ruysschaert, 2007).

The rapid change in climate, caused by the acceleration of greenhouse gases (GHG) in the atmosphere, will leave ecosystems and coastal cities vulnerable through sea level rise. Climate change impacts would also include an increase in intensity of storms, cyclones, drought, and flooding. Furthermore, many climate researches in the literature indicate that climate change would lead to greater frequency of heat and cold waves, more rapid spread of vector and water-borne diseases, population displacement, and conflict over scare natural resources (IPCC, 2007). Particularly, climate change pose threats to countries with dense population and economic activities in fragile and vulnerable regions, including coastal, delta and low-lying areas (Nicholls et al., 2007)

A recent World Bank report showed that Vietnam is one of the top five most countries affected by consequences of climate change, including sea-level rise, temperature and extreme weather events. The study showed that a projected 1-meter rise in sea level would affect about 5 percent of Vietnam's land area, 11 percent of the population, 7 percent of agriculture and reduce the country's GDP by 10 percent (Dasgupta et al., 2007).

Vietnam's coastal economy has been accelerated and strived to compete. However, the coastal zone with its natural and socio-economic assets is increasingly threatened by consequences and impacts of global climate change, including: sea level rise, storm surges, floods and droughts. The IPCC's 4th Assessment Report (2007) indicated that:

- By 2050, more than 1 million people will be directly affected in the Mekong Delta from risks through coastal erosion and land loss;

- There will be observed changes in extreme weather events and severe climate anomalies, including increased occurrence of extreme rains causing flash floods.

Global climate change has implications for the East Asia Pacific (EAP) region, which are already vulnerable to impacts of natural disaster and extreme weather events. A projected 1-meter sea level rise would lead to 2 percent loss of the region's GDP and 1 percent depletion of agricultural land (World Bank, 2008).

Cities of the EAP region will be home of 1.2 billion people in 2030. This region also accounts for high concentration of economic activities, and therefore, climate change may have severe impact on social and economic figures. Accordingly, Vietnam is expected to be the most affected by sea-level rise along with China, Myanmar and Thailand (World Bank, 2008). For examples, the per capita GDP of Ho Chi Minh City is more than three times Vietnam's national average; per capita GDP of Shanghai is five times China's national average. Similarly, incomes in Jakarta, Seoul and Bangkok are at least 80 percent higher than in surrounding areas.

Given this context, Ho Chi Minh City and the Mekong Delta region subject to be most affected and vulnerable to climate change consequences in Vietnam. To assess the vulnerabilities of the city assumed to develop as the Master Plan in the future, this report initially introduces the current context of Ho Chi Minh City and focuses on 6 major aspects as follows:

(i) Context of Urban development in Ho Chi Minh City;

(ii) Existing Knowledge of Climate Change Impacts in Ho Chi Minh City and Perception of Climate Change among stakeholders;

(iii) Climate Change and Vulnerability Assessment (Socio-economic Assessment);

(iv) Institutional Capacity and Policy Respond to Climate Change;

(v) Urban Planning and the Risk of the Development according to Master Plan; and

(vi) Climate Change and Urban Governance in Ho Chi Minh City

This report will be followed by a project proposal for a research on the Risk and Climate Change Vulnerability Assessment for Ho Chi Minh City.

1.1 Urban Context of Ho Chi Minh City

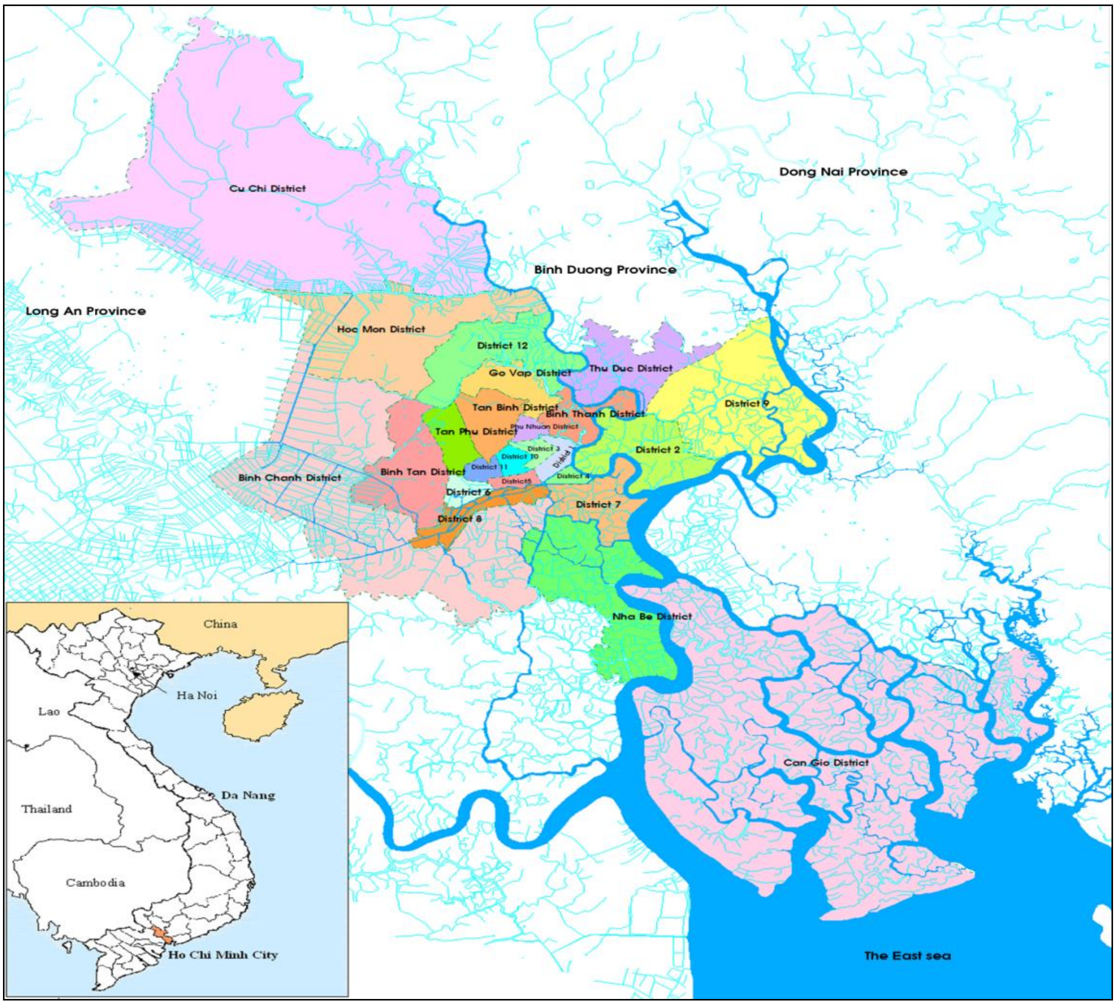
1.1.1 Geographical Location

Ho Chi Minh City (HCMC) is located at $10^0$10' to $10^0$38' North and $106^0$2' to $106^0$54' East. Its total land area is approximately 2,095 km^2. The distance from north to south is 120 km, and from the eastern point to the western point is about 50 km. Its neighbouring provinces include Binh Duong in the north, Tay Ninh in the northwest, Dong Nai and Ba Ria- Vung Tau in the Southeast, and Long An in the west and southwest (Nguyen et al., 2006). The geographical location of Ho Chi Minh City is shown in **Figure 1**.

1.1.2 Natural and Climatic Conditions

HCMC features a diverse terrain that is part of a transitional region with different characteristics between the southeastern and the Mekong Delta region. The terrain is lower from north to south and from east to west (Nguyen Phuoc Dan et al. 2005; People's Committee of Ho Chi Minh City 2002). HCMC's topography can be divided into three areas, as follows:

- *Area 1*: the elevation of this area is below 2 m. This is a low-lying plain in the south-west of the city. This area includes the downstream basin of the Dong Nai- Sai Gon River (consisting of Nha Be and Can Gio districts) and is strongly affected by tidal movements.



Source: People's Committee of Ho Chi Minh City (2002)

Figure 1. Location of Ho Chi Minh City

- *Area 2*: Altitude of this area ranges from 2 to 5 m. This area includes urban centres, population-concentrated areas comprising Hoc Mon, Binh Chanh and south of Cu Chi districts. They are dense residential areas and tenured land with cultivated vegetables and crops, fruit-trees and industrial crops.

- *Area 3*: the altitude of this area varies from 5 to 25m, and is mainly occupied by the remainder of Cu Chi district, the north of Thu Duc district and Go Vap district. This area features a large proportion of the urban population and industrial crops .

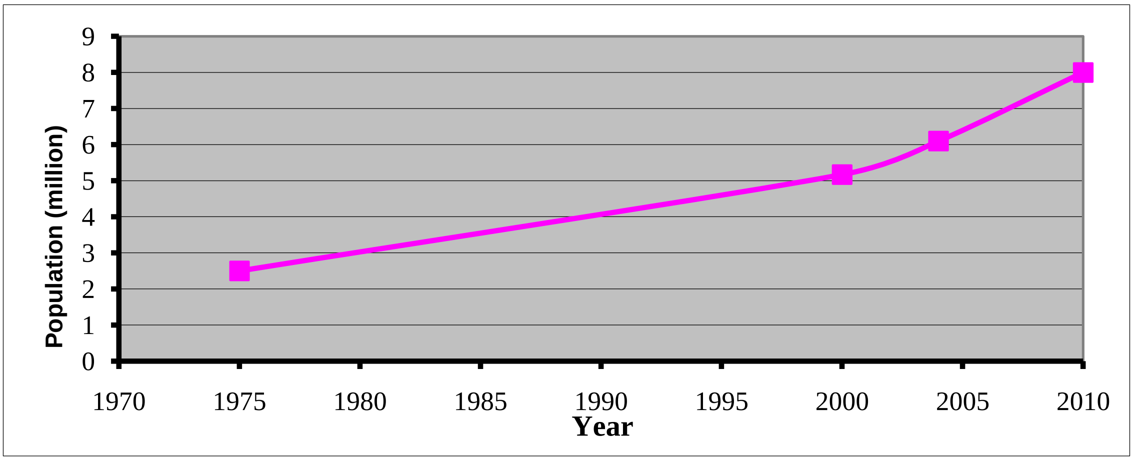
Ho Chi Minh City is situated in the sub-equatorial and tropical zone. Thus, its climate is monsoonal with a high level of solar radiation, a relatively stable temperature, and with clearly divided rainy and dry seasons. The dry season is from November to April while the wet season lasts from May to October. The city's climate is as follows:

- *Temperature*: daily average temperature is 27^{0}C. The highest daily temperature is 35–36^{0}C and the lowest is 24–25^{0}C. Urban areas have average temperature higher than the surrounding suburbans by 1– 1.5^{0}C.
- *Humidity*: The annual average humidity is 70–80%. During the rainy season, humidity reaches 85–90% and falls in the dry season to 60–75%.
- *Rainfall*: Yearly average rainfall is about 1,950 mm. The rainy season accounts for 80–85% of yearly rainfall. High rainfalls occur in June and September, averaging 250–330 mm/month, and maximum rainfall is up to 640 mm. The highest annual rainfall was recorded in 1908 at 2,718 mm and in 1958 at 1,392 mm. The rainfall is not distributed evenly and tends to increase from the southwest to northeast. Most central districts and northern districts usually have higher rainfall than districts in the south and southwest. The Can Gio suburban district has the lowest rainfall, 1,300 mm–1,700 mm. Cu Chi and Thu Duc districts have the highest rainfall, 1,900 mm–2,100 mm.
- *Evaporation*: Average evaporation is 3–5 mm/day; the highest evaporation is in the dry season, about 80–180 mm/month.

1.1.3 Demographic Condition

After reunification in 1975, the demography and the population pattern of HCMC dramatically changed. Its population has doubled over 25 years from 2.5 million in 1975 to 5.17 million people in 2000. By 2004, the mid-term census indicated the population figure has accelerated to 6.1 million people, accounting for 7% of the country's population in which 5.2 million inhabitants live in urban districts and 0.9 million people in outlying districts (Vo, 2008). Due to the rapid population growth, population density steadily increased up to 2,987 inhabitants per km^2 in mid-2005 (Demaine 2005). By 2005, the urban population increased to 6.2 million By 2010, it is estimated to reach around 8-10 million people or a megacity size taking into account the unofficial population (Gubry and Le 2002). The urban population growth is depicted in **Figure 2** below.

HCMC consists of 19 urban districts and 5 outlying suburban districts. The five outer suburban districts are named Can Gio, Nha Be, Hoc Mon, Cu Chi and Binh Chanh, accounting for 79% of the City's total area (1,601 km^2) and 16% of the total urban population. Of five suburban districts, Can Gio and Nha Be are the two coastal districts. Eighty-four percent of the City's population is located in urban districts (Gubry and Le 2002; UN ESCAP 2003).



Source: Compiled by the authors from different cited sources

Figure 2. Evolution of urban population growth in Ho Chi Minh City, 1975-2010

1.1.4 Socio-Economic Growth

Despite accounting for only 0.6% of Vietnam's total area and 8.3% of the country's total population, Ho Chi Minh City made an important contribution to Vietnam's GDP in 2000. During the period 1995–2000, the City's GDP steadily accelerated. Its contribution to total GDP was 16.7%, 18.9% and 19.3% in 1995, 1999 and 2000 respectively (People's Committee of Ho Chi Minh City 2006). In 2004, the city's GDP continued to rise and accounted for one-third of Vietnam's total GDP value, more than 130 trillion Vietnam dong (People's Committee of Ho Chi Minh City 2006b). Importantly, the value of its industrial output in 2000 was VND 76.66 million, which was many times higher than its counterpart provinces (Ba Ria – Vung Tau and Dong Nai provinces) in the Southern Focal Economic Zone (SFEZ) (People's Committee of Ho Chi Minh City 2002, 2006). In 2008, the city's GDP was estimated of 289,550 billion VND (2,534 USD/person/year), increasing nearly 11% (in 2006 increased 12.2% and in 2007 was 12.6% increased). There are 3 main sectors of economic structure: services industry shares 51.1% of GDP; industrial manufactory - construction shares 47.7% and agriculture productivity shares 1.2% of GDP.

Importantly, HCMC is the heart of the southern region as it makes up 66% of SFEZ's GDP and 30% of southern GDP growth. Thus, HCMC has been a leading contributor to Vietnam's economic and industrial development for the past 20 years.

1.2 Perception of Climate Change among Stakeholders

At the state level, the Vietnam's National Target Program to Respond Climate Change (NTP, see Appendix 1) was approved in December 2008 under Decision 158/2008/QD-TTg. The strategic objectives of the NTP are to assess climate vulnerability and impacts of climate change on different fields, sectors and regions, and develop climate change scenarios.

The NTP is divided into three phases: (i) First Phase (2009-2010): **Start Up**; (ii) Second Phase (2011-2015): **Implementation**; (iii) Third Phase (after 2015): **Development**. The specific objectives of the NTP are various but included (MRC, 2009):

- Identifying the extent of climate change in Vietnam due to global climate change;
- Identifying measures to respond to climate change;
- Developing science and technology programs/activities as well as practical basis for climate change response measures;
- Strengthening the capacities of organizations, institutions and policies on climate change;
- Enhancing public awareness, responsibility and participation as well as human resource development;
- Promoting international cooperation to attain external support in response to climate change;
- Mainstreaming climate change issues into socio-economic, sectoral and local development strategies and plans;
- Developing action plans of all ministers, sectors and regions

However, perception of climate change amongst stakeholders is one of the critical gaps both at national and local levels. Therefore, the inadequate perception of climate change has been identified in gap analysis of countries in the Lower Mekong Basin (LMB) included Vietnam as follows (MRC, 2009):

- Awareness of climate change in the population;
- Awareness of climate change in policy makers at different levels;
- Technical knowledge amongst government agencies and NGOs;
- Concrete implementation of climate change policies;
- Perception of climate change as sector and not mainstreaming necessity;
- Tools for advising and instructing policy makers;
- Analytical studies on climate change impacts;
- Inadequate, reliable climate change data;
- Progress implementation of national target plan;
- Coordination to respond to climate change in developing policies and plans;

Given the context of urbanization and population growth in Ho Chi Minh City, it is obviously a hub for socio-economic development in southern provinces and the Vietnam Mekong Delta region. Unfortunately, past urban development plans are not yet considered potential climate change impacts. Therefore, there is a need for developing the City's adaptation strategies that need to be well integrated into wider policies for sustainable urban development.

Recently, DONRE of Ho Chi Minh City took its responsibility to develop an initial mitigation and adaptation measures to respond to climate change for the City's key sectors, including energy, water resources, waste management and public health (see Appendix 2).

2. Existing Knowledge of Climate Change Impacts in Ho Chi Minh City

Climate change is expected to result in modifications in weather patterns in terms of temperature, rainfall and wind, not only the intensity but also the frequency of extreme events, including: droughts, floods, seasonal water shortage and salt intrusion. These events would become more common and severe and exacerbate the problems of food demand, water supply, health to growing populations and changes in land use planning in urban areas.

To date various investigations of climate change indicate that Vietnam is amongst the countries with potential to be the most severely affected by the consequences of climate change (Dasgupta et al., 2007) in which the Mekong Delta is the region is most at risk, substantially as a result of increased inundation (Carew-Reid, 2007). The consequences of climate change in Vietnam are summarized as follows (MRC, 2009)

- Annual average temperature is estimated to increase by 2.5^0C by 2070 in which an increase in temperature is predicted more significant in highland areas, while temperatures are projected to increase by 1.5^0C in coastal areas;
- An increased incidence in floods and droughts is predicted, together with changes in seasonal rainfall patterns and severity of typhoons;

- By 2100, a possible rise in sea level would be 1.0m that would impact on 10% of population and 10% of GDP due to the inundation of 40,000 km^2 of coastal areas;
- An increase in saltwater intrusion in the Mekong Delta is also expected to accelerate, resulting in decreases of productivity of crops and aquatic ecosystems;
- Prevalence of vectors, water-borne disease and infectious diseases is also projected.

2.1 Why Ho Chi Minh City is one of the 10 most Cities Affected by Climate Change?

Up-to-date, manifestation of simulations of temperature, rainfall and sea level changes in Ho Chi Minh City and southern region of Vietnam is presented in Table 1:

Table 1. Climate change predictions in southern region of Vietnam

Factors	Season	2010	2050	2070
Temperature increase (^{0}C)	n/a	0.3	1.1	1.5
Change in precipitation (%)	Rainy	0	0 - +5	0 - +5
	Dry	0	-5 - +5	-5 - +5
Sea level rise (cm)	n/a	9	33	45

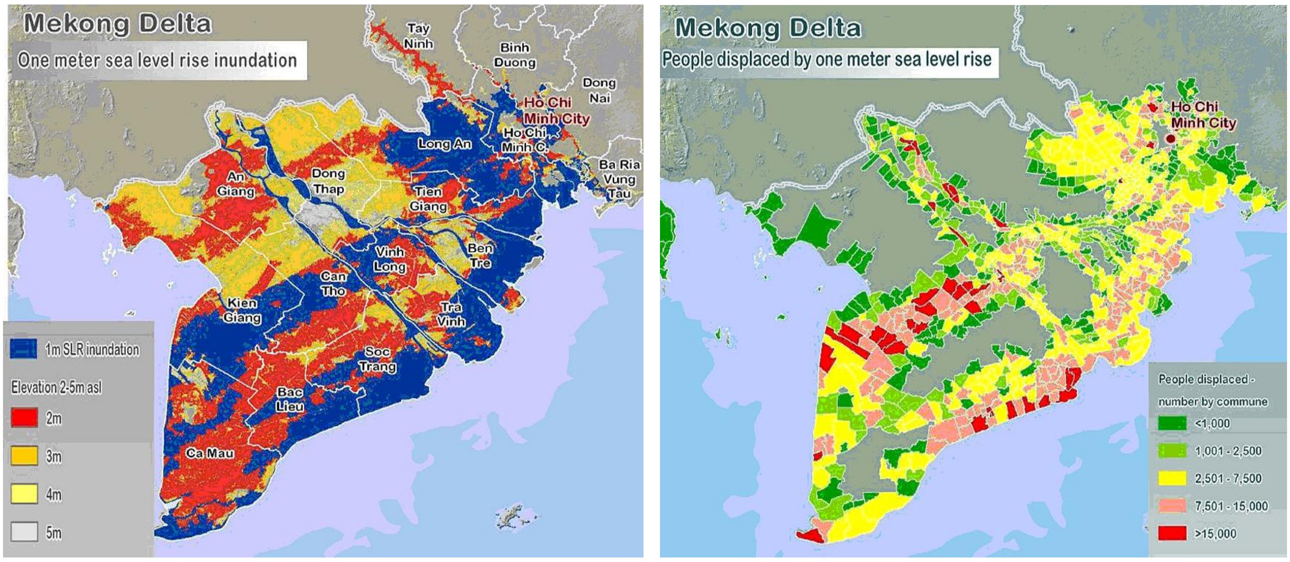
Source: MONRE, 2003

More importantly, Ho Chi Minh City is one of the top 10 Vietnam's southern provinces will be enormous affected by a projected 1 meter of sea level rise. As a largest urban area in the Mekong Delta, Ho Chi Minh City will be inundated with 43% of its total area, and more than 660,000 people (about 12% of the City's population) will be faced with placement (Carew-Reid 2007). Inundation and displacement of area and population in the Ho Chi Minh City and the Mekong Delta are illustrated in **Table 2** and **Figure 3**.

Table 2. Area and population affected by 1 meter sea level inundation

Province	Total area (sq. km)	Area inundated (sq. km)	Percent inundated	Number of people affected	People affected as percent of total population
Ben Tre	2,257	1,131	50.1	759,174	54.6
Long An	4,389	2,169	49.4	581,456	39.1
Tra Vinh	2,234	1,021	45.7	418,066	37.9
Soc Trang	3,259	1,425	43.7	457,821	35.0
Ho Chi Minh City	**2,003**	**862**	**43.0**	**664,074**	**12.1**
Vinh Long	1,528	606	39.7	364,414	31.6
Bac Lieu	2,475	962	38.9	383,764	44.8
Tien Giang	2,397	783	32.7	497,075	28.8
Kien Giang	6,224	1,757	28.2	295,989	18.6
Can Tho	3,062	758	24.7	426,511	20.8

Source: Carew-Reid, 2007



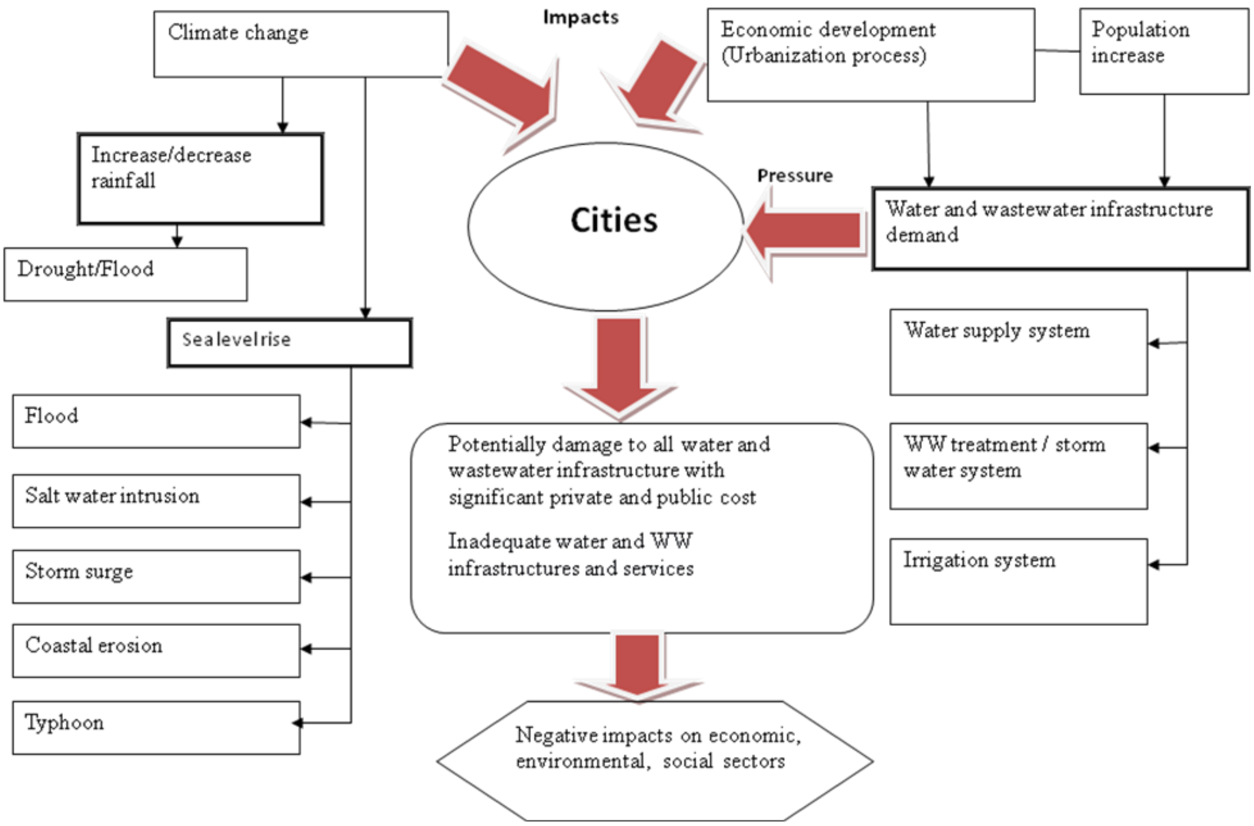
Source: Carew-Reid, 2007

Figure 3. Impacts on inundation of land areas and population displacement by a projected 1-meter sea level rise

2.2 Climate Change and Vulnerability Assessment in Ho Chi Minh City

2.2.1 Direct and Indirect Impacts of Climate Change at Community Level

According to literature review, the most critical areas for global environmental changes are coastal cities where they have to face risks from climate change. Pollution, erosion of wildlife habitat, water quality, water and wastewater infrastructure and increased vulnerability to possible sea level rise such as floods, salt water intrusion and subsidence were identified as immediate concerns of coastal cities (**Figure 4**).



(Source: Compiled by the authors from different cited sources)

Figure 4. Main climate change impacts related to water

The **Figure 5** provides an overview of key direct and indirect impacts of climate change in urban areas as outlined in the selected adaptation strategies (base on literature with many case studies). The Figure illustrates that some direct impacts are considered to cause much more indirect impacts than others and may, therefore, imply more challenges with respect to comprehensive adaptation strategies. In addition, the Figure shows that perceived potential impact-portfolios can vary drastically depending on the geographic location and bio-physical assets of the respective city.

Direct Impacts

1.Temperature increase

2. Sea level rise

3. Increase salt water intrusion

4. More intense rainfall

5. Increase in frequency and magnitude of flooding

6. Higher variability in local climate

7. Warmer winters and hotter summers

8. Increase occurrence of storms and storm surges

9. Stronger winter storms

10. Heat waves

Indirect Impacts in Urban Areas

- Loss of coastal land
- Problems for water supply and drainage systems due to more extreme events and climate variability
- Increased risk of flooding, also due to the combination of extreme events, storms and floods, can contribute to blockages of drainage system
- Lower water levels of lakes and rivers will raise water temperatures and aggravate water quality problems (higher concentration of contaminants)
- Increased risk of flood damages due to more severe and frequent urban flood events
- Major increase of hours and trips lost due to extreme events (e.g. aggregated traffic delays during storm periods, and due to flooded roads)
- Disruption of the transport system
- Increased risk of new vector-borne and water-borne diseases or changes in their spatial distribution, e.g. due to more severe disruptions of the sewage and drainage system
- Increased health risks, especially for elderly people
- Problems of energy supply during heat waves
- Increased mortality and health risk due to the combination of heat and air pollution
- Water demand heightened during hot, dry summers
- Higher risk of fires particularly in informal settlements
- Higher risk of wildfires and respective effects on biodiversity, particularly soil structure and spread of fire adapted alien invasive plants
- Reduced opportunities for shipping (on the Great Lakes due to lower water levels case)
- Decrease of fish population due to water temperature sensitivity, loss of biodiversity

Figure 5. Overview of selected direct and indirect impacts of climate change in urban areas (Case study in HCMC, Cape Town, Boston)

2.2.2 Vulnerability to Floods in Coastal Communities

HCMC is vulnerable because it is barely above sea level such as 40%–45% of land cover is 0–1 m in elevation, 15%–20% is 1–2 m, and very little land sits above 4m. HCMC has a large and growing population - residents number approximately 7 million and the dynamic economy draws migrants from all over the country; local development patterns especially infrastructure development are also affecting vulnerability and the local climate-urban development. There is a fact that current climate and hydrodynamics are already extreme and are expected to intensify so there will be more severe storms, storm surges, and tidal flooding (ADB, 2008 and ICEM, 2009)

According to research of ICEM (2009) proximity to flooding will also cause disruption to districts and communes even if they are not flooded. **Table 3** shows the numbers of communes in each district that might be faced with inundation in an extreme event (in category "0 km") and those with increasing distance from the flooded areas (<1km, <2 km, <5 km).

Table 3 Districts and communes vulnerable to extreme flood events in 2050

Risk indicator
0 km: Inundated
<1 km: Very high risk
<5 km: High risk
<10km: Medium risk
>10km: Low risk

District Name	Numbers of Communes in each District WITHOUT DYKE SYSTEM				Numbers of Communes in each District WITH DYKE SYSTEM			
	0 km	<1km	<2km	<5km	0 km	<1km	<2km	<5km
District 1	10				9	1		
District 2	11				10	1		
District 3	13	1			11	3		
District 4	15				14	1		
District 5	15				14	1		
District 6	14				10	4		
District 7	10				10			
District 8	16				13	3		
District 9	12	1			12	1		
District 10	15				15			
District 11	12	4			10	6		
District 12	9	2			9	2		
District Go Vap	7	8	1		6	9	1	
District Tan Binh	9	6			9	6		
District Binh Thanh	16	4			16	4		
District Phu Nhuan	5	9	1		1	10	4	
Thu Duc	9	1	1	1	7	3	1	1
Cu Chi	16	2	1	2	17	2	2	
Hac Mon	8		3	1	8		3	1
Binh Chanh	16				16			
Nha Be	7				7			
Can Gio	7				7			
District Tan Phu	5	6			4	4	3	
Binh Tan	8	2			4	5	1	
Total communes	265	46	7	4	239	66	15	2

Source: ICEM, 2009

2.3 Current Climate Change Adaptation Activities in Ho Chi Minh City

It is generally noted that climate change will impact future spatial patterns, growth and development in urban areas (World Bank, 2008). The urbanization trend created enormous economic and social benefits. In Asia, urbanization brings both opportunities and challenges. Roberts and Kanaley (2006) claim that most Asian countries have benefited from urbanization in terms of employment, lifestyles, welfare, social structures and institutions. On the other hand, people in cities are vulnerable to natural disasters and climate change (World Bank, 2008).

Up to date, Vietnam's national adaptation strategies have been focused on the reduction of risks of disasters, including disaster preparedness plans, the establishment of disaster forecast centers and awareness raising activities. However, such strategies emphasize on emergency responses to short-term climate extremes and reconstruction rather than long-term adaptive measures to climate change (MRC, 2009).

Primarily, Flood Prevention Center, under the Committee of Flood and Storm Control, is assigned to develop adaptation measures to climate change in HCMC. Some selected adaptation measures to climate change in Ho Chi Minh City are depicted in **Table 4**

Table 4 Overview of adaptation strategies and measures proposed for HCMC

Climate Change Impact/Stressor	Strategies/Goals	Measures
Floods and sea level rise	HCMC flood control plan/project and other responses	New dykes; resettlement; new institutions and programs (e.g., flood prevention centre under the Committee for Flood and Storm Control)
	Restoration and protection of urban wetlands and mangrove forests	Protection of mangrove forests; land use planning that controls development and protects urban sprawl into sensitive ecosystems
	Clearance of canals	Regular maintenance and removal of sediments and pollutants after floods
	Improved early warning for floods, storms and tidal waves	Improved technical early warning; improved communication procedures to people at risk
	Strengthening the resilience and reduction of exposure	Resettlement of population at risk; provision of new land for farmers in safer areas; upgrading of slum areas; resettlement of companies and businesses at risk
Sea level rise and salinity	Strengthening the resilience of urban agriculture	Promotion of drought-resistant crops and production patterns
Droughts and salinity	Resilient agriculture	Drought- and saline-tolerant crops; development of coping strategies at household level
Storms	Strengthening the coping capacity of farmers and fishermen	Storm protection barriers; promotion of resilient housing and infrastructure; and storm-resistant agriculture

Source: Birkmann et al ., 2010 and ICEM, 2009

3. Institutional Capacity and Policy Respond to Climate Change

3.1 National Policy Respond to Climate Change

The government of Vietnam ratified the UNFCCC in 1994 and the Kyoto Protocol in 2002. Subsequently, there are a number of policy documents were stipulated to enable the implementation of national commitments to address climate change issues.

Accordingly, the "National Strategy for prevention and mitigation to the year 2020" was approved by the Prime Minister in 2007. Importantly, the Vietnamese National Target Plan Program to Respond to Climate Change (NTP) was approved by the Prime Minister in December 2008 under Decision 158/2008/QD-TTg.

Accordingly, the Prime Minister is the head of "National Steering Committee for the National Target Program on responding to climate change" which was established in 03/2010 with the task of setting up "plan to prevent and overcome consequences of natural disasters, response and mitigate of negative consequences caused by climate change".

Referring to the general policy of the state, ministries, sectors and local authorities plan and carrying out measures to cope with climate change, the Ministry of Natural Resources and Environment (MONRE) has issued "Framework to guide the establishment of action plan to respond to climate change of ministries, sectors and localities" to guide the ministries, and local implementation. MONRE has also chaired the study and building of climate change scenarios for the whole of Vietnam and a number of specific areas to the orientation for further studies in other localities.

The Ministry of Agriculture and Rural Development has issued the Framework Program of Action to adapt to climate change of the agriculture and rural development in the period 2008-2020.

The local guidelines based on the framework were established to conduct the research and make plans to prevent and respond to the impacts of climate change. However, the framework is rather new to relevant actors and the awareness of climate change among the stakeholders has yet to be exact. Moreover, the lack of local manpower would also become crucial problem. Many localities just formed the agency for responding to climate change, but the agency actually has no specific activity. Many local agencies are still waiting for additional instructions and more detailed guidelines for the implementation.

3.2 Local Policy Respond to Climate Change

It is forecasted that the local is to bear with high level of impacts from climate change. Ho Chi Minh City has been received supports from many domestic and international organizations to research on the impacts and risks caused by climate change. The city also has generated programs and specific activities to cope with climate change. The city has assigned the Department of Natural Resources - Environment (DONRE) as the agency in charge of studying and advising the city government to conduct activities in this field.

The city also has a number of specific activities on the establishment of "Centre launched anti-submerged city of Ho Chi Minh", which is responsible for advising the planning and investment decisions for projects and anti-flooding works in the city. The city also issued Action Implementation Strategy on prevention and mitigation of the city by 2020; and the proactive prevention and response to inundation plan due to heavy rain and tidal intensity over the city.

The responding to changing of climate and sea level rise will require the cooperation of many departments in various fields with the participation of social organizations and communities. This generates the opportunity to build accurate, specific and realistic responding programs and action plans. Currently, DONRE of HCMC plays the role as Permanent Steering Committee. This department is responsible for making plans to respond to climate change, organizing official conferences on climate change, organizing action plan for dealing with climate change and being agency official spokesman. This shows that the cooperation and collaboration among the city government, official agencies, and other stakeholders remain poor and weak. Additionally, capacity of authorities at different levels to response to climate change is limited. Therefore, the conducting of the action plan will be poor performance and difficult to implement.

4. Urban Development in the Context of Climate Change in Ho Chi Minh City

4.1 Urban Development and Management

The current population of the City, including the number of visitors, is 10 million while the urban structure originally designed by the French in 1860 is for a population of 500,000 only. As such, the urban structure was overloaded. Saigon used to be a green city with the architectural space of the former French planning. Nowaday, it has changed dramatically into narrower green space and crowded with a number of houses, chaotic and non-uniform constructions. The following shows some major issues in Ho Chi Minh City:

4.1.1 The Fact of Land Use

As a result of an inventory of land by the Department of Natural Resources and Environment of Ho Chi Minh City implemented in 2008, agricultural land accounts for 1,213.1 km2 and shares 57.89% of total natural land area with most concentrated land is in the district Can Gio, Cu Chi, Binh Chanh. Agriculture land is divided into five categories as follows: agricultural land, land for forest, land for aquaculture, soil and salt, and other agricultural land.

Non-agricultural land occupied an area of 859.88 km2, accounting for 41.03% of the total natural area of land, divided into six categories as follows: Residential land, land for public purpose (including land offices, career building, land defense, security of land, land producing non-agricultural business, infrastructure hub), land for special use (religion, belief, cemeteries, rivers and ground water), and other non-agricultural land.

Unused land has an area of 2,253.56 hectares, accounting for 1.08% of total natural land area of the city.

In fact, urban land development in the City is being unreasonable used. Many development projects and urban residential areas are being conducted in areas of low ground, land along rivers and canals including storage areas of green area. Existing urban areas are exploited with low efficiency: building density is very high, but the floor area ratio (FAR) is very low. The space for green area and public activities in the inner city is very low.

4.1.2 The Demand of Housing Development

Housing development is a major issue in Ho Chi Minh City, according to the statistics; the city currently has approximately 1 million housing units and flats in urban areas. Since 2000, the housing space (floorage) in HCMC has increased by over 3 million m^2/year on average, particularly in 2004 the increase was nearly 4.2 million m^2, hence in total the city has approximately 90 million m^2 of housing floor. However, the housing demand has not been supplied. The too low incomes of urban dwellers in poor class have made them unable to afford for the housing. The workers' houses in the industrial parks and export processing zones and students' dormitories have failed to reach the quantity and quality as expected demands. The living quality in poor residential area must be considered as the bad condition in density, environment situation, disposal, and infrastructure. It is reported that there are more than 300,000 people in Ho Chi Minh city living in slums and up to 25% of dwellers is living lower than standard while most of new housing projects recently served the higher income people.

The city government has decided many solutions for housing investment, those lead to the operation of many investment projects, property development and the establishment of new residential area in the city, for example the program of serving 30,000 apartments for resettlement, or Social Housing Program and Program on "Building a million m^2 of housing accommodation of workers" are three major programs in Ho Chi Minh City to promote 2.85 million m^2 of floor area for low – income residence.

4.1.3 Transportation and Infrastructure Development

The transportation development status in Ho Chi Minh City has been seriously considered, particularly in congestion, road extension and railroad development etc.

The number of cars and motorcycles are increasing day by day and is claimed to be the reason for traffic congestion. The total number of registered motorcycles and cars in the city in 2005 was 3.64 million (510 vehicles per 1000 people) and 366,583 (51.4 cars per 1000 people). The increasing number of motorcycles has raised the total trips from 19.3 million per day by the year 2002 to 26.5 million per day in 2020 (as estimated population by 10 million). The major infrastructure of transport in HCMC is road, which provides

98% of the needs and the other 2% is waterway. However, the capacity of road network is very low when the ratio of road area occupancy is only 5.6 % and ratio of road network density is 4.4km/km^2. To solve the problem of urban traffic, Ho Chi Minh City has planed public transport systems and extended the road network.

Flooding is the one of the most serious issue in Ho Chi Minh City with 163 points flooded regularly. The cause of the flood situation was rushed by the low ground, sewer system overloaded and outdated, heavy rain and high tides. The city has actively implemented measures to reduce flooding by high tides in early 2008 by investing in 156 projects to build embankments to prevent high tides in 12 districts. However, the flooding will be more serious due to the climate change and sea level rise.

Clean water for people living in the city and the suburbs is the important task of urban development. The fact is only 83% of city households were supplied from water supply network. Other households used water wells from underground and surface water from rivers that have high risk of salinity and pollution. Besides, the rate of water loss is surprisingly high at 25% per day due to the damage and degradation of pipelines.

Water pollution in the canal must be concerned as well. For many years, this problem greatly affects public health. Bad sanitation causes health blood fever, diarrhea occurred in many areas of the city.

4.2 Urban Planning and the Risk of the Development According to the Master Plan

The Master Plan of Ho Chi Minh City was approved by the Prime Minister in January 2010, issues of land use are proposed by the orientation of economic development and social development of urban space. The Plan has assigned the increasing of the urban land use and infrastructure, especially housing and transportation. The urban land use is proposed to extend from 650 km^2 to approximately 1000 km^2 in 2025 and the housing is increasing from 90 million m^2 to 150 million m^2 (GOV, 2010).

Urban development in Ho Chi Minh City has been oriented by two major plans: The Regional Plan approved by Prime Minister in May 2008 and the Master Plan approved in January 2010.

4.2.1 Regional Planning and Urbanization in the Regional Level

According to the Regional Plan (MOC, 2009), Ho Chi Minh City has been defined as the role of Regional Center of the region including the entire city and the administrative boundaries of the provinces of Binh Phuoc, Long An, Tay Ninh, Binh Duong, Dong Nai, Ba Ria-Vung Tau and Tien Giang province with an area of 30,404 km2 in totally, within a radius of 150-200 km.

The estimated population of the region in 2020 is 20 to 22 million (16 to 17 million in urban) and in 2050 is 28 to 30 million (25 to 27 million in urban) with the urban land use is 18 to 21 thousand hectares in 2020 and 25 to 27 thousand hectares in 2050. The region is formed by urban areas, which are the center with the radius of 30 km (including the Ho Chi Minh City as a nuclear, the independent and dependent satellite cities) and the surrounding cities in Southeast, East, North, Northwest, and Southwest.

The cities' network is distributed based on their nature and function: general national cities, specialized scientific services, industrial park and service, regional industrial developments, tourism… Nuclear region is formed as the center of trade, finance, culture, science and art of international stature. In infrastructure development-oriented economic zone, there have been distributed training systems, regional health, housing and commercial services. In the plan, it is defined that there will be no setting up of industrial zones in central radius of 30 km, instead of that they will be transformed into industrial zones, industrial parks and high-tech clean industries.

Besides, the regionally technical infrastructure has also oriented the separate development of each sector: Transport (roads, railways, waterways, and airports), land preparation construction engineering, water supply, electricity supply, drainage, solid waste, cemetery, burial technology and ecological environment protection.

In general, the Regional Plan of Ho Chi Minh City has determined the maximum development of urban space, however this project has not been completely identified and studied the scenarios of climate change, especially has not identified the risk of areas flooded when sea levels rise. Many development areas identified in the South area of the region and along the Dong Nai River, Vam Co River have not been integrated with the sea level rising scenarios.

4.2.2 Urban Planning in Ho Chi Minh City

According to the Master Plan (GoV, 2010), the City is developed with 15 km of inner radius and 4 poles of development. The main vision of development has been oriented towards multi-center city and developed the city by two major directions of East and South towards the sea and two sub directions towards the west side: North-West and South–West. In the Plan, the Scheme Regulation is very strict on urban areas, conservation areas and ecological restoration of natural protected areas such as Can Gio mangrove forest and protected and special use forests in Binh Chanh, Cu Chi districts.

(i) Urban Structure and Framework for Development

The City Center is located at the old area. The new area is developed in Thu Thiem while the urban areas are expanded into 4 directions:

- ***To the East:*** develops along corridor of the expressway: Ho Chi Minh City - Long Thanh - Dau Giay and Ha Noi Highway. This leads the city to highly densed development towards the Eastern and the new international airport. The new city center – Thu Thiem and many new urban areas will be developed as this direction, included many low land areas along the Dong Nai and Saigon River.

- ***To the South:*** The corridor of development is Nguyen Huu Tho highway, which is oriented for the city to move towards the sea. The city harbor is moved to the downstream of Saigon River. Especially, the new harbor city, Hiep Phuoc, will be built with 500.000 residences.
- The direction to the North West establishes the new urban area (The North-West City) to connect with Cambodia through a corridor of development.
- The corridor development of the South-West direction connects to Mekong Delta which compliantly protect rivers, does not reduce surface water for consumption, the city's drainage.

(ii) Urban Land Use Planning

The structure of urban land use has been defined in 3 main parts: the old inner city, the extension inner city and the development towns, which are new urban areas at suburban districts. According to the plan, the urban area includes the existing 13 districts, 6 new districts and 5 suburban districts. The total area is about 209,600 ha with the size of the population in 2025 is expected to be 10 million.

The old inner city includes 13 existing districts with total area of 14,200 hectares and a population size of 4.5 million in 2025, the function of which was: general government center with administrative functions, cultural, historical, tourist and service sectors.

The extension inner city includes six new districts (districts 2, 7, 9, 12, Thu Duc, Binh Tan) has an area of 35,200 hectares, is expected to have 2.9 million people, will be focusing on urban construction, modern new scale, synchronous social infrastructure and urban technology. In particular, the main center of expansion will be located in the Thu Thiem New Urban Area in District 2 and has an area of 737 hectares. There will also a number of underground transportation, public works and underground parking at some locations in the area. The natural typology indicates that all of these districts are the lowland lying areas and affected by sea level rise.

The towns - new urban in five suburban districts (Binh Chanh, Hoc Mon, Cu Chi, Nha Be, Can Gio) accounts for 160,200 ha and an estimated population of 2.5 million in 2025, with focus investment in construction of residential rural model and some areas of modern satellite city to motivate the development of suburban districts.

The Master Plan has also determined the size and location of protected areas and agricultural land conversion that are not functioned and the reserved land for the green system and the city park. In term of industrial areas, the Plan has relocated all of the polluting industrial enterprises from the old inner city, limited the development of industrial areas in the inner city development. New industrial clusters will be built in the district of Cu Chi, Hoc Mon, Binh Chanh and Nha Be.

The plan has combined agricultural development with ecological belt in the district of Cu Chi, Hoc Mon, Binh Chanh, Can Gio. The Plan also considers the protection of agricultural land with size of about 43,600 hectares of suburban districts to form the third ring line with ecological green space. The regional conservation areas and ecological restoration in protected areas of natural mangrove forest area of Can Gio biosphere reserve covers about 75,000 ha of special use forests with the strict prohibition of building in these areas.

(iii) Urban Infrastructure Planning

The Master plan has proposed many solutions to develop residential area, housing and public education, cultural center, health center and public service systems in accordance to the increasing population and development municipality. Oriented urban development and land use planning for areas of new construction are based on four development directions, mainly in east and south direction.

This report cannot present all of the planned orientation and only focus on important issues such as the development of the transport network and planning the code of ground elevation for construction.

- ***The development of transportation:*** To ensure regional development and establish the new urban areas, especially to serve the increasing demand for transport, the Plan has identified a new urban traffic network in a mixed type of road, railway and waterway. In particular, the major objectives are development of belts 03 and 08 axes of road network, forming a network of regional railway linkage and the urban railway network consists of six lines with total length up to 120 km. The road network promotes the city to develop in four directions, focusing on two main directions of East and Southeast. For those, the network has to be improved the capacity by development of new routes and increasing of land used for traffic. Despite taking only less than 1.5% of traffic demand, waterway network has been oriented to take advantage of developing terrain of canals, especially at the south of the city. In addition, the seaport system is moved towards the sea and allocated the new town for harbor development in Hiep Phuoc.
- ***Oriented planning of ground elevations*** of the city has taken into account the flooding because of tides. This orientation defined that the controlled minimum elevation of urban areas in Ho Chi Minh City is 2.0 m while the highest tide in the last 50 years is up to 1.5m. To limit the flooding caused by tidal conditions, some areas are protected by dikes with heights up to 3m. However, the elevation of 2.0 m only is calculated to prevent flooded by tidal but this is not integrated with the sea level rise scenarios.
- ***Besides the solution of elevation management***, the Master Plan has oriented solutions to upgrade drainage system and prevent flooding. Specifically, include the upgrading of sewage systems, improved canal system, preserving green areas and natural areas to facilitate natural drainage. Yet this is also common solution to limit the flooding tide, while the forecasts of rising sea levels have not been up to.

4.3 Climate Risk and Urban Development

Generally, the Regional Plan and Master Plan of Ho Chi Minh City are not integrated with the predicted sea level rise that is clearly showed by climate change scenarios of the Ministry of Natural Resources and Environment. The Plan only solves the current issues of urban development such as land use, public works and infrastructure to serve the population increasing. However, the structure urban area and the planed new urban areas are at risk of flooding due to the impact of sea level rise. Many residential areas, new city centers, new hubs of infrastructure planned at Nha Be, Cu Chi, Can Gio are lowland areas. Especially, the Hiep Phuoc Harbor City is being proposed by many scientists to reconsider because of the high risk due to climate change.

There exists an elevation planning for construction, but this planning is only based on the current tidal level, while without considering of the impact of heavy rain and sea level rise. It is said that, if high tide, heavy rain and sea level rise happened at the same time, the water level would exceed that elevation. Transportation is planned in a modern and multi-model network way, but most of the projects are located in the East, South and South West in which lands are low and river network is too dense. The investment of construction cost is high, meanwhile many projects encounters the fact of high risk due to floods.

Within this report, it is not the intention of the group to mention all the risks of urban development in the context of climate change, but only mentioned some concerns about the risk of social, cultural aspect and natural landscape of the city.

- Firstly, the risk of flooding will affect the living of communities, especially in urban area with highly dense population located along the river channel. Moreover, many planned residential areas and new urban areas located in low lands will face with high risk of flooding when the sea level is rising.
- Secondly, cultures and habit of living along the river might be demolished by not only flooding but also by non - thoughtful solutions for example: building high dikes to separate communities with the waterfront, or concreting of riverbanks, which will lead to destroying of natural landscapes along the river.
- The last but not least, public health is one of the most concerned problems in those flooded areas. Current pollution of river in addition to hygiene issues after floods should be seriously taken into consideration, especially for groups of the poor who are living along the river channel and workers who are living in low standard residential areas.

5. Climate Change Adaptation and Urban Governance in Ho Chi Minh City

The quality of government at the local level has a potentially significant impact on climate risk (Tanner et al., 2009). Municipal governments are responsible for decisions on quality and provision of infrastructure, disaster preparedness and disaster response, and city planning development. HCMC's government has direct influences on poverty and vulnerability which is though the extent of their provision on water, sanitation, drainage, solid waste collection public health and housing construction and improvement.

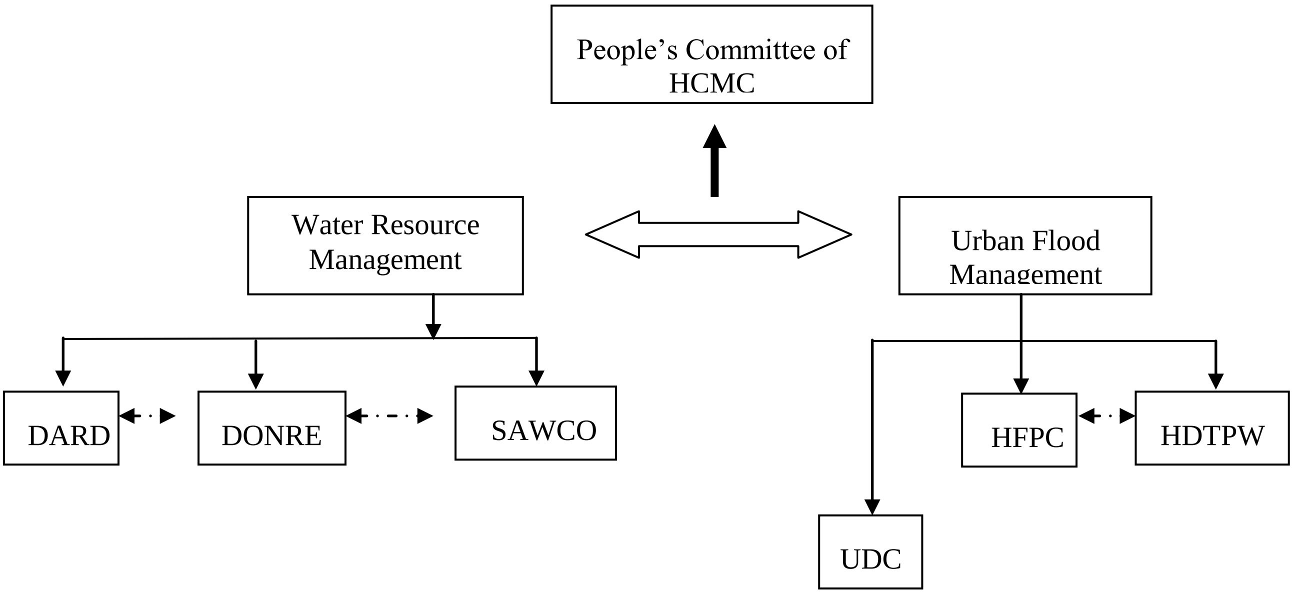
Like many municipal governments in developing countries, HCMC's government do not have adequate provisions in order to deal with increased climate hazards such as flood and salt water intrusion management.

In HCMC, the Department of Planning and Architecture is responsible for planning. But as the department is technically under the Ministry of Construction, all architectural, planning and construction aspects of a project have to observe ministry regulations. All technical revisions or adjustments regarding design, construction height and other details must be approved by the Ministry. In essence, the main function of the department is not to implement planning and architecture but administrate. The department consults the City People Committee leaders on city planning, assesses planning for group of projects, is a link between foreign investors and the Committee, guides investors on architectural criteria and regulations, receives planning documents and solves problems and requests from citizens on architectural and planning issues, and consults districts on architecture and planning. The Department assists architects and companies in detailed designing of housing projects and public works (Tanner et al., 2009).

HCMC is given more autonomy to solve urgent problems related to disaster management in other sectors. Facing more frequent adverse natural phenomena, the City People's Committee has set up the City Steering Committee for Flooding and Storm Prevention. The Committee is in charge of resolving problems related to natural disasters and building management strategies for the city. Overall though, natural disaster prevention include flood risk is more decentralized than any other sector.

HCMC is also allowed by the Central Government to raise funds to carry out flooding and storm prevention activities without submitting to the government. Under decision No 43/2006/QĐ-UBND each city dweller must pay a fee for flood and storm prevention activities in the city. The City People's Committee has also specified, in Decision No 166/2003/QĐ-UB, the authority and responsibilities of different organizations at each level (city, district and commune/ward) for natural disaster management, enabling each organization to work independently for a fast and effective response.

According to information from the HCMC Bureau of Water Management and Flood Prevention, HCMC has begun a short-term flood prevention projects since mid of 2008. Those projects are implementing by Department of Transportation, Flood Prevention Center work with Urban Drainage Company, Department of Agriculture and Rural Development. Currently, the main agencies responsible for water resources management and urban flood management are shown in **Figure 6**.



Where:

- DARD: Department of Agricultural and Rural Development
- DONRE: Department Of Natural Resources and Environment
- SAWACO: Saigon Water supply Company
- HFPC: HCMC Flood Prevention Center
- HDTPW: HCMC Department of Transport & Public Works
- UDC: Urban Draining Company

Figure 6. Organizational diagram of water resources management and flood prevention

Having experienced serious losses caused by severe flooding and storms in recent years, the Government as well as the city authority has been forced into strengthening its disaster prevention and preparedness capacity. However the activities of the Committee have been more passive and reactive than proactive. Natural disaster prevention or climate change adaptation strategies have not been prioritized in agendas of the City People's Council meetings. As described above, the decision-making in the disaster management sector is more decentralized than other areas. Yet environmental issues have received little attention by the city authority and little has been done with regards to climate change adaptation.

HCMC governance was assessed by main indicators and summarized in **Table 5**.

Table 5. Summary of climate resilient governance indicators in HCMC

Indicators				
Decentralization and Autonomy	Transparency and Accountability	Responsiveness and Flexibility	Participation and Inclusion	Experience and Support
• Highly centralized urban planning • Decentralized disaster management • Lack of financial autonomy	Lack of transparency and access to information	• Reactive disaster management • Lack of capacity and coordination limit responsiveness	Lack of participatory decision making	Experience in dealing with storm and flooding

Source: Tanner et al., 2009

HCMC has no unified information centre and poor data collection and storage. In the area of disaster management especially climate change impacts such as food, salt water intrusions, drought , it is very difficult to access information and despite public debates demanding more transparency there has been little progress. Important information is only available through informal channels. There are few mechanisms for citizens to access all useful information of water management, flood prevention, and pollution control.

6. Conclusion

Ho Chi Minh City is the heart of Southern provinces and the Mekong Delta. While taking its leading role in contributing GDP to the country and region, the City is subject to be most vulnerable to climate change impacts and consequences. Being a coastal city, future development of Ho Chi Minh City will be enormously affected by climate change impacts. Such impacts include intensity of urban flooding, increase in inundation of urbanized areas, increase in epidemic and infectious diseases, and exacerbation of public health of the population.

Therefore, a comprehensive research on climate change vulnerability of the City is needed. Future strategies and adaptation measures need to be built up for urban sustainable development. Most importantly, potential climate change consequences must be taken into consideration in adjusting and reviewing regional and master plan.

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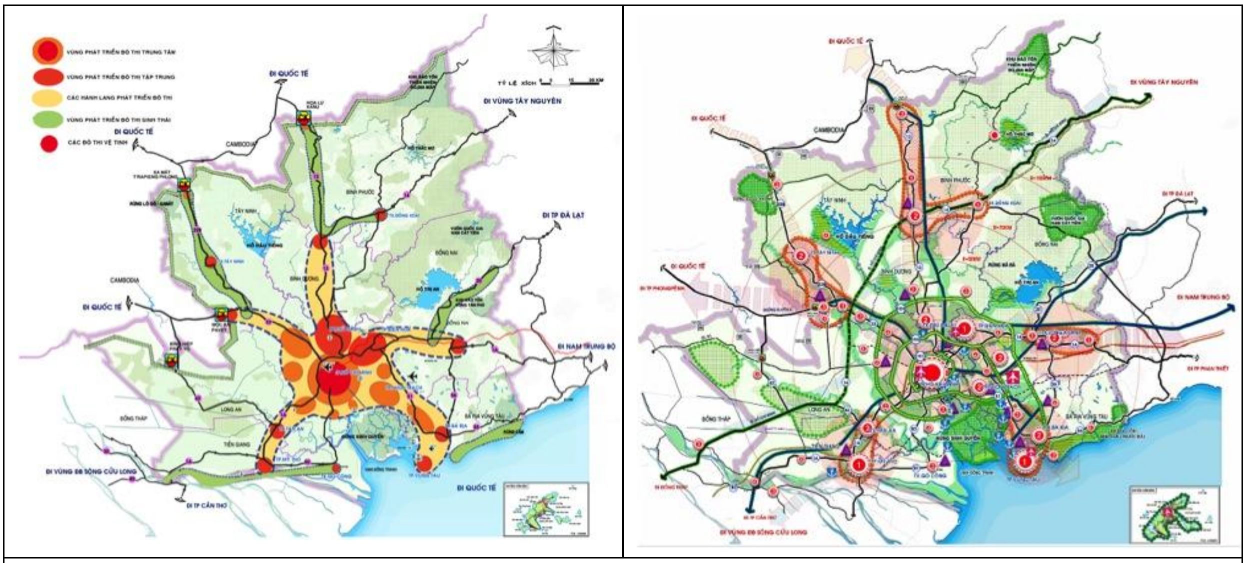
8. Appendices

Appendix 1

Map of Planning the Region of Ho Chi Minh City



The Orientation for development of Region of Ho Chi Minh City

Source: MoC, 2010

Appendix 2

Losses by common hazards in HCMC from 1997 to 2007

Factors	Parameter	Storm	Whirl-wind	Landslide	High tide and Heavy rain	Total losses
Death	person	5	4	2	0	**11**
Injured	person	2	43	0	2	**47**
Unfound	person	2	0	0	0	**2**
Destroyed house	house	363	102	13	0	**478**
Partial damaged house	house	2,383	958	75	23	**3,439**
Flooded house	house	0	0	0	10,062	**10,062**
Partial damaged department	unit	33	15	0	0	**48**
Flooded department	unit	116	0	0	9	**125**
Damaged irrigation system	part	11	0	0	2	**13**
Slided dyke	m	2,308	0	3,892	1,419	**7,619**
Affected area along the river	m^2	0	0	2,760	0	**2,760**
Overflowed dyke	km	0	0	0	65	**65**
Destroyed dyke	part	0	0	0	691	**691**
Broken road	km	33	0	0	158	**190**
Affected plants	unit	160	35	0	0	**195**
Agricultural losses	ha	1,282	0	10	4,236	**5,528**
Fishery losses	ha	768	0	0	241	**1,008**
Damage fruit plants	tree	14,855	0	0	0	**14,855**
Affected shrimp/fish breeding farm	unit	1	0	0	0	**1**
Affected shrimp/fish seed	Mil. of individual	0	0	0	11	**11**
Affected boats	unit	14	0	0	0	**14**
Affected river bed		116	0	0	0	**116**
Electrical losses	line	34	108	0	0	**142**
Damaged coal industries	ton	0	0	4,000	0	**4,000**
Loss of construction materials	m^3	0	0	0	120	**120**
Total of monetary lost	**Mil.USD**	**7**	**1**	**2**	**2**	**12**

Source: Data analyzed from HFSPA, 2008

Appendix 3

Vietnam's National Target Plan to Respond to Climate Change

(In the attach file**)**

THE PRIME MINISTER	THE SOCIALIST REPUBLIC OF VIETNAM
	Independence - Freedom - Happiness
No: 158/2008/QĐ-TTg	*Hanoi, 2 December 2008*

DECISION
on approval of the National Target Program to respond to climate change

THE PRIME MINISTER

Pursuant to the Law on the Organization of the Government dated 25 December 2001;

Pursuant to Resolution No. 60/2007/NQ-CP dated 03 December 2007 of the Government;

Upon the proposal of the Minister of Natural Resources and Environment,

DECIDES:

Article 1. Approve the National Target Program to respond to climate change (hereinafter referred to as the NTP) with its main contents as the follows:

I. VIEWPOINTS, GUIDING PRINCIPLES, AND SCOPE

1. Viewpoints

- Response to climate change should be carried out following the principle of sustainable development, encompassing sectors and inter-sector links, regions and inter-regional links, gender equality, and hunger eradication and poverty alleviation.

- Activities responding to climate change must be carried out with clear focus to ensure to effectively respond to immediate impacts as well as potential long-term impacts; investment in response to climate change is an important factor to ensure sustainable development; immediate response will help to mitigate future damages.

- Response to climate change is the responsibility of the whole political system, the society, sectors and organizations at all levels, and every individual. It requires consensus and a strong determination at local, regional, national and global level.

- Tasks to respond to climate change must be integrated into development strategies, programmes, plans, planning in all sectors and at all levels; into legal documents and policy institutions; into development of legal documents and their implementation.

- Following the principle of "common but differentiated responsibility" as defined in the United Nations Framework Convention on Climate Change

(UNFCCC), Vietnam will effectively implement measures to mitigate green house gas (GHG) emissions with sufficient finance support and technology transfer from developed countries as well as other international funding sources.

2. Guiding principles

- The Government gives the unified, overall direction to activities to respond to climate change; the Ministry of Natural Resources and Environment is the standing agency to collaborate with relevant agencies to assist the Government in directing this area.

- Ensure the compliance to the State's direction, policy and legal system; protect the sustainable development of the country and cultural and spiritual values for the present and the future.

- Enhance effectiveness and efficiency of State administration and promote responsibilities of all organizations and individuals in response to climate change. Gradually perfect institution and organizational system from central to local level raise awareness and popularize experiences in response to climate change.

- The NTP must be implemented synchronously with clear phasing and focus; in both immediate and long-term period; actively, promptly and effectively, thus ensuring sustainable development for each region and sector.

- The State ensures the necessary resources, and mobilizes contributions of domestic and international communities to invest in activities to respond to climate change; develops and implements measures to respond to climate change for comprehensive exploitation, in harmony with natural systems and the country's development.

- Ensure the implementation of international commitments on responding to climate change.

3. Scope

The NTP will be implemented for the whole country in three phases:

- First Phase (2009 - 2010): Starting up

- Second Phase (2011 - 2015): Implementation

- Third Phase (after 2015): Development

II. OBJECTIVES

1. General Objectives

Strategic objectives of the NTP are to assess climate change impacts on sectors and regions in specific periods and to develop feasible action plans to effectively respond to climate change in the short-term and long-term to ensure sustainable development of Viet Nam, to take opportunities to develop towards a low-carbon economy, and to join the international community's efforts in mitigating climate change and protecting the climatic system.

2. Specific Objectives

a) To identify the extent of climate change in Vietnam due to global climate change and assess climate change impacts on every sector, area and locality;

b) To identify measures to respond to climate change;

c) To promote scientific and technological activities to establish the scientific and practical basis for climate change response measures;

d) To consolidate and enhance the organisational structure, institutional capacity and the development and implementation of policies to respond to climate change;

e) To enhance public awareness, responsibility and participation; and develop human resources to respond to climate change;

f) To promote international cooperation to obtain external support in response to climate change;

g) To mainstream climate change issues into socio-economic, sectoral and local development strategies, plans and planning;

h) To develop and implement action plans of all ministries, sectors and localities to respond to climate change; to implement projects, and first of all pilot projects to respond to climate change.

III. TASKS AND SOLUTIONS

1. Assessment of climate change extent and impacts in Viet Nam

The key tasks to be implemented immediately are to assess climate variability, develop climate change scenarios, particularly sea level rise; and assess climate change impacts on different fields, sectors and localities.

a) <u>Targets to be achieved by 2010</u>

- Complete climate change scenarios, especially sea level rise, in Vietnam by early 2009 based on existing studies so that sectors and localities can use the scenarios to develop their action plans to respond to climate change;

- Complete the assessment of level, nature and trend of climate factors and phenomena in Vietnam;

- By the end of 2010, update climate change scenarios, especially sea level rise, for each period between 2010-2100. The scenarios must have a solid scientific and practical basis;

- Complete the development of the scientific basis, methodologies, and guidance on assessment of climate change impacts, especially sea level rise, on fields, sectors and localities;

- Implement pilot projects to assess climate change impacts, especially sea level rise, on fields, sectors and localities which are sensitive and vulnerable to climate change, i.e. water resources, irrigation, agriculture, health and livelihoods, deltas and coastal areas.

b) Targets to be achieved by 2015

- Update climate change scenarios, especially sea level rise, in Vietnam;

- Complete assessment of climate change impacts, especially sea level rise, on fields, sectors and localities.

2. Identification of measures to respond to climate change

Development and selection of measures to respond to climate change are based on results of climate change impact and vulnerability assessment for fields, sectors, and localities.

a) Targets to be achieved by 2010

- Complete the development of methodologies and guidance for identifying measures to respond to climate change;

- Implement a number of pilot projects to respond to climate change for fields, sectors and localities that are sensitive and vulnerable to climate change and sea level rise.

b) Targets to be achieved by 2015

- Complete development of measures to respond to climate change for fields, sectors and localities;

- Start to implement selected measures to respond to climate change for fields, sectors and localities according to action plans.

3. Development of a science and technology program on climate change

Develop and implement a national science and technology program on climate change to provide the scientific basis for the development of policies, institutions and action plans to respond to climate change;

a) Targets to be achieved by 2010

- Complete design and development of a basic framework for climate change data;

- Develop a national science and technology program on climate change; identify and start to implement tasks regarding science and technology.

b) Targets to be achieved by 2015

- Complete and update the climate change database;

- Effectively implement the national science and technology program on climate change in ministries, sectors and localities;

- Update and effectively implement research on nature, trend and scenarios of climate change impacts on sectors/regions and response measures, thus contribute to strengthening capacity to respond to climate change.

4. Strengthening the capacities of organization, institutions and policy on climate change

Review the current legislation and policy system, and assess the current way of addressing climate change in the State's legal documents and policies; develop, supplement and perfect the legal document system, mechanisms and policies to ensure the legal basis for activities to respond to climate change.

a) Targets to be achieved by 2010

- Basically develop a framework of legal documents, mechanism, and policies to respond to climate change;

- Develop, promulgate and implement a mechanism for coordination among the ministries, sectors, and localities, and the NTP management and implementation apparatuses.

b) Targets to be achieved by 2015

- Promulgate, supplement and update legal documents, policies and mechanisms to respond to climate change;

- Identify mechanisms and policies to prioritize activities to respond to climate change;

- Review, supplement and perfect the mechanism for coordination among agencies responsible for climate change issues.

5. Awareness raising and human resources development

Strengthen communication and education to raise the awareness and responsibilities on climate change issues for the whole society; enhance human resource development, especially highly qualified human resources.

a) Targets to be achieved by 2010

- Develop an awareness-raising plan and start to implement the plan at sectors/localities which are sensitive and vulnerable to climate change;

- Start to implement an awareness raising plan in the education and training system; materials and tools for raising awareness developed and popularised;

- Develop a human resources development plan and start to implement the plan at sectors/localities which are sensitive and vulnerable to climate change;

- Over 10% of population communities and over 65% Government's staff possess basic knowledge on the climate change and its impacts.

b) Targets to be achieved by 2015

- Gradually and effectively implement climate change awareness raising plan at central and local levels;

- Complete, update and widely popularise materials and tools for raising awareness on climate change;

- Implement the awareness-raising plan and the human resources development plan in training and education system at all levels;

- Over 80% population communities and 100% Government's staff will possess basic knowledge on climate change and its impacts.

6. Enhancement of International Cooperation

Taking opportunity to obtain and effectively use support from the international community, including financial support and technological transfer through bilateral and multilateral cooperation channels. Participate in regional and global cooperation activities on climate change.

a) Targets to be achieved by 2010

- Establish a cooperation mechanism between Vietnam and international donors in implementing the NTP;

- Establish bilateral and multilateral cooperation between Vietnam and some other countries/international organizations to respond to climate change;

- Vietnam proactively contributes to the development of international agreements/documents on climate change;

- Supplement and perfect the framework of legal documents on mechanisms/policies to encourage investment into CDM projects, climate change response projects, and environmentally friendly technology transfer projects to facilitate foreign partners to invest into projects in Vietnam.

b) Targets to be achieved by 2015

- Complete and effectively implement the cooperation mechanism between Vietnam and international donors in implementing the NTP;

- Continue to expand bilateral and multilateral cooperation between Vietnam and other countries/international organizations to respond to climate change;

- Promote the role of Vietnam in regional and international negotiations and cooperation on climate change.

7. Mainstreaming climate change issues into socio-economic, sectoral and local development strategies, plans and planning

Potential impact of climate change and response measures are considered in development, adjustment and supplementation of strategies, programs, planning and socio-economic development and sectoral/local development plans (hereinafter referred to as development plans).

a) Targets to be achieved by 2010

- Complete the assessment of climate change impacts, especially sea level rise, on development plans;

- Complete the classification of response measures for each development plan;

- Develop and issue legal documents and guidance documents on how to comprehensively mainstream climate change issues into development plans; start to mainstream climate change issues into development plans according to the legal decisions issued.

b) Targets to be achieved by 2015

- Mainstream climate change issues into development plans for the period 2010-2020;

- Assess the results of the mainstreaming process applied for development plans for the period of 2010-2015;

- Widely and effectively implement the mainstreaming of climate change issues into development plans for later periods.

8. Development of Action Plans of Ministries, sectors and localities to respond to climate change

Ministries, sectors, and localities develop their action plans to respond to climate change. The development of the action plans is carried out step by step following a predefined procedure, ensuring quality, feasibility, and effectiveness of implementation.

a) <u>Targets to be achieved by 2010</u>

- Ministries, sectors, and localities complete the development of action plans to respond to climate change;

- Ministries, sectors and localities administering fields and areas sensitive and vulnerable to climate change start to implement their action plans.

b) <u>Targets to be achieved by 2015</u>

- Ministries, sectors, and localities initiate implementation of action plans to respond to climate change.

9. Develop and implement projects of the Program

In the period of 2009-2010: develop and implement prioritized projects to respond to climate change for sectors/localities that are sensitive and vulnerable to climate change, thus take lessons learnt to perfect action plans for comprehensive implementation in the period of 2011-2015.

Portfolio of projects and estimated budget to implement the projects is in the Annex attached to this Decision.

IV. FINANCIAL MECHANISM AND RESOURCE MOBILIZATION

1. Financial mechanism

- The State ensures necessary resources, and mobilizes domestic and international supports; the State provides a legal basis to encourage participation and investment of socio-economic components and domestic and overseas organizations in activities to respond to climate change;

- Combine with other programs and projects to attract more investments;

- Projects and investment activities under the NTP will be considered to obtain tax remission in accordance with the legislation.

2. Budget

The budget for implementing activities of the NTP in the period of 2009 - 2015 (excluding funds for the implementation of the Action Plans of Ministries, sectors, and localities) is estimated at 1,965 billion VND, of which the structure of investment finance sources is as follows:

+ Foreign capital: 50%.

+ Domestic capital: 50%, within which:

- Central budget: about 30%;
- Local budget: about 10%;
- Private sector and other capital contributions: about 10%.

The budget of the NTP for the post-2015 periods will be defined in accordance with concrete objectives of each period.

3. Budget planning methodology

Procedures of planning, annual estimated budget development, budget allocation, management, disbursement and auditing follow existing regulations on management and implementation of national target programs.

Article 2. Organization for implementation

1. Establish the National Steering Committee, Executive Board, and Standing Office of the NTP

a) The National Steering Committee for the National Target Program to Respond to Climate Change (hereinafter referred to as the Steering Committee) comprises of: the Prime Minister - Chairman; Minister of the Ministry of Natural Resources and Environment - Standing Vice Chairman; Minister of the Ministry of Planning and Investment - Vice Chairman; Minister of the Ministry of Finance - Vice Chairman; Others Members are the Minister of the Ministry of Agriculture and Rural Development and Minister of the Ministry of Foreign Affairs.

b) Executive Board of the NTP (hereinafter referred to as the Executive Board) comprises of: the Minister of the Ministry of Natural Resources and Environment - Chairman; the two Vice Chairmen are a Vice Minister of the Ministry of Planning and Investment and a Vice Minister of the Ministry of Finance; Other members are representatives of the Ministries of Agriculture and Rural Development, Foreign Affairs, Industry and Trade; Labour, Invalids, and Social Affairs; Transportation; Construction; Information and Communication; Education and Training; Home Affairs; Health; Science and Technology; Culture, Sport and Tourism; Defense; and Public Security.

The Minister of Ministry of Natural Resources and Environment shall submit to the Prime Minister functions, tasks, and operational regulations of the Steering Committee and the Executing Board.

c) The Standing Office of the NTP, located at the Ministry of Natural Resources and Environment, is an assisting agency of the Executing Board to co-ordinate activities of the NTP.

The Minister of Ministry of Natural Resources and Environment shall promulgate operation regulation of the Standing Office of the NTP.

2. Responsibilities of Ministries, sectors, provinces, and related organizations

a) Ministry of Natural Resources and Environment

The Ministry of Natural Resources and Environment, according to the assigned State management functions responsibilities, shall assist the Executive Board to coordinate activities of Ministries, sectors, provinces in managing and implementing the NTP, focusing in the following main tasks:

- To chair and co-operate with the relevant agencies and authority of different levels in developing mechanism, policies for the management and execution of the implementation of the NTP to submit to the Prime Minister for issuing or to issue according to the assigned functions and tasks;

- Based on the NTP implementation plan, calculate the necessary budget to submit to the Executing Board in order to summarize and incorporate into annual funding plans reported to the Ministries of Planning and Investment and Finance in accordance with the Law on State Budget;

- To guide and assist ministries/sectors/provinces in developing and implementing their action plans to respond to climate change;

- To inspect, test, and regularly assess and draw lessons learnt from implementation of the NTP;

- To generally co-ordinate the activities of the publication of information, training, education, and communication related to climate change;

- To annually synthesize and report to the Prime Minister results of the NTP implementation, and propose measures to resolve problems that are outside the Ministry's functions and authority;

- To chair, co-ordinate with Ministry of Planning and Investment to develop a monitoring and evaluation mechanism for NTP implementation;

- To instruct, monitor and evaluate NTP implementation;

- To develop and implement action plans of the Ministry to respond to climate change, and carry out assigned projects/plans.

b) Ministry of Planning and Investment:

- To take the lead and co-ordinate with other ministries/sectors/provinces to develop a standard framework procedure and guidelines for mainstreaming climate change issues into socio-economic development strategies, programs, plans and planning;

- To co-ordinate with the Ministry of Natural Resources and Environment in the development of a monitoring and evaluation mechanism for NTP implementation;

- To develops and implements action plans of the Ministry to respond to climate change.

c) Ministries, ministerial agencies and other Governmental authorities:

To develop and implement their action plans to respond to climate change;

carry out tasks assigned by the NTP; proactively participate in common coordinated activities under the direction of the Steering Committee.

d) People's Committees of Provinces and central-governed Cities

- To develop and implement action plans to respond to climate change in their provinces and cities;

- To organize the implementation of related activities approved in the NTP;

- To ensure the correct and efficient use of funds allocated under the NTP;

- To mobilize additional resources and combine all related activities of other programs within provinces/cities to achieve the objectives of the NTP;

- To comply with the monitoring and evolution principles defined in the NTP;

- To periodically report on the implementing progress of the NTP objectives and tasks at the provincial/ city level.

e) Social Organizations, Non-Government Organizations, and Enterprises

Promote political-social organizations, unions, non-government organizations, private sector, and enterprises, according to their functions and roles, to actively participate in climate change response activities, especially in the area of information, education and communication; support and mobilise the communities in active participation, expansion and dissemination of experiences of climate change response models; implement or participate in the NTP and action plans of Ministries, sectors and localities.

4. Monitoring and Evaluation

Monitoring and evaluation of the NTP implementation is carried out at national, sectoral, and local level:

- District level

+ The Division of Natural Resources and Environment is responsible for information collection, synthesis, management and archiving of information, and prepares regular reports;

+ The People's Committee at district level periodically submits reports to the standing agency of the NTP of provinces and centrally-governed cities.

- Province and City level

+ The Department of Natural Resources and Environment is responsible for management and archiving of relevant information and data; monitoring and instruction of district level units to submit their report timely;

+ The People's Committee of province and centrally-governed city synthesize and submit regular reports to the Executive Board.

- Central level:

+ Ministries and sectors are responsible to regularly report to the Executive Board.

+ The Executive Board is responsible for management and archiving of information reported by provinces and centrally-governed cities; monitoring and instruction of ministries, sectors, provinces, and centrally-governed cities to submit their report timely; checking sources and reliability of information; development of regular reports and submitting the reports to the Steering Committee to submit to the Prime Minister.

Article 3. This decision shall come into force after fifteen (15) days from the date of its publication in the Official Gazette.

Article 4. Ministers, Heads of Ministerial equivalent bodies, Heads of Government's agencies, political and social organizations, and Chairmen of People's Committees of provinces and centrally-governed cities bear responsibility to implement this Decision./.

PRIME MINISTER

[*signed and sealed*]

Nguyễn Tấn Dũng

To:

- Central Party Secretariat;
- Prime Minister, Vice Prime Ministers;
- Ministries, ministerial equivalent bodies, government agencies;
- The Office of Central Steering Board on Anti-corruption;
- People's Councils, People's Committees of provinces and centrally-governed cities;
- Central Party Office and departments;
- Presidential Office;
- National Assembly Ethnic Minority Committee and other committees;
- National Assembly Office;
- The Supreme People's Court of Vietnam;
- The Supreme People's Procuracy;
- State Auditor;
- Management Board of Bo Y International Border-Gate Economic Zone;
- Bank of Social Policies;
- Vietnam Development Bank;
- Central level Office of unions and associations;
- Government Office:
- VPCP: BTCN, Chairperson, Vice Chairpersons, departments, bureaux, subordinate units, Official Gazette;
- Filing: archives, KTN (5 copies).

THE PRIME MINISTER

THE SOCIALIST REPUBLIC OF VIETNAM

Independence - Freedom - Happiness

ANNEX: LIST OF TASKS AND PROJECTS FOR IMPLEMENTING THE NATIONAL TARGET PROGRAM TO RESPOND TO CLIMATE CHANGE IN THE PERIOD OF 2009-2015

(Enclosed with Decision No. 158/2008/QĐ-TTg dated 02 December 2008 of the Prime Minister)

No	Category, task, project	Leading Agency	Collaborating Agencies	Tentative budget (VND b)	Execution period
I. Assess climate change intensity and develop climate change and sea level rise scenarios				**38**	
1	- Assess climate change in Vietnam: develop methodologies to assess climate variability and climate change; assess variability and characteristics of climatic elements and phenomena, particularly temperature, rainfall, natural disasters and climatic extremes; assess tendency of climatic elements: temperature, rainfall, sea level, natural disasters (typhoon, flood, drought, etc.). - Develop climate change and sea level rise scenarios; identify scientific basis and methodologies; analyze and assess global and regional climate change scenarios; develop specific climate change and sea level rise scenarios in the period of 2010-2100 for each region of Vietnam.	Ministry of Natural Resources and Environment	Ministries, sectors, and localities	38	2009-2015
II. Develop and implement science and technology programs on climate change				**350**	
2	Develop and implement national science and technology programs (medium and long terms) to provide scientific basis for development of institutions, policies and plans to respond to climate change. Main contents are:	Ministry of Science and Technology and Ministry of	Ministry of Agriculture and Rural Development, Ministry of Planning	350	2009-2015

No	Category, task, project	Leading Agency	Collaborating Agencies	Tentative budget (VND b)	Execution period
	- Enhance researches on phenomena, scientific nature, and unclear facts of climate change; impacts of climate change on socio-economic activities; analyze and assess socio-economic effective (cost-benefit) of activities to respond to climate change; - Consider mainstreaming climate change issues into environmental protection programs, reasonable use of natural resources programs, natural disaster prevention programs, and marine research programs, etc.; - Promote research on scientific basis to enhance climate and climate change monitoring system; - Develop databases for climate change impacts assessment; - Develop technologies to mitigate green house gases emission and technologies to adapt to climate change - Promote the development of coordination mechanism among research, education/ training and technology implementation institutions in the related areas; - Promote international cooperation in scientific and technological activities, effectively apply and transfer climate friendly technologies.	Natural Resources and Environment	and Investment, other ministries, sectors and localities		
III. Building capacity of organization, institution, policy on climate change				**104**	
3	Develop documents, instructions, and resolutions on Climate change of the Secretariat of the Central Committee of Communist Party and the Politburo.	Ministry of Natural Resources and Environment (invite Office of the Central Committee of Communist Party to chair)	Ministry of Planning and Investment, other ministries, sectors and localities	4	2009-2010

No	Category, task, project	Leading Agency	Collaborating Agencies	Tentative budget (VND b)	Execution period
4	Establish and consolidate the management and organization systems of the Program, and action plans to responds to climate change at central and local level and at relevant ministries and sectors.	Ministries, sectors and localities	Ministry of Natural Resources and Environment, Ministry of Home Affairs, other ministries, sectors and localities	100	2009-2010
IV. Awareness enhancement and human resources training				**292**	
5	Develop plans and programs to raise awareness of selected groups in the Communist Party, State administration system, social organizations, media and the community.	Ministry of Natural Resources and Environment	Ministry of Public Security, Central Department of Propaganda and Training, other ministries, sectors, localities and social organizations	60	2009-2015
6	Develop education and training programs on climate change in school curricula.	Ministry of Education and Training	Ministry of Natural Resources and Environment, Ministry of Public Security, relevant ministries, sectors and localities	70	2009-2015
7	Establish thematic channels on public media (newspaper, radio, television, web, etc) for climate change information exchange.	Ministry of Information and Communication	Ministry of Culture, Sports and Tourism, Ministry of Natural Resources and Environment, Ministry of	60	2009-2015

No	Category, task, project	Leading Agency	Collaborating Agencies	Tentative budget (VND b)	Execution period
			Agriculture and Rural Development, Ministry of Education and Training and relevant ministries, sectors, localities, and social organizations		
8	To propagate and raise awareness of public community on climate change.	Ministry of Natural Resources and Environment (invite Vietnamese Fatherland Front to co-chair)	Vietnam General Federation of Labour, social organizations, ministries, sectors and localities	15	2009-2015
9	To propagate and promote awareness on the role of women and gender issues in climate change responding activities.	Ministry of Natural Resources and Environment (invite Vietnam Women's Union to co-chair)	Vietnam General Federation of Labour, Ministry of Public Security, social organizations, ministries, sectors and localities	7	2009-2015
10	Conduct awareness raising programs and contests on climate change.	Ministry of Natural Resources and Environment (invite Ho Chi Minh Communist Youth Union to co-chair)	Vietnam General Federation of Labour, social organizations, ministries, sectors and localities	80	2009-2015

No	Category, task, project	Leading Agency	Collaborating Agencies	Tentative budget (VND b)	Execution period
V. Enhance international cooperation				**50**	
11	Enhance capacity to participate in regional and international negotiations on climate change.	Ministry of Natural Resources and Environment	Ministry of Foreign Affairs, other Ministries, sectors and localities	25	2009-2015
12	Enhance international information exchange system on climate change.	Ministry of Natural Resources and Environment	Ministry of Foreign Affairs, other Ministries, sectors and localities	25	2009-2015
VI. Develop a standard framework for mainstreaming climate change issue into development				**60**	
13	Develop a standard framework for mainstreaming climate change issue into development.	Ministry of Planning and Investment	Ministries, sectors, localities, and Office of Climate Change Executive Committee of sectors and localities	60	2009-2015
VI. Develop and implement action plans to respond to climate change				**921**	
14	Develop and implement action plan to respond to climate change of the Ministry of Natural Resources and Environment. - Assess impacts of climate change and sea level rise on sectors administered by the Ministry; - Identify measures to respond to climate change and sea level rise for sectors administered by the Ministry; - Mainstream climate change issues into strategies, programs, plans and planning of the Ministry; - Implement other relevant tasks: improve and upgrade climate monitoring system and climate and natural disasters	Ministry of Natural Resources and Environment	Ministry of Planning and Investment, other ministries, sectors and localities	450	2009-2015

No	Category, task, project	Leading Agency	Collaborating Agencies	Tentative budget (VND b)	Execution period
	early warning system; develop integrated river basins management model and integrated coastal zone management model towards adapting to climate change; improve forecasting and warning capacity for natural disasters prevention and mitigation; propose measures to rehabilitate damages caused by natural disasters; and implement pilot projects.				
15	Develop and implement action plan to respond to climate change of the Ministry of Agriculture and Rural Development. - Assess impacts of climate change and sea level rise on sectors administered by the Ministry; - Identify measures to respond to climate change and sea level rise for sectors administered by the Ministry; - Mainstream climate change issues into strategies, programs, plans and planning of the Ministry; - Implement other relevant tasks: develop coastal eco-economic models to respond to climate change; study science bases, realities and propose projects on socio-economic development in regularly dry areas; Propose to integrate climate change issues into development of measures to ensure security of water sources, sea dyke system, reservoir; propose measures to develop protective forests (upstream forests and coastal forests) in accordance with climate change scenarios; study to modify management strategy and planning on protected areas system of Vietnam to respond to climate change; and implement pilot projects.	Ministry of Agriculture and Rural Development	Ministry of Natural Resources and Environment, Ministry of Planning and Investment, and other ministries, sectors and localities	120	2009-2015
16	Develop and implement action plan to respond to climate change of the Ministry of Planning and Investment. - Assess impacts of climate change and sea level rise on	Ministry of Planning and Investment	Ministry of Natural Resources and Environment,	60	2009-2015

No	Category, task, project	Leading Agency	Collaborating Agencies	Tentative budget (VND b)	Execution period
	sectors administered by the Ministry; - Identify measures to respond to climate change and sea level rise for sectors administered by the Ministry; - Mainstream climate change issues into strategies, programs, plans and planning of the Ministry; - Implement other relevant tasks: collaborate with the Ministry of Natural Resources and Environment to develop guidelines for mainstreaming climate change issues into socio-economic development plans of localities and development plans of Ministries/sectors; plans to respond to climate change for regions and areas; develop mechanisms and policies to encourage investment into clean development mechanism, emission reduction, and environmental protection; and implement pilot projects.		Ministry of Agriculture and Rural Development, and other ministries, sectors and localities		
17	Develop and implement action plan to respond to climate change of the Ministry of Public Security. - Assess impacts of climate change and sea level rise on sectors administered by the Ministry; - Identify measures to respond to climate change and sea level rise for sectors administered by the Ministry; - Mainstream climate change issues into strategies, programs, plans and planning of the Ministry; - Implement other related tasks: develop curriculum/training manual and practice/drill in rescuing and fast reacting to urgent situations relating to climate change, natural disaster; implement pilot projects.	Ministry of Public Security	Ministry of Natural Resources and Environment, Ministry of Planning and Investment, and other ministries, sectors and localities	24	2009-2015
18	Develop and implement action plan to respond to climate change of the Ministry of Defense. - Assess impacts of climate change and sea level rise on sectors administered by the Ministry;	Ministry of Defense	Ministry of Natural Resources and Environment, Ministry of Planning and	12	2009-2015

No	Category, task, project	Leading Agency	Collaborating Agencies	Tentative budget (VND b)	Execution period
	- Identify measures to respond to climate change and sea level rise for sectors administered by the Ministry; - Mainstream climate change issues into strategies, programs, plans and planning of the Ministry; - Implement other related tasks: including adjust plans, planning towards climate change adaptation; develop curriculum/training manual and practice/drill in rescuing and fast reacting to urgent situations relating to climate change/natural disasters; and implement pilot projects.		Investment, other ministries, sectors, localities		
19	Develop and implement action plan to respond to climate change of Ministry of Transportation. - Assess impacts of climate change and sea level rise on sectors administered by the Ministry; - Identify measures to respond to climate change and sea level rise for sectors administered by the Ministry; - Mainstream climate change issues into strategies, programs, plans and planning of the Ministry; - Implement other related tasks: develop measures to adjust planning and designs of transport works**;** plan and methods of emission reduction such as: energy saving and proper use, strengthening of use of friendly-environmental new energies; traffic jam reduction; and implement pilot projects.	Ministry of Transportation	Ministry of Natural Resources and Environment, Ministry of Planning and Investment, and other ministries, sectors, localities	18	2009-2015
20	Develop and implement action plan to respond to climate change of Ministry of Industry and Trade. - Assess impacts of climate change and sea level rise on sectors administered by the Ministry; - Identify measures to respond to climate change and sea level rise for sectors administered by the Ministry; - Mainstream climate change issues into strategies, programs, plans and planning of the Ministry;	Ministry of Industry and Trade	Ministry of Natural Resources and Environment, Ministry of Planning and Investment, and other ministries, sectors, localities	80	2009-2015

No	Category, task, project	Leading Agency	Collaborating Agencies	Tentative budget (VND b)	Execution period
	- Implement other related tasks: energy saving and proper use; study and apply emissions-reduction technologies and energy saving (focus on renewable energies use); study and propose measures ensuring energy security to climate change adaptation; study and propose measures to respond to climate change in trade activities; and implement pilot projects.				
21	Develop and implement action plan to respond to climate change of Ministry of Health. - Assess impacts of climate change and sea level rise on sectors administered by the Ministry; - Identify measures to respond to climate change and sea level rise for sectors administered by the Ministry; - Mainstream climate change issues into strategies, programs, plans and planning of the Ministry; - Implement other related tasks: measures to high temperate/heat wave adaptation; measures to prevent water and intermediary born diseases, etc caused by climate change; solutions of epidemic prevention for regions / climatic refugees; sanitary methods of epidemic prevention after natural disasters (typhoons, floods, droughts); measures to control new diseases caused by climate change; study and propose additional contents in health criteria, norms to respond to climate change; and implement pilot projects.	Ministry of Health	Ministry of Natural Resources and Environment, Ministry of Planning and Investment, and other ministries, sectors, localities	15	2009-2015
22	Develop and implement action plan to respond to climate change of Ministry of Construction. - Assess impacts of climate change and sea level rise on sectors administered by the Ministry; - Identify measures to respond to climate change and sea level rise for sectors administered by the Ministry; - Mainstream climate change issues into strategies, programs,	Ministry of Construction	Ministry of Natural Resources and Environment, Ministry of Planning and Investment, and other ministries, sectors, localities	42	2009-2015

No	Category, task, project	Leading Agency	Collaborating Agencies	Tentative budget (VND b)	Execution period
	plans and planning of the Ministry; - Implement other related tasks: measures to adjust technical infrastructure planning, urban areas according to climate change scenarios; study and propose additional contents in construction criteria, norms, technical directions to respond to climate change; and implement pilot projects.				
23	Develop and implement action plan to respond to climate change of Ministry of Labour, Invalids and Social Affair. - Assess impacts of climate change and sea level rise on sectors administered by the Ministry; - Identify measures to respond to climate change and sea level rise for sectors administered by the Ministry; - Mainstream climate change issues into strategies, programs, plans and planning of the Ministry; - Implement other related tasks: research and propose measures in term of employment security, poverty reduction for the most vulnerable areas caused by climate change; research and propose solutions and plans on migration, resettlement and life security for residents in the most vulnerable areas caused by climate change and sea level rise; issues on gender, population, livelihood; issues on HIV and other social evils; and implement pilot projects.	Ministry of Labour, Invalids and Social Affair	Ministry of Natural Resources and Environment, Ministry of Planning and Investment, and other ministries, sectors, localities	80	2009-2015
24	Develop and implement action plan to respond to climate change of the National Committee for Search and Rescue. - Assess impacts of climate change and sea level rise on research and rescue sectors; - Identify measures to respond to climate change and sea level rise in search and rescue sectors; - Integrate climate change issues into the Committee's strategies, plans and planning;	Ministry of Defense	Ministry of Natural Resources and Environment, Ministry of Planning and Investment, and other ministries, sectors, localities	10	2009-2010

No	Category, task, project	Leading Agency	Collaborating Agencies	Tentative budget (VND b)	Execution period
	- Mainstream climate change issues into strategies, programs, plans and planning of the Committee; - Implement other related tasks: research and establish salvage and rescue network in adaptation to climate change for each region/sector and natural disaster; develop regulations to ensure effectiveness of salvage and rescue network; and implement pilot projects.				
25	Develop and implement action plan to respond to climate change of the Ministry of Culture, Sports and Tourism. - Assess impacts of climate change and sea level rise on sectors administered by the Ministry; - Identify measures to respond to climate change and sea level rise for sectors administered by the Ministry; - Mainstream climate change issues into strategies, programs, plans and planning of the Ministry; - Implement other related tasks: research and propose measures on conservation of cultural and tourism areas to respond to climate change; and implement pilot projects.	Ministry of Culture, Sports and Tourism	Ministry of Natural Resources and Environment, Ministry of Planning and Investment, and other ministries, sectors, localities	10	2009-2010
26	Provinces, Central-governed cities: - Assess impacts of climate change and sea level rise to their localities; - Develop action plans to respond to climate change and sea level rise.	People Committees of provinces and Central-governed cities	Ministry of Natural Resources and Environment, Ministry of Planning and Investment, and other ministries, sectors, localities	150	2009-2010
	Total budget ***Say in words: One thousand nine hundred sixty five billions Vietnam Dong*** (*This budget excludes budget to implement action plans of Ministries, sectors, localities. Budget to implement action plans of Ministries, sectors, localities will be specified in these plans*)			**1,965**	2009-2015

Table of Contents

JAKARTA CITY TEAM

JAKARTA CITY REPORT

Information related to Climate Change in Jakarta City

Indra M. Surbakti, Izhar C. Idroes, Hendricus A. Simarmata and Tommy Firman

Paper prepared for the Workshops of Climate Change Vulnerability Assessment and Urban Development Planning for Asian Coastal Cities, Rose Garden Sampran Riverside, Nakorn Pathom, Thailand, 22 – 28 August, 2010

JAKARTA CITY REPORT

Jakarta City Report is a review of climate change information status that can be collected and had been understood by the Jakarta team members. This report's aim is to assess the present status of climate change knowledge and research gap of Jakarta. All information that has been put in this report came from secondary data sources and our own experiences in conducting previous research or other works in Jakarta.

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Introduction

Jakarta as the capital city of Indonesia is vulnerable to environmental change due to its location on the northern coast of Java Island. The metropolitan is the largest city in Indonesia as well as being the capital of the country and the center of business. Due to these characteristics, the city is susceptible to external shocks. Jakarta's environmental condition is also considered far from ideal due to its vulnerability to floods, rising sea water and other natural disasters as well as man-made calamity such as pollution and excessive extraction of ground water. The International Panel on Climate Change (IPCC) listed higher temperatures over land and sea, higher sea level, higher humidity as some of the ten indicators of climate change. A study by Yusuf and Fransisco (2009) listed Jakarta as the most vulnerable city to climate change in Southeast Asia.

Jakarta is also a magnet for people looking for better living conditions. These include poor people who came to Jakarta. Based on the 2008 Poverty data released by BPS, Jakarta still has approximately 400.000 poor population and around 300.000 near poor population which are vulnerable to any external shocks, including environmental change. There are also slum areas in several parts of Jakarta where many of these people reside. To assess whether or not these people are at risk from climate change, one must first obtain information on the environmental conditions of Jakarta.

This report attempts to address the current perceived conditions of climate change in the city of Jakarta as well as the readiness of the local government and its people in coping with the impact of climate change. The report also states some evidence of climate change impact, such as rising sea water and constant flooding. Finally, recommendations on what the local government should be done to cope with climate change.

Current perception of climate change related risk

- **General public**

  Most of people in Jakarta recognize that flood disaster not only caused destruction of private and public infrastructure, but also disrupted the fabric of social and economic conditions of the people who calls Jakarta their home. Flood disaster has increased the level of social and economic vulnerability of Jakarta. Most people also believe that the level of stress in Jakarta has increased, especially for the poor or marginalized people who are often involved in the communal conflict, such as mass brawl between communities in Jakarta. BPS data (based on the Village Potential Survey 2008) listed 8 villages in Jakarta (two in North Jakarta) where communal conflict occurred in the last three years. The recent Tanjung Priok incident which pitted public order officials against locals concerning the removal of a sacred tomb emphasized the ease in which things can easily go out of control and can potentially cause large financial loses within the conflict area. There are also other more natural incidences of disaster such as the dengue outbreak which usually occurs during transition from dry to wet season. Thus, it could be surmised that disaster such as these is the determinant factor for socio-economic vulnerability of the people of Jakarta.

The above opinion is supported by a number of NGO's statements in the mass media, such as EEPSEA, KIARA, IHI, KNTI, and FKNJ who stated that Jakarta is a vulnerable city. Several studies have even suggested that Jakarta is one of the most vulnerable cities. But the question in everyone's mind is whether the main cause of these disasters is natural or human? Perhaps the best answer is both. Nevertheless, there is still no sufficient evidence that can corroborate that statement.

Some research have concluded that these disasters were caused by climate change, such as a study released by the BRKP (Board of Ocean and Fisheries Research, 2010) which concluded that the flood which occurred more and more often in Jakarta coastal area caused by climate change, especially Sea Level Rise (SLR) and High Precipitation. But another study conducted by JEDI (Jakarta Emergency Dredging Initiative, 2008) stressed that other local factors may also have affected the flood, such as land subsidence in several locations and the failure of land use control and infrastructure maintenance.

> The project developed a framework to find the decisive causes of, and proper measures against flooding. The main conclusions are:
> (1) successive rainstorm in January and February cause floods in the Jakarta area,
> (2) high sea tides in combination with **subsidence cause** floods in the Northern part of the city, and
> (3) insufficient maintenance of infrastructure aggravates the floods.
>
> (Brinkman, Jan Jaap and Hartman, Marco, 2008)

Thus, when we are talking about the vulnerability, it can be inferred that socio-economic vulnerability has been increased by the disaster risk factors, but the problem now is that which factor is the more dominant factor in increasing the risk of disaster? Climate change factors or the lack of urban management capacity did.

- **City officials and city managers**

  Currently, the Jakarta Capital City Government does not have a policy which specifically tailored to climate change. However, they do have policies on disaster mitigation such as, a system of rapid mass transportation system which include the Trans Jakarta bus system and the upcoming MRT system. There is also a policy of conversion from kerosene to gas stove with a target of 2 million residents in Jakarta and 1 million small enterprises. In addition, Jakarta also plans to increase green open space areas to 30 percent in 2030 and reducing carbon emission to around 30 percent.

  Perceptions on climate change within the high level Jakarta Capital City Government can be obtained from the news. For instance, the Head of Social Division said that poor citizens are very vulnerable to the impact of climate change. Thus, the Jakarta Government provides Neighborhood Empowerment Program (*Program Nasional Pemberdayaan Masyarakat Kelurahan/PNPM*) to create opportunities for poor people to develop themselves. The policy actually aimed at reducing poverty and not adapting to climate change. Other comments came from the head of Environmental Management Board who stated that several regulations have been implemented such as air quality control, absorption well, and gas emission control and other social activities such as a car free day on Sunday, bio-pore absorption hole, smoke free zone, and river/drainage normalization. The head of city planning has developed a green building policy and tried to implement it to the real estate development in Jakarta, especially for superblock and mix land use development.

  Thus, even though it can be surmised that the Jakarta Capital City Government has some mitigation policy for disaster prevention, there are still gaps in which the Jakarta Government still needs to address. One major problem is implementation as well as enforcement. The so-called smoke free zone is not really effective throughout Jakarta due to lack of enforcement. People are still seen smoking in places where the there is suppose to be a ban. Another paramount issue is that the Jakarta Government still lacks adaptation policy or program for climate change. Many have argued that climate change is on the horizon and people have no choice but to adapt to the changes. The main problem is that there is difficulty in finding the proper instrument to measure the level of adaptation. It is this issue that opportunity for research can be done to explore the form and mechanism of adaptation policy in micro, mezzo, and macro scale of development.

Assessment of Climate Risks in Jakarta

Climate risk can be understood as risks that variables in the climate/weather system reach values that affect human life adversely. However, one must distinguished between natural climate change and that caused by indiscriminate human tampering of the environment. Jakarta has experienced a number of natural disasters over the years. The highest number of natural disasters is the flood which appears to occur every year and in almost all the villages in Jakarta. Jakarta also has to deal with rising sea water, particularly in North Jakarta municipality and the Thousand Island district where high tides coupled with growing incidence of rising sea water is a growing concern.

Table 1. Number of Villages Where Natural Disasters Occurred in Jakarta during the last 3 years by Municipality and Type of Disaster

Municipality	Flood	Rising Sea Water	Twister	Landslide
Thousand Islands	-	4	3	-
South Jakarta	42	-	-	-
East Jakarta	43	-	1	1
Central Jakarta	27	-	-	-
West Jakarta	37	-	-	-
North Jakarta	29	3	1	-
Total	178	7	5	1

Source: BPS, Podes 2008

A personal view of the sea water level in Ancol Amusement Park is higher than the previous year (2007). Other natural disasters but does occur frequently are twisters or tornadoes and landslides. Jakarta also experienced the after effect of earthquakes quite a number of times during a year. Fortunately, Jakarta is not close to the earthquake fault lines, even though the effect of an earthquake elsewhere in the archipelago can sometimes be felt in the capital. If there are earthquakes in Indonesia that can affect Jakarta, its epicenter is usually too far away from Jakarta to cause any significant damage. Nevertheless, Jakarta is still vulnerable to other natural and manmade disasters as well as other environmental changes.

A study conducted by Yusuf and Fransisco found that Jakarta is the most vulnerable mega city in Southeast Asia to climate change (2009). The report showed that Central and North Jakarta is ranked 1 and 2 of the most vulnerable districts in Southeast Asia. Central Jakarta is most at risk because of incidences of flooding, whereas North Jakarta also experienced flooding caused by rainfall and rise in sea water. Other districts in Jakarta such as East, West and South Jakarta are also on the top list, although Central Jakarta is considered the most adaptive compared to the other districts.

There are several climate risk assessment activities that have reportedly been in Jakarta. Here are several climate risks factors have been assessed:

1. **Floods caused by Rainfall, Temperature, and Sea Level Rise**
   A study conducted by The Center for Sea and Coastal Development at Bandung's Institute of Technology (2007) concluded that the sea water level off the coast of Jakarta increased by 0.8 meter. It was also projected that by 2050 some areas in Jakarta, such as Kosambi, Penjaringan, and Cilincing will be under water if global warming continuous at the current pace. This conclusion seems to be corroborated by a vulnerability assessment of Jakarta and Java Island by Rahmadi et.al (2009), using 2(two) approaches, firstly, by MRI method with Japan Model Scenario for DKI Jakarta Province. Secondly, by PRA method in the neighborhood scale (Kelurahan Kamal Muara). The conclusion is that the sea level rise is projected to inundate most of Central Jakarta and will likely cause a significantly large socio-economic impact. Climate related hazards that frequently occurred in Kamal Muara (Penjaringan Sub-district) are sea level rise, flood caused by sea water or high tide, and climate uncertainty
2. **Inundation caused by Sea Level Rise and High Tide**
   The Coastal Vulnerability Index (CVI) Mapping of Jakarta, Tangerang, Surabaya, Pekalongan, and Bekasi by Board of Ocean and Fisheries Researh (2009) using Haesller & Timmer, USGS (2001) has shown that there are 4 (four) sub-districts in Jakarta which experienced flood caused by Sea-Level Rise.
3. **Heat Stress caused by Urban Heat Island**
   A study undertaken by Sobry Efendy (2007) attempted to develop a functional relationship between air temperature and urban green space using Landsat data. It also aims to estimate the contribution of various forcing, namely, urban green space, population density, urban area, and automobile densities to urban heat island. The

result stated that a 50% reduction in urban green space would bring air temperature to rise between 0.4 to 1.8^{o}C and Automobile density is found to be the most important cause of urban heat island in Jakarta.

4. **Disease Outbreak and water scarcity caused by Rainfall and Air Quality**
   Based on a study by Haryanto (2009), diseases stemming from vehicular emissions and air pollution include acute respiratory infection, bronchial asthma, bronchitis, and eye and skin irritations (Boer et al., 2007) and it has been recorded that the most common disease in northern Jakarta communities is acute upper respiratory tract infection – at 63% of total visits to health care centers (Indriyanti and Pedrique, 2006).
5. **Water Scarcity, Air Pollution, and GHG Emissions**
   Water scarcity is an additional issue as a result of global and regional climate change in which between 2010 and 2015 the country is predicted to experience a major clean water shortage, and this is expected to occur mainly in urban areas (Boer et al., 2007). Air pollution is proven to be a major environmental hazard to residents in Jakarta, regardless of their socio-economic status. Transportation comprises 27 % of Indonesia's GHG emissions, and traffic congestion is a huge problem in Jakarta (Pelangi, 1999).

In our opinion, the climate risks assessments in Jakarta which are conducted by sectoral government institutions, are mostly in the coastal area, and used the IPCC model and GCM data. The gap that we have here is that there is no linkage or even integration among the sectors' risks assessment. In urban development, we should deliver the interdisciplinary approach to achieve the coherent and appropriate solution. Therefore, we think that the cross cutting risks assessment should be introduced to identify the current and future aggregate climate risks. The aggregate risks will be more useful to create stronger and more effective urban policies for climate change.

Thus, the opportunity to conduct research emphasized comprehensive and integrated climate risk analysis to achieve relative risk index among vulnerable zones. The relative risk index as well as other indicators o climate change are needed by the stakeholders to assess the conditions of areas in Jakarta, and to identify the capabilities of their regions and institutions to be more resilient and adaptive to climate change.

Assessment of Social Economic Vulnerability of Jakarta

The social vulnerability is a term under which the social structure of a community or a society is exposed to shock or stress typically brought about by economic strife, environmental changes, and government policies or even caused by internal events and forces resulting from a combination of factors (SOPAC 2003). In this paper, the impact is from climate or environmental change.

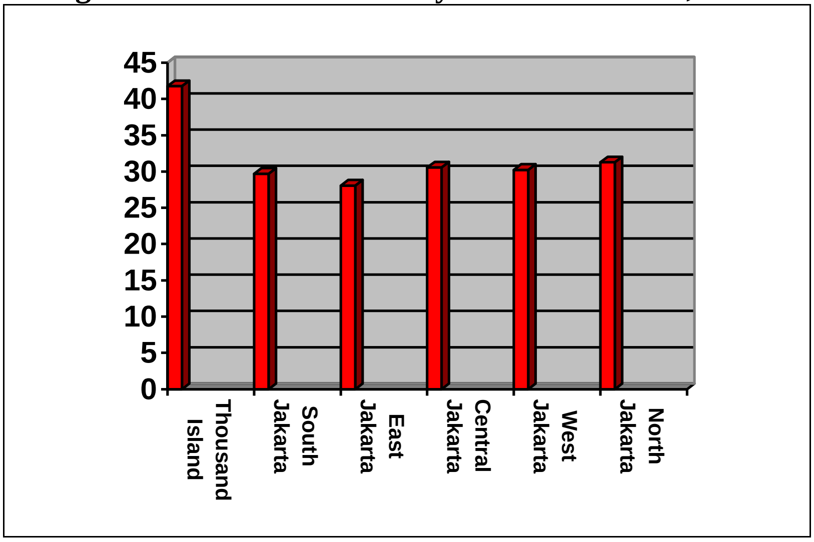
Social vulnerability concerns with the human side of climate change. Treating environmental hazards as merely geological phenomena separates them from the social environment and ignores the human impact (Wisner 2005). Thus, it is important to assess the human side of the environmental change.

Officially, assessment and mapping on social/economic vulnerability has not been done yet in Indonesia. Most of the vulnerability assessment still focuses on vulnerability to conflict or economic crisis. BPS, as the primary collector of statistical data in Indonesia, has been conducting data collection on vulnerability from the recent global economic crisis. However, BPS has been experimenting on the development of some measures of vulnerability to environmental change. One of those few measures is the so-called social vulnerability index.

The social vulnerability index is one measure to assess the impact of these external forces which include environmental change. BPS has developed an index which assesses the exposure of Indonesian society from social conflict and economic crisis. In terms of social vulnerability to environmental change, some parts of Jakarta can still be considered vulnerable socially. The areas on the northern part of Jakarta, i.e., North Jakarta and Thousand island Municipalities have higher social vulnerability index than other parts of Jakarta.

It means that these areas of Jakarta are the most vulnerable parts of Jakarta. North Jakarta is vulnerable not just from rising sea water, but also flood water from Jakarta's rivers. The thousand Island Municipality is vulnerable to rising sea water as well as polluted water of the Jakarta Bay. Figure 2 below shows that the Thousand Islands municipality has an index of 41.76 which is the highest in Jakarta. North Jakarta came in second with 31.28. East Jakarta has the lowest index (28.07). This means that the higher the index the more vulnerable the society in the area to environmental change. Whereas, the lower the index the lower the vulnerability of the social order in the area.

Figure 1. Social Vulnerability Index of Jakarta, 2008



Source: BPS, Socio-Economic Survey, 2008

Other research that can be identified as vulnerability assessment and coping mechanism related to floods in urban areas is a community based case study in Kampung Melayu Jakarta which is done by Marschiavelli (2008). The Kampung Melayu is where there are slum areas coupled by the fact that they are located on the banks of Ciliwung River, a river known for its tendency to overflow during the wet season. It is also an area with one of the highest concentration of poor and near poor populations (See Figure 1). She tried to explore the vulnerability as well as the capacity for flood management and she found that low-income people are more vulnerable than those in the high-income bracket.

According to our opinion, the social and economic vulnerability assessment still needs to be explored deeper and more comprehensively, especially for micro, mezzo, and macro level. The current activities tend focus more on the physical-nature aspects rather than the socio-economic impact of climate change. Combining both assessments of climate change measurement can resulted in a more comprehensive assessment of the impact of climate change. There is also another side of the climate change spectrum. Current assessment mostly took place in coastal areas where the direct impact of climate change can be seen with the naked eye. Nevertheless, the impact of climate change can also affect other areas outside the ecological boundaries and further inland, as well as in the socio-economic dimension. Indirectly, climate change can have a significant impact on the people. Accordingly, when assessing the impact of climate change, social and economic impact should also be taken into account to measure vulnerability within the administrative boundaries.

Jakarta needs appropriate method to assess the socio and economic condition which represent the pluralism and income gap among society. Social factor and economic factors should be integrated with the physical vulnerability to find the urban vulnerability assessment. There are a number of indicators which can be constructed using available statistical data in Indonesia. Earlier it is mentioned that Indonesia, through its statistical institution is developing a social vulnerability index to climate change (SOVI). However, the index is still in the experimental stage and needs further development. Other indicators related climate change impact that can be developed or further improved are, among others:

1. Urban Vulnerability Index (UVI)
2. Disaster Risk Index
3. Environmental Vulnerability Index (EVI)
4. Natural disaster vulnerability Indicators.
5. Economic vulnerability.

Dissemination of Climate Risks and Vulnerability

Risk is defined as the product of the three vectors: hazards, vulnerability, and adaptive capacity (Framework adapted from Mehrotra, 2003; Rosenzweig & Hillel, 2008). Currently there is a knowledge gap among the public regarding risk associated with climate change, particularly the difference between climate risk and vulnerability. Communications among the media is used extensively for seminars or public consultations, without using layman's terminology for the general public. Mass media, like TV, radio, and newspaper are not being used to the fullest extent for the dissemination of climate risk or vulnerability. It can be inferred that the issues of climate risks and vulnerability have been circulating within the scientific community, but few, if any, are communicated to the wider public.

The Jakarta Capital City Government sometimes indirectly communicates to the public via its official website, but not in the continuous way. The role of the public figures (artists, Politician, etc) has not been as effective in conveying the message of climate change to the public. Research publication in Indonesia is also very limited and far between. In the other hand, international NGOs that have plenty interest in climate change have only campaigned on a micro level. More importantly, there is no special campaign on climate risk to the people who are at most risk, such as the poor and marginalized. Thus, there is still a huge gap that has to be filled regarding dissemination of climate risk information among the 11 million people in Jakarta.

The problem with dissemination of climate change has more to do with the method of delivery on climate risks message and the substance of the climate risk and vulnerability itself. Who are the target group? In what way they should know and be engaged with climate issues? What are the direct benefits if they are involved in the climate adaptation or mitigation? Thus, public awareness is one of the key issues of climate change campaign.

Urban GIS Information Base

Jakarta has spatial information which is located in several agencies, not only at the provincial level, but also at national level. In national level, in the scale of map 1:50.000, it is managed by *Bakosurtanal*, while in Jakarta level, in the scale of map 1:1.5.000 to 1:1.000, it is managed by Department of Spatial Planning.

There are two source data of GIS Information base in Jakarta level. First is aerial photography (including satellite images) in the scale of map 1:5.000 and second is topographical maps (based on survey) in the scale of map 1:1.000.

The GIS is mainly used for urban planning (creating land use map), unfortunately it is not integrated yet with the other social and economic data in one system. Therefore, it’s not easy to superimpose the map with other information to allow spatial or intersectional analysis. There is also a lack of information in terms of types and depth of scale related to climate change which is available in Jakarta. The lack of available data also makes it difficult to conduct any meaningful assessment of the climactic conditions in Jakarta, such as long time series data on rainfall, baseline data on tides, the daily measurement of temperatures, etc. Data is available in several government institutions, such as BPS or the Meteorological and Geo-physical Board (BMG). However, there is an urgent need to enrich the data specific to climate change as well as to unify the data to make them more comprehensive.

Therefore, there are a lot of efforts that must be done in relations to preparing Jakarta for the imminent impact o climate change. There is a need to collect baseline information on factors related to climate change and constructing appropriate indicators to assess the impact of climate change. There are also plenty of opportunities to conduct research stemming from the availability of the data in providing GIS information base to support adaptation policy, such as defining the need of data/information and the appropriate systems application to support the information. Fortunately, in year 2010, Department of Spatial Planning is going to collect GIS data using LIDAR (Light Detection and Ranging) technology. Hopefully, the data can be used for climate risk and vulnerability assessment.

Institutional Pattern

There are no particular agencies or institution in Jakarta which oversees account risk and vulnerability assessments, managing climate change knowledge, or disseminating the climate related information to the general public. Moreover, there appears to be a lack of coordination or accommodation among stakeholders on effective and sufficient media coverage, such as communication forum or social network. There is also no road map about adaptation or mitigation program. Thus, it appears that most government agencies, NGOs, and the private sector conduct their own activities to cope with climate change without coordinating with each other.

Jakarta Capital City Government has several agencies which oversee climate change related activities, especially for risks and vulnerability assessments such as:

1. Board of Environmental Management (BPLHD)

   The institution under the current name was established in 2001 based on Local Provision Number 3 2001. It is formerly known as the Environmental Impact Control Board or BAPEDAL. Its mission is to develop professionalism in managing the environment; to develop and strengthen the institutional capacity, as well as to improve to quantity and quality of equipments and infrastructure, and; to develop an environmental information system to support to the establishment of cooperation, supervision, monitoring, evaluation, assessment, research and development of environmental management.
2. Board of Regional Development Planning (BAPPEDA)

   This board has put the climate change issues in the Jakarta Mid-Term Development Plan (RPJMD) 2010-2020 and has also put the risk and hazard assessment in the making of urban structure and land use plan in the General Spatial Plan (2010-2030), even though it is not so specific.

3. Provincial Coordinating Unit for Disaster and Refugee Management (Satkorlak PB)
   This institution's function is to conduct disaster risk reduction, handling evacuees, and recovery. However, their main task is to focus on providing search and rescue equipment, mitigation procedure, and post disaster mechanism, not many research activities in pre disaster analysis or disaster risk assessment.

The interesting to note that most of the mitigation or adaptation efforts both in research and action programs are being done by the central government through the National Council of Climate Change (DNPI) and related Ministries in which the action plan of climate change is a national Priority. The Jakarta Government staffs are involved in the program only if Jakarta became one of the study locations and their involvement is restricted to being informants and/or participants.

Thus, there is a knowledge gap among city level officials on climate change adaptation compare to officials at national level. Jakarta city officials are aware of the impact of climate change, but still needs knowledge on coping strategies to climate change. Their knowledge about climate hazard, climate vulnerability, climate risks, and climate resilience need to be enhanced by providing them with the technical skills necessary to assess the vulnerability and risk of climate change.

The NGO that has done several activities related to climate change in Jakarta is ESSEA (Economy and Environment Program for Southeast Asia) which is funded by IDRC. ESSEA stated that 5 (five) administrative city of Jakarta has been categorized in 10 ASEAN vulnerable cities, but we have no detail information about this research methodology. In general, as far as we know, we can say that mostly NGO in Jakarta did the mitigation side, such as reducing carbon emission from motor vehicle and waste/garbage (KPBB). So, the gap is even Jakarta is stated as the most vulnerable city in ASEAN, but there is still rare the research about climate risk and resilience indicators of Jakarta itself.

Academic institution in Jakarta, such as UI and ITB has already initiated their research in climate change. Several researchers and graduate students have done the research about climate change and they usually publish the result in the limited media which is the journal/bulletin. But, mostly their concern is in climate modeling and the impact to the sectors, such as health, agriculture, and fisheries. Not many researchers yet have paid attention in incorporating the climate risks factor in the spatial or development planning. So, the research gap is too many efforts in the climate change hazard modeling, but still limited in the risk analysis and urban adaptation strategy.

We have limited information on business activities related to climate change adaptation, but it appears that the developers in North Coastal Jakarta, such as BP Ancol and PIK has anticipated the flood disaster by building canals or well-designed drainage. However, there is little information on civic housing and settlement in the coastal area of Jakarta. In our understanding, the climate-disaster risk has only been considered by the big enterprise, but not in the middle-low income people. They tend to use their own perception about the disaster risk and prepare themselves separately to cope with climate change on their own. So, there is still gap in the city wide scale of institutional pattern of climate change adaptation.

Urban Spatial Plan

Jakarta already has a provincial regulation concerning General Spatial Plan 2000-2010, but now it is in the legislation process for revision. It is estimated that in the revision will be completed in the last month of the 2010, and the new provincial regulation concerning General Spatial Plan will be established. The planning process of this spatial plan appears to include hazard analysis of Jakarta, such as flood, sinking, inundation, and fire hazard. There will also be a map of disaster hazards of Jakarta. However, the map will not explain climate vulnerability level, much less the future climate risk level.

Jakarta has also the detailed spatial plan (RDTR) which plans the land use for every district in Jakarta. RDTR regulates the intensity and density of each land use that has been planned in the general spatial plan. The recent provincial regulation of the RDTR is made in 1997, so if the amendment of general spatial plan would be completed in December 2010, then there will be a spatial planning process for detailed spatial plan in the next year. So, it is the opportunity for us to incorporate the climate hazard and risk assessment to the detailed spatial plan.

The other detailed spatial plan which is made for north coastal Jakarta is about the reclamation plan. The reclamation plan is now being revised due to environmental reason. Related to climate change factors, such as sea level rise and land subsidence, the reclamation should be made properly. The climate risk assessment can be introduced as a tool for environmental feasibility for reclamation plan.

Building Codes, Zoning Regulations, Sanitation Codes Enforcement

The City of Jakarta is serious in contributing for lower carbon emission. The Government has established the working group of GHG emissions, which is focused on the intensification of mass rapid transportation, green building regulation, safe energy for office building, and free smoking area. But, the green building code itself is not completed yet. Additionally, enforcement needs to be strengthened if the regulations want to be properly imposed.

Zoning Regulation is relative new in Indonesia since the law of spatial management (UU 26/2007) was implemented. The zoning regulation is one of the spatial development control instruments in Indonesia. So, it’s very much required for the coastal area, especially for the hazard prone area. The Jakarta Government is still working on the zoning regulation formulation. So, there is a big opportunity to incorporate the climate risk assessment to those regulations.

Early Warning System

Government of Jakarta has used the teleconference technology to monitor the government official preparation and built the automatic weather station (AWS) which functions as an early warning system of flood disaster, especially the water flow from the catchment area through the main river network. This AWS is in coordination of Provincial Coordinating Unit for Disaster and Refugee Management (*Satkorlak PB*) with the information section of Board of Meteorology, Climatology, and Geophysics and Hidro-oceanography Naval Army, and other official as well.

The process of early warning system is done by monitoring the level of water in every flood control gates. If the level of water is in danger level, then the information will be delivered by the task force in every sub-district to alert community in the hazard area.

Nonetheless, Jakarta has maintained a number of disaster response plans, except for earthquake. An official from the Jakarta Governor’s office has stated recently that Jakarta has no disaster response plan to deal with earthquakes, although there are efforts to identify a number of risks associated with this type of disaster (Jakarta Post, 2010, P. 18 Saturday July 17, 2010). The existing disaster response covers flooding, fire and epidemics, such as dengue fever and bird flu.

Based on the *Podes* 2008 data from BPS, Jakarta has several disaster response schemes. They are, an early warning system, safety advisory, community self help, and safety equipments. Jakarta has only one early warning system in the Thousand Island Sub-district presumably for tsunami warning. In terms of safety equipments, there are 177 villages that have these disaster response measures. There are 145 villages that have safety advisory. And there are also 234 villages which have their own safety measures (self help).

In our opinion, this EWS has focused on the flood which is caused by the high volume of rainfall, not really handle the flood problem which may be caused by the sea level rise.

Public Funding and Commitment

There is currently no information on public funding and commitment on climate change. However, based on the Jakarta City Government Medium Term Development Plan for 2007-2012, some sort of funding must be available and there should also be commitment. Even though the development plan does not specifically state climate change, the Local Provision No. 8, 2008 on the Medium Term Development Plan, placed the environment as one of the priorities of the Jakarta City development. The medium term plan also shows commitments, at least on paper, by the Jakarta City Government to take into account the changing environment. The plan also shows that the local government is aware of the problem of environmental damage due to increasing population, limited land and continuous development. They are also appears to be aware of the damage to the environment, such as air pollution, water pollution as well as the pollution caused by the management of garbage which is not optimum. The plan also stated constraints faced by the local government, and, more importantly, efforts to tackle the problems, including clean water, air and sea water programs. Therefore, it can be surmised that there should be budget allocation for these efforts.

Governance and Social Justice

Governance: emergence of non-formal institutional

Since the reform era (2001), many non formal organizations have been born in Jakarta and strived for their regime in strategic location of Jakarta. Most of them are civil society organizations which are built based on the ethnicity and religion or belief of group of people.

The role of these groups sometimes is more powerful than the formal institution, such as sub district governments and/or police institutions. This transition of governance pattern in Jakarta needs to be considered in appropriate way, especially in proposing climate governance established in the society.

Economic issues (people's welfare) and environmental issues (people's security) sometimes have been conflicted in order to find the priority of development program. And until now, there is no sufficient tool and methodology to assess the objectivity in program prioritizing. So, it's still a big gap to address or to mainstream the climate-risk factors in the level of community in the term of climate governance.

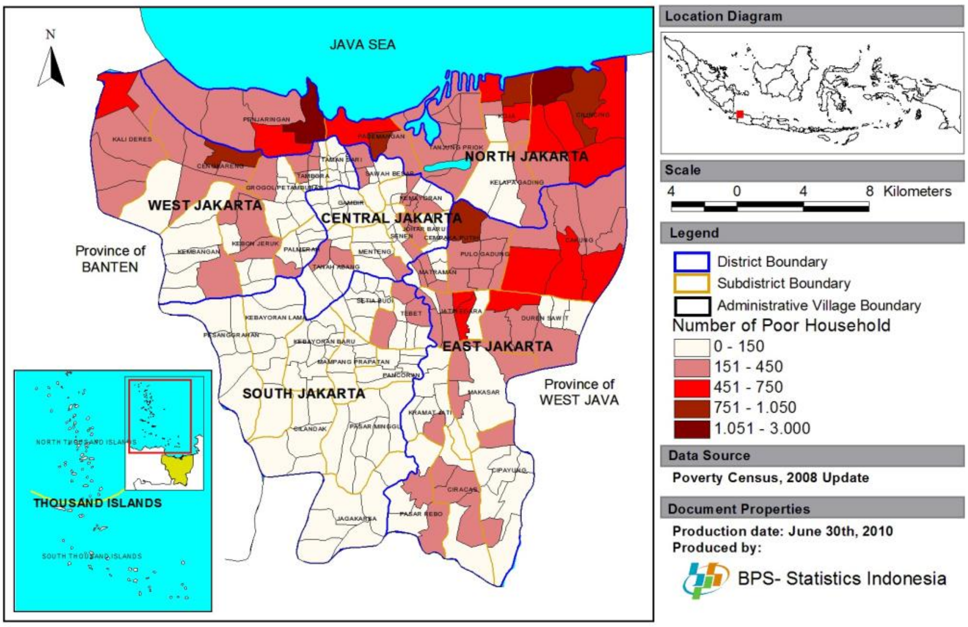
Social Justice: Poor people

It is arguable that the poor in Indonesia is the group most vulnerable to the adverse impact of climate change. Indonesia still has a significant number of poor. Based on the figures produced by BPS-Statistics Indonesia in 2010, the number of poor in Indonesia stood at 31.02 million people or 13.33 percent of the whole population. The majority of poor are in rural areas and live in the eastern parts of Indonesia. Jakarta, as the capital of the country, still has a significant number of poor. Based on the 2010 figure, the number of poor in Jakarta is still more than 300,000 people or about 3.5 percent of the population.

These groups are vulnerable of becoming even poorer if there are some radical changes in the environment where they live. The problem for these people is that if there is an environmental change, such as flood or rising sea water, they have nowhere else to go. Thus, they must face the full brunt of the environmental shocks which may negatively affect the social cohesion of the group.

Figure 1 below shows the number of poor households in the Jakarta Area. As can be seen in the figure, the poor in Jakarta are concentrated mainly in the North and Eastern parts of Jakarta. There are two villages with the highest concentration of poor households which are located in North Coastal Jakarta, which are Kalibaru *Kelurahan* in the Cilincing Sub-district and Penjaringan *Kelurahan* in the Penjaringan Sub-district. Penjaringan is one of the villages in North Jakarta which experienced the worst flooding in 2007 and subsequent flooding due to the rise in sea water (Susandi, 2009).

Figure 2. Number of Poor Households in Jakarta Province by Subdistrict and Administrative Villages, 2008



The two villages not only have highest concentration of poor people, but also near poor people who are vulnerable to becoming poor if there is an external shock such as natural or non-natural disaster. The two villages are also prone to rising sea water. These poor and near poor households are vulnerable to changes in the sea water level. If there is global warming which causes rising sea level, these poor households will be the first to suffer.

Others

As with many large metropolitan cities, Jakarta also has a high degree of environmental pollution. In addition to air pollution, Jakarta also has polluted water, polluted soil as well as noise pollution. Based on the Podes 2008, there are 62 villages in the Jakarta area which experienced air pollution. There are 42 areas that have noise pollution and 24 villages with high polluted water. Only 3 villages experience high degree of soil pollution.

Table 2. Number of Villages Where Pollution Occurred in Jakarta by Municipality and Type of Pollution (2008)

Municipality	Water Pollution	Air Pollution	Land/Soil Pollution	Noise Pollution
Kepulauan Seribu	1	4	-	1
South Jakarta	6	6	-	13
East Jakarta	15	9	2	7
Central Jakarta	18	2	-	12
West Jakarta	8	7	1	9
North Jakarta	14	-	-	-
Total	62	24	3	42

Source: BPS, *Podes* 2008

In addition to these types of pollution, due to the uncontrolled extraction of fresh groundwater, some freshwater in the north part of Jakarta are mixed with sea water making it unfit for drinking. Furthermore, due to the extraction and uncontrolled development, there is some evidence that Jakarta is sinking slowly. Some have predicted that Jakarta is sinking by an average of 10 cm to 12 cm a year (www.brudirect.com, 24 April 2010; ABC News, April 15, 2008; Brinkman and Hartman, 2008). However, there is no clear evidence that climate change or global warming is the cause of the rising sea level. It maybe due to the sinking of Jakarta or might also is caused by global warming, or a combination of both factors. One thing is certain; Jakarta must have an adaptive plan to cope with the imminence of climate change.

CONCLUSION

The City of Jakarta does not have concrete steps to tackle the problem of climate change. Current endeavors by the Jakarta City Government tend to focus more on disaster management, rather than efforts to specifically tackle the impact of climate change. The government has placed early warning systems and mitigation programs to cope with disasters, such as flood and rise in sea water. However, these efforts are more of reactive measures rather than proactive measures to tackle the problem of climate change. In particular, the local government must be able to obtain knowledge on how to adapt to the changes.

The lack of response from the local government may not be entirely their fault. Studies on climate change in Jakarta are sorely lacking, and those that do could not conclude whether the events related to the environment is irrefutably caused by climate change. There is also a lack of available baseline data on factors related to climate change, such as air temperature, rising sea water as well as the social impact of climate change. Commitment by local officials appears to be lacking, despite all the political rhetoric and promises. Finally, there is still a lack of knowledge on what climate change really is, not to mention the coping mechanism which the local government has to master in adapting to climate change.

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APPENDIX

Figure 3. Number of Families who Lived in Slum Areas in Jakarta Province by Subdistrict and Administrative Villages, 2008

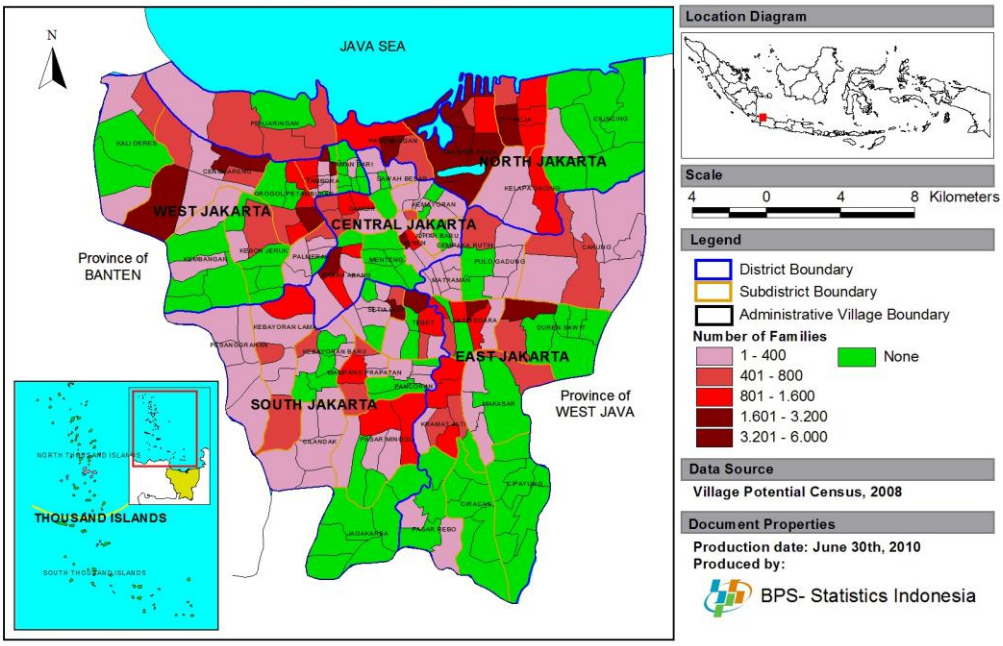


Figure 4. Number of Families who Lived on River Banks in Jakarta Province by Subdistrict and Administrative Villages, 2008

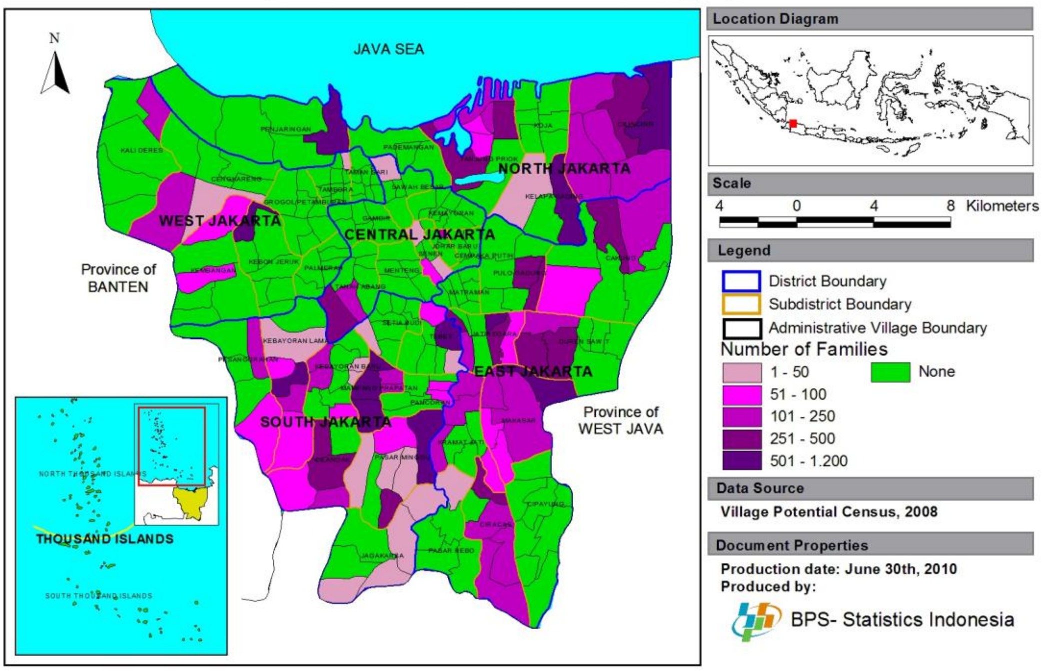
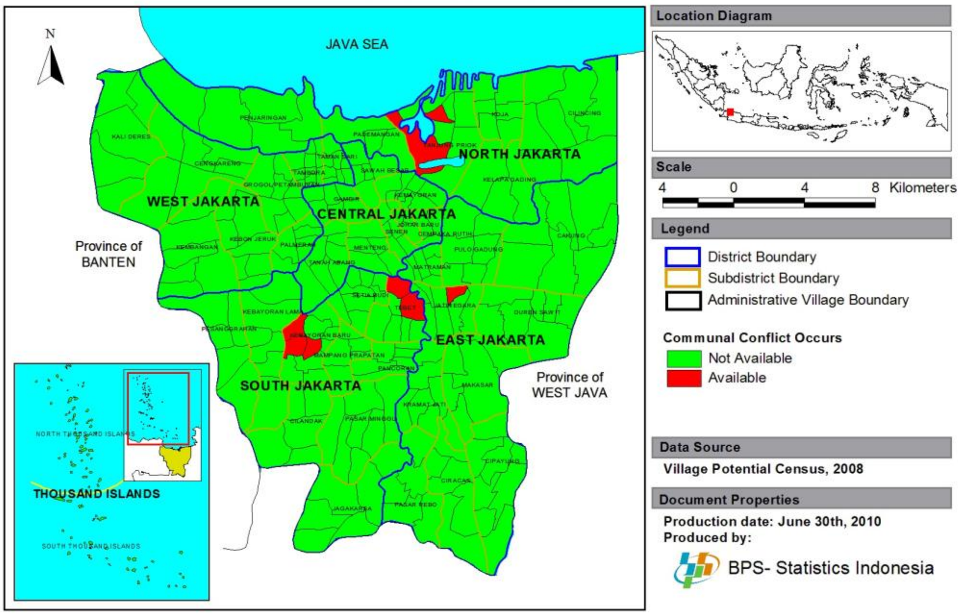


Figure 5. Areas (Villages) where Communal Conflict Occurs within Last Year in Jakarta Province, 2008



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PRELIMINARY DRAFT: PLEASE DO NOT CITE NOR DISTRIBUTE

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Introduction

Assessment of climate change-related impacts and adaptation are very important for city planning and development. In early July 2008, the World Bank estimated that the Philippines loses P15 billion every year to disasters like typhoons and floods. This amount represents about 0.7 percent of the gross national product (GNP). Investments, therefore, in disaster and climate risk vulnerability assessment and prevention would certainly minimize losses from these calamities. In October 2009, Typhoons Ondoy and Pepeng caused a total of Php 3.8 billion in damages and Php 24.8 billion in immediate losses1 in the agriculture, fisheries, and forestry sector (Joint Assessment of Ondoy and Pepeng, 2009).

This city report consists of three parts. Part I describes the social, political and economic characteristics of Metro Manila (also known as the National Capital Region or NCR) that may make the metropolis more vulnerable to climate change impacts. Part II identifies some of the geo-physical or ecological characteristics which may heighten its vulnerability and risks to climate change-related impacts such as heavy rains, floods, typhoons, subsidence or sea level rise (SLR). Meanwhile, part III outlines the perceptions of the different stakeholders and publics (national/local officials, private sector/business groups, civil society organizations (CSOs), vulnerable groups like the urban poor) about climate change related risks, planning, and adaptation and perceived data gaps, while part IV provide suggestions for future collaborative research. This final section suggests a science-action mode in collaborative research where research provides decision-makers (in government, business and civil society) support for policy, planning and program formulation and implementation.

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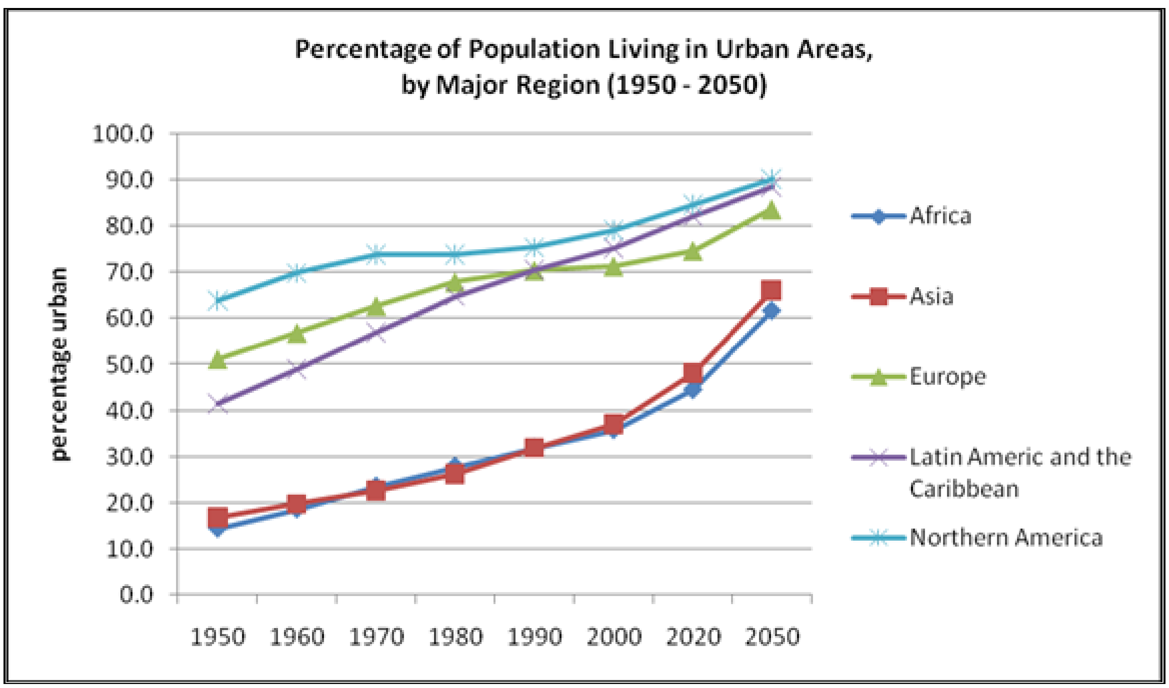
Part I

Part I is mainly from, "Urban Transition, Poverty and Development in the Philippines", written by Emma Porio as part of the country demonstration paper for urbanization supported by the United Nations Fund for Population Assistance (UNFPA) and will be published by the International Institute of Environment and Development (2010). No part of this paper shall be cited without proper reference (see bibliography for proper reference).

1. Urbanization, Population Growth and Urban Services[3]

Rapid population growth and increasing density in urban settlements make cities vulnerable to climate change related impacts. During the last few decades, rapid urbanization process in the Philippines had resulted in high densities of residential settlements in Metro Manila and the increasing shortage and inadequacy of basic services (water and sewerage, energy, transport, etc.) to meet the needs of the burgeoning population. The following section describes this urbanization process in Asia and the Philippines.

Figure 1 Percentage of Population Living in Urban Areas by Major Region, 1950-2050



Source: Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, *World Population Prospects: The 2006 Revision* and *World Urbanization Prospects: The 2007 Revision*, http://esa.un.org/unup.

Currently, the pace of urbanization in the developing world is led by Asia followed by Africa. The number of people residing in urban areas in Asia and Africa has been steadily rising

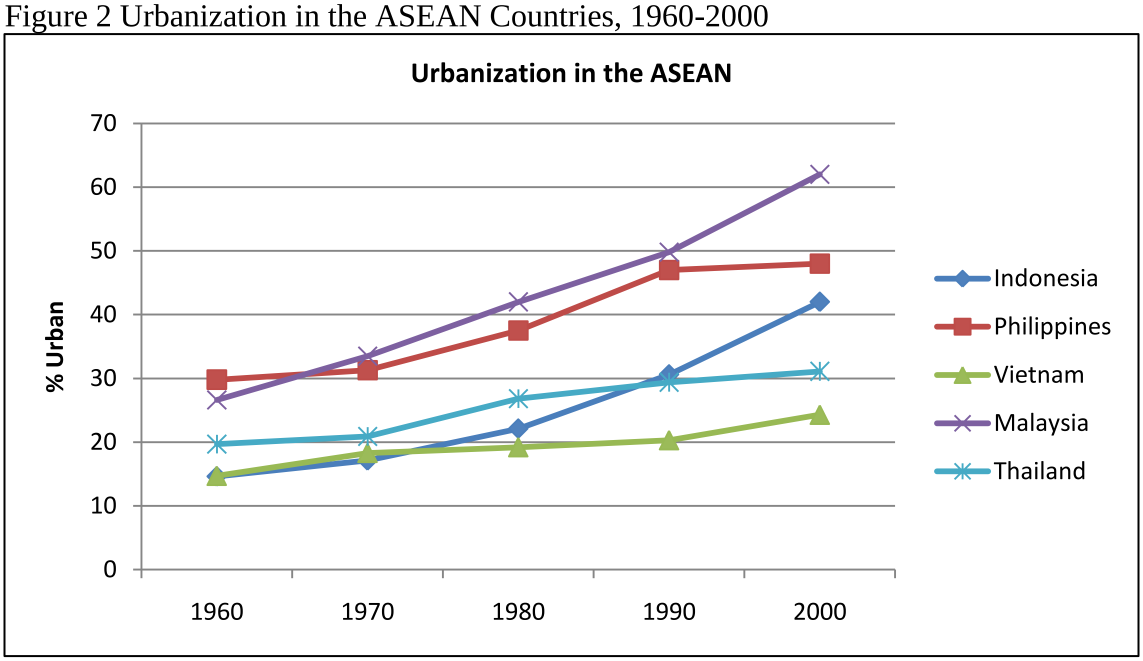
[3] A large part of this section is drawn from, Porio, Emma (2010)," Urban Transition in the Philippines", part of urbanization study series, International Institute of Environment and Development (IIED, London) and United Nations Fund for Population Assistance (UNFPA, New York).

since the 1970s. This period also saw the sharp rise in urban growth, with urban populations projected to be about 40 percent, 50 percent and over 60 percent in 2000, 2020, and 2050, respectively. In the 1970s, 50 percent of urban residents lived in developing countries, which increased to 66 percent in the 1990s, and is projected to be 80 percent by 2020. The bulk of Asia's urban growth is occuring in the following countries: Bangladesh, China, India, Indonesia, Pakistan, Philippines, and Vietnam. In 2008, 12 of the 17 megacities of the world are located in Asia. By 2015, there will be 27 megacities in the world, 18 of them will be in Asia (Porio 2009).

Population growth in the Philippines has been quite rapid. By the end of 2009, the Philippine population is estimated to be 92. 2 million and projected to reach 111.7 million in 2020. In 1948, the population at 19 million doubled 25 years later at 42 million in 1975. But in 1960, the population at 27 million took 30 years to double at 61 million in 1990. Almost 20 years later, another 30 million was added to the population in 2009. With 54 percent of the 92.2 million residing in urban areas, the Philippines experienced an urban transition in the first part of the 21st century (Porio 2009).

Like most Asian countries, the urban population in the Philippines has grown steadily since 1950 and more rapidly during the last four decades, reaching almost 50 percent in 1990. In 2007, the National Statistics Office (NSO) estimated that 54 percent of the population lived in urban areas compared to 30 percent in 1950, 47 percent in 1990 and 48 percent in 2000. The acceleration of urban growth approached its peak in 1990 with almost one-half (47 percent) of the population living in urban areas. NSO projects that by 2030, more than two-thirds (about 80 percent) of Filipinos will be living in cities and urban agglomerations.

Figure 2 Urbanization in the ASEAN Countries, 1960-2000

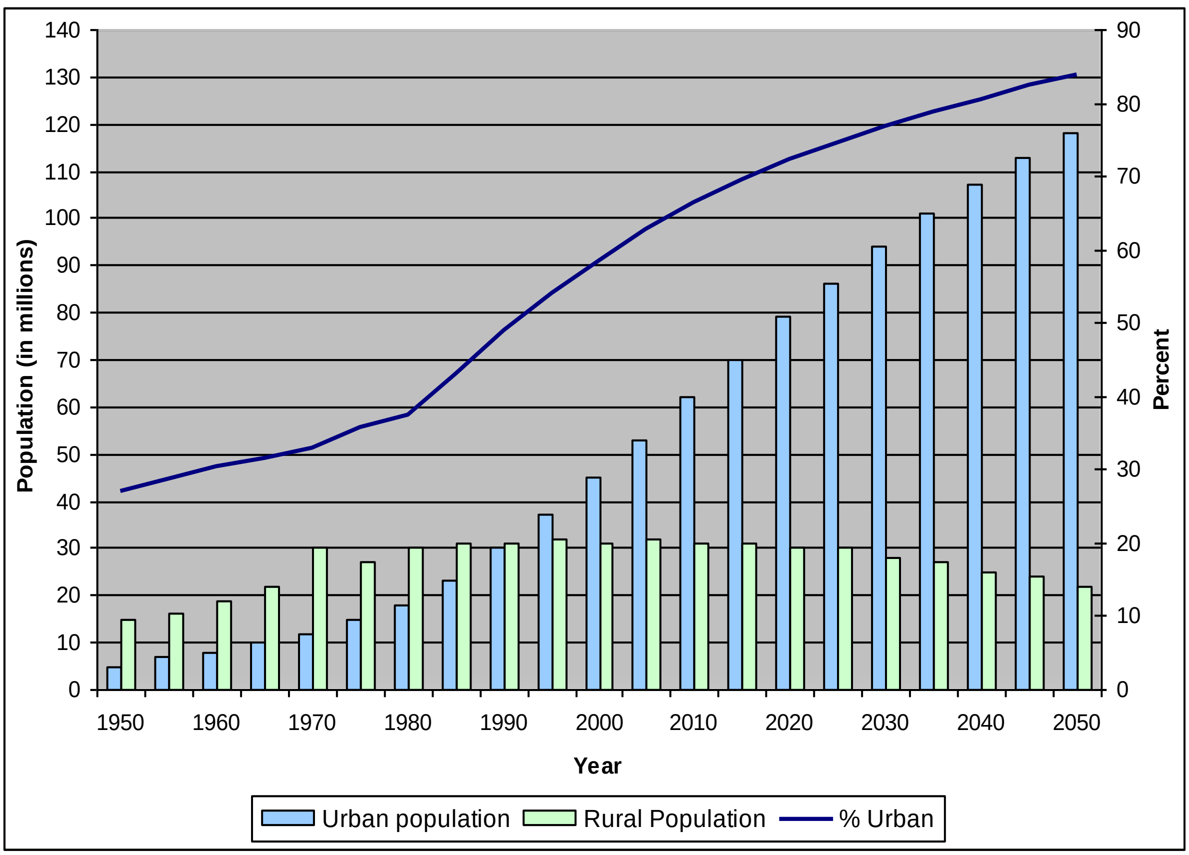


Source: National Statistics Office (Philippine figures)

Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, *World Population Prospects: The 2006 Revision* and *World Urbanization Prospects: The 2007 Revision*,http://esa.un.org/unup. (Indonesia, Vietnam, Malaysia, Thailand)

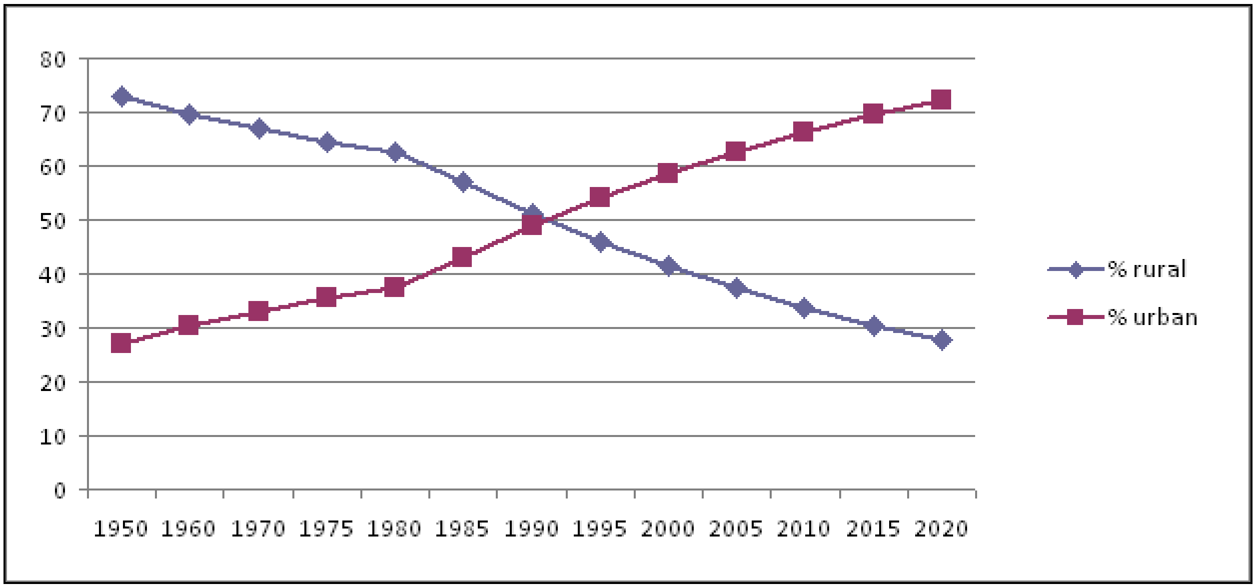
As mentioned earlier, the pace of urbanization in the Philippines is is quite fast compared to other ASEAN countries in the region (see Appendix Table 1). With more than half of its population (54 percent) living in urban areas in 2007, the Philippines, is one of the most highly-urbanized countries in Southeast Asia, second only to Malaysia. In 2000, while Philippines had 48 percent of its population living in urban areas, Malaysia already had 57 percent. Trailing behind the Philippines in terms of proportion of urban population are Indonesia, Thailand and Vietnam with 41 percent, 22 percent, and 19 percent, respectively. Today, Asian cities are leading the pace of urbanization in the developing world.

Figure 3 Urban and Rural Population Growth



Source: UN World Urbanization Prospects: The 2007 Revision

Figure 4 Percentage of Rural and Urban Population, 1950-2020



Source: UN World Urbanization Prospects: The 2007 Revision

1.1.1 Urban Growth in the Philippine Geographic Regions

While the urbanization process in the Philippines has been quite rapid, the overall pattern of urban growth among the geographical regions has been quite uneven. The growth and levels of urbanization among the regions are largely associated with the growth of a metropolitan center like Metro Manila or the traditional regional centers like Cebu City or Davao City. Lately, the latter two cities have organized themselves as metropolitan centers together with the surrounding towns/cities. Thus, the regions nearest to the National Capital Region (NCR), Southern Tagalog and Central Luzon, have consistently experienced the highest levels of urban growth, outstripping the national growth rates (37 percent) from the 1980s onwards. This pattern of urban expansion seem to be a key characteristic of regional development found in Luzon (Metro Manila), Visayas (Meteo Cebu), and Mindanao (Metro Davao).

Table 1. Urban Growth in Philippine Regions, 1960 - 2000

Urban Growth in Philippine Regions						
Region		**Level of Urbanization**				
		1960	**1970**	**1980**	**1990**	**2000**
Philippines		**29.8**	**31.8**	**37.5**	**47.0**	**48.0**
NCR	National Capital Region	98.1	100	100	100	100
CAR	Cordillera Administrative Region	-	-	20.1	30.1	35.6
I	Ilocos	17.6	19.4	23.6	32.3	38.2
II	Cagayan Valley	14.1	14.1	17.7	21.5	22.2
III	Central Luzon	26.5	30.2	41.8	54.3	60.5

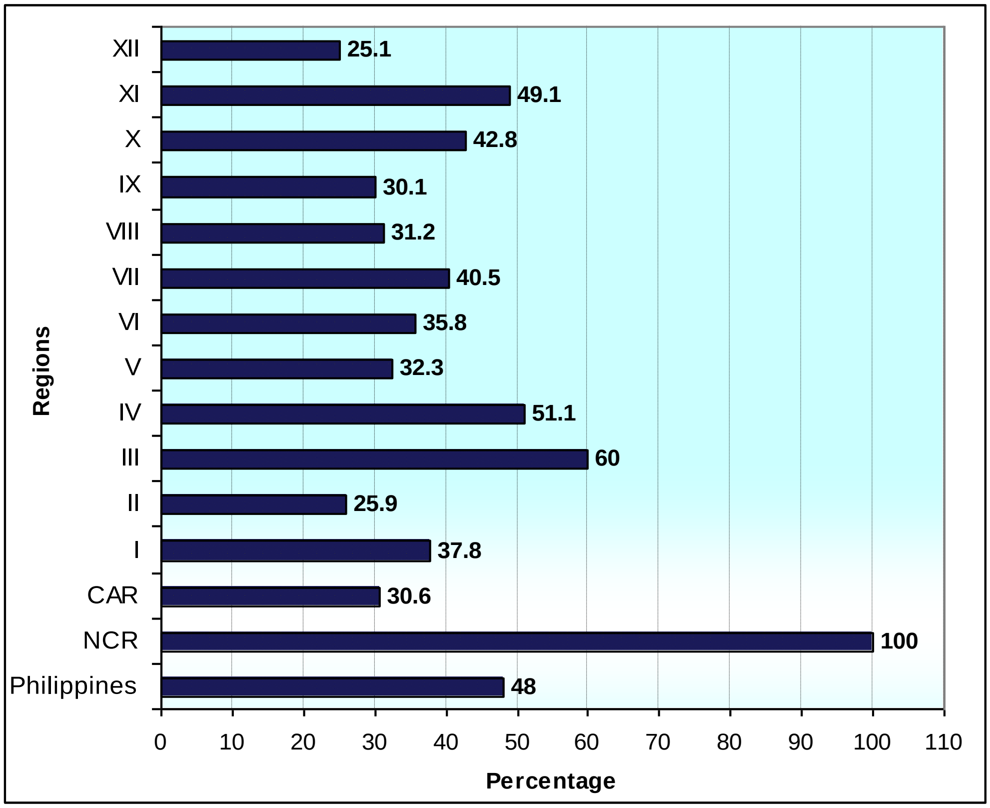
IV	Southern Tagalog	26.8	30.6	37.1	53	58.2
V	Bicol	21.9	19.2	21.9	26.8	27.6
VI	Western Visayas	30.5	26.7	28.4	37.1	30.3
VII	Central Visayas	22.2	27.9	32.1	42.5	46.4
VIII	Eastern Visayas	18.9	19.4	21.8	28.1	19.5
IX	Western Mindanao	16.8	15.8	17.6	31.5	26
X	Northern Mindanao	20.2	20.9	25.6	42.3	40.5
XI	Southern Mindanao	20.9	26.6	34.3	38.4	38
XII	Central Mindanao	-	15.6	24.3	32.8	32.7
ARMM	Autonomous Region of Muslim Mindanao	-	-	11.8	22	21.2
XIII	Caraga	-	-	30	36	27.2

Source: National Statistics Office.

Note: The Autonomous Region in Muslim Mindanao (ARMM) was formally recognized as a separate region in 1990. Region 13 or Caraga was formally recognized as a separate region in 1995.

Table 1 above shows the level of urbanization from 1960 to 2000 of the geographical regions. In 1960, while only a third of the country was urbanized, Metro Manila was almost 100 percent urban. Regions around the NCR, Regions III and IV, Central Luzon and Southern Tagalog, respectively, became the most urbanized regions in the country.

Figure 5. Urbanization Levels by Region, 2000.



Source: National Framework for Physical Planning 2001-2030 (2002).

Rapid urban growth in the past four decades has resulted in the concentration of populations in three metropolitan regions, namely, Metro Manila, Metro Cebu, and Metro Davao. Of the three, Metro Manila towers over the two regions, with its population almost 12 times the population that of either region. The metropolis serves like a giant economic engine colonizing and appropriating resources from the other regions of the country. Lately, however, this primacy has been slowly eroded because of decentralization of local governance and the government's desire to diffuse investments outside these traditional centers. As shown in Table 1 and figure 5, the regions around the metropolitan capital like Central Luzon and Southern Tagalog have always been growing at a faster rate compared to the other regions of the country.

1.1.2. Urban Primacy of Metro Manila

Metro Manila, historically the primate city of the country, has always been the major locus of urban investments and development. It is the national center of growth and the country's premier urban center. With a land area of only 636 square kilometers and a population of nearly 12 million in 2007, it has the highest population density in the country and accounts for about 13 percent of the total population. The primacy of Metro Manila can be seen in its population size, density, and its political-economic and socio-cultural power (see Table 2 below). Before the nation and the international community, Metro Manila is viewed synonymously with the Philippines and the Filipino people (Porio 2009). As the economic and political epicentre of the country, many politicians and citizens outside the metropolis call it ”Imperial Manila” with the state bureaucracies and their functionaries treating the rest of the country as their hinterlands and/or vassals. Manila is the major connecting point between the country and the rest of the world, serving as the main transport, finance, political and social hub of the nation.

Table 2. Comparative Population Growth and Density, Philippines and Metro Manila(1980-2007).

Year	Philippines		Metro Manila		
	Total Pop	Density	Population	% Share to Total Pop	Density
1980	48,098,460	141	5,926,000	12	9,565
1985	54,668,332	161	6,942,204	13	11,206
1990	60,703,206	178	7,948,392	13	12,830
1995	68,616,536	201	9,454,040	14	15,260
2000	76,504,077	225	9,932,560	13	16,032
2007	88,574,614	260	11,553,427	13	18,650

Source: Philippine Yearbook (NSO), various years

As the city of Manila expanded and incorporated the surrounding areas in the 1970s, it became the National Capital Region (NCR). This also started the transformation of the urban landscape and the organization of several sub-centers within the metropolis. Makati, a privately planned community of the Ayala Corporation, emerged as the leading financial and commercial center starting in the 1970s, an alternative to the increasingly congested Manila. Over the years, Makati bcame the headquarters of most major national/international corporations, embassies, and overseas development assistance agencies (ODA). The city also became synonymous with exclusive or gated communities, expensive hotels, leisure, and consumption spaces. By the 1980s, other commercial and residential sub-centers emerged such as the Ortigas Center in Mandaluyong City, EastWood City in Quezon City, and Ayala Alabang in Muntinglupa City. Recent additions to these sub-centers include The Global City in Taguig City (formerly Fort Bonfacio, a military reservation) and the Mall of Asia (MOA) in Paranaque City (see map of MM). Currently, Metro Manila holds the distinction of having three (Mega Mall, SM City, and MOA) of the largest shopping malls in the world.

The national capital region is also the educational and cultural center, accounting for almost one-half of the number of universities and educational institutions and having the monopoly of the film, communications media (print, tv, broadcasting) institutions and networks in the country. As shown in the above figures, the demographic, economic, and socio-cultural primacy of the national capital region is undisputed. What mars this primacy is its dwindling quality of life and questionable environmental sustainability. The metropolis is generally viewed both by residents and outsiders as a city that is hard to navigate. Traffic jams, floods, air and water pollution, demonstrations and protests, impermeable gated communities, exclusive commercial and consumption spaces, empowered urban poor groups in huge informal settlements, all constituting the metropolis (Porio 2009).

NCR’s primacy over other urbanized regions can also be seen in the following figures. In 2008, the capital region accounted for the bulk of the country’s economy with a 33 percent share of the total GDP followed by the adjoining provinces of CALABARZON (Cavite, Laguna, Batangas, Rizal, Quezon) with 12.3 percent. NCR, the fastest growing economy in 2006 contributed 2.2 percentage points to the growth of the GDP, while contributing also the highest to the growth of industry with 1.9 percentage points. In terms of GDP growth rates, the capital region has the highest with 8.8 percent, compared to the national average of 5.4 percent (NCSB 2006). The importance of Metro Manila is also seen in terms of the share of foreign direct investments (FDI) it receives compared to the rest of the country, which about one-third of the country's FDI (Gonzalez, et al. 2001). Another indicator of the NCR's economic primacy is that it accounts for the largest share in the growth of the services sector, which claimed the largest share in the growth of the national economy at 48.7 percent in 2008 (Porio 2009, NUDF 2009).

In 2003, the metropolis had a real per capita income of P39,639, almost double that of the second highest, the Cordillera region with P17, 836. But in terms of social welfare indicators, Metro Manila's human development index (HDI) of 0.777 suffers in comparison to other cities in economically advanced regions (e.g., Hongkong, 0.916; Singapore, 0.907). Compared to other cities in the Philippines, however, Metro Manila's HDI score does not appear so bad. Cebu, the second largest city had an HDI score of 0.728 while Davao, the third largest city had 0.702.[4] In terms of life expectancy, Metro Manila residents only have 70 years compared to Cebu's life expectancy of 72 years. Of course, these indices are much higher compared to the province of Tawi-Tawi, which had the lowest life expectancy score of 51 years old (Porio 2007).

In 1960, only 30 percent of the country resided in urban areas but Metro Manila's level of urbanization was already 98 percent and reached 100 percent in 1970 (See Table 2). The primacy of the metropolis is also evident when compared to the urban growth patterns of the other regions in the country

Table 2 above shows Metro Manila's primacy in population density. In the 1980s, it's population density was below 10,000 persons per square kilometer but this leaped to 17, 942 persons per square kilometer in 2000, and peaked at 18,650 persons per square kilometer in 2007. Among the cities in the metropolis, the old city of Manila has the highest population density with 66,429 persons per square kilometer partly because of its high number of informal settlers. This is attributed to the fact that it was, though to a lesser extent today, the center of trade, commerce, and politics dating back to the colonial times. Quezon City, where most government institutions are located (including the House of Representatives), has a lower population density of 15, 605 persons per square kilometer owing to its having the biggest land area among the cities but it hosts the largest number of informal settlers. Makati City, the main financial business district, has a 27, 890 persons per square kilometer population density.

Metro Manila also handles the largest volume of international trade and transactions. According to the NSO (2001), it accounts for the largest regional shares in financial service (78 percent), transportation, communication, and storage sector (53 percent), services (45 percent) and the industrial sector (38 percent).). In 2000, Metro Manila contributed 43.5 percent to the GDP growth but in 2007, this declined to 33 percent.

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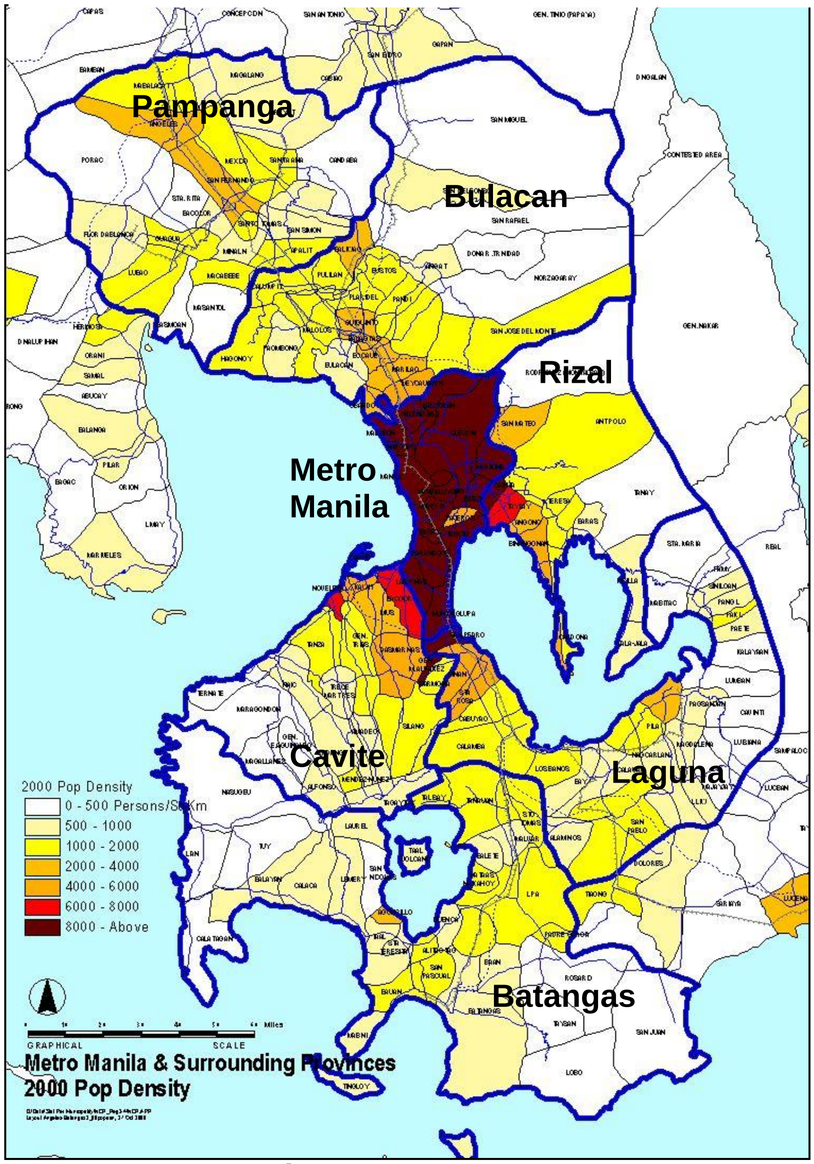
[4] The lack of data disaggregated down to the city/municipal level in most national statistical systems indicate the lack of recognition of the city as a unit of analysis or a key variable in social science scholarship. This can be clearly seen in the way HDI indicators are disaggregated.

Figure 6. Map of Mega Manila 2000 (Metro Manila and Surrounding Provinces).



Source: Corpuz, 2006b.

Table 3. **Population size, density and growth by zone in Manila in 1980 and 1990.**

	Population ('000)		**Density (persons/km^2)**		**Annual growth (%)**
	1980	**1990**	**1980**	**1990**	**1980 – 1990**

Core	5,926	7,948	9,318	12,947	3.41
Inner Zone	2,820	4,107	964	1,403	4.56
Outer Zone	2,932	3,908	312	416	3.33
Total	11,678	15,963	901	1,231	3.67

Notes: Core - Metro Manila
Inner Zone - parts of the provinces of Cavite, Pampanga, Rizal, Batangas, Bulacan and Laguna
Outer Zone - parts of the provinces of Cavite, Pampanga, Rizal, Batangas, Bulacan and Laguna
Basis: Jones 2002 (Southeast Asian Urbanization and the Growth of Mega-Urban Regions)

Table 4. **Growth of Population by zone in Manila, 1990 - 2000.**

	1990 [a] ('000)	**2000 ('000)**	**Average annual increase (%)**
Metro Manila (core)	**7,945**	**9,933**	**2.3**
Manila zones[b]	**6,481**	**9,855**	**4.3**
Manila Region	**14,426**	**19,788**	**3.2**
Philippines	**60,703**	**72,345**	**1.9**

Notes:

a. Figures differ slightly from those in the previous table because of updating and minor definitional differences
b. Inner and outer zones – provinces of Bulacan, Batangas, Cavite, Laguna and Rizal.

Basis of computation: Jones 2002, Southeast Asian Urbanization and the Growth of Mega-Urban Regions.

1.1.3 Urban Growth, Poverty, and Social Inequality

As in other third world cities, Philippine cities today suffer from a number of problems accompanying urbanization and the development of agglomeration economies. These include congestion, shortage of housing, inadequate basic services like potable water supply, health, waste collection and management, etc. These problems are also compounded by water and air pollution, the increasing need for disease control and health services (e.g., destruction of urban habitats and rising incidence of dengue, HIV and STDs, pollution and rise of pulmonary diseases, etc.), fire and police protection, and the proliferation of slum and squatter settlements (Manasan 2004:30).

In terms of spatial expansion and urban growth, the above problems are also reflected in the pattern of urban settlements. In most cities, but most pronounced in Metro Manila, slum and squatter communities and other smaller informal settlements with no security of tenure and inadequate access to basic services side by side with exclusive, fully-serviced gated communities. Architects and planners like Alcazaren et al (2005) coined the term "*gilidges*" (Pilipino for side or *gilid*, i.e., beside villages, the popular term for exclusive, gated communities) to summarize this kind of residential development in Philippine cities, which is partly a function of the absence of well-defined comprehensive land use plans (CLUPs) and the weakness of government agencies.

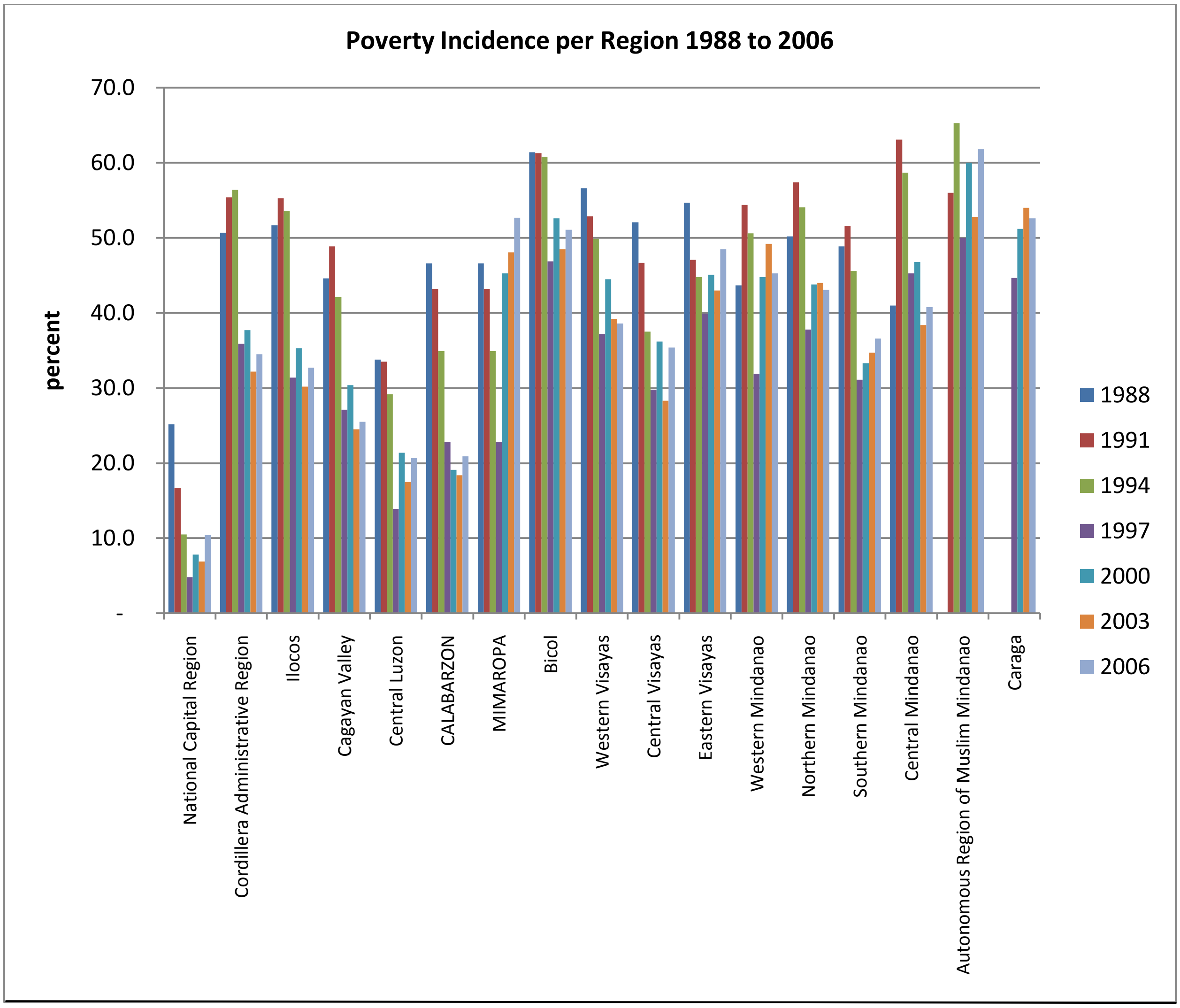
Poverty Incidence in Metro Manila, Across Regions and Income Groups.

Figure 13 below show that Metro Manila and the surrounding regions like Central Luzon and Southern Tagalog have much lower poverty levels. In 1985, while the whole country had a poverty incidence of 44 percent, Metro Manila only had 23 percent. In 2000, the three regions with the lowest incidence of poverty were Metro Manila (9 percent), Central Luzon (19 percent) and southern Tagalog (25 percent).

Poverty incidence levels indicate clearly the proportion of the population who are quite vulnerable to climate change related risks as well as their decreased levels for climate change adaptation. While, it may appear that there are less poor people in Metro Manila compared to other cities in the Philippines, in reality, most of them are residing in informal settlements, i.e., without security of tenure and adequate access to basic services and therefore suffer high levels of vulnerability to climate change related risks. In fact, most of these settlements are located in what is considered danger zones by the Metro Manila Development Authority and therefore unsuitable for human habitation.

The following data in the following sections will show that the poor in Metro Manila suffer multiple levels of vulnerability. At the geo-physical or ecological level, they live in wet and swampy areas and in danger of floods, soil erosion and landslides. Having low education and low or irregular sources of income, their access to food, nutrition, water, education, health and other basic services is poor and inadequate. Within the urban poor population, there are those who more vulnerable to climate change related risks like young children, old women who also come from female-headed households (Porio, 2009).

Figure 7 Poverty Incidence per Region 1988-2006



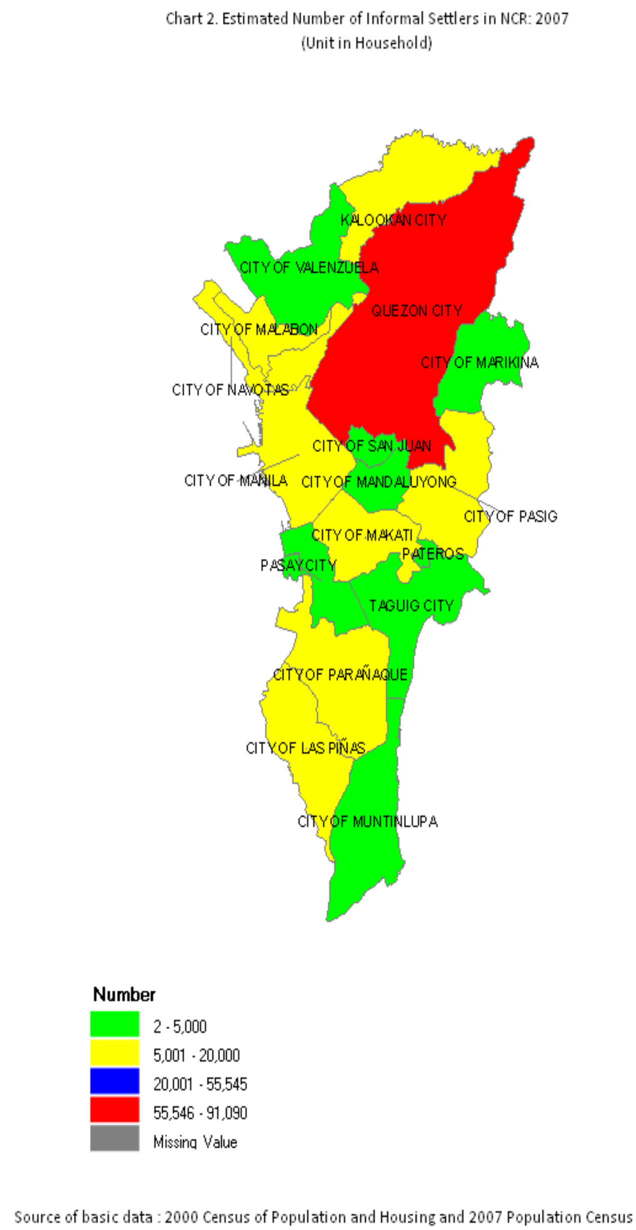
Source: Philippine Statistical Yearbook, 2000
NSCB,
http://www.nscb.gov.ph/poverty/2006_05mar08/table_2.asp
http://www.nscb.gov.ph/poverty/2000/povertyprov.asp

Table 5. Number and Percentage of Urban Households in Metro Manila

City/Municipality	Total Households	Number of Depressed HHs	% of Total
City of Manila	333,547	99,549	29.8
Mandaluyong	59,682	25,383	42.5
Marikina City	80,160	28,580	35.6
Pasig City	107,835	27,328	25.2
Quezon City	480,624	169,490	35.2
Kalookan City	249,567	67,292	26.9
Malabon	74,137	12,461	16.8
Navotas	49,450	19,030	38.4
Valenzuela City	106,382	36,404	34.2
Las Piñas City	97,962	36,107	36.8
Makati City	98,225	27,024	27.5
Muntinlupa City	78,016	40,457	51.8
Parañaque City	94,106	29,790	31.6
Pasay City	78,180	57,436	73.4
Pateros	12,029	3,502	29.1
Taguig	102,723	21,931	21.3

Source: HUDCC unpublished report, 2002

Figure 8. Estimated Number of Informal Settlers in NCR: 2007 (Unit in Household)



According to HUDCC, the total informal settlers in the country number 550,771 households, with 36 percent or 199,398 households found in the NCR. HUDCC further breaks the urban households 1) homeless, 2) dilapidated or condemned, 3) informal settlers, 4) marginal housing, and 5) acceptable housing. Almost 800, 000 households have unacceptable housing. Comparing these numbers to the surveys conducted by NGOs (e.g., Urban Poor Associates, CO-Multiversity, PHILSSA, ICSI) indicate that the housing problem and its consequences remains largely underestimated by government agencies.

2. Environment and Climate-Change Related Vulnerabilities of Urban Populations

Population density, increasing poverty and inequality, and environmental problems (intensified by climate change) create new levels of vulnerabilities and risks (e.g., disasters caused by natural and man-made calamities, pandemics) for cities and their residents. The continued rise in population, increasing urban densities, combined with environmental hazards coming from the sea level rise (SLR), increasing number and intensity of typhoons and floods pose great challenges to the planning and organization of cities. More siginifcantly, these ecological and social vulnerabilities are going to put more burden and risks to urban poor communities and other vulnerable populations. In particular, high population densities in coastal cities and flood plains combined with the effects of climate change create new and unprecendented risks, like Metro Manila and Metro Cebu. Thus, flooding has increased because of increase in sea level rise (SLR), and rising number/intensity of typhoons making Metro Manila residents very vulnerable, especially the urban poor communities residing in its major floodplains[5], river systems and the coastal areas.

In Metro Manila alone, the number of barangays/people who suffered losses from floods and typhoons have increased greatly over the past 10 years (see Figure 19 below). The number of people affected by typhoons and floods sharply rose from less than a million in 1995 to almost 3.5 million in 2000. Thus, a large number of baragays in Metro Manila experience flooding (see Figure 19) below.

[5] Floodplains of Metro Manila include KAMANAVA (Kaloocan, Malabon, Navotas and Valenzuela), Pasig-Marikina, and West Mangahan.

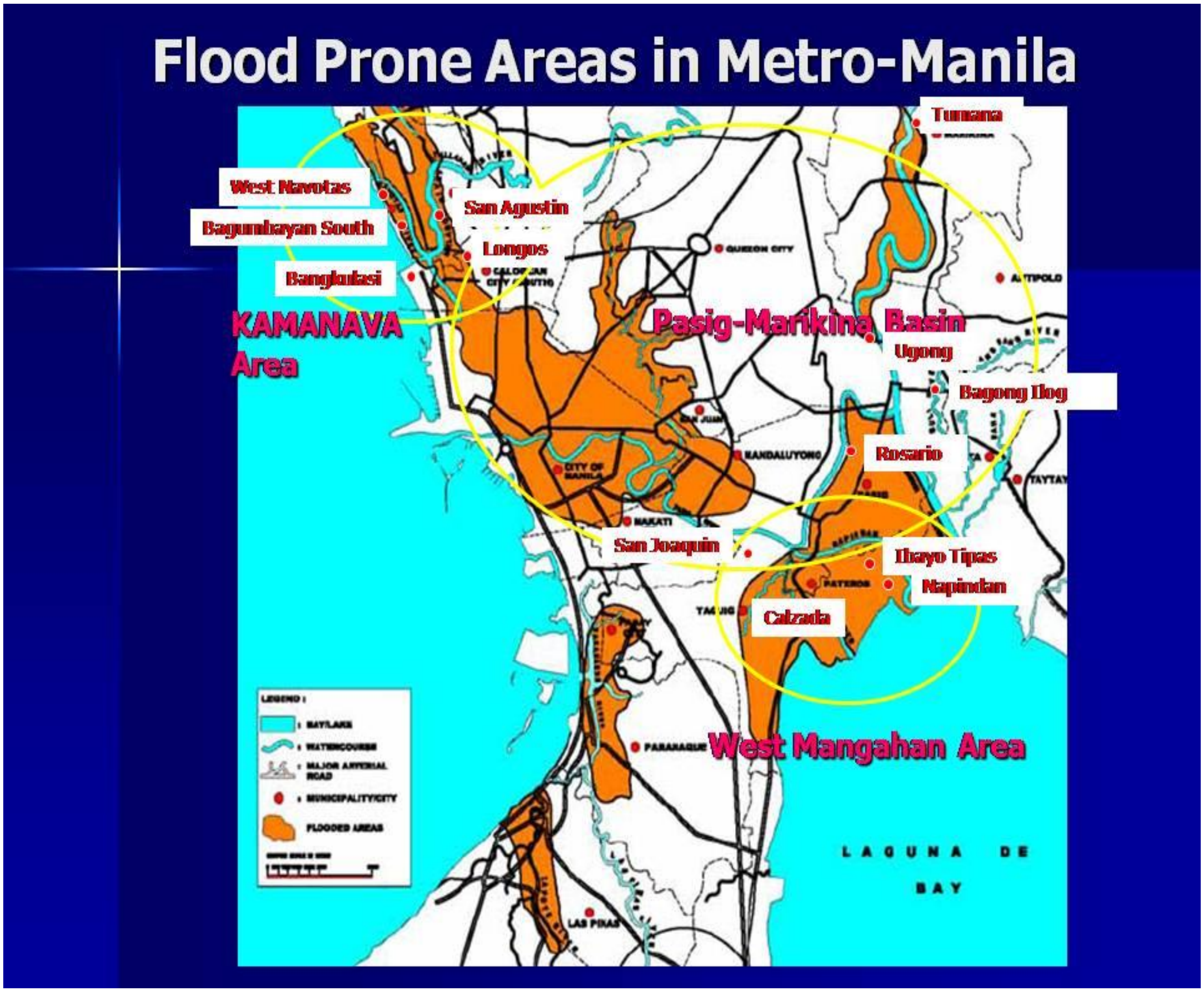


Figure 9. Map of the Flood Prone Areas of Metro Manila River Basins, and the Location of the Sample Research Communities (Porio, 2009). Source: JICA.

Figure 10. Number of People Affected by Floods

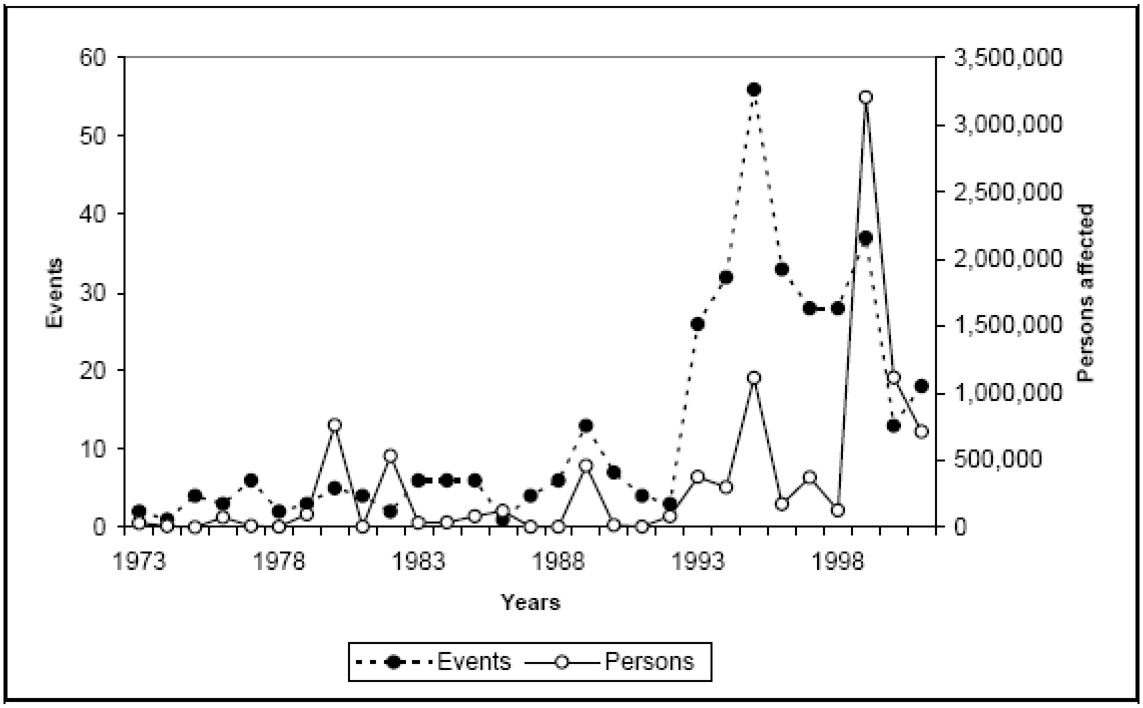


Figure 1 Number of people affected by floods, 1973–2001

Source: Disaster Data 1973 to 1999 Floodings/Flashfloods (NDCC, 1999) and Disasters in the Philippines 2001 (CDRC, 2001a: 2, 10).

Source: Bankoff, G. (2003). Constructing Vulnerabiltiy: The Historical Natural and Social Generation of Flooding in Metropolitan Manila. *Disasters.*Vol. 27 (3). 95-109.

Figure 11. Per cent of Barangays in Metro Manila by city affected by flood in 2000

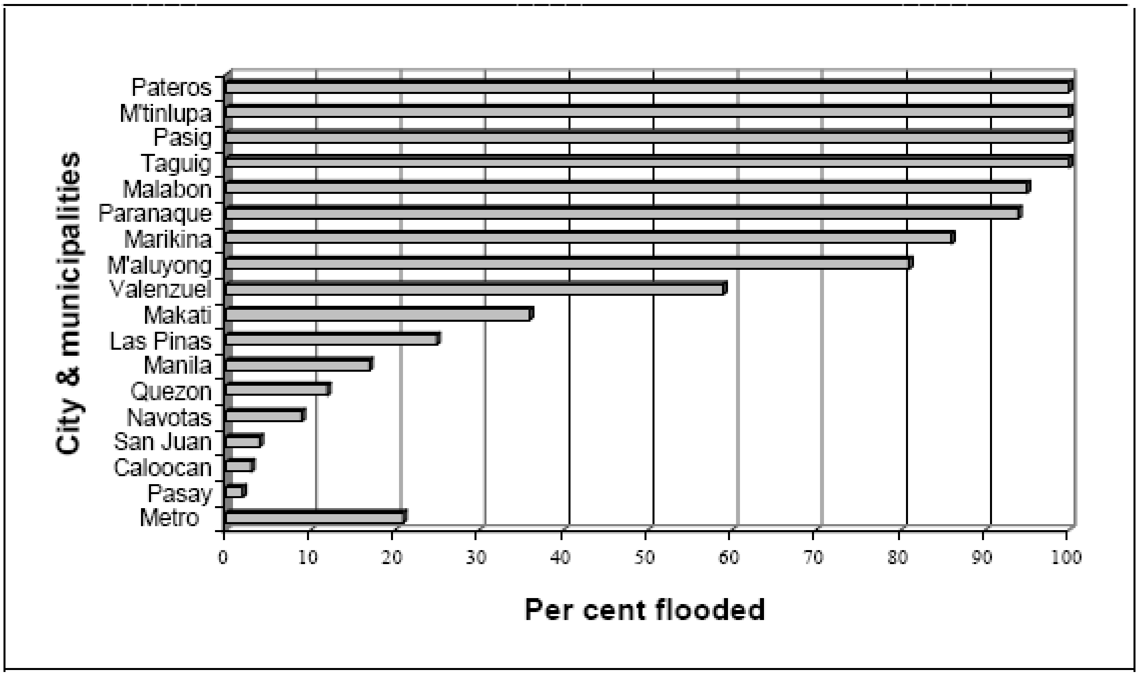


Figure 2 Per cent of Barangays in Metro Manila by city affected by flood in 2000

Source: Hazard Prone Areas in Metro Manila (OCD, 2000a).

Source: Bankoff, G. (2003). Constructing Vulnerabiltiy: The Historical Natural and Social Generation of Flooding in Metropolitan Manila. *Disasters.*Vol. 27 (3). 95-109.

Pollution Levels (Air, Water, and Surface, Noise). With the increasing degradation of the urban environments, pollution levels are also rising (see Table 11). Increased economic activities, lack of mass transport system, dependence on polluting vehicles (jeepneys, buses and tricycles), and reliance on fossil-based fuels account for this rise. About 40 percent of the total registered vehicles in the country are in Metro Manila. Reducing pollution levels mean that both government and private sector need to change their approach to infastructure and service delivery.

Table 5. Pollution Levels in Metro Manila Cities (June 2006 - June 2008)

Cities	**Jun '06**	**Jan '07**	**Jun '07**	**Jan '08**	**Jun '08**
Pasay	326	226	277	277	276
Valenzuela	198	243	231	179	263
Manila	102	178	127	122	198
Mandaluyong	122	142	175	119	175
NPO	166	135	130	119	122
Makati	157	143	87	207	120
Quezon City	135	111	94	139	113
Pasig	82	72	144	102	96
Average	**161**	**156**	**158**	**158**	**170**

Data Source: Ambient Air Monitoring, Environmental Management Bureau

Part II.

Geo-physical/Environmental Hazards, Exposure and Vulnerability of Metro Manila

The following section is largely based on the data bases and publications of the Manila Observatory (cf. Loyzaga, Narisma, Olaguer, Perez, Vicente, et al, 2009) relating to hazard, exposure and vulnerability of Metro-Manila. These mapping results have as yet to be integrated in the form of a GIS.

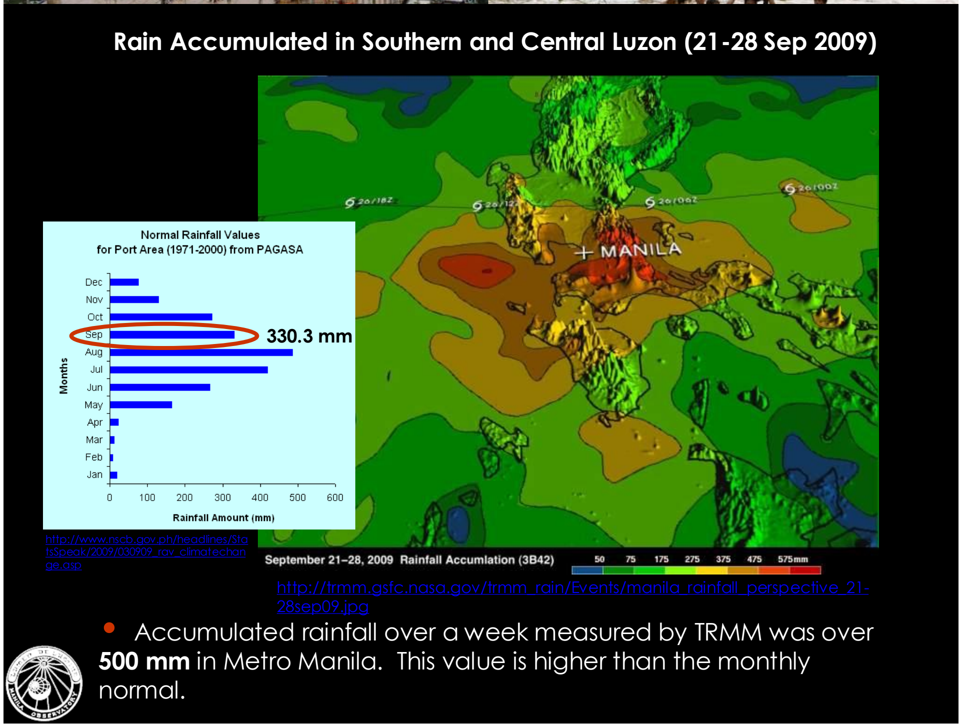
Storm Ondoy in October 2009, an example of extreme hazard, had maximum exposure over large areas of high vulnerability (see illustrations/figures below) inMetro Mania and Luzon. The accumulated rainfall within a week (Sept. 21-28) was over the monthly average for September 2009. The highest rainfall of 368.8 mm was experienced on 26 April 2010 from 9 am to 1 pm.

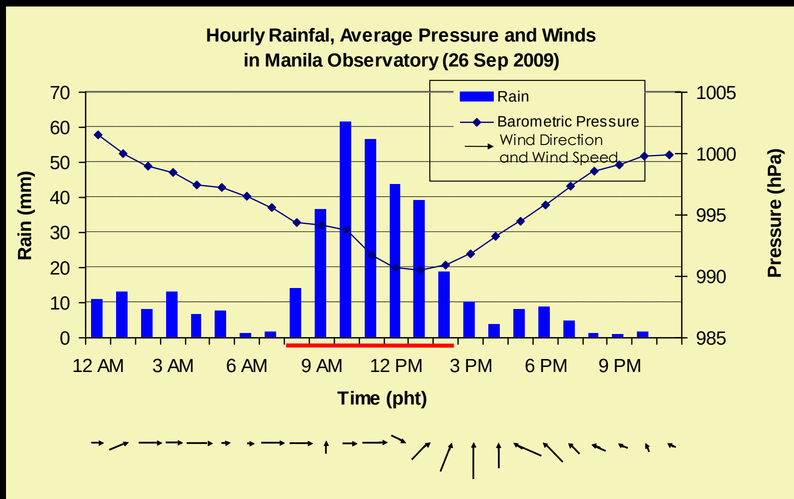
ONDOY

Extreme HAZARD

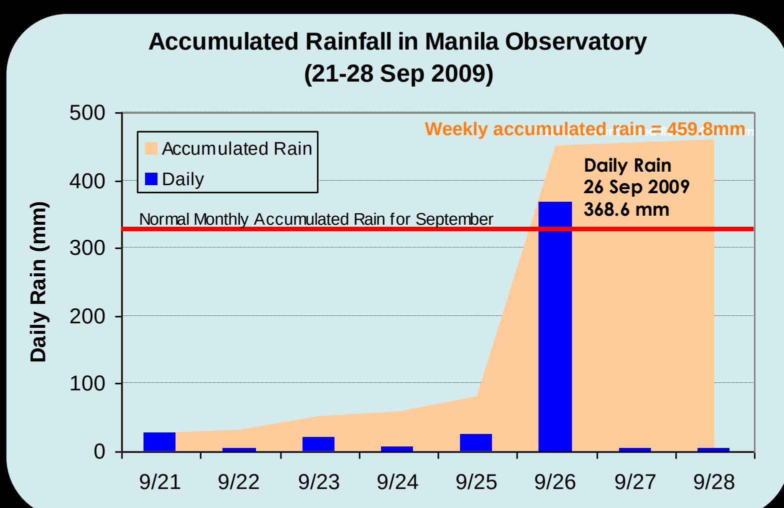
Maximum EXPOSURE

High VULNERABILITY



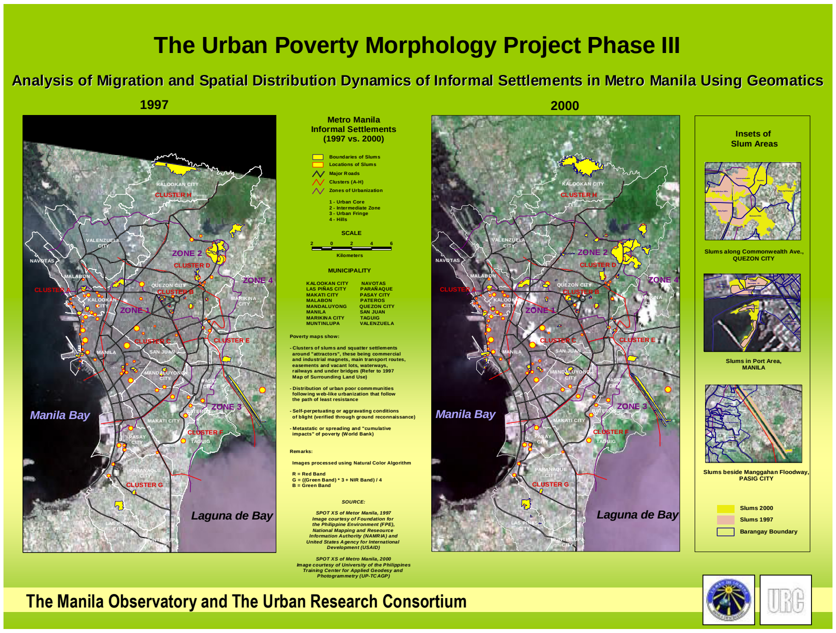


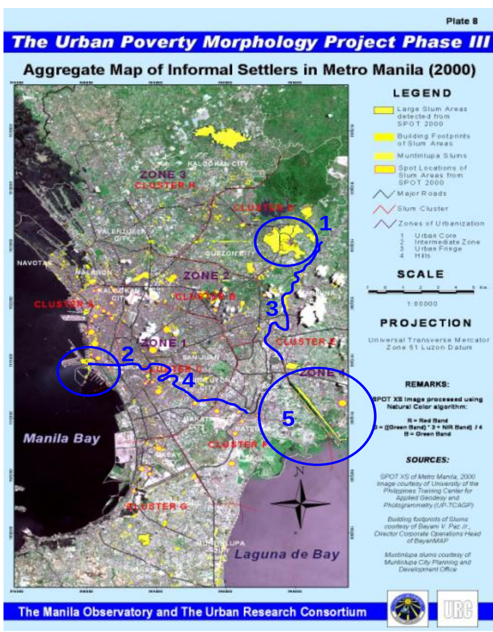
- The highest rainfall was measured in Manila Observatory between 9 AM and 1 PM.
- Highest rainfall of 61.4 mm/hr was measured at 10 AM



- "Ondoy" brought a total of **368.8 mm** of rain over Manila Observatory on September 26, 2009.
- This daily rain measured in Manila Observatory is higher than the monthly normal (330.3mm) in the Port Area.

Change detection of informal settlements reveals that, conservatively, there is increase in the number of informal settlers at about 1 M per year. Expansion, agglomeration and densification are physically observable.





Estimated number of Informal Settlers

1 – Batasan: Batasan Hills, Const. Hills, Commonwealth, Holy Spirit, Payatas, Bagong Silangan in Quezon City: 2,891,987

2 - Port Area: Brgy 19-20 of Tondo, Brngy 275 of San Nicolas, Brgy 649 of Port Area: 309,355

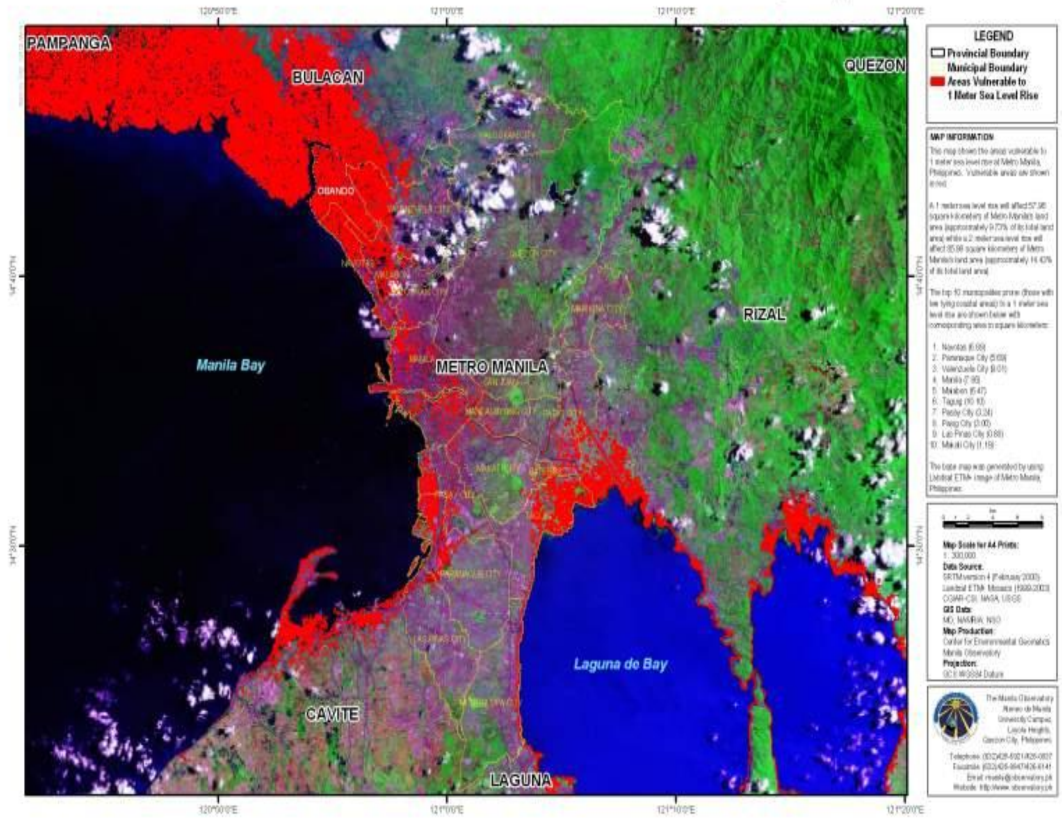
3 - Marikina River: Barangka, Industrial Valley of Marikina, Bagong Silangan of Quezon City: 299,286

4 - Pasig River: Brgy 900, 902-905 of Sta. Ana: 77,636

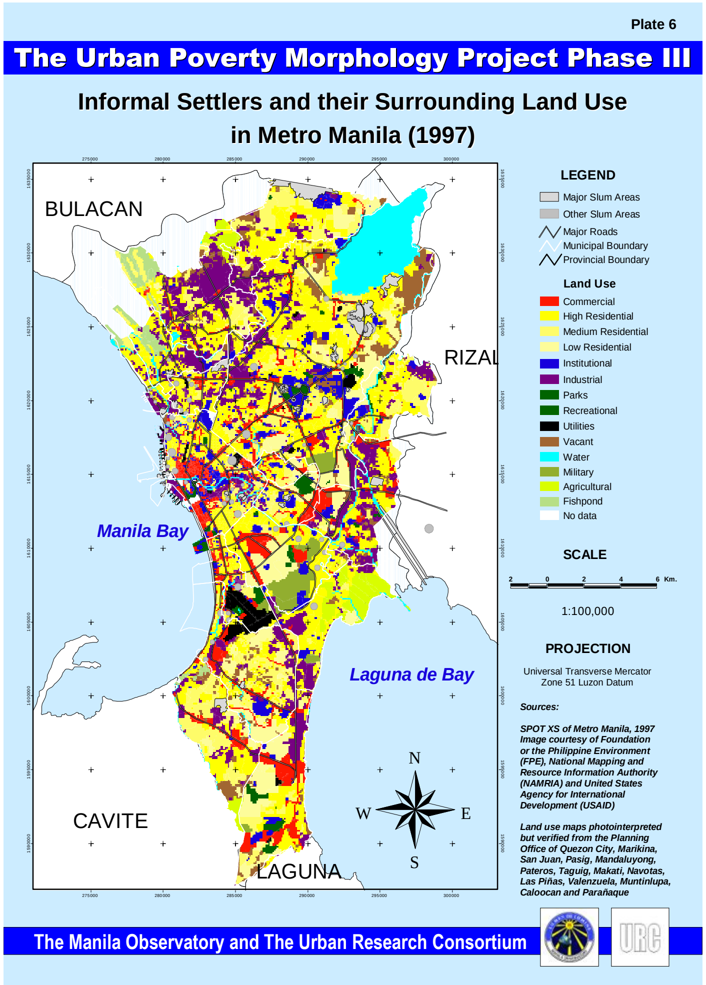
5 - Manggahan Floodway: 1,153,726

TOTAL: 4,731,989

Areas Vulnerable to 1 Meter Sea Level Rise at Metro Manila, Philippines

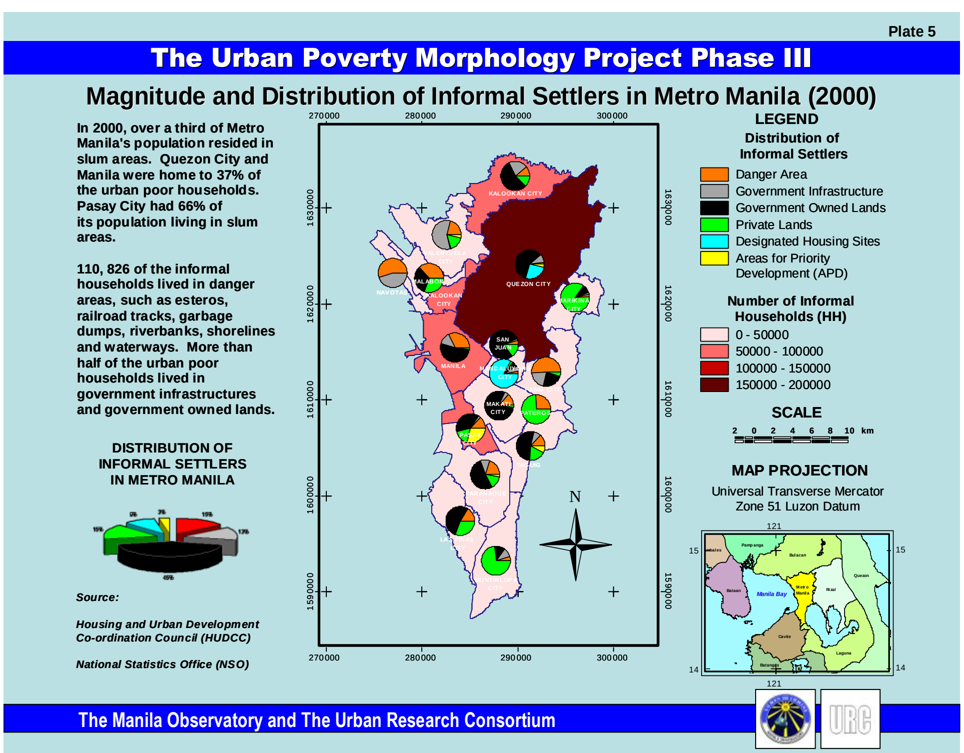


The above maps and figures highlight the social and ecological vulnerabilities of the 17 cities and municipalities of Metro Manila and the surrounding regions and provinces.



Informal settlements are found to cluster around socio-economic attractors, with ease of transportation and utilities, aside from occupying vacant lands and easement, often along rivers and creeks and with potential for nearby urban agriculture. Informal settlements are also often found along hazard-prone or danger areas.

For the population distribution of informal settlers in Metro Manila, please see figure 8 in page 14 of this report.



Part III. Perceptions and Understanding of Climate Change Related Risks and Adaptation

This section (mainly reponses to the questions posed by APN) has been drawn from the studies done by the Manila Observatory (Toni Loyzaga, Gemma Narisma, Deanna Olaguer, Rosa Perez, Celine Vicente, et al) , Department of Sociology and Anthropology of the Ateneo de Manila University (Emma Porio) JICA study of Megumi Muto, and to a lesser extent from the interviews of Ronald Cartegana with local government and MMDA officials.

Perceptions to Climate Change Related Risks

• Current perception of climate change related risk (such as *floods, water and food supply, land losses, air quality, heat stress, disease outbreaks, etc.*) and social/economic vulnerability (such as *poverty, investment, capital and opportunity losses, social conflicts and divides, genders, justice, etc.*) in your city, e.g., how do they perceive on the differences and linkages between weather/climate risks and social/economic vulnerability?

> With their extreme experiences of typhoons and floods in recent years like Typhoon Milenyo, Pepeng and Ondoy, the residents of Metro Manila have heightened sense of awareness of climate change related risks. But while they maybe aware of its severe consequences of their lives, they have not been systematically oriented/educated on this phenomenon nor have their capabilities been systematically built to respond or adapt to these risks and hazards. In like manner, government agency officials and barangay officials in-charge of coordinating disaster responses are very ill-equipped to respond to these hazards and risks as demonstrated during Typhoons Ondoy and Pepeng in September-October 2009.
>
> Among urban officials, city managers, however, there are selected LGUs who have incorporated risk information into their action plans, e.g. Makati, Marikina. However, since Metro Manila consists of 17 municipalities and cities which are interconnected by the same rivers, watersheds and drainage ways, a Metro-wide risk framework plan is badly needed.

• Have various climate risks to your **c**ity have been assessed and/or mapped, and if so do they take into account possible effects of current and future climate changes?

> To our knowledge, none yet, but a post-Ondoy assessment is being planned for Metro Manila.

• Have social/economic vulnerability to climate related risks have been assessed and/or mapped, how, by whom, details?

Under “Mapping Philippine Vulnerability to Environmental Disasters”, climate-related risk (Historical and projected) has been mapped and is being improved for the Philippines as these are pegged to provinces (Typhoon, Rainfall, Temperature, El Niño). The World Bank, under the Global Fund for Disaster Risk Reduction (GFDRR), recently commissioned a desk review of risk and exposure maps. Additionally, agricultural infrasturcture damage maps were generated using data available from the national government. Metro Manila or the national capital region (NCR) was treated as a special risk case in the identification of top 20 high-risk provinces.

The critical issues in this meso-scale initiative are access to good data, scale and spatial unit of the outputs, ground verification, weighting and classification of variables, most especially vulnerability. The nature of vulnerability can vary across cities. Moreover, inter-vulnerability may occur wherein the actions of one city may adversely affect the neighboring city.

These critical gaps were most apparent during Tropical Storm Ketsana where rapid risk assessments were required in order to execute appropriate response.

Under “Mapping Philippine Vulnerability to Environmental Disasters”, Climate-related risk (Historical and projected) has been mapped and is being improved for the Philippines as these are pegged to provinces (Typhoon, Rainfall, Temperature, El Niño). The World Bank, under the Global Fund for Disaster Risk Reduction (GFDRR), recently commissioned a desk review of risk and exposure maps. Additionally, agricultural infrasturcture damage maps were generated using data available from the national government. NCR was treated as a special risk case in the identification of top 20 high-risk provinces.

The Kyoto University’s IEDM Laboratory recently published the Metro-Manila City Profile: Climate and Disaster Resilience. This publication was produced in collaboration with METROPLANADO, the association of Metro-Manila planning officials from Local Government Units. Research was funded by the Global Center of Excellence (GCOE) Program “Human Security Engineering forAsian Megacities.” This study is a valuable starting point in establishing a baseline for metro-wide risk. City profiles detail risk in terms of physical, social, economic, institutional and natural conditions.

• Have the climate risks and vulnerability of city been communicated to the public, and how?

To the best of our knowledge, the integrated risks and vulnerability of Metro Manila has not been systematically communicated to the public. Some LGUs like Marikina City have their own communication plan, though limited they might be.

• Is there an existing urban GIS information base that may be used for climate risk and vulnerability assessment? What is included?

Aside from thematic layers from the Manila Observatory, as shown previously, there is also the Metro Manila Earthquake Impact Reduction Study (MMEIRS) in the form of a GIS, which may contain related information on exposure and vulnerability. It is said that this is accessible by the LGUs.

• Which agencies and institutions (e.g., government, nongovernment, business, academic, civic society, etc.) in the city have roles in risk and vulnerability assessments, communicating such assessments to public and managing for information and knowledge about climate change? Their skill level and capacities needed?

The Metro-Manila Development Authority, NDCC, DSWD, DOH, DPWH, police, PNRC, and the local government executives should have such a mandate and should convene LGUs in terms of risk and vulnerability assessments and their communication.

• Is there an urban master plan? When it was completed? Does urban master plan take into account future risk to climate change?

These are as follows:

(1) METRO-MANILA DEVELOPMENT AUTHORITY. Towards a Humane-World Class Metropolis : A Physical Framework Plan for Metro-Manila, 1996-2016. Manila : MMDA, 1996.

(2) METROPOLITAN MANILA AUTHORITY. NCR Medium-Term Development Plan (1993-1998). Manila : MMA, 1992.

(3) METROPOLITAN MANILA COMMISSION, OFFICE OF THE COMMISSION FOR PLANNING, NATIONAL ECONOMIC DEVELOPMENT AUTHORITY. Regional Development Framework Plan (1983-1992). Manila, 1983.

(4) METROPOLITAN MANILA COMMISSION, OFFICE OF THE COMMISSION FOR PLANNING, NATIONAL ECONOMIC DEVELOPMENT AUTHORITY. Regional Development Framework Plan (1985-1994). (No date)

Neither past nor current master plans for MM take into account climate-related risk, except the National Framework for Strategy for Climate Change (2010-2022). But like other government planning frameworks, it largely remains at the planning level.

The JICA-financed "KAMANAVA Area Flood Control and Drainage System Improvement Project" has the design scale of a 10 year return period. The project works include construction of a polder dike, heightening of river walls on the Malabon and Marala Rivers, construction of a submersible radial navigation gate facility, construction of flood gates, construction of control gates, construction of pumping stations without flood gates, and improvement and new construction of drainage channels.

• Have and how building codes, land use regulations, sanitation codes, etc. been enforced?

Selectively, it cannot be determined whether these are adequate or whether these have been enforced.

The JICA study projected a high number of casualties if a strong intensity earthquake hit Metro Manila because of poor regulation and enforcing of building related laws and codes as well as in the compliance of requirements for business permits. In general, LGUs are unable to enforce laws and ordinances.

• Is there an early warning system? Evacuation or emergency response plans for various types of weather and climate related disasters? How effective they are?

PAGASA is designated government agency to provide hazard warnings. But the information released by these early warning system are sometimes inaccurate as shown in the recent typhoon Basyang. PAGASA predicted it will not pass Metro Manila when in fact it did! Moreover, the Metro Manila flood warning system or EFCOS is reportedly not in operation.

The information is supposed to be relayed to the respective LGUs and related instituions (e.g., Dept. of Education) but the desired systematic communication and coordination among agencies leave much to be desired. This is particularly evident during rainy and typhoon seasons and the need to know whether classes will be suspended.

Most LGUs have response teams for emergency situations but often these cannot cope when the need rises during typhoons and floods.

• Level and effectiveness of public funding and commitment to respond to climate related risks and vulnerability?

Funding has been mostly project-based and donor-driven. Sustainability and progress of these initiatives are a major concern for most stakeholders. The terms of local government executives (3 years) highly constrain the effectiveness of their implementation of risk reduction measures at the local and district levels.

The local disaster or calamity fund is the main source of local governments during flood and typhoon related evacuations. Currently, some LGUs are advocating to mainstream climate change and disaster management issues into the city's regular planning and budgeting calendar. But local planning officials are co-terminus with the local executives who, on the average, hold only a three year term in office. Mainstreaming climate change issues into the planning process and cycle poses some challenge.

• Governance and social justice issues, institutional, jurisdictional and social conflicts, etc. that may lead to worsening climate related issues?

The National Disaster Coordinating Council (NDCC), created by PD 1566, is headed by the Secretary of National Defense heads the NDCC with the heads of 18 departments/ agencies as members. These include the Chief of Staff, Armed Forces of the Philippines; Secretary-General, Philippine National Red Cross; Philippine Information Agency; Executive Secretary and the Administrator, Office of Civil Defense who is the Executive Officer of the Council. It is expected that NDCC member-agencies carry out its corresponding tasks and responsibilities related to disaster preparedness, prevention, mitigation and response under the NDCC system.

But the major weakness of NDCC is that unlike other department coordinating bodies, does not have its own regular budget to disburse. It operates through the member-agencies and its local networks, which are the regional and local disaster coordinating councils. While its website has a disaster incident monitoring window, it is not very responsive to the needs of decision makers and stakeholders on the ground.

Climate with the associated geophysical and ecological risk to food, water and energy security as well as health need to be assessed. These assessments should serve as inputs into decision support systems for national planning and local governance. There is a need to support interdisciplinary research which will determine the intersections between and among human and natural systems. Risk assessments should be prioritized for areas wherein pre-existing vulnerabilities due to such conditions as socio-cultural conflicts may exacerbate environmental changes due to climate change.

In Metro Manila and other Philippine cities, institutional capacity-building, i.e., the need to develop, mainstream and disseminate knowledge about climate change related risks and adaptation is very critical for the community to develop adaptation and resilience strategies. But the bench mark here is very shallow.

The vulnerability of urban populations cannot be overemphasized, especially the poor, residing in areas which are socially and ecologically vulnerable areas of the city (for elaboration refer to Muto (2009), Porio (2009) and Vicente (2004) cited in earlier pages of this report.

Part IV. Future Areas of Research and Collaboration

From the previous section, the need for accurate assessment of climate change related risks is very crucial. There is a critical need to integrate the various scattered studies and initiatives from the different sectors and stakeholders. More importantly, there is a need to integrate risk and vulnerability assessments from different disciplinal and political-economic perspectives that highlight the intersections of social-ecological dimensions of climate change.

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MUMBAI CITY REPORT

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Presented at

International Workshop on
Climate Change Vulnerability Assessment and Urban Development Planning for Asian Coastal Cities

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1. Introduction

The world is urbanizing at a rapid pace. In 2008, the world crossed a landmark, where more than half of the human population, about 3.3 billion, became urbanized. It is expected that by 2030, almost 5 billion people will reside in urban areas. At the global level, all future population growth is expected to happen in towns and cities. Further, most of this growth will be in the developing countries. Estimates suggest that about 80% of the urban dwellers in the world will reside in cities of the developing world, particularly in Asia and Sub-Saharan Africa, by 2030[1]. Urban growth now stems more from natural increase (more births than deaths) rather than migration[2]. This is also termed as the 'Second Wave' of urbanization, the first having occurred in Europe and North America in the early 18th Century. The difference between the two waves is that of scale. In the first wave, urban population increased from 15 to 423 million between 1750 and 1950. In the second wave, we are expecting an unprecedented increase from 309 million to 3.9 billion between 1950 and 2030 in the developing world[3]. Urbanization is inevitable and essential for future economic growth. What happens in cities in near future will largely shape the global economic growth, poverty alleviation, environmental sustainability and ultimately the human life. Yet, cities on the brink of exploding population, inadequate infrastructure, poverty, growth of slums and rampant environmental degradation do not pose a good picture for sustainable growth.

Asia with 1.5 billion people living in cities has the largest urban population in the world. Out of the 75 million born every year the worldover, six countries from Asia and Africa – Bangladesh, China, India, Indonesia, Nigeria and Pakistan – are accounting for almost half of them[4]. Urbanization in Asia is happening at a much higher rate (1.31% annual average growth rate) than the world average (0.83% annual average growth rate). In South and South-East Asian countries, capital cities like Mumbai, Dhaka, Bangkok, Manila and Jakarta have populations above 5 million. In fact, both Mumbai and Manila support more than 10 million people. There are serious implications of such massive populations for these cities. Their proximity to coast also enhances their vulnerability to weather/climate risks.

A significant proportion of Asia's growing population is living in the large coastal cities that are highly vulnerable to sea level increases, storm surges and floods. Asia's densely populated mega-cities and other low-lying coastal urban areas are described in the IPCC Fourth Assessment Report (AR4) as "key societal hotspots of coastal vulnerability" with millions of people at risk. In recent years,

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[1] UNFPA, State of the World Population 2007: Unleashing the Potential for Urban Growth, United Nations Population Fund 2007

[2] *Ibid.*

[3] *Ibid.*

[4] UN-HABITAT, Urbanization Facts and Figures, World Urban Forum III, An International United Nations Human Settlements Programme, Event on Urban Sustainability, Canada, 2006

there have been many extreme weather events, such as, Mumbai floods in July 2005 that have led to massive damages, loss of life and property and affected the economic and social activities adversely. Such events also tend to have long-term consequences for economic development and poverty alleviation in the city and can potentially alter the development trajectory permanently. Accompanied by physical, economic and social vulnerabilities in such areas is the low adaptive capacity due to constraints on physical, financial and human resources. It is, therefore, absolutely essential to assess the vulnerability of Asian coastal cities to climate change and understand the implications for long-term development planning for the cities.

Mumbai is one of the largest mega cities in the world in terms of population and is currently ranked 4th after Tokyo, Mexico City and New York[5]. The city is the financial capital of India with a large commercial and trading base. It plays host to a number of industries, multinational companies and important financial institutions. With a per capita income thrice that of the national average, Mumbai makes huge contribution to the total tax revenues of the country. The city is also an important international sea port and strategic from defence perspective. Unfortunately, the city is also more vulnerable to climate risks due to its flood prone location and the landmass composed largely of reclaimed land. The most vulnerable section is also the slum dwellers and squatter communities in the city that comprise more than half of the total residents. Therefore, it is critical for the city to assess the vulnerabilities and devise adaptation and mitigation mechanism to cope with future climate risks.

This report takes an overview of the weather/climate risks for Mumbai city and identifies the physical, economic and social vulnerabilities. The report reviews the current status of planning and implementation efforts to reduce the vulnerabilities in the city and identifies the knowledge and research gaps in addressing vulnerabilities to direct the efforts in near future. The outline of the report is as follows. The next section creates the profile of the mega city of Mumbai to identify the physical and socio-economic vulnerabilities. The section also reviews the current adaptation and mitigation efforts undertaken in the city. The current perception pertaining to the climate risks in Mumbai is discussed in Section 3. This section reviews recent studies projecting climate risks and vulnerability for Mumbai. Section 4 deals with the expected roles of different stakeholders in the adaptation efforts undertaken at all levels. The concluding section identifies the knowledge and research gaps that academia and policy makers need to address in near future.

[5] *Ibid.*

2. Coastal mega-city – Mumbai

Mumbai (formerly known as Bombay) is located on the western seacoast of India on the Arabian Sea at $18^{0}53^{'}$ N to $19^{0}16^{'}$ N latitude and 72^{0} E to $72^{0}59^{'}$ E longitude. It was originally a cluster of seven islands, which were later joined to form the present city. Greater Mumbai Region (referred to as Mumbai in the text) consists of 7 islands in the city area and 4 islands in the suburbs. The present day city is divided into two revenue districts, Mumbai City District, i.e, the island city in the South and Mumbai Suburban District comprising the Western and Eastern suburbs. Mumbai occupies an area of 468 square kilometers (sq. km.) and its width is 17 km. east to west and 42 km. north to south[6]. The entire region encompasses rich natural heritage, such as, hills, lakes, coastal water, forests, and mangroves, alongside built areas. The coastline of Mumbai has been reclaimed for development purposes; *e.g.*, areas like Cuff Parade and Mahim creek were wetlands, later reclaimed for residential and commercial uses.

The Municipal Corporation of Greater Mumbai (MCGM) is the primary agency responsible for governance of the GMR or Mumbai city. The city is divided into different administrative zones known as *'wards'* to ease the day-to-day functioning of the civic authority. The map of Mumbai city, including the location of different administrative wards is shown in Figure 1 below. MCGM has a long history in urban governance. It was the first municipal corporation established in India in the year 1882. Since then, the civic body has been responsible for the provision of civic amenities, education, public health, art and culture and heritage conservation in the city. MCGM holds the distinction of being one of the largest local governments in the Asian continent[7]. For administrative purposes, Mumbai Metropolitan region (MMR) has been designated to combine GMR and the surrounding areas of Thane, Navi Mumbai, Ulhasnagar, Mira Road, Vasai, Virar, Bhayandar, Bhiwandi, Karjat, Alibaug, *etc.* Mumbai Metropolitan Region Development Authority (MMRDA), set up in 1975, is responsible for planning and coordination of the development activities of this region. The total area of the MMR, excluding Mumbai city, is 3887 sq. km., with a population base of 5.90 million as per 2001 census[8]. These surrounding areas hold significance for the economy and transportation in Mumbai, as thousands of people travel everyday from these areas into the city for employment. This puts additional pressure on the transport network and other civic amenities in the city.

The geographical location of the city and its physical, economic and social characteristics make the city more vulnerable to the threats posed by climate risks, such as, sea level rises, storms and floods. This section looks at each of these vulnerabilities in detail.

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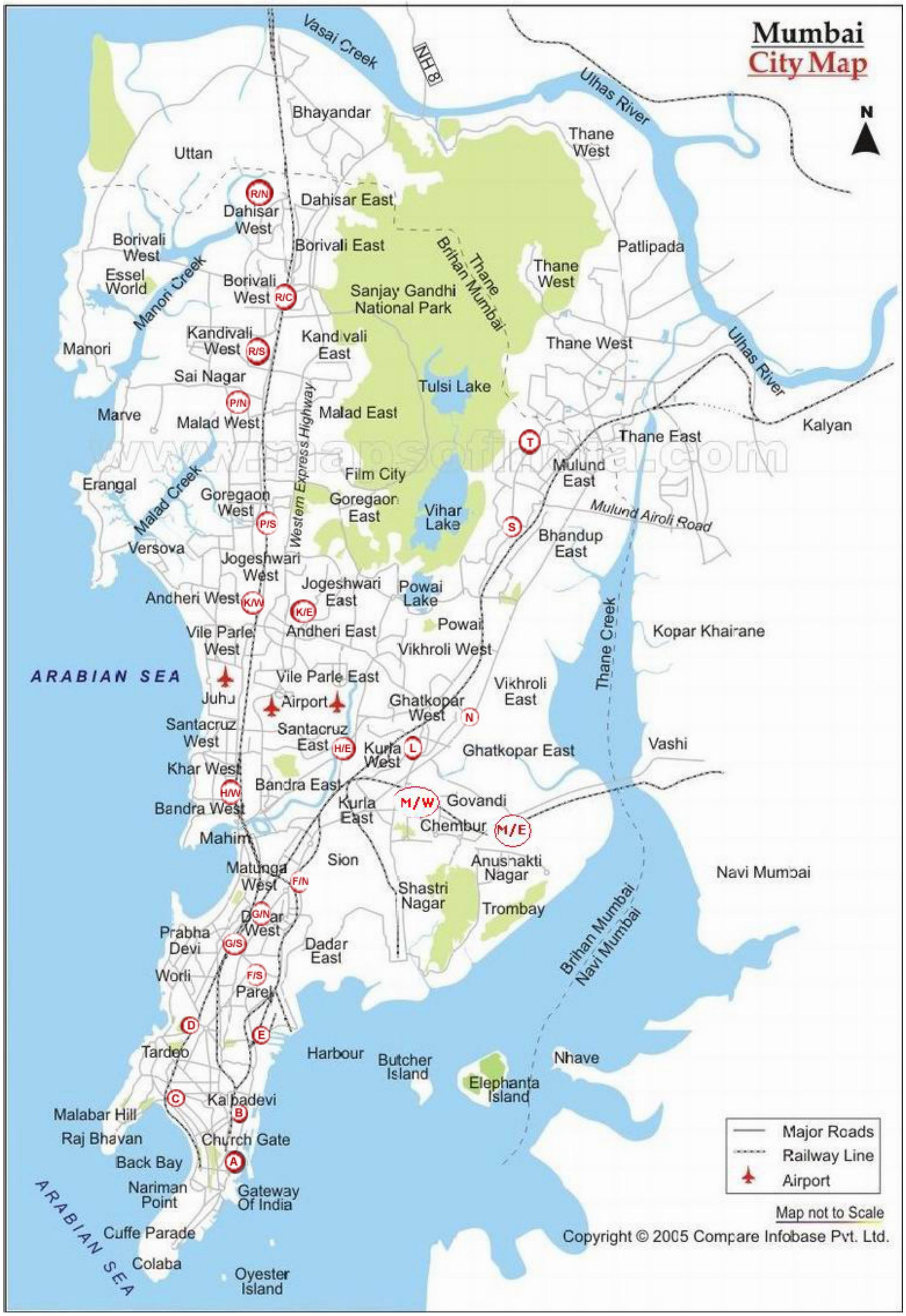
[6] MCGM, (2007), Statistics on Mumbai, Municipal Corporation of Greater Mumbai, available at http://www.mcgm.gov.in

[7] *Ibid.*

[8] MMRDA, (2007) Basic statistics on MMR, Mumbai Metropolitan Region Development Authority, http://www.mmrdamumbai.org/basic_information.htm

Figure 1: Map of Greater Mumbai Region



Source: http://www.mcgm.gov.in

2.1 Physical vulnerability

Mumbai is an island outside the mainland of Konkan in Maharashtra State and is separated from the mainland by a narrow creek known as Thane Creek and a Harbour Bay. The city is surrounded on three sides by the sea: Arabian Sea to the West, Harbour Bay in the West and Thane Creek in the East. The height of the city is just 10-15 meters above the sea level. A large part of the City District and Suburban District is land reclaimed from the sea. The new industrial, commercial and residential settlements have developed along the reclaimed coastal areas which are low-lying and flood prone.

Mumbai, being on the seacoast, experiences a tropical savanna climate[9,10] with a heavy southwest monsoon rainfall of more than 2100 millimeters a year. Mumbai experiences three seasons – summer from March to May, monsoon between June and September and winter during October to February. The city receives heavy rainfall during monsoon and relative humidity is quite high during this season. Similarly, winds are generally moderate but pick up during monsoon months. In the City District, daily average temperatures range from the minimum of 23.7^{0}C to the maximum of 31.2^{0}C. The average total annual rainfall is 2146.6mm. In the Suburban District, the temperatures vary from the minimum of 16.3^{0}C to the maximum of 33.3^{0}C. This district receives the average annual total rainfall of 2363.0 mm. The flash floods that led to the complete disruption of normal life in Mumbai in July 2005 were the result of an unprecedented rainfall of 944.2 mm on July 26th in the Suburban District[11].

Figure 2 shows the original seven islands and subsequent physical growth of Mumbai. Most parts of the present day city are built on the reclaimed land. The city is about 10-15 metres above sea level in many places[12]. The airport area is only 7.5 metres above sea level. Similarly Bandra-Kurla Complex, Wadala and major residential areas of Worli are low-lying areas. Coastal erosion, landslides, flash floods associated with heavy precipitation and the unprecedented 2005 floods are some of the incidents that highlight the vulnerability of the city to coastal climate hazards.

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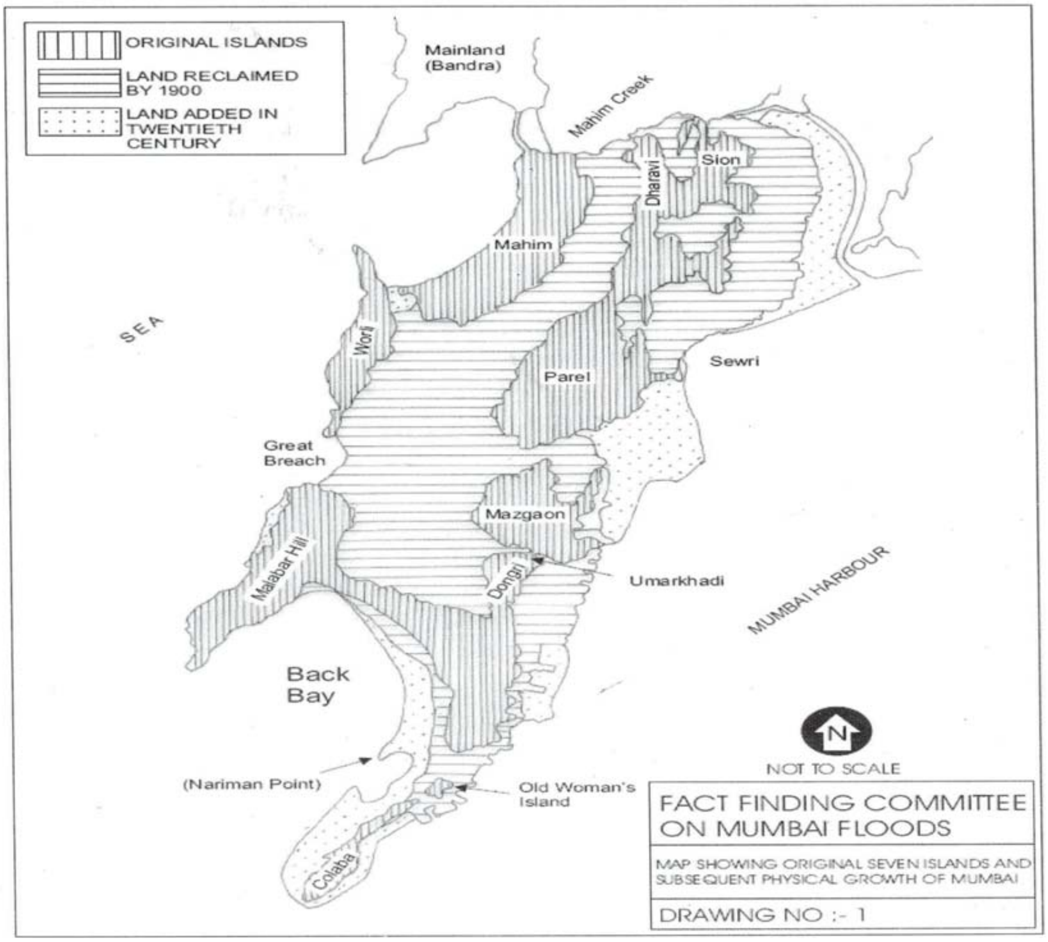
[9] MCGM, (2003), Environment Status Report 2002-03, MCGM

[10] MPCB, (2005), Report on Environment Status of Mumbai Region, Maharashtra Pollution Control Board, Government of Maharashtra

[11] Govt. of Maharashtra, (2007), Greater Mumbai Disaster Management Action Plan, Maharashtra Emergency Earthquake Management Programme, Govt. of Maharashtra

[12] *Ibid.*

Figure 2: Original Seven islands and subsequent Physical growth of Mumbai



Source: Gazetteer of India, Maharashtra State, History of Bombay, Modern Period 1987

Being a coastal city, Mumbai is prone to cyclones and gusty winds. There are a number of wards along the coast (Arabian Sea and Thane Creek) that are vulnerable to cyclonic impacts. For instance, in wards A – D, G-North, G-South, S and T, the Greater Mumbai Disaster management Action Plan (DMAP) has identified settlements that are acutely vulnerable to cyclones. There settlements were originally fishing communities, but are now home to many slums along the coast. Given the poor quality of construction material used by these homes, they are extremely vulnerable to cyclones and winds[13]. In addition to this, there are 40 chronic flooding locations identified in the DMAP that are spread over the island city, eastern and western suburbs. These flooding spots are a worry for the civic administration as heavy precipitation would cause flooding in the local settlements as well as disrupt traffic and normal city life.

[13] *Ibid.*

Mumbai falls in the seismic zone III which is Moderate Damage Risk Zone. As per 2001 census, Mumbai has over 276,000 dwellings (residential, industrial and commercial) of which only 9% are made of reinforced concrete, 31% are engineered constructions and around 60% are non-engineered constructions, which correspond with the large presence of slum settlements[14]. The major risk category is the engineered constructions, some of which are 'cessed' buildings[15]. These buildings, on account of rent control, have suffered from lack of maintenance and apathy from landlords and are now in dilapidated conditions. Such constructions are more vulnerable to extreme weather events as well. Many slum settlements also face the risk of landslides usually occurring during heavy rains with gusty winds. These are generally located on the hill slopes, bottom of hills or near abandoned quarries. DMAP identifies 117 such settlements which are extremely vulnerable to landslides, loss of life and damage to property in case of heavy precipitation.

Mumbai also plays host to around 900 industries that are involved in manufacturing or processing or storage of hazardous goods. Many of these are in close proximity to residential and commercial areas, thereby increasing the risk of fires and explosions. The major concentration of such industries is in the Chembur-Trombay belt (Wards M-West and M-East). The area has major chemical complexes, refineries, fertilizer plans, atomic energy establishment and thermal power plant. The presence of such industries only enhances the vulnerability in case of extreme weather events.

Mumbai, with a large population to cater to, requires basic infrastructure in the form of a large transport network. Transport network in Mumbai comprises a huge railways and roads network. The length of the railway tracks joining western and eastern suburbs with the island city is 25 km. and 30 km. respectively. Plus, there are other railway tracks catering to smaller sections within the city. Thousands of people avail of this huge network every day. The total length of the road network is 1941.172 km., out of which 506.480 km. are in the island city and 927.05 km. in the suburbs[16]. There has been a massive growth in the number of vehicles (more than 79%) in recent years between 1991 and 2004. Among the total number of vehicles, the number of two-wheelers and three-wheelers has gone up by more than 100% between 1995 and 2004, whereas the number of passenger cars during the same period has gone up by more than 62%[17]. The massive railway and road network, however, is not sufficient for such a large population moving in a single direction during peak business hours. Most commercial activity is concentrated in the island city in the south. The movement between south and north for business purposes in the peak hours places a huge burden on the transport network. The road network has become very congested over the years with increasing number of vehicles and

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[14] *Ibid.*

[15] Cessed buildings are constructions prior to 1960, wherein the residents pay a 'cess', i.e., a predetermined amount to the civic authority for building repairs.

[16] MPCB, (2005), Report on Environment Status of Mumbai Region, Maharashtra Pollution Control Board, Government of Maharashtra

[17] Govt. of Maharashtra, (2005), Motor Transport Statistics, Office of the Transport Commissioner

more people traveling to and from the city. For instance, people residing in surrounding areas of Mumbai, known as the MMR, use the railways and roads network to come to the city everyday for employment or business. In addition to this, Mumbai has an international airport catering to more than 4 million travelers and domestic airport servicing more than 4.2 million travelers[18]. Such a huge network of transportation faces the risks from extreme weather events and would suffer from massive damages and costs from flash floods, storm surges and sea level rises.

2.2 Economic and social vulnerability

Perhaps the most important factor enhancing the vulnerability of the city to climate risks is the ever growing population of Mumbai. The city population has grown steadily in the last 5 decades. There is a consistent growth from about 3 million in 1951 to 8 million in 1981 to 12 million in 2001 as per the Census figures[19]. The mid-year population estimates for 2008 suggest that the population has grown to 13.4 million with the density of 30,803 per sq. km.[20] Mumbai, being the financial capital of the country with a large industrial and commercial base, attracts a large workforce into the city. The growing population adds to the pressure on basic infrastructure, civic amenities and housing. It also leads to congestion, heavy vehicular traffic, growth in illegal slum dwellings, unhygienic living conditions and the problem of solid waste disposal.

The estimates for year 2008 suggest that 56% of the population in Mumbai lives in slums[21]. With expanding trade and commerce, more and more people are getting attracted to the city. However, due to increasing costs of land and material, it has become virtually impossible for the poor and low-income households to acquire residential property in the city. As a result, the base of slum-dwellers has increased tremendously. Slums have mushroomed in almost all the wards of Mumbai, along the coast, on the hill slopes, along the highways, railways and in low-lying areas. Many settlements lack even basic infrastructure like water, sanitation and legal electricity connections. Policy makers and society, over the years, have looked at slums with different perspectives. They were earlier seen as unfit settlements and dens of crime leading to decisions about demolishing and replacing them with 'acceptable' housing. The Slum Clearance Programme of 1956 gave enough powers to the government for redeveloping the acquired slum areas. However, redevelopment could not match the pace of demolitions and the pace of growing slums. In 1972, policies were formulated with emphasis on 'improvement in living conditions' rather than 'redevelopment' and 'rehabilitation'. Provision of basic civic amenities such as drinking water, sewerage system, paved roads, community

[18] Govt. of Maharashtra, (2007), Greater Mumbai Disaster Management Action Plan, Maharashtra Emergency Earthquake Management Programme, Govt. of Maharashtra

[19] MMRDA, (2007) Basic statistics on MMR, Mumbai Metropolitan Region Development Authority, http://www.mmrdamumbai.org/basic_information.htm

[20] MCGM, (2008), Public Health Department at a Glance 2007-08, MCGM

[21] *Ibid.*

toilets etc., indicated a level of acceptance of slum communities[22]. However, slums are non-existent on city's developmental plans. None of the 2335 settlements are recognized on the developmental plan of Mumbai and the land under slums has development plan reservations, even though some settlements have existed before development plans were formulated[23]. This deliberately induced invisibility of slums pushes its dwellers to multiple forms of displacements. Regular displacements prevent slum-dwellers from settling in safe and secure localities and they further move towards landslide prone areas, low-lying regions, and unsafe dumping sites etc., which are breeding grounds for hazards in changing weather/climate conditions.

Given the increasing population and more than half living a life of poverty and destitution with limited access to basic civic amenities and infrastructure, health vulnerabilities become imminent. As the Mumbai Human Development Report 2009 indicates, the overall life expectancy in Mumbai is much lower at 52.6 years for males and 58.1 years for females[24]. Tuberculosis (known as a poor man's disease), HIV/AIDS, Malaria and Jaundice are some of the major killers in the city. Infant mortality is 36.66 per 1000 live births and malnourishment is rampant among slum children. In fact, severe malnourishment is marginally higher among slum children in Mumbai than those living in tribal areas of the adjoining district, Thane[25]. The city boasts of enviable health infrastructure compared to other Indian cities, yet the public health facilities are grossly insufficient to cater to such a huge population and in the event of a disease outbreak, the civic machinery does not adequate infrastructure to deal with the health emergency. 75-80% population depends on relatively expensive private healthcare facilities for treatment and coverage of health insurance negligible[26].

As regards economic vulnerability, Mumbai has a pre-eminent position in the country as the commercial and trading base. In the financial year 2004-05, the per capita income of Mumbai was Rs. 69,696[27], which was twice that of Maharashtra State per capita income of Rs. 32,170 and thrice that of the national average per capital income of Rs. 22,946[28]. Mumbai is also an important source of tax revenue for the country, *e.g.*, in 2002-03, Rs. 28,000 crores were collected from the city in the form of taxes, which was 35% of the total tax collection at Rs. 82,000 crores for the entire country[29]. In recent

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22 Bhide, A. (2009). Shifting Terrains of Communities and Community Organization: Reflections on Organizing for Housing Rights in Mumbai, Community Development Journal, Vol. 44, No. 3 pp. 367-381

23 *Ibid.* Reservations indicate intended use of the land thereby making all other activities illegal.

24 MCGM, (2009), Mumbai Human Development Report 2009

25 Hatekar N. and Rode S., (2003), Truth about Hunger and Disease in Mumbai: Malnourishment among Slum Children, Economic and Political Weekly, pp. 4604-10

26 MCGM, (2009), Mumbai Human Development Report 2009

27 Govt. of Maharashtra, (2006), Economic Survey 2006-07, available at http://www.maharashtra.gov.in

28 RBI, (2007), Handbook of Statistics on Indian Economy, available at http://www.rbi.org.in

29 Bombay First, (2004), Statistics on Mumbai, http://www.bombayfirst.org

years, the share of tertiary sector in Mumbai's income has increased, whereas, the share of secondary sector has remained almost stagnant. Further, 2001 census suggests that the total employment in Mumbai is 44.64 lakhs[30], of which 41% are in secondary sector and 58% are in tertiary sector[31]. Most of the industries in Mumbai are located in eastern and northeastern corridor with a few in the western region. The number of factories in Mumbai has declined in the last decade and so also its share of factories in the state from 44% to 34% between 1993 and 2000[32]. As of 2003, there were more than 7800 large, medium and small-scale enterprises operating in Mumbai[33]. Most of these units are in mixed areas as no buffer zone is provided for them. In fact, Mumbai was the first City Corporation to adopt the concept of a development plan under which industrial zones were allowed to be used for residential and commercial purposes[34]. Therefore, there is no clear distinction between residential, commercial and industrial zones for the city. Industrial areas are further being converted into residential complexes, leading to a boom in construction activity, mainly in the suburbs. For instance, most textile mills have closed down in recent years giving way to residential and commercial complexes. The land use pattern in the city has undergone major changes in recent years with the conversion of industrial areas into residential and commercial complexes. The climate vulnerability of Mumbai, therefore, means a threat to the life and property within the city, impact on the entire development trajectory and the economic loss for the entire nation.

2.3 Managing vulnerability

In December 2005, in the aftermath of the unprecedented Mumbai floods, Government of India enacted the Disaster Management Act, under which the National Disaster Management Authority and State Disaster Management Authorities have been created. The Act also seeks to constitute Disaster Response Fund and Disaster Mitigation Fund at national, state and district levels. In Maharashtra, the state government accordingly has prepared the Greater Mumbai Disaster Management Action Plan (DMAP) in 2007. Under this plan, the risks and vulnerabilities associated

[30] 1 lakh = 100,000

[31] Govt. of Maharashtra, (2007), Greater Mumbai Disaster Management Action Plan, Maharashtra Emergency Earthquake Management Programme, Govt. of Maharashtra

[32] World Bank, (2005), For a Breath of Fresh Air: Ten Years of Progress and Challenges in Urban Air Quality Management in India, 1993-2002, Environment and Social Development Unit, South Asia Region, The World Bank (India Country Office), New Delhi, India

[33] MPCB, (2005), Report on Environment Status of Mumbai Region, Maharashtra Pollution Control Board, Government of Maharashtra

[34] World Bank, (2005), For a Breath of Fresh Air: Ten Years of Progress and Challenges in Urban Air Quality Management in India, 1993-2002, Environment and Social Development Unit, South Asia Region, The World Bank (India Country Office), New Delhi, India

with floods, earthquakes, landslides, cyclones, *etc.*, have been identified. The plan further envisages specific relief and mitigation measures for Mumbai[35]:

- ***Infrastructure improvements:*** The mitigation strategy seeks to improve the transport, services and housing infrastructure. These include improvements in road and rail networks, sanitation and sewer disposal system, storm water drainage systems, slum improvements, housing repairs and retrofitting programmes.
- ***Contingency plan:*** This strategy includes plans to provide extra transportation if the major transport systems fail, transit camp arrangements, improvements in wireless communication and public information systems and NGO volunteers' assistance.
- ***Land use policies and planning:*** The Draft Regional Plan for MMR Region 1996-2011 provides a basic framework for the land use policies for the city. This plan includes strategies like protection of landfill sites, control on land reclamation, shifting of hazardous units from residential areas and decongestion.

The DMAP looks comprehensive on paper, yet does not provide any specific timeframe for achieving the mitigation measures. Again, no specific attention is given to adaptation strategies which may be more important in the short to medium-term to deal with the climate risks of flooding, storms and cyclones. Measures related to infrastructure improvements would require a longer time frame given the socio-economic and political dynamics in the city. Also, the land use policies and planning will not be effective unless they are coupled with strategies to deal with slum settlements and migrants into the city. The experience of the city dwellers in the aftermath of 2005 floods only shows that the city administration and other stakeholders would need more specific strategies and an integrated approach to build resilience of the city to climate risks.

3. Climate risks in Mumbai

From the discussion in the previous section, it is evident that a mega-city like Mumbai is an important engine of population concentration, economic growth and innovation for the rest of the country. However, its location on the coast also puts it at greater risk of sea-level rise, flooding, high winds, cyclones and coastal erosion. The prevailing physical and socio-economic conditions make it important that we increase our understanding of who are vulnerable, to what extent, what are the climate hazards that we are exposed to and how do we deal with the vulnerability. This section focuses the discussion on some of these aspects. We try to analyze the climate risks for the city taking into account the past events and future projections based on scientific assessment. We further explore the linkages between climate risks and vulnerability and the framework within which the vulnerability is currently assessed and should potentially be assessed.

[35] Govt. of Maharashtra, (2007), Greater Mumbai Disaster Management Action Plan, Maharashtra Emergency Earthquake Management Programme, Govt. of Maharashtra

3.1 Events in the past and future projections

Mumbai has regularly been facing weather events related to flooding due to heavy precipitation and landslides during the rainy season. Mumbai's vulnerability to extreme weather events was demonstrated on 26 July 2005 when more than 900mm of rainfall occurred in the suburban district in the 24-hour period. The catastrophic event is described in Box 1 below. Before and after this catastrophic event, heavy precipitation and floods have regularly occurred in Mumbai. On many occasions, heavy rains over the city are the result of tropical storms or cyclones that hit the city or pass nearby. Many low-lying and reclaimed areas get flooded, especially when heavy rains combine with high tide or storm surges, with the added difficulties due to unsanitary methods of solid waste and sewage disposal and problems with the drainage systems[36]. Slums and squatter communities are particularly vulnerable to such events as the amenities and infrastructure is typically very poor and the built environment is also in a dilapidated condition. Landslides accompanied with heavy rains are also common in settlements on the hill slopes and in the quarries. There have been landslide events in the past where lives were lost along with damage to property. For instance, in July 2000, between 60 and 160 people were killed due to landslide. The most recent events of landslide occurred during the heavy rains in June and July 2010 in Dindoshi (Ward P-South) where many houses were damaged and families were rendered homeless.

Studies carried out over the past decade indicate that Mumbai is likely to be highly vulnerable to climate change with majority of its population living on the flood prone and reclaimed land. Estimates obtained in 2001 from the Goddard Institute for Space Studies[37] suggest that in the Canadian Climate Centre's business-as-usual emissions (A2) scenario and sustainable path (B2) scenario, the average annual temperatures in the city would increase by 1.75^0C and 1.25^0C respectively. Mumbai is also predicted to have an average annual decrease in precipitation of 2% for the A2 scenario and an increase of 2% in the B2 scenario. Perhaps, the most damaging scenario for the city would be the predicted sea-level rise of 50cm by 2050[38].

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[36] Sherbinin A., Schiller A. and Pulsipher A., (2007), The Vulnerability of Global Cities to Climate Hazards, Environment and Urbanization, Vol. 19(1), Sage Publications on behalf of International Institute for Environment and Development

[37] *Ibid.*

[38] *Ibid.*

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Box 1: Mumbai floods on 26 July 2010

On this fateful day, Mumbai recorded the highest rainfall the country during a 24-hour period in the last 100 years. Santacruz monitoring station (in Western suburbs) recorded 944mm rainfall between 8.30am and 8.30pm with the highest precipitation for a few hours between 11.30am and 2.30pm. The rainfall coinciding with the high tide brought the city to a standstill. Civic amenities such as electricity, water supply and transportation and communication networks were completely shut down. The worst-hit were the low-lying areas and the poor living in slums or squatter settlements along the pavements and near railway tracks.

Floods claimed more than 700 lives in the city. More than 14,000 houses were completely damaged and more than 357,000 houses were partially damaged. The total cost of damages has since been estimated at Rs. 306 crores (US$ 68 million @ 1US$ = Rs.45). The most extensive loss was suffered by trade and commerce as a large number of shops, commercial establishments and warehouses suffered heavy losses due to flooding. The Indian Merchants Chamber has estimated these losses to the tune of Rs. 5000 crores (US$ 1100 million). In the immediate aftermath, Mumbai also saw 3000 hospital admissions due to gastroenteritis, malaria, hepatitis, dengue and so on.

Source: Govt. of Maharashtra (2005), Maharashtra Floods 2005, Relief and Rehabilitation Department, Govt. of Maharashtra

An OECD study[39] has analyzed the recurrence of an extreme weather event like July 2005 for Mumbai. Its findings suggest that in the current scenario, the return period for an event of this magnitude is greater than 200 years. However, with imminent climate change, today's extreme events could become more frequent. For instance, a 1 in 10 event could occur every other year. Using the Storm Water Management Model of USEPA, the study further explores the future flood footprints for Mumbai. By 2080, the study finds extended flood footprints in the city with deeper flooding in more vulnerable areas. The total costs of such an event by 2080 would dramatically go up to US$ 2300 million from the present-day costs of US$ 650 million.

Yet another OECD study[40] has done a global screening of 136 coastal cities to identify their exposure to storm surges and high winds. The study has also investigated how climate change is likely to impact these cities through coastal flooding by 2070s. For the present day conditions (reference year 2005), Mumbai is ranked the first among top ten coastal cities in terms of exposed population. The total exposed population to weather events resulting from current climate conditions in Mumbai is estimated at 2.787 million. Under the future climate conditions, the population exposed to weather events like storm surges and flooding will go up to 11.418 million. Similarly, the value of exposed assets is currently US$ 46.20 billion, which would dramatically increase to US$ 1598.05 billion by 2080. Further, the city is ranked 2nd in terms of population exposure to future climate conditions by 2080, second only to another vulnerable coastal city in India, Kolkata (Formerly Calcutta). Mumbai is also among the top 20 cities with greatest exposure to extreme sea-level and with greatest exposure to wind damage from tropical cyclones. The city is also expected to have a high exposure to coastal flood risk in the 2070s. The study further emphasizes that exposure will not necessarily translate into impact if effective adaptation and risk management strategies are in place. However, for a city like Mumbai with far lower standards of adaptation and risk management or flood defences, the impacts of extreme weather events are likely to be large in future.

3.2 Mapping climate risks

Revi (2008)[41] has reviewed the climate risks for Indian cities in general in order to highlight the importance of infrastructure investments and urban management and the need to connect these with the official adaptation initiatives. As mentioned in the paper, climate change is expected to increase the frequency and intensity of current hazards and the probability of extreme weather events. The cities will further face the new hazards in terms of sea-level rise. This will degrade the resilience

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39 Hallegatte S., Coastal Cities, Climate Change Vulnerability and Adaptation, OECD Project led by Jan Corfee-Morgot, available at www.oecd.org/dataoecd/31/34/44104953.pdf

40 OECD (2008), Ranking Port Cities with High Exposure and Vulnerability to Climate Extremes: Exposure Estimates, Environment Working Papers No. 1

41 Revi A., (2008), Climate Change Risk: An Adaptation and Mitigation Agenda for Indian Cities, Environment and Urbanization, Vol. 20(1), Sage Publications on behalf of International Institute for Environment and Development

of urban poor, which make up almost half of Mumbai's population. There is a broad consensus among the scientific community on the first-order climate change impacts in India. There may be a general increase in both mean minimum and maximum temperatures by 2-4^{0}C depending on the atmospheric GHG concentrations[42]. This could lead to a mean surface temperature increase of 3.5-5^{0}C by the end of the century[43]. The regional temperature rise coupled with changes in the global climate system and Indian Ocean monsoon system may lead to a mean increase of 7-20% in annual precipitation[44]. Simultaneously, there might be a decrease in total number of rainy days over much of India, along with an increase in heavy rainfall days and frequency of such days in the monsoon season[45]. A substantial increase in extreme precipitation (e.g., Mumbai floods 2005, Gujarat floods 2005, 2006) is also expected over a large area of the west coast (including Mumbai) and central India[46]. Further, a sea surface temperature rise of 2-4^{0}C is expected to induce a 10-20% increase in cyclonic intensity[47]. A sea-level rise of 30-80 cm has also been projected over the century along India's coast based on multiple climate change scenarios[48]. Such sea-level rises, cyclones and storm surges could have a devastating impact on a large urban centre like Mumbai, which falls into a low elevation coastal zone (LECZ). Another important climate risk for Indian cities, in particular Mumbai, is the onset of water-borne diseases (diarrhea, cholera and typhoid) and vector-borne diseases (malaria and dengue). In fact, the recent reports emerging from the city suggest that malaria cases have doubled over the last year and in the first two weeks of July alone over 8600 cases of malaria have been reported[49]. Malaria is expected to expand its endemic range to western southern India in future[50] and the city of Mumbai with its large population will be at further risk.

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[42] Sharma S., Bhattacharya S. and Garg A., (2006), Greenhouse Gas Emissions from India: A Perspective, Current Science, Vol. 90, No. 3, February 2006

[43] Planning Commission (2006), Report of the Expert Committee on an Integrated Energy Policy, New Delhi

[44] Ramesh R. and Yadava M. G., (2005), Climate and Water Resources of India, Current Science, Vol 89, No. 5, September 2005

[45] Rupa Kumar K., Sahai A. K., Krishna Kumar K., Patwardhan S. K., Mishra P. K., Revadekar J. V., Kamala K. and Pant G. B., (2006), High-resolution Climate Change Scenarios for India for the 21st Century, Current Science, Vol 90, No.3, February 2006

[46] *Ibid.*

[47] Aggarwal D. and Lal M., (2001), Vulnerability of Indian Coastline to Sea-level Rise, Centre for Atmospheric Sciences, Indian Institute of Technology Delhi, New Delhi, India

[48] *Ibid.*

[49] Times of India, (2010), http://timesofindia.indiatimes.com/city/mumbai/Malaria-cases-double-in-city-since-09/articleshow/6202936.cms

[50] Bhattacharya S., Sharma C., Dhiman R. C. and Mitra A. P., (2006), Climate Change and Malaria in India, Current Science, Vol. 90, No. 3, February 2006

A few studies are attempting to map the climate risks specific to Mumbai. For instance, the Canadian Climate Centre's business-as-usual emissions (A2) scenario[51] predicts that with the annual precipitation decrease of 2%, Mumbai may suffer from acute water shortages due to its heavy dependence on rainfall for water supply in future. Also, draughts might become more common in areas surrounding Mumbai triggering migrations into the city. Further, the predicted sea-level rise may have a disastrous impact on the city. Flooding along coastal and low-lying areas would increase dramatically endangering the slums located there. Vulnerability assessment undertaken by Schiller et al. (2007)[52] further suggests that a 'bundle' of stresses, such as, Mumbai's flat topography, geology, wetlands and flood prone areas, projected sea-level rise, building conditions including not meeting building codes, squatter settlements, flood-ravaged buildings, poor sanitation and waste treatment and low incomes reducing the ability for disaster preparedness will create an enhanced vulnerability for the city. However, it must be noted that Mumbai's informal coping mechanism – a strong social network and cooperation among people – would become an important part of the city resilience and reduce vulnerability to some degree[53].

An OECD study is also currently underway in Mumbai to demonstrate an approach to assess the future risks from extreme weather events and quantify the benefits of different adaptation options on a city-scale. The study will focus on applying this approach to flood risk in Mumbai. The findings of the study (soon to be published) suggest that by 2080, in a SRES A2 'upper bound' climate scenario, the likelihood of a 2005-like event will more than double. The total direct and indirect losses from such an event would also triple to around US$ 1890 million. The study specially looks at the marginalized population comprising a large number of households in the city (engaged in the informal sector) who would suffer from the total losses of US$ 250 million. The analysis also shows how the adaptation efforts could significantly bring down the costs of extreme flooding events in future.

4. Adaptation efforts: Role of different stakeholders

The Greater Mumbai Disaster Management Action Plan (DMAP) prepared by Government of Maharashtra in 2007 identifies the risks and vulnerabilities associated with floods, cyclones, earthquakes, etc., and outlines the measures to deal with these vulnerabilities. However, as mentioned earlier, the DMAP, comprehensive on paper, does not provide any specific timeframe for achieving the mitigation measures. No specific attention is given to adaptation strategies which may be more important in the short to medium-term to deal with the climate risks of flooding, storms and cyclones. The report has, however, identified the stakeholders in the government machinery and

51 Sherbinin A., Schiller A. and Pulsipher A., (2007), The Vulnerability of Global Cities to Climate Hazards, Environment and Urbanization, Vol. 19(1), Sage Publications on behalf of International Institute for Environment and Development

52 *Ibid.*

53 *Ibid.*

others and the specific tasks they need to perform as a part of the mitigation strategies. We identify these and other stakeholders to take a comprehensive overview of the roles different stakeholders are currently performing or expected to perform as a part of the efforts to reduce the climate risks. Table 1 below summarizes these roles.

Table 1: Role of different stakeholders in Mumbai to tackle climate risks

Stakeholder	Current / Expected roles
National, state and district disaster management authorities	❖ Prepare policies, plans and guidelines for disaster management ❖ National Disaster Management Authority to declare nation-wide policies ❖ Constituting National Institute of Disaster Management that imparts training and research and develops nationwide database on policies and prevention mechanisms ❖ Constituting National Disaster Response Force ❖ State Disaster Management Authority to prepare the state-level plans ❖ District Authority as district planning, coordinating and implementing body for all disaster management functions ❖ District Authority functions include mitigation and preparedness, response, relief and rehabilitation
Local authority (MCGM – specific to Mumbai)	❖ Impart training to employees to cope with disasters ❖ Maintenance of resources for managing any extreme events ❖ Ensuring that all construction activity conforms to prescribed standards and specifications (building codes, earthquake and fire proof construction, coastal zone regulations, FSI regulations, etc.) ❖ Relief, rehabilitation and reconstruction activity in affected areas

MCGM and MMRDA	❖ Infrastructure improvement in terms of transport, services and housing ❖ Projects like MUTP and MURP to work towards these objectives ❖ Constructing flyovers, additional roads and road over bridges to reduce the traffic density and congestion in identified spots of high traffic density ❖ Road improvement programme to improve the conditions of roads particularly before monsoon ❖ Slum Rehabilitation Scheme to improve the quality of housing for slum dwellers and scatter communities
MCGM – storm water drainage department	❖ Regular de-silting (cleaning) of nallahs (narrow waterways) to reduce the tendency of flooding or choking during heavy precipitation ❖ Augmenting the capacity of the present storm water drains ❖ All flood gates manned to operate them during high and low tides ❖ Chronic flooding spots management by deploying special sqauds
MCGM – early warning system	❖ Automatic weather stations with rain gauge monitoring system to be installed across city to monitor rain intensity to facilitate early warning ❖ Anti-flood control rooms in all wards with equipped staff, wireless equipments, etc. ❖ A list of days when there is a hide tide of 4.7 mtrs and above to be prepared and distributed to railways, police and the district collector ❖ Nodal officer of MCGM to brief print, audio and visual media to provide timely and clear information and put a stop to rumours ❖ Electronic information display monitors controlled to be installed at different places in city ❖ Booklet of all important contact numbers to be distributed widely

Police and fire brigade departments	❖ Police departments to work with municipal authorities to respond quickly and effectively to extreme events ❖ Identify and get equipped with specific equipments and facilities required to respond to extreme events ❖ Commissioned six command centres of fire brigade capable of acting independently ❖ Three highly trained search and rescue teams to be deployed and each team equipped with enhanced equipments
MCGM – public health department	❖ Preventive measures to stop the spread of water, food borne and vector borne diseases ❖ Information to be disseminated to the general public about prevention and cure of such diseases ❖ Keep stock of essential medicines, vaccines and pest control chemicals and equipments ❖ Provide immediate and urgent health services through primary health centres and hospitals run by the civic authority
MCGM – contingency plan	❖ Each ward to identify five schools as temporary transit camp during disasters ❖ BEST (transport authority in Mumbai) to put in service extra buses in case of transport failure ❖ Disaster management Cell to be equipped with all state-of-art communication equipments and networks to control the rescue and relief operations
NGOs	❖ Role in setting up an effective communication and public information system ❖ Role in rescue, relief and rehabilitation activities by providing volunteers ❖ To create awareness among people and educate them about extreme events and level of preparedness
Communities	❖ Based on past experience, perhaps the most crucial role performed by communities and individual people in helping with rescue and relief work

5. Knowledge and research gaps

It is apparent from the discussion so far that Mumbai is acutely vulnerable to climate risks. It is one of the largest mega-cities in the world supporting more than 13 million residents. Given its unique geographical location along the western coast of India, surrounded by water from three sides, and the physical, economic and social characteristics, the city experiences enhanced vulnerability to the threats posed by climate risks like sea level rises, storms and floods. Studies carried out over the past decade indicate that Mumbai is likely to be highly vulnerable to climate change with majority of its population living on the flood prone and reclaimed land. Under the future climate conditions, the population exposed to weather events like storm surges and flooding will go up to 11.418 million. Similarly, the value of exposed assets would dramatically increase to US$ 1598.05 billion by 2080. Against this backdrop, we need to look at the mitigation and adaptation efforts in Mumbai.

The state government prepared a Disaster Management Action Plan for the city in the aftermath of the 2005 devastating floods. This Plan broadly identifies the risks and vulnerabilities associated with risks like flood, earthquake and so on and outlines measures that need to be undertaken. The role of different stakeholders is also identified in the Plan. However, there are no specific mitigation and adaptation strategies or the timelines for achieving them outlined in the Plan. Besides this Plan, there are no visible mitigation and adaptation efforts currently underway in Mumbai that would target to reduce vulnerabilities to climate risks.

In general, vulnerability reduction and adaptation to the adverse impacts of climate change is an important area for policy formulation at national, regional and local levels. An interdisciplinary approach is needed to create an information and knowledge base to help identify, develop and implement effective responses to reduce vulnerability and enhance adaptive capacity[54]. Specific information needs to be built on what are the available adaptation options, under which climatic conditions will they work effectively, anticipated benefits, resource requirements to implement them, requisite institutional structures and processes and potential spillover effects[55]. In addition to this, more fundamental research is required on different adaptation and mitigation options, requirements for such efforts at all levels, potential performance of these options and strengthening institutional capabilities to manage adaptations.

The research gaps and challenges that need to be addressed for Mumbai in immediate future in order to reduce climate vulnerabilities and build city resilience can broadly be classified into three categories: Information, Assessment and Knowledge. There is a need to compile information regarding different climate-related risks. We further need to assess how and where different models &

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[54] Patwardhan A., Downing T., Leary N. and Wilbanks T., (2009), *Towards an Integrated Agenda for Adaptation Research: Theory, Practice and Policy*, Current Opinion in Environmental Sustainability, 1:219-225, Elsevier

[55] *Ibid.*

tools can be applied to look at changes in hazards, exposure & vulnerability. We also need to build on the fundamental knowledge about topics where there is inadequate understanding currently, e.g., health impacts of climate change, intra-seasonal variability in the monsoon, studies of subsidence and stability of reclaimed lands, etc. The focal areas for further research in Mumbai in respect of climate change vulnerability, adaptation and mitigation are given in Table 2 below. These areas are developed on the basis of the review of adaptation literature, in particular, the strategy paper developed by Patwardhan et al. (2009)[56].

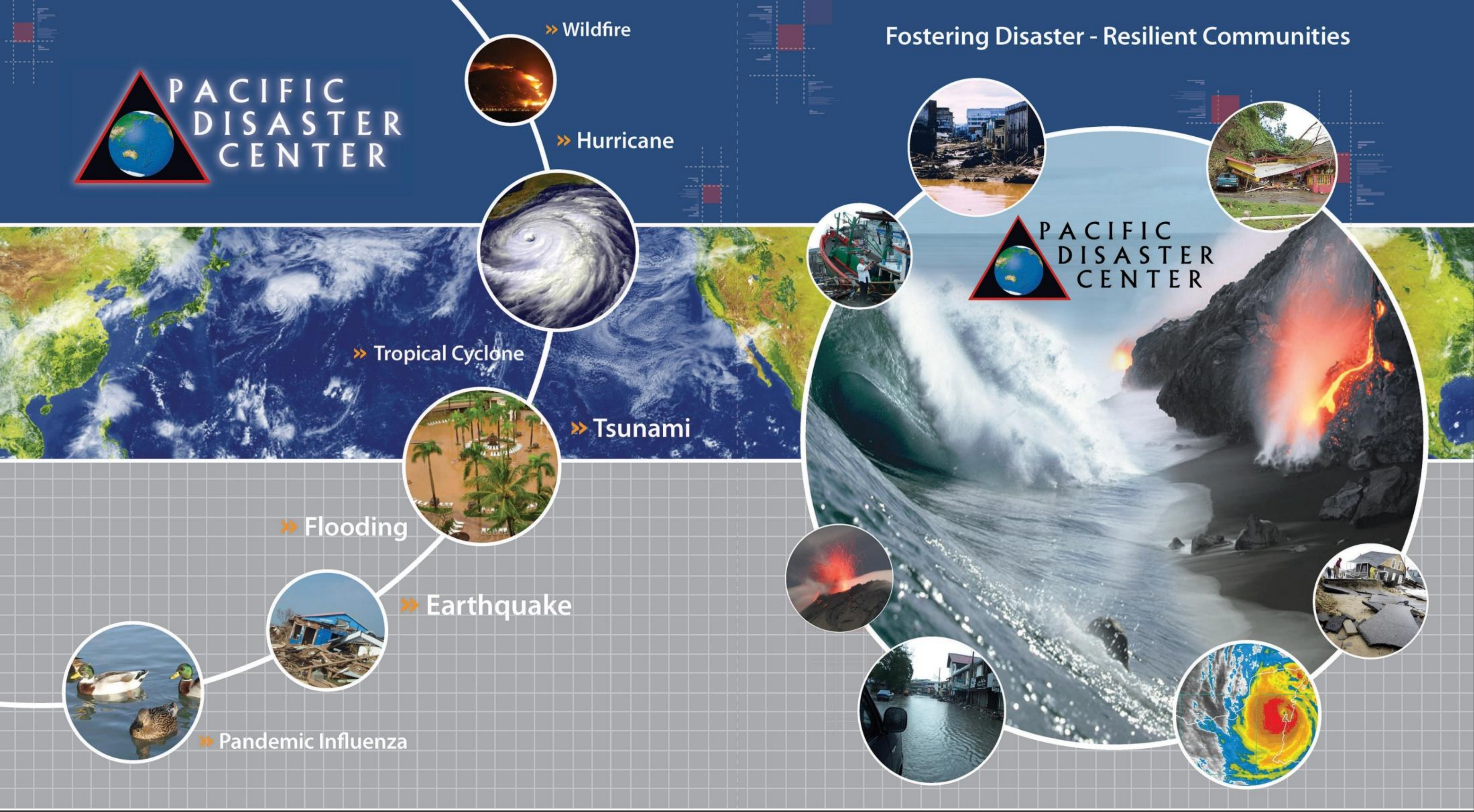
Table 2: Scope for further research

Theme	**Focal area**	**Specific research activities**
Information	Risk identification (who is at risk?)	* Moving from broad and generic projections about future risks to the identification of specific risks * Identifying exposure, sensitivity and capacity to cope for people and institutions * Understanding interaction of climate change with other stresses to assess amplification or diminution of risks * Risks at different spatial and temporal scales
	Vulnerability characterization (what is at risk?)	* Specific risks to city infrastructure, civic amenities, economy and society and risk magnitudes * Vulnerability of marginalized population, informal sectors * Mapping current as well as future physical, economic, social and cultural vulnerability

[56] *Ibid.*

Assessment	Adaptation measures	* Identifying specific adaptation measures taking into account current and future technological, socio-economic, political and institutional conditions * Identification, planning and implementation of adaptation responses considering the past experience of responses to climate risks
	Integrating adaptation into mainstream planning	* Identifying contexts such as disaster management or infrastructure development activities for mainstreaming adaptation into current planning and policies * Carrying out policy oriented studies to understand where such integration is possible
	Institutional mechanism	* Identifying and defining specific roles of public and private stakeholders in adaptation * Capacity building in institutions to strengthen adaptation decision-making

Knowledge	Health impacts	* Establishing the link between climate variability and health impacts * Assessing the vulnerability of the city to water-borne and vector-borne diseases * Sensitizing city stakeholders including health professionals, public health administrators, municipal officials and citizens' groups to health risks of climate change
	Geo-climatic studies	* Understanding the intra-seasonal variability in monsoon * Studying the subsidence and stability of reclaimed land



RISK ASSESSMENT AND SOCIAL VULNERABILITY METRICS

Christina Finch

August 26,2010

Climate Change Vulnerability Assessment and
Urban Development Planning for Asian Coastal Cities

Vulnerability and Emergency Management

- Social vulnerability influences all phases of the emergency management cycle
- Aggregation of all social and economic characteristics
- Identification of vulnerable areas
- Application to different scales and areas

Prevention	Preparation	Mitigation	Response	Recovery

End-to-end Disaster Management

Vulnerability Science

- What makes people and places vulnerable to environmental threats from natural, technological, and human-induced hazards?
  - What circumstances place people and localities at risk?
  - What enhances or reduces the ability to respond to environmental threats?
- Development of methods and metrics for analyzing societal vulnerability and resilience to environmental hazards and extreme events

Demonstration Examples

- National Level
  - AFRICOM
- US County Level
  - Temporal and Spatial Trends
- US Census Tract Level
  - New Orleans, Louisiana
- US Census Block Group Level
  - National Capital Region

Demonstration

National Index

AFRICOM

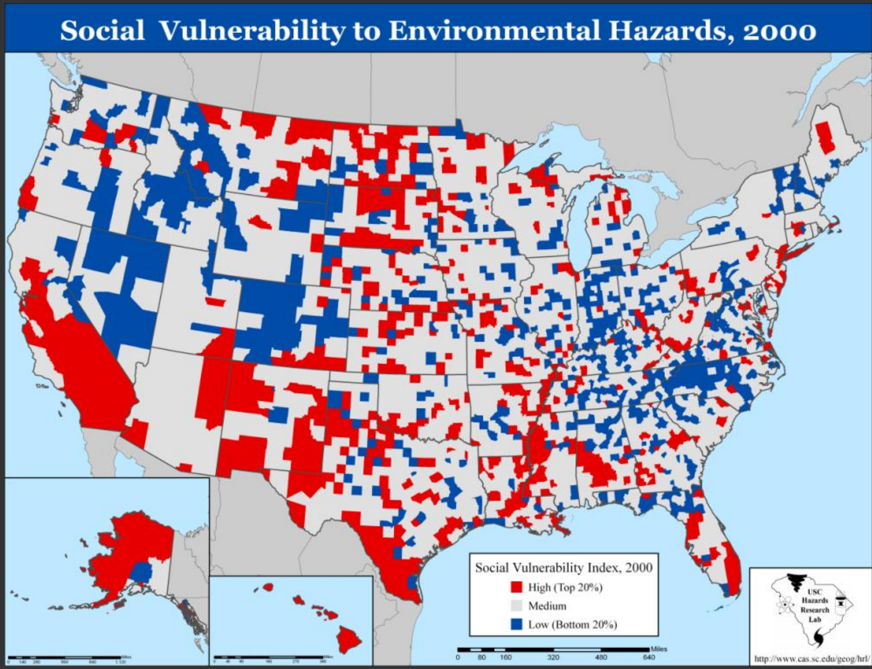
Learning Check

Demonstration

US County Index

SoVI

US Social Vulnerability Index (SoVI)



» Demonstration Goals

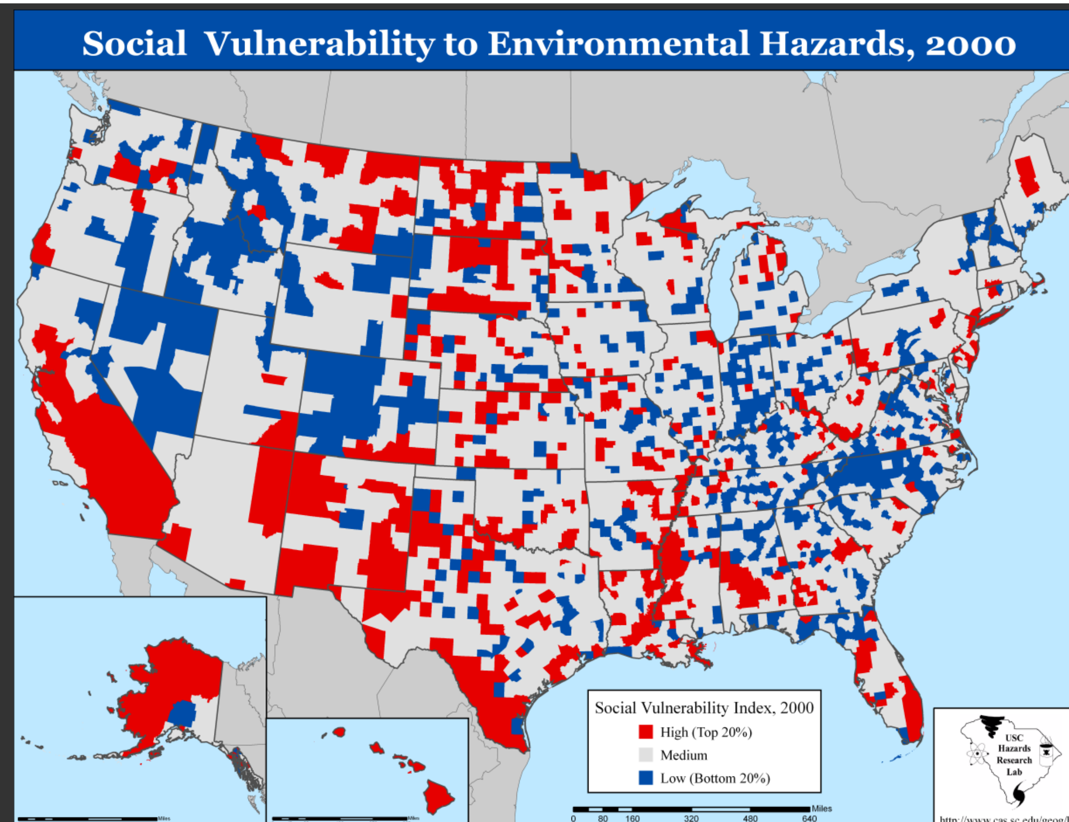
- Additional Methodology
- US Standard
- Spatial and Temporal Trends

» Outcomes

- Develop County Priorities
- Temporal Trends
- Multiple Scale Applications

Social Vulnerability Index (SoVI)

- Relative Index
- County Level
- United States
- Decade - 2000
- Data Reduction
- 42 Socioeconomic Variables



- www.sovius.org

Cutter, S.L., B.J. Boruff, and W.L. Shirley. 2003. “Social Vulnerability to Environmental Hazards.” *Social Sciences Quarterly*. 84(2): 242-261.

Cutter, S. L. and C. Finch. 2008. “Temporal and Spatial Changes in Social Vulnerability to Natural Hazards,” *Proceedings of the National Academy of Sciences* .

SoVI

- Socioeconomic Status (Income, Political Power, Prestige)
- Gender
- Race and Ethnicity
- Age
- Commercial and Industrial Development
- Employment Loss
- Rural/Urban
- Residential Property
- Infrastructure and Lifelines
- Renters
- Occupation
- Family Structure
- Education
- Population Growth
- Health Status
- Medical Services
- Social Dependence
- Special-needs Population

Cutter, S.L., B.J. Boruff, and W.L. Shirley. 2003. "Social Vulnerability to Environmental Hazards." *Social Sciences Quarterly*. 84(2): 242-261.

Social Vulnerability and Hazards

Special Needs Populations ↑

» Difficult to identify (infirm, transient) let alone measure; invariably left out of recovery efforts; often invisible in communities

Age (Elderly and Children) ↑

» Affect mobility out of harm’s way; need special care; more susceptible to harm

Socioeconomic Status (Rich, Poor) ↓ ↑

» Ability to absorb losses and recover (insurance, social safety nets), but more material goods to lose

Race and Ethnicity (Non-white, Non-Anglo) ↑ ↑

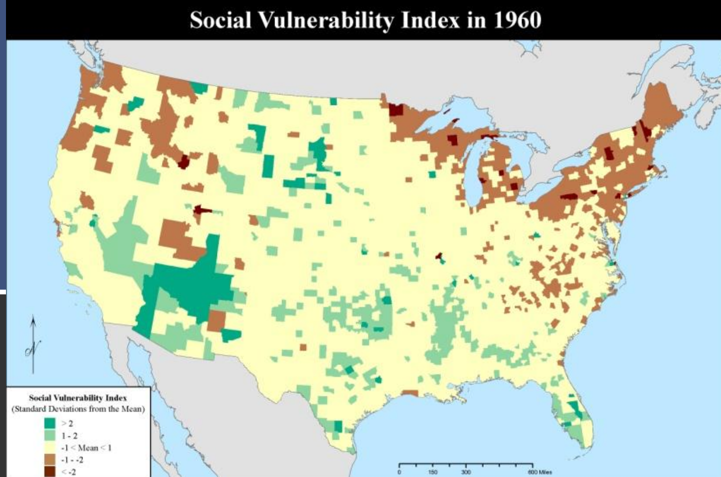
» Impose language and cultural barriers; affect access to post-disaster recovery funding; tend to occupy high hazard zones

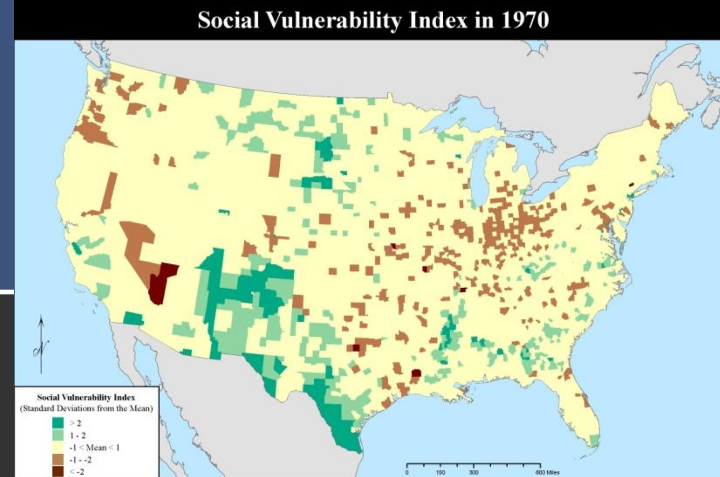
Gender (Women) ↑

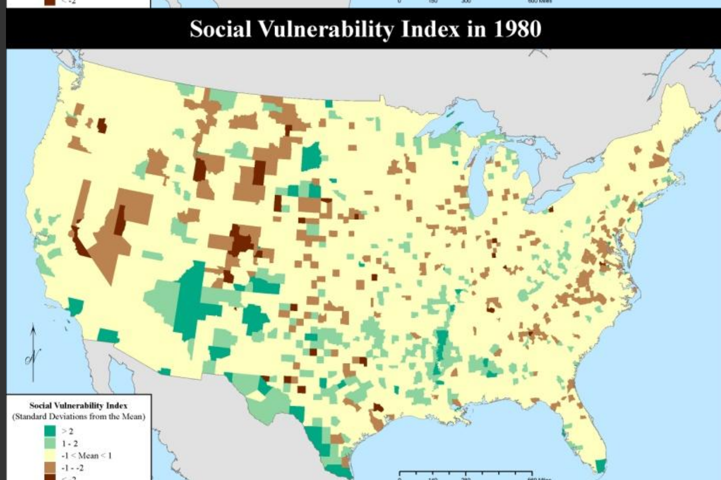
» gender-specific employment, lower wages, care-giving role

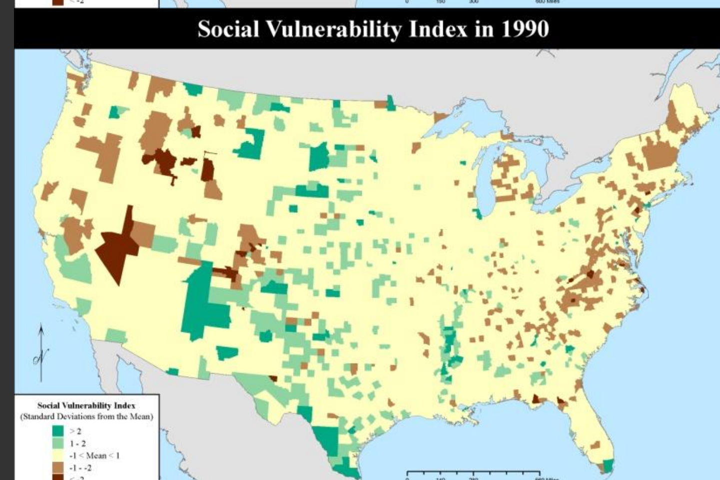
Social Vulnerability Index (SoVI)

- Identify Vulnerable Populations
- Replicate Methodology for Different Time Periods
- Assess Spatial Patterns and Changes
- Highlight Temporal Trends
- Project Future Vulnerability
- Scale Methodology for Different Levels of Geography



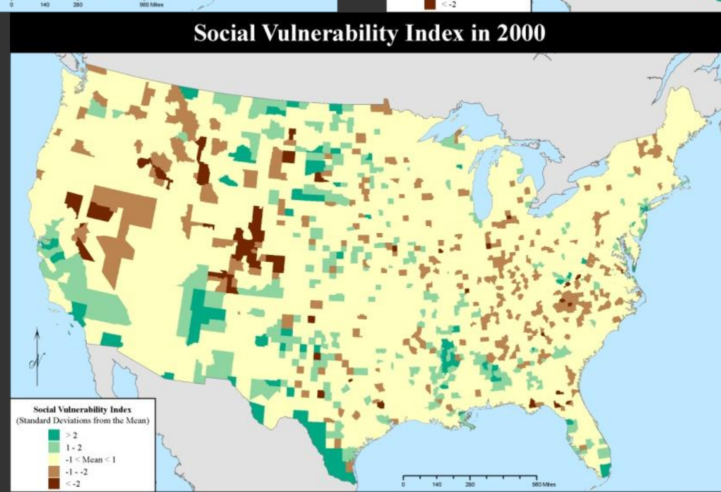






High Social Vulnerability Regional Trends

- Lower Mississippi River
- Texas-Mexico Border
- North Central US/Great Plains



Low Social Vulnerability Regional Trends

- Northwest
- Nevada
- Colorado

25 Most Vulnerable Counties

1960	1970	1980	1990	2000
New York, NY	New York, NY	New York, NY	New York, NY	New York , NY
Shannon, SD	San Francisco, CA	Yellowstone National Park, MT	San Francisco, CA	Roanoke City, VA
Monroe, WI	Bronx, NY	San Francisco, CA	Washington, DC	Bronx , NY
Todd, SD	Kings, NY	Shannon, SD	Bronx, NY	Webb , TX
Duval, TX	Suffolk, MA	Todd, SD	Kings, NY	Northampton , VA
Jackson, SD	Washington, DC	Kings, NY	Suffolk, MA	Shannon , SD
Apache, AZ	Maverick, TX	Apache, AZ	Shannon, SD	San Francisco , CA
Athens, OH	Queens, NY	Bronx, NY	Benton, WA	Kings , NY
Navajo, AZ	Starr, TX	Starr, TX	Todd, SD	Starr , TX
San Juan, UT	Zavala, TX	Maverick, TX	St. Louis City, MO	Todd , SD
McKinley, NM	Philadelphia, PA	Buffalo, SD	Buffalo, SD	Maverick , TX
Buffalo, SD	Kenedy, TX	Hudson, NJ	Apache, AZ	McKinley , NM
Adams, WA	Webb, TX	Queens, NY	Hudson, NJ	Zavala , TX
Monroe, IL	Dimmit, TX	Falls Church, VA	Baltimore, MD	Buffalo , SD
Rolette, ND	St. Louis City, MO	Suffolk, MA	Philadelphia, PA	Issaquena , MS
Ormsby, NV	Jim Hogg, TX	Menominee, WI	Queens, NY	Clifton Forge City, VA
Dewey, SD	Willacy, TX	Sioux, ND	Sioux, ND	Queens , NY
Sioux, ND	Hudson, NJ	McKinley, NM	McKinley, NM	Hudson , NJ
Brown, NE	Zapata, TX	Rolette, ND	Platte, NE	Brooks , TX
Alpine, CA	Hidalgo, TX	Webb, TX	Webb, TX	Wilcox , AL
Mohave, AZ	Denver, CO	St. Louis City, MO	Big Stone, MN	Cameron , TX
Coryell, TX	Shannon, SD	Dewey, SD	Menominee, WI	Presidio , TX
Coconino, AZ	Santa Cruz, AZ	Corson, SD	Arlington, VA	Apache , AZ
Kings, NY	Presidio, TX	Val Verde, TX	Dewey, SD	Sioux , ND
Stanley, SD	Cameron, TX	Emporia, VA	East Carroll LA	Dimmit , TX

Occurrence Frequency of Most Vulnerable Counties			
2 Decades	**3 Decades**	**4 Decades**	**5 Decades**
Cameron, TX	Dewey, SD	Apache, AZ	Kings, NY
Dimmit, TX	Maverick, TX	Bronx, NY	New York, NY
Menominee, WI	St. Louis City, MO	Buffalo, SD	Shannon, SD
Philadelphia, PA	Starr, TX	Hudson, NJ	
Presidio, TX	Suffolk, MA	McKinley, NM	
Rolette, ND		Queens, NY	
Washington, DC		San Francisco, CA	
Zavala, TX		Sioux, ND	
		Todd, SD	
		Webb, TX	

Main Themes

Development - Urban

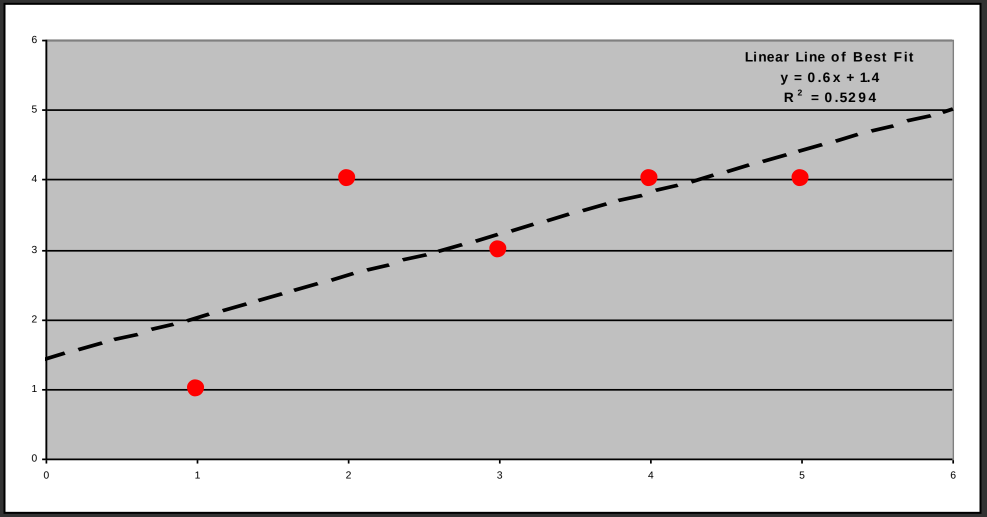
Race/Ethnicity – Native American

Race/Socioeconomic Status – Lack of Education, Poverty, Diversity

Temporal Trends

» Linear Regression for Each County
  • Line of Best Fit
    – Slope (Direction of Trend)
    – R^2 (Strength of the Trend)
    – F-Statistic (Level of Significance)

» Identify Counties with Significant Trends in SoVI

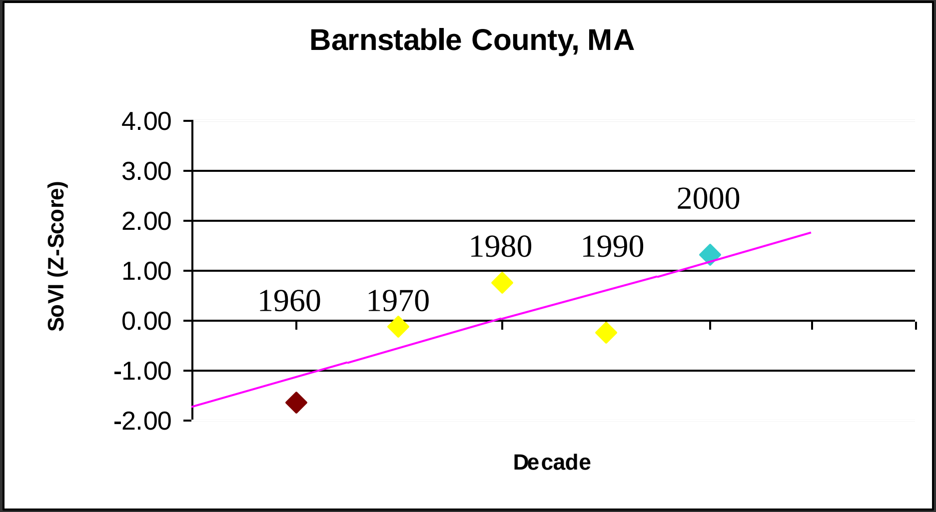


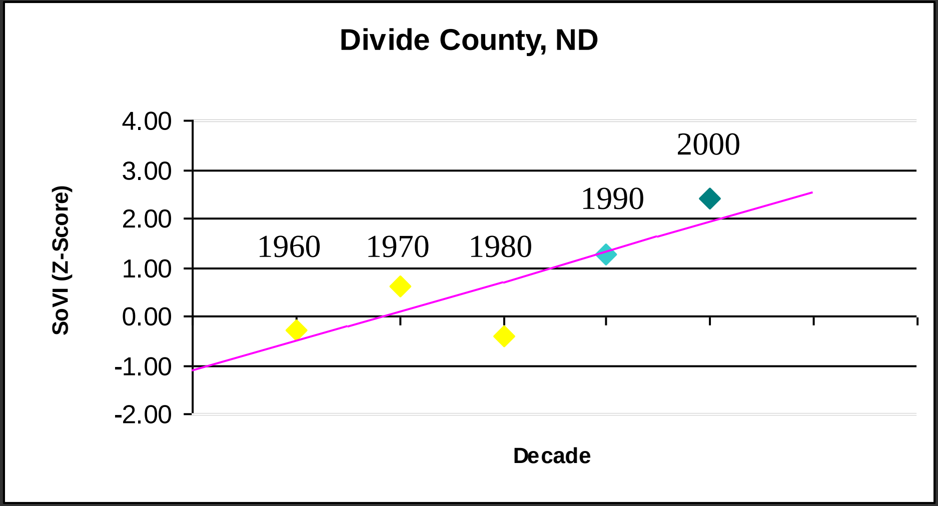
• Predict 2010 SoVI Based on Linear Trend through Time

Significant Increase in Social Vulnerability

- 46 Counties
- 25 Counties Shown in Table

COUNTY	ZSOVI_1960	ZSOVI_1970	ZSOVI_1980	ZSOVI_1990	ZSOVI_2000	SLOPE	R_SQUARED
Roanoke city, VA	-0.38	1.15	1.83	1.58	6.41	1.40	0.75
Northampton, VA	-0.26	2.02	1.01	1.50	4.95	0.99	0.66
Beaver, PA	-1.89	-0.69	0.08	1.54	1.59	0.92	0.95
Clifton Forge city, VA	0.26	0.22	2.89	2.38	3.62	0.89	0.81
McIntosh, ND	-0.43	1.79	0.30	2.23	2.95	0.72	0.66
Box Butte, NE	0.55	-0.03	1.60	2.46	2.85	0.71	0.84
Delaware, PA	-1.87	-0.29	0.66	0.56	1.23	0.71	0.85
Wyandotte, KS	-0.56	-0.52	1.82	2.10	1.65	0.70	0.71
Bergen, NJ	-1.95	0.52	-0.25	0.34	1.56	0.68	0.70
San Mateo, CA	-1.30	-0.07	1.60	0.24	1.82	0.65	0.65
Salem, NJ	-1.46	-0.93	-0.11	0.58	0.97	0.64	0.99
Jefferson, OH	-1.35	-0.76	0.70	0.42	1.23	0.63	0.88
Brooke, WV	-1.86	-0.73	-0.19	-0.23	1.02	0.63	0.91
Moore, TX	-0.57	-0.39	0.43	0.89	1.92	0.63	0.96
Towner, ND	-0.76	0.25	-0.33	0.89	2.02	0.62	0.81
Norton city, VA	-0.10	0.01	2.07	2.04	1.95	0.61	0.73
Divide, ND	-0.29	0.59	-0.42	1.28	2.41	0.61	0.67
Mahoning, OH	-1.64	-0.27	0.74	0.57	0.99	0.61	0.81
Middlesex, NJ	-1.55	-0.18	-0.39	-0.19	1.47	0.60	0.78
Hancock, WV	-1.81	-0.65	0.07	0.19	0.78	0.60	0.92
Boyd, KY	-0.98	-1.71	0.67	0.65	0.81	0.59	0.66
DuPage, IL	-1.68	-0.90	-0.71	0.13	0.72	0.58	0.98
Barnstable, MA	-1.63	-0.10	0.75	-0.23	1.32	0.58	0.66
St. Louis, MO	-2.17	-0.87	-0.22	-0.24	0.39	0.58	0.87
Orange, CA	-0.33	-0.28	-0.28	0.65	2.07	0.57	0.76

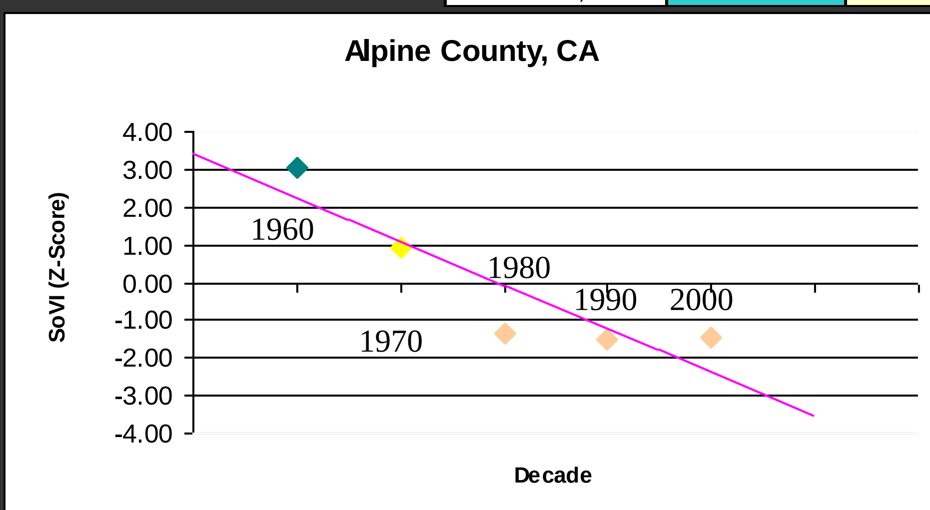


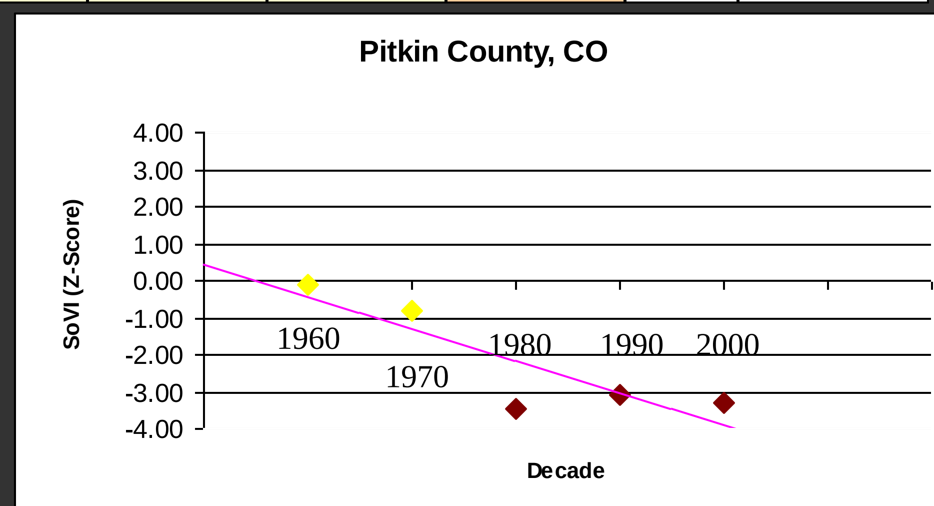


Significant Decrease in Social Vulnerability

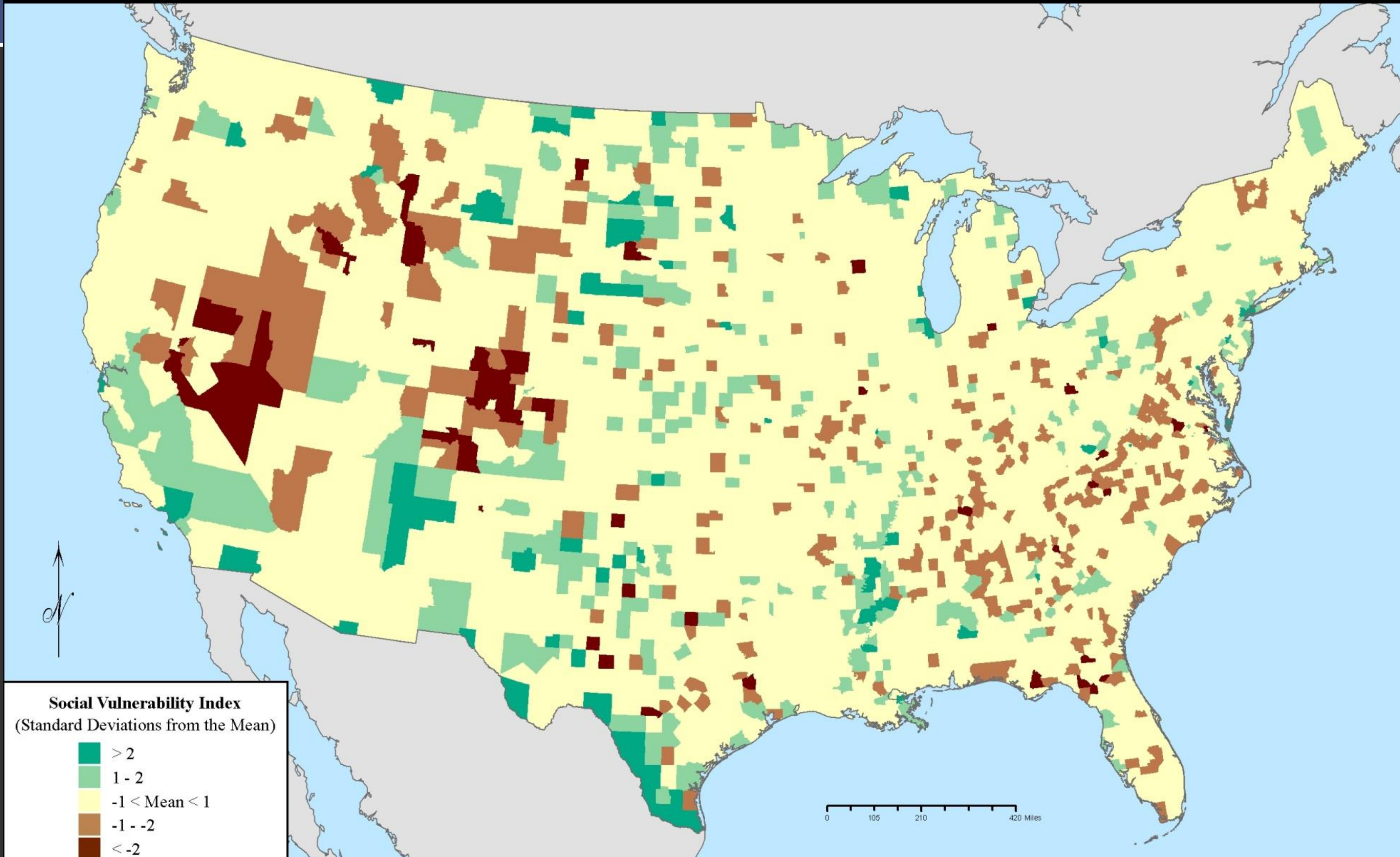
- » 40 Counties
- » 25 Counties Shown in Table

COUNTY	ZSOVI_1960	ZSOVI_1970	ZSOVI_1980	ZSOVI_1990	ZSOVI_2000	SLOPE	R_SQUARED
San Miguel, CO	0.80	0.38	-1.41	-2.77	-3.72	-1.22	0.97
Alpine, CA	3.07	0.95	-1.34	-1.50	-1.46	-1.15	0.80
Daggett, UT	1.98	2.22	-0.11	-0.70	-2.18	-1.12	0.91
Stanley, SD	2.95	0.14	-0.75	-0.71	-2.23	-1.12	0.86
King, TX	0.50	1.05	-2.33	-1.53	-3.30	-1.02	0.75
Pitkin, CO	-0.13	-0.80	-3.48	-3.07	-3.29	-0.86	0.75
Mono, CA	1.15	-0.69	-2.06	-0.93	-2.98	-0.85	0.74
Lafayette, FL	0.04	0.81	-0.74	-2.36	-2.61	-0.85	0.81
Gilpin, CO	0.15	-0.73	-2.31	-2.61	-3.04	-0.83	0.93
Roberts, TX	0.52	-0.19	-1.15	-1.49	-2.85	-0.80	0.97
Union, FL	1.08	-1.01	-1.46	-1.20	-2.71	-0.78	0.81
Brown, IL	0.25	0.07	-0.02	-1.35	-2.83	-0.76	0.84
Grand, CO	-0.30	-0.36	-2.67	-1.85	-3.23	-0.73	0.76
Liberty, FL	-0.22	0.24	-0.24	-2.61	-2.41	-0.72	0.72
Teton, WY	-1.08	-0.18	-2.44	-2.50	-3.52	-0.72	0.75
Echols, GA	-0.15	1.15	-0.64	-1.00	-2.51	-0.69	0.67
Bandera, TX	0.77	-0.05	-0.23	-1.56	-1.88	-0.68	0.95
Pershing, NV	0.46	0.71	-0.35	-0.66	-2.23	-0.68	0.85
Grant, NE	1.46	0.39	-0.48	-0.46	-1.41	-0.66	0.93
James City, VA	0.21	-0.24	-1.39	-1.97	-2.22	-0.66	0.95
Blaine, ID	-0.14	-0.14	-1.93	-2.32	-2.28	-0.65	0.82
Granville, NC	0.78	0.56	-0.91	-0.73	-1.78	-0.64	0.90
Carroll, MS	1.20	1.37	0.07	-0.09	-1.19	-0.62	0.89
Lafayette, MS	1.19	-0.64	0.14	-0.93	-1.76	-0.62	0.77
Baldwin, GA	1.49	-0.02	0.26	-0.35	-1.41	-0.61	0.85





Projected Social Vulnerability Index in 2010



Temporal Trends

- Identified Significant Changes in Social Vulnerability
- Increasing Vulnerability
  - Depopulation
  - Development
- Decreasing Vulnerability
  - Increasing Wealth
- SoVI in 2010
  - Significant Positive Spatial Autocorrelation
  - Moran’s I Supports Decreasing Trend
  - Decrease also Apparent in LISA Clusters

Learning Check

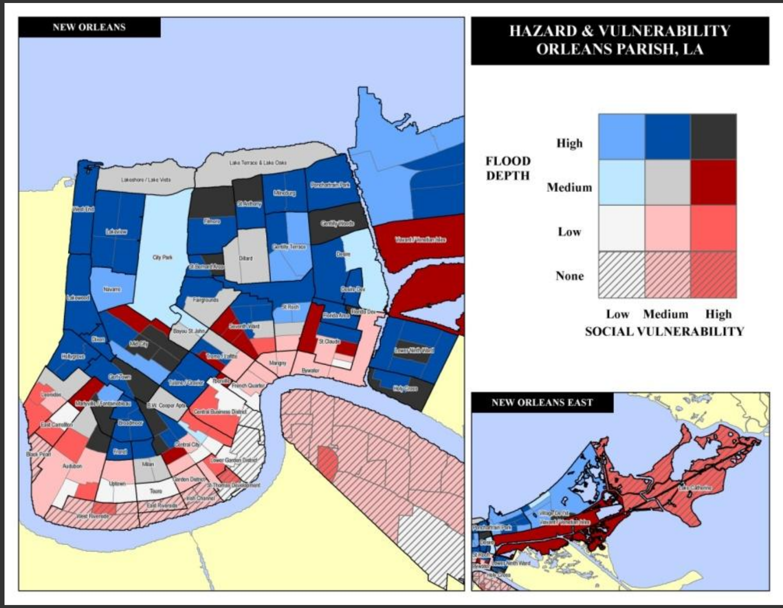
Demonstration

US Census Tract SoVI New Orleans, LA

New Orleans Social Vulnerability Index (SoVI-NOLA)

» Demonstration Goals
- Downscale Methodology
- Validate Model

» Outcomes
- Identify Vulnerability
- Intersect with Hazard
- Validate with Recovery Measures
- Use Method to Suggest Mitigation Measures



Hurricane Katrina

- August 23, 2005
- **Damage**: $81 billion total; $40.6 billion in insured losses
- **Deaths:** 1,833
  - LA: 1,577, MS: 238, FL: 14, GA: 2, AL: 2
- **Storm Surge**
  - Mississippi: 17-28 ft
  - Louisiana: 5-15ft
  - Alabama: 8-15ft
- **Evacuees**: 1.2 million people

Mississippi

New Orleans, Louisiana

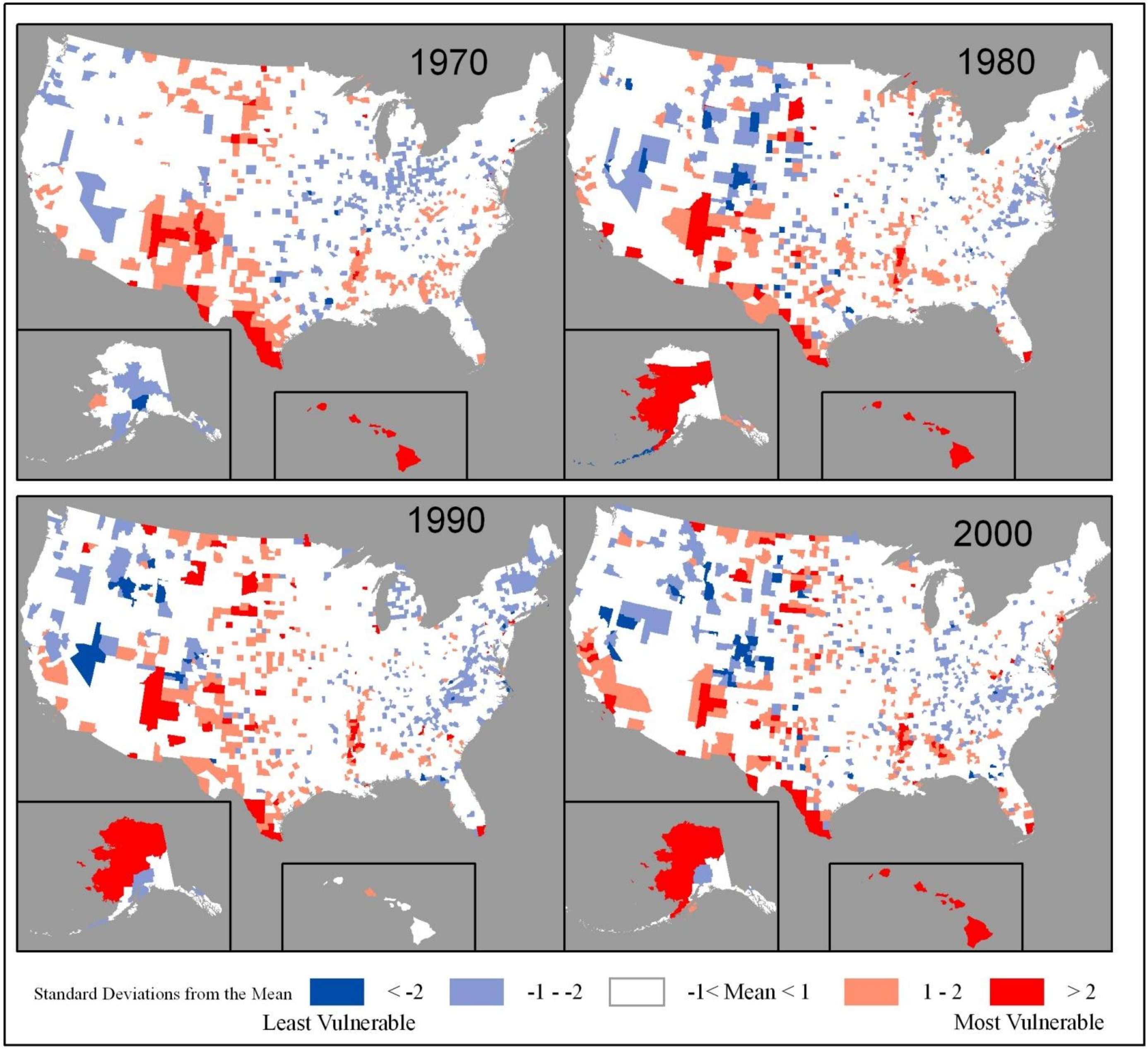
SoVI for New Orleans, LA

» Methods
- Orleans Parish, LA
- Tract Level (181)
- 31 Variables

» Results
- Explained 76.57% of the Variance
- 8 Components

» Dominant Variables
- Socioeconomic Status
- Age and Gender
- Poverty and Unemployment

Spatial and Temporal Analysis



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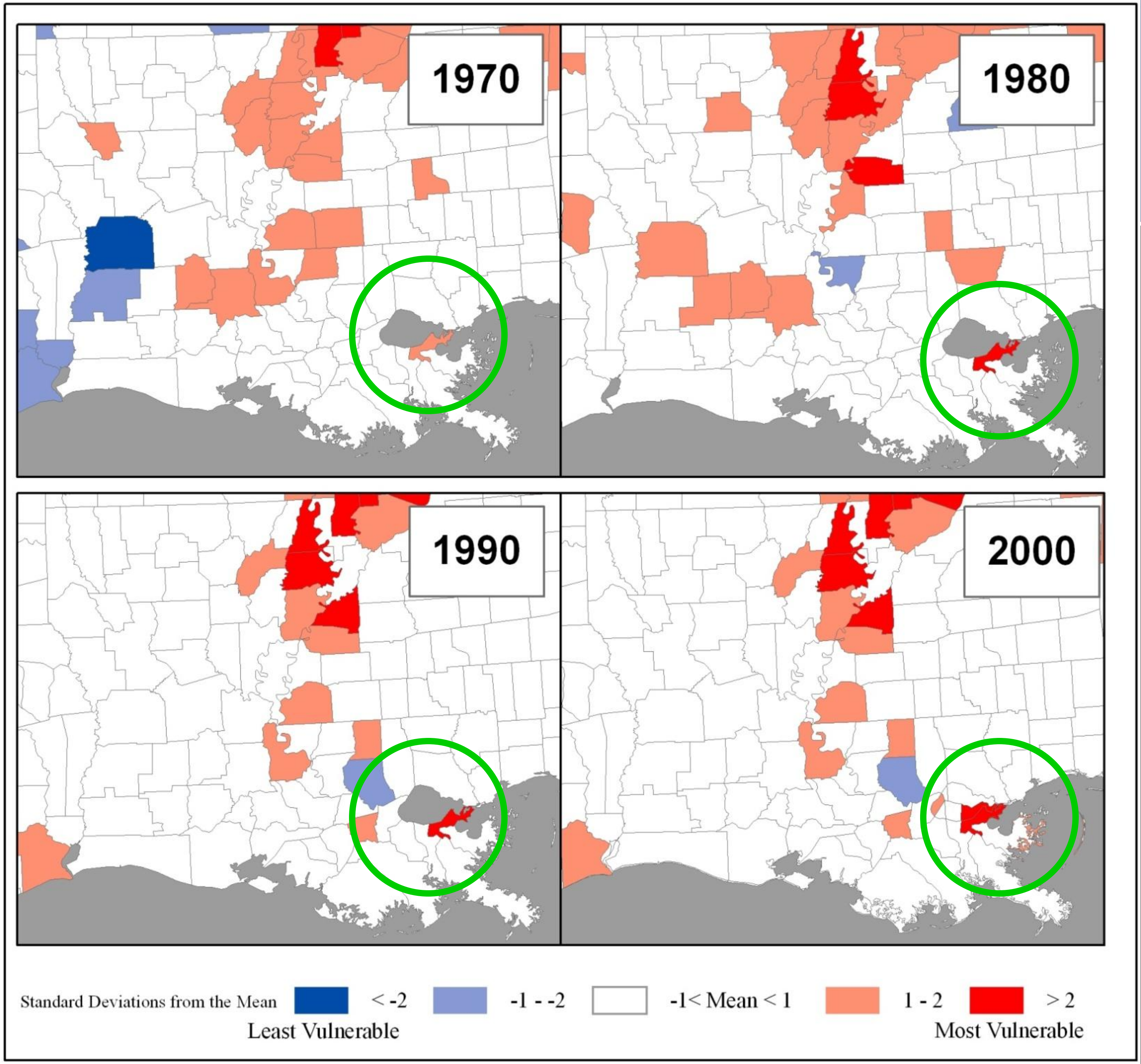
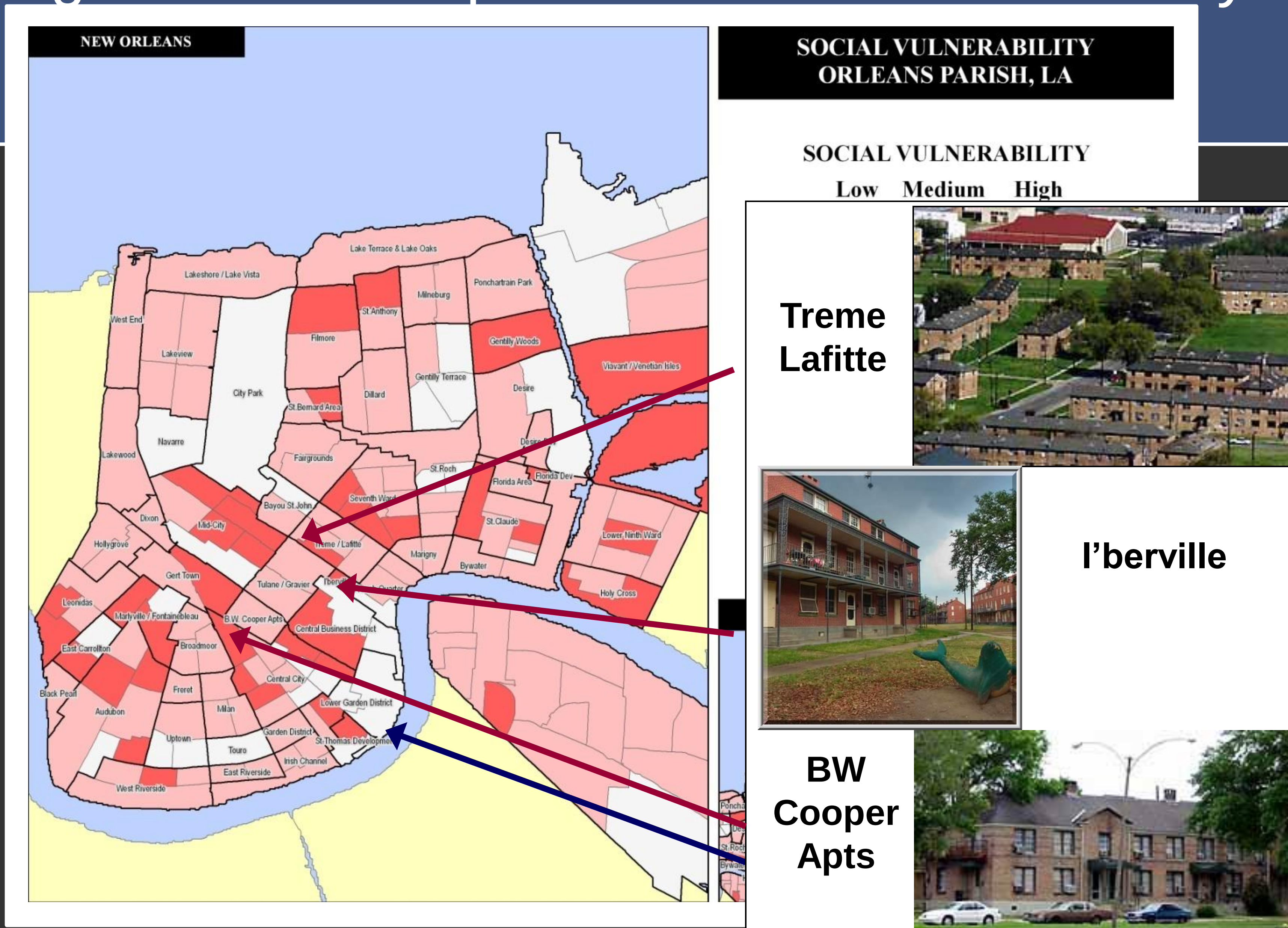


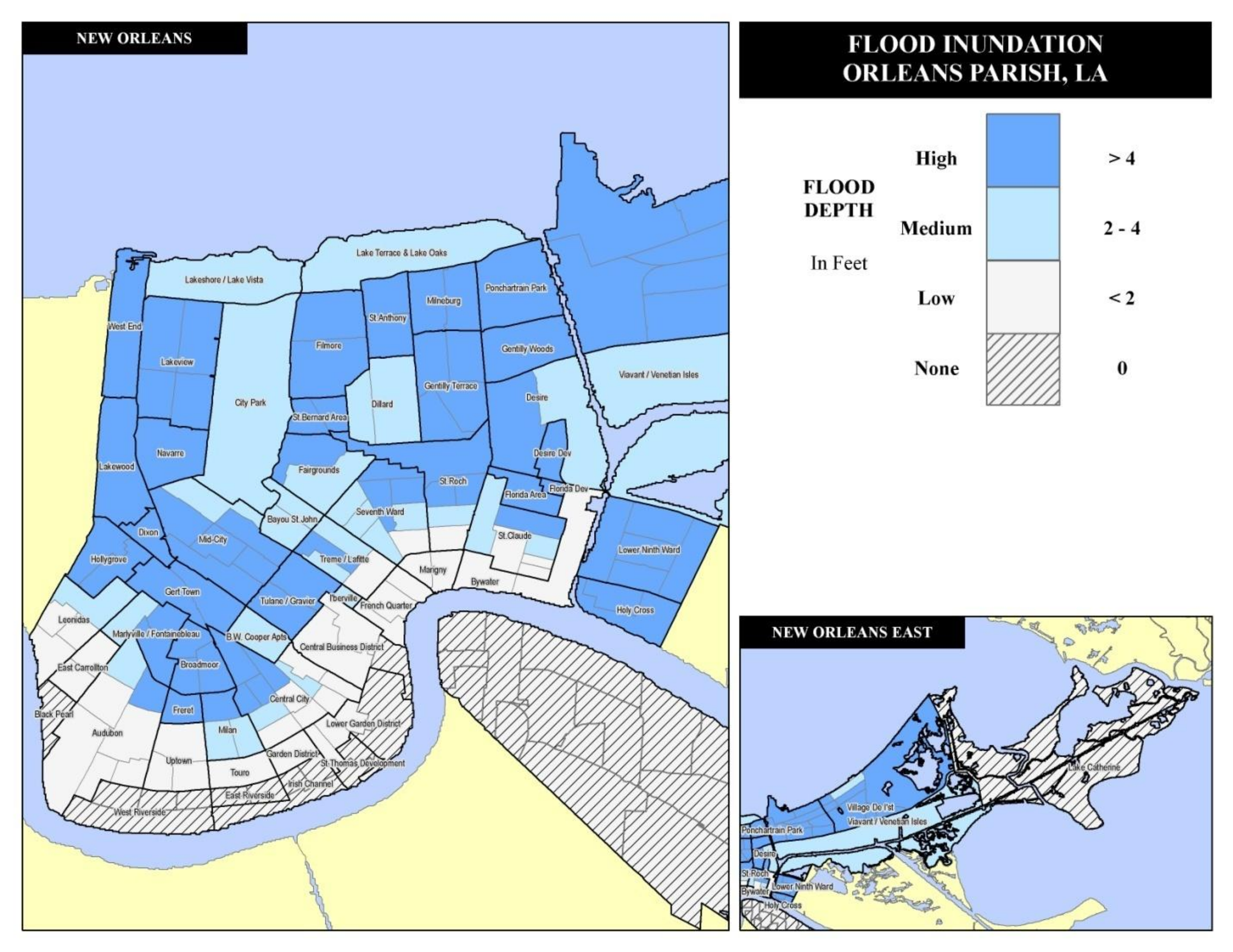
Cutter, S. L. and C. Finch. 2008. "Temporal and Spatial Changes in Social Vulnerability to Natural Hazards," *Proceedings of the National Academy of Sciences* .

Neighborhood Disparities: Social Vulnerability



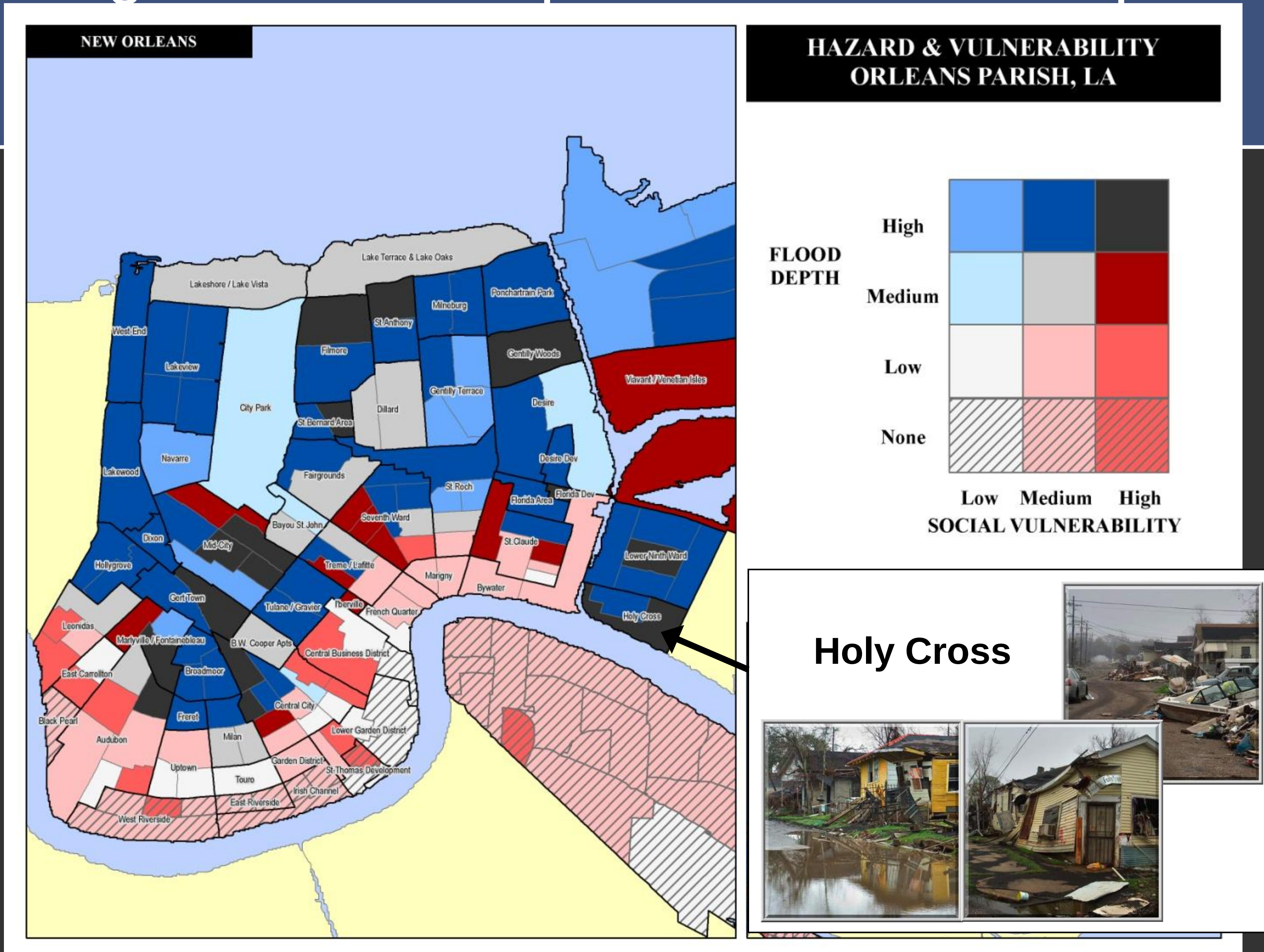
Finch, C., C.T. Emrich, and S.L. Cutter, 2010. "Disaster disparities and differential recovery in New Orleans," *Population and Environment*, DOI 10.1007/s11111-009-0099-8.

Neighborhood Disparities: Flood Inundation



Finch, C., C.T. Emrich, and S.L. Cutter, 2010. "Disaster disparities and differential recovery in New Orleans," *Population and Environment*, DOI 10.1007/s11111-009-0099-8.

Neighborhood Disparities: Uneven Impact



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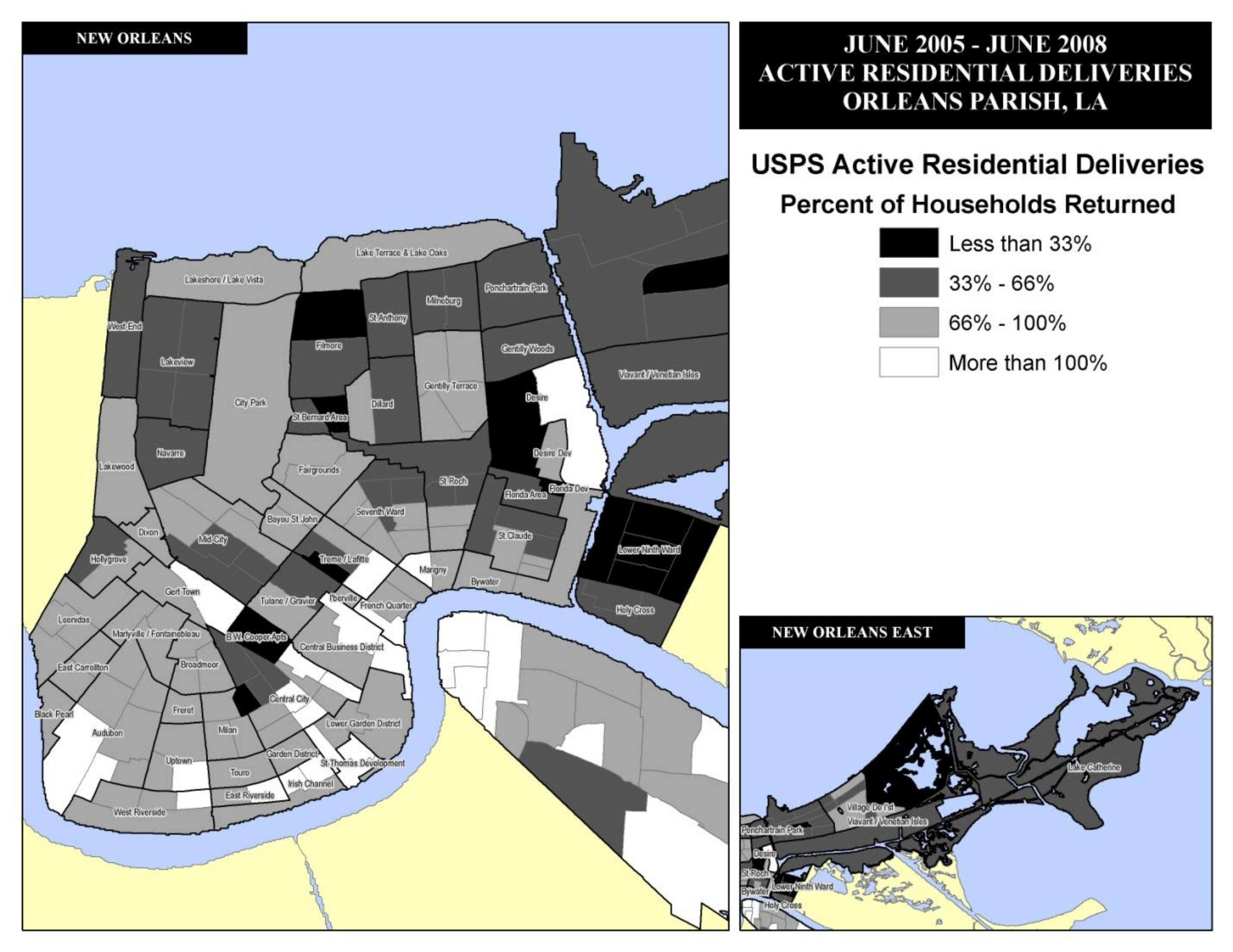
Neighborhood Disparities: Uneven Recovery



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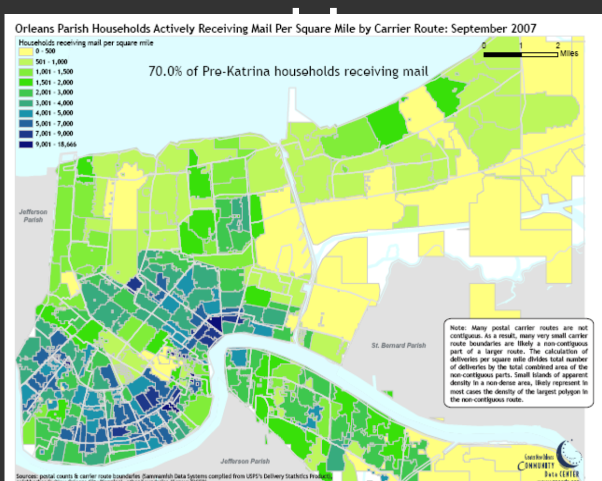
Lessons Learned

- Disproportionate impacts based on pre-existing vulnerabilities means uneven recovery
- Measurement of recovery in relation to pre-existing vulnerabilities
- Need to consider the spatial inequities in risk and vulnerability in any risk reduction decision



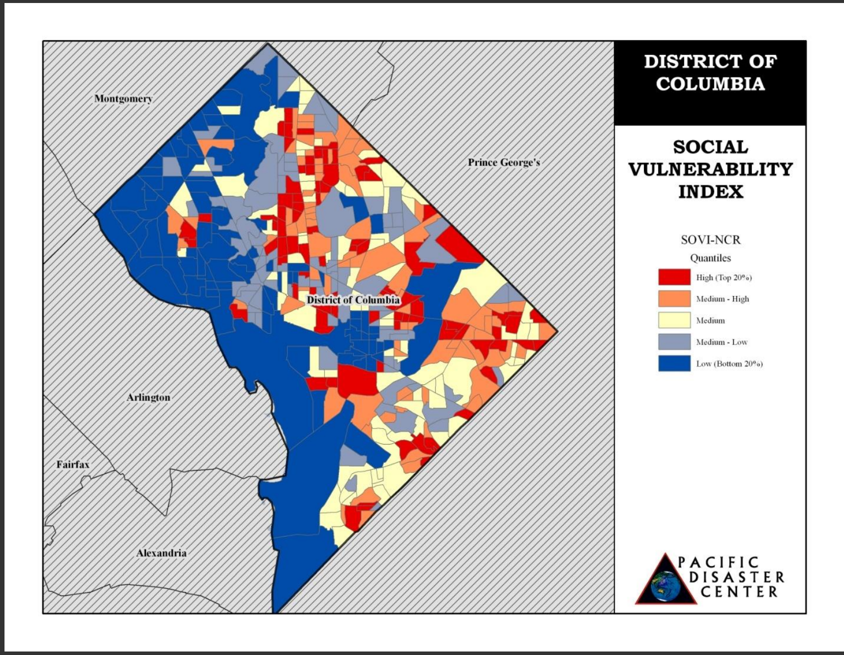
Learning Check

Demonstration

US Census
Block Group SoVI
National Capital Region

National Capital Region – Social Vulnerability Index (SoVI-NCR)

- » Demonstration Goals
  - Downscale Methodology
  - Dasymetric Mapping
- » Outcomes
  - Identify Vulnerability
  - Intersect with Hazard
  - Use Method to Suggest Mitigation Measures



Aftermath of Hurricane Katrina

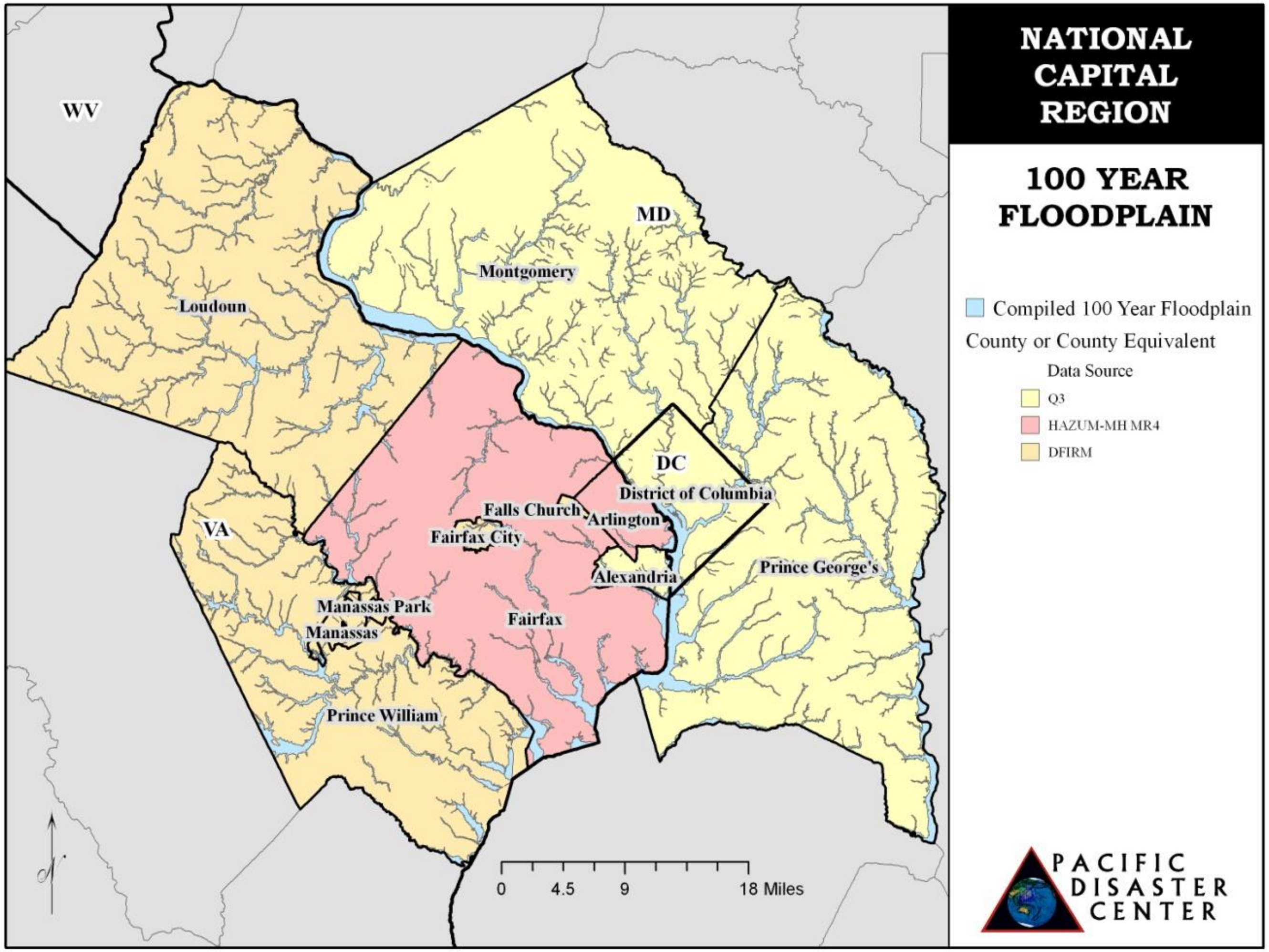
- “Television images from New Orleans in the days following Hurricane Katrina made many Americans confront anew the nation's deep divisions by race and class.

- If you live in D.C., though, you don't need CNN to see the sort of concentrated urban poverty that affected places like New Orleans' Lower Ninth Ward. Our city's most troubled neighborhoods closely resemble New Orleans' distressed corridors before the hurricane.

- In fact, a new Brookings analysis shows that in 2000, one-fourth of D.C.'s poor—roughly 30,000 people, the vast majority of them African-American—were locked into "extreme poverty" neighborhoods. In these neighborhoods, most of them east of the Anacostia River, at least four in ten people lived below the federal poverty line. Washington ranked 11th among the nation's big cities on this concentration of poverty and because D.C.'s overall poverty rate has risen since 2000, the picture probably isn't any better today.

- Katrina showed how residents of the poorest neighborhoods, lacking transportation and cut off from information, can get left behind in an emergency.” (Berube, November 2005)

Hazard Delineation

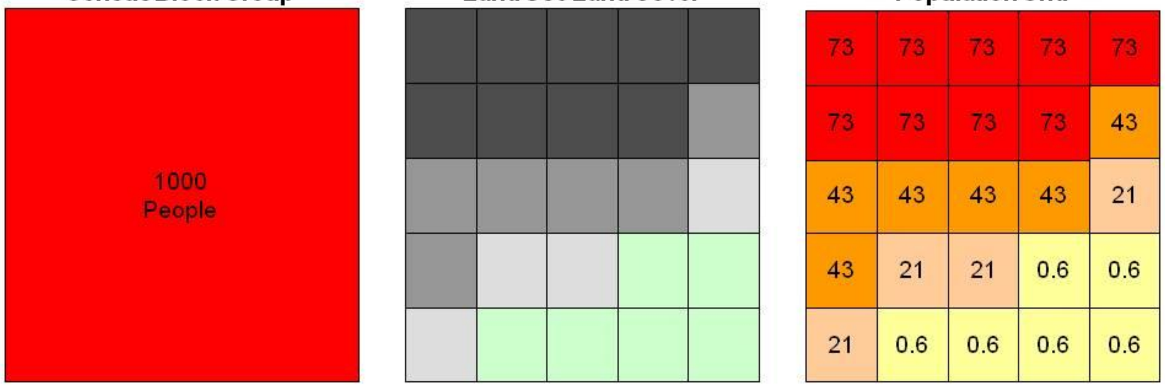


Dasymetric Mapping

- General Definition:
  - Redistributes data from one spatial unit to a new spatial geography using an ancillary data source
- Modified Mennis 2003
- Components:
  - Population Density Fraction
  - Area Ratio
  - Total Fraction

Methodology

Census Block Group | Land Use Land Cover | Population Grid

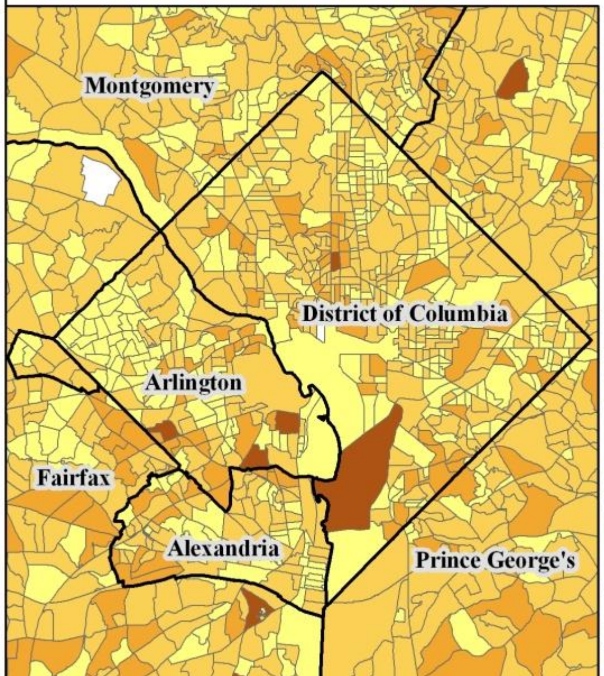


Population Density Fraction (PDF)	Area Ratio	Total Fraction	Relative Total Fraction
53.11	9 Cells/25 Cells = 36%	53.11 * 36 = 1911.96	1911.96 / 2914.2 = 65.61%
31.04	6 Cells/25 Cells = 24%	31.04 * 24 = 744.96	744.96 / 2914.2 = 25.56%
15.39	4 Cells/25 Cells = 16%	15.39 * 16 = 246.24	246.24 / 2914.2 = 8.45%
0.46	6 Cells/25 Cells = 24%	.46 * 24 = 11.04	11.04 / 2914.2 = .38%
		2914.2	

	Population Per Land Use	Population Per Land Use Cell
High Density	65.61% * 1000 = 656.1	656.1 / 9 = 72.9
Medium Density	25.56% * 1000 = 255.6	255.6 / 6 = 42.6
Low Density	8.45% * 1000 = 84.5	84.5 / 4 = 21.13
Non-Urban	.38% * 1000 = 3.8	3.8 / 6 = .63

Dasymetric Mapping Project
District of Columbia

Census Block Group

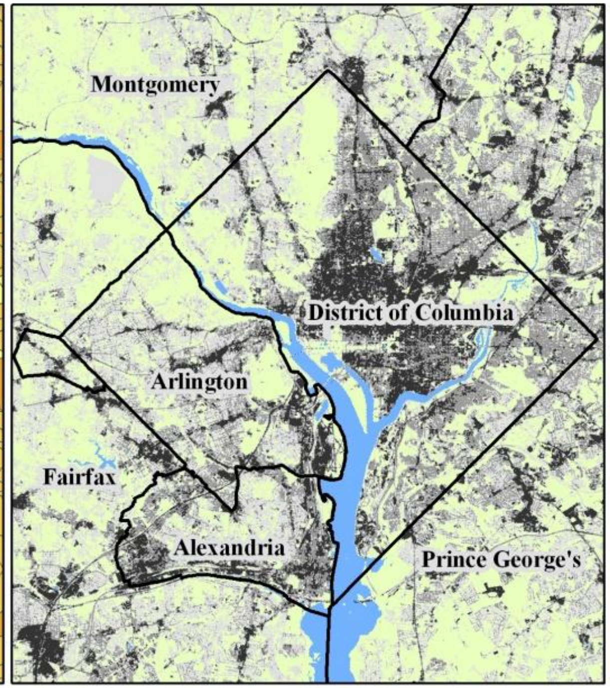


Estimated 2007 Population

Census Block Group

- 1 - 1,000
- 1,001 - 2,500
- 2,501 - 5,000
- 5,001 - 10,000
- 10,001 - 27,548

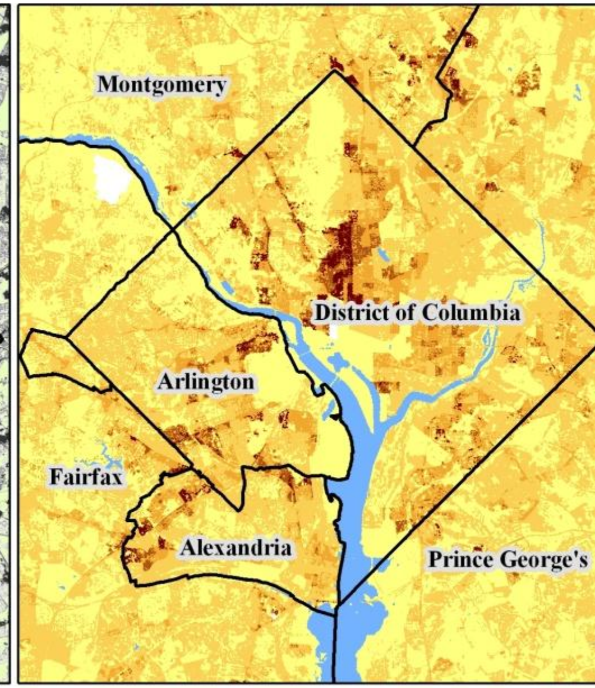
NOAA C-CAP - Land Use



Land Use (2006)

- Water
- High Intensity Developed
- Medium Intensity Developed
- Low Intensity Developed
- Non-Urban

Population Grid



Estimated 2007 Population

30m Grid

- 0 - 1
- 2 - 5
- 6 - 10
- 11 - 15
- 16 - 70

0 3.75 7.5 15 Miles

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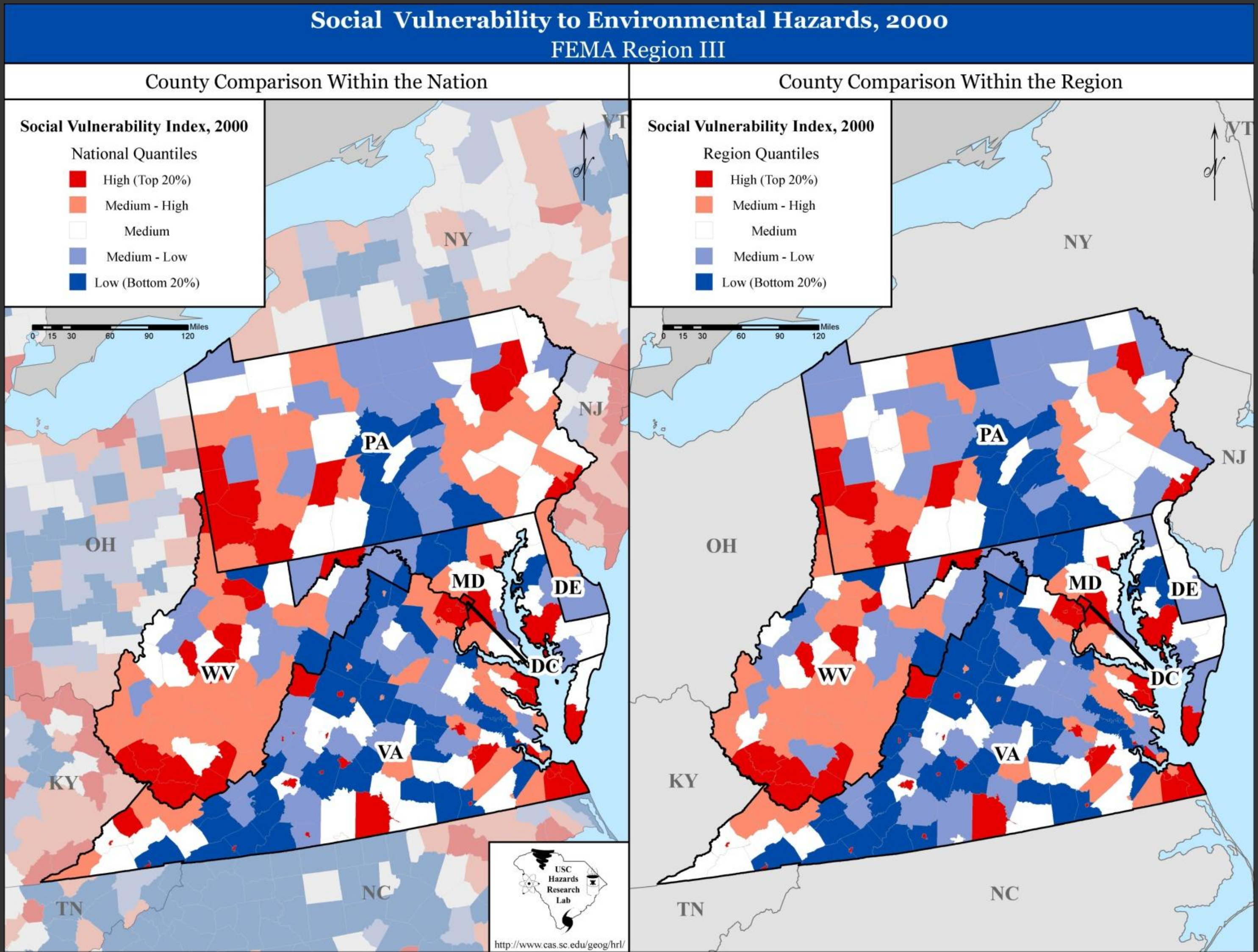
National SoVI 2000



SoVI-NCR

- Block Group Level
- 25 Socioeconomic Variables
- Principal Components Analysis
  - 6 Components
  - 74% Variance Explained

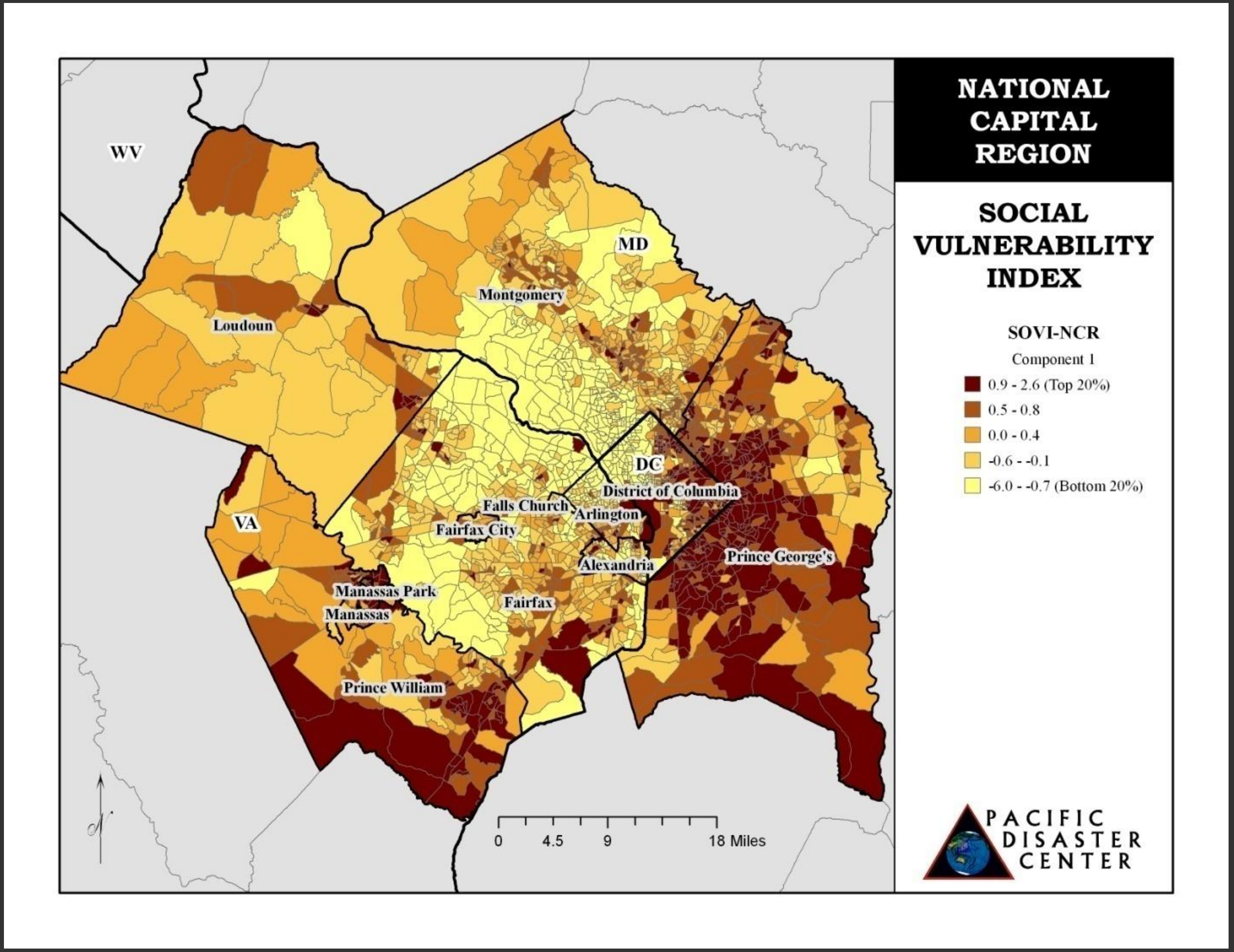
Variable Name	Description
QBLACK	% Black Population
QASIAN	% Asian Or Pacific Islanders Population
QSPANISH	% Hispanic Population
QKIDS	% Population Under 5 Years Old
QPOP65O	% Population 65 Years Or Older
MEDAGE	Median Age
QFEMALE	% Female
QCVLUN	% Unemployed Population
PERCAP	Per Capita Income
PPUNIT	Average Number Of People Per Household
QRICH	% Families Earning More Than $100,000
QPOVTY	% Persons Living Below Poverty Level
MDHSEVAL	Median Dollar Value Of Owner Occupied Housing Units
QRENTER	% Renter Occupied Housing Units
MEDRENT	Median Gross Rent ($) For Renter Occupied Housing Units
QFHH	% Female Headed Households With No Spouse Present
QED12LES	% Population Over 25 Years Old With Less Than 12 Years Of Education
HODENT	# Housing Units Per Square Mile
QCVLBRP	% Civilian Labor Force Participation
QFEMLBR	% Female Participation In Civilian Labor Force
QAGRI	% Employed In Primary Industry Farming, Fishing, Mining, Forestry
QTRAN	% Employed In Transportation, Communications, And Other Public Utilities
QSERV	% Employment In Service Occupations
QSSBEN	P% Social Security Recipients
MIGRA	International Migration

SoVI-NCR: Components

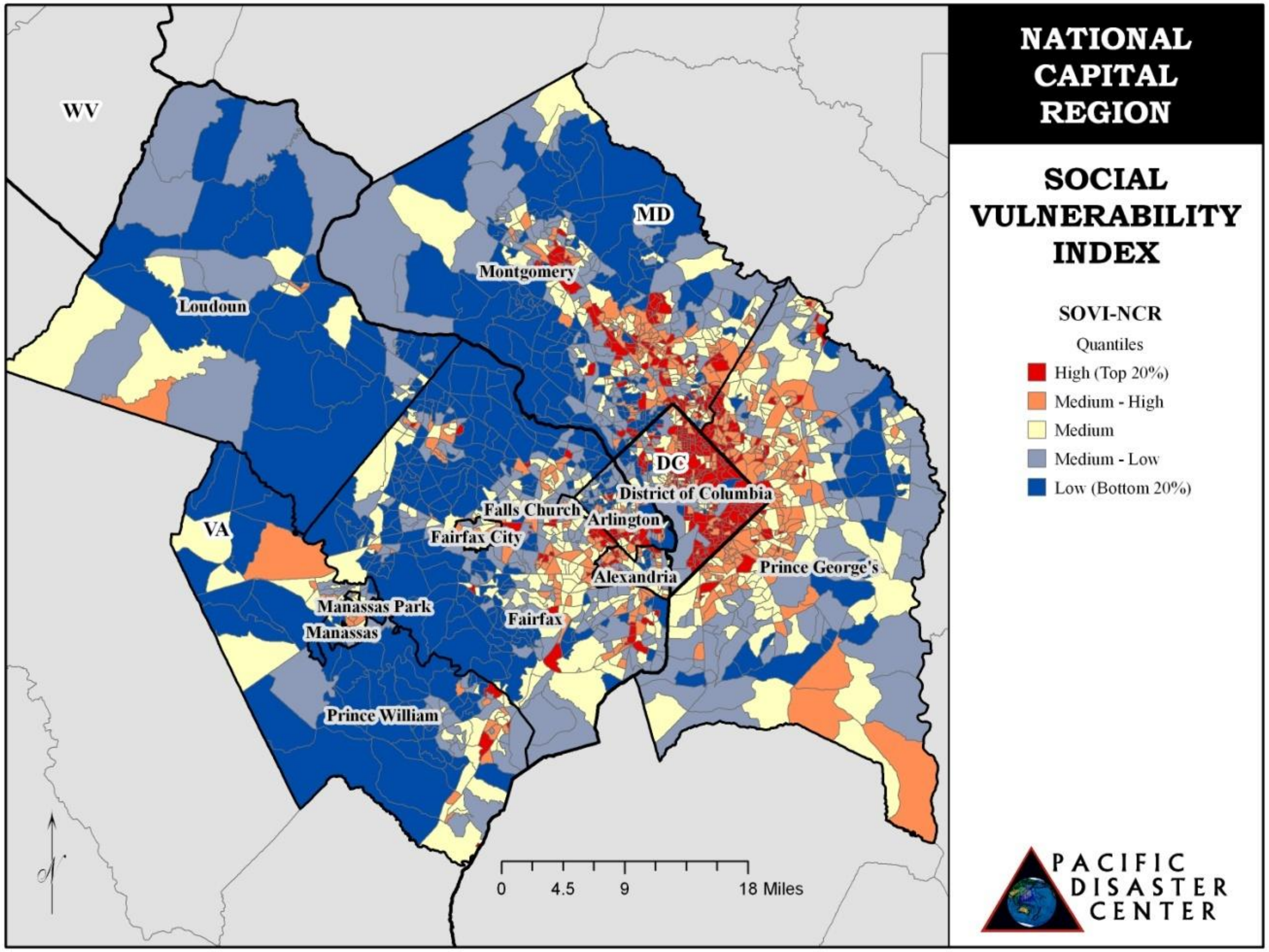
Sign Adjustment	Component	Name	Percent Explained	Variable	Loading
-	1	Socioeconomic Status	16.72	MDHSEVAL	.859
				PERCAP	.827
				QRICH	.769
				MEDRENT	.515
				QSERV	-.511
				QBLACK	-.565
				QTRAN	-.647
+	2	Poverty and Unemployment	14.60	QPOVTY	.825
				QCVLUN	.728
				QED12LES	.639
				QBLACK	.542
				QFHH	.524
+	3	Elderly	12.44	QPOP65O	.911
				QSSBEN	.884
				MEDAGE	.736
				QCVLBRP	-.637
+	4	Immigration	11.64	MIGRA	.887
				QSPANISH	.866
-	5	High Density Renters	9.20	PPUNIT	.906
				QKIDS	.547
				QRENTER	-.561
				HODENT	-.641
+	6	Female	8.99	QFEMALE	.883
				QFEMLBR	.800
				QFHH	.504
		Total Explained	73.60		

Component 1: Socioeconomic Status

» Dominant Variables:
- MDHSEVAL
- PERCAP
- QRICH
- MEDRENT
- QSERV
- QBLACK
- QTRAN



SoVI-NCR


NATIONAL CAPITAL REGION
SOCIAL VULNERABILITY INDEX
SOVI-NCR
Quantiles
High (Top 20%)
Medium - High
Medium
Medium - Low
Low (Bottom 20%)
WV
MD
VA
Loudoun
Montgomery
DC
District of Columbia
Falls Church
Arlington
Fairfax City
Alexandria
Prince George's
Manassas Park
Manassas
Fairfax
Prince William
0
4.5
9
18 Miles
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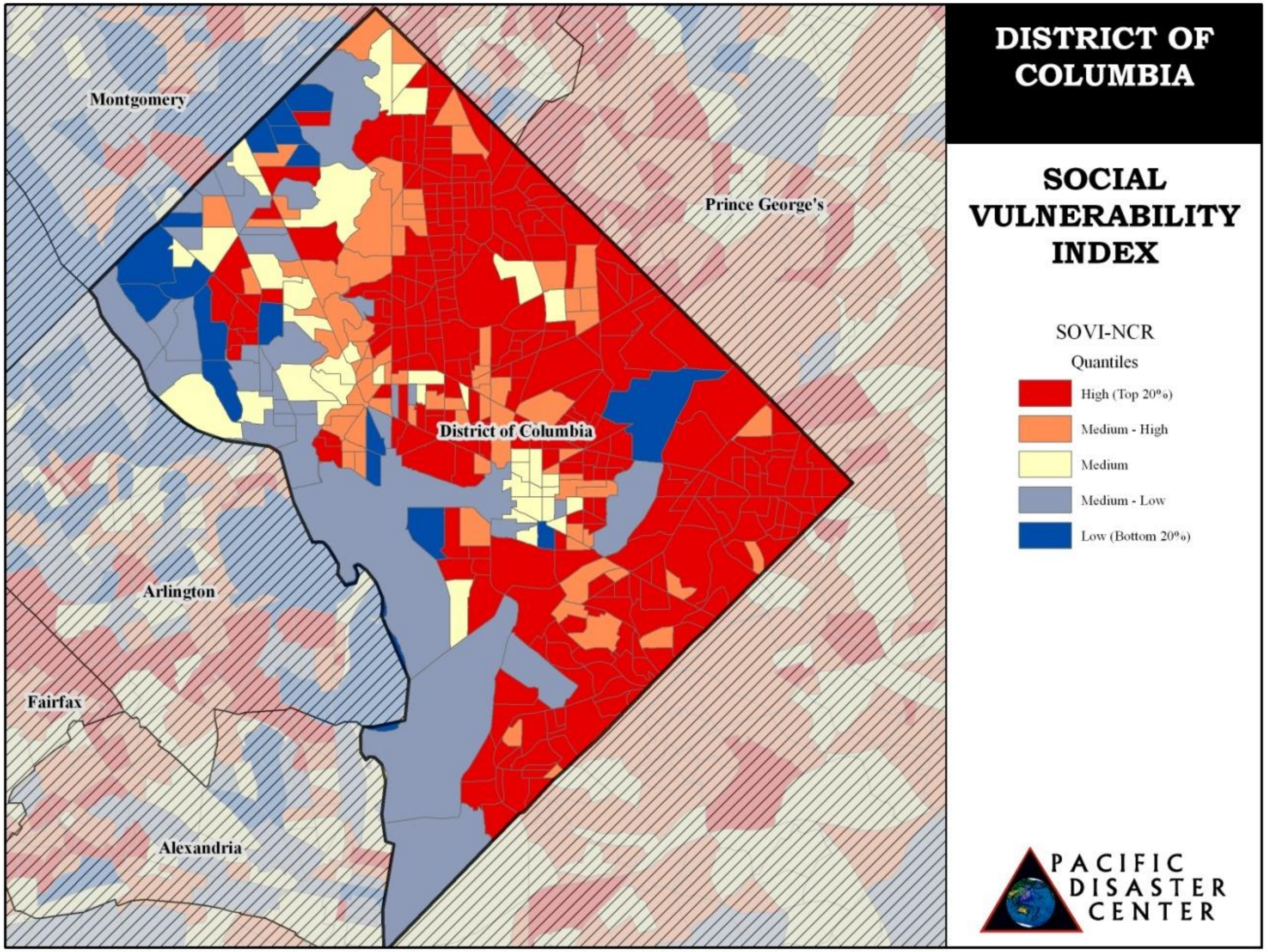
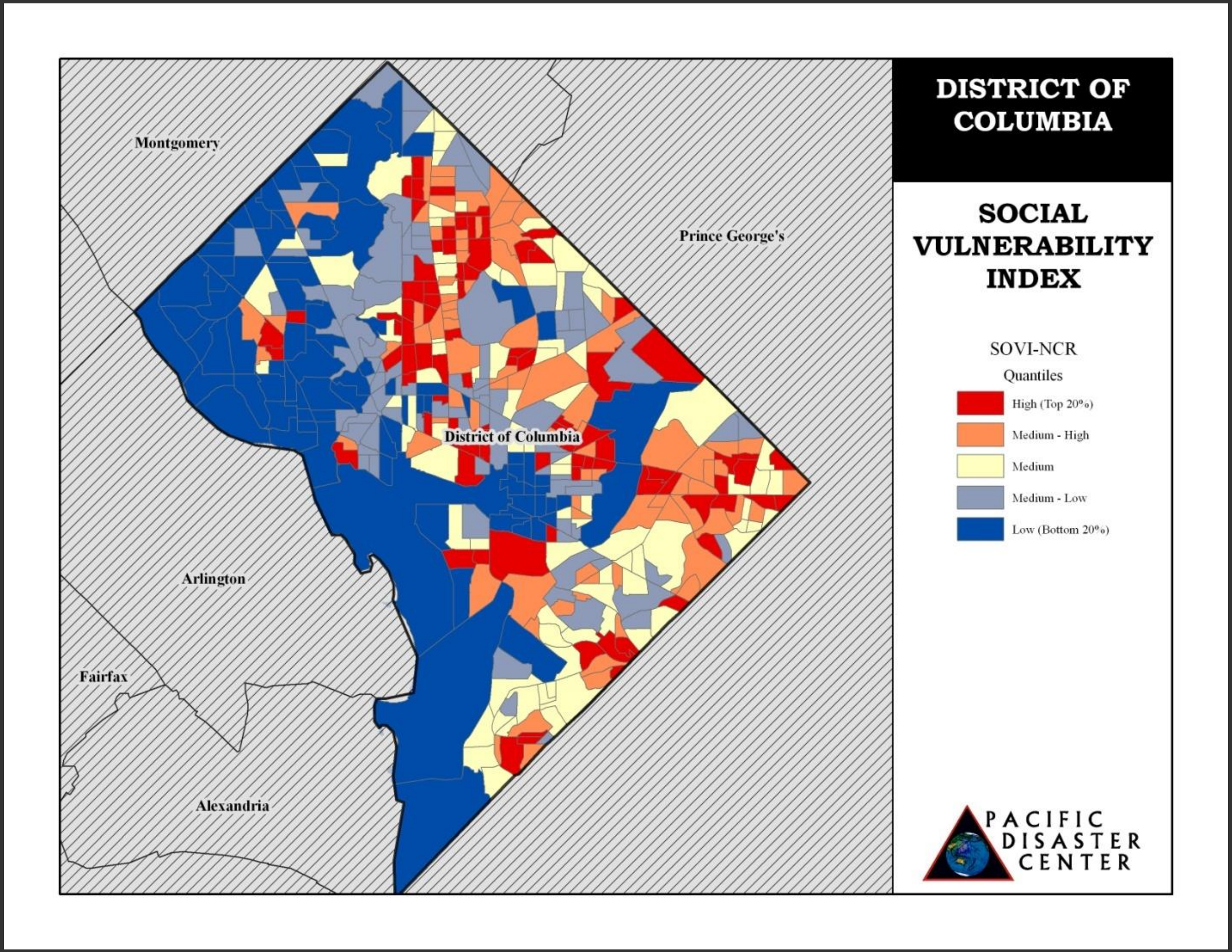
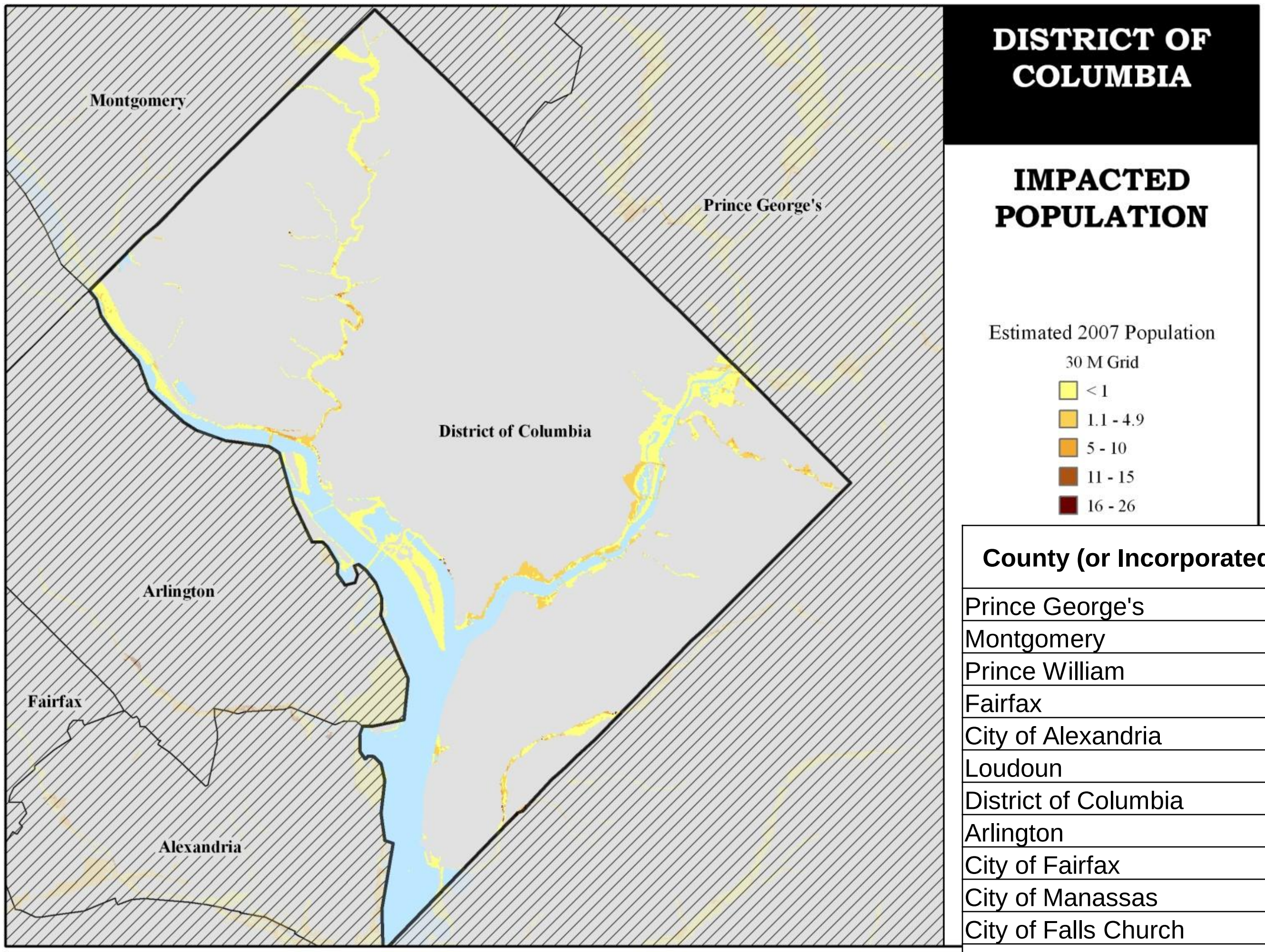
SoVI-NCR: District of Columbia



SoVI-NCR:
Reclassification of District of Columbia

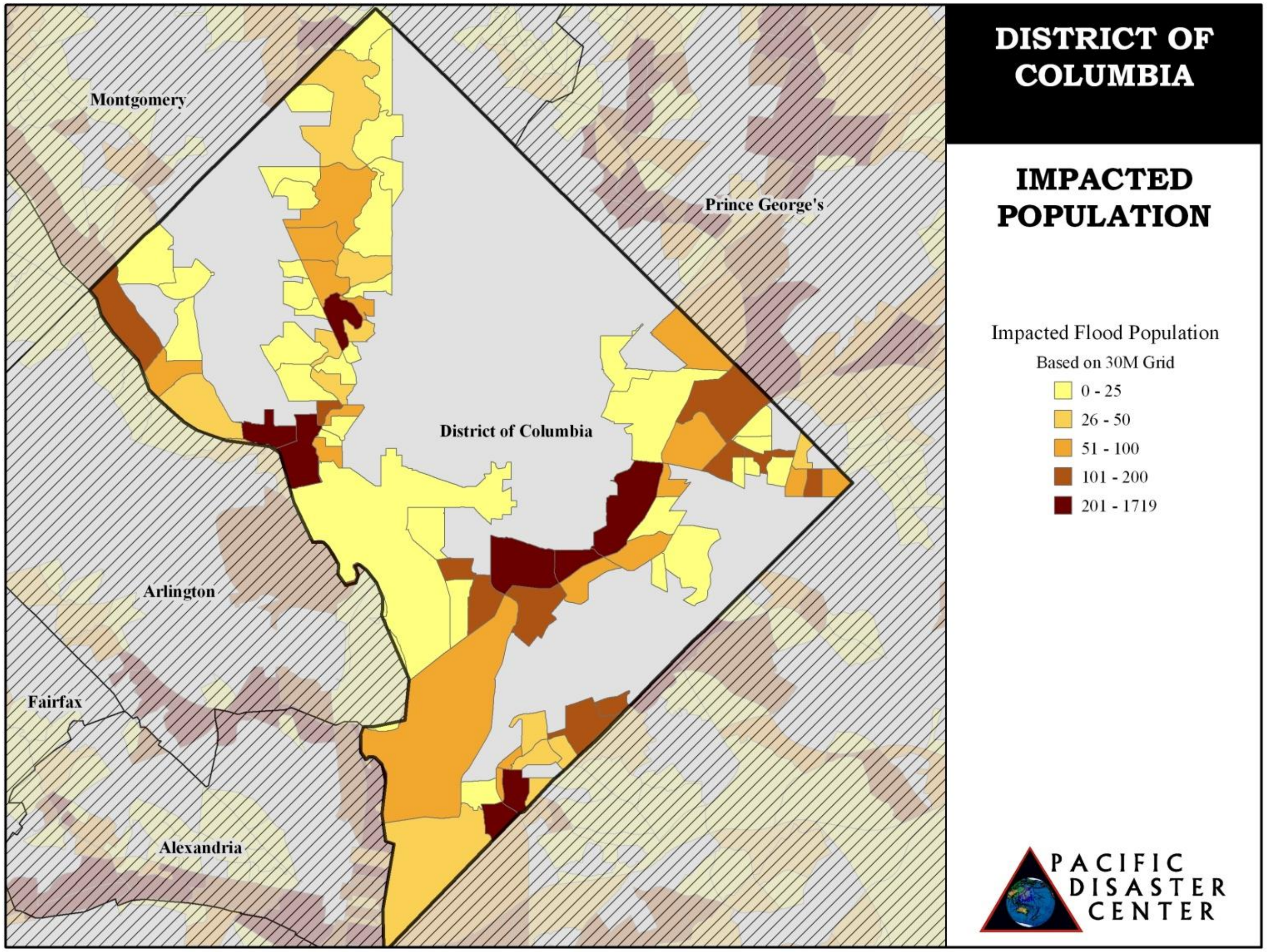


Dasymetric Population Within Floodplain

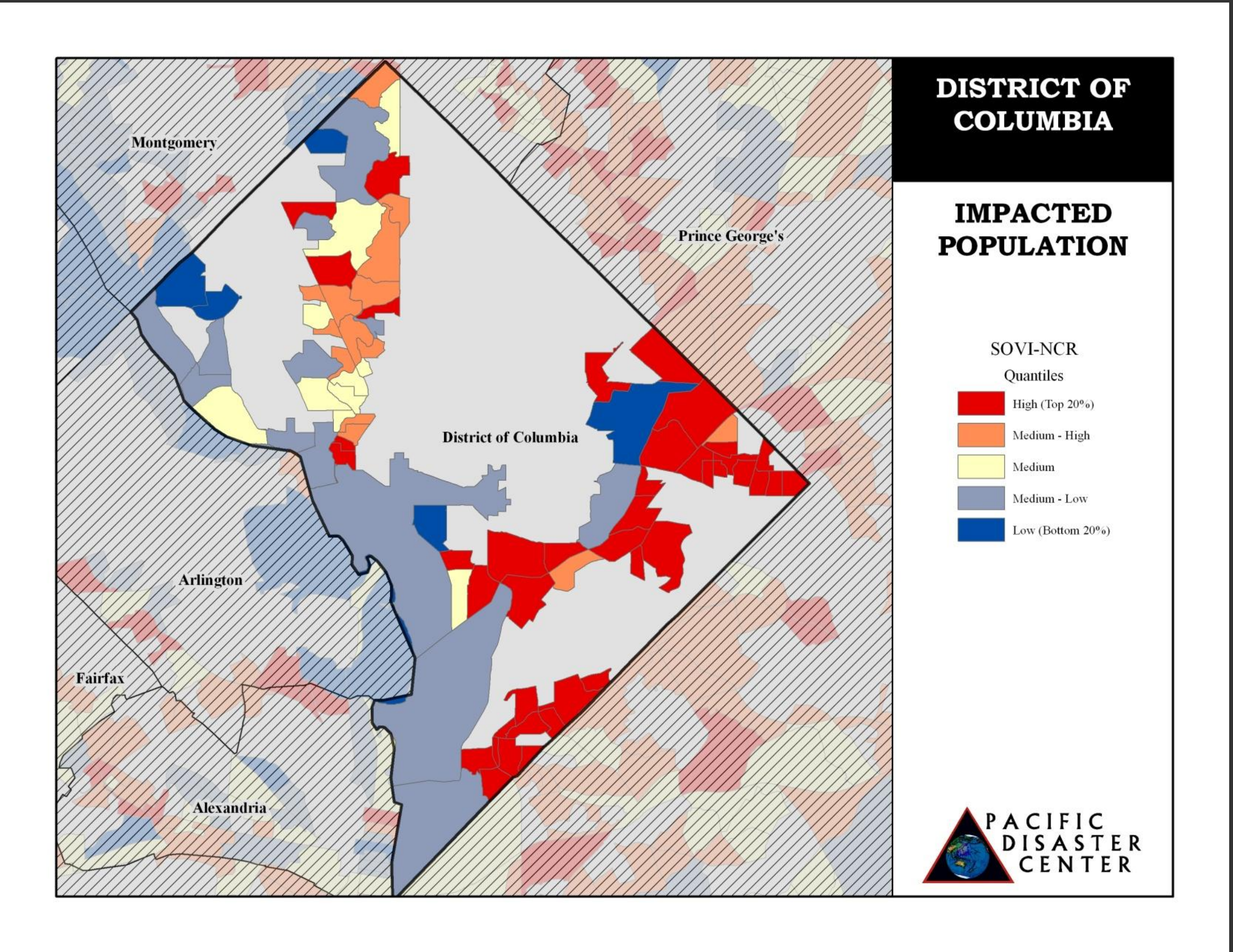


County (or Incorporated Area)	Estimated Population in Flood Zone
Prince George's	22,787
Montgomery	15,690
Prince William	11,294
Fairfax	10,575
City of Alexandria	8,315
Loudoun	7,180
District of Columbia	6,325
Arlington	4,141
City of Fairfax	1,640
City of Manassas	861
City of Falls Church	334
City of Manassas Park	244
TOTAL	89,386

Dasymetric Population Within Floodplain

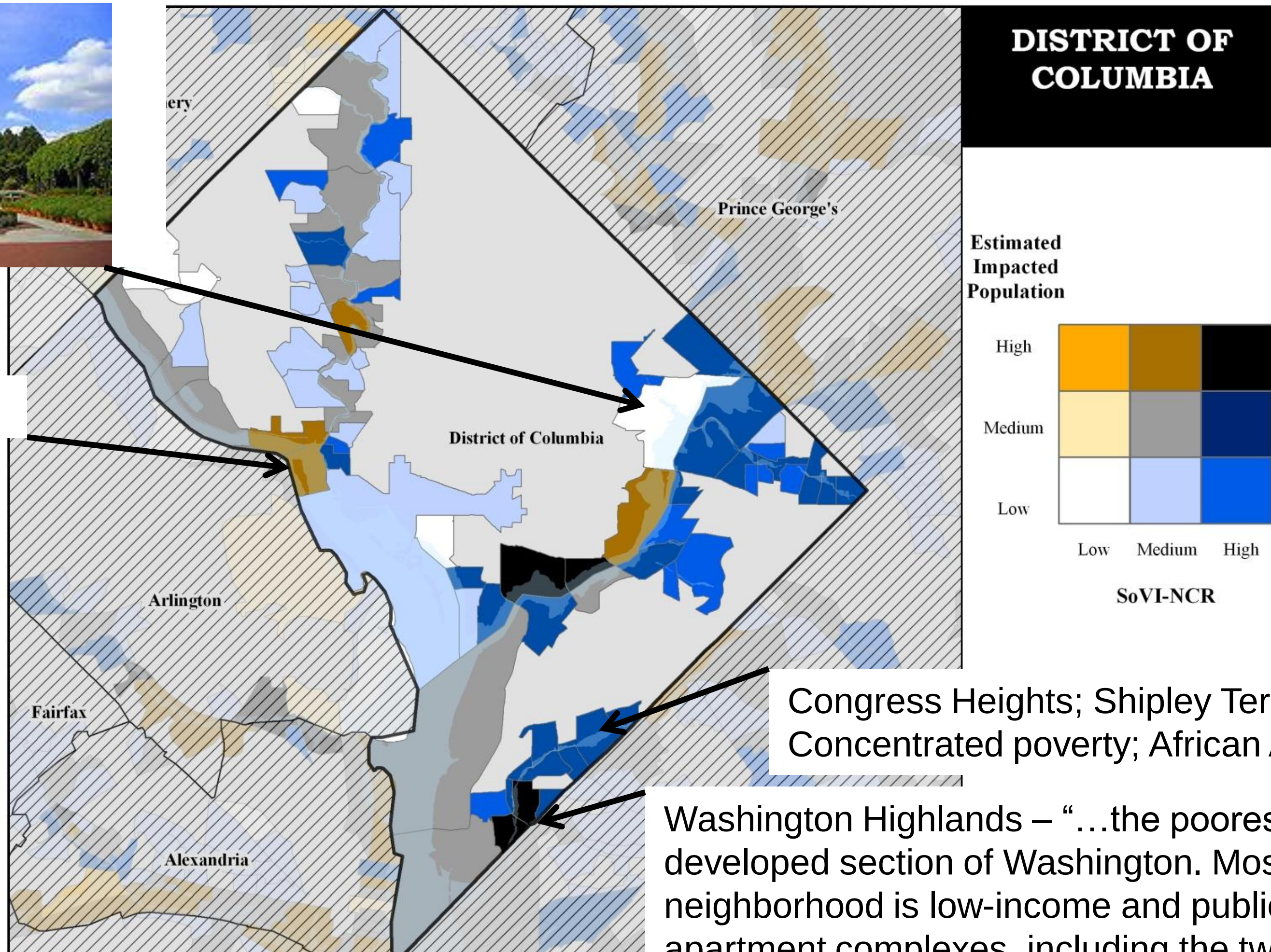


SoVI-NCR Impacted by Floodplain



Bivariate Risk Map

National Arboretrum

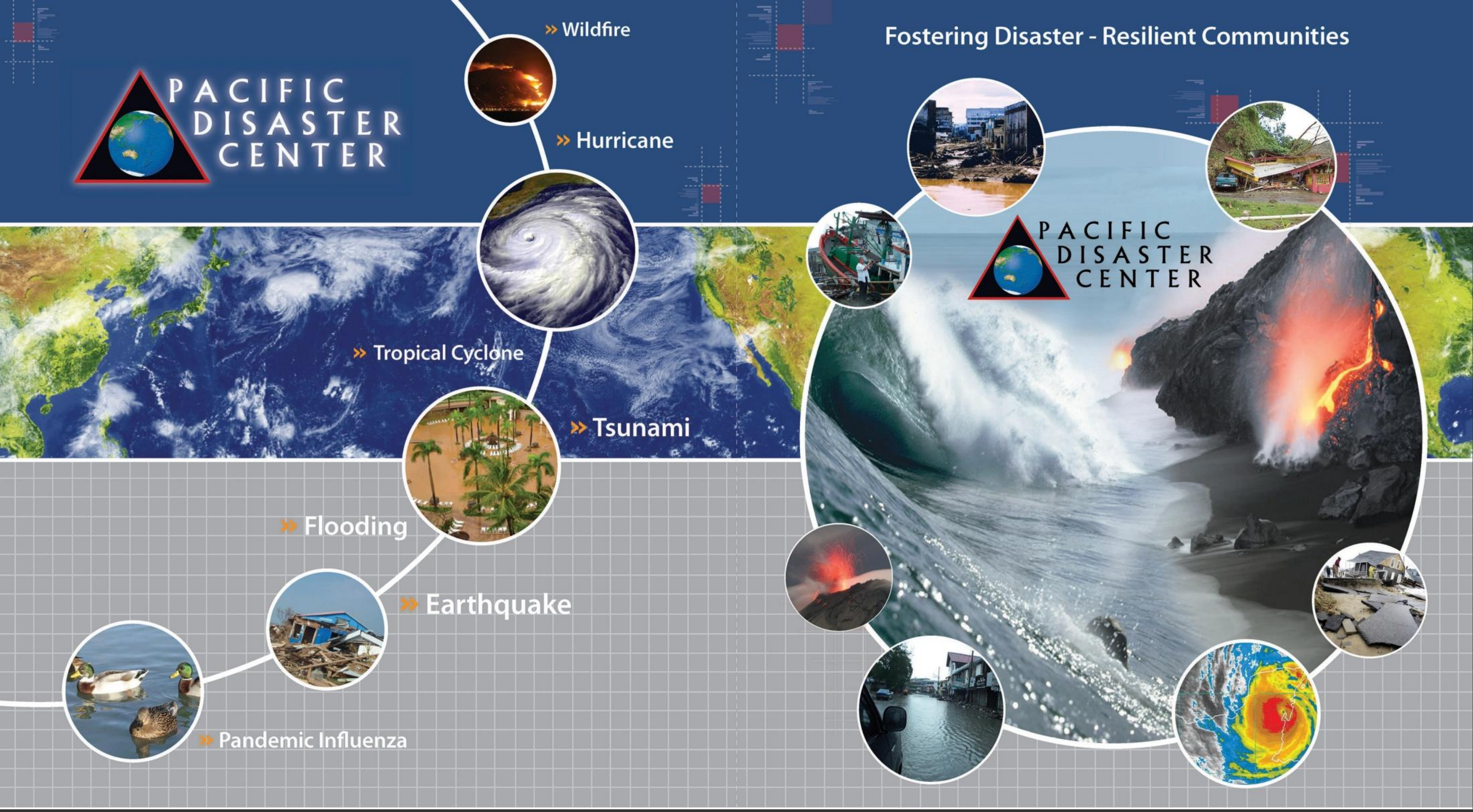


Georgetown

Congress Heights; Shipley Terrace – Concentrated poverty; African American

Washington Highlands – "…the poorest and least developed section of Washington. Most of the neighborhood is low-income and public housing apartment complexes, including the two large housing projects Valley Green and Highland Dwellings."

Learning Check



Thank You

Christina Finch
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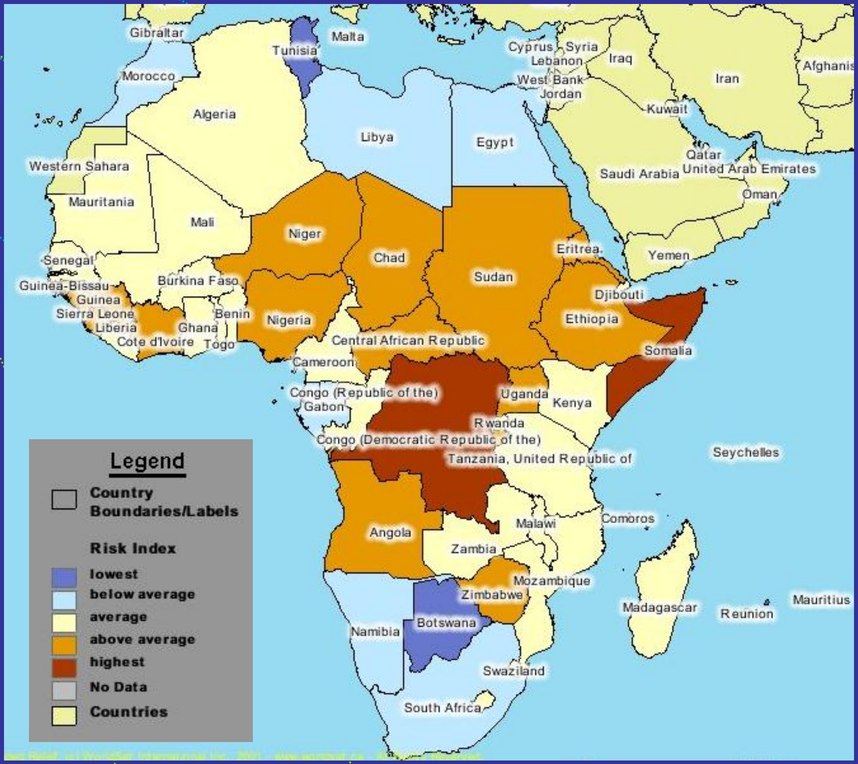
AFRICOM Demonstration

- Demonstration Goals
  - Quantification of Characteristics
  - Data Availability
  - Simple Methodology
- Outcomes
  - Develop National Priorities
  - Identify Vulnerability and Coping Capacity



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Project Overview

- National Level Risk Assessment for Continent of Africa
  - Including Physical and Social Spatial Data
- Interactive Map Viewer
  - Visualize and Interact with Risk Assessment Indicators and Indices
- Sub-National Analysis
  - Example: Travel Costs in Kenya

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Risk Assessment Framework

RISK = Hazard + Vulnerability - Capacity

- Composite Index Relative to Africa
  - Three Components: Hazard; Vulnerability; Capacity
  - Equally Weighted
  - Range from 0 to 1
  - Components Created from Sub-Indices
- Sub-Indices
  - Combination of Indicators
  - Indicator Values Scaled from 0 to 1
- Risk Scores Can Range from -1 to 2

Why Might Assessment be Useful?

- Assessment Can Help:
  - Increase Familiarity
  - Identify Areas Perhaps More Likely to Suffer Negative Impacts
  - Identify Areas Perhaps Less Likely to Cope with Impacts
  - Set Priorities
  - Identify Specific Strengths and Weaknesses

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RISK = Hazard + Vulnerability - Capacity

- Hazard:
  - A potentially damaging physical event, phenomenon or human activity that may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation.
- Hazard Specific Vulnerabilities and Capacities (e.g. ARV Therapy) Included in Hazard Sub-Indices
- Sub-Indices
  - HIV/AIDS
  - Conflict

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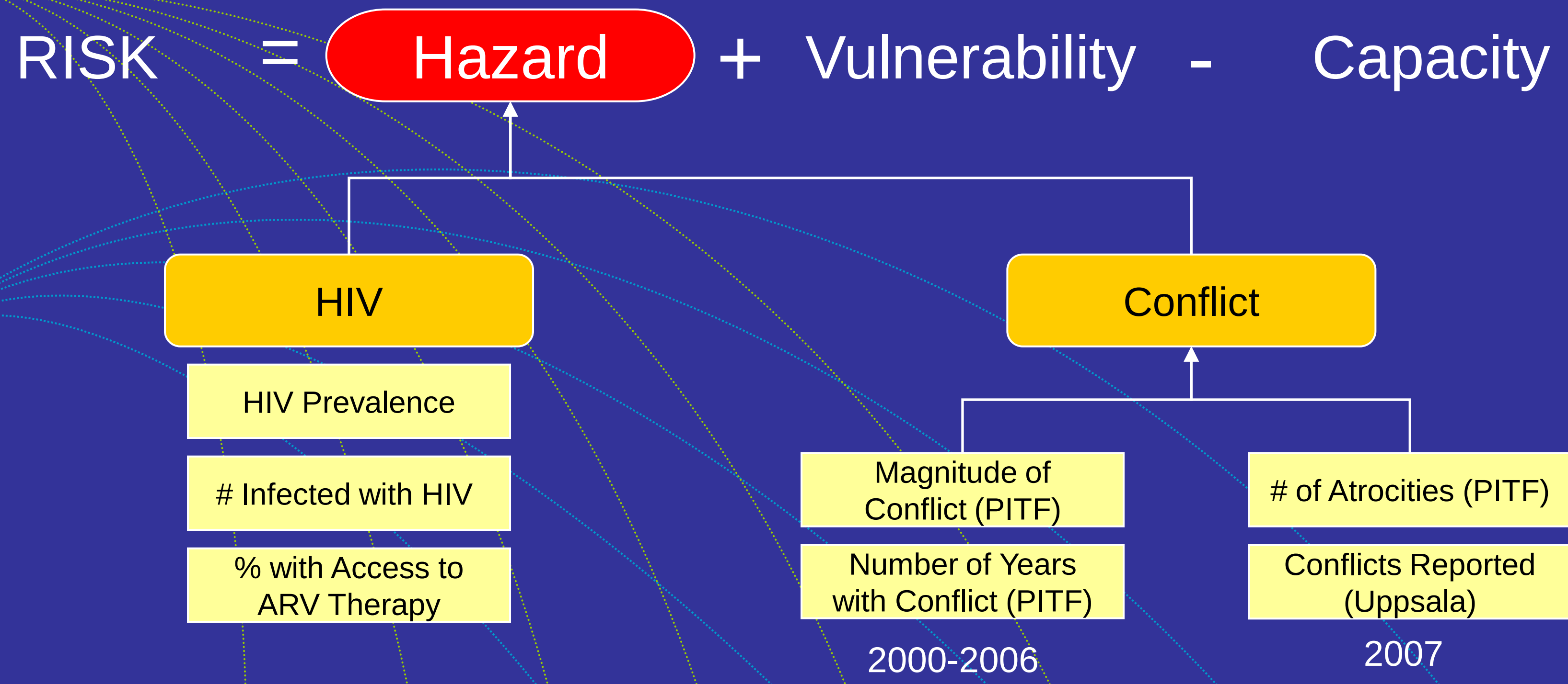

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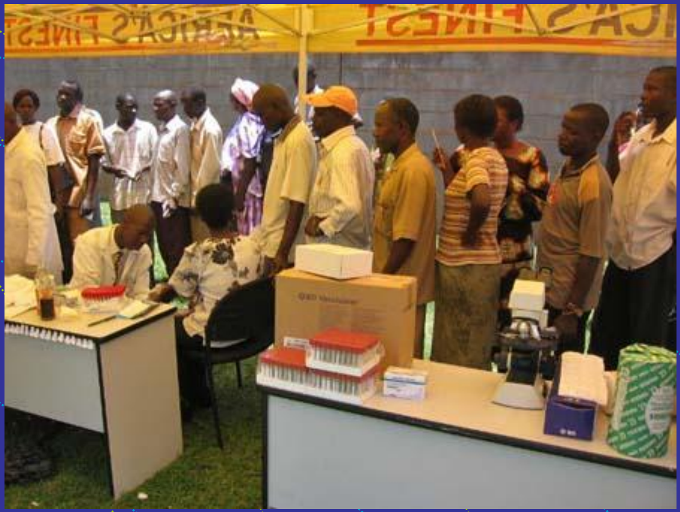
RISK = Hazard + Vulnerability - Capacity

HIV

HIV Prevalence

Infected with HIV

% with Access to ARV Therapy



Employees line up for HIV tests to mark the opening of a workplace HIV/AIDS program at the Nile Brewery Company in Uganda. Source: USAID

Medication available at a maternal care clinic in Senegal. Source: USAID

A crowded clinic waiting room in Liberia. Source: USAID

Patients waiting in a clinic in South Africa. Source: USAID

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RISK = Hazard + Vulnerability - Capacity

Hazard

Conflict

Magnitude of Conflict (PITF)	# of Atrocities (PITF)
Number of Years with Conflict (PITF)	Conflicts Reported (Uppsala)
2000-2006	2007

Child soldiers in eastern DRC. Source: USAID

A battle-damaged school prior to reconstruction in Sierra Leone. Source: USAID

A roadside sign indicating danger from landmines in Angola. Source: USAID

Damage from the war in Angola. Source: USAID

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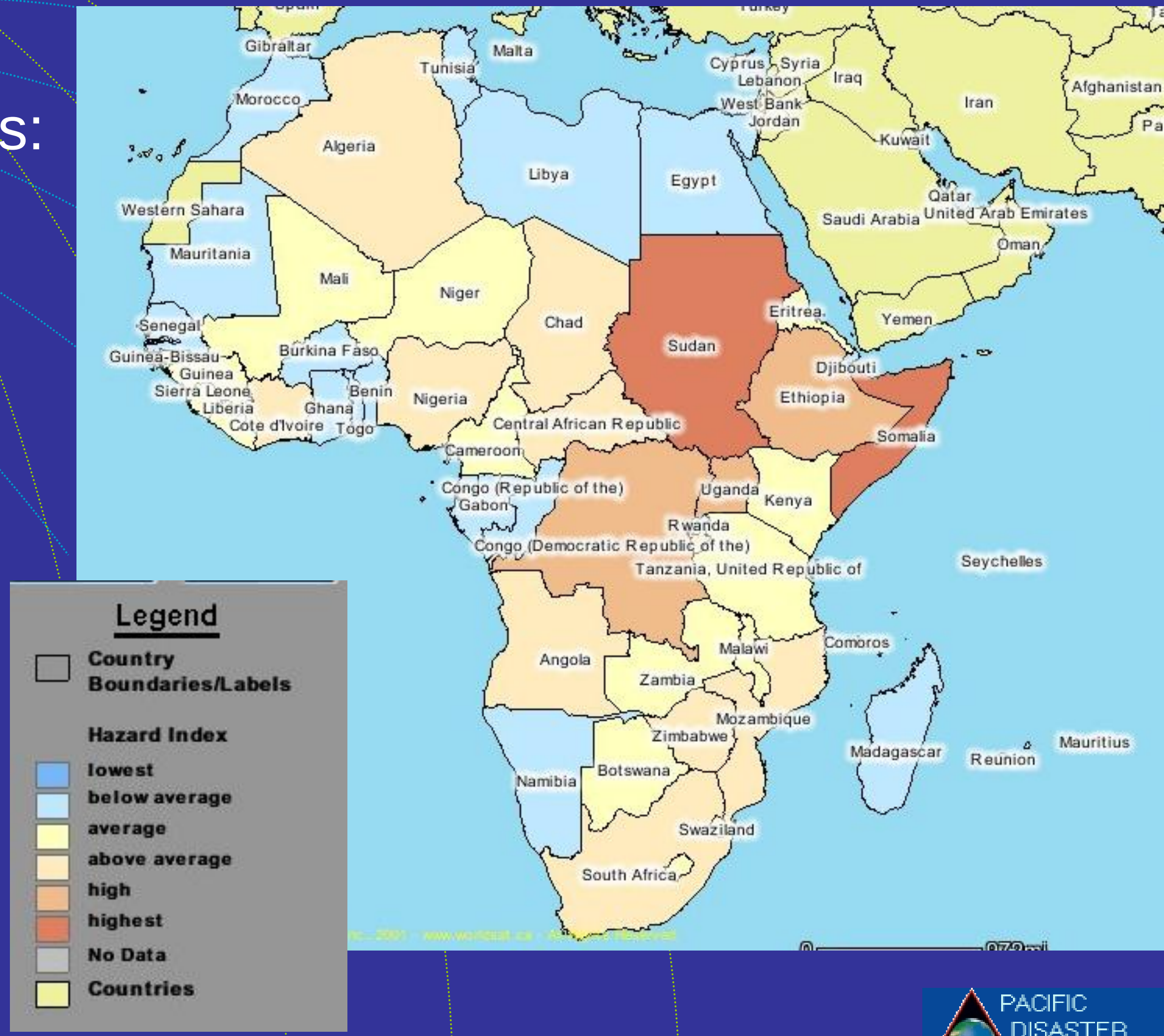
RISK = Hazard + Vulnerability - Capacity

- Hazard Index
- Top Ten Countries:
  - Somalia
  - Sudan
  - Congo (DRC)
  - Uganda
  - Ethiopia
  - Angola
  - Algeria
  - Chad
  - South Africa
  - Nigeria



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RISK = Hazard + Vulnerability - Capacity

- Congo
  - Middle HIV/AIDS, Higher Conflict
- Algeria:
  - Higher Conflict, Lower HIV/AIDS
- South Africa
  - Highest HIV/AIDS, Lowest Conflict

Top 10	Hazard		HIV/AIDS		Conflict	
	Index	Rank	Index	Rank	Index	Rank
Country	(Range 0-1)	(Rank x of 53)	(Range 0-1)	(Rank x of 53)	(Range 0-1)	(Rank x of 53)
Somalia	0.63	1	0.34	24	0.92	1
Sudan	0.62	2	0.39	15	0.85	2
Congo (DRC)	0.51	3	0.37	17	0.65	3
Uganda	0.49	4	0.39	15	0.60	5
Ethiopia	0.47	5	0.46	11	0.47	7
Angola	0.44	6	0.35	21	0.52	6
Algeria	0.42	7	0.25	41	0.60	5
Chad	0.41	8	0.36	18	0.45	8
South Africa	0.40	9	0.81	1	0.00	53
Nigeria	0.35	11	0.66	3	0.04	21

RISK = Hazard + Vulnerability - Capacity

- **Vulnerability**:
  - The conditions determined by physical, social, economic, and environmental factors or processes which increase the susceptibility of a community to the impact of hazards.
- Sub-Indices:

- Access to Food and Water
- Economic Dependence
- Population Pressures
- Environmental Stress
- Dependent Population
- Health Systems
- Difference and Inequality
- Access to Information

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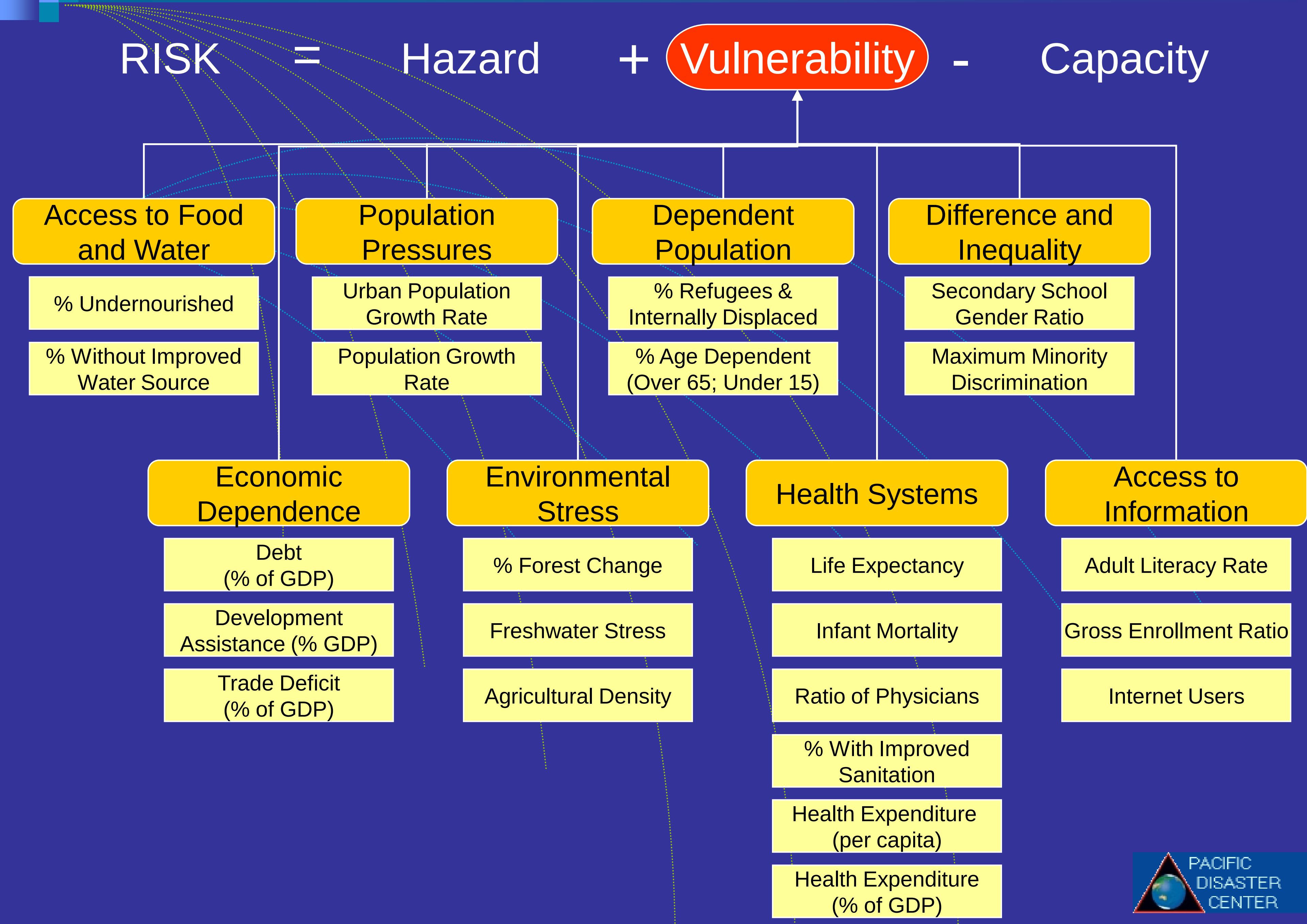

RISK = Hazard + Vulnerability - Capacity
Access to Food and Water
% Undernourished
% Without Improved Water Source
Population Pressures
Urban Population Growth Rate
Population Growth Rate
Dependent Population
% Refugees & Internally Displaced
% Age Dependent (Over 65; Under 15)
Difference and Inequality
Secondary School Gender Ratio
Maximum Minority Discrimination
Economic Dependence
Debt (% of GDP)
Development Assistance (% GDP)
Trade Deficit (% of GDP)
Environmental Stress
% Forest Change
Freshwater Stress
Agricultural Density
Health Systems
Life Expectancy
Infant Mortality
Ratio of Physicians
% With Improved Sanitation
Health Expenditure (per capita)
Health Expenditure (% of GDP)
Access to Information
Adult Literacy Rate
Gross Enrollment Ratio
Internet Users
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RISK = Hazard + Vulnerability - Capacity

Access to Food and Water

% Undernourished

% Without Improved Water Source

Collecting water from a newly improved well in Ethiopia. Source: USAID

Binta Seck (right) fills her water container at the end of a day in the rice fields. The new pump on Carabane Island, guarded by Abdou Diatta (left) is a welcome development; it is the first source of potable water for islanders. (Senegal) Source: USAID

Malnutrition in Ethiopia. Source: USAID

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RISK = Hazard + Vulnerability - Capacity

Economic Dependence

Debt Service (% of GDP)

Development Assistance (% GDP)

Trade Deficit (% of GDP)

US and Senegalese officials participate in the official ribbon cutting ceremony at the opening of the West Africa Trade Hub in Dakar. (Senegal) Source: USAID

A newly constructed building in Uganda. Source: USAID

Donated food being unloaded in Conakry in Guinea. Source: USAID

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RISK = Hazard + Vulnerability - Capacity

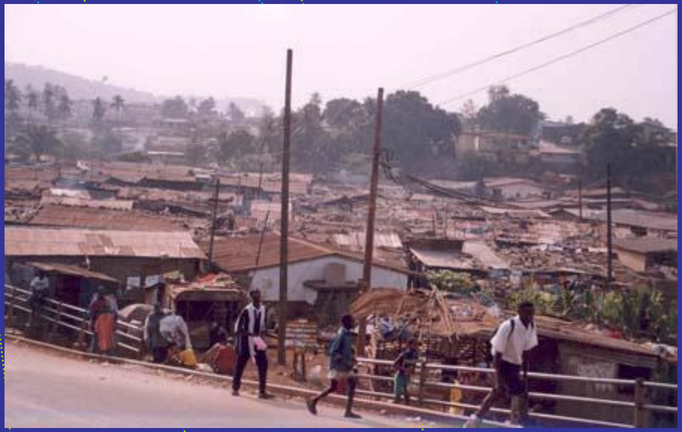
Population Pressures

Urban Population Growth Rate

Population Growth Rate

Informal settlements near Cape Town in South Africa. Source: USAID

Constructing homes in South Africa. Source: USAID



Housing in Freetown in Sierra Leone. Source: USAID

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RISK = Hazard + Vulnerability - Capacity

The results of slash and burn style agricultural practices in a baobab grove in Madagascar. Source: USAID

A new irrigation canal constructed in Mali. Source: USAID

Drilling a well in the Koro region, where wells range from 95 to 140 meters deep. (Mali) Source: USAID

Environmental Stress

% Forest Change

Freshwater Stress

Agricultural Density

Abandoned farmland in Uganda. Source: USAID

A hillside awaiting reforestation in Guinea. Source: USAID

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RISK = Hazard + Vulnerability - Capacity

Dependent Population

% Refugees & Internally Displaced

% Age Dependent (Over 65; Under 15)

The tightly packed Kitgum camp for internally displaced persons viewed from above. (in Uganda) Source: USAID

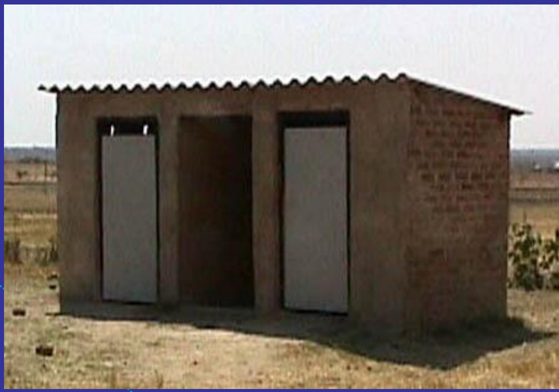
A group of orphans and other vulnerable children at a HIV/AIDS resource center in Walvis Bay in Namibia. Source: USAID

A refugee camp in Guinea. Source: USAID

RISK = Hazard + Vulnerability - Capacity

Patients in a newly rehabilitated hospital in Sierra Leone. Source: USAID

Performing a blood test at the Gulu Hospital in Uganda. Source: USAID



New latrines in Zambia. Source: USAID

Health Systems

- Life Expectancy
- Infant Mortality
- Ratio of Physicians
- % With Improved Sanitation
- Health Expenditure (per capita)
- Health Expenditure (% of GDP)

A family from a Ba Aka pygmy village in DR Congo. Source: USAID

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RISK = Hazard + Vulnerability - Capacity

Difference and Inequality

Secondary School Gender Ratio

Maximum Minority Discrimination

Excited students at a newly rehabilitated primary school in Sierra Leone. Source: USAID

Students in a nonformal school in Uganda. Source: USAID

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RISK = Hazard + Vulnerability - Capacity

Net surfing students are glued to their screens in Djibouti. Source: USAID

A school rehabilitated through USAID funding in Mali. Source: USAID

Access to Information

Adult Literacy Rate

Gross Enrollment Ratio

Internet Users

A proud librarian in Uganda. Source: USAID

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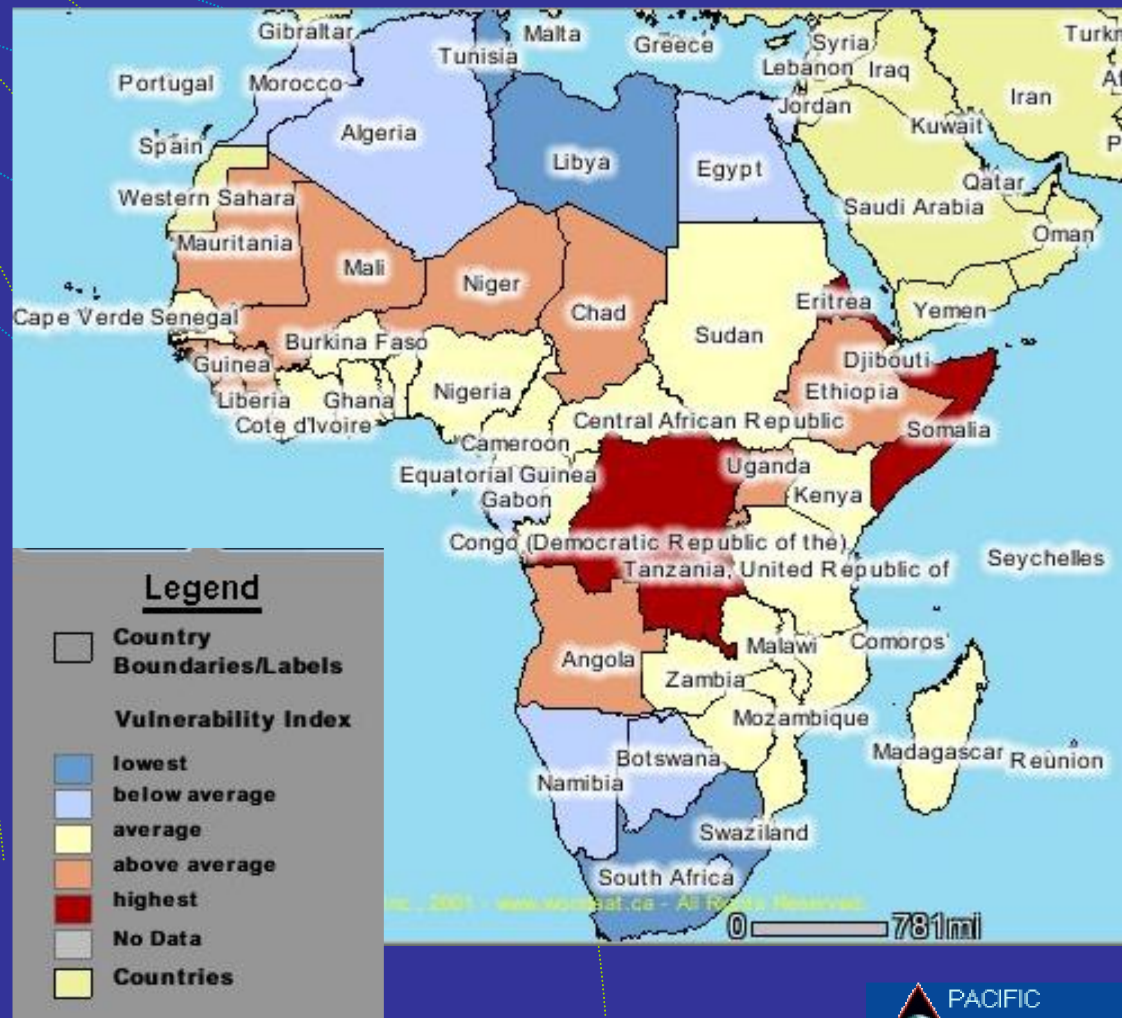
RISK = Hazard + Vulnerability - Capacity

- Vulnerability Index
- Top Ten Countries:
  - Somalia
  - Eritrea
  - Congo (DRC)
  - Chad
  - Burundi
  - Sierra Leone
  - Ethiopia
  - Guinea-Bissau
  - Niger
  - Guinea



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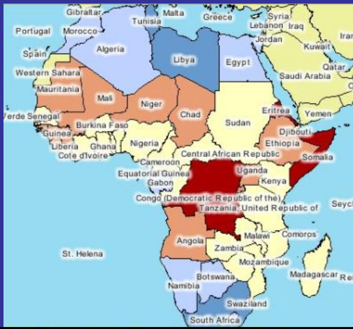
RISK = Hazard + Vulnerability - Capacity



- Guinea-Bissau; Niger (Same Vulnerability Rank)
  - Higher Dependent Populations, Lower Environmental Stress, Low Access to Health Care
  - Different Contributors:
    - Economic Dependence, Population Pressures

Top 10	Vulnerability		Dependent Population		Access to Water & Food		Economic Dependence		Environmental Stress	
	Index	Rank	Index	Rank	Index	Rank	Index	Rank	Index	Rank
Country	(Range 0-1)	(Rank x of 53)	(Range 0-1)	(Rank x of 53)	(Range 0-1)	(Rank x of 53)	(Range 0-1)	(Rank x of 53)	(Range 0-1)	(Rank x of 53)
Somalia	0.71	1	0.88	3	0.66	4	NA	NA	0.42	4
Eritrea	0.67	2	0.35	36	0.76	3	0.60	4	0.35	7
Congo	0.66	3	0.69	6	0.84	1	0.32	16	0.20	27
Chad	0.61	5	0.91	2	0.59	7	0.08	48	0.12	41
Burundi	0.61	5	0.43	18	0.57	10	0.64	2	0.51	3
Sierra Leone	0.60	6	0.38	32	0.61	6	0.38	10	0.23	21
Ethiopia	0.58	7	0.40	24	0.80	2	0.28	19	0.30	13
G.-Bissau	0.55	9	0.52	9	0.51	15	0.62	3	0.13	39
Niger	0.55	9	0.48	12	0.54	12	0.19	33	0.10	46
Guinea	0.54	11	0.40	24	0.46	19	0.21	30	0.25	19

Top 10	Health Access		Difference & Inequality		Access to Information		Population Pressures	
	Index	Rank	Index	Rank	Index	Rank	Index	Rank
Country	(Range 0-1)	(Rank x of 53)	(Range 0-1)	(Rank x of 53)	(Range 0-1)	(Rank x of 53)	(Range 0-1)	(Rank x of 53)
Somalia	0.87	5	NA	NA	NA	NA	0.70	11
Eritrea	0.75	18	0.79	3	0.73	18	0.99	1
Congo	0.87	5	0.93	1	0.74	17	0.65	15
Chad	0.87	5	0.63	12	0.92	4	0.80	4
Burundi	0.85	7	0.26	36	0.75	15	0.85	3
Sierra Leone	0.89	2	0.54	18	0.84	8	0.96	2
Ethiopia	0.80	14	0.60	13	0.85	6	0.57	22
G.-Bissau	0.84	9	0.47	22	0.79	9	0.55	27
Niger	0.84	9	0.57	15	0.98	1	0.71	9
Guinea	0.80	14	0.85	2	0.86	5	0.50	29

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RISK = Hazard + Vulnerability - Capacity

- Capacity:
  - The means by which people or organizations use available resources and abilities to face adverse consequences that could lead to a disaster
- Sub-Indices:
  - Infrastructure
  - Economic Strength
  - Government Strength

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RISK = Hazard + Vulnerability - Capacity

- Infrastructure
  - Telephone Mainlines and Cell Subscribers
  - Road Density
  - Runway Density
- Economic Strength
  - GDP per capita
  - Average Growth of GDP
- Government Strength
  - Voice and Accountability
  - Control of Corruption
  - Rule of Law
  - Government Effectiveness
  - Political Stability

RISK = Hazard + Vulnerability - Capacity

Infrastructure

Telephone Mainlines and Cell Subscribers

Road Density

Runway Density

A newly constructed bridge on a critical stretch of highway in Mozambique. Source: USAID

A typical road in rural Sierra Leone. Source: USAID

Airplane delivery of hand-crank-powered radios arrives in Southern Sudan. Source: USAID

A new telecenter and internet facility in Iringa. Source: USAID

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RISK = Hazard + Vulnerability - **Capacity**

Economic Strength

- GDP per capita
- Average Growth of GDP

Grading diamonds in Sierra Leone. Source: USAID

A clothing factory in South Africa. Source: USAID

Avocados in Kenya. Source: USAID

A furniture maker in Guinea. Source: USAID

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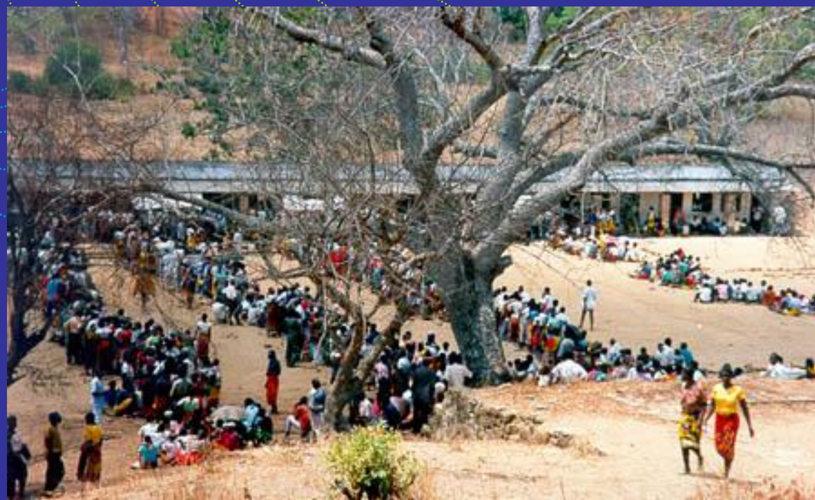
RISK = Hazard + Vulnerability - Capacity

Government Strength

- Voice and Accountability
- Control of Corruption
- Rule of Law
- Government Effectiveness
- Political Stability



People waiting to vote in Mozambique. Source: USAID

A meeting of the Northern Uganda Peace Initiative. Source: USAID

Guinean politicians listening to the Senegalese prime minister. Source: USAID

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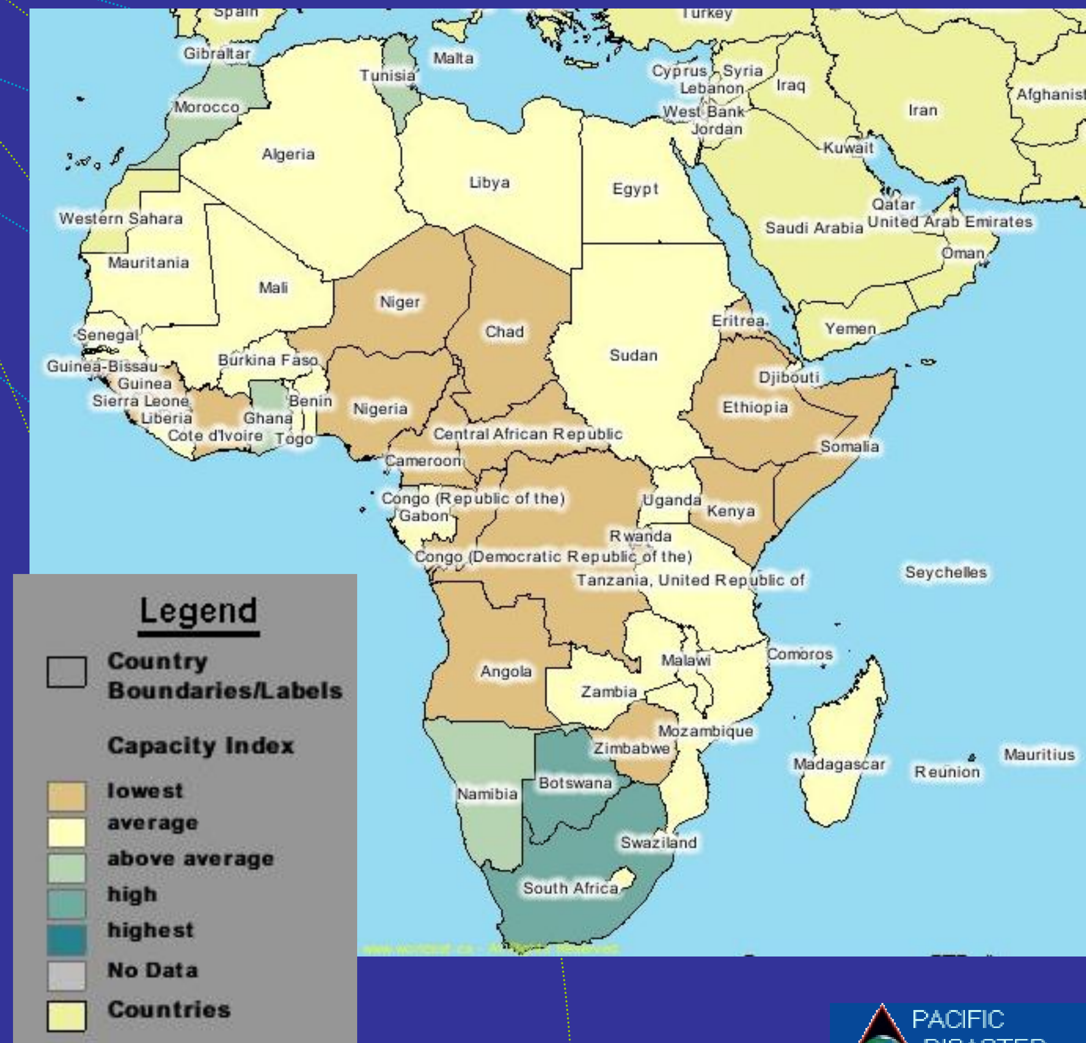
RISK = Hazard + Vulnerability - Capacity

- Capacity Index
- Top Eleven Countries:
  - Mauritius
  - Cape Verde
  - Botswana
  - Seychelles
  - South Africa
  - Tunisia
  - Namibia
  - Sao Tome and Principe
  - Equatorial Guinea
  - Morocco
  - Ghana



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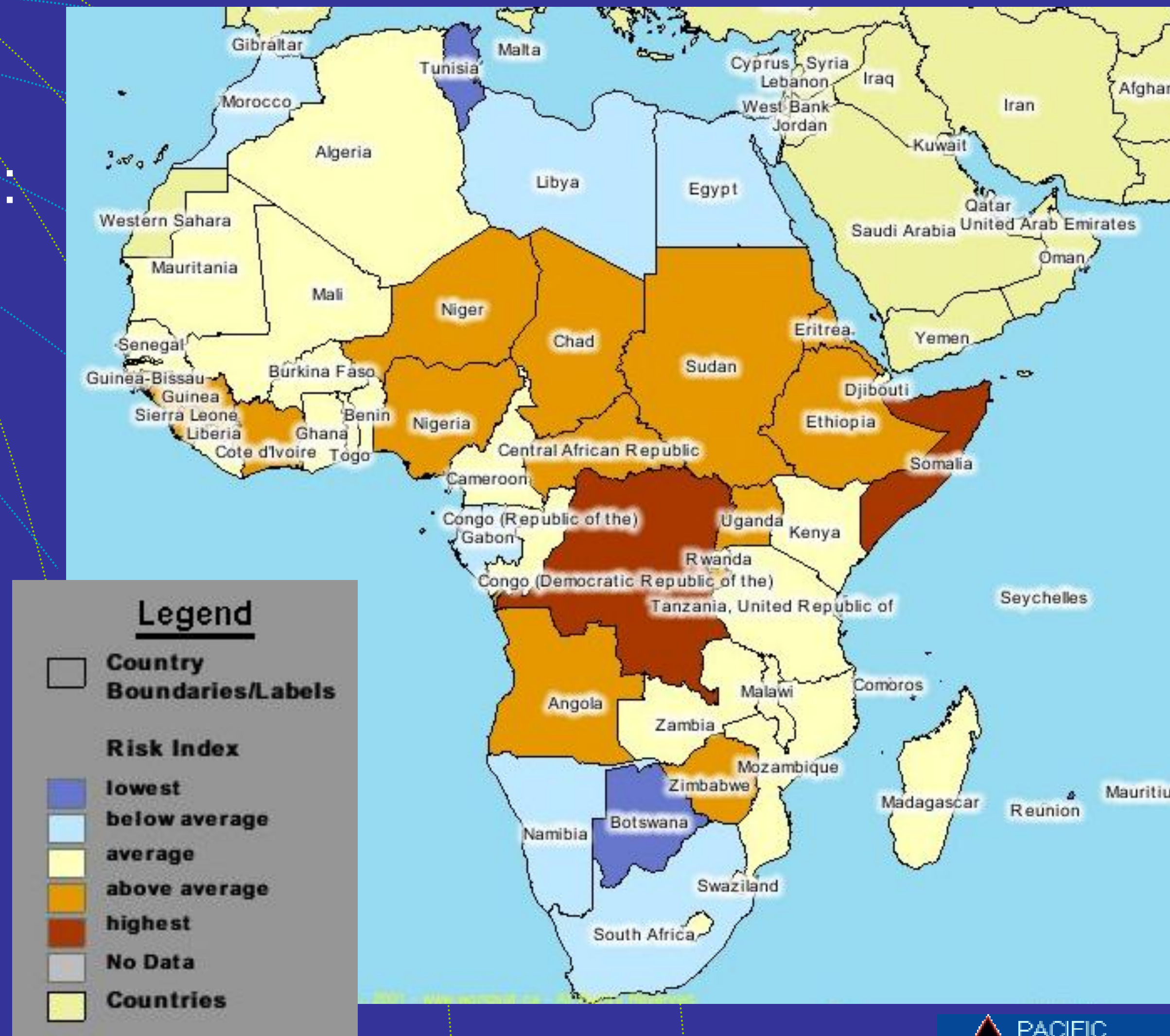
RISK = Hazard + Vulnerability - Capacity

- Mauritius
  - Higher Capacity in All Aspects
- Equatorial Guinea
  - Weak Governance, High Economic Strength
- Ghana
  - Strong Governance, Relatively Weak Infrastructure

Top 10	Capacity		Governance		Infrastructure		Economic Strength	
	Index	Rank	Index	Rank	Index	Rank	Index	Rank
Country	(Range 0-1)	(Rank x of 53)	(Range 0-1)	(Rank x of 53)	(Range 0-1)	(Rank x of 53)	(Range 0-1)	(Rank x of 53)
Mauritius	0.90	1	0.93	3	0.89	1	0.89	2
Cape Verde	0.76	2	0.94	1	0.78	2	0.56	7
Botswana	0.73	3	0.93	3	0.26	10	0.99	1
Seychelles	0.71	4	0.78	6	0.71	3	0.65	6
South Africa	0.61	5	0.83	5	0.51	6	0.49	8
Tunisia	0.55	6	0.64	8	0.36	7	0.66	5
Namibia	0.48	7	0.84	4	0.19	20	0.43	10
Sao Tome and Principe	0.46	8	0.57	13	0.70	4	0.11	32
Equatorial Guinea	0.39	9	0.15	45	0.24	13	0.80	3
Morocco	0.38	11	0.56	14	0.27	9	0.31	16
Ghana	0.38	11	0.72	7	0.14	32	0.28	17

RISK = Hazard + Vulnerability - Capacity

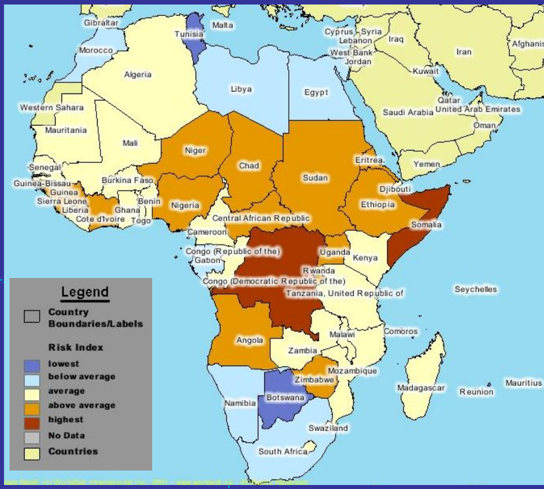
- Risk Index
- Top Ten Countries:
  - Somalia
  - Congo (DRC)
  - Chad
  - Sudan
  - Burundi
  - Ethiopia
  - Angola
  - Eritrea
  - Sierra Leone
  - Central African Republic



PACIFIC DISASTER CENTER

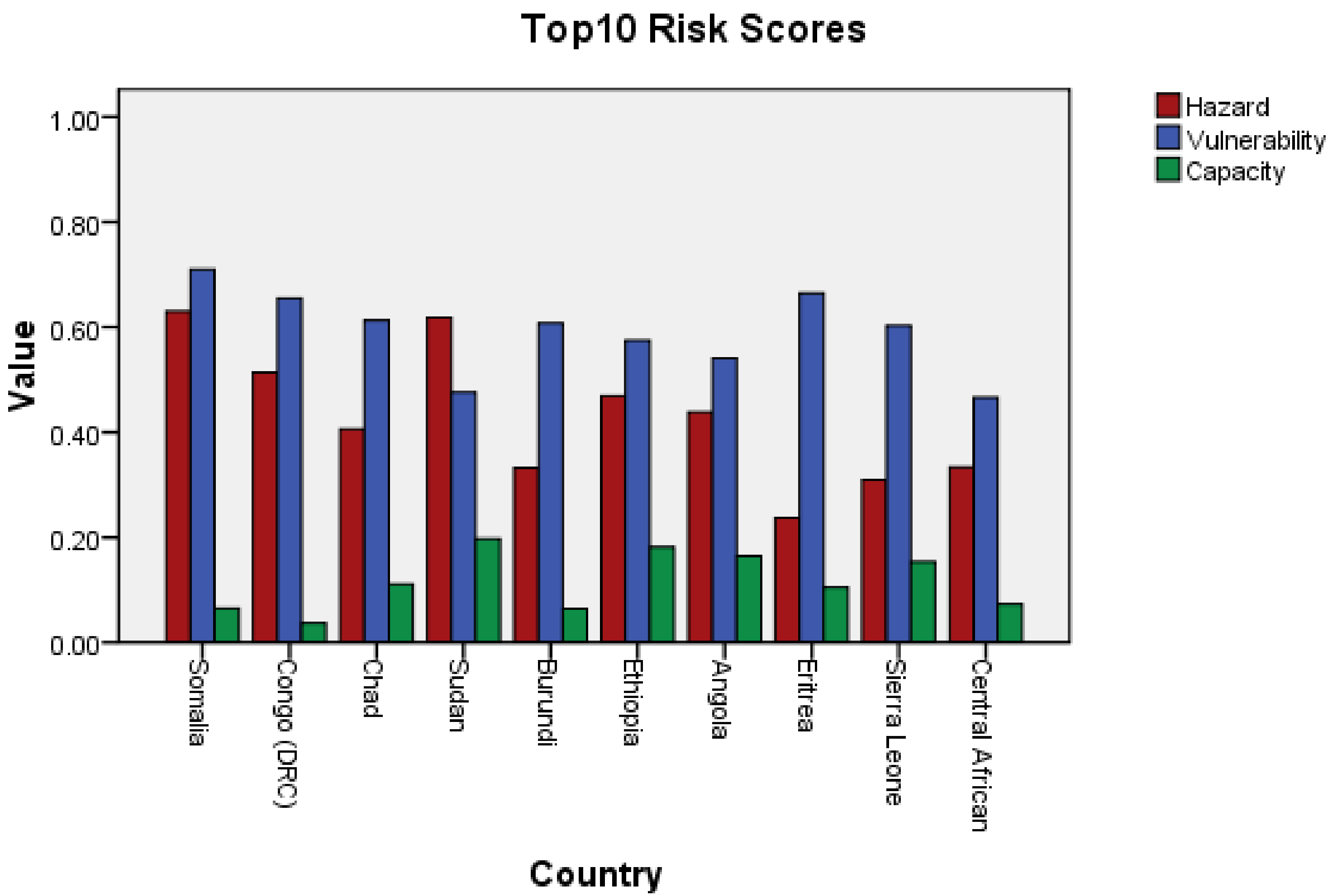
RISK = Hazard + Vulnerability - Capacity

- Somalia and Congo (DRC)
  - Higher in All Aspects of Risk
- Sudan
  - Higher Hazard, Medium Vulnerability and Capacity
- Burundi
  - Medium Hazard, High Vulnerability, Low Capacity



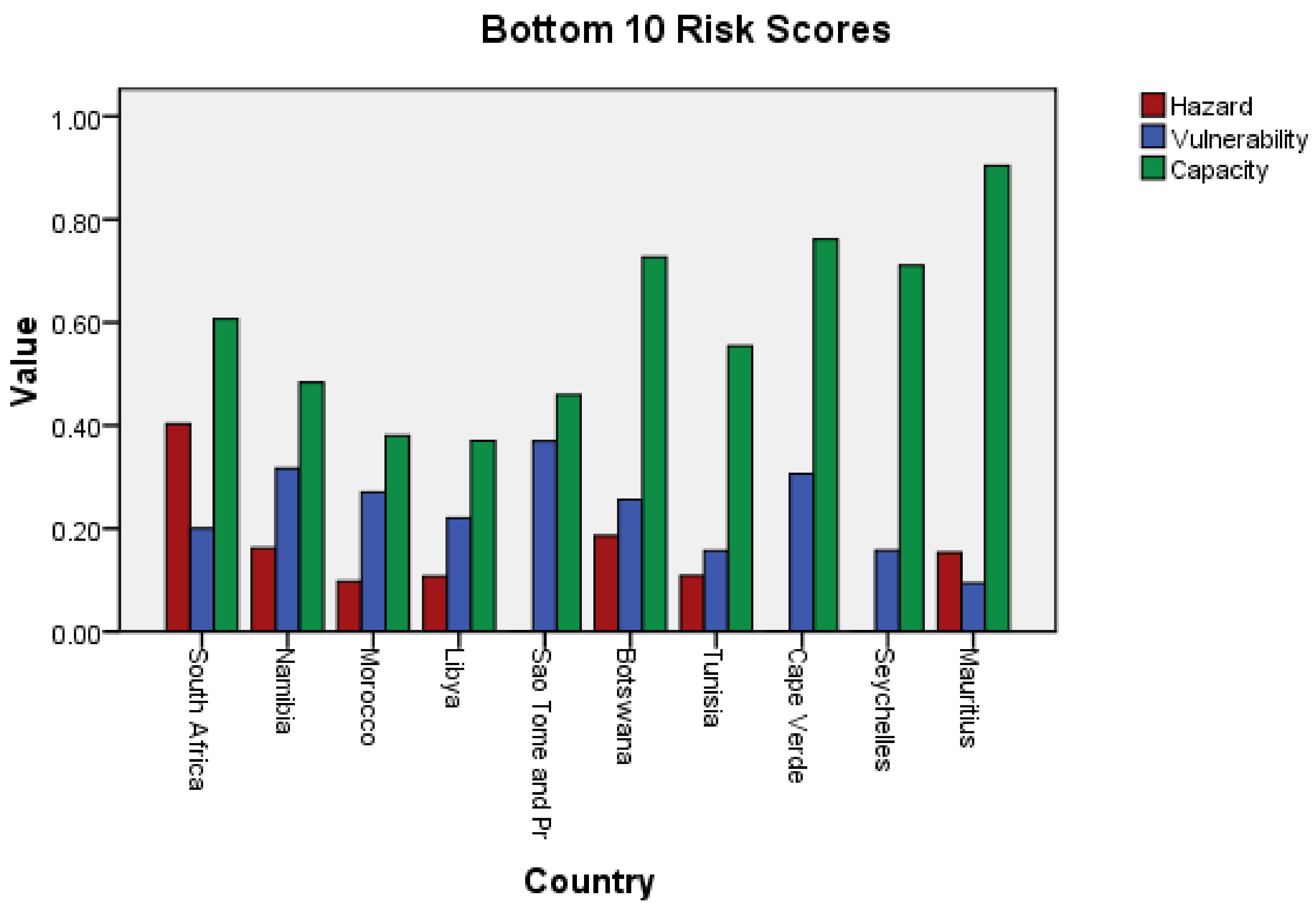
Top 10	Risk		Hazard		Vulnerability		Capacity	
	Index	Rank	Index	Rank	Index	Rank	Index	Rank
Country	(Range 0-1)	(Rank x of 53)	(Range 0-1)	(Rank x of 53)	(Range 0-1)	(Rank x of 53)	(Range 0-1)	(Rank x of 53)
Somalia	1.28	1	0.63	1	0.71	1	0.07	52
Congo	1.13	2	0.51	3	0.66	3	0.04	53
Chad	0.91	3	0.41	8	0.61	5	0.11	46
Sudan	0.90	4	0.62	2	0.48	22	0.20	32
Burundi	0.88	5	0.33	15	0.61	5	0.06	52
Ethiopia	0.86	6	0.47	5	0.58	7	0.18	37
Angola	0.82	7	0.44	6	0.54	11	0.16	40
Eritrea	0.80	8	0.24	26	0.66	2	0.11	46
Sierra Leone	0.76	9	0.31	16	0.60	6	0.15	41
CAR	0.73	10	0.33	15	0.47	24	0.07	50

Risk Index Components

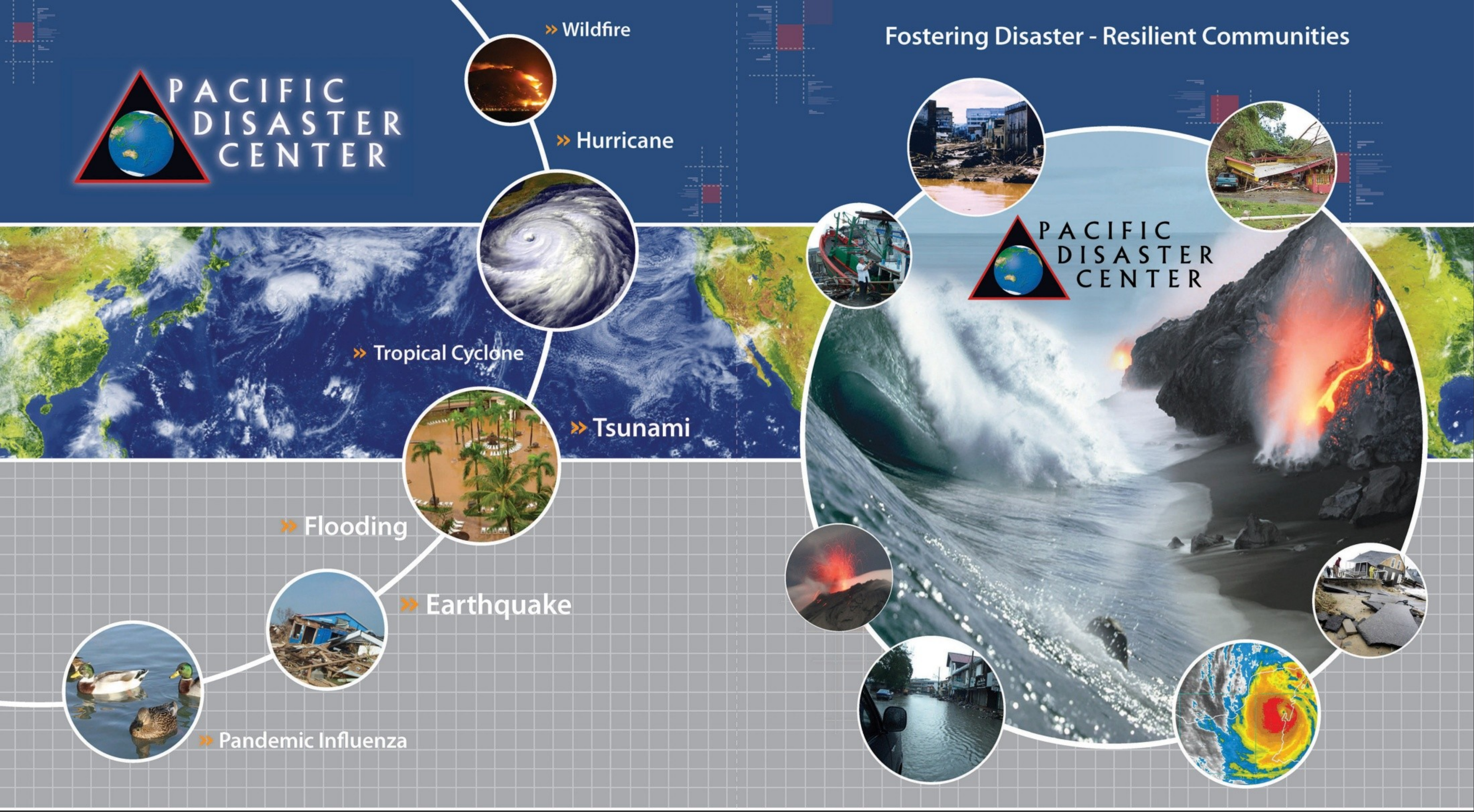


PACIFIC DISASTER CENTER

Risk Index Components



PACIFIC DISASTER CENTER



RISK ASSESSMENT AND SOCIAL VULNERABILITY METRICS

Christina Finch and Stanley Goosby
August 24,2010

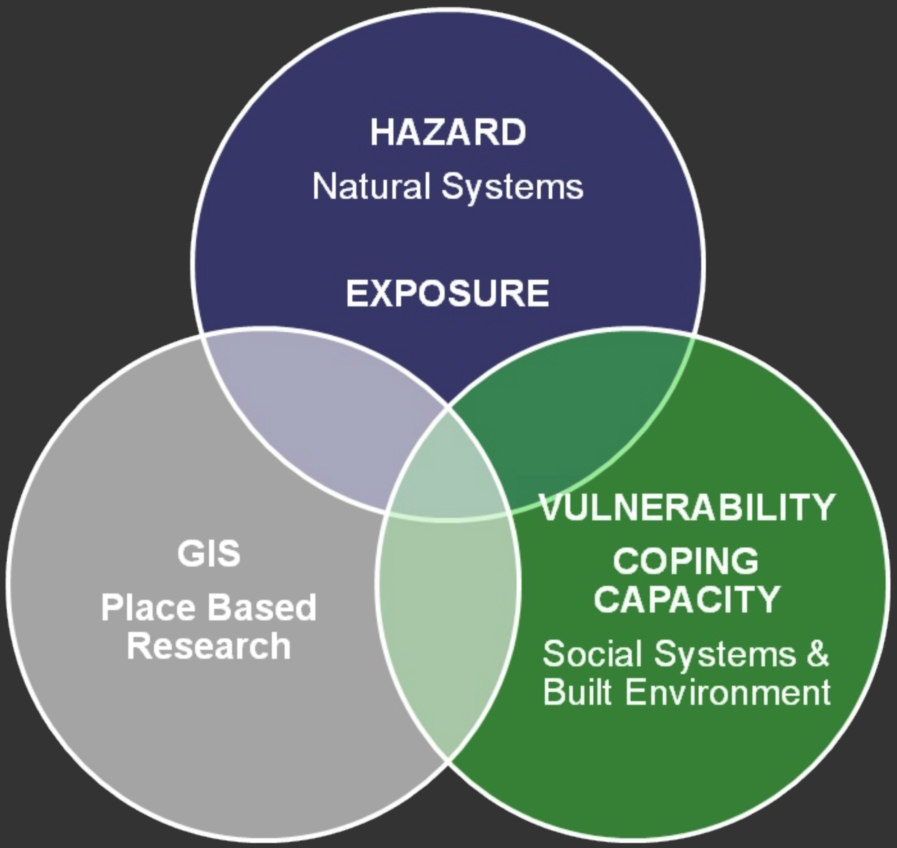
Climate Change Vulnerability Assessment and
Urban Development Planning for Asian Coastal Cities

Overview

- Day One
  - Components of a Disaster
  - Risk Reduction Process
  - Risk Assessment
    - Marikina City
    - American Samoa
  - Types of Vulnerability
    - Physical Factors
    - Environmental Factors
    - Socio-Cultural Factors
    - Economic Factors

The Makings of a Disaster

- All Disasters are Unique
- Interaction of Natural Systems, Social Systems, and Built Environment
- Place-Based Research



Disaster

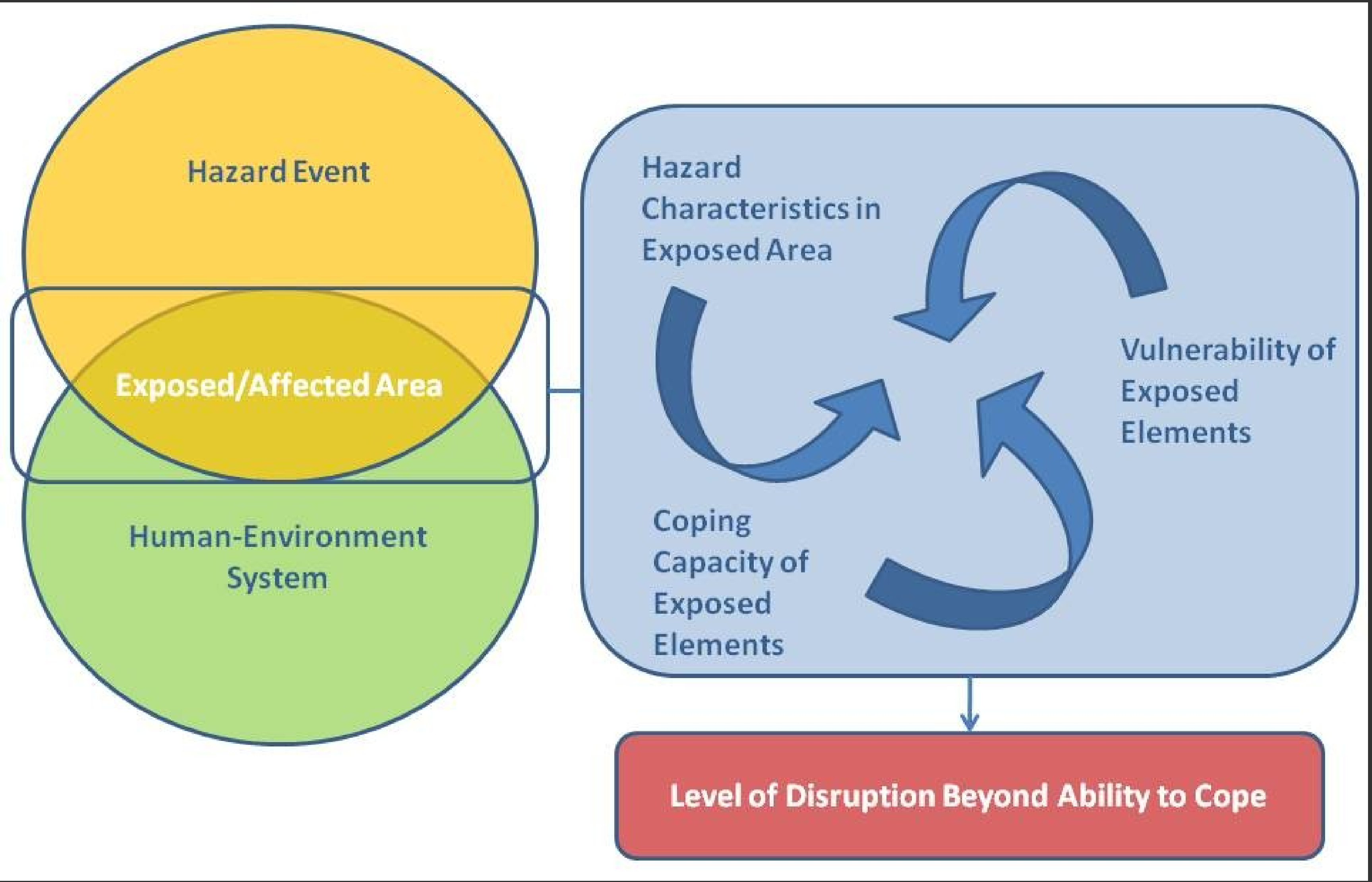
» "A serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceed the ability of the affected community or society to cope using its own resources."

- (UNISDR, 2009)

Hurricane Katrina New Orleans, LA

Sichuan Earthquake, China

Components of Disaster

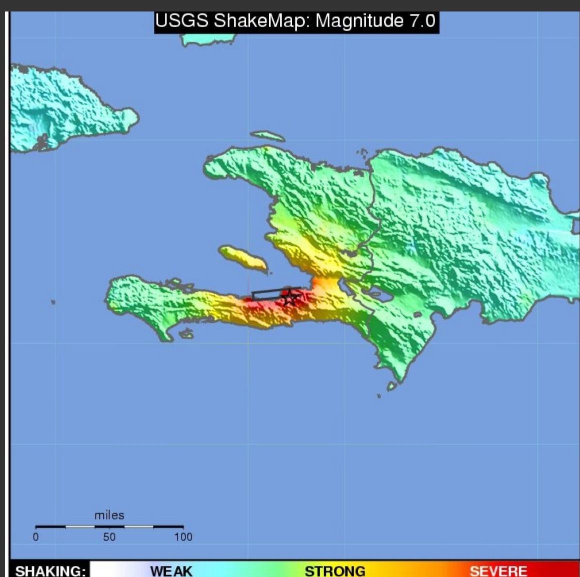


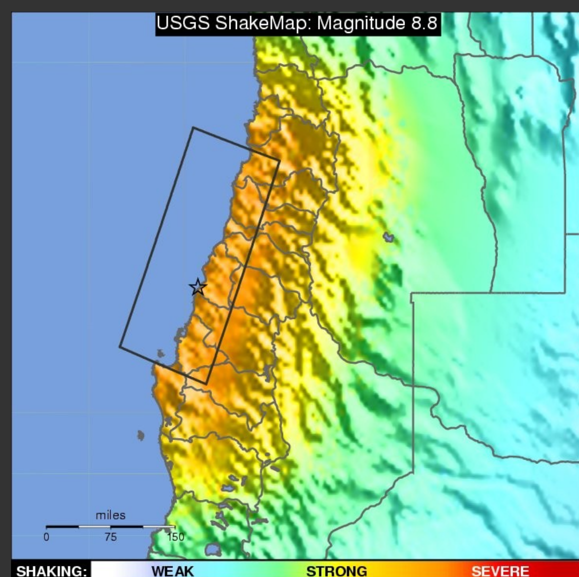
Hazard - Earthquake

HAITI	CHILE
7 Magnitude	8.8 Magnitude
8 Miles Deep	21 Miles
Port-au-Prince	Relatively Unpopulated Area
Strike-slip Fault	Subduction Zone

HAZARD
Natural Systems

EXPOSURE

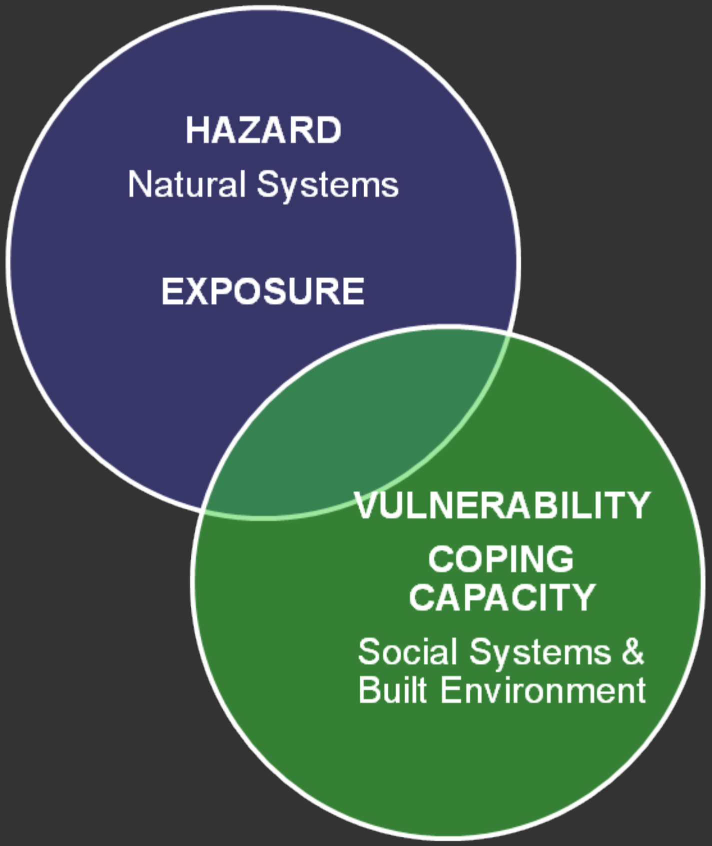




Social Systems & Built Environment

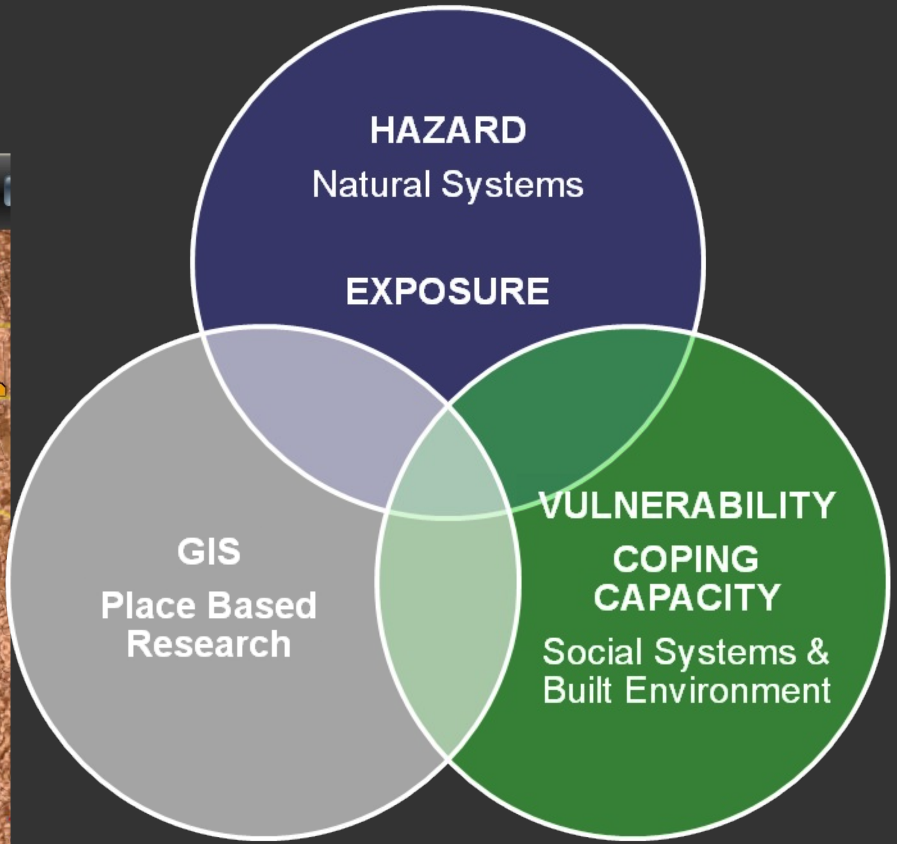
HAITI	CHILE
7 Magnitude	8.8 Magnitude
8 Miles Deep	21 Miles
Port-au-Prince	Relatively Unpopulated Area
Strike-slip Fault	Subduction Zone

HAITI	CHILE
Poor Governance	Good Governance
No Enforced Building Codes	Enforced Building Codes
No Recent Experience	Historical Experience
Poverty	Wealth



GIS – Place Based Research

» Integration



Component of Disaster: Hazard

» "A dangerous phenomenon, substance, human activity or condition that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage."

- (UNISDR, 2009)

Hurricane Katrina

Discussion

Component of Disaster: Exposure

- "People, property, systems, or other elements present in hazard zones that are thereby subject to potential losses."
  - (UNISDR, 2009)

Wildfire in San Diego County, CA

Discussion

Component of Disaster: Vulnerability

- "The characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard."
  - (UNISDR, 2009)

Shanty Town in Haiti

Discussion

Component of Disaster: Coping Capacity

» "The ability of people, organizations and systems, using available skills and resources, to face and manage adverse conditions, emergencies or disasters."

- (UNISDR, 2009)

International Forum on Tornade Disaster Risk Reduction for Bangladesh

"Promotion of Disaster Education in Schools" Project in Indonesia

Discussion

Learning Check

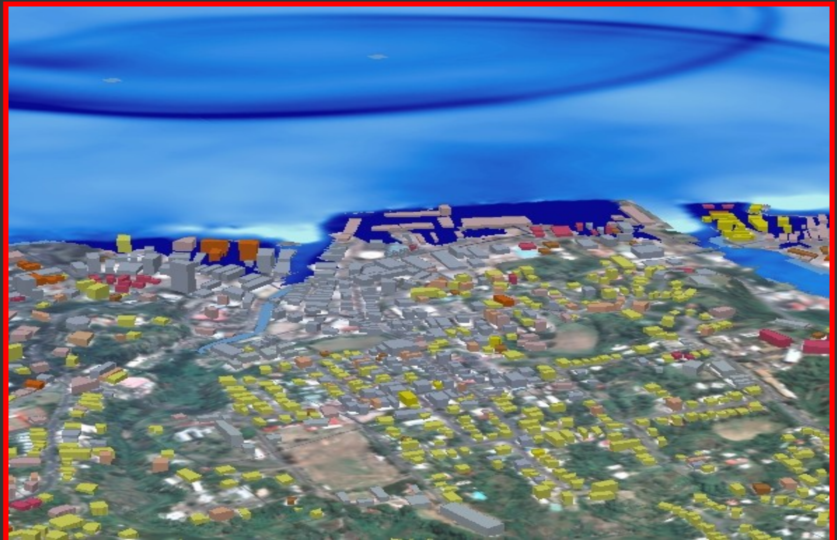
Any Questions?

Disaster Risk

» "The potential disaster losses, in lives, health status, livelihoods, assets and services, which could occur to a particular community or a society over some specified future time period."

- *(UNISDR, 2009)*

The tsunami flooding completely destroyed apartment buildings. Indonesia; USAID



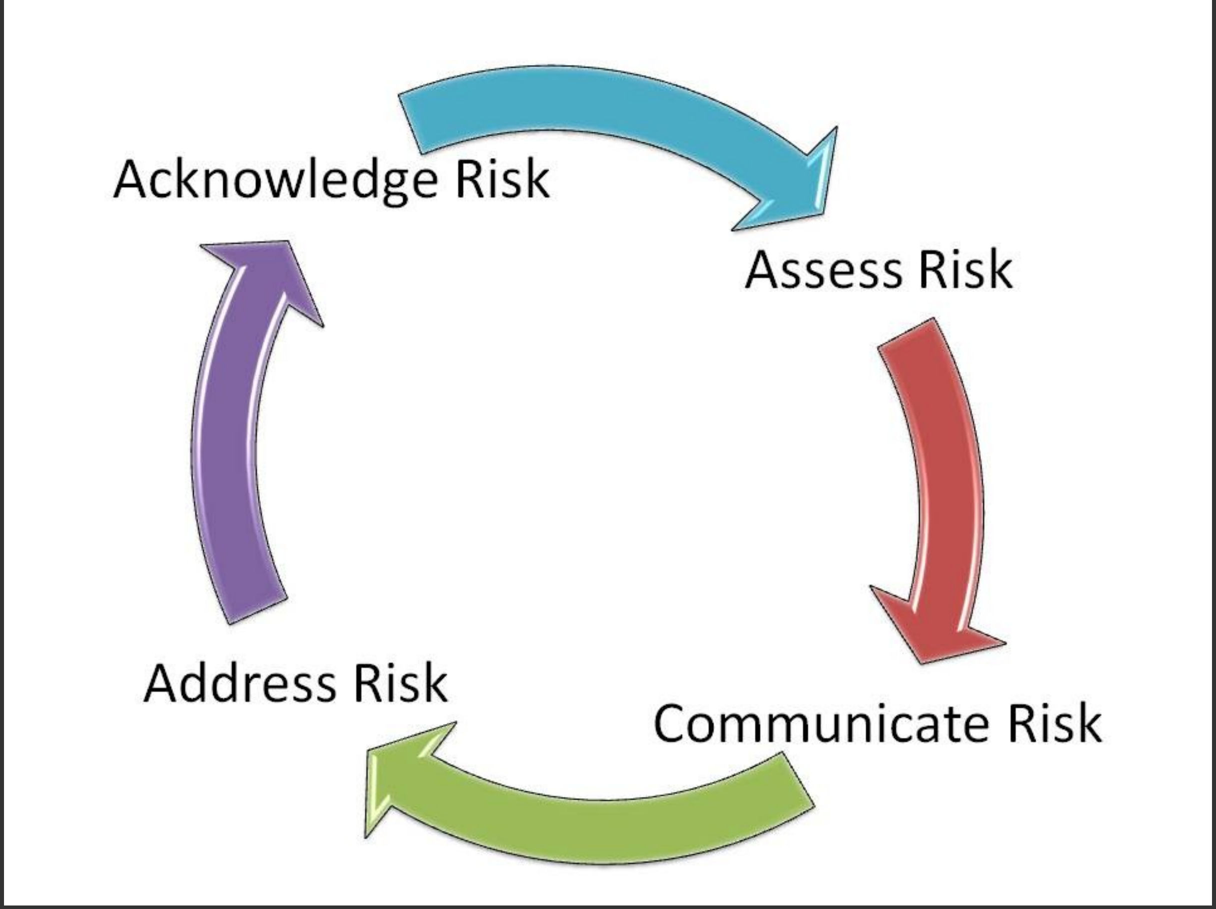
Model of 1953 Tsunami Event

Disaster Risk Reduction (DRR)

- “The concept and practice of reducing disaster risks through systematic efforts to analyze and manage the causal factors of disasters, including through reduced exposure to hazards, lessened vulnerability of people and property, wise management of land and the environment, and improved preparedness for adverse events.”
    - *(UNISDR, 2009)*

A Basic Approach to DRR

» Disaster Risk Reduction (DRR) Process



PDC's Risk Reduction Framework

Acknowledge Risk

Build High-Level Advocacy
- Promote and guide process
- Goals and objectives

Assess Current Organizational Capacity
- Technical
- Institutional
- Financial
- Legal Framework

1. Goals and objectives
2. Gap analysis

Assess Risk

Identify Hazards

Profile Hazards
- Data Collection
- Hazard Mapping

Analyze/Evaluate Risk
- Social
- Economic
- Environmental
- Critical Facilities

1. Catalog of hazard occurrences
2. Hazard maps
3. Vulnerability maps
4. Loss assessment

Communicate Risk

- Education
- Stakeholder workshops
- Informational meetings
- Training sessions
- Tools and guidelines

1. Reports
2. Maps
3. Internet Map Viewers
4. Model visualizations
5. Knowledge bases
6. Public awareness programs

Address Risk

Organize Planning Resources

Identify, Evaluate and Prioritize Risk Reduction Activities

Apply Risk Reduction Options
- Physical
- Informational
- Strategic
- Adaptive

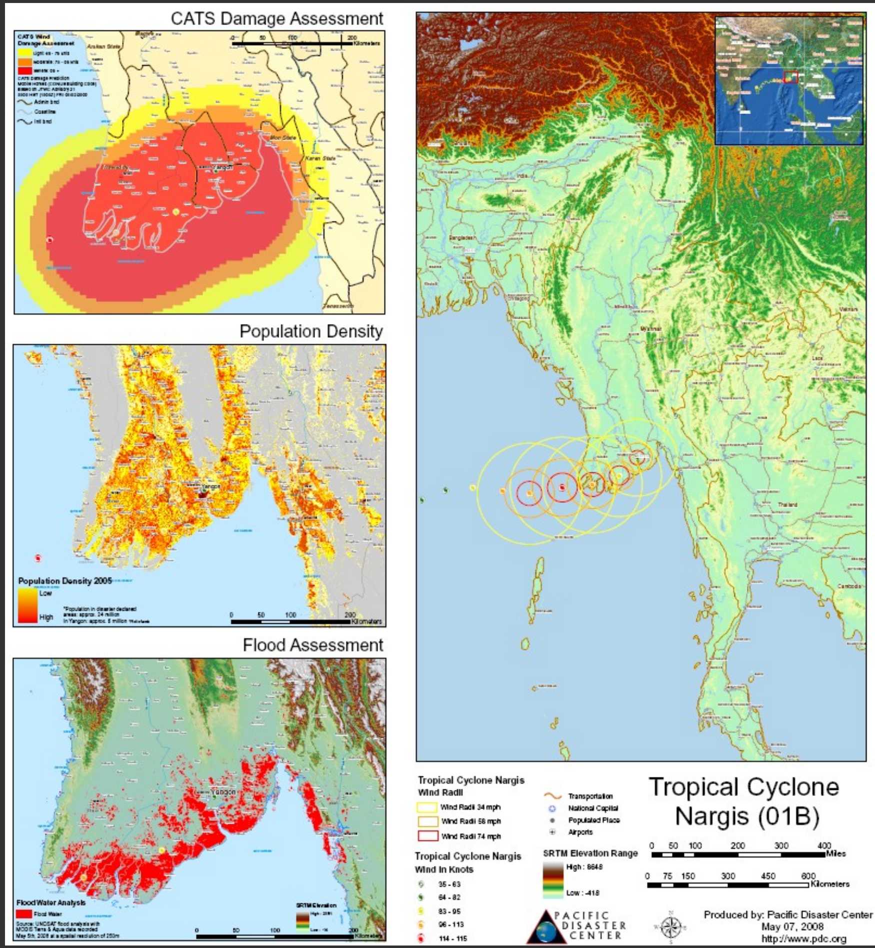
Manage residual risk

A safer more resilient community

Risk Assessment

» “A methodology to determine the nature and extent of risk by analyzing potential hazards and evaluating existing conditions of vulnerability that together could potentially harm exposed people, property, services, livelihoods and the environment on which they depend.”

- (UNISDR, 2009)



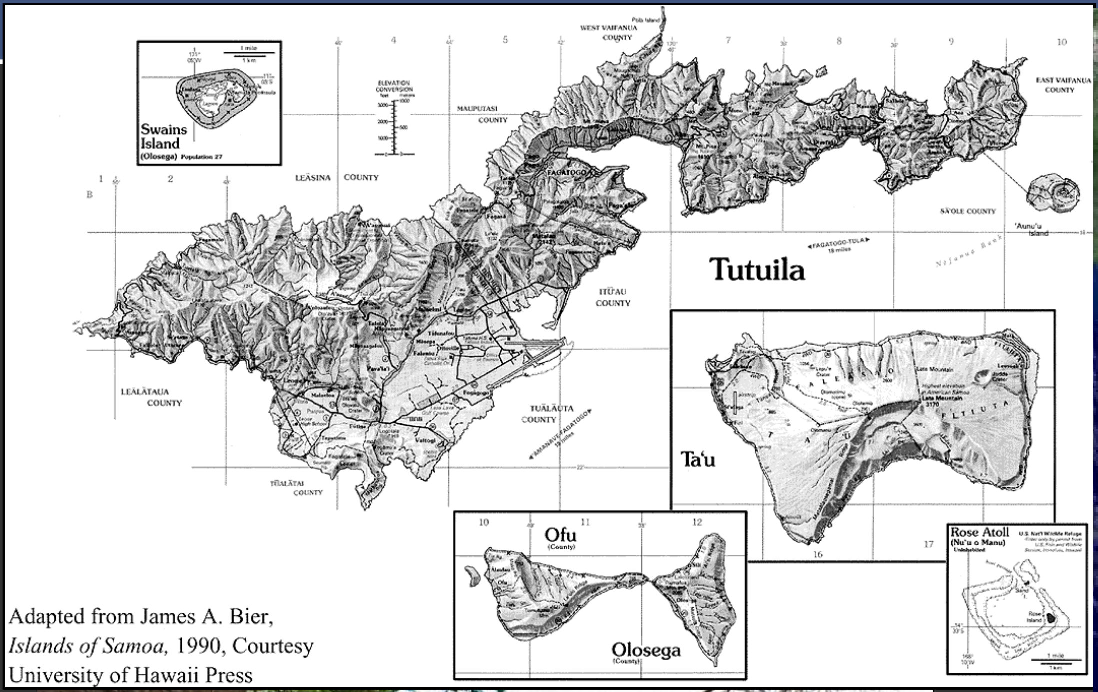
Benefits of Risk Assessments

- Supports other DRR requirements
- Help disaster managers, decision makers and the public understand the patterns of risk and its consequences
- Identify gaps and “hotspots”
- Help make disaster management activities more effective
- Enable prioritization of resources
- Supply both the content and form of communication
- Allow decision makers to set meaningful goals
- Makes the idea of risk more tangible

EXAMPLE

American Samoa

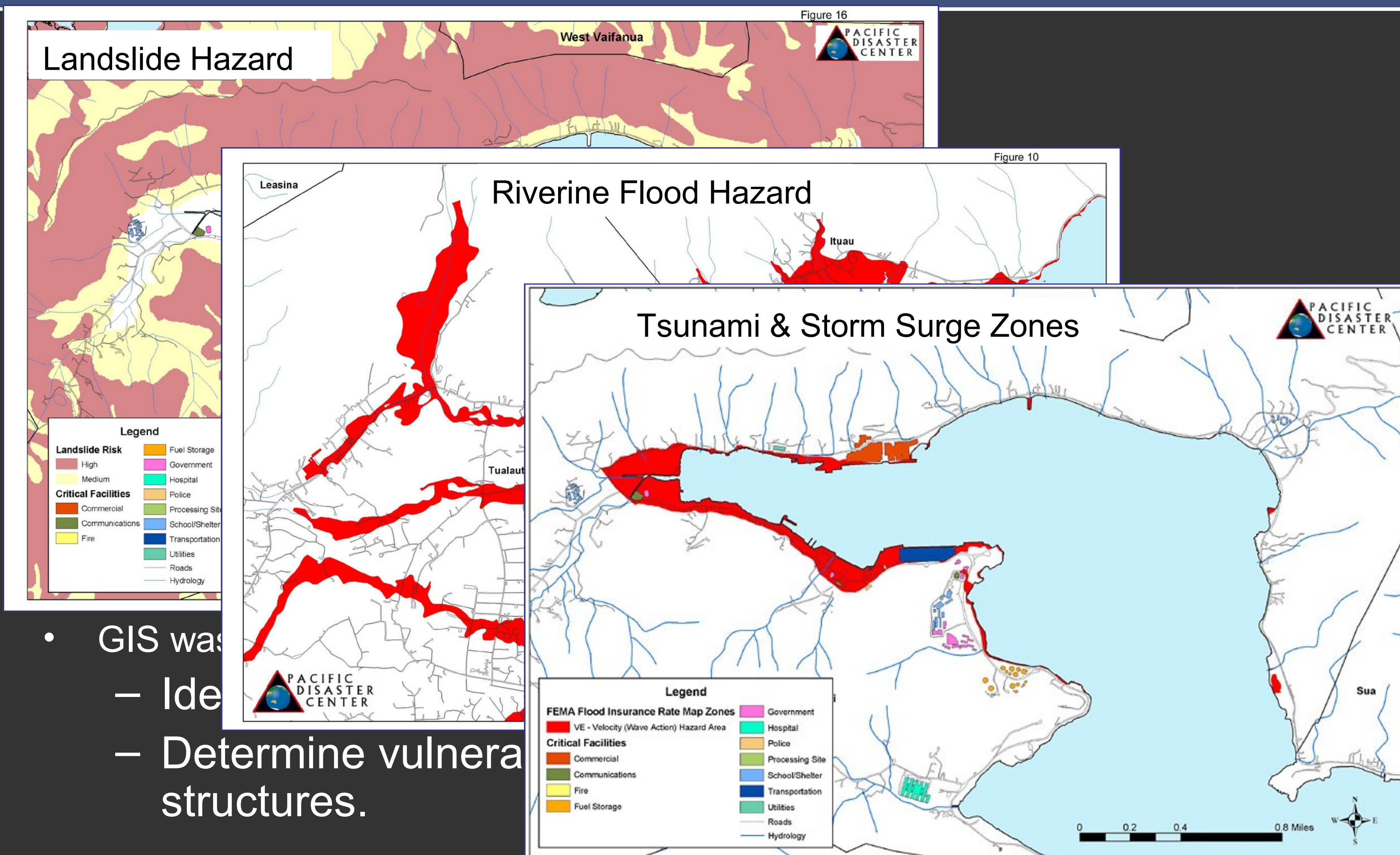
Identify Goals, Study Area, Scale



Adapted from James A. Bier, *Islands of Samoa,* 1990, Courtesy University of Hawaii Press

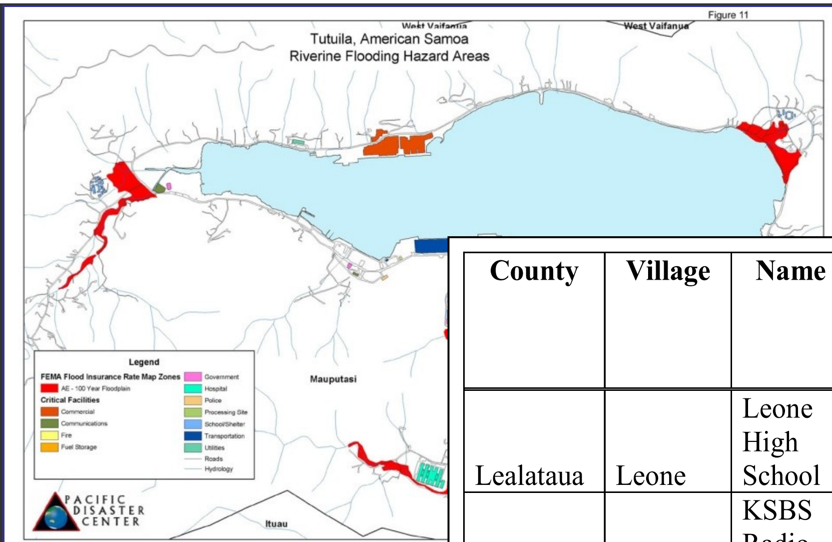
- American Samoa
  - National scale
  - FEMA methodology
  - Focus on critical facilities
  - Data collection and visualization

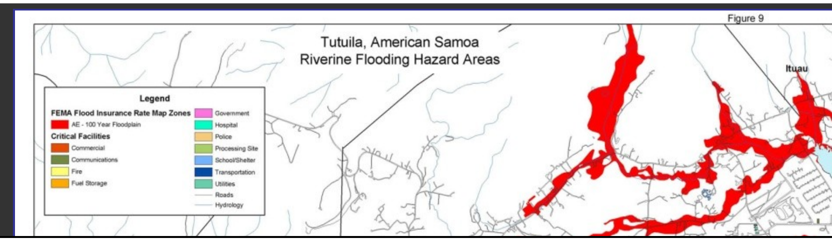
Hazard Visualization
Critical Facilities and Infrastructure

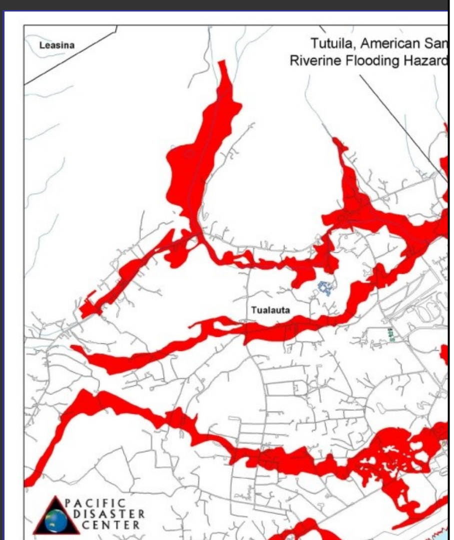


- GIS was
  - Ide
  - Determine vulnera structures.

Loss Estimation for Critical Facilities Tutuila, American Samoa







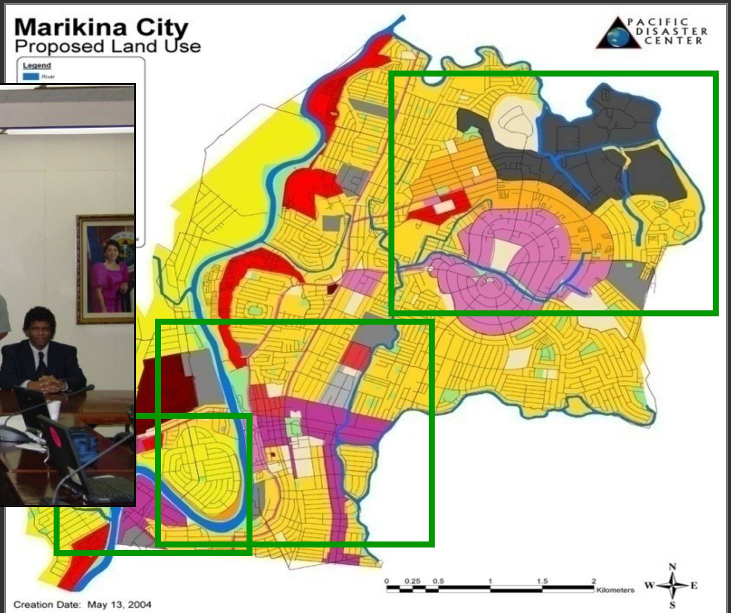
County	Village	Name	Function	Number of Employees	Estimated Replacement Cost ($)	Critical Facilities Ownership	Approx. Value Contents ($)	1st-Floor Flood Elevation (feet)
Lealataua	Leone	Leone High School	School/Shelter		$1,960,000	Gov’t.	$1,960,000	53
Maoputasi	Fagaalu	KSBS Radio Station	Communications	10	$384,000	Private	$384,000	15
Maoputasi	Fagaalu	LBJ Tropical Medical	Hospital	500	$18,836,193	Gov’t.	$28,254,289	17
Maoputasi	Fagatogo	ASG Gov't Bldgs.	Government		$14,000,000	Gov’t.	$14,000,000	12.5
Maoputasi	Fagatogo	DPS Central Station	Police	230	$770,414	Gov’t.	$1,155,621	8
Maoputasi	Fagatogo	DPS Fire Division	Fire	25	$150,000	Gov’t.	$225,000	6
Tualauta	Tafuna	PPG Intl. Airport	Transportation	77	$69,080,080	Gov’t.	$69,080,080	15.5

EXAMPLE

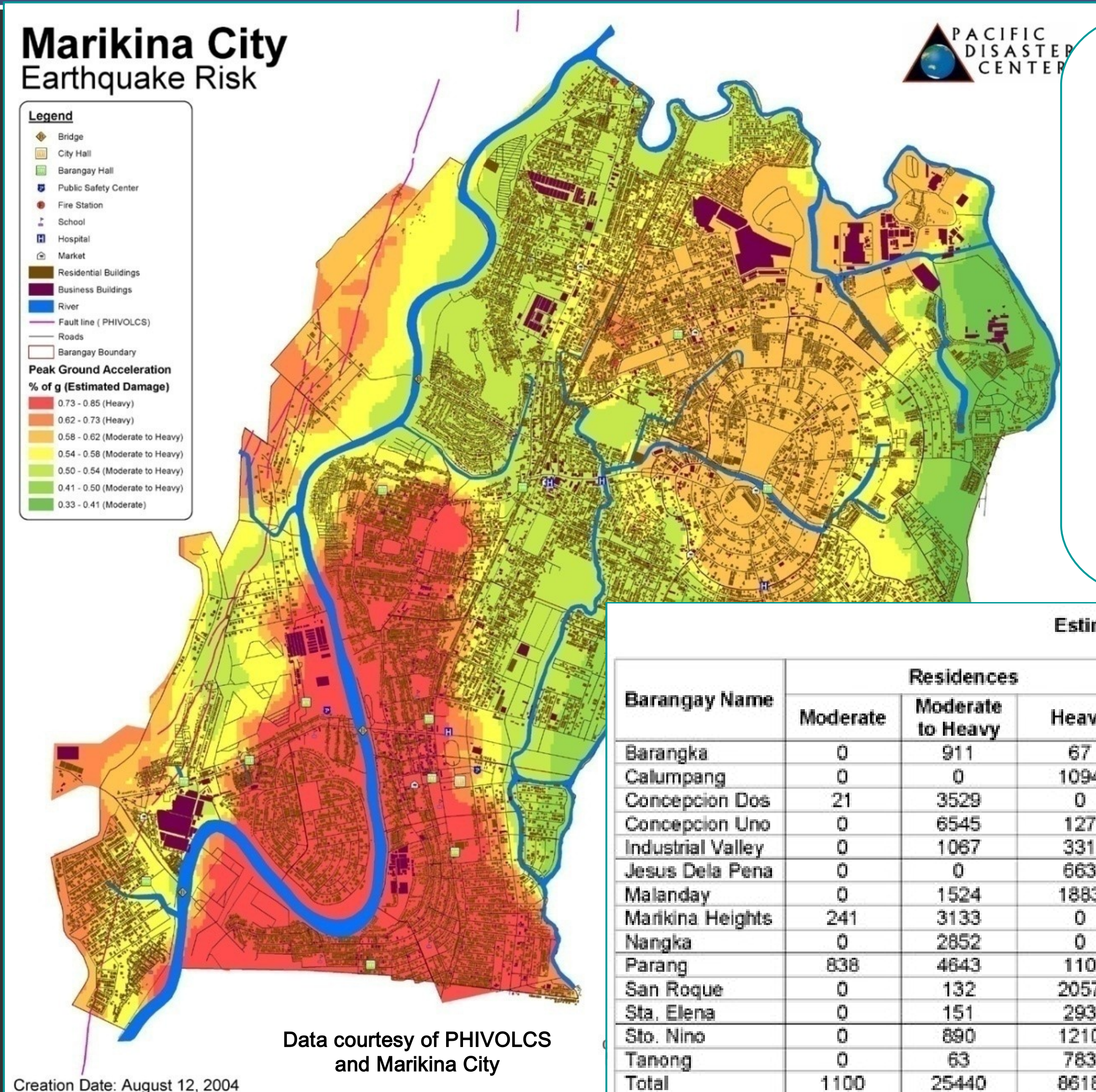
Marikina City, Philippines

Identify Goals, Study Area, Scale

- Marikina City, Philippines
  - Municipal scale
  - Land-use planning, long-range development
  - Mitigation success
  - Risk communication



Earthquake Vulnerability Map



Legend

- Bridge
- City Hall
- Barangay Hall
- Public Safety Center
- Fire Station
- School
- Hospital
- Market
- Residential Buildings
- Business Buildings
- River
- Fault line (PHIVOLCS)
- Roads
- Barangay Boundary

Peak Ground Acceleration

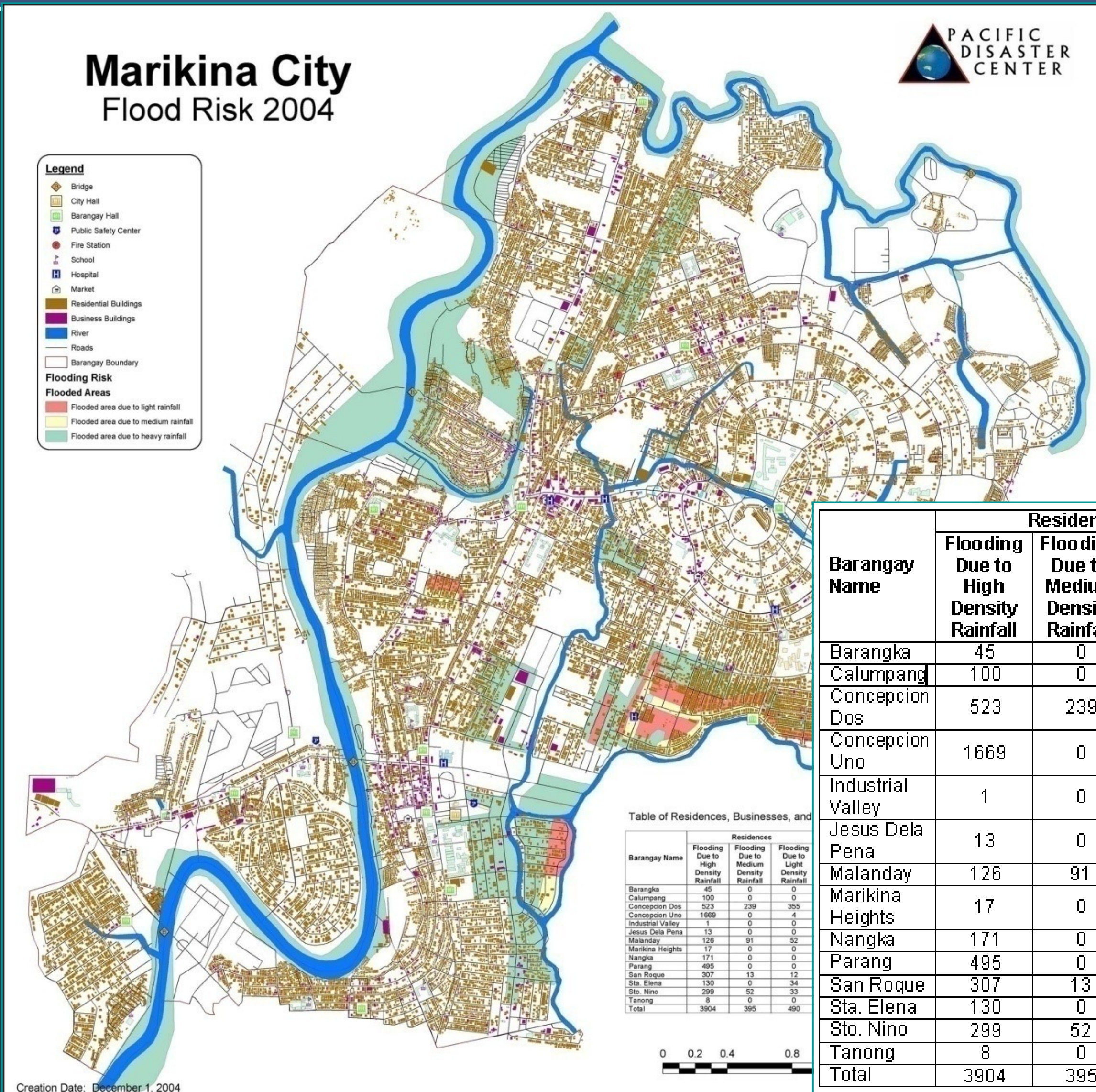
% of g (Estimated Damage)

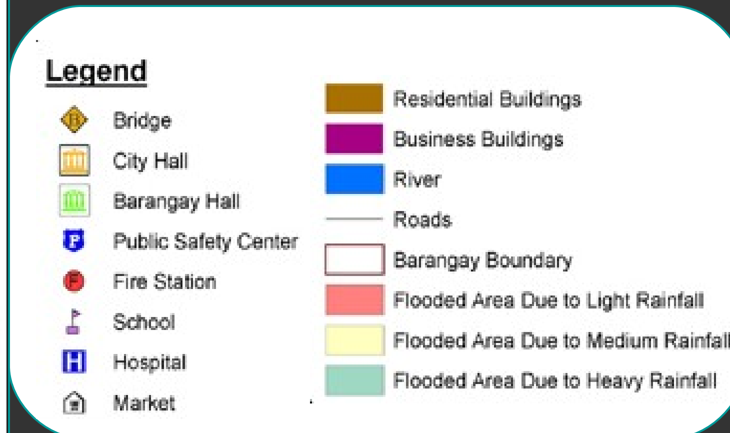
- 0.73 - 0.85 (Heavy)
- 0.62 - 0.73 (Heavy)
- 0.58 - 0.62 (Moderate to Heavy)
- 0.54 - 0.58 (Moderate to Heavy)
- 0.50 - 0.54 (Moderate to Heavy)
- 0.41 - 0.50 (Moderate to Heavy)
- 0.33 - 0.41 (Moderate)

Estimation of Damage to Buildings

Barangay Name	Residences			Businesses			Critical Facilities		
	Moderate	Moderate to Heavy	Heavy	Moderate	Moderate to Heavy	Heavy	Moderate	Moderate to Heavy	Heavy
Barangka	0	911	67	0	118	45	0	3	0
Calumpang	0	0	1094	0	0	85	0	0	2
Concepcion Dos	21	3529	0	1	109	0	0	3	0
Concepcion Uno	0	6545	127	0	626	15	0	12	0
Industrial Valley	0	1067	331	0	8	1	0	2	1
Jesus Dela Pena	0	0	663	0	0	16	0	0	2
Malanday	0	1524	1883	0	40	99	0	1	0
Marikina Heights	241	3133	0	13	177	0	0	6	0
Nangka	0	2852	0	0	150	0	0	5	0
Parang	838	4643	110	24	356	5	0	7	0
San Roque	0	132	2057	0	9	156	0	0	2
Sta. Elena	0	151	293	0	5	153	0	1	4
Sto. Nino	0	890	1210	0	74	145	0	1	3
Tanong	0	63	783	0	8	73	0	1	3
Total	1100	25440	8618	38	1680	793	0	42	17

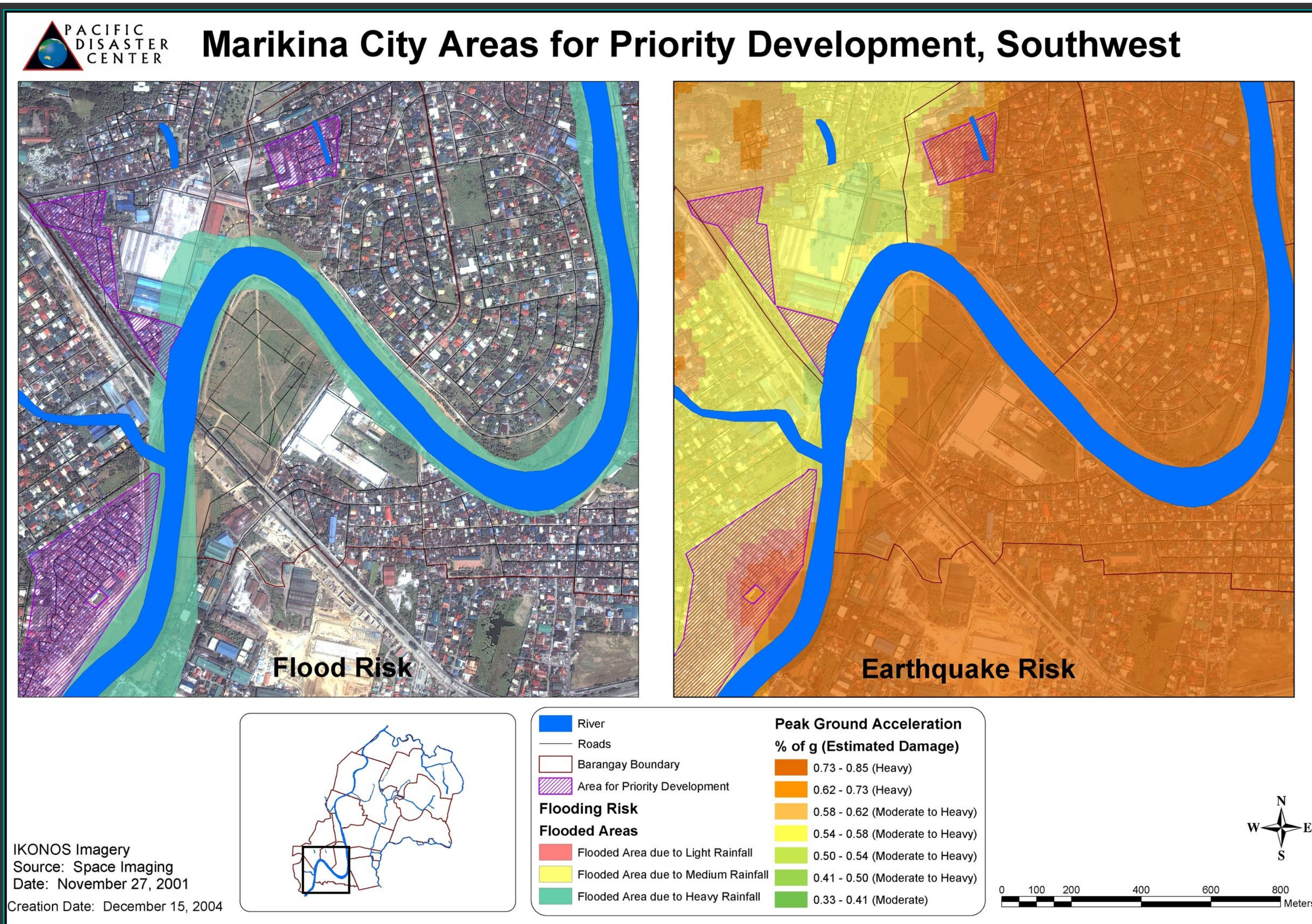
Riverine Flood Vulnerability Map



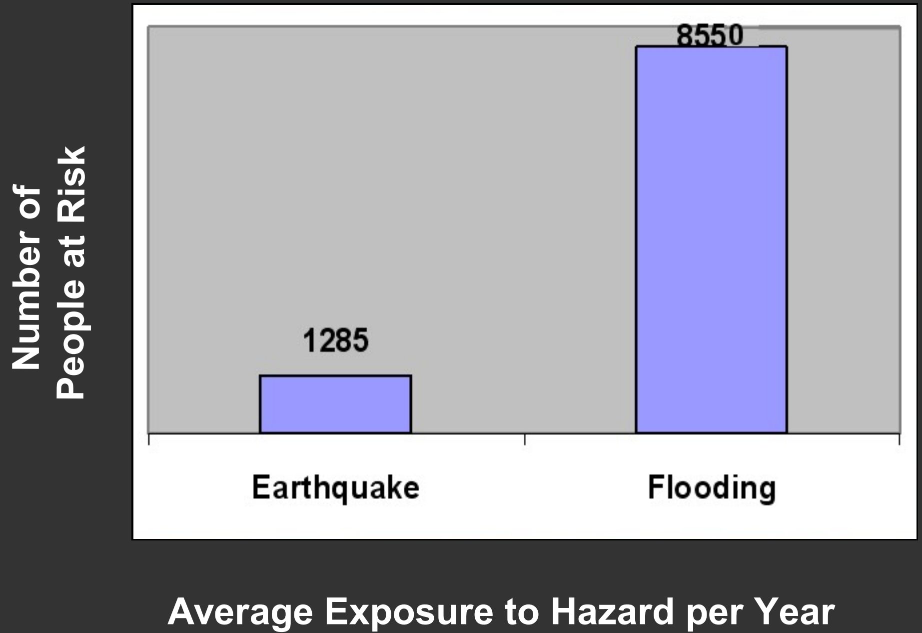


Barangay Name	Residences			Businesses			Critical Facilities		
	Flooding Due to High Density Rainfall	Flooding Due to Medium Density Rainfall	Flooding Due to Light Density Rainfall	Flooding Due to High Density Rainfall	Flooding Due to Medium Density Rainfall	Flooding Due to Light Density Rainfall	Flooding Due to High Density Rainfall	Flooding Due to Medium Density Rainfall	Flooding Due to Light Density Rainfall
Barangka	45	0	0	16	0	0	0	0	0
Calumpang	100	0	0	2	0	0	0	0	0
Concepcion Dos	523	239	355	22	2	5	0	1	0
Concepcion Uno	1669	0	4	132	0	0	3	0	0
Industrial Valley	1	0	0	0	0	0	1	0	0
Jesus Dela Pena	13	0	0	0	0	0	1	0	0
Malanday	126	91	52	4	3	3	0	0	0
Marikina Heights	17	0	0	1	0	0	0	0	0
Nangka	171	0	0	3	0	0	2	0	0
Parang	495	0	0	15	0	0	1	0	0
San Roque	307	13	12	41	0	0	0	0	0
Sta. Elena	130	0	34	11	0	0	1	0	0
Sto. Nino	299	52	33	21	3	0	0	1	0
Tanong	8	0	0	5	0	0	0	0	0
Total	3904	395	490	273	8	8	9	2	0

Vulnerability Maps
Area of Priority Development



Population at Risk from Earthquakes and Flooding

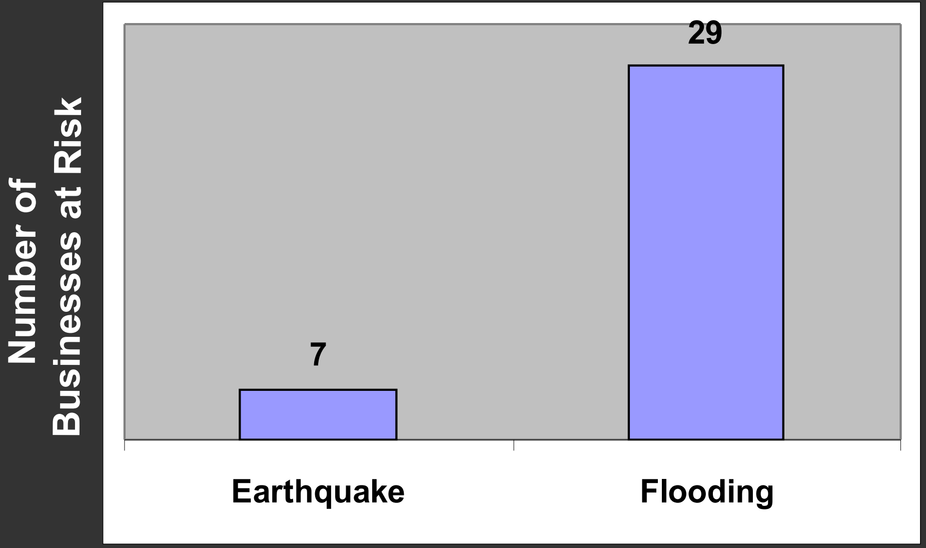


Basic Assumptions:

- The return period for a significant earthquake is 350 years, affecting 450,000 people.
- The return period for significant flooding is 10 years, affecting 19% or 85,550 people.

Businesses at Risk from Earthquakes and Flooding

Structure	Total	Curve	PGA g	GESI
RC Infill	1	C	0.59	Extensive



Average Exposure to Hazard per Year

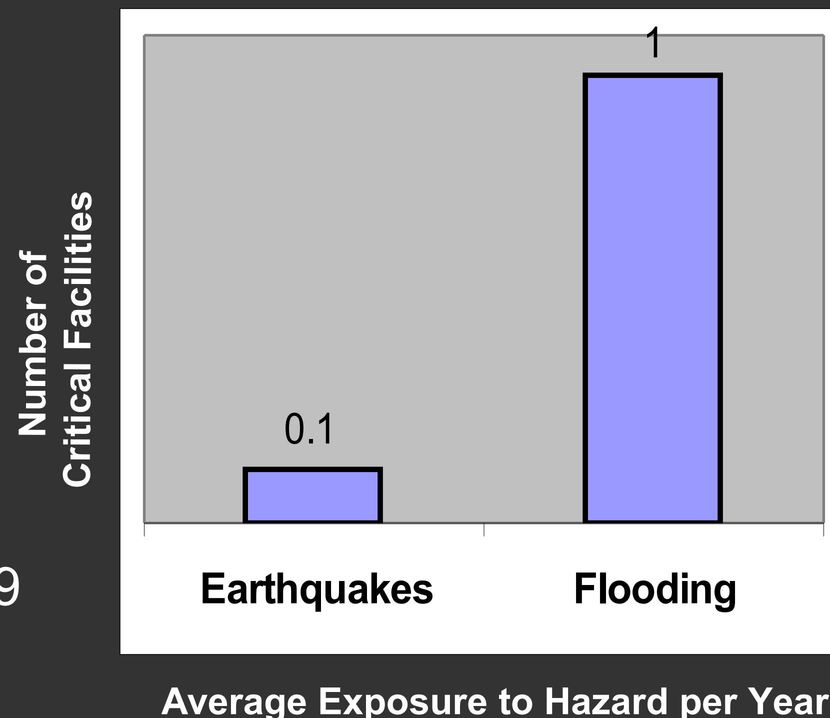
<u>Basic Assumptions:</u>

- The return period for a significant earthquake is 350 years, impacting 2,511 businesses.
- The return period for significant flooding is 10 years, impacting 289 businesses.

Critical Facilities at Risk from Earthquakes and Flooding

City Hall

Structure	Total	Curve	PGA g	GESI
RC Infill	0	C	0.70	Extensive



Basic Assumptions:

- The return period for a significant earthquake is 350 years, impacting 59 critical facilities.
- The return period for significant flooding is 10 years, impacting 11 critical facilities.

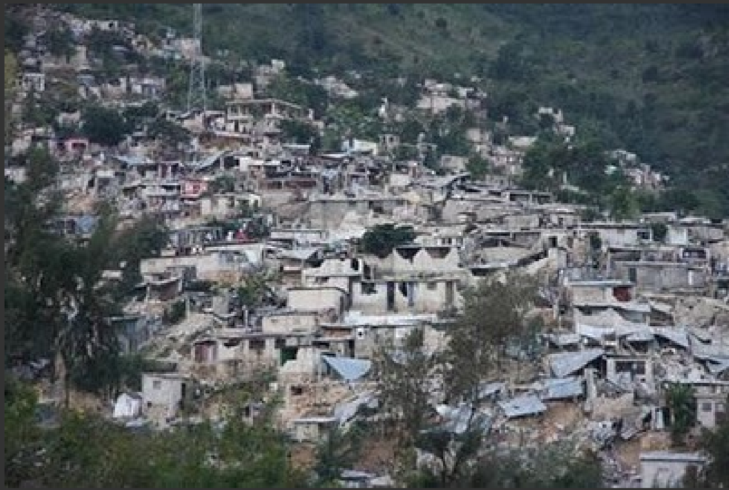
Learning Check

Any Questions?

Component of Disaster: Vulnerability

- The characteristics and circumstances of a community, system or asset that influence their ability to anticipate, cope with, resist and recover from the impact of a natural hazard.

» The 4 pillars of vulnerability and sustainable development:
  - Physical Factors
  - Environmental Factors
  - Socio-Cultural Factors
  - Economic Factors



Shanty Town in Haiti

Physical Factors of Vulnerability

- Structural Aspects of Objects
  - Materials
  - Design
- Hazardous Location
- Exposure
  - Voluntary or Involuntary
  - Known or Unknown

Environmental Factors of Vulnerability

- National Resource Depletion and Degradation
- Pollution
- Exposure to Toxic and Hazardous Materials
- Reduced Access to Clean Air and Safe Water
- Inappropriate Sanitation and Waste Management
- Diminished Biodiversity, Soil Degradation or Growing Water Scarcity
- Food Security (Dependence on Agricultural Products)

Socio-Cultural Factors of Vulnerability

» Access to Food and Water
- Basic Human Right
- Malnutrition
- Decreases Productivity
- Increase Susceptibility to Injury and Disease

Collecting water from a newly improved well in Ethiopia. Source: USAID

Malnutrition in Ethiopia. Source: USAID

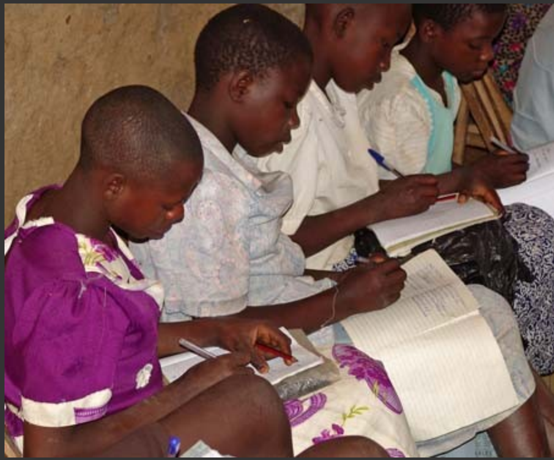
Socio-Cultural Factors of Vulnerability

- Access to Food and Water
- Health Status and Access to Health Care
  - Predisposition to Infection
  - Exaggerated Exposure to Communicable Diseases
  - Lack of Defensive Mechanisms
  - Dependent Populations
  - Mobility

Patients in a newly rehabilitated hospital in Sierra Leone.
Source: USAID

Socio-Cultural Factors of Vulnerability

- Access to Food and Water
- Health Status and Access to Health Care
- Levels of Literacy and Education
  - Ability to Access and Use Information
  - Influence on Skill Set and Opportunities
  - Understand Disaster Risk
  - Understand Warning and Evacuation Messages
  - Reduce and Distribute Impacts



Students in a nonformal school in Uganda. Source: USAID

Socio-Cultural Factors of Vulnerability

- Access to Food and Water
- Health Status and Access to Health Care
- Levels of Literacy and Education
- Social Equity and Marginalization
  - Decreased Access to Information
  - Poverty
  - Lack of Political Resources
  - Class, Ethnicity, Race, Gender
  - More Likely to Suffer Impacts
  - Less Likely to Access Coping Resources

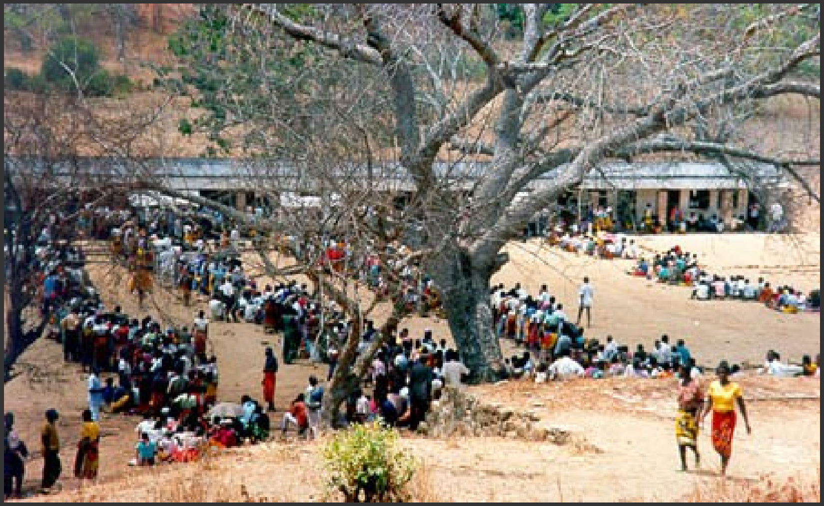
Informal settlements near Cape Town in South Africa. Source: USAID

Socio-Cultural Factors of Vulnerability

- Access to Food and Water
- Health Status and Access to Health Care
- Levels of Literacy and Education
- Social Equity and Marginalization
- Age
  - Children
  - Elderly
  - Dependent Populations
  - Mobility

Socio-Cultural Factors of Vulnerability

- Access to Food and Water
- Health Status and Access to Health Care
- Levels of Literacy and Education
- Social Equity and Marginalization
- Age
- Governance
  - Corruption
  - Access
  - Policy
  - Enforcement
  - Security, Stability



People waiting to vote in Mozambique. Source: USAID

Distribution of Resources

Socio-Cultural Factors of Vulnerability

- Access to Food and Water
- Health Status and Access to Health Care
- Levels of Literacy and Education
- Social Equity and Marginalization
- Age
- Governance
- Cultural Aspects
  - Belief Systems
  - Language Diversity
  - Relationship with Decision Makers

Discussion

Discussion

How are socio-cultural vulnerabilities manifest in the emergency management cycle?

Group Activity

Community Vulnerability: What do You See?


02.02.2007

AP

http://www.wired.com/autopia/2008/07/will-scooters-m/

Economic Factors of Vulnerability

- Economic Status
  - Individual; Community; Nation
- Poverty
  - Inadequate Access to Critical and Basic Socio-economic Infrastructure
    - Communication Networks
    - Utilities and Supplies
    - Transportation
    - Water
    - Health Care Facilities
- Debt
- Dependence

Coping Capacity

- Good Governance
- Financial Reserves
- Insurance
- Transportation Network
- Communication Network
- Effective Health Services
- Education
- Emergency Management Planning

Discussion

Update Vulnerability Components for Your City

Discussion

Select Disaster Components for Each City

Discussion

What risk reduction methods could be utilized to reduce disaster risk?

Does your city have any risk reduction plans in place currently?

Disaster Risk Reduction (DRR)

» Reducing Disaster Risks Through Systematic Efforts to Analyze and Manage the Causal Factors of Disasters

- Modify the Hazard
- Reduce Exposure
- Lessen Vulnerability of People and Property
- Increase Coping Capacity
- Land Use Management
- Improve Preparedness

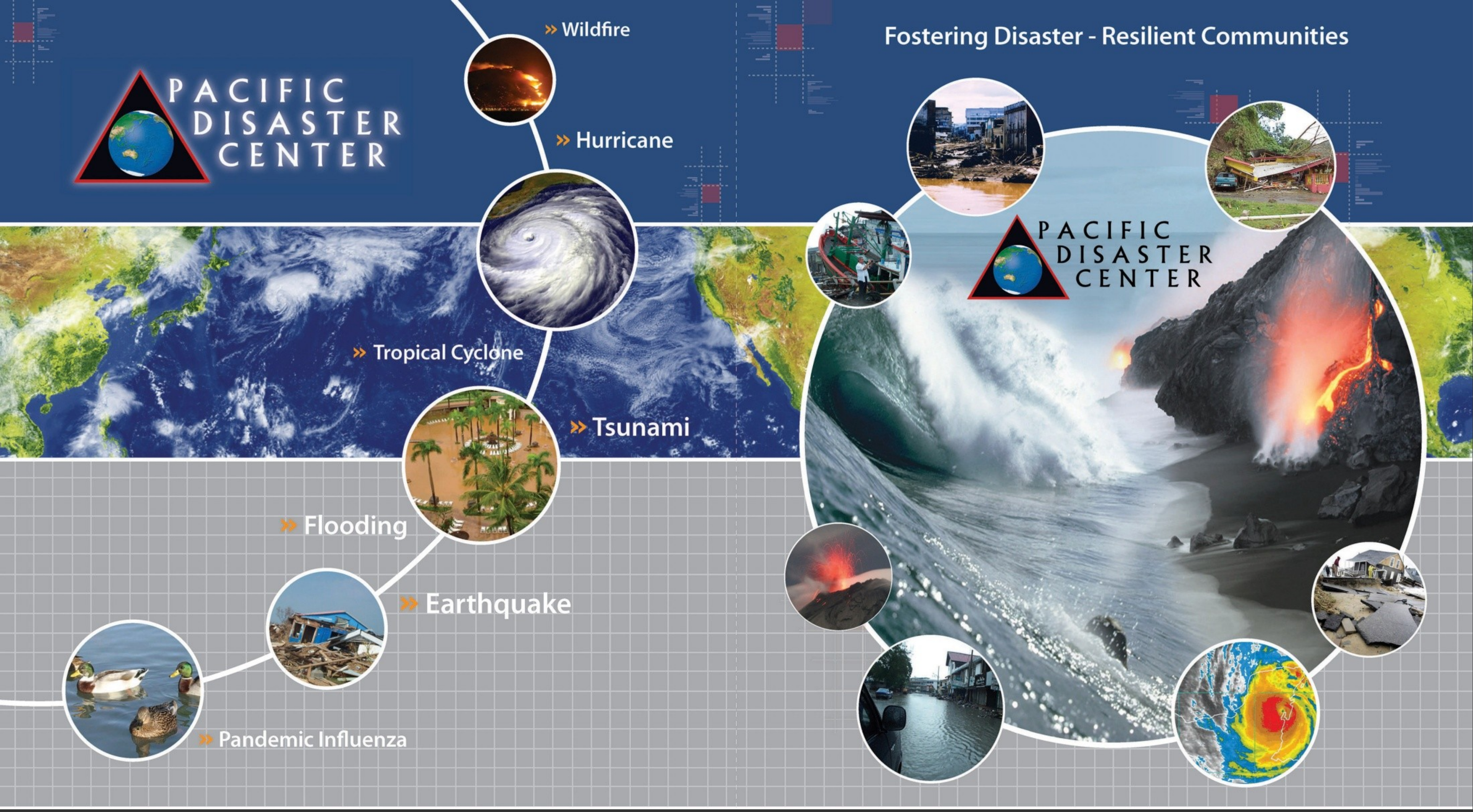
Discussion

Can you identify these vulnerable communities within your city?

Does spatial data exist for this vulnerability characteristic?

Overview for Thursday

» Day Two
- GIS and Demographic Data
- Quantification of Social Vulnerability
- National Risk Assessment
  - AFRICOM
- SoVI Methodology
  - US County
  - New Orleans, LA
  - National Capital Region
- Next Steps



Thank You

Christina Finch and Stanley Goosby
cfinch@pdc.org sgoobsy@pdc.org

Hanoi

Agnieszka Soska - http://www.singtime.de/40/trip-vietnam-hanoi-halong-bay

Hai Phong

World Press - http://nusvietnam.wordpress.com/chapters/

New York

Mike Crawford - http://amazingnewyorkcity.blogspot.com/

New York

Flickr - http://www.flickr.com/photos/click-see/25803645/

Hong Kong

Red di - http://www.reddi.net/public_html/Lilys%20Page/HongKong%20pics.htm

Singapore

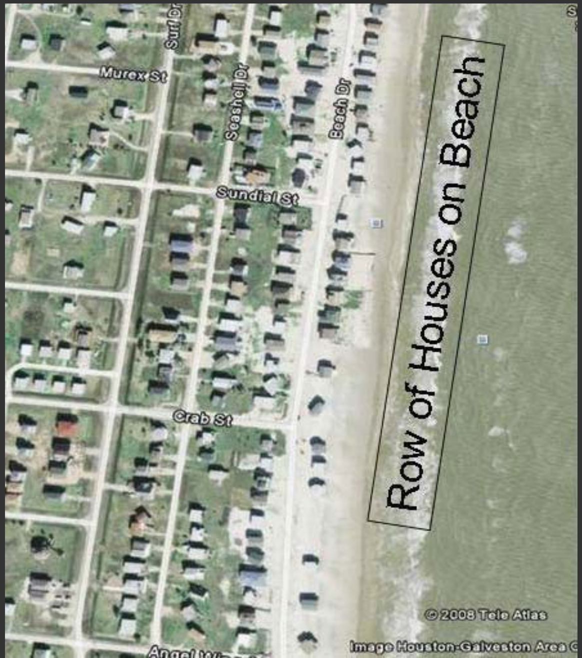
http://www.celsias.com/media/uploads/admin/singapore.jpg

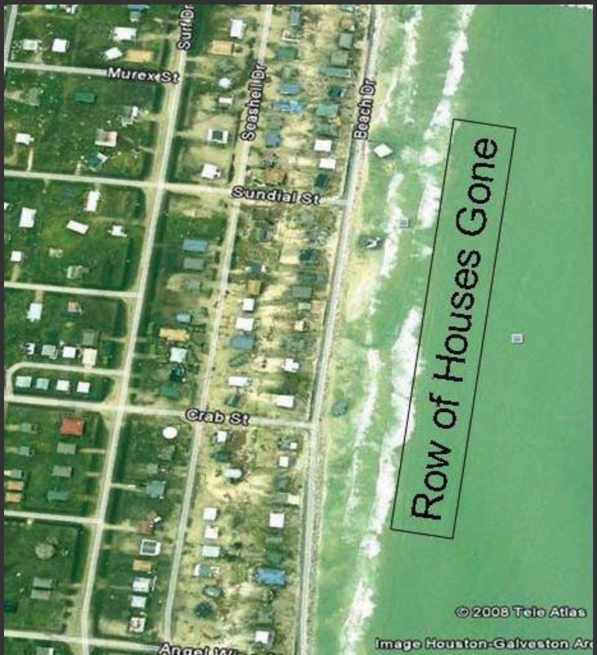
Leptospirosis outbreak and lack of safe drinking water confronts the residents of Malanday Marikina after the devastating Typhoon Onday hit the Philippines. Flash floods from the nearby treeless mountain submerged almost the entire city and left mud everywhere, contaminating the water source.

A housewife cooks in her flooded home in Kamrangirchar, Dhaka, Bangladesh.

Children and their mother play at the Bukit Duri slums in Cililitan District, E. Jakarta, Indonesia, during the peak of the 2008 monsoon season. The houses are constructed of mainly leftover building materials, and have no access to potable water. These semi-permanent houses are awash with flood water from the Ciliwung River that arrives annually for months at a time.

Hurricane Rita (2005)
Surfside Beach, Texas

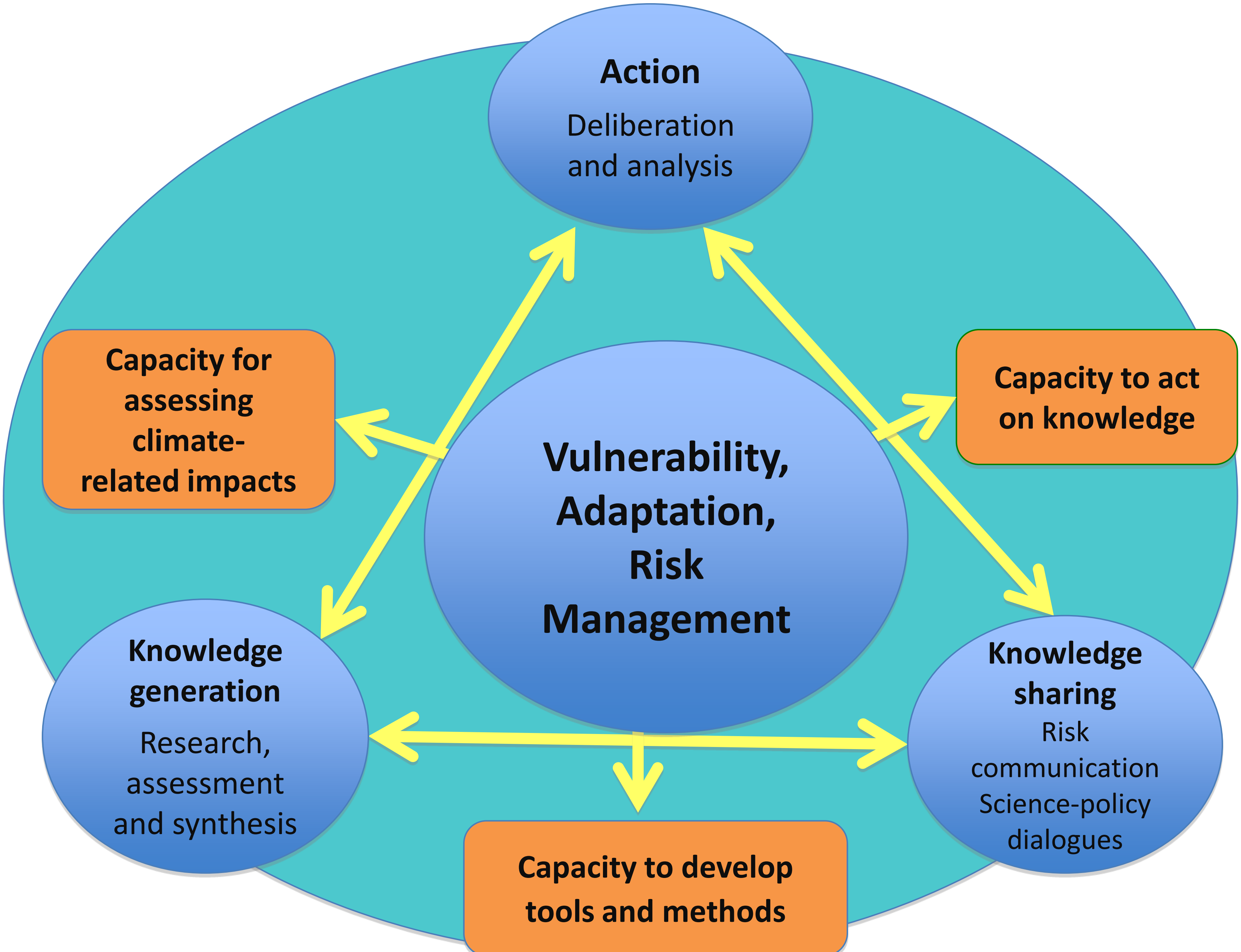




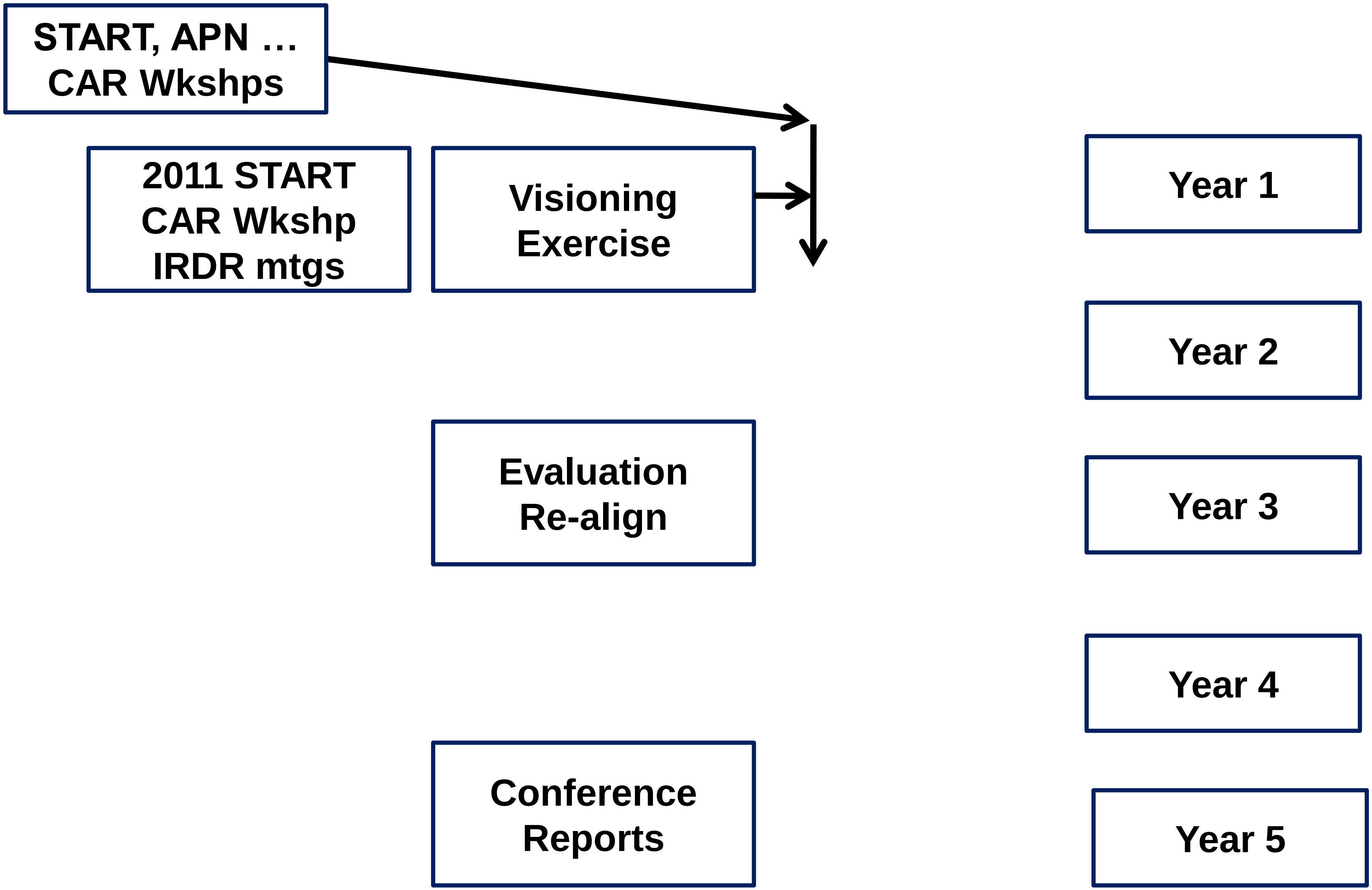
Coastal Cities at Risk (CCaR)

- **Coastal Cities at Risk (CCaR): Building Adaptive Capacity for Managing Climate Change in Coastal Megacities**
  - **PIs: Anond Snidvongs and Gordon McBean**
  - **Proposed for funding to: International Development Research Centre (of Canada) and the Canadian research Tri-Councils (Natural Sciences and Engineering, Social Sciences, Health Research).**
  - **Funding - $2.5M (Cdn) over 5 years**
- **The overall objective - to develop the knowledge base and enhance the capacity of mega-cities to successfully adapt to and when necessary cope with risks posed by the effects of climate change, including sea level rise, in the context of urban growth and development**

- **an interdisciplinary approach involving natural, engineering, socio-political-economic and health scientists**
- **partner with START, Integrated Research on Disaster Risk and other Canadian and international projects.**
- **The outputs:**
  - **new integrated knowledge on climate change adaptation and disaster risk reduction strategies and their socio-economic-health implications,**
  - **integrated, interdisciplinary simulation models to develop, test and validate knowledge-based actions, and**
  - **increased numbers of highly-qualified people, both academic and practitioners, through knowledge mobilization and translation.**
    - **Graduate students**
    - **Workshops, city teams**


Action
Deliberation and analysis
Capacity for assessing climate-related impacts
Capacity to act on knowledge
Vulnerability, Adaptation, Risk Management
Knowledge generation
Research, assessment and synthesis
Knowledge sharing
Risk communication
Science-policy dialogues
Capacity to develop tools and methods

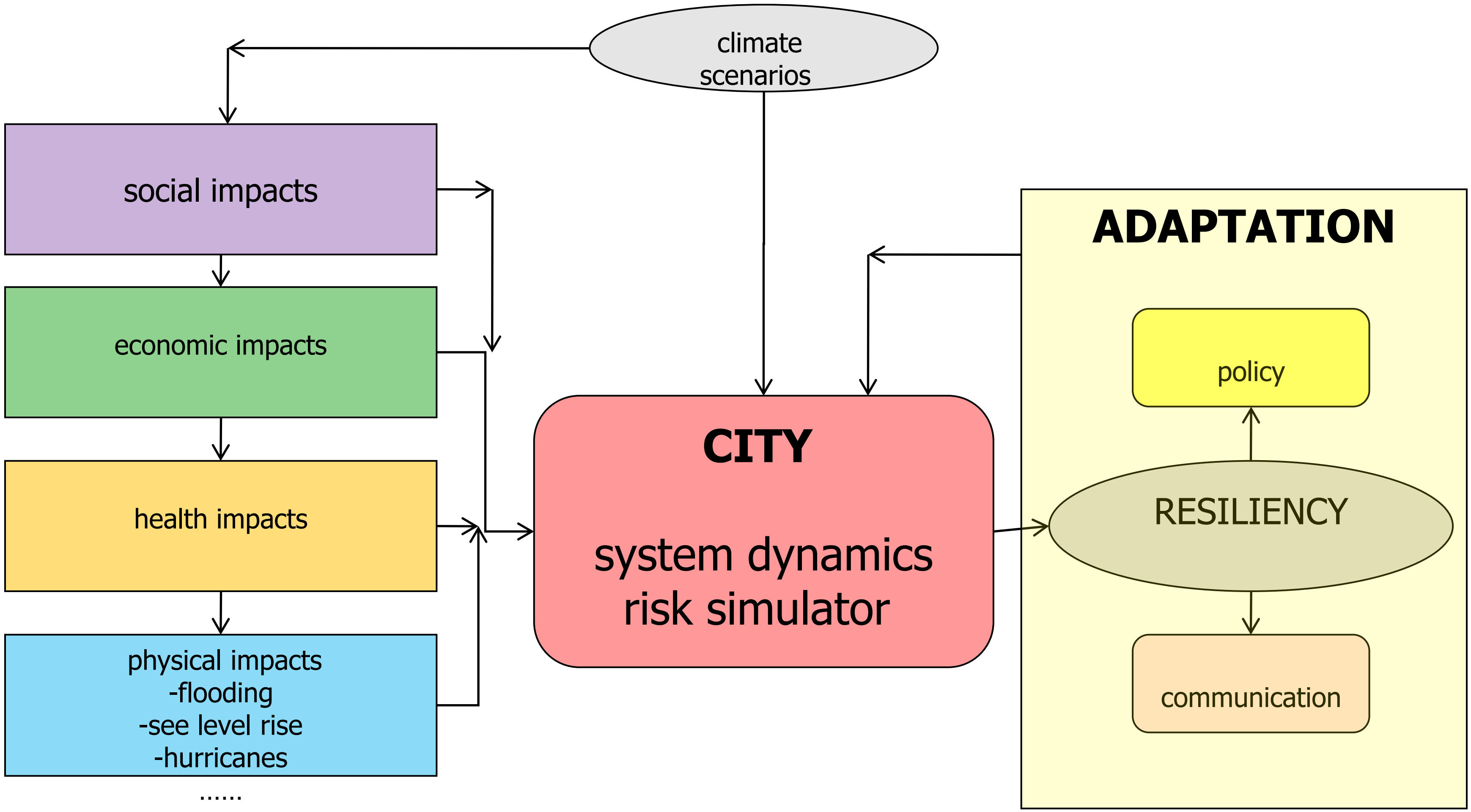
Research Schedule



Research Themes

- **Characterization of vulnerability and risk**
- **Characterization of hazards**
- **Understanding decision making**
- **City System Dynamics Risk Simulator**
- **Response strategies leading to Knowledge-based Actions**
- **Knowledge Transfer and Capacity Building**

City Risk Simulator



- **The cities (Bangkok, Lagos, Manila and Vancouver) were chosen to: have a range of climate-weather, socio-cultural-economic characteristics; be representative of other cities; and provide research opportunities.**
- **Develop, test, validate model and ideas on other cities**
  - **Workshops involving other cities:**
  - **Shanghai, Mumbai, Jakarta, Ho Chi Minh, …**

- **Full proposal – 15 Sept – decision Jan 2011 – start April 2011**
- **International Advisory Panel**
- **Related – IRDR International Centres of Excellence**
  - **Academia Sinica Taipei – international components – visitors, workshops, …**

Visioning and Participatory Process

Developing Stakeholder Partnerships and Strategies



Hassan Virji

S T A R T

Some observations from this week

Many ways to think of the future:

- GEC models >> downscaling >> impacts >> design actions and investments?
- Assess current vulnerabilities >> project future vulnerabilities >> consider options for actions?
- Consider possibilities of significant and irreversible changes in a coupled human-natural (socio-ecological) system leading to state change (tipping points)
- ….

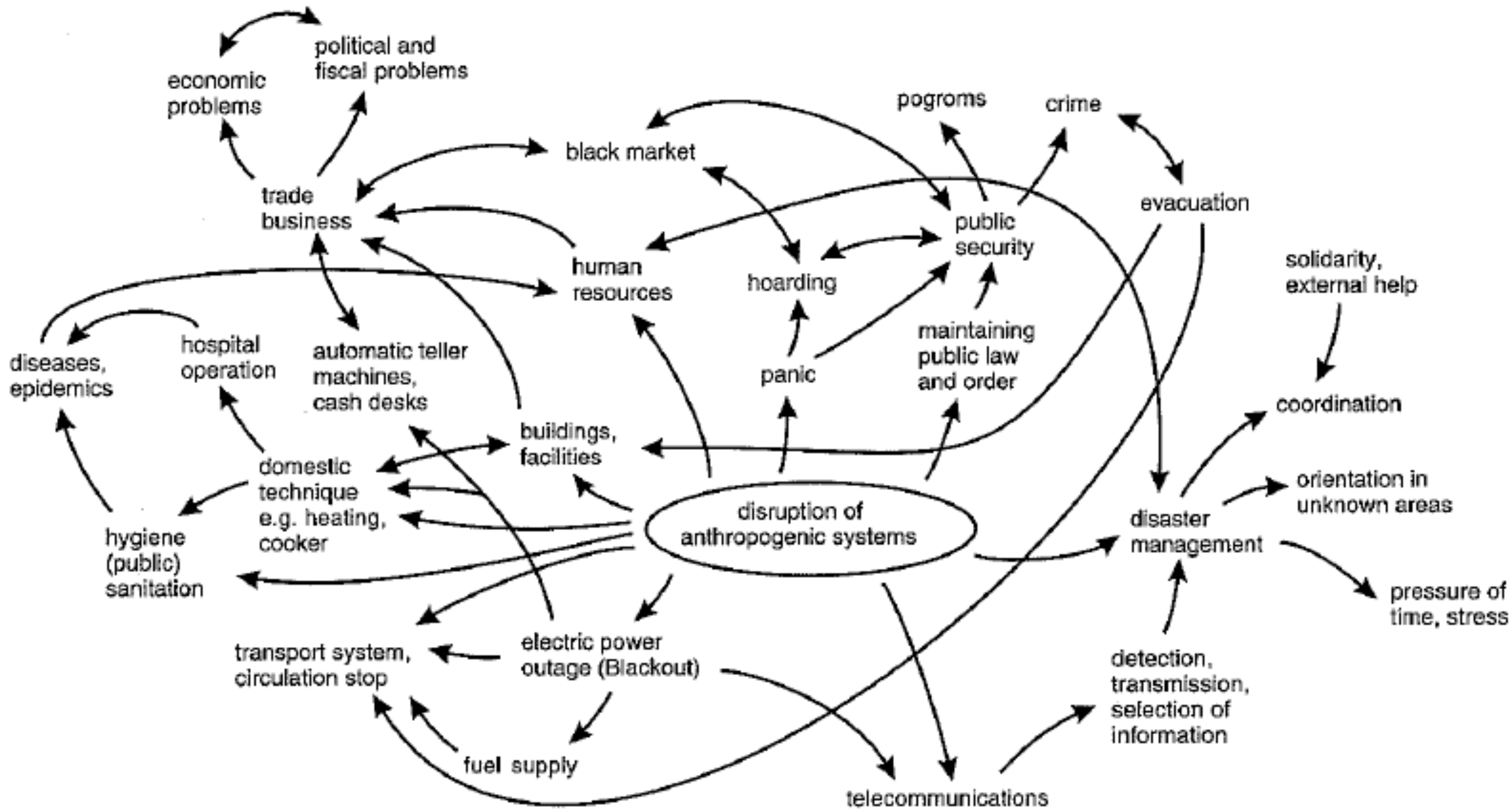


Figure 5. Illustration of the interaction network in anthropogenic systems. When the system is seriously challenged, this is likely to cause cascading failures along the arrows of this network (after[21])

Source: D. Helbing, 2009: Managing Complexity in Socio-Economic Systems
European Review, Vol. 17, No. 2, 423-438

Comparative analysis and synthesis of urban experiences with adaptation to climate change

Table 3: Response Capacity (Action)

Criterion	Bogotá	Cape Town	Delhi	Pearl River Delta	Pune	Santiago	Sao Paulo	Singapore
What motivated Action	External funding for the National Adaptation Project	Existing threats; Experiences with disasters	Perceived role as leader and a global city; Urgent need to address problems related to basic services provision and opportunity to capitalize on CDM and other financial mechanisms	Scientific findings + consensus on CC risks; International collaboration (UN-FCCC (common but differentiated respon-sibilities), IPCC, UK's DFID); Participation in international environmental agreements; Establishment of a National Leading Committee on CC; National plan is first climate plan from a developing country	No climate change motivators; Poverty alleviation, Disaster management	On National level: response to interna-tional commitments (OECD, UN)	Mayor brought back the idea from a C40 meeting	Adaptation as the continuation of a well established long-term/coordinated planning approach
Policy Fields where dedicated Climate Action has been introduced	No information	Water resources conservation and consumption; Disaster management/ preparedness	"Air Ambience Fund" to promote clean air policies.;Transporta-tion (CNG buses), Energy sector (greater reliance on solar, shutting down some coal powered plants), Water (rain-water harvesting, solar heaters), Waste management (inter-ceptor sewer canals)	No urban policy but China's National Climate Change Program (national policy established by central government)	No dedicated CC action; Sectoral interventions in flooding, water supply and transport (mitiga-tion: Bus Rapid Transit)	No dedicated plan of action	Disaster management; Vulnerability analyses Plan 'Parque Lineares'; Transportation, Energy, Waste Management, Health, Building standards, Land use/ Resettlement	Infrastructure Planning: Drainage, recent tidal barrier and reservoir; Trans-portation coordinated land use (short dis-tances); Energy effi-ciency (techno-logy, audits, standards, behaviour change); Water supply (desalination, recyc-ling); Urban Greening
Type of Action	No dedicated action; Pre-existing sectoral initiatives	Adaptation linked to goal and ongoing initiatives of reducing vulnerability and sustainability; Pro-active and protecting; Knowledge driven	Action plans primarily focused on mitiga-tion, strongly driven by need to tap opportunities offered by CDM. Adaptation linked to existing development concerns and largely follows a sectoral approach.	Ecosystem protect-tion, disaster preven-tion + reduction, and other key infrastruc-ture construction (anti-flood safety of large rivers, key cities + regions, guarantee safe drinking water + sound social + eco-nomic development,); Technological ad-vancement	No dedicated action; Pre-existing sectoral initiatives. Shifting of slums along flood prone river bed; Bus Rapid Transport System	No dedicated action; Pre-existing sectoral initiatives	Adaptation linked to prominent concerns (transportation); Mix of retreating, accom-modating, and pro-tecting; Short term + project orientation	Protecting; Linking with Science and Technology

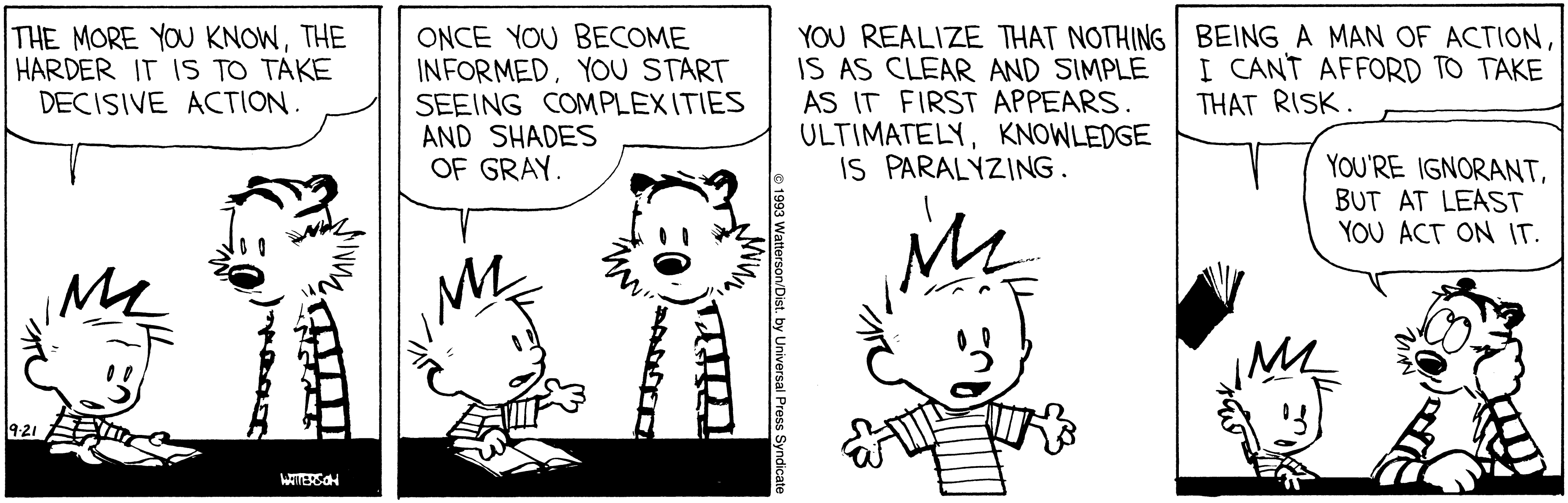
Source: Heinrichs et al., 2009. Urban Research Symposium (in prep.)

Sustainable Adaptation

GECHS

- Adaptation to climate change is a social process;
- Not every adaptation is positive—some may exacerbate the vulnerability of others (in the present or future);
- Climate change adaptation must be closely linked to development and address local needs;
- Climate change affects the things people value, both individually and collectively;
- There are both objective and subjective limits to adaptation as a response to climate change.

START

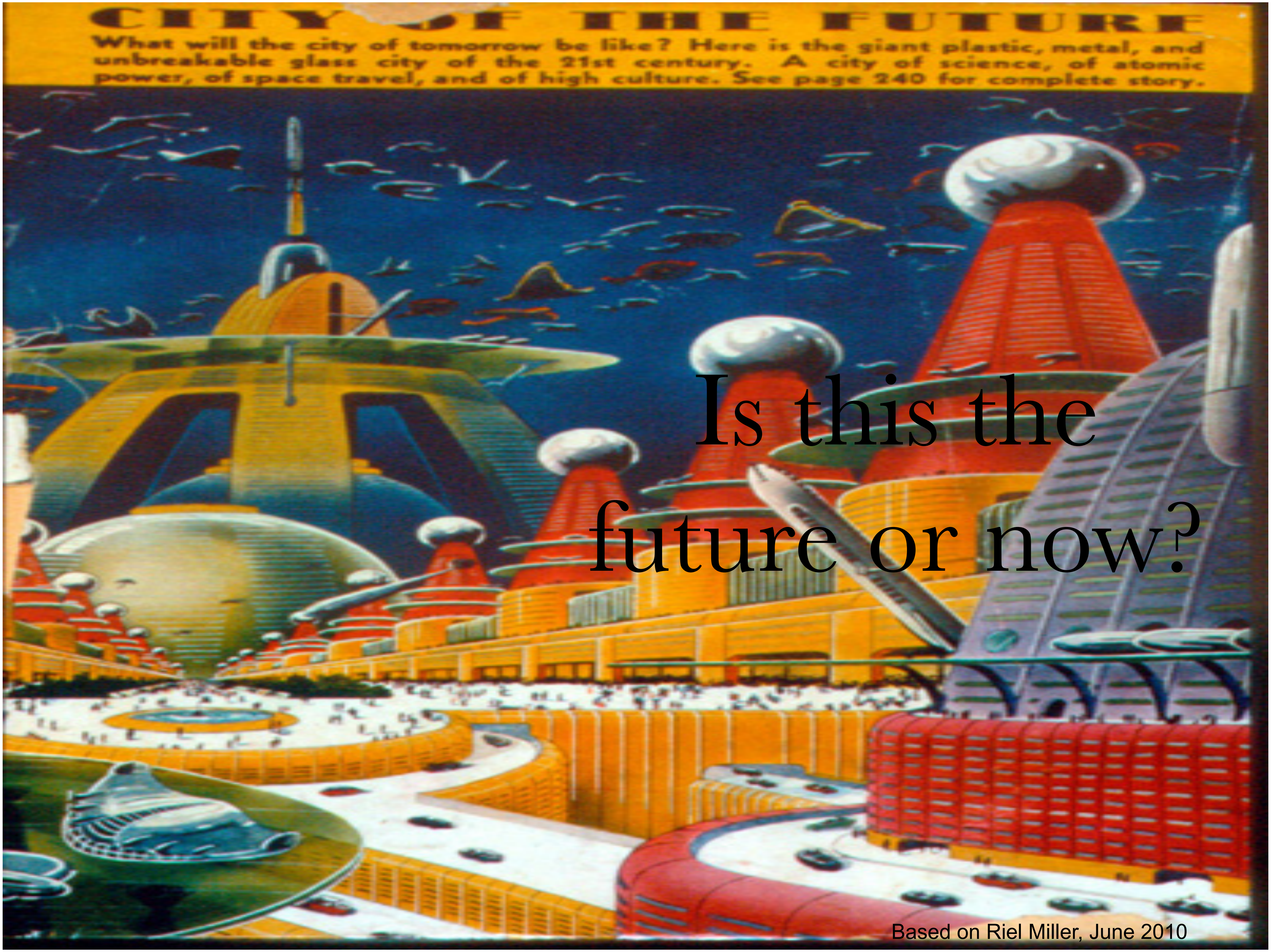

THE MORE YOU KNOW, THE HARDER IT IS TO TAKE DECISIVE ACTION.
9·21
WATTERSON
ONCE YOU BECOME INFORMED, YOU START SEEING COMPLEXITIES AND SHADES OF GRAY.
© 1993 Watterson/Dist. by Universal Press Syndicate
YOU REALIZE THAT NOTHING IS AS CLEAR AND SIMPLE AS IT FIRST APPEARS. ULTIMATELY, KNOWLEDGE IS PARALYZING.
BEING A MAN OF ACTION, I CAN'T AFFORD TO TAKE THAT RISK.
YOU'RE IGNORANT, BUT AT LEAST YOU ACT ON IT.

START

How describe the future?
Some examples:

Bruegel the Elder, 1559, Staatliche Museen zu Berlin - Gemaldegalerie, Berlin Link:
http://www.ibiblio.org/wm/paint/auth/bruegel/proverbs.jpg

The Past in one region



Is this the future or now?

Based on Riel Miller, June 2010


Based on Riel Miller, June 2010

The Bangkok Visioning Exercise

- Follow up to CAR I Conference: A facilitated dialogue to form stakeholder partnerships
- Process; NOT a solution!
- Recognize that capacity building is, in of itself, good adaptation
- Aims:
  - Engage and provide training to representatives of city-based research and administration representatives to facilitate stakeholder sessions
  - Experiment with stakeholders to Bangkok to vision future Bangkok (in a couple of decades)
    - Personal daily life style descriptions
    - Consideration of how development trajectories might be realized despite multiple stresses

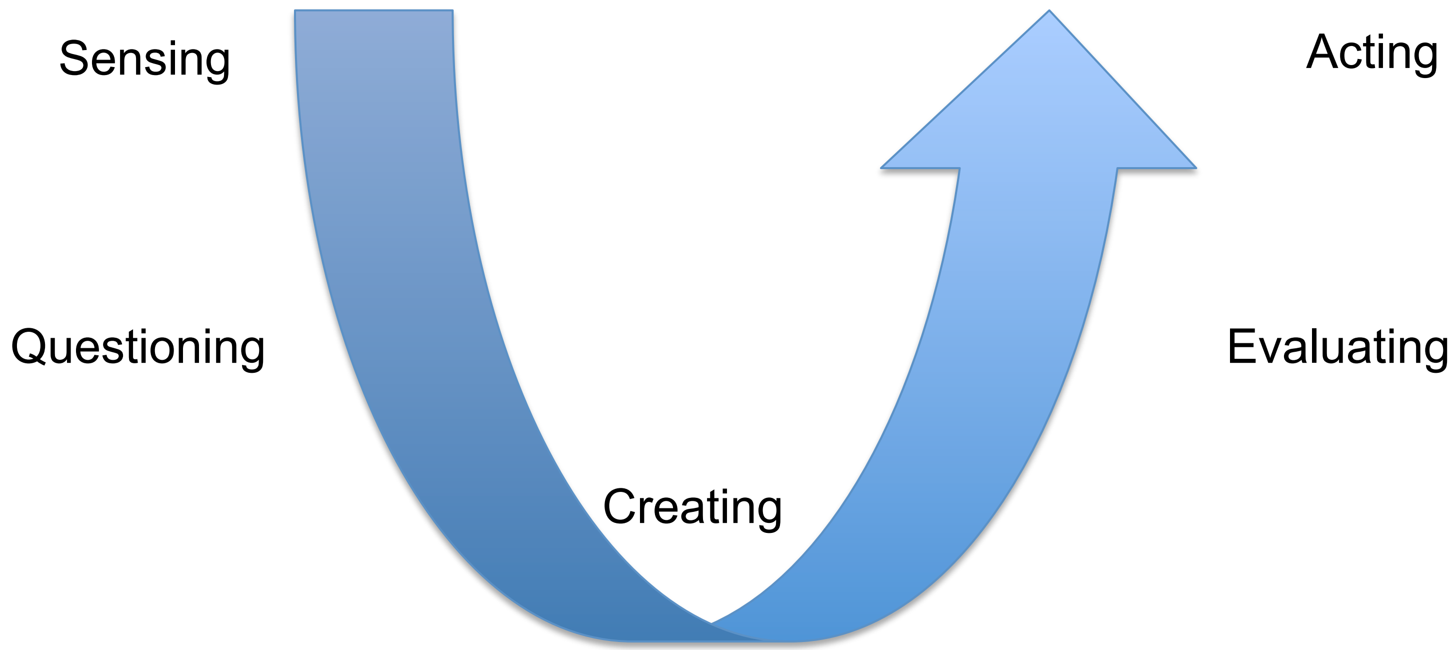
Use rigorous imagining framework – to develop an analytically rich (decision relevant) and imaginative (detecting emergence) stories of a functioning society as a way to reveal and question the assumptions used to make choices.

Imagining Changes in the Conditions of Change of Daily Life

Based on Riel Miller, June 2010

What was done?

- "The **U** process": Towards a better coping strategy – from abstract to personal



- <u>Participatory</u> and <u>facilitated</u> process
- Several interacting break out groups and synthesis

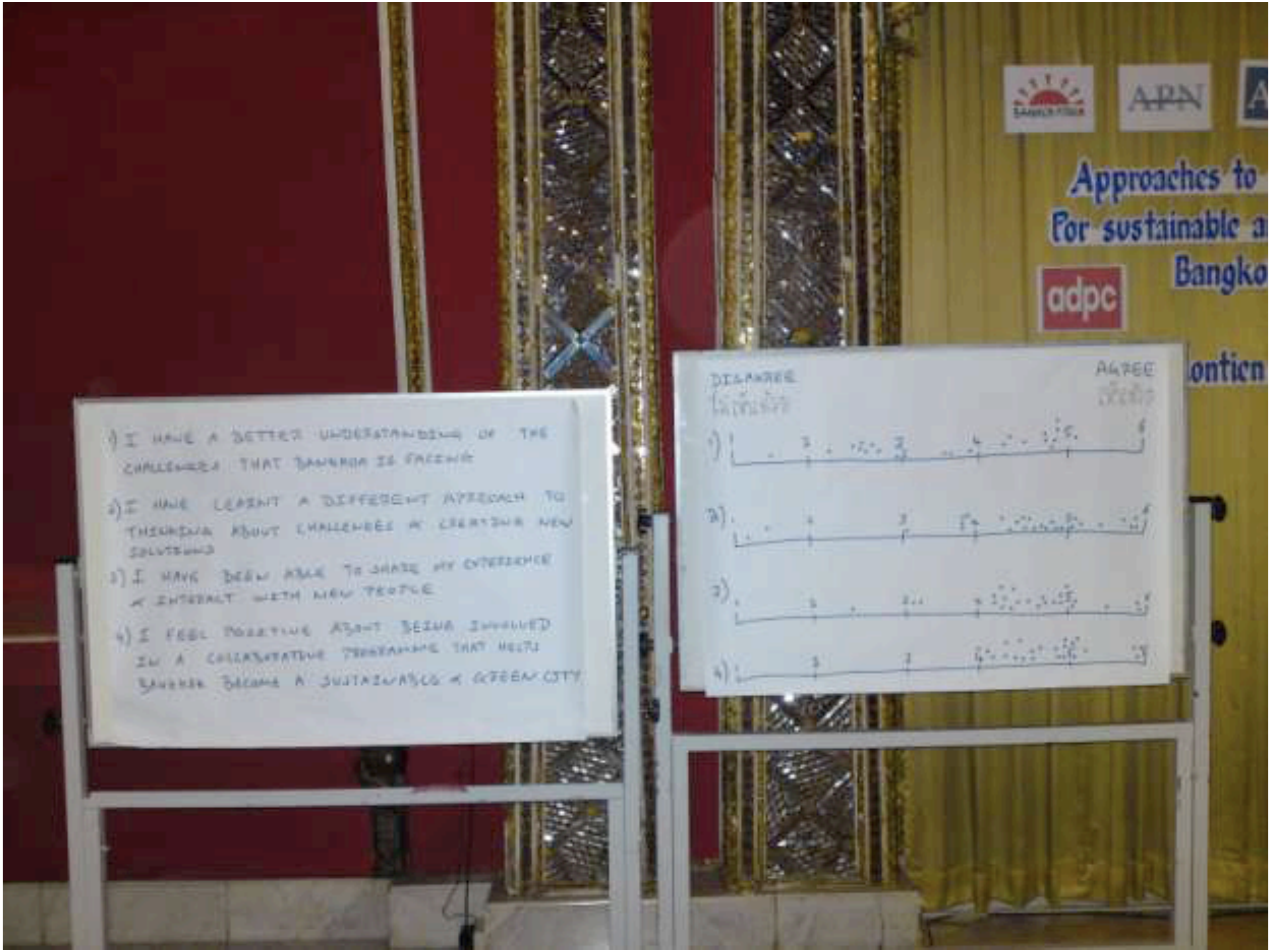

CHANGE
LEARNING
1. SENSING
Scoping
CONTEXT
MAPPING
UNDERSTANDING
IDEAS CREATION
2. PRESENCING
PROTO-TYPING
IMMERSION
3. ACTING
IMPLEMENTATION
PLANNING
EVALUATION
Piloting
TESTING
ASSESSMENT

Designed to:

Nurture the capacity to tell anticipatory stories using rigorous imagining based on sharing depth of knowledge from across the community

Internalize the constant development of our understanding of the potential of the present and of changing anticipatory assumptions.

Based on Riel Miller, June 2010


APN
Approaches to
For sustainable a
Bangko
adpc
ontien
DISAGREE
AGREE

Outcomes

- A mobilized and active civil society process in Bangkok led by the Bangkok Forum
- 11 city representatives (from Manila,Hanoi and Bangkok) were trained as knowledgeable facilitators >> Potential city level facilitators who can engage with the civil society within a city to mobilize discussion and debate on development trajectories
- Seeds of a network? Potential for repeat exercises in other cities?

Points to ponder

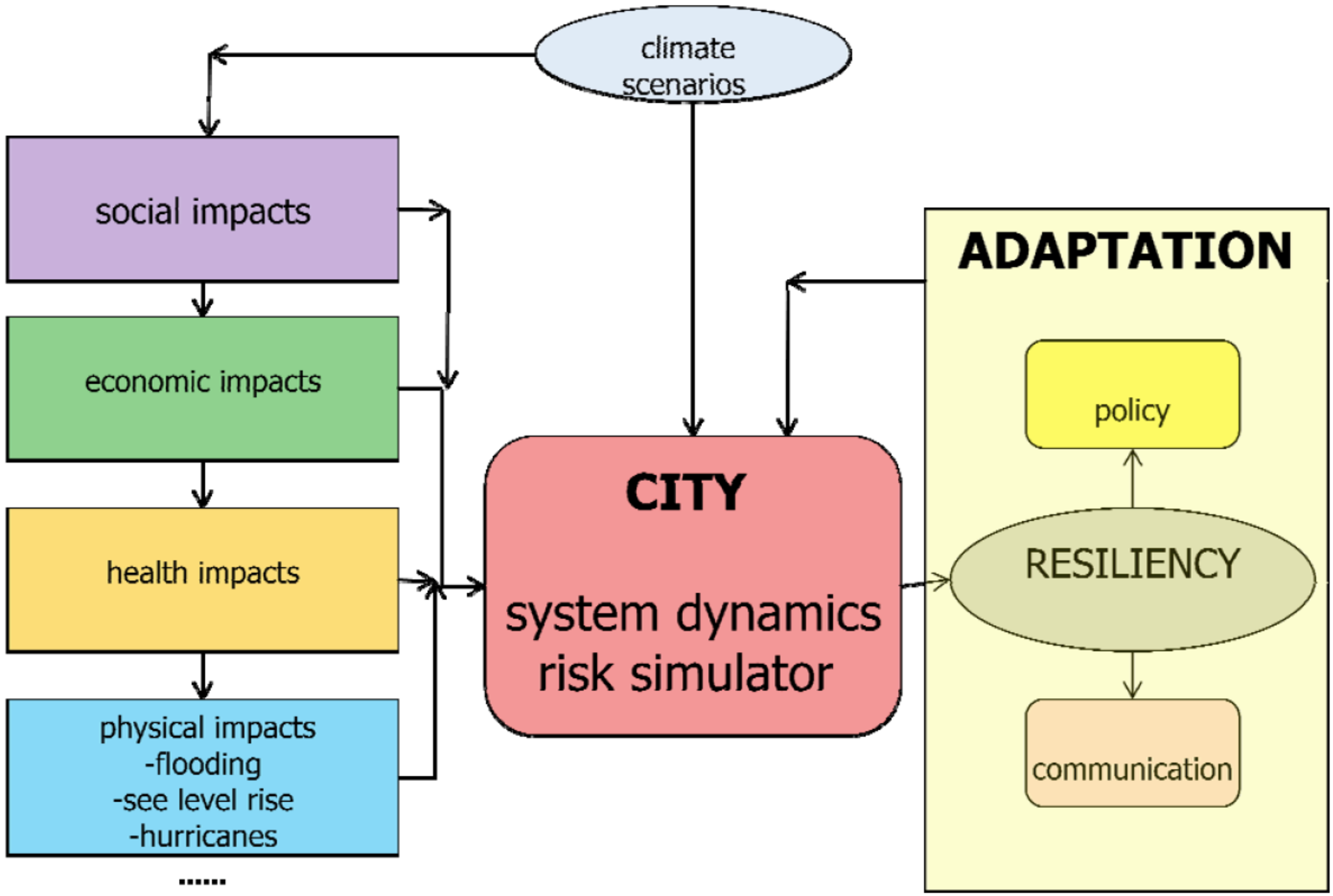
- During stressful times of change, agencies typically champion infrastructure changes (e.g., “climate-proof” buildings, build dams, …)
- Adaptation as a socio-ecological and dynamic adjustment process requires continuous innovation, experimentation, and change to meet change!
- Social inertia to change is a challenge
- But evolution is a fact of life; urban form and function must and will evolve

If you over esteem great men, people become powerless. If you overvalue possessions, people begin to steal. The Master leads by emptying people's minds and filling their cores , by weakening their ambition and toughening their resolve. He helps people lose everything they know, everything they desire, and creates confusion in those who think that they know. Practice not-doing, and everything will fall into place. Lao Tzu, Tao Te Ching, Chap. 3

From Assessments of Vulnerability to Assessment of Resilience

- The TriCouncil/Canada Proposal Proposal:
  - look at CC drivers, but also consider development context
  - engage stakeholders ("research-action" effort)
  - Focus on resilience
  - Three-track approach: (1) Resilience framework (2) Visioning-Development Context; (3) Strategic Partnering Context

S T A R T


climate scenarios
social impacts
economic impacts
health impacts
physical impacts
-flooding
-see level rise
-hurricanes
......
CITY
system dynamics risk simulator
ADAPTATION
policy
RESILIENCY
communication

Estimation of future flood and inundation risks due to climate change at downstream regions of major rivers in Japan

23 August 2010

International Workshop
Climate Change Vulnerability Assessment
and Urban Development Planning for Asian Coastal Cities

Hiromune Yokoki and Yuji Kuwahara
Ibaraki University

茨城大学
Ibaraki University

Contents

Part 1:

- Flood and Inundation simulation
  - Concept and method
  - Examples of results
  - Indexes of risk

Part 2:

- Examples of Hazard maps
  - Purpose
  - Information

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Background and Purpose

Climate change (extreme events)
Heavy rainfalls, intensified typhoon

⇩

Increased flood flows in rivers

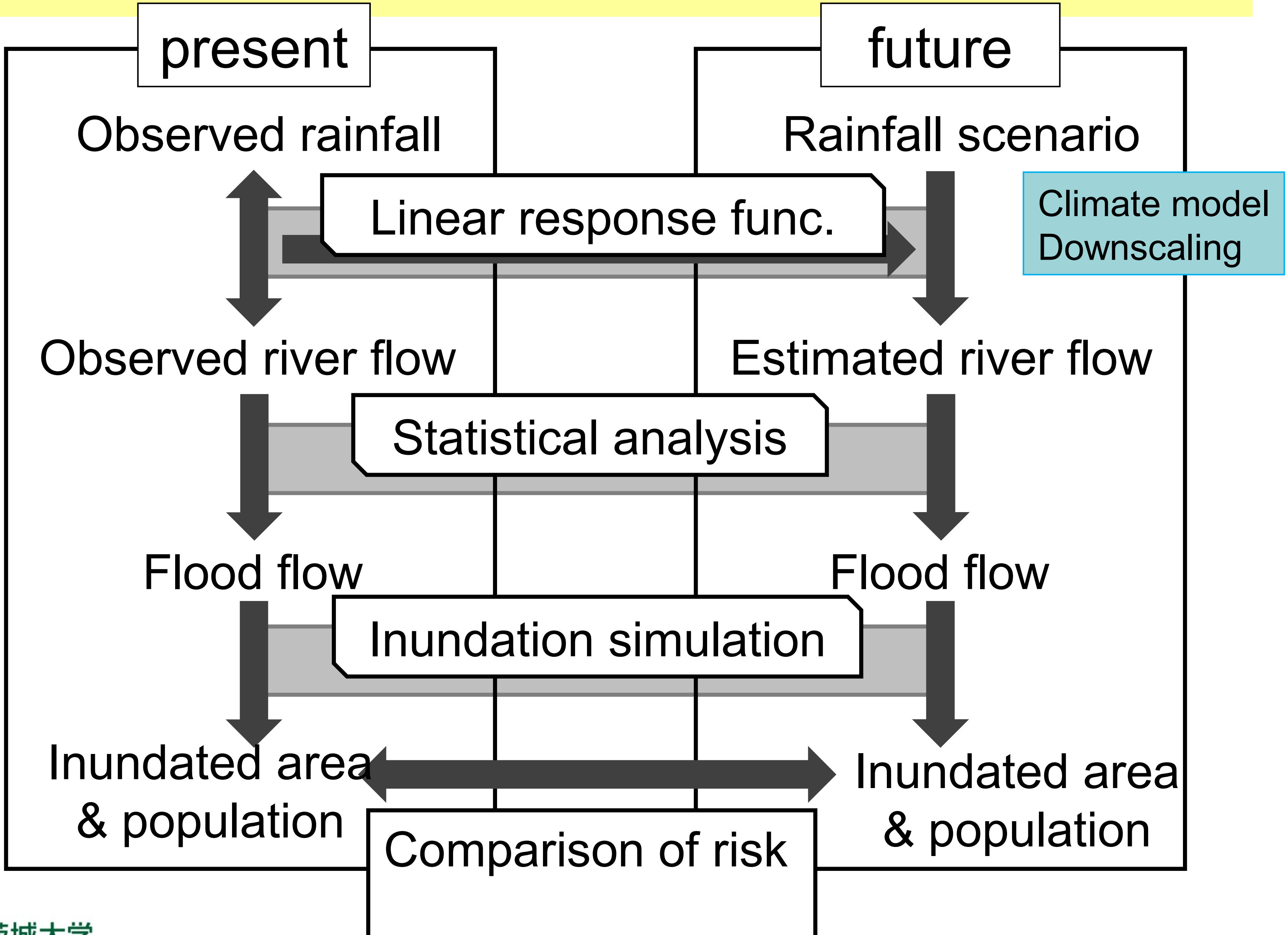
⇩ (sea-level rise)

Increasing risk of flooding

⇩ (Geographical feature)

Assessments of future flooding risks in the downstream regions of major rivers

Methods of assessment



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Linear response analysis

<<Model>>

$$y(t) = \int_0^{\infty} h(\tau)\, r(t-\tau)\, \mathrm{d}\tau$$

$r(t)$: rainfall
$y(t)$: river flow
$h(\tau)$: response function
τ : lagged time

$h(\tau)$ is obtained by using Fourier transform of the equation.

<<Data adopted>>

ainfall: daily observed data averaged for multiple points

iver flow: daily observed data for one point

uration of data: 1981--2000

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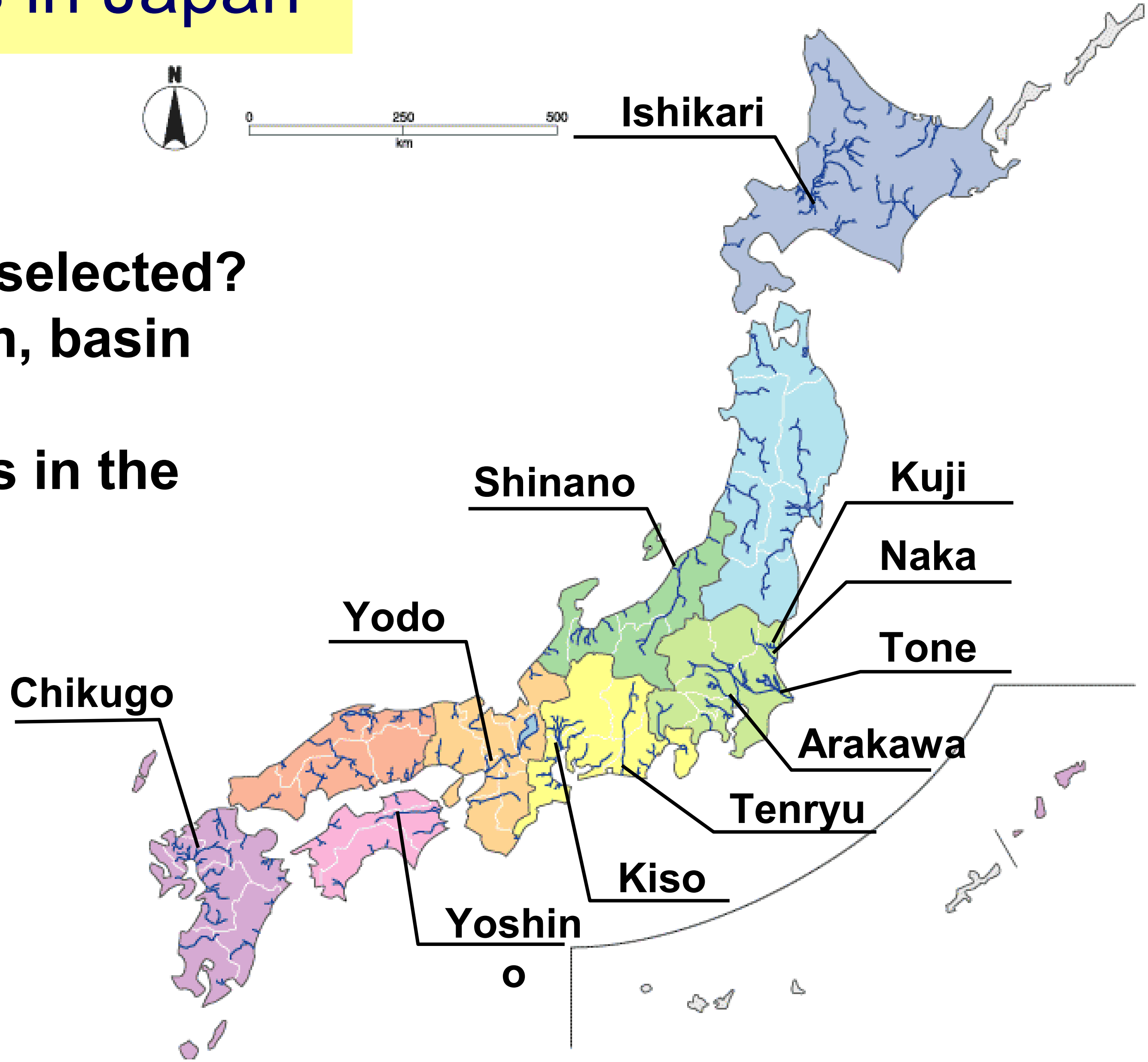
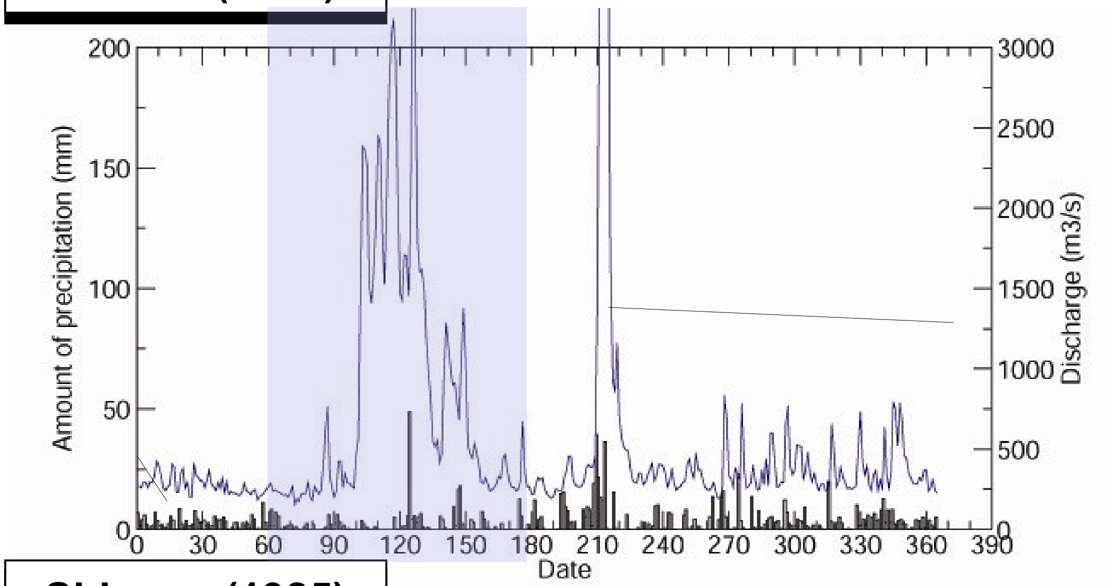
Major rivers in Japan

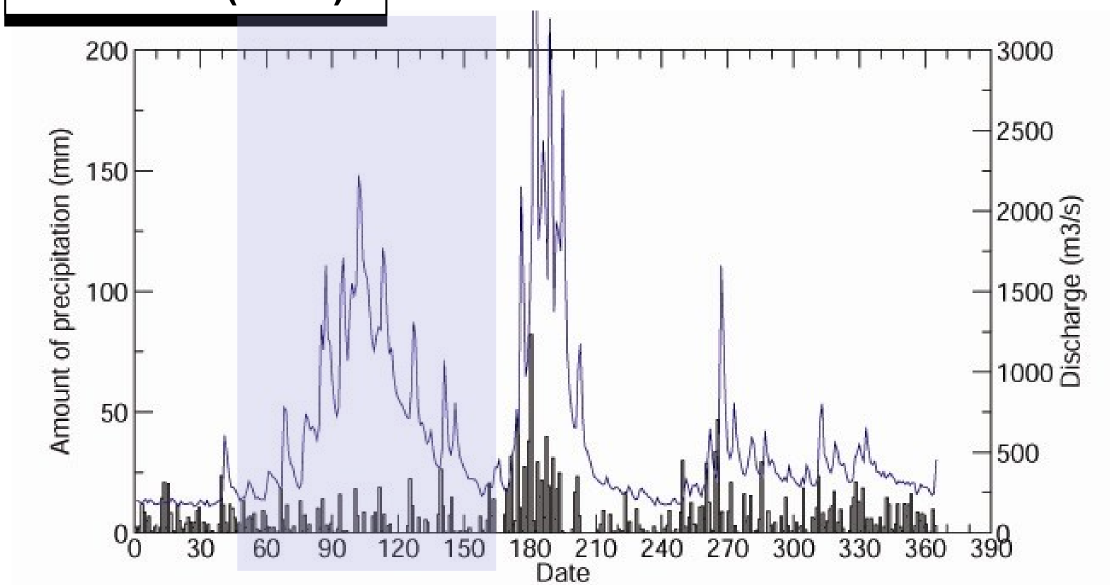
Why are these selected?
1． River length, basin area
2． Urban areas in the downstream



Ishikari (1999)



Shinano (1985)



At rivers in northern or mountainous areas, river flows in spring season are not affected by the rainfall but the snowfall of last winter.

In the analyses, those durations were excluded.

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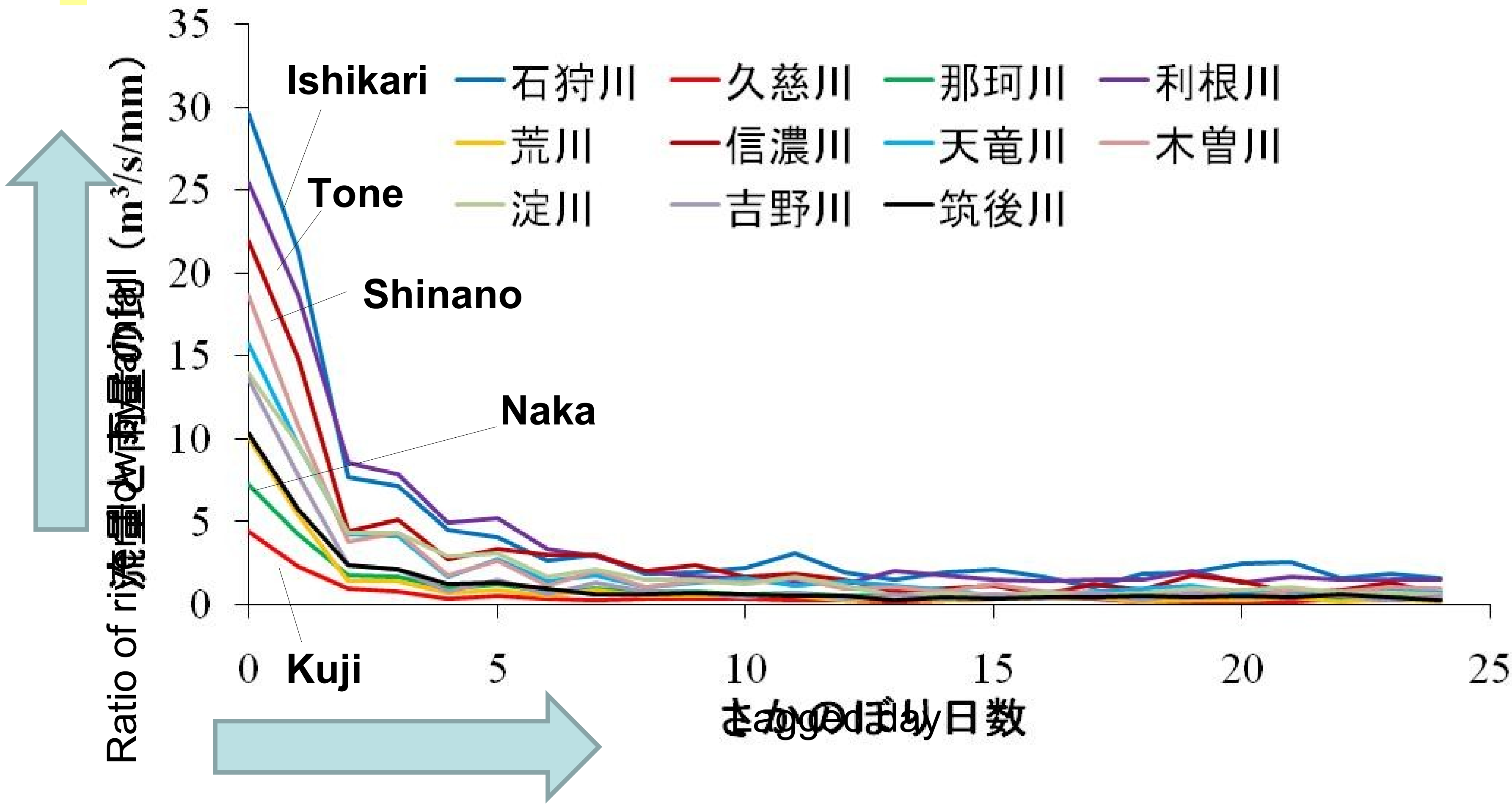
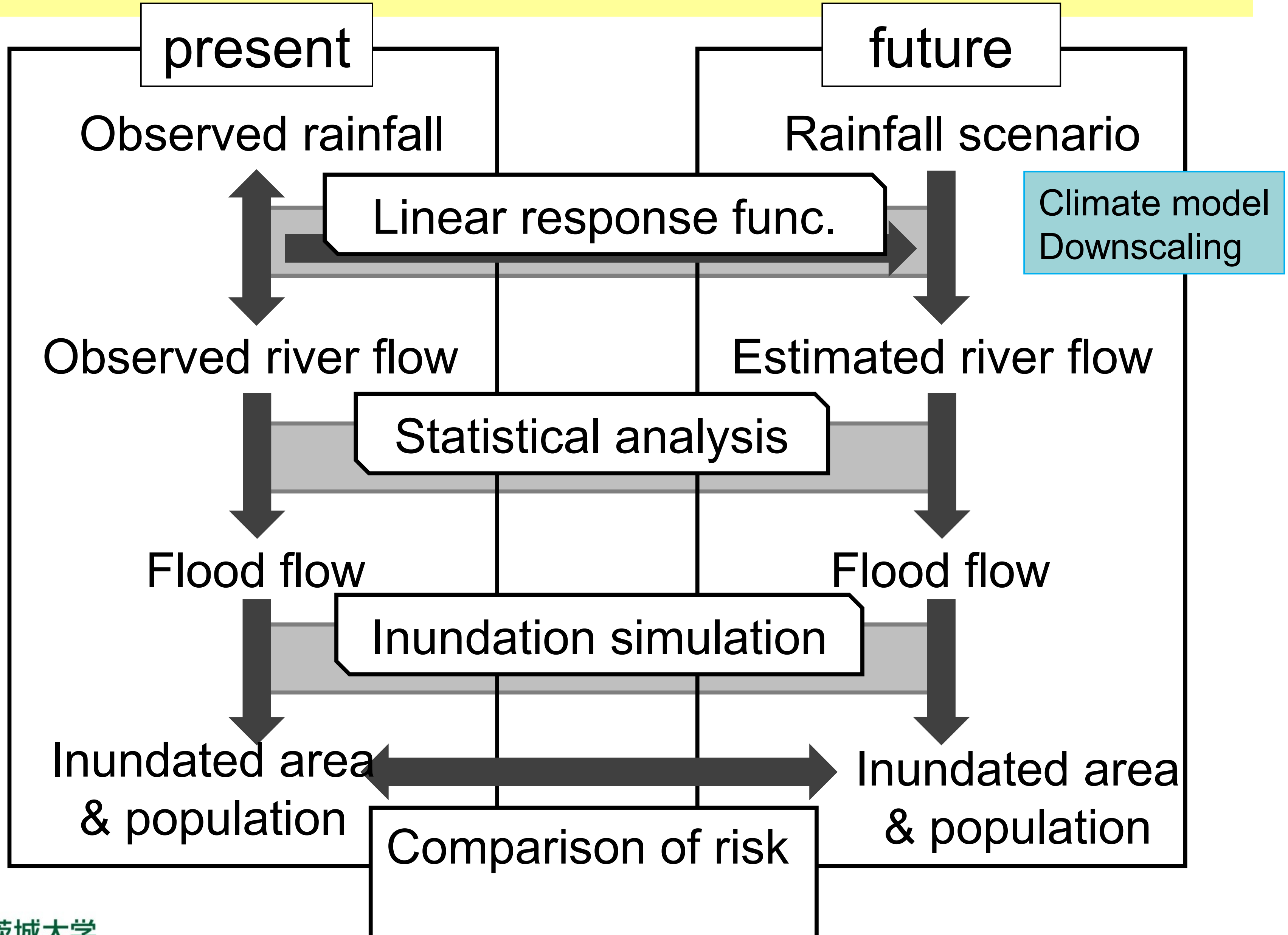
Response functions obtained



(Basin area)

Methods of assessment



Statistical analysis

(Unit: m^3/s) (単位：m^3/s)

Naka riv. 那珂川	観測値 Observed Gumbel L積率法	観測値 Observed GEV L積率法	観測値 Observed LN3 積率法	気候シナリオ（1981~2000年） 1981~2000 (scenario) Gumbel L積率法	気候シナリオ（1981~2000年） 1981~2000 (scenario) GEV L積率法	気候シナリオ（1981~2000年） 1981~2000 (scenario) LN3 積率法
No. of samples 標本数	20	20	20	20	20	20
確率規模（1/100）	3303	-	3849	2750	2299	2513
SLSC SLSC	0.0489	-	0.1422	0.0353	0.0552	0.0353
Estimation 推定値	3303	-	4617	2750	2091	2547
Error 推定誤差	696	-	1029	312	155	233
採用手法	○			○		

Naka riv. 那珂川	気候シナリオ（2031~2050年） 2031~2050 (scenario) Gumbel L積率法	気候シナリオ（2031~2050年） 2031~2050 (scenario) GEV L積率法	気候シナリオ（2031~2050年） 2031~2050 (scenario) LN3 積率法	気候シナリオ（2081~2100年） 2081~2100 (scenario) Gumbel L積率法	気候シナリオ（2081~2100年） 2081~2100 (scenario) GEV L積率法	気候シナリオ（2081~2100年） 2081~2100 (scenario) LN3 積率法
No. of samples 標本数	20	20	20	20	20	20
確率規模（1/100）	2555	2270	2661	3431	2744	3670
SLSC SLSC	0.0343	0.068	0.0357	0.0538	0.158	0.0398
Estimation 推定値	2555	1546	2591	3431	1670	3526
Error 推定誤差	330	619	315	522	478	370
採用手法	○					○

Distrubutions：
Gumbel dist.
GEV dist.
LN3 dist.

Cunnane plotting & Jackknife

SLSC:
Standard least square criteria

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Estimated flood flows

(Observed) (Scenario) （単位：m^3/s）

	観測値	1981~2000年		2031~2050年		2081~2100年
Ishikari 石狩川	7958	5028	↗	6561	↗	8017
	2299	545		676		999
Kuji 久慈川	1558	1708	↘	1606	↗	1851
	313	292		169		141
Naka 那珂川	3303	2750	↘	2555	↗	3526
	696	312		330		370
Tone 利根川	8861	9815	↘	9358	↗	13130
	1176	1432		830		2028
Arakawa 荒川	3506	5387	↘	4130	↗	6576
	550	931		332		990
Shinano 信濃川	10357	5544	↘	4412	↗	8727
	2093	785		556		1470
Tenryu 天竜川	7766	5195	↘	5045	↗	5195
	758	443		443		579
Kiso 木曽川	6343	5240	↗	6955	↗	7925
	396	485		999		1160
Yodo 淀川	5568	6828	↘	5204	↗	8432
	796	1137		701		1472
Yoshino 吉野川	10856	6171	↘	5237	↗	6568
	1965	767		451		830
Chikugo 筑後川	4450	3606	↗	3791	↗	5037
	569	620		399		605

（上：推定値，下：推定誤差）

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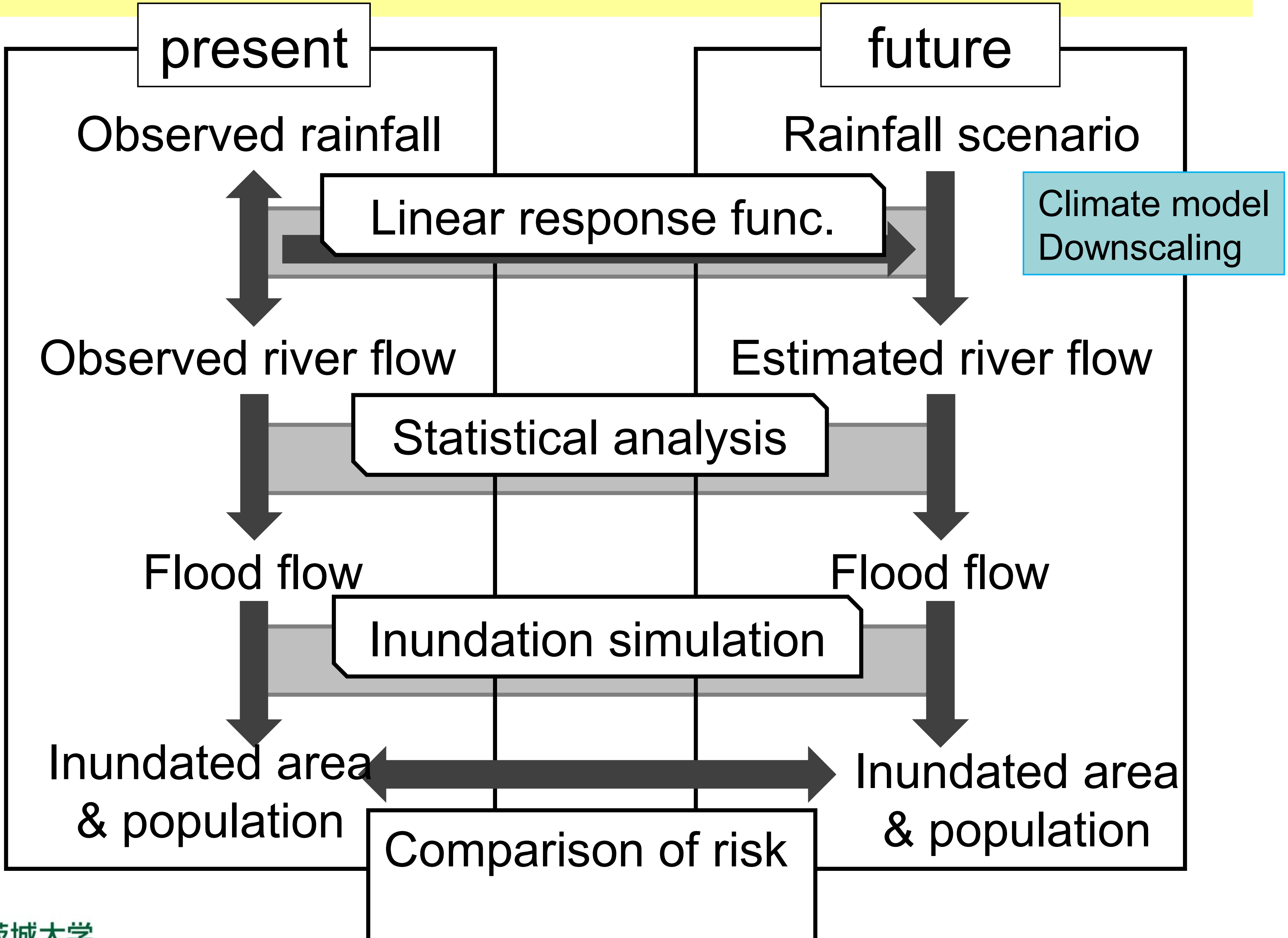
Methods of assessment



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Inundation simulation

Basic equations of two dimensional flow

h: depth (m)
z_b : ground level (m)
n : Manning's roughness parameter ($m^{-1/3}s$)
g : gravitational acceleration （ m/s^2 ）
U , V : vertical averaged flow velocity in x , y direction（ m/s ）
M , N : flow flux in x , y direction （ m^2/s ）（ $=Uh$, Vh ）

Continuity equation

$$\frac{\partial h}{\partial t} + \frac{\partial M}{\partial x} + \frac{\partial N}{\partial y} = 0$$

Eqs. of motion

$$\frac{\partial M}{\partial t} + \frac{\partial (UM)}{\partial x} + \frac{\partial (VM)}{\partial y} = -gh\frac{\partial (h+z_b)}{\partial x} - \frac{gn^2U\sqrt{U^2+V^2}}{h^{1/3}}$$

$$\frac{\partial N}{\partial t} + \frac{\partial (UN)}{\partial x} + \frac{\partial (VN)}{\partial y} = -gh\frac{\partial (h+z_b)}{\partial y} - \frac{gn^2V\sqrt{U^2+V^2}}{h^{1/3}}$$

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Inundation simulation

$$M_{or}N = 0.544 h_h \sqrt{g h_h}$$ (Gap)

$$M_{or}N = 0.35 h_h \sqrt{2 g h_h}$$

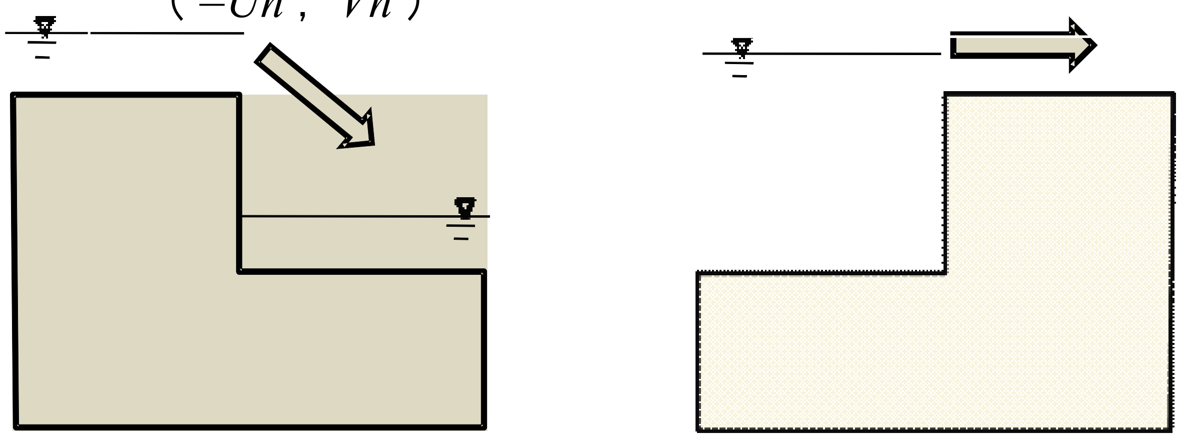
h_h: depth between the surface and higher ground (m)

g : gravitational acceleration （m/s^2）

U , V : vertical averaged flow velocity in x , y direction（m/s）

M , N : flow flux in x , y direction （m^2/s）（=Uh , Vh）

(Gap)



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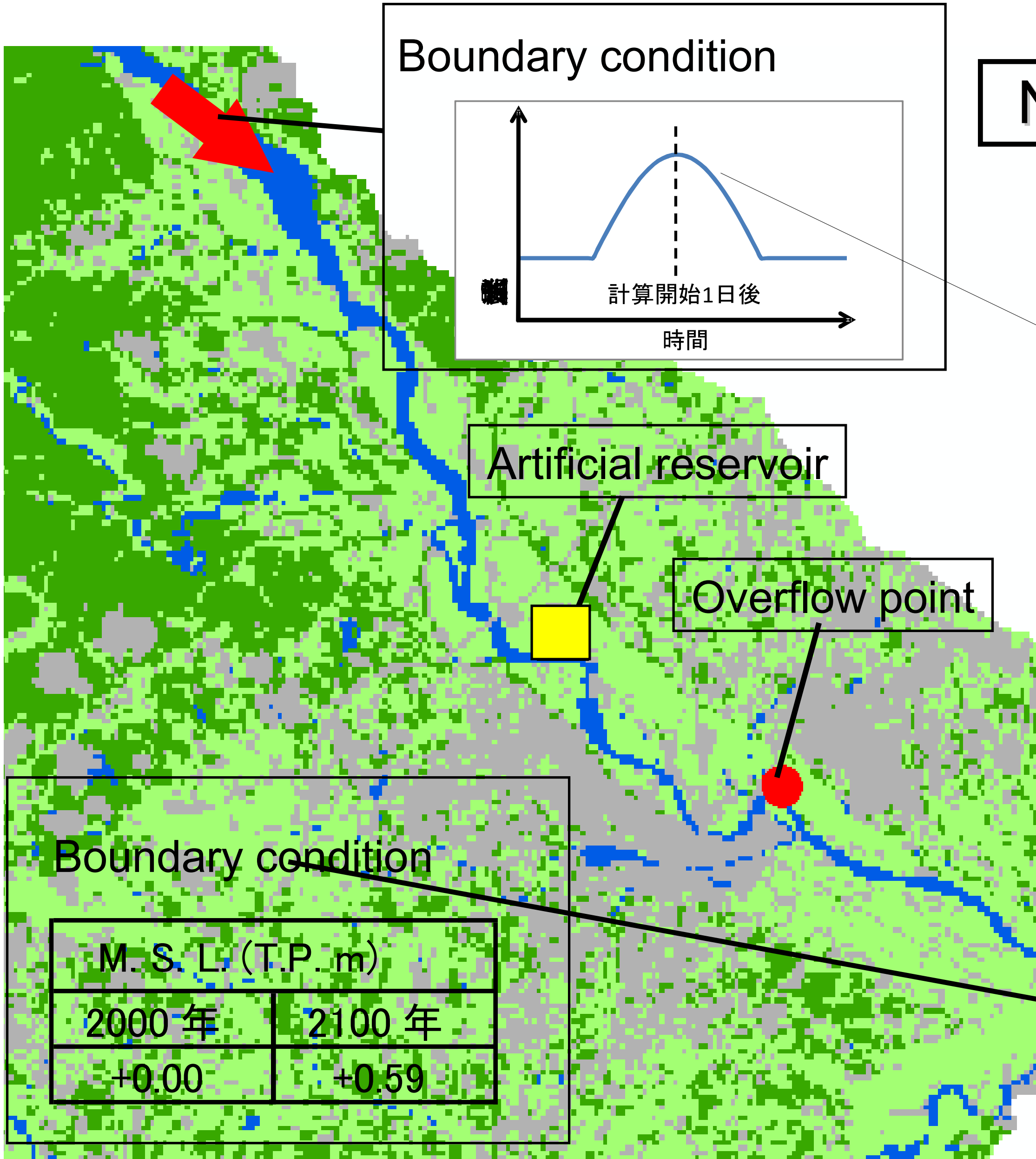
Inundation simulation

- Manning's roughness parameter
  - To show the difference of flood flow velocity due to land use:
    - 0.020 for agricultural fields
    - 0.025 for general areas
    - 0.060 for building areas

Calculation domain and conditions



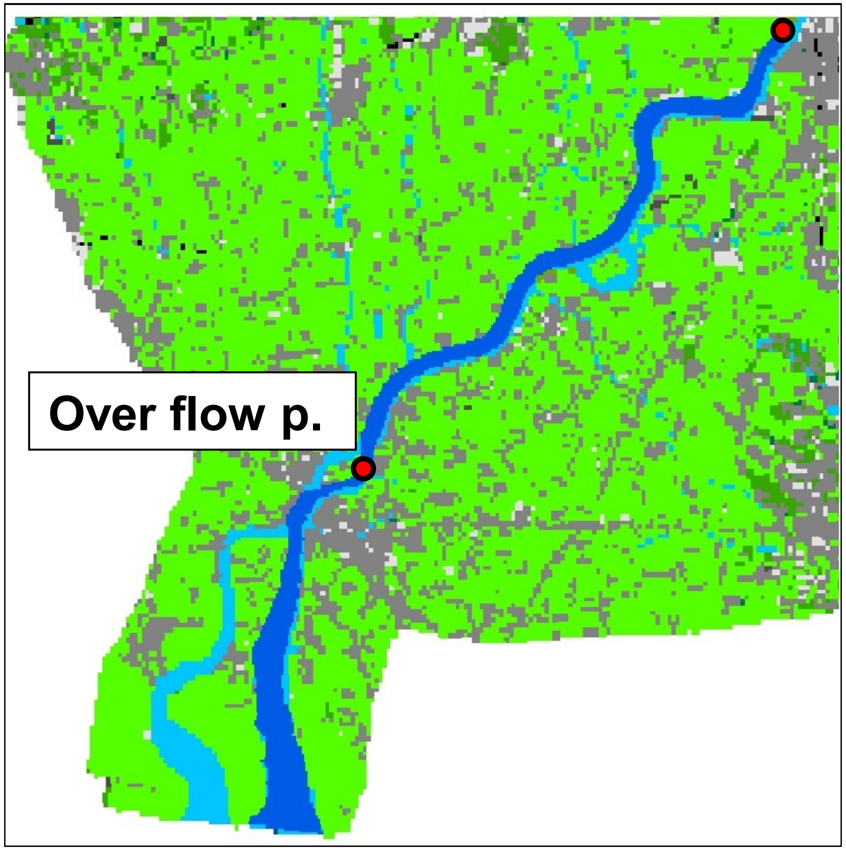
M. S. L. (T.P. m)	
2000 年	2100 年
+0.00	+0.59

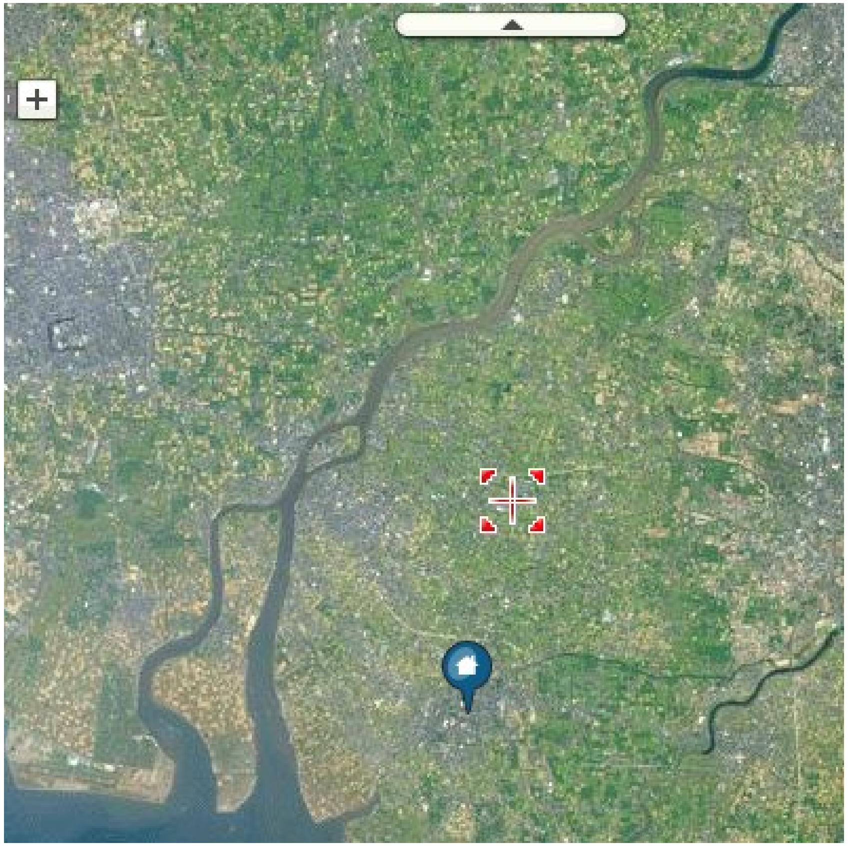
Naka river

流域名	年	洪水流量(m³/s)
荒川	2000	5512
	2100	6701
久慈川	2000	1708
	2100	1851
筑後川	2000	3667
	2100	5092
那珂川	2000	2825
	2100	3600
吉野川	2000	6220
	2100	6617
信濃川	2000	6047
	2100	9173
淀川	2000	7096
	2100	8736
天竜川	2000	5435
	2100	5933

Example of results

Chikugo river





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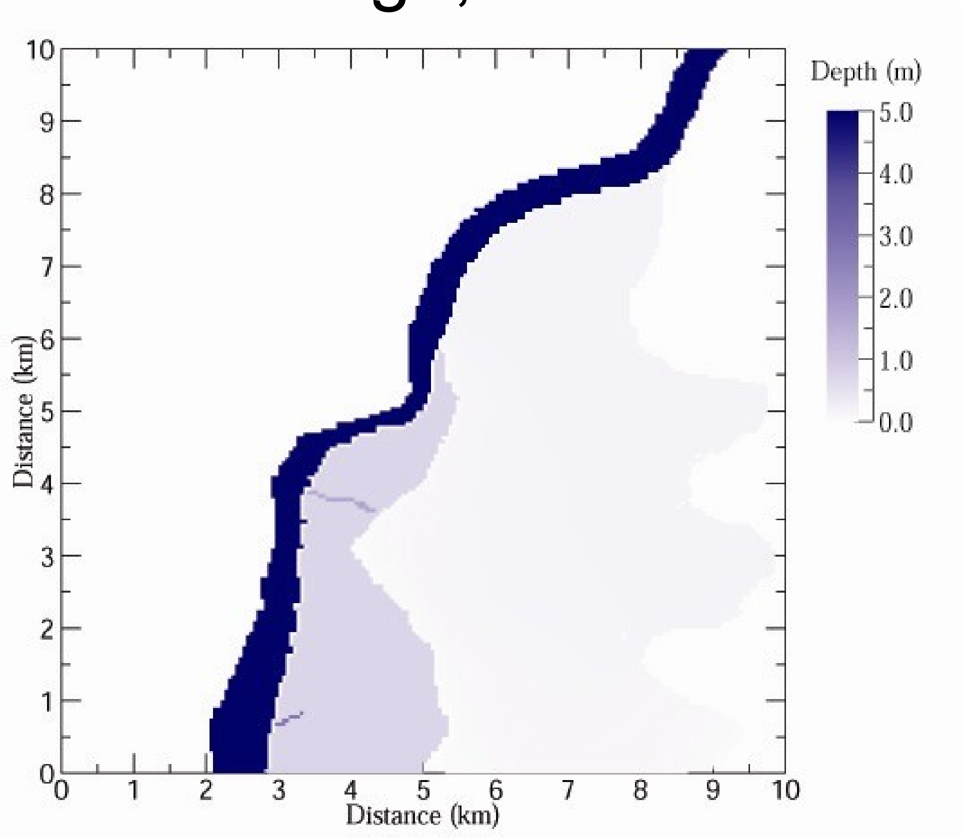
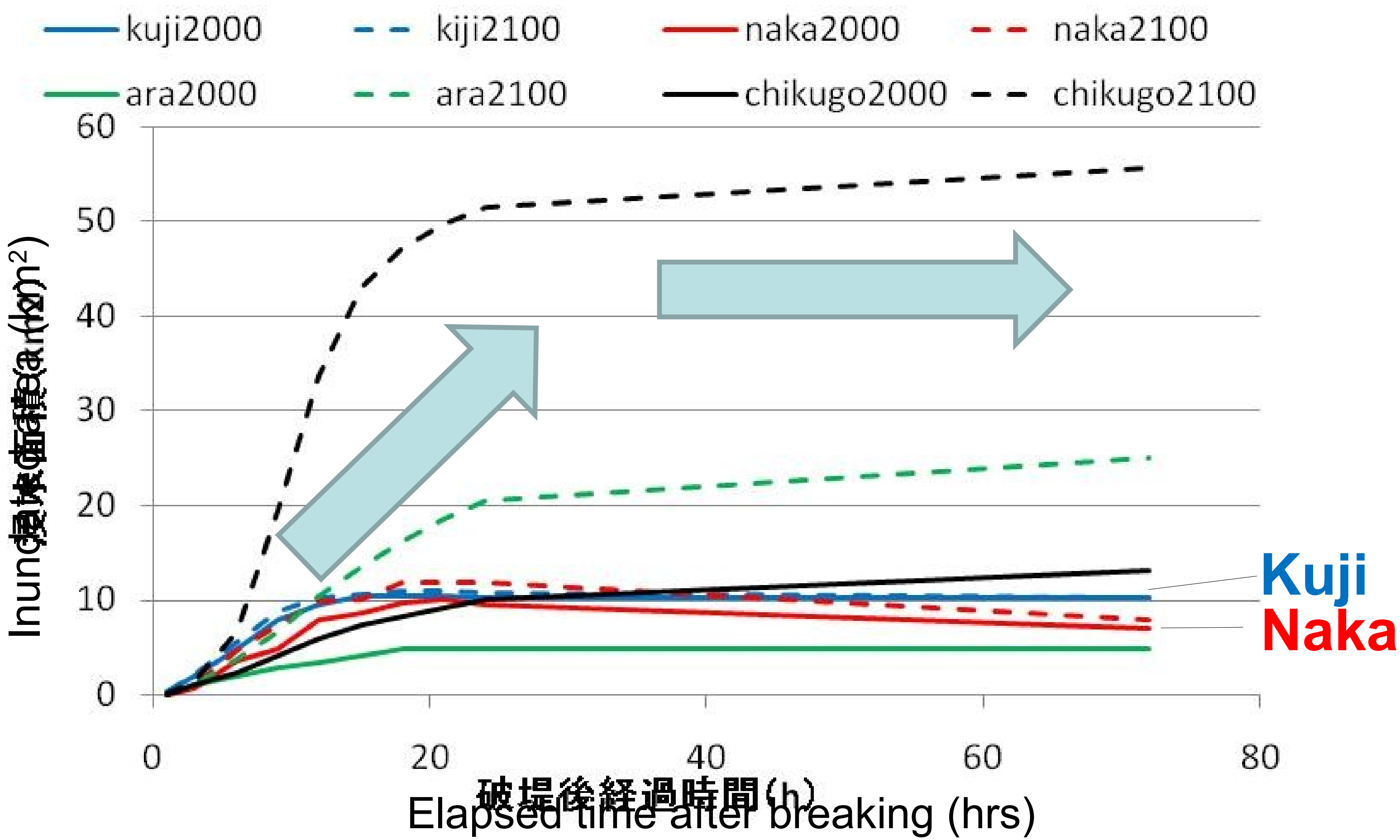
Chikugo, 2100



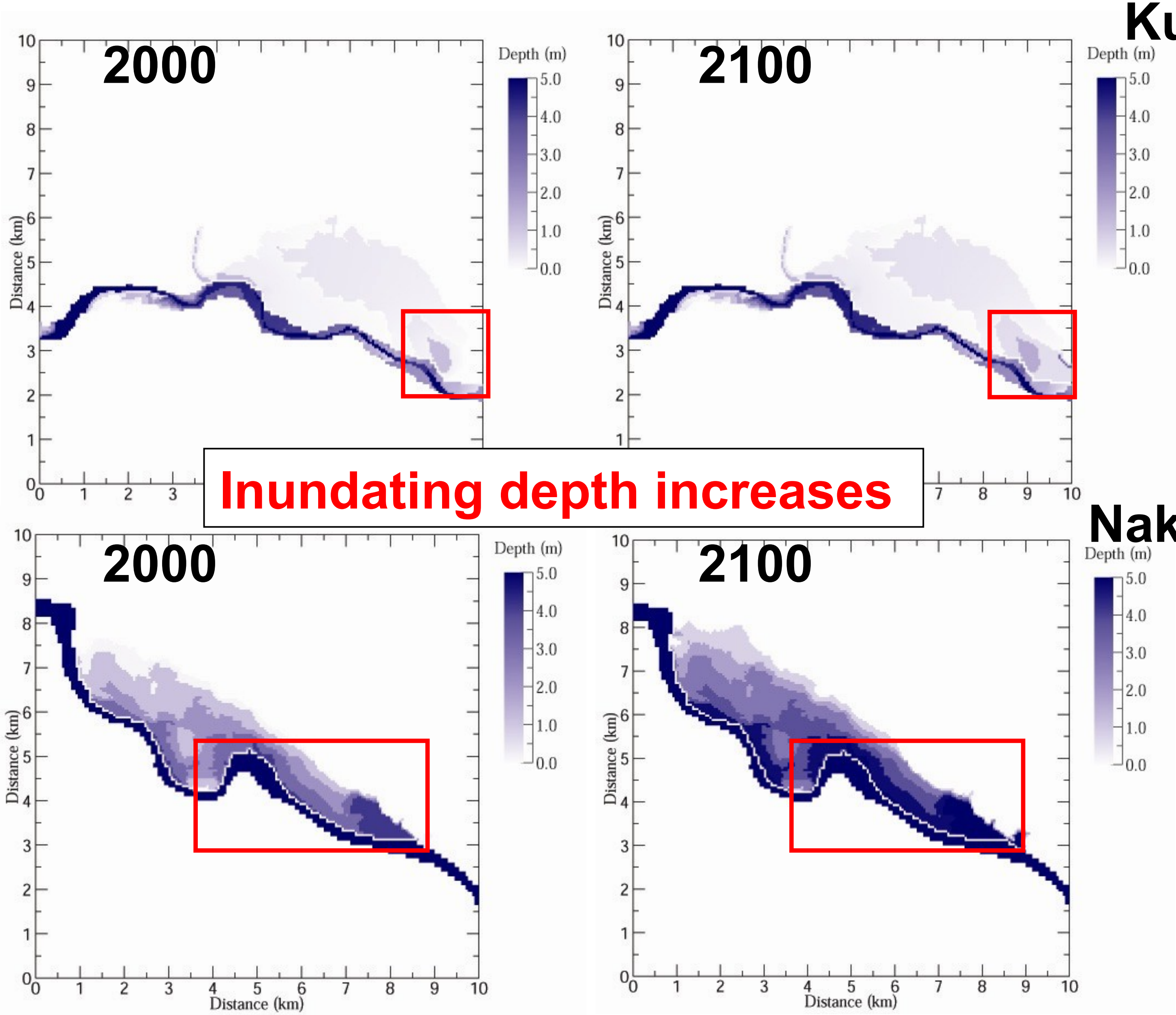
破堤後12時間

Inundated area



Kuji (24hrs)

Naka (Max. area)



Indexes of flood risk

流域名 area	年 Year	浸水人口 Population （千人） (x10³)	最大浸水面積 Inundated (km²)
久慈川 Kuji (km²)	2000	122.80	10.99
	2100	123.40	11.07
那珂川 Naka	2000	398.70	10.02
	2100	445.50	11.80
荒川 Arakawa	2000	209.80	5.24
	2100	967.10	26.40
筑後川 Chikugo	2000	19.40	13.19
	2100	126.70	55.95

- Flood risks are shown as
  (1) Inundated area
  (2) Inundated population
  (3) Inundating depth

	洪水流量比 Floodflow	氾濫流量比 Overflow ratio	浸水面積比 Inundated area	浸水人口比 Population
久慈川 Kuji	1.08	1.61	1.01	1.01
那珂川 Naka	1.28	1.16	1.18	1.12
荒川 Arakawa	1.22	10.14	5.04	4.61
筑後川 Chikugo	1.40	19.37	4.24	6.53

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Summary

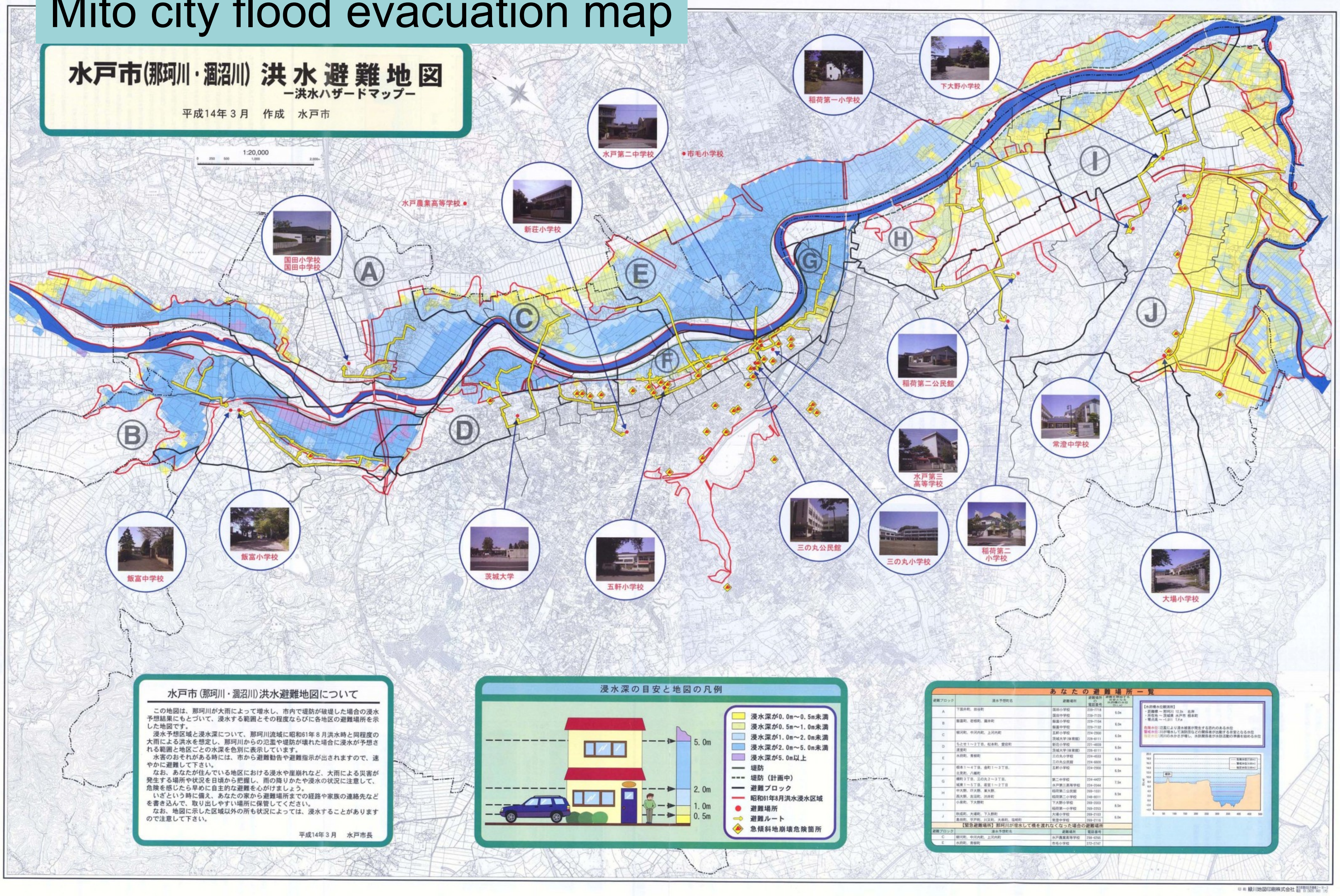
Future flood risk were assessed: Changes in rainfall and sea-level due to climate change affected the areas and depths of inundations.

- Linear response is assumed between the daily rainfall and river flow data.
- Future river flow were estimated by the linear response function and the rainfall data in climate scenario.
- Future flood flow (1/100 years) were estimated by using statistical analysis: The future flood flows increased in most river basins.
- Inundation risks (areas) were affected by flood flow rate, overflowed volumes, and geographical feature.

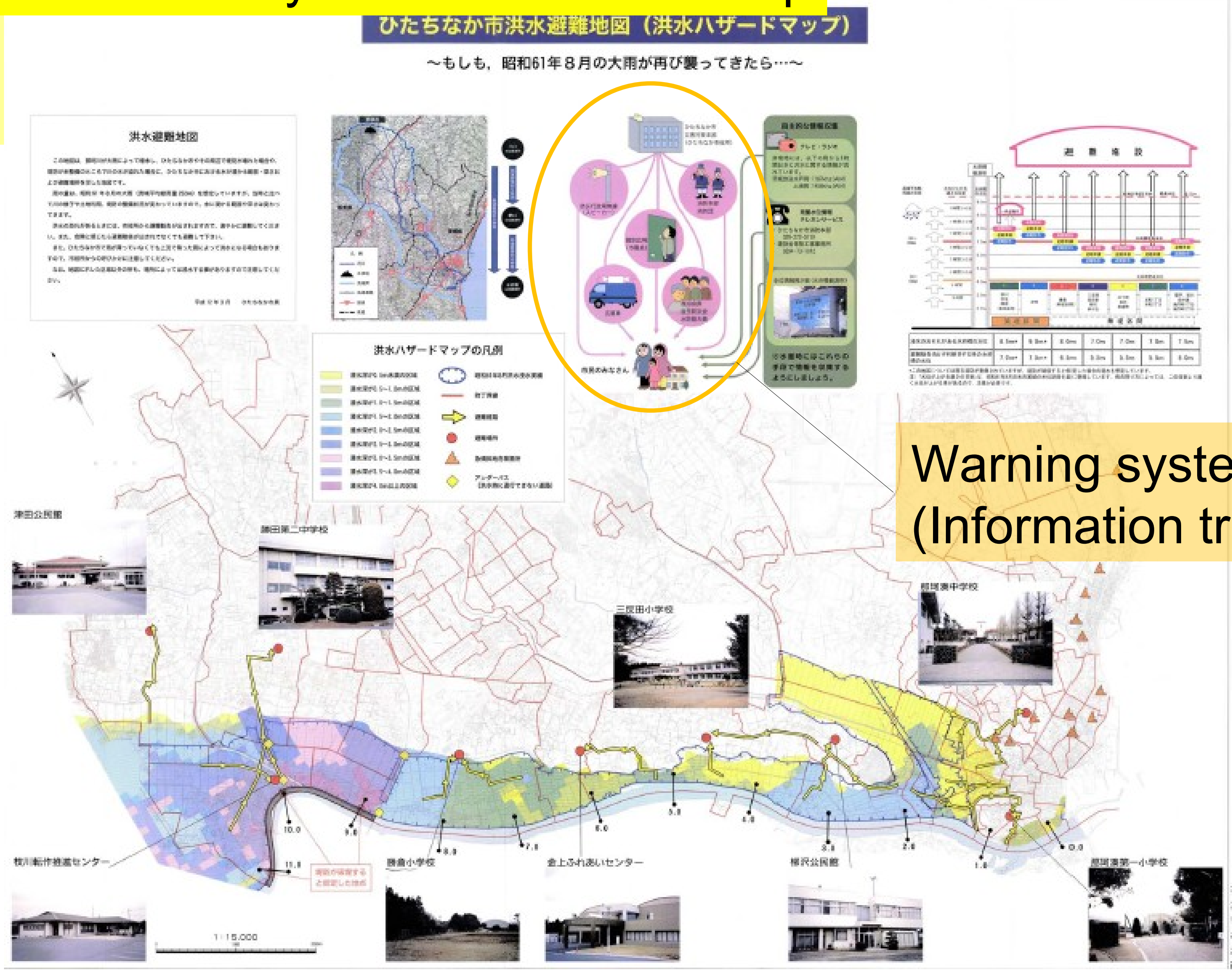
Hazard Map

- To show the risk of flood to residents
  - Local and Central governments
  - Records of maximum inundation areas and depths among the past floods
- To show the evacuation route
  - Higher grounds and safe roads
  - Shelter areas
- To show projected flood area
  - Heavier rainfalls due to climate change
  - Real time hazard map

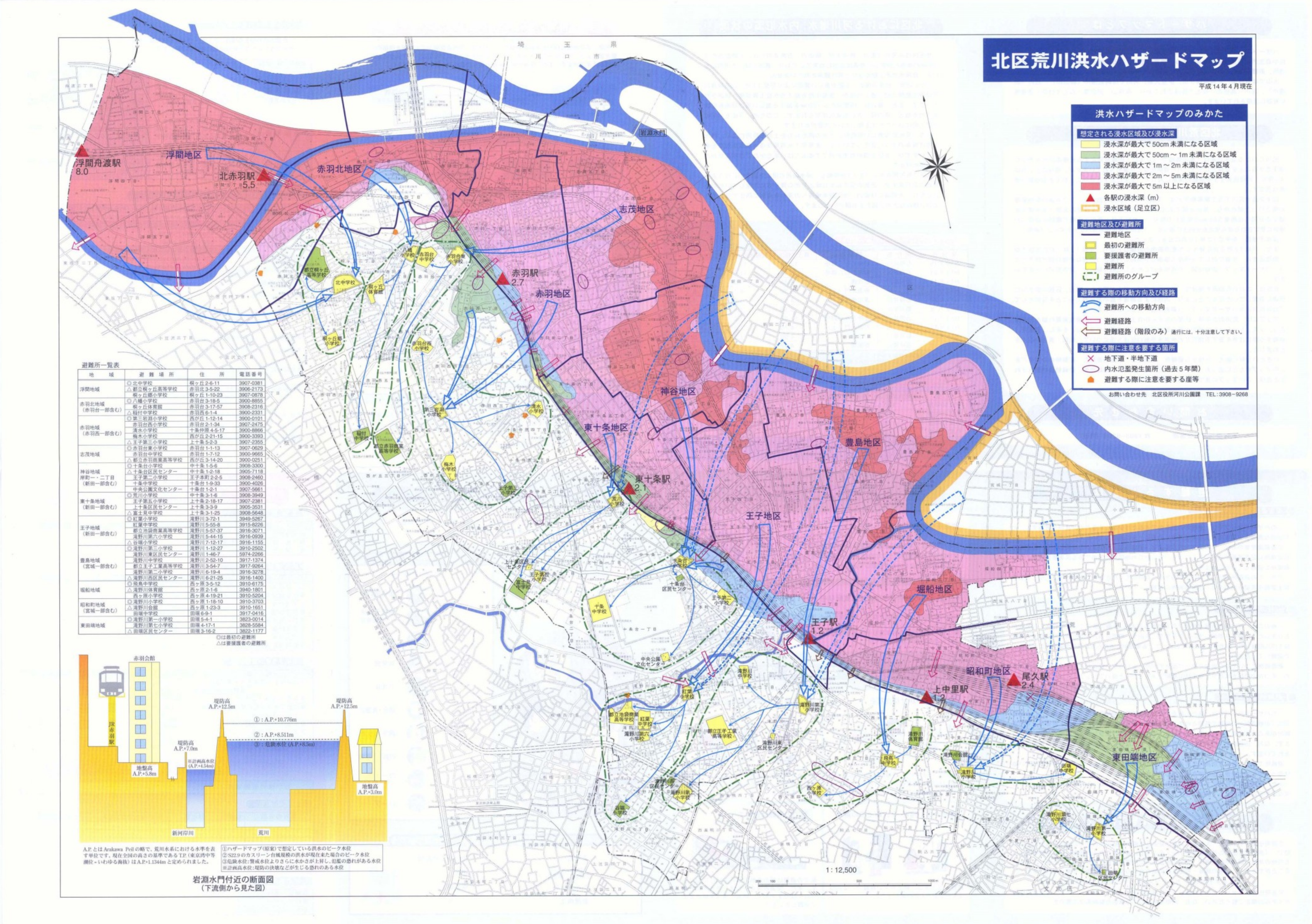
Mito city flood evacuation map



Hitachinaka city flood evacuation map



Warning system
(Information transfer)



Evacuation routes are shown

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Hazard Map

- To show the risk of flood to residents
  - Local and Central governments
  - Records of maximum inundation areas and depths among the past floods
- To show the evacuation route
  - Higher grounds and safe roads
  - Shelter areas
- To show projected flood area
  - Heavier rainfalls due to climate change
  - Real time hazard map

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Climate Change Vulnerability Assessment and Urban Development Planning for Asian Coastal Cities

Vulnerability Assessment as an Entry Point to Link DRR and CCA for Adaptive Urban Governance

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UNITED NATIONS UNIVERSITY
birkmann@ehs.unu.edu

Hypotheses

1. The assessment of vulnerability to natural hazards and climate change is a prerequisite for informed urban adaptation strategies

2. Current vulnerability assessments are often focusing solely on exposure and economic losses – multi-dimensional foci are missing

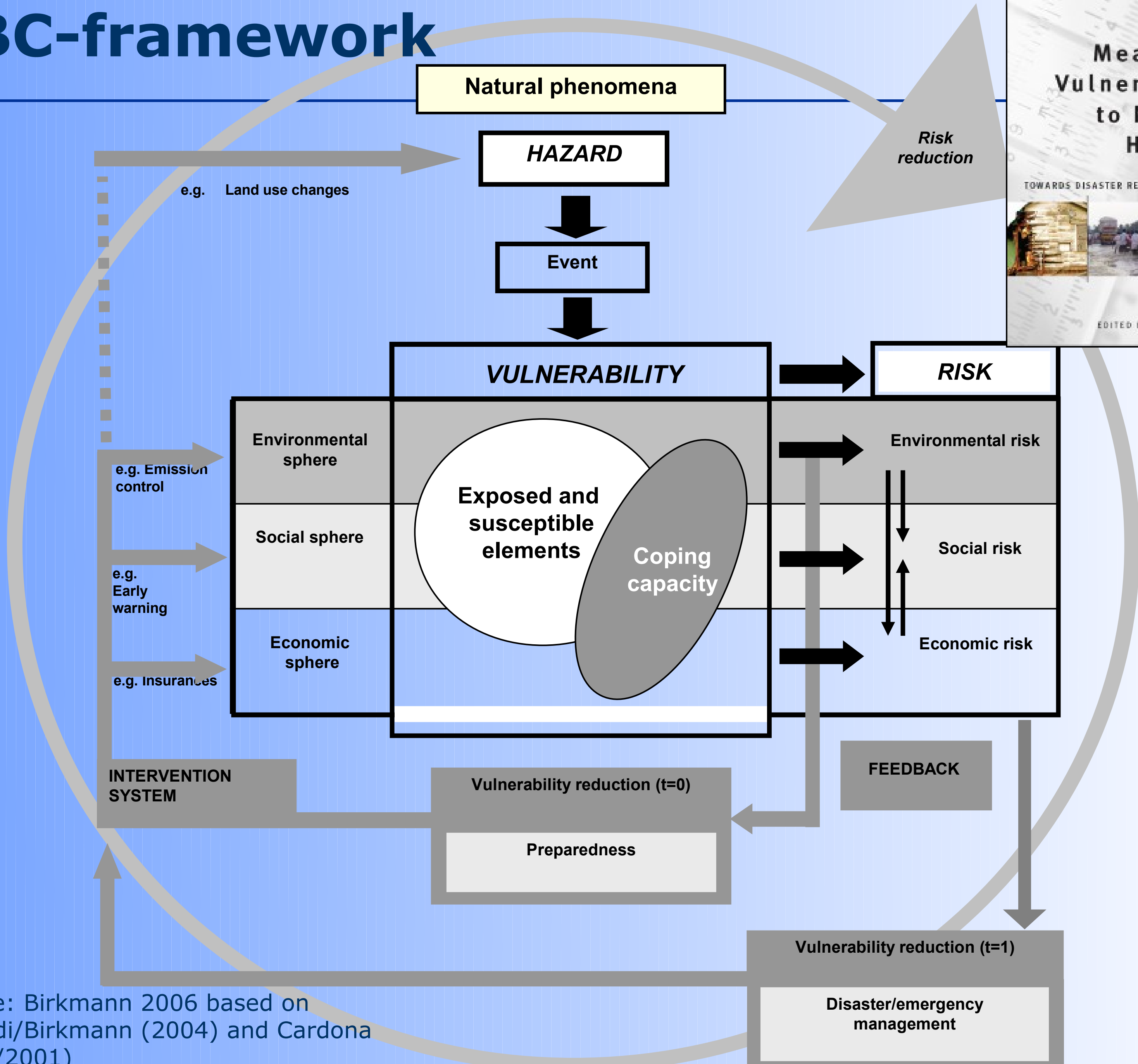
3. Vulnerability Assessment and adaptation strategies need to combine different data and knowledge sources as well as methodologies

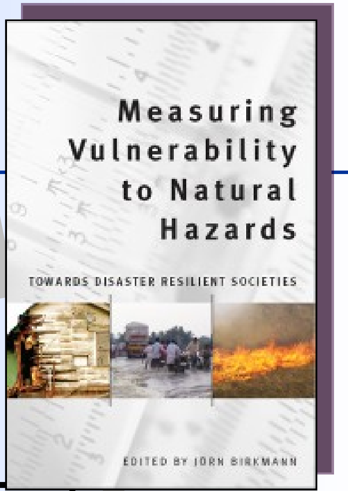
4. Current urban adaptation strategies largely privilege structural measures

5. The implementation of adaptive urban governance requires a more rigorous review of the constraints of existing measures

Areas of Work linked to Climate Change

BBC-framework





Source: Birkmann 2006 based on Bogardi/Birkmann (2004) and Cardona (1999/2001)

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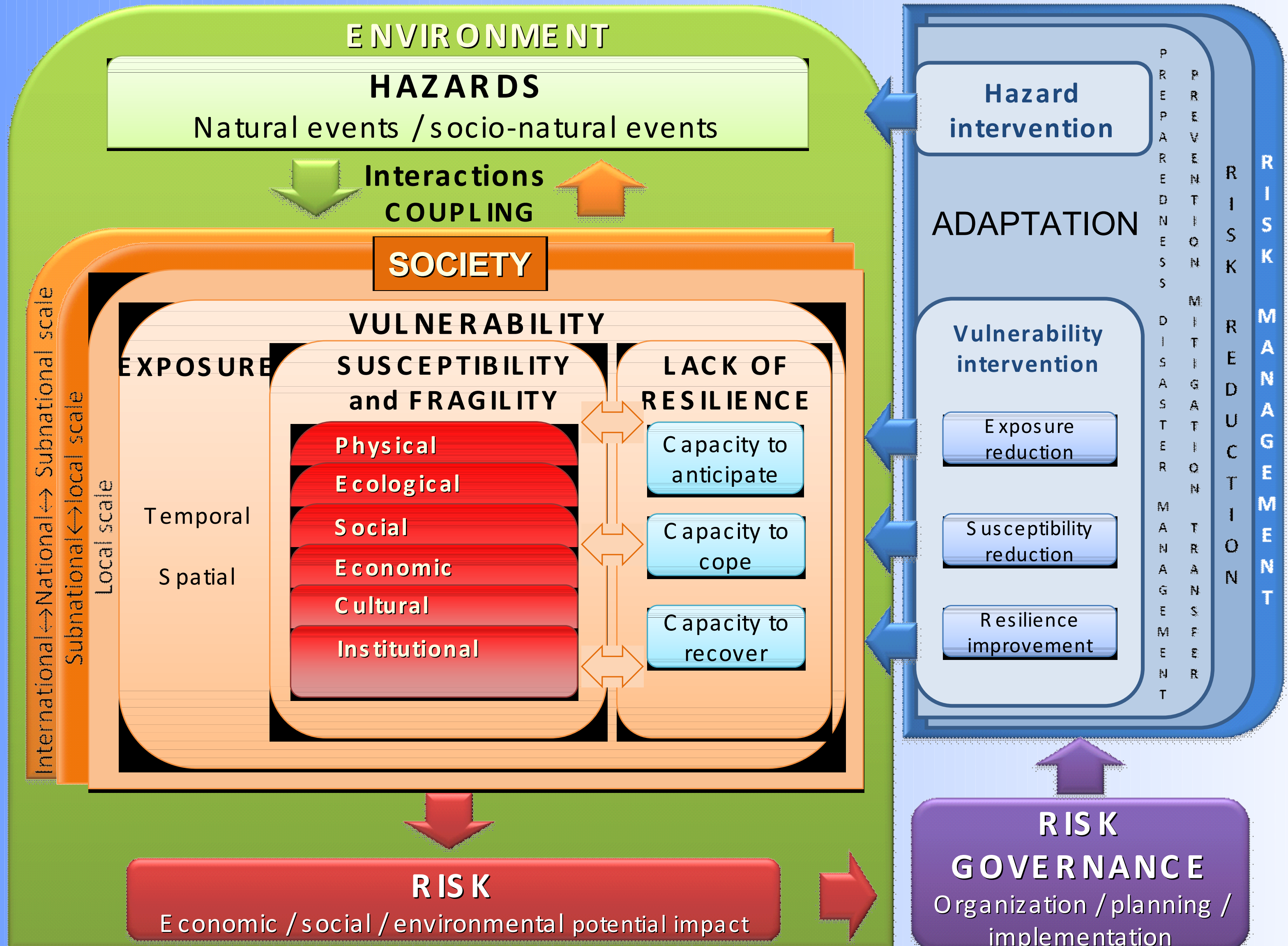
MOVE-project framework for VA



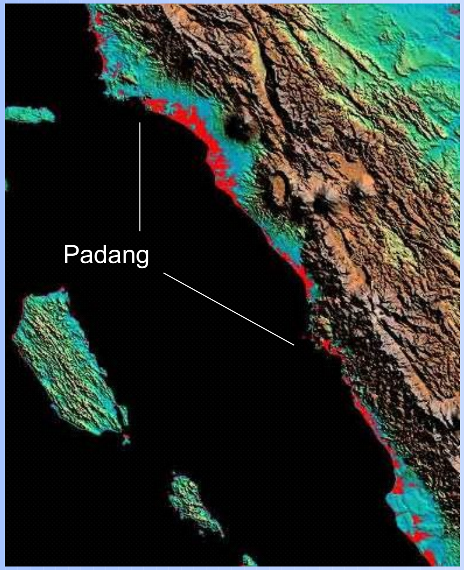
Source: EC MOVE Project (authors Cardona, Birkmann, Barbat et al. 2010)

Vulnerability Assessment

Case studies

Cologne

Padang



Can Tho

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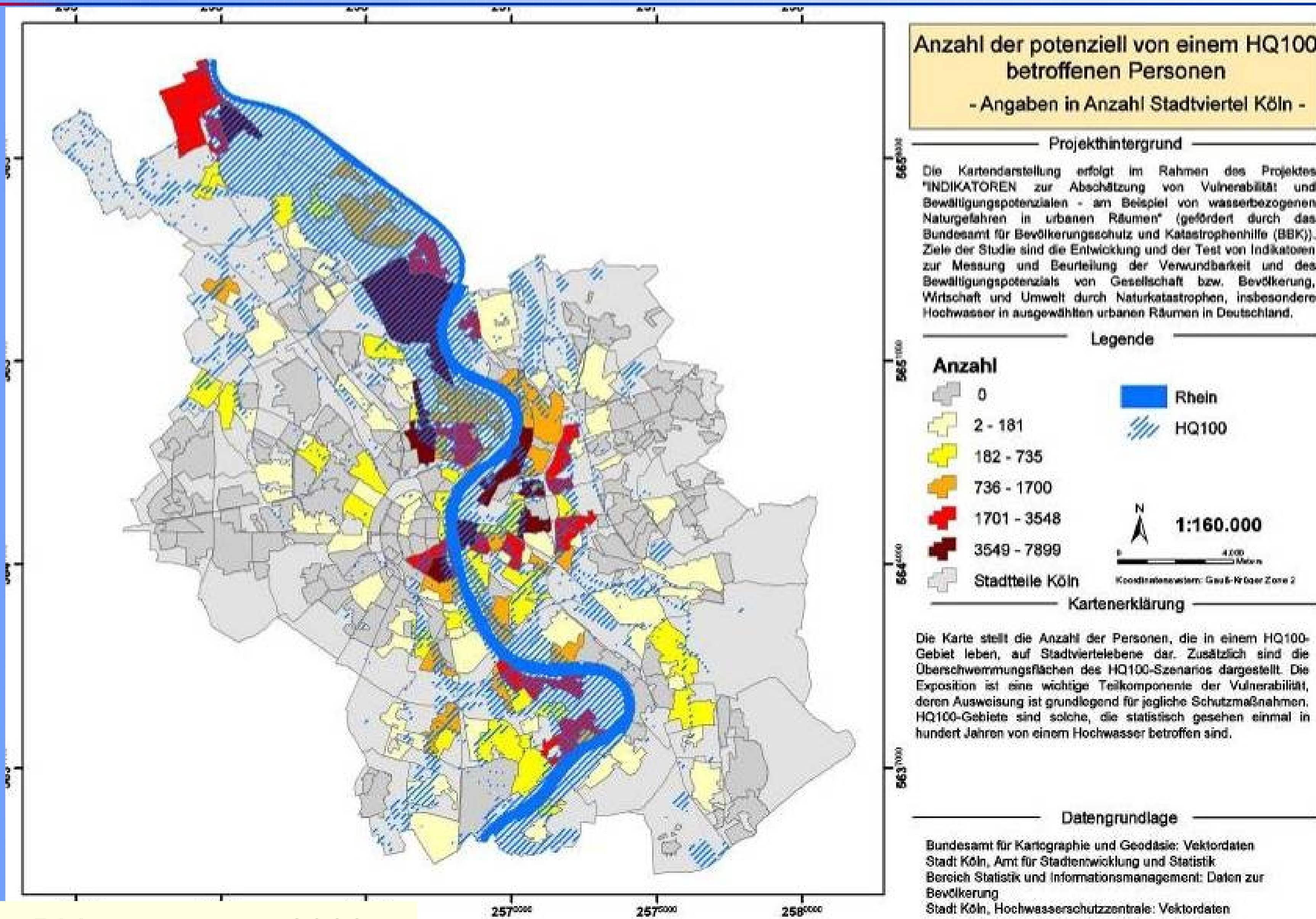
Exposure of People to Floods - Cologne

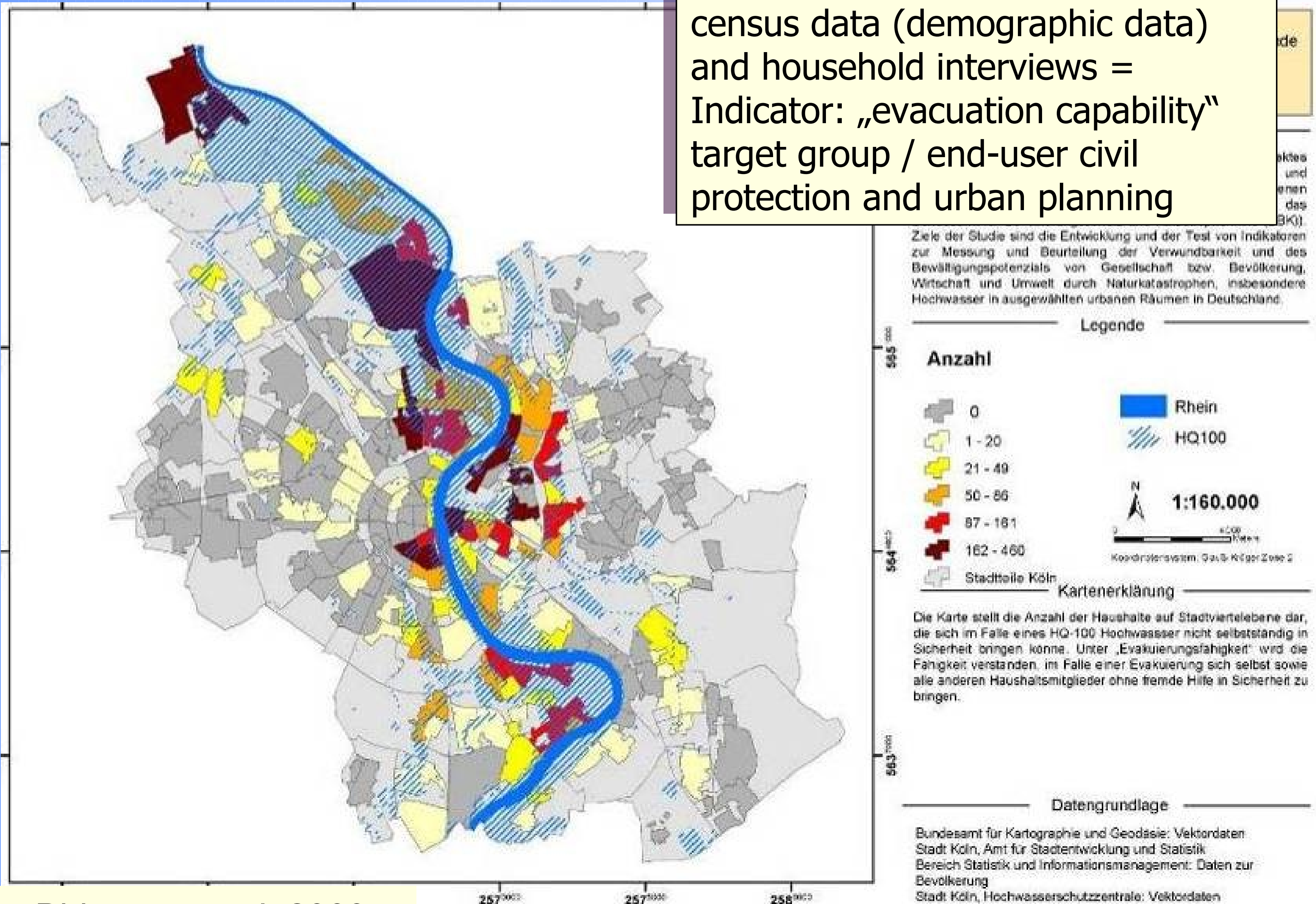


Source: Birkmann et al. 2009

Susceptibility

Case study Cologne:

Susceptibility calculation based on census data (demographic data) and household interviews = Indicator: „evacuation capability" target group / end-user civil protection and urban planning



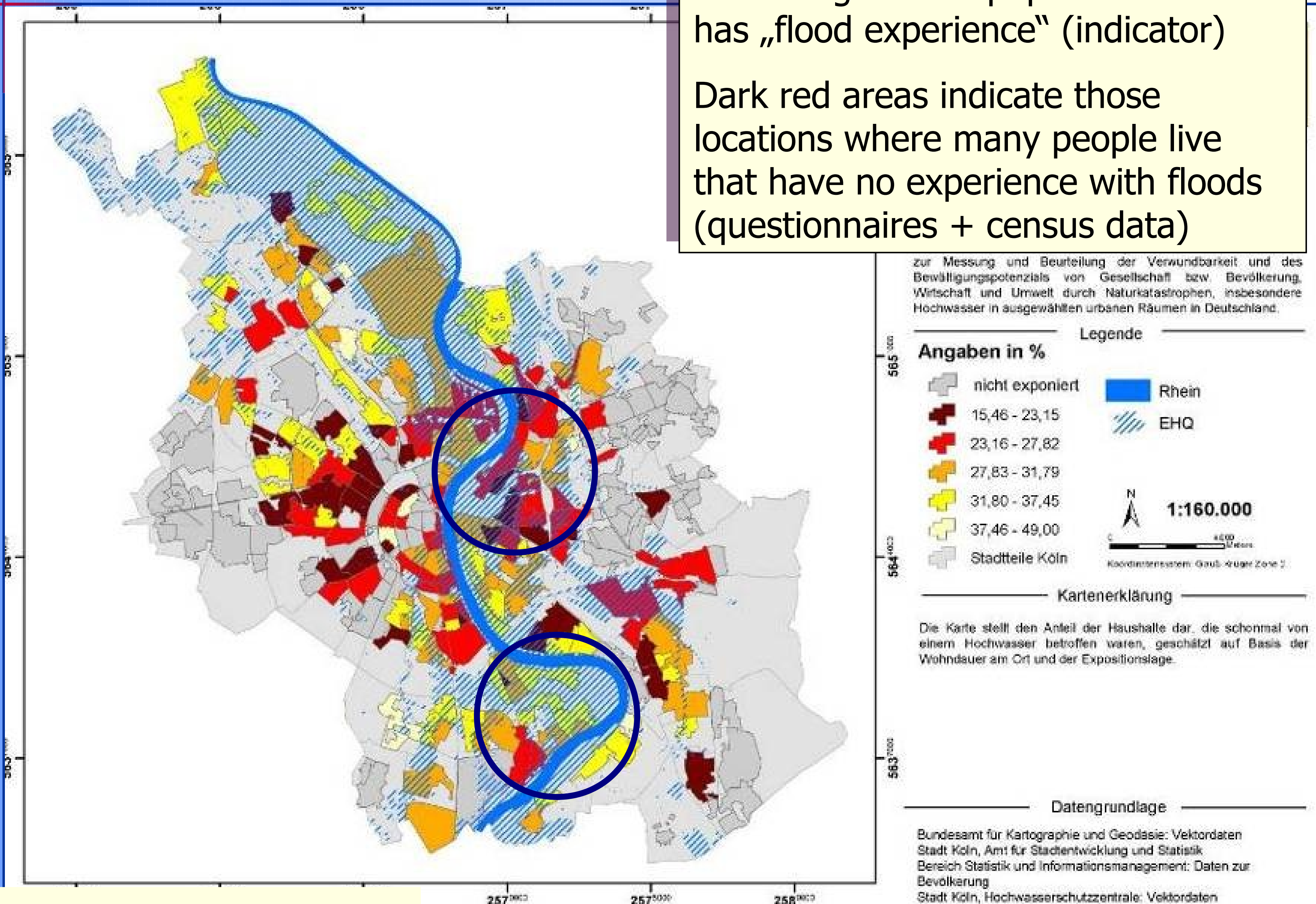
Source: Birkmann et al. 2009

Coping Capacity

Case study Cologne:

Percentage of the population that has „flood experience“ (indicator)

Dark red areas indicate those locations where many people live that have no experience with floods (questionnaires + census data)



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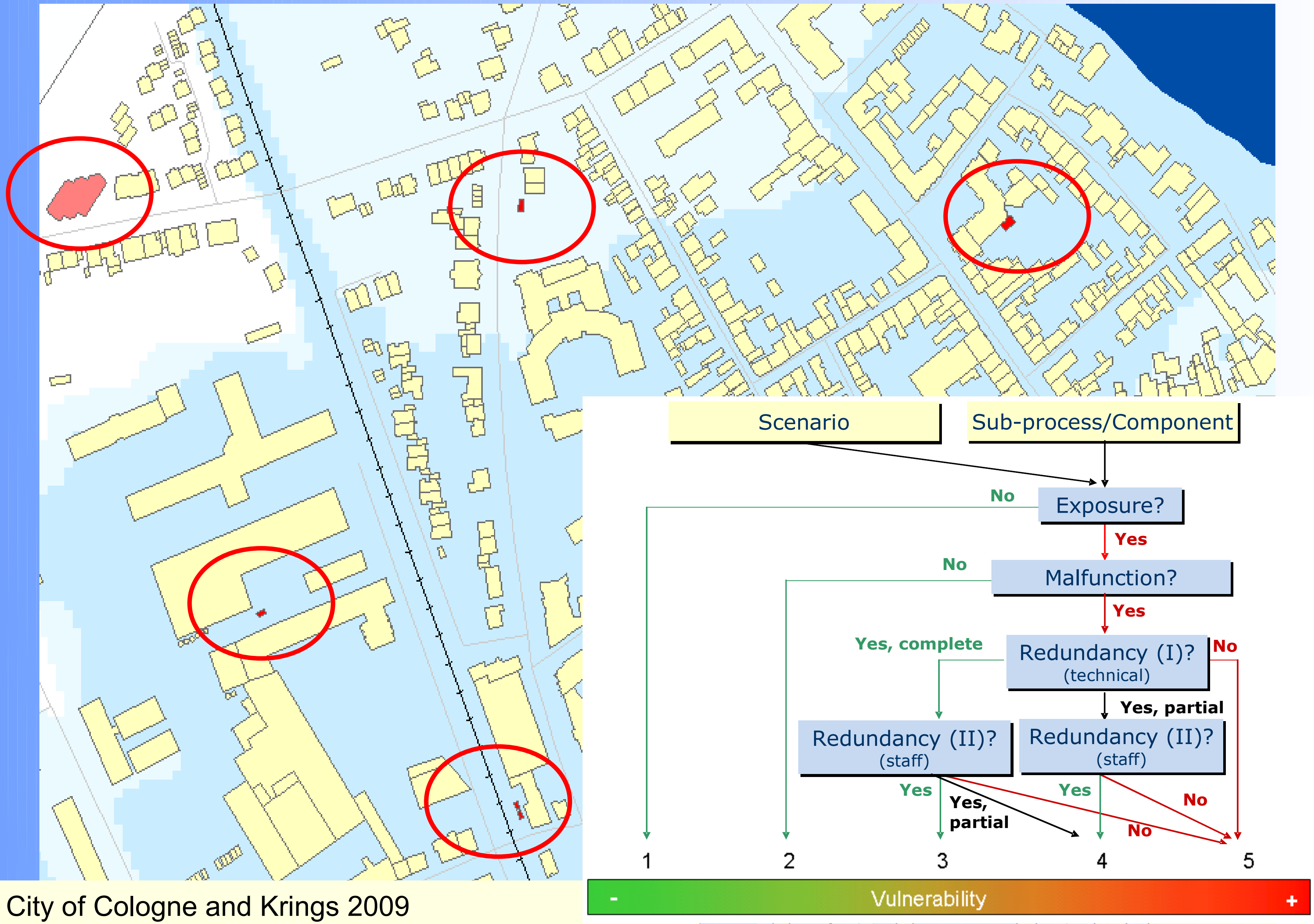
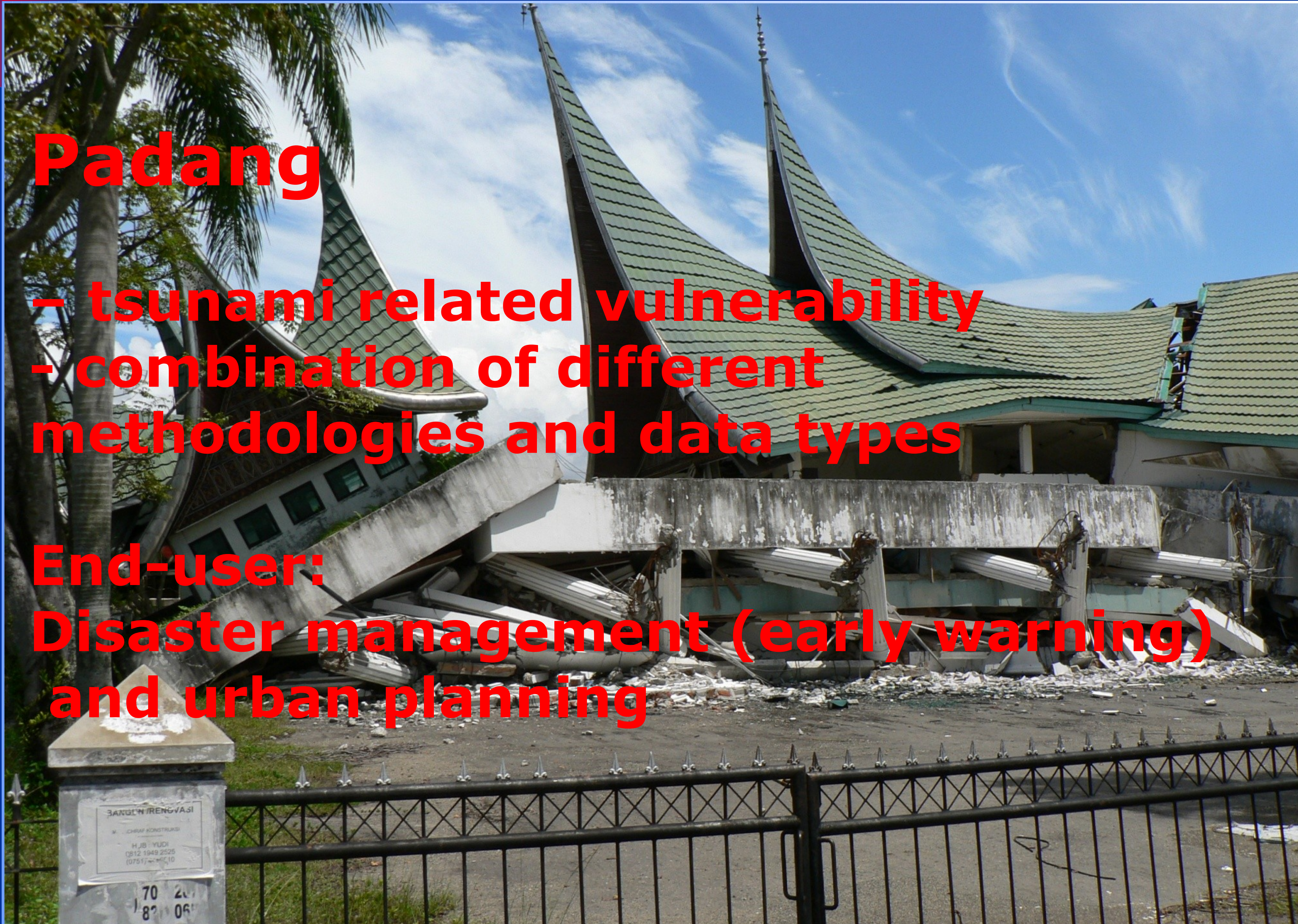
Source: Birkmann et al. 2009

Vulnerability of critical infrastructures



Source: City of Cologne and Krings 2009

Case study: Padang (Indonesia)



Padang

- tsunami related vulnerability
- combination of different methodologies and data types

End-user:
Disaster management (early warning) and urban planning

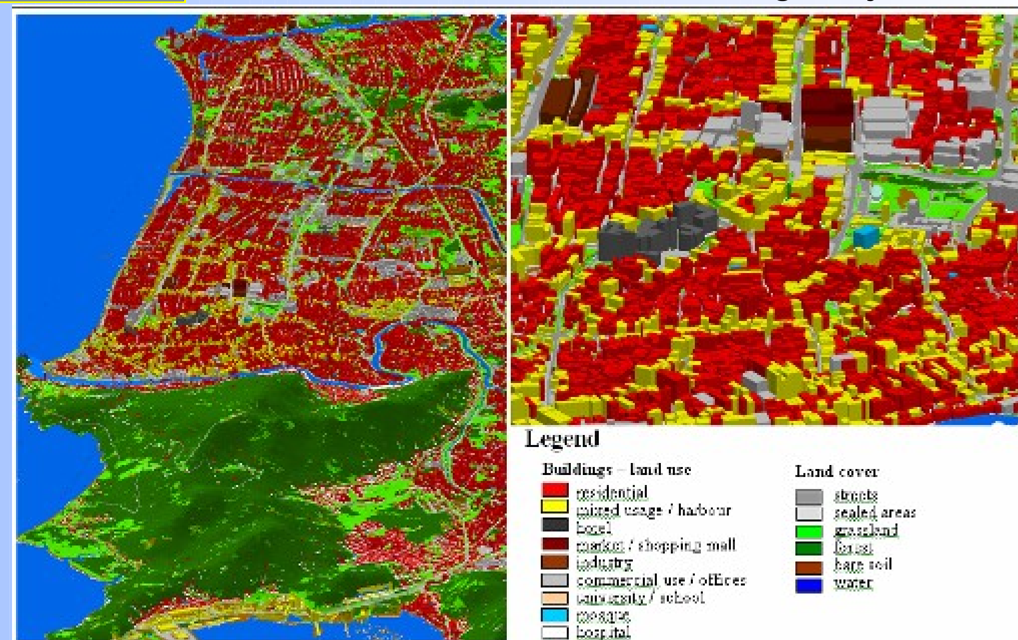
Combining different methodologies

WEIGHTS	CLASSIFICATION
% social groups:	Children (0-14) · Male (15-64) · Female (15-64) · Elderly (65+)
% of main activity by social group:	Education · Work (Trade, Service, Industry) · Others
% activities conducted -morning -afternoon -night	Home activities · School / campus activities · Work activities · Care and social activities
% Mobility - Location of activities:	**Outside House** Building – school, commercial, office, mixed use, other public facilities · **At home / Neighbourhood** Building - residential, mixed use

Activity Pattern by Social Groups derived from Population Census & Household Survey

Integration of both data sources & analysis methods

Building – land use types derived from remote sensing analysis



Urban morphology & socio-economic structure

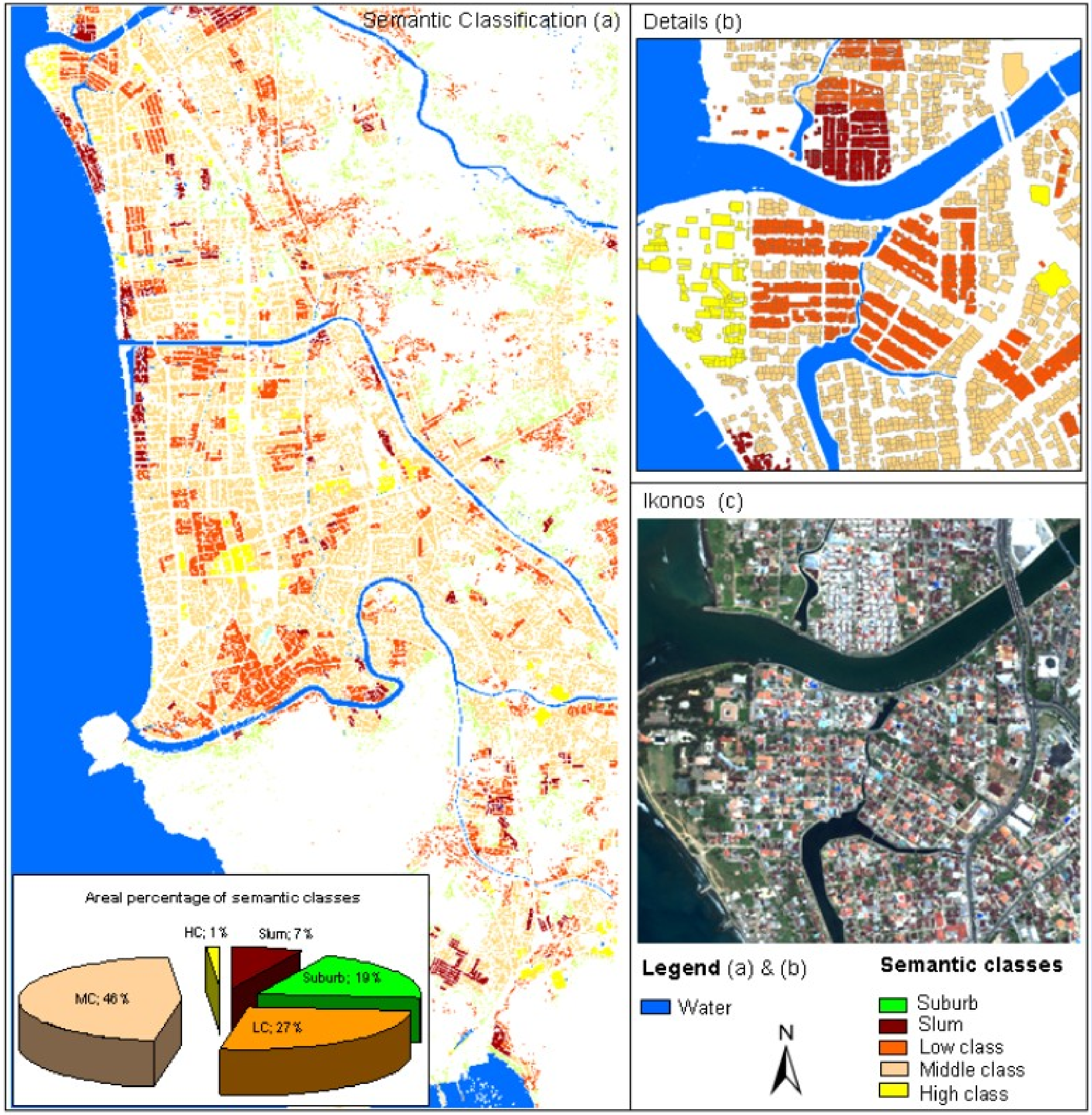
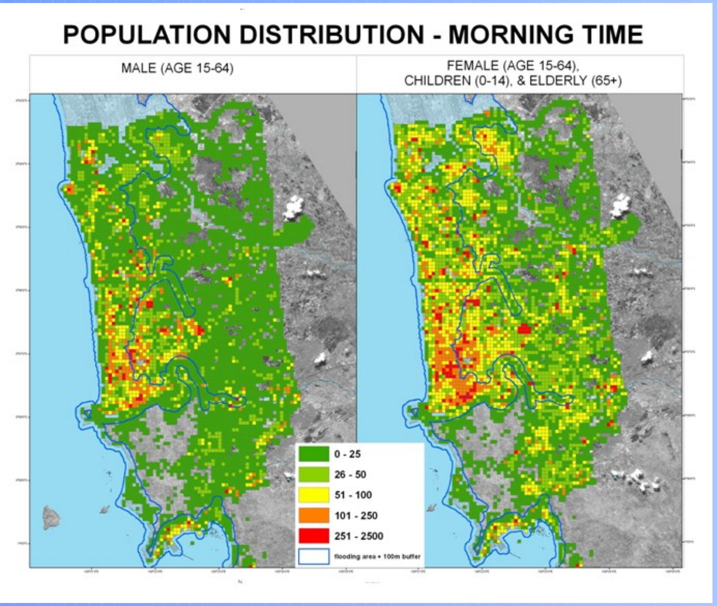
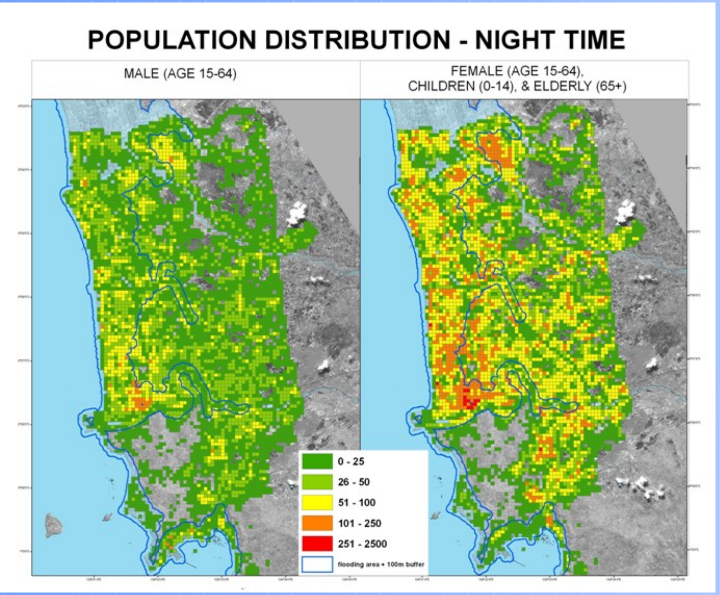


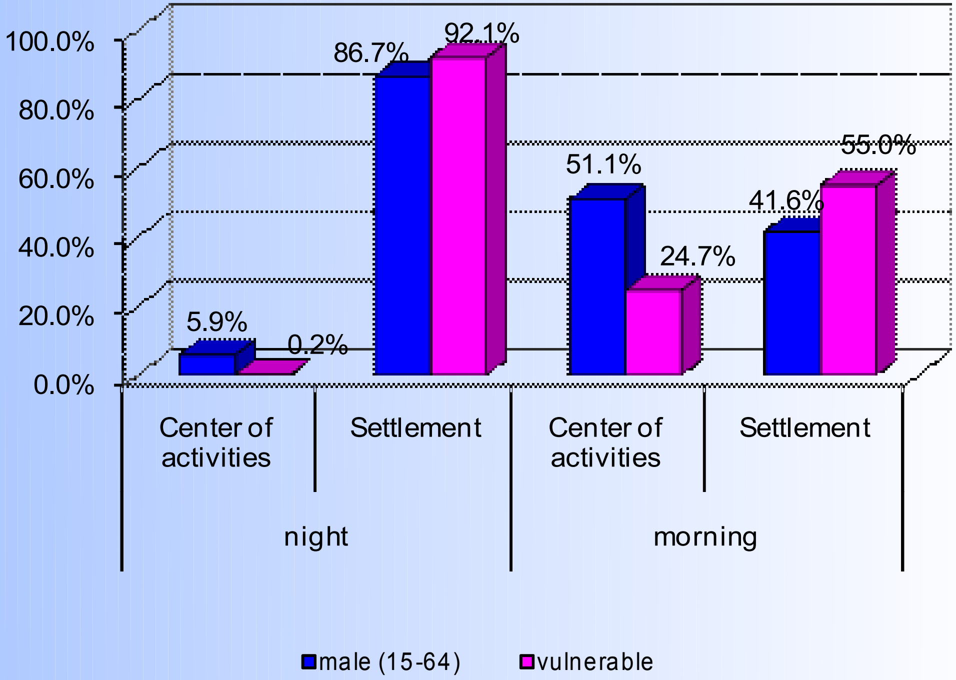
Figure 3: Semantic Classification of Buildings – Urban Physical Morphology (Source: Taubenböck, 2008)

Dynamic Exposure





%-age of Population Groups by Daytime and Building Use
Hazard Zone



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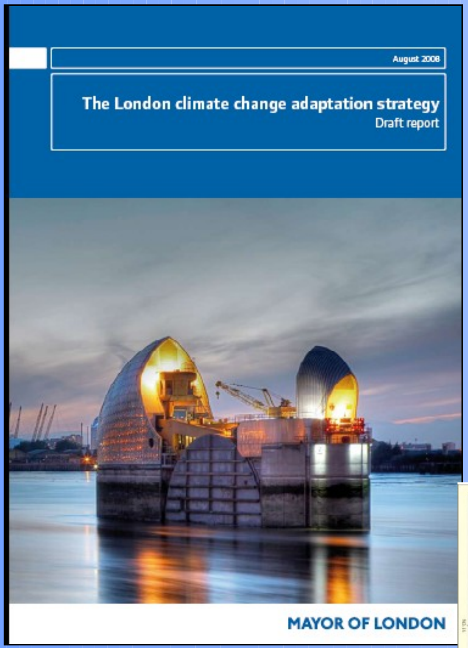
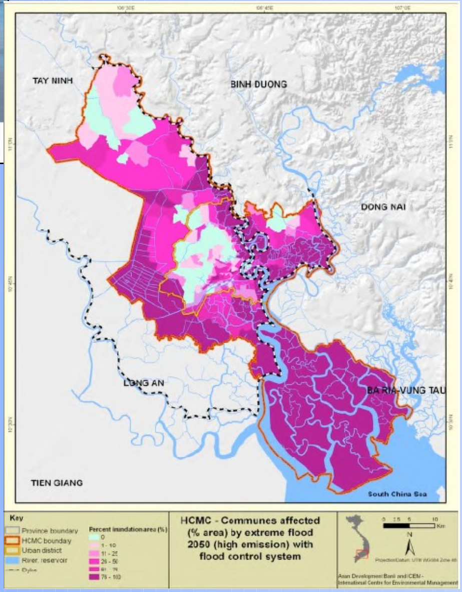
Urban Adaptation Plans
and
Extreme Events

Examination of international examples





Key-Questions

- Guiding Vision (Risk perspective, resilience, transformation)
- Expected changes in the context of climate change in cities
- Topics and areas of concern, Strategies and Concepts
- Informationbasis
- Measures and actions proposed
- Stakeholders

Adaptation

IN THE NORTH

LONDON

Greater London

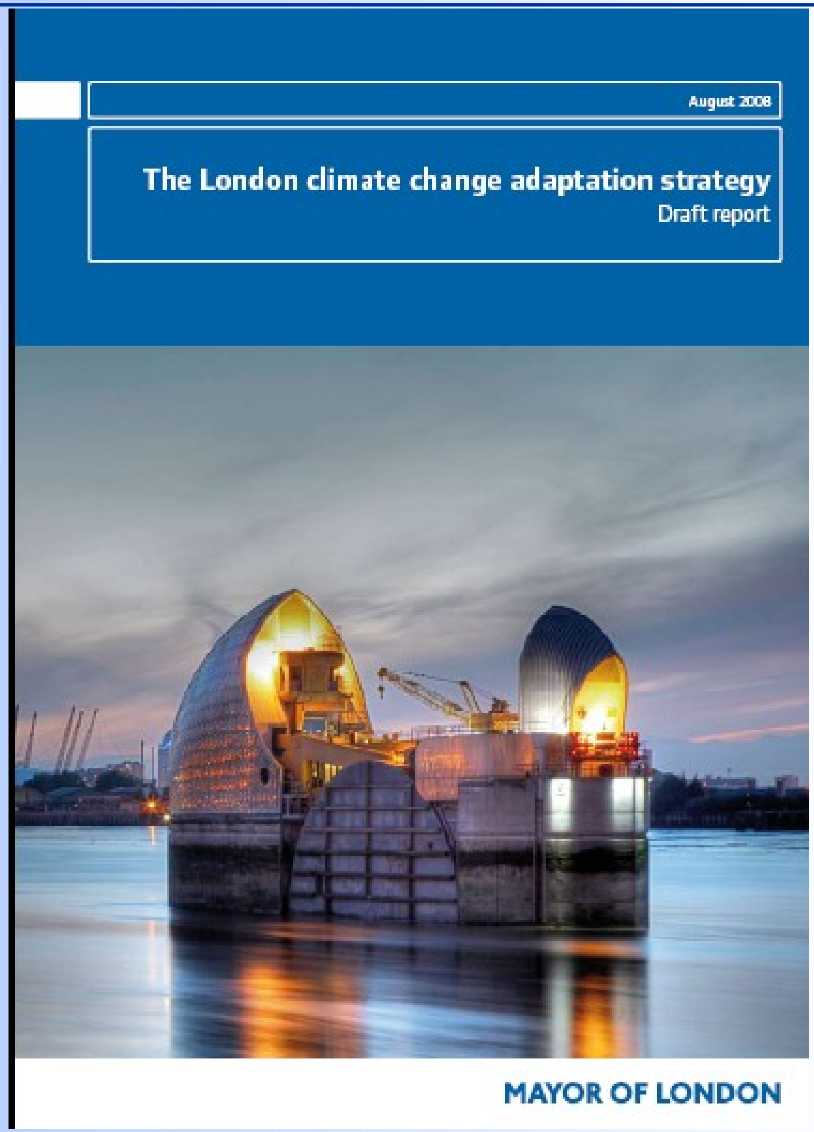
14 Mio. Inhabitants, spatial extend 1.570 km²

Density ~4.000 inhabitants/km²

27% of the population are immigrants

Land is 5-18m above normal zero

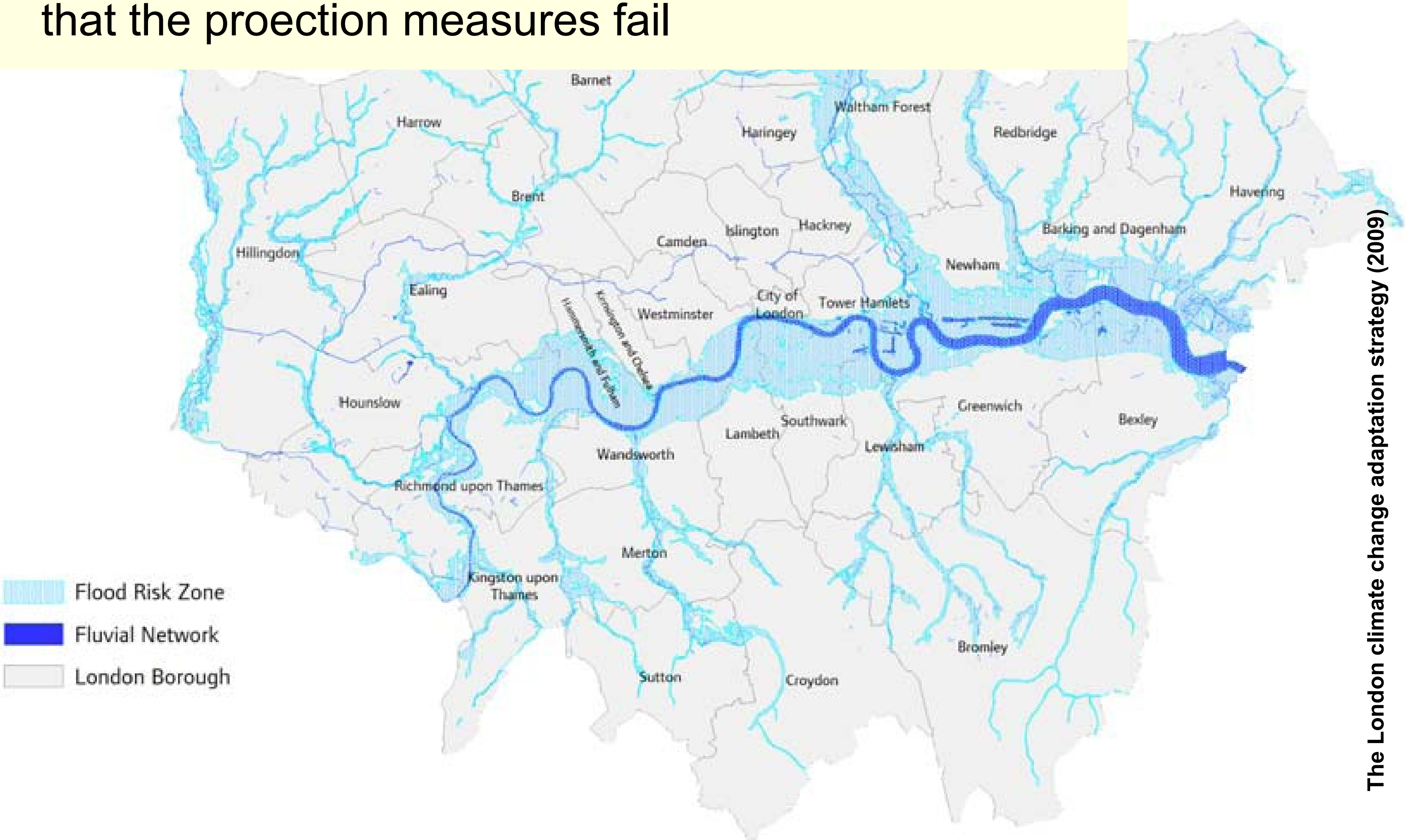
South/East England is one of the dryest areas in England with ~1.000mm/a precipitation



Quelle: http://upload.wikimedia.org/wikipedia/commons/6/67/PIA04301.jpg

Floods

- New Scenarious for flash floods, sea level rise and rise of ground water tables – planning in the case that the proection measures fail



The London climate change adaptation strategy (2009)

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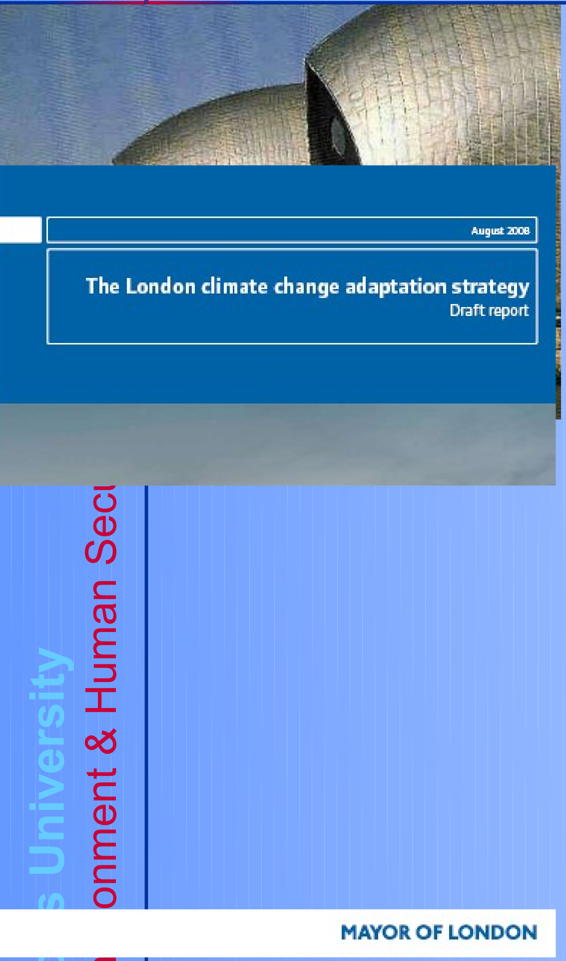
Adaptationstrategy - Water



- Realization: not the major floods, but droughts are a key problem under the further intensification of CC
- London is losing more than 25% of its fresh water due to leaking pipes, 80% of the frehs water comes from the neighbouring communities
- Definition of actions to reduce water consumption in drought periods
- Further development of the Thames barrier
- Urban planning strategies for critical infrastructures
- Development of emergency management plans
- Awareness raising for multi-hazard phenomena

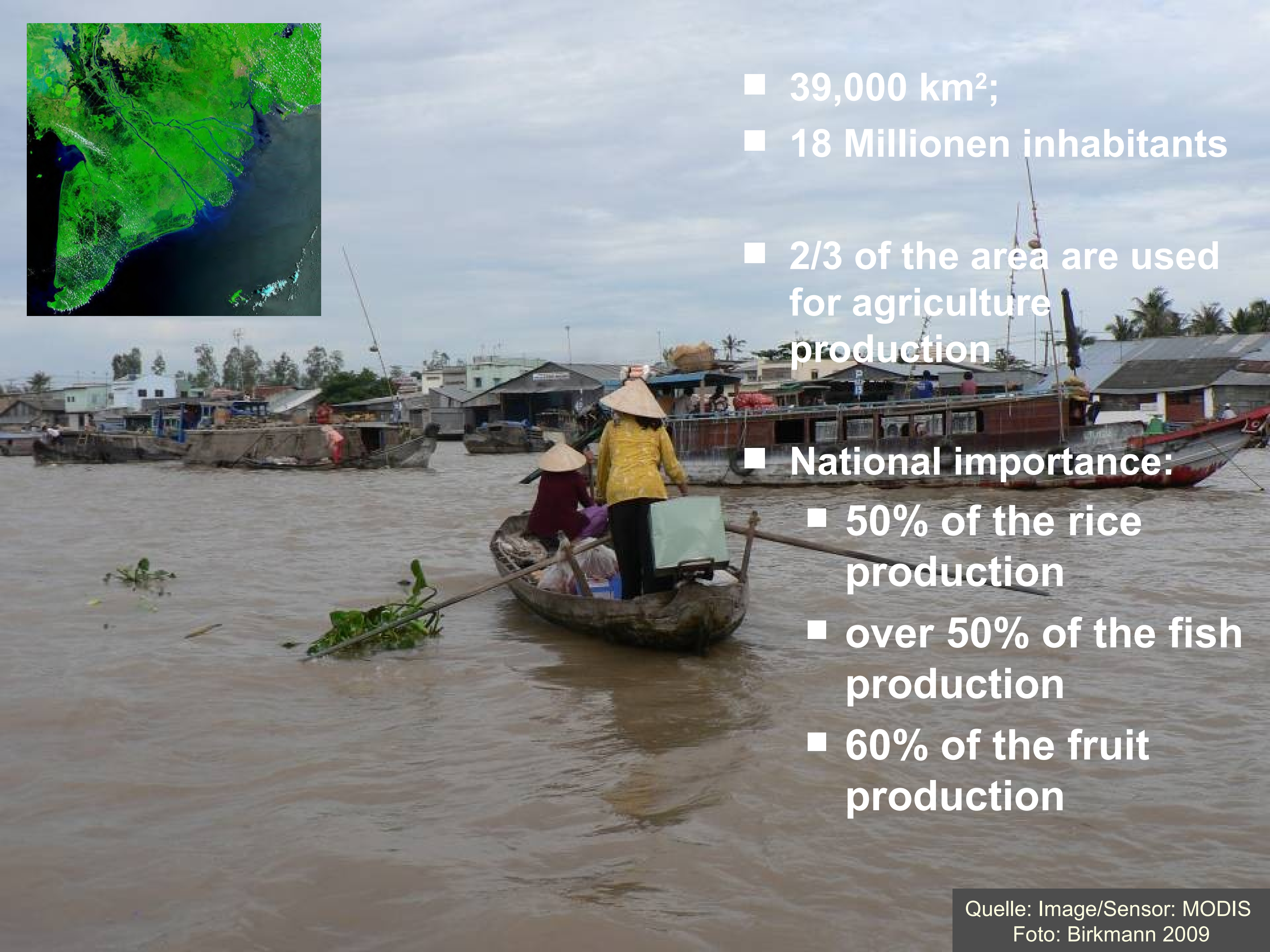
Awareness raising

Challenges:

- Linkages between formal and informal measures not sufficiently defined
- No targets
- mainly technical measures (desalinization plant=
- Limited acknowledgement of participatory tools

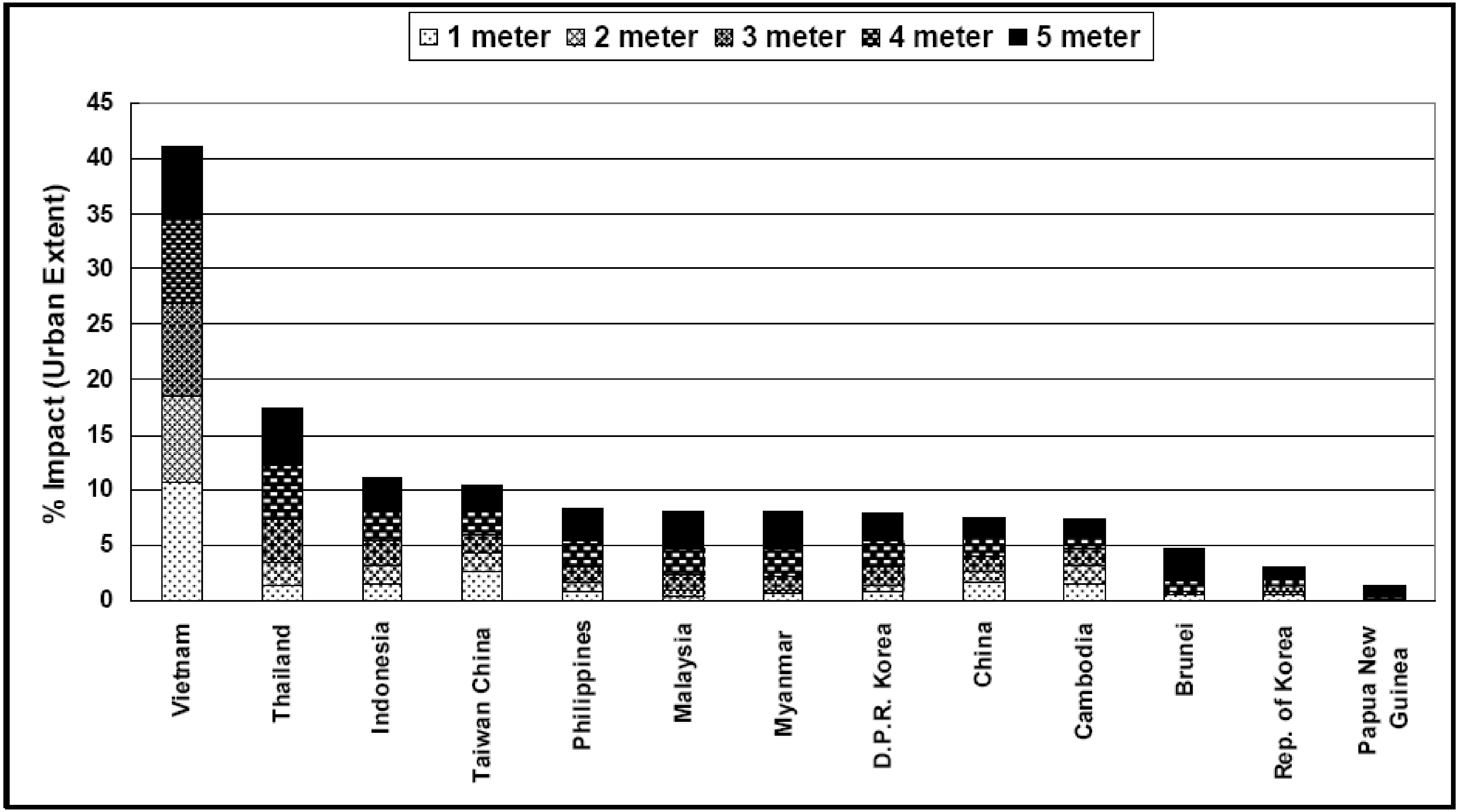
Adaptation

IN THE SOUTH



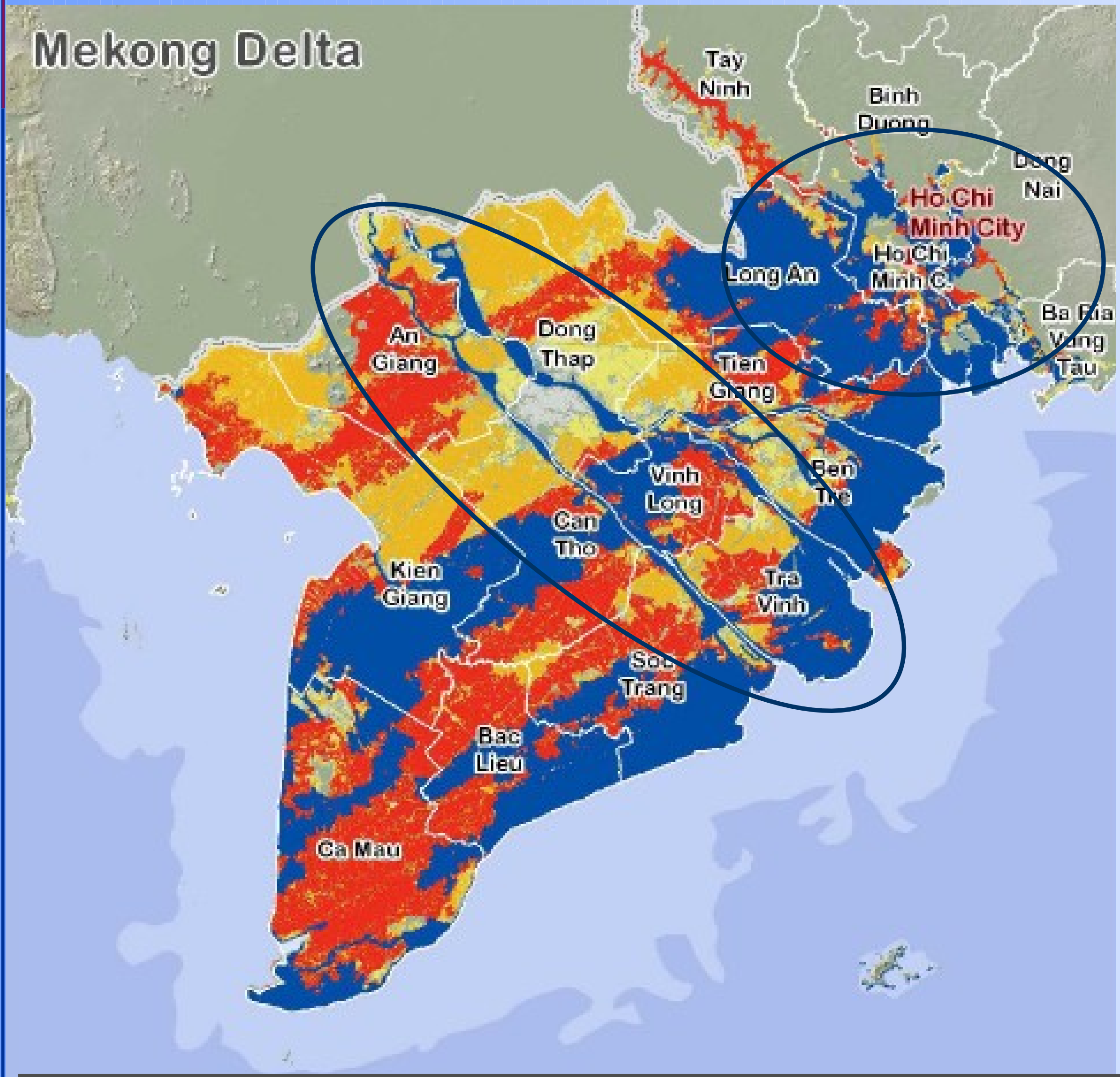
Quelle: Image/Sensor: MODIS
Foto: Birkmann 2009

SLR and its Impact on Urban Areas

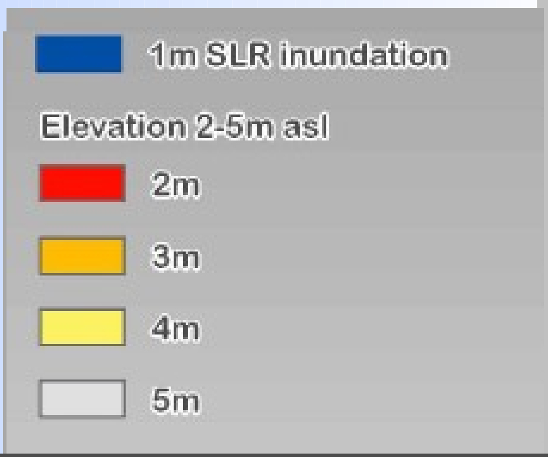


Source: Dasgupta et al. 2007

Climate Change: Sea Level Rise

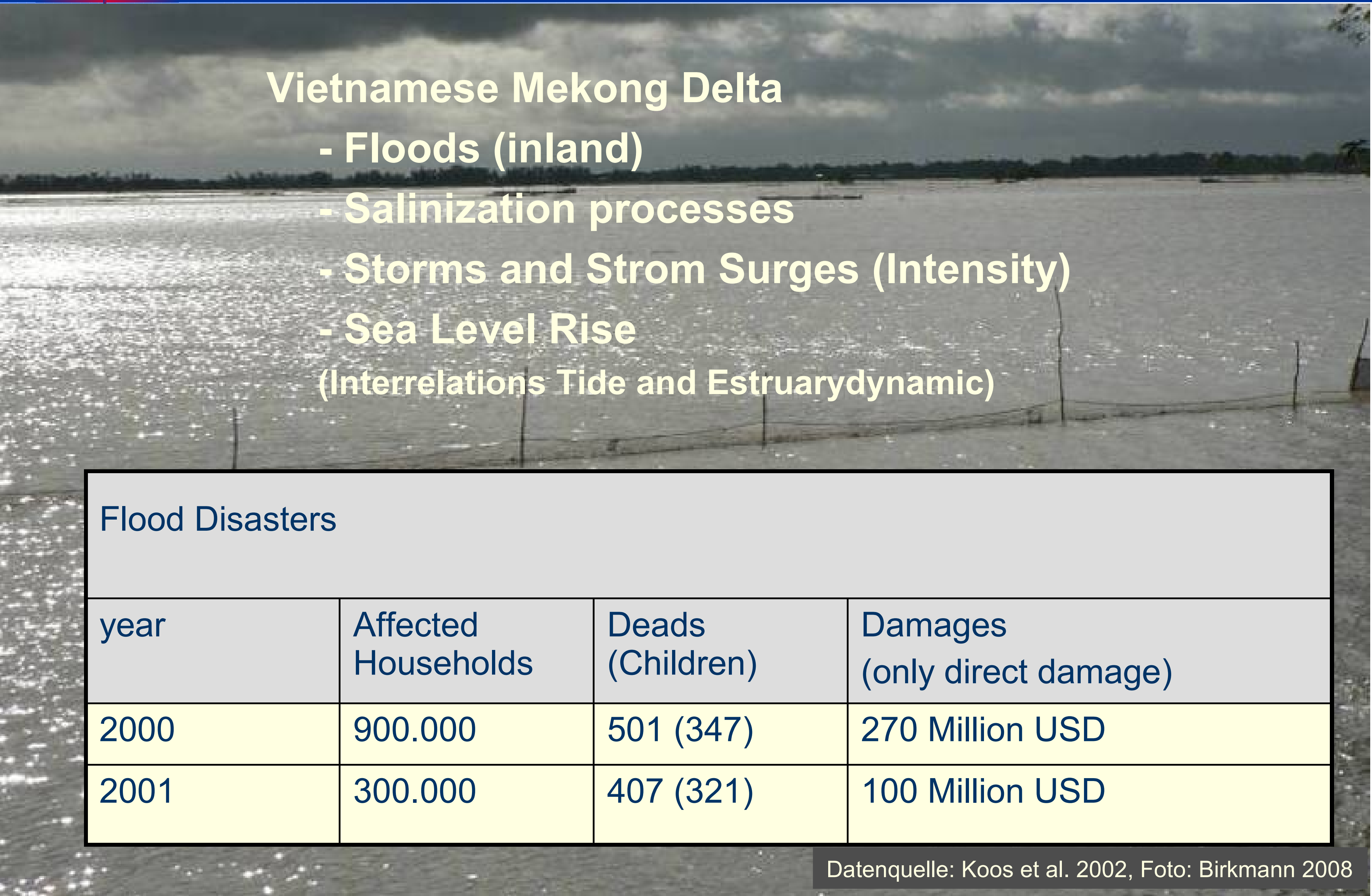


Legende:



Quelle:
Carew-Reid, 2008 - Rapid Assessment of the Extent and Impact of Sea Level Rise in Viet Nam. ICEM

Natural Hazards



Vietnamese Mekong Delta

- **Floods (inland)**
- **Salinization processes**
- **Storms and Strom Surges (Intensity)**
- **Sea Level Rise**

(Interrelations Tide and Estruarydynamic)

Flood Disasters			
year	Affected Households	Deads (Children)	Damages (only direct damage)
2000	900.000	501 (347)	270 Million USD
2001	300.000	407 (321)	100 Million USD

Datenquelle: Koos et al. 2002, Foto: Birkmann 2008

HO CHI MINH CITY

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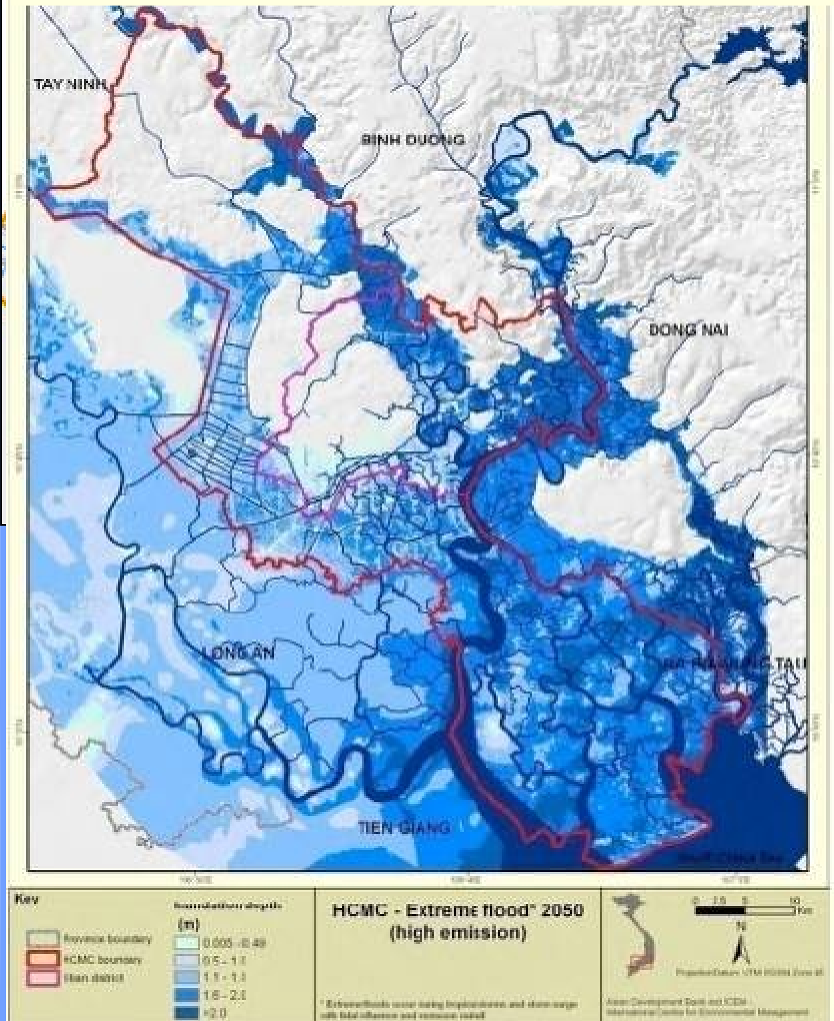
Ho Chi Minh City

- 8 Mio. Inhabitants
- 2.095km² (North-South Expansion of 120km)
- 1,8 m over NN
- Rapid population growth
  Until 2050 the city might encompass 20 Mio. people

  → 2 Mio. Climate refugees expected in the city

ICEM study for HO CHI MIN CITY

Map: Predicted extent of flooding in extreme events under the A2 scenario for HCMC

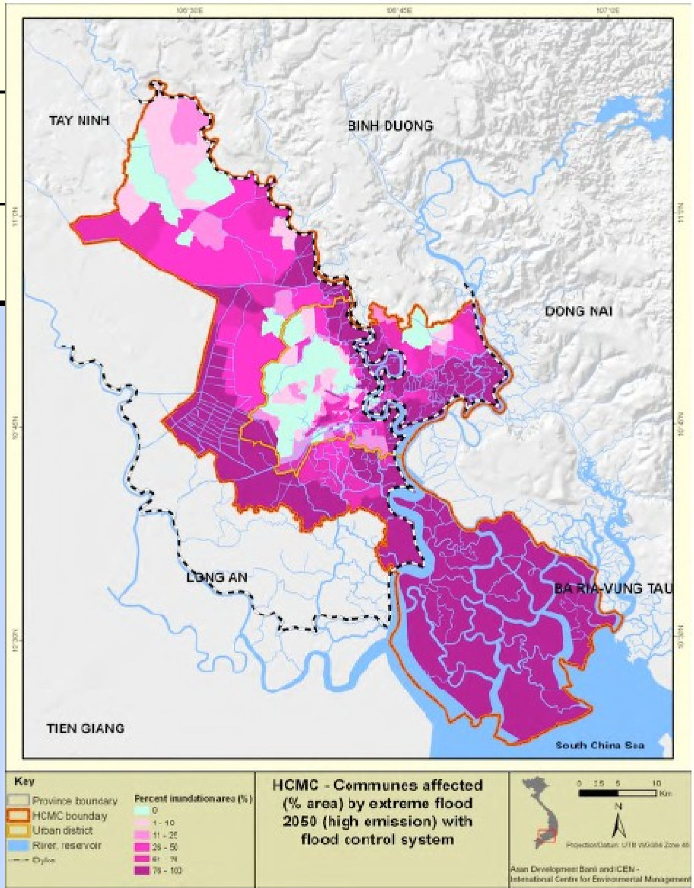


Source: International Centre for Environmental Management 2009, S. 23ff.; Fotos: Bach Tan 2008/2009

- Temperature increase of 1-2°C until 2050
- It is expected that a SLR of 1m would imply a loss of 40% of the city area
- until 2070 it is expected that approx. 70% of the urban areas of Ho Chi Min City might be affected by floods and inundations (without adaptation)
- Current planning activities consider a SLR of 30 cm
- Salinization and saltwater intrusion due to SLR

Limits of Adaptation

Impacts of extreme floods and sea level rise on land use HCMC (2050 extreme events)		
Land use	Affected area without new dykes and flood protection	Affected area with dykes and flood protection
Urban Areas	61%	49%
Industrial	67%	63%
Open Space	77%	76%



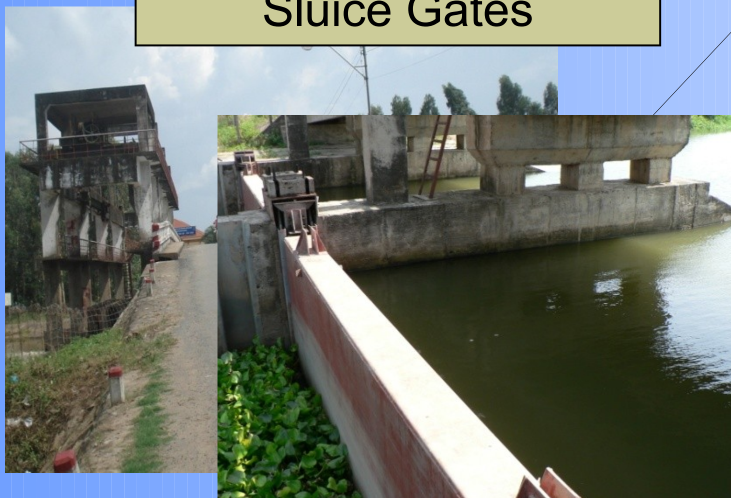
Impacts and Consequences

- Approx. 5 Million people in the Vietnamese Mekong Delta (approx. 18% of the population) would be affected by sea level rise of one metre (Carew-Reid 2008).
- Indirect: Degradation of environmental services and environmental functions, e.g. soils – important impllications of livelihood strategies
- Most likely „socio-ecological tipping points“ will be reached
- Economic liberalization processes (Doi Moi) will cause a further reduction of social protection regimes

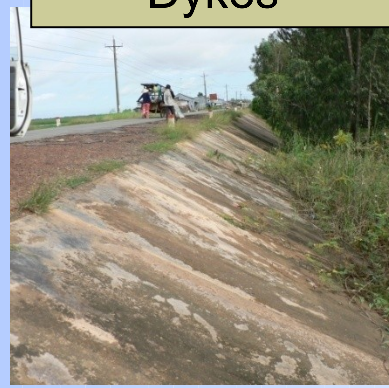
DRR and CCA Measures

Interventions

Sluice Gates



Dykes



Resettlement

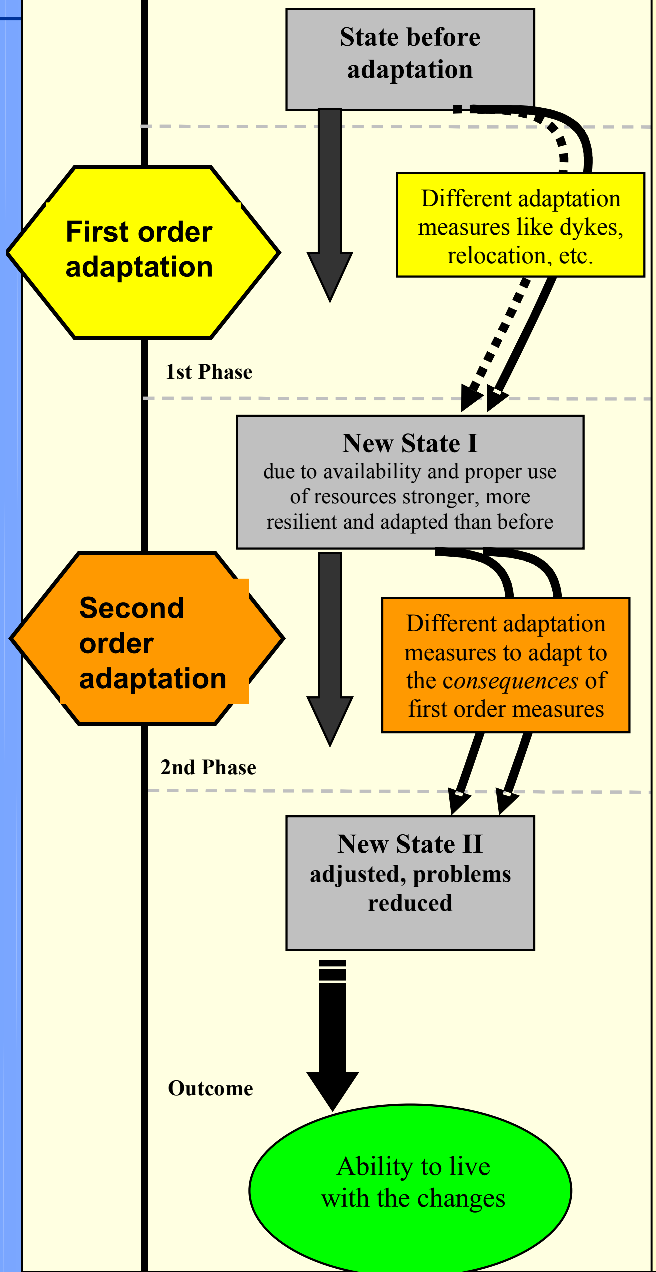
Mini Dyke

Houses on pillars

Salinization | Floods

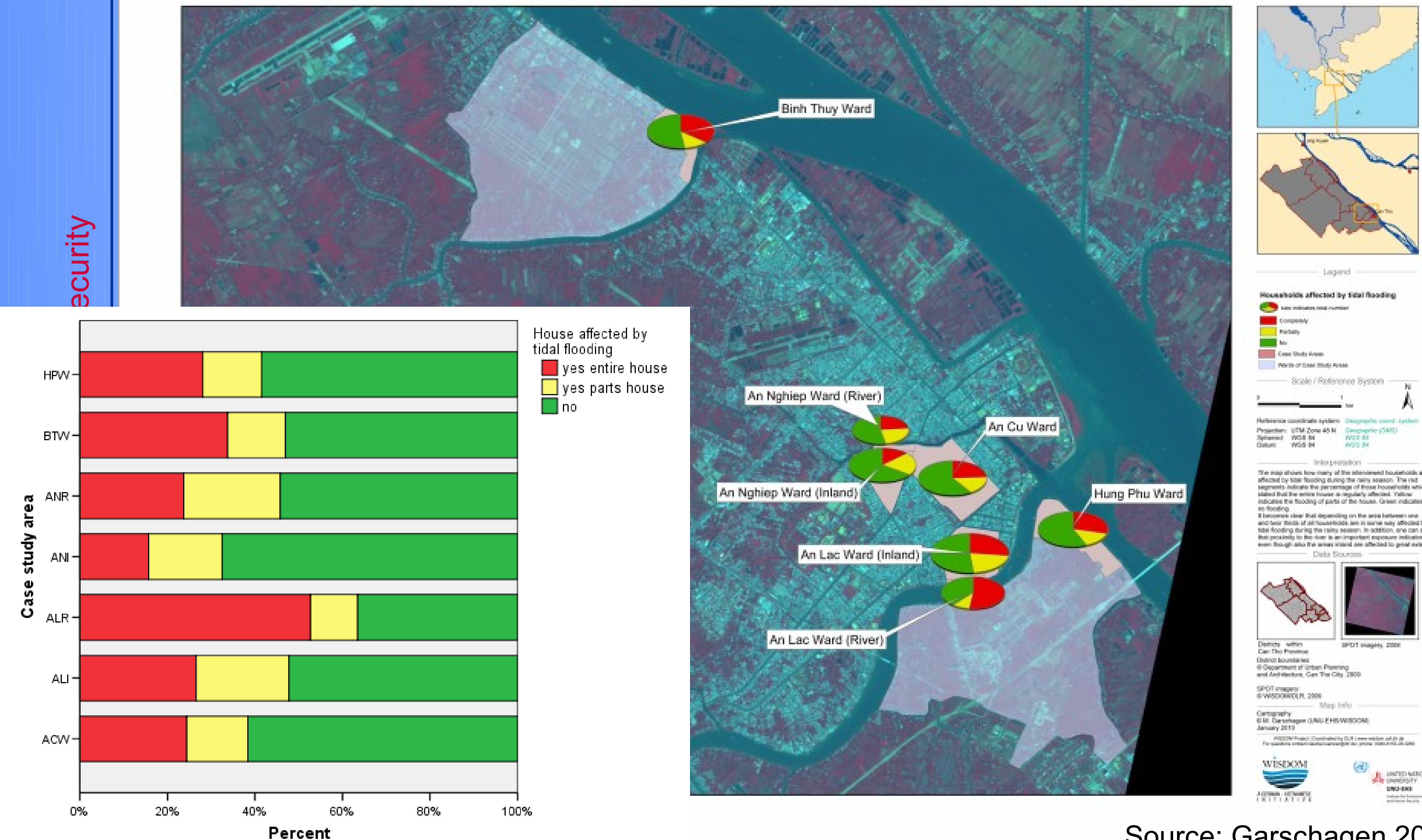
Quelle: Fotos Birkmann 2009

Case I
Adaptive and resilient system



Adaptive Capacities at the Local Level

Households Affected by Regular Tidal Flooding During Rainy Season

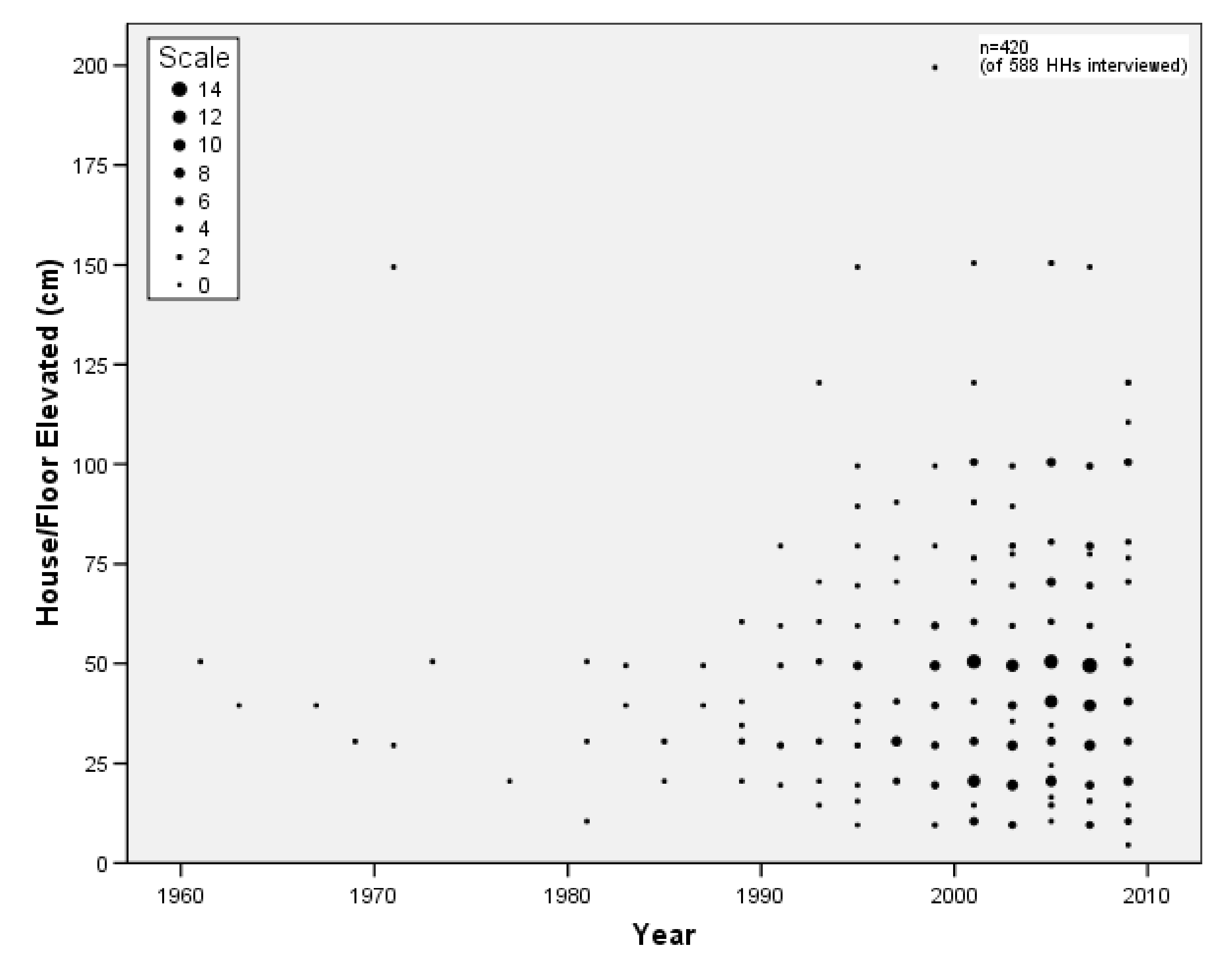


Source: Garschagen 2010

Adaptation: elevation of the house

Case study Can Tho:

71% of all households interviewed elevated their house/floor at least once over the last 50 years



Source: M. Garschagen 2009

Source: Garschagen 2010

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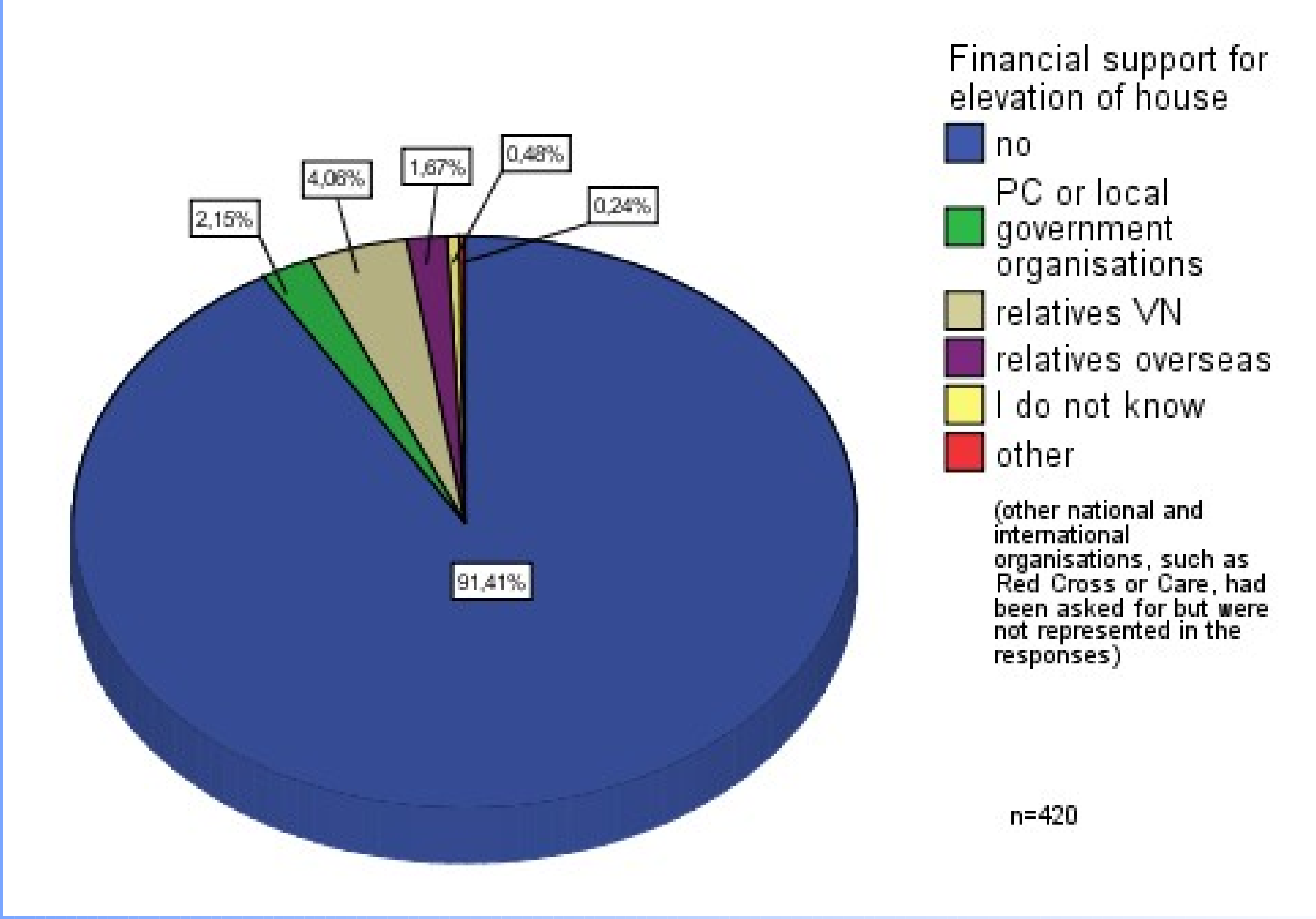
Who is paying the costs of adaptation?



Source: Garschagen 2010

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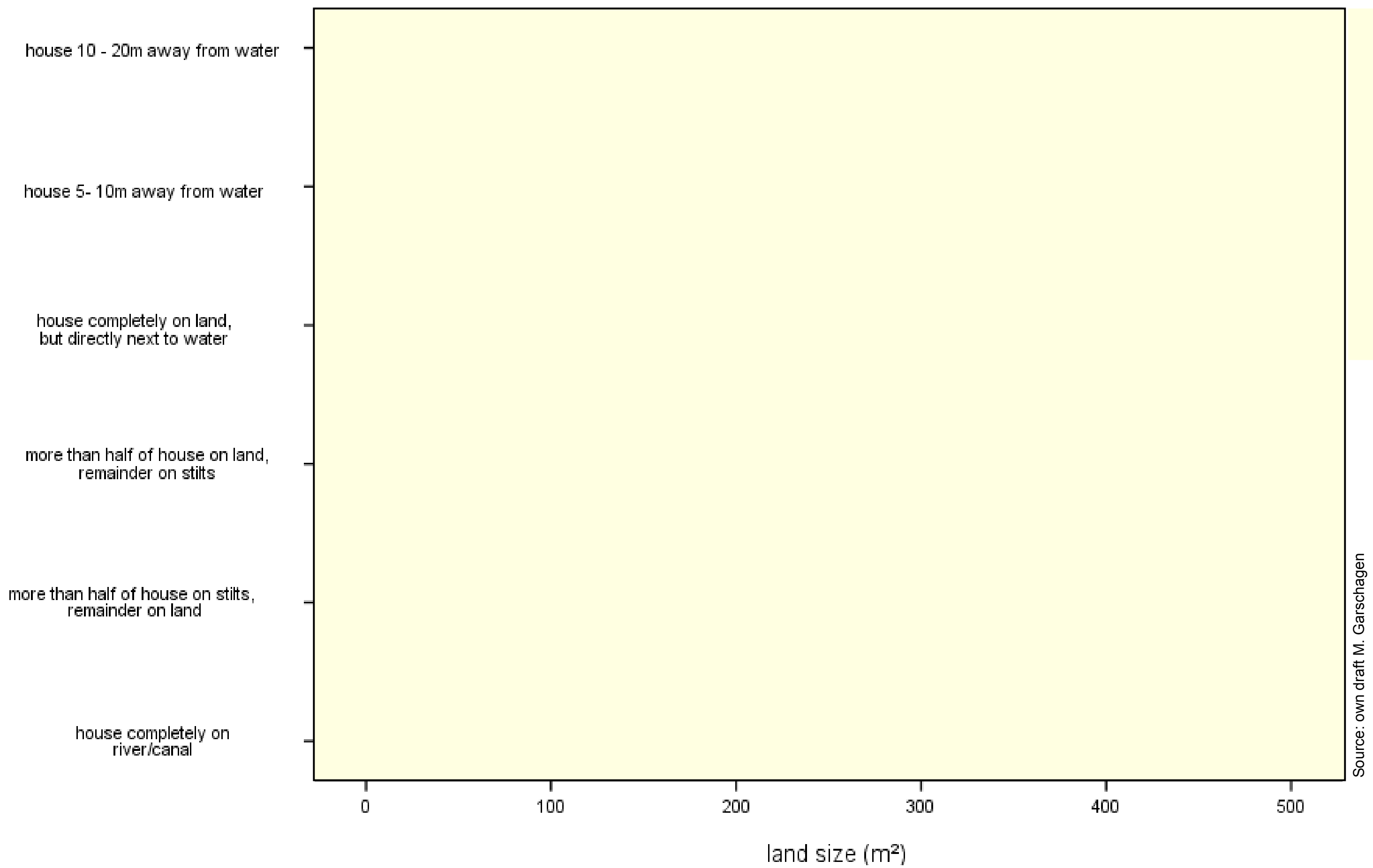
Relation: Distance to Water and Land Title



Urban Upgrading and Resettlement

1. Goal to decrease vulnerability and „make city more beautiful“
2. Follows modern middle-class model
3. Majority of resettled people in debt or forced to sell land-use-title and move somewhere else (often in other slum areas)
4. Overall resilience effect for those people, hence, contested

Conclusions and Outlook

Conclusions

1. Vulnerability is an important entery point to link DRR and CCA, however, most of the urban planning concepts focus solely on the development of the hazards
2. Concepts for adaptation often do not accoutn for the „Urban-Peri-Urban-Rural“ Interface
3. Conflicts between interests of the city and the rural areas are not sufficiently addressed (consequences of dyke construction, water resource extraction etc.)
4. Climate Change is mainly seen as a risk, only very few studies and concepts also consider Climate Change as a chance for transformation
5. New Approaches for more integrative „Urban Adaptation Governance“ are not sufficiently developed yet
6. Linkages between formal and informal adaptation strategies are underdeveloped

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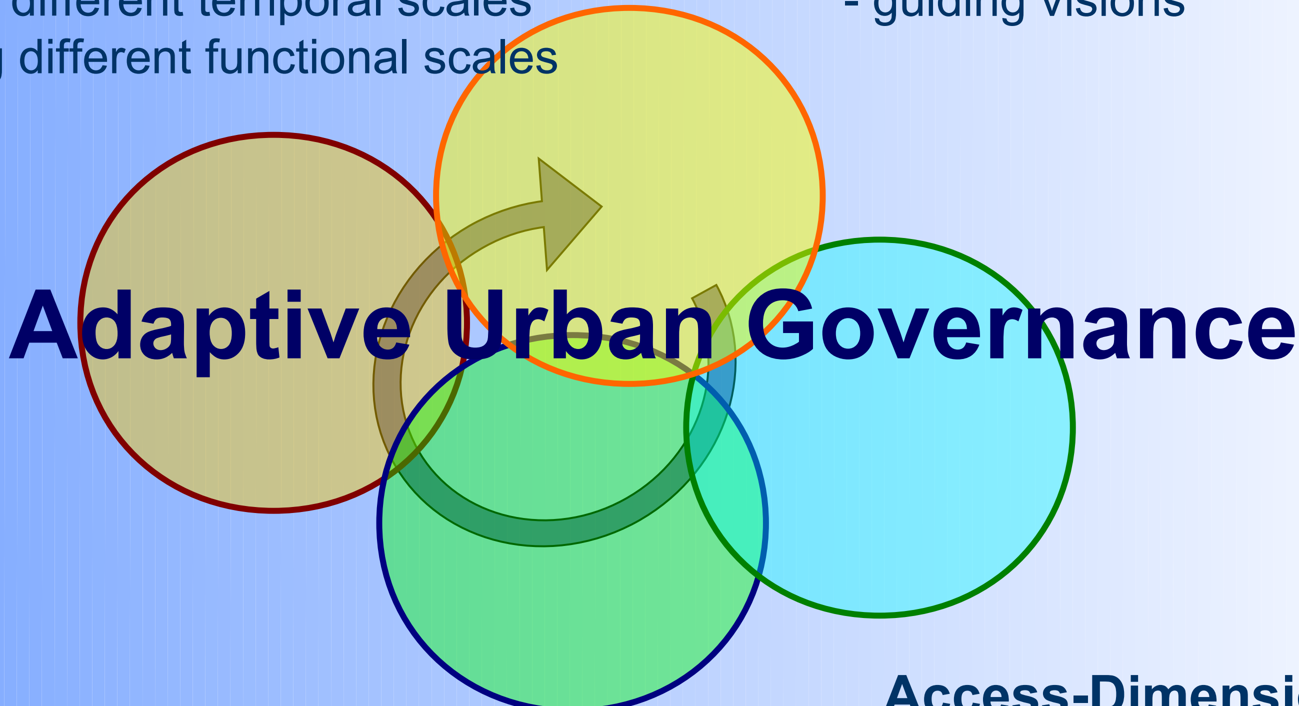
Challenges

Scale-Dimension
- linking data from different scales
- capturing different temporal scales
- balancing different functional scales

Normative-Dimension
- thresholds versus scenarios
- guiding visions



Knowledge-Dimension
- combination of different data and knowledge sources
- acknowledgement of the limits of information

Access-Dimension
- Access to information and resources
- target groups

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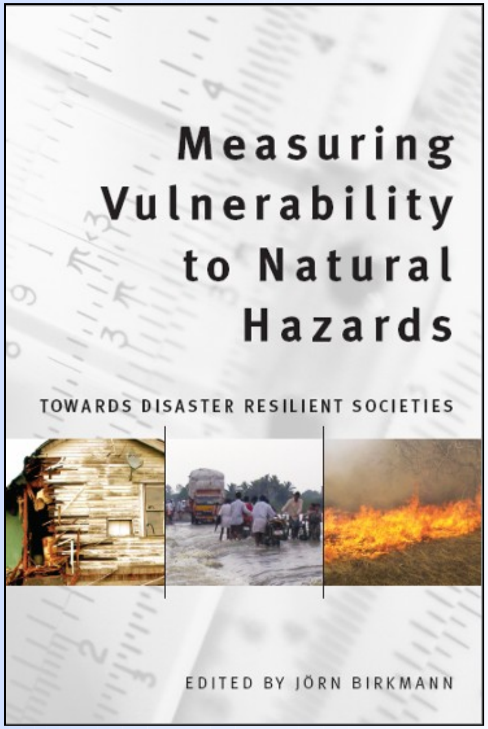
Thank you
for your attention!



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Major Questions: Group work

- What are the key impacts the local adaptation strategies outline for the different cities?
- What are adaptation goals for the cities?
- Which measures are proposed for climate change adaptation?
- Is the issue of vulnerability and risk also considered?
- How would you evaluate the overall strategy and the measures proposed?
- What are remaining questions you would have? (imagine you would go to interview experts/ city planners in London, Cape Town, Ho Chi Min City or Rotterdam).

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JICA-WB-ADB Joint Study: Climate Risks and Adaptation in Asian Coastal Mega-Cities (The Case of Metro Manila)

Photo: BBC

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August 24, 2010

Japan International Cooperation Agency

Objectives of the Research

- **To inform decision makers:**

- The scale of climate related impacts and vulnerabilities at the city level
- Estimates of associated damage costs
- Approaches to prioritize adaptation options

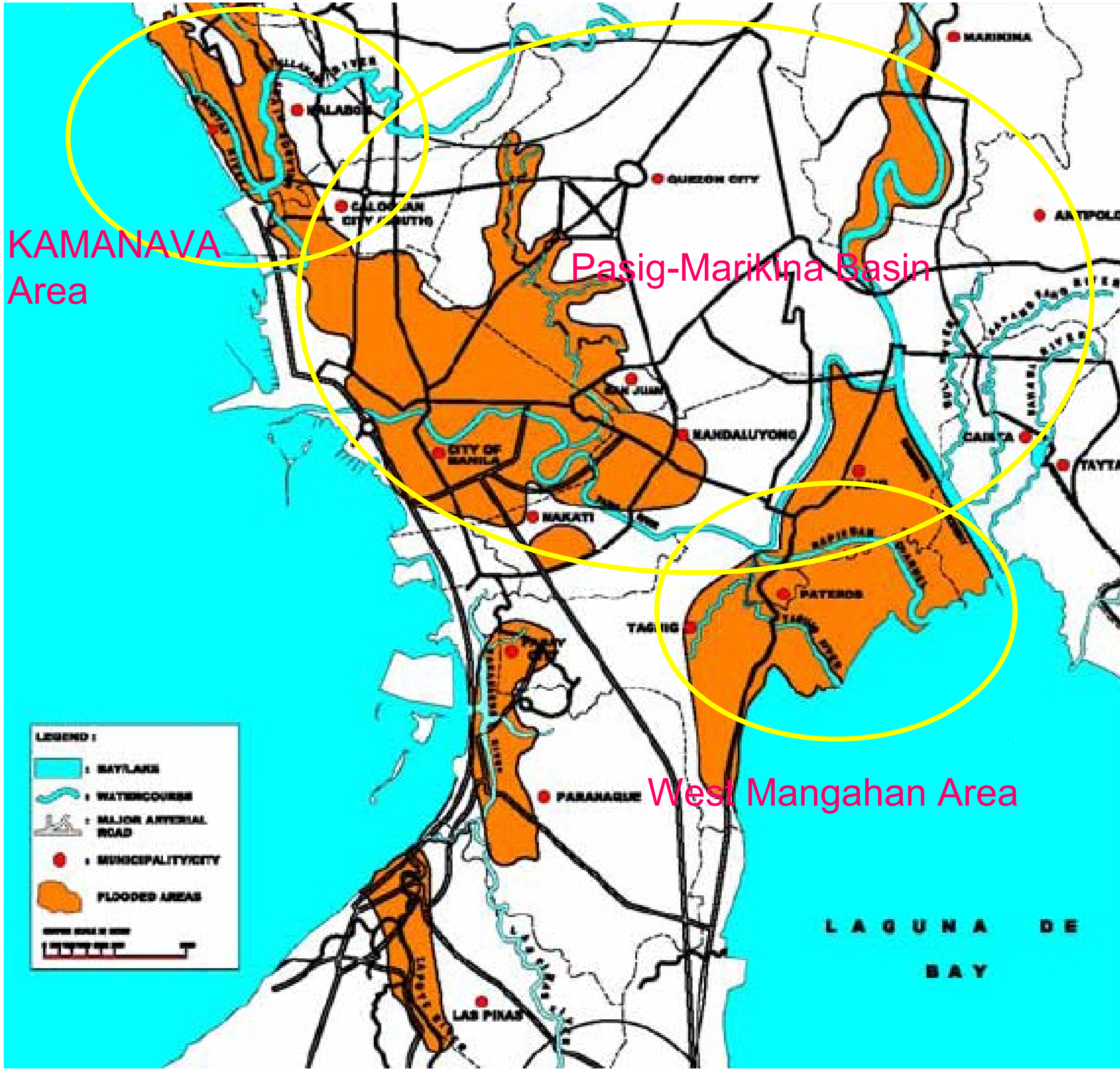
- **Through:**

i) Determining climate variables at the level of the city/watershed through downscaling
ii) Estimation of impacts and vulnerability through hydro-meteorological modeling, scenario analysis and GIS mapping

Bridging Science and Practice

Overall Framework	JICA (Manila) – ADB (HoChiMin City) – World Bank alliance (Bangkok, Kolkata)
Methodology	JICA – IR3S alliance
City Case Studies	E.g. JICA: Metro Manila Coastal Engineering & Storm surge: University of Ibaraki River hydro: CTI International Transport: ALMEC Urban poor: Ateneo de Manila University Firms: National Statistics Office Health: University of Tokyo Coordinator and economic analysis JICA
Solutions to Operations	- Urban planners, local governments - Concerted donor efforts (e.g. World Bank, ADB, bilateral donors)

Flood Prone Areas in Metro Manila



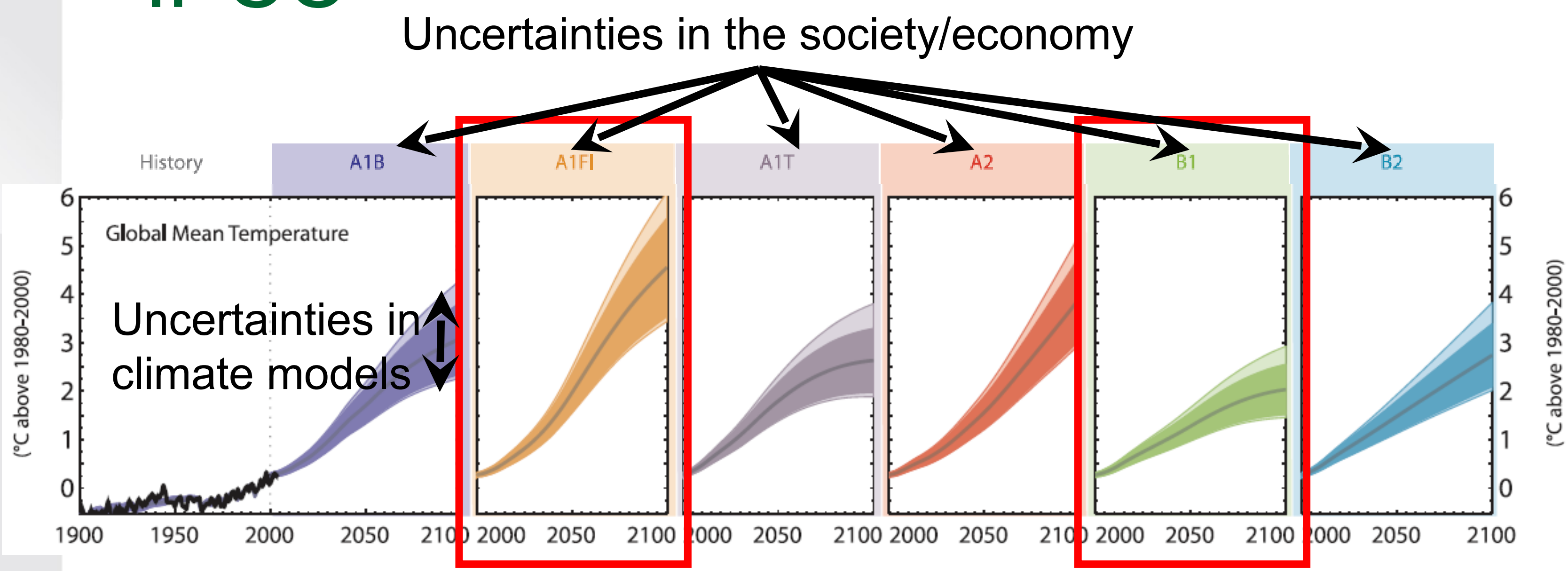
1. Downscale IPCC climate models for temperature increase @2050 for B1 and A1FI scenarios
2. Assess local effects on precipitation and combine with sea level rise/ storm intensification
3. Simulate different types of hydraulic effects: 1) through river systems, 2) through sea level rise, and 3) through storm surge at the coast
4. Based on the flood maps produced for 18 cases (3 climate scenarios x 2 infrastructure scenarios x 3 return periods), estimate socio-economic impact (both direct and indirect) with available data, thus deriving the benefit side of adaptation.
5. Consider investment mix and their costs necessary for adaptation (focusing on flood control infrastructure)
6. Conduct Net Present Value Calculations

1

Downscale IPCC climate models for temperature increase @2050 for B1 and A1FI scenarios

Photo: BBC

Global temperature projection by IPCC



		Year		
		2020	2030	2050
Scenario	A1FI	0.7K	1.0K	2.0K
	B1	0.6K	0.8K	1.3K

Overall procedure

IPCC A1FI Scenario (Specified)

$$\Delta T_{\text{global}}^{\text{mean}} = 2.0\,\text{K}$$

Local temperature change

$$\Delta T_{\text{local}}^{\text{mean}} = \Delta T_{\text{global}}^{\text{mean}} \times \left(\frac{\Delta T_{\text{local}}^{\text{mean}}}{\Delta T_{\text{global}}^{\text{mean}}} \right)^{\text{model}}$$

$$= \quad 2.0 \quad \times \quad \boxed{0.88} \quad = \quad 1.76\,\text{K}$$

IPCC models

% change of Precipitation

$$\frac{\Delta P_{\text{local}}^{\text{extreme}}}{P_{\text{local}}^{\text{present, extreme}}} = \Delta T_{\text{local}}^{\text{mean}} \times \left(\frac{1}{\Delta T_{\text{local}}^{\text{mean}}} \frac{\Delta P_{\text{local}}^{\text{extreme}}}{P_{\text{local}}^{\text{present, extreme}}} \right)^{\text{model}}$$

$$= 1.76 \quad \times \quad \boxed{0.08} \quad \approx \quad 0.14$$

IPCC models

Future precipitation

$$P_{\text{local}}^{\text{future,extreme}} = \left\{ 1 + \left(\frac{\Delta P_{\text{local}}^{\text{extreme}}}{P_{\text{local}}^{\text{present,extreme}}} \right) \right\} \times P_{\text{local}}^{\text{present,extreme}}$$

observation

$$= (1 + \quad 0.14 \quad) \times \boxed{183.5} \quad = \quad 209\,\text{mm/d}$$

2

Assess local effects on precipitation and combine with sea level rise/ storm intensification

Simulation Cases (Case of Metro Manila)

	Simulation Case	Temperature Rise (°C) (downscaled)	Increase Rate of Rainfall (%)	Sea Level Rise (cm) (global)	Storm Surge Height (m)
1	Status quo climate	0	0	0	0.91
2	B1 with storm level at status quo	1.17	9.4	19	0.91
3	B1 with strengthened storm level	1.17	9.4	19	1.00
4	A1FI with storm level at status quo	1.80	14.4	29	0.91
5	A1FI with strengthened storm level	1.80	14.4	29	1.00

3

Simulate different types of hydraulic effects: 1) through river systems, 2) through sea level rise, and 3) through storm surge at the coast

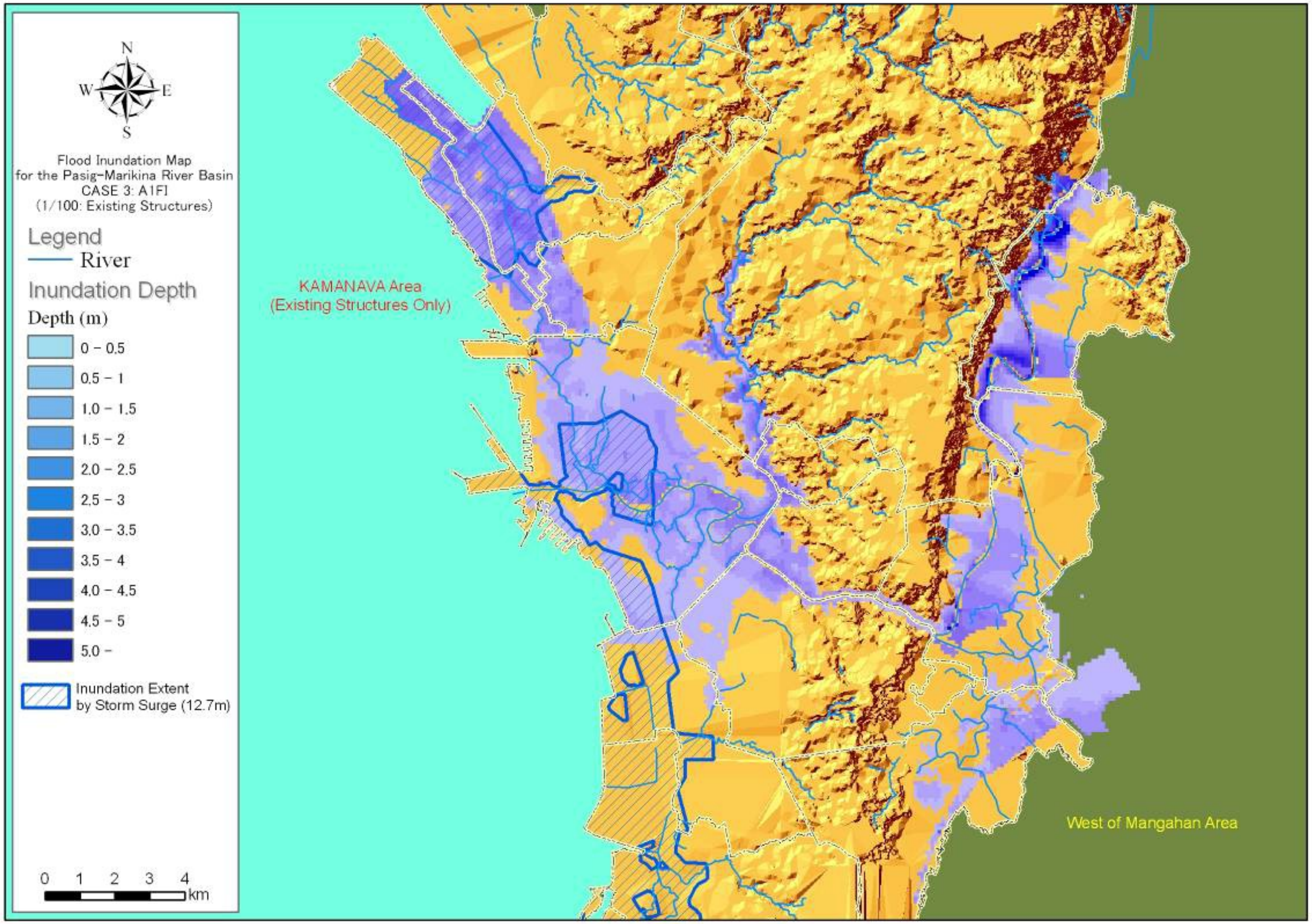
Photo: JICA

Upper Watershed of Metro Manila

Rainfall Runoff Calibration Hydrographs

Source: (JICA, 2010)

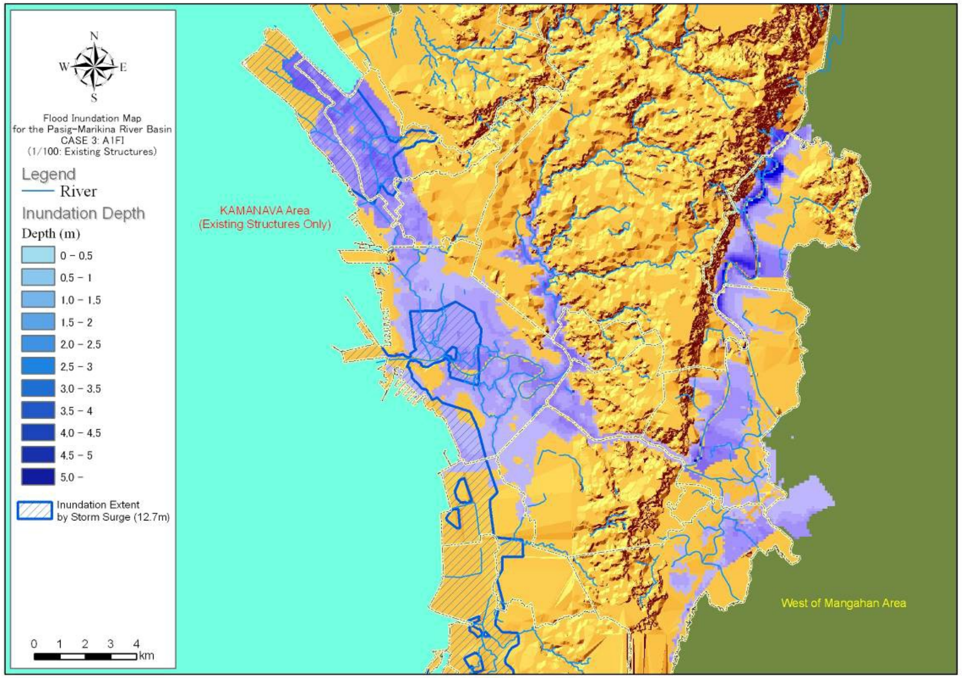
100-year Flood, A1FI under Existing Structures



Summary of Inundation Area in the Pasig-Marikina Basin

Simulation Case		30-year Flood		100-year Flood	
		Existing Structures (halfway through current Master Plan)	Continue Implementing Current Master Plan	Existing Structures (Halfway through current Master Plan)	Continue Implementing Current Master Plan
1	Status quo climate	34.6 km^2	14.7 km^2	53.7 km^2	29.1 km^2
2	B1	42.5 km^2	20.8 km^2	63.2 km^2	40.1 km^2
3	A1FI	47.0 km^2	22.8 km^2	68.0 km^2	44.1 km^2

Bridging between research and practice is challenging



A : Flood due to insufficient drainage

B : Not covered in our model due to lack of lateral profile data

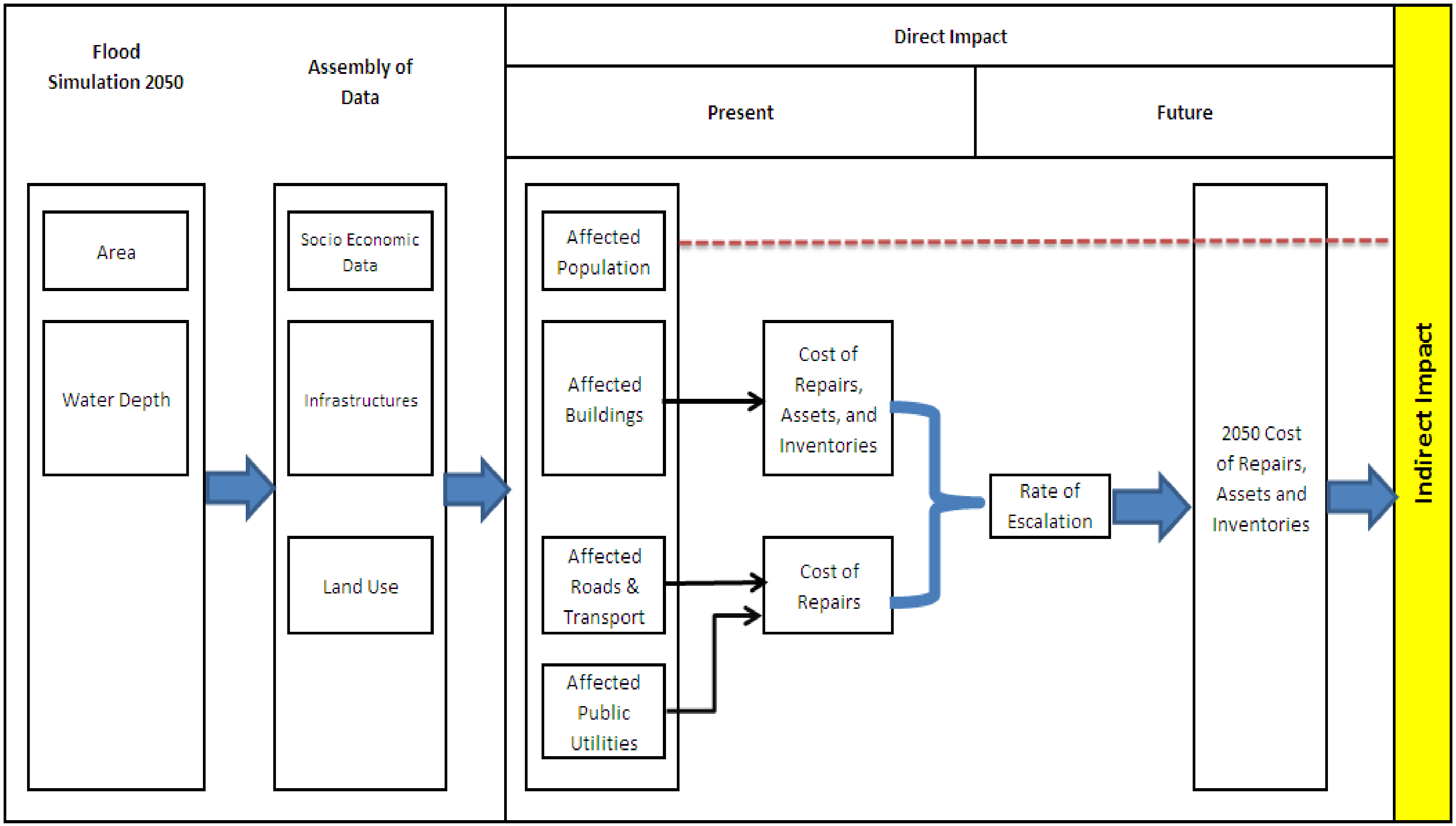
C : Not covered in our model as it is not overflow from Pasig-Marikina River

D : Area not covered in our analysis

4

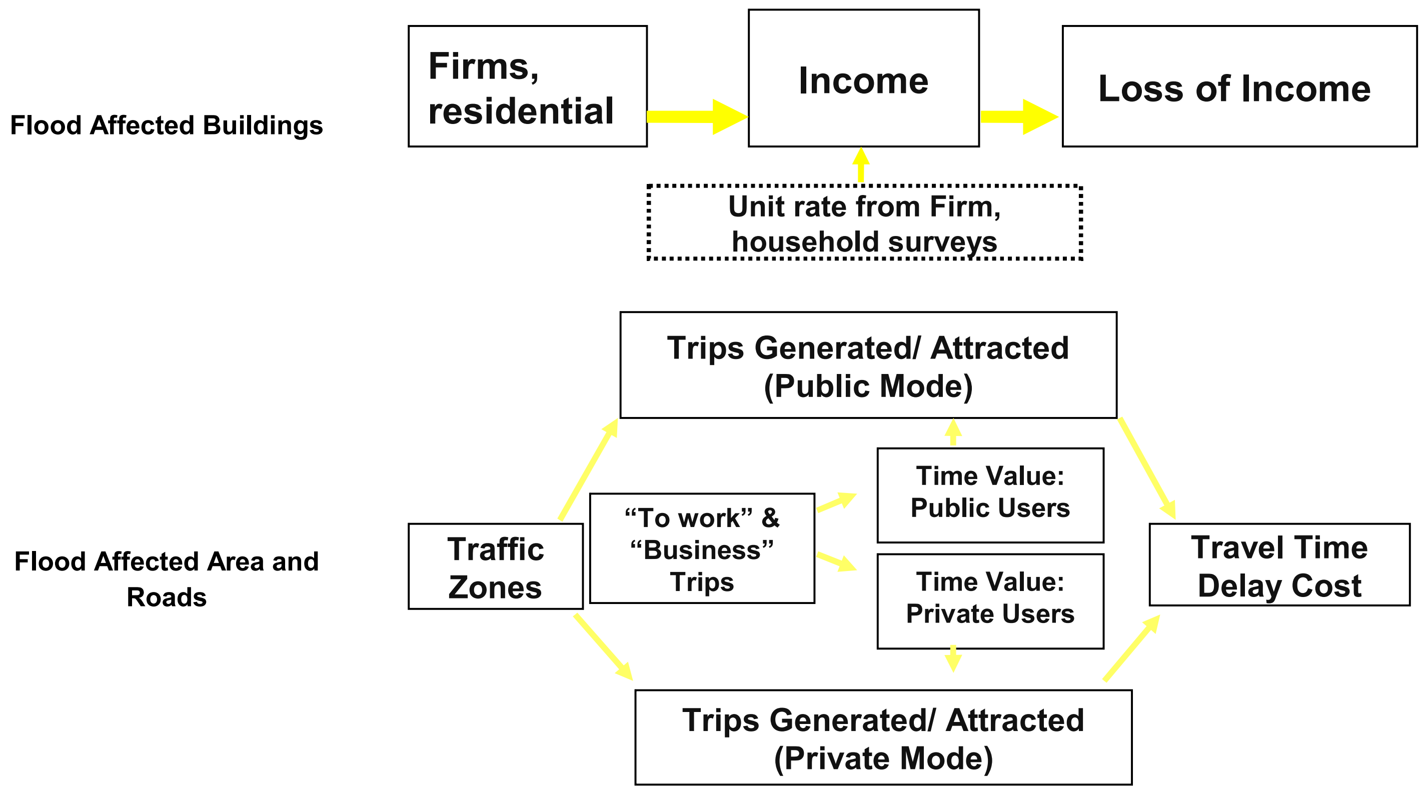
Based on the flood maps produced for 18 cases (3 climate scenarios x 2 infrastructure scenarios x 3 return periods), estimate socio-economic impact (both direct and indirect) with available data, thus deriving the benefit side of adaptation.

Direct Impact Assessment Flowchart



Data from Direct Impact

Indirect Impacts Analysis



Added up benefits (savings in damages)

- Savings in damage to buildings
- Maintenance cost savings on flood affected roads
- VOC savings
- Travel time cost savings
- Avoided loss of firms
- Avoided income loss of formal/informal settlers

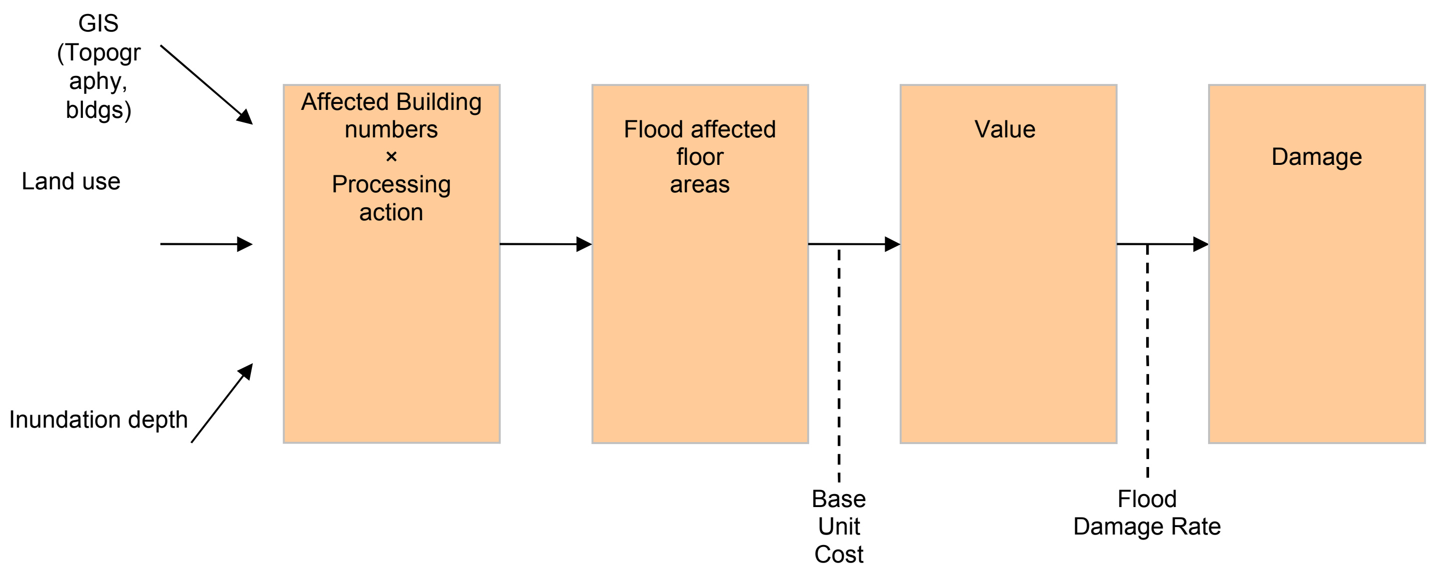
- -*Use future predicted values as much as possible. Use growth rate to arrive from these future values up to 2050.*

Field	Item	Data Collected
Electricity / Power	Generation	Location of generation facility, boundary, year constructed year, volume of generation, cost of generation
	Distribution	Location of distribution tower, boundary, height of tower, year constructed, volume of distribution
	Transformation	Location of transformation facility, boundary, year constructed, volume of in/out electricity
	Distribution network, etc.	Distribution route (polyline) and coverage, material, year installed, capacity of distribution line
Transportation and Traffic	Road	Alignment, ROW and width of carriageway, height of embankments, surface material, year constructed year, traffic volume by vehicle type
	Railway[2/]	Alignment, ROW and track line, height of embankments, year constructed, transport capacity
	Bridge	Location, shape line, boundary, width, girder height, structure, material, year constructed, traffic volume by vehicle type
	Port, Airport[2/], etc.	Location, boundary, year constructed, number of carriers/airplanes, volume of cargo handling, number of warehouses, capacity of warehouses
Water Supply and Drainage	Purification plant	Location, boundary, area, constructed year, volume of water intake/distribution
	Water pipe	Line shape, diameter, material, constructed year, elevation of pipe
	Pumping station	Location, boundary, area, year constructed, capacity
	Distribution network, etc.	Distribution route, capacity of distribution
Flood Control	Discharge channel	Line shape, year constructed, material, capacity
	Pumping station	Location, boundary, area, year constructed, capacity
	Bund	Line shape, boundary, height, thickness, type of soil
	Drainage network, etc.	Drainage route, capacity of drainage
Public health	Waste management	Location of waste management facility, boundary, area, method of treatment, collection route, place for collection, number and capacity of collection vehicle
	Healthcare center	Location, number of beds, number of staff
	Hospital, etc.	Location, boundary, number of beds and staff
Ordinal Building and Infra-Structures [1/]	Industrial use	Location, utilization, electricity usage
	Commercial use	Location, utilization, electricity usage
	Residential use, etc.	Location, electricity usage
Others[1/]	Community Disaster Management Facility	Location, facility, stocks, capacity
	Meeting hall	Location, boundary, capacity
	Religious facility, etc.	Location, boundary, type, capacity

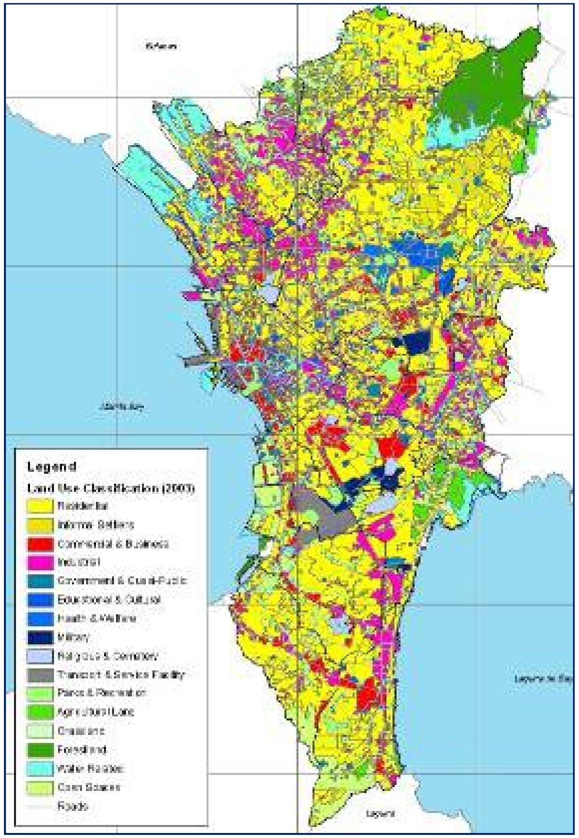
[1/] Information were collected for the flood-affected areas only.

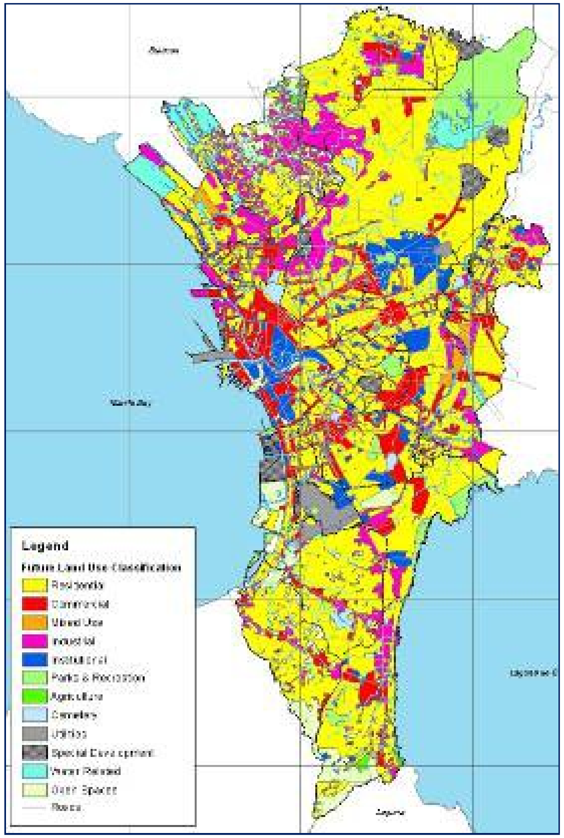
GIS Data Collected

Damage to buildings: Flowchart



Land Use Data, 2007 and 2020





Flood-Affected Residential Buildings (P100, EX, SQ)

(100-Year Flooding, Status Quo Climate, Existing Infrastructure)

LGU	Flood-Affected Buildings
	Less Than 12 m Tall
City of Manila	66,057
Kalookan City	9,356
Makati City	7,593
Malabon City	32,876
Mandaluyong City	6,227
Marikina City	12,721
Navotas City	23,384
Pasay City	953
Pasig City	19,059
Municipality of Pateros	20
Quezon City	6,600
San Juan City	2,102
Taguig City	4,104
Total	191,052

Building Heights (m)	Depth Category	Land Use	Action (Building Area)
All building heights	1 2	Residential	x 0
		Commercial	x 0
		Institutional	x 0
		Industrial	x 0
		Informal Settlers	x 0
		Park and Recreations	x 0
		Religious	x 0
		Open Space	x 0
		Transport Facilities	x 0
		Agriculture	x 0
All building heights	3 4	Residential	x 0.5
		Commercial	x 0.5
		Institutional	x 0.5
		Industrial	x 0.5
		Informal Settlers	x 0.5
		Park and Recreations	x 0.5
		Religious	x 0.5
		Open Space	x 0.5
		Transport Facilities	x 0.5
		Agriculture	x 0.5
All building heights	5	Residential	x 1
		Commercial	x 1
		Institutional	x 1
		Industrial	x 1
		Informal Settlers	x 1
		Park and Recreations	x 1
		Religious	x 1
		Open Space	x 1
		Transport Facilities	x 1
		Agriculture	x 1
Only for buildings above 12m. Lower buildings heights should be x 1.	6	Residential	x 1.5
		Commercial	x 1.5
		Institutional	x 1.5
		Industrial	x 1.5
		Informal Settlers	x 1.5
		Park and Recreations	x 1.5
		Religious	x 1.5
		Open Space	x 1.5
		Transport Facilities	x 1.5
		Agriculture	x 1.5
Only for buildings above 12 m. Lower building heights should be x 1.	7	Residential	x 2.5
		Commercial	x 2.5
		Institutional	x 2.5
		Industrial	x 2.5
		Informal Settlers	x 2.5
		Park and Recreations	x 2.5
		Religious	x 2.5
		Open Space	x 2.5
		Transport Facilities	x 2.5
		Agriculture	x 2.5

Processing Action

Inundated Floor Areas in Metro Manila (100-Year Flood)

(Existing Infrastructure)

Climate Scenario	Land Use	Inundated Floor Areas (m^2) by Water Depth (P100, EX)									
		Water Depths with Present Land Use					Water Depths with Future Land Use				
		20 cm to 50 cm	>50 cm to 3 m	>3 m to 6 m	>6 m to 9 m	<9 m	<50 cm	50 cm to 3 m	>3 m to 6 m	>6 m to 9 m	>9 m
Status Quo	Residential	1,825,925	6,624,579	259,954	19,719	198	1,561,807	6,523,200	213,135	25,754	-
	Commercial	561,611	1,192,165	9,818	27,554	534	1,001,849	2,312,735	18,719	11,258	534
	Institutional	303,515	657,157	2,893	-	-	315,143	597,179	3,523	582	-
	Industrial	398,711	1,989,335	29,410	12,622	-	181,406	977,637	21,590	29,239	-
B1	Residential	1,488,290	9,071,261	289,572	46,598	256	850,632	8,081,618	223,221	38,021	-
	Commercial	471,270	1,624,147	14,427	27,554	15,038	1,165,249	4,059,993	31,747	2,589	15,038
	Institutional	184,700	925,930	2,893	-	-	245,698	1,102,962	2,941	582	-
	Industrial	294,114	2,655,751	26,308	10,021	-	119,962	1,064,117	21,590	27,554	-
A1FI	Residential	1,747,771	10,127,129	325,131	51,077	751	1,181,815	8,791,215	241,259	41,177	701
	Commercial	441,927	1,898,583	16,274	27,554	15,038	1,152,368	4,744,357	40,053	322	17,305
	Institutional	144,796	1,037,482	5,249	-	-	178,354	1,247,366	4,726	582	-
	Industrial	347,281	2,891,794	25,365	14,456	2,267	117,535	1,156,340	12,524	34,254	-

Schedule of Base Unit Costs for Residential Buildings

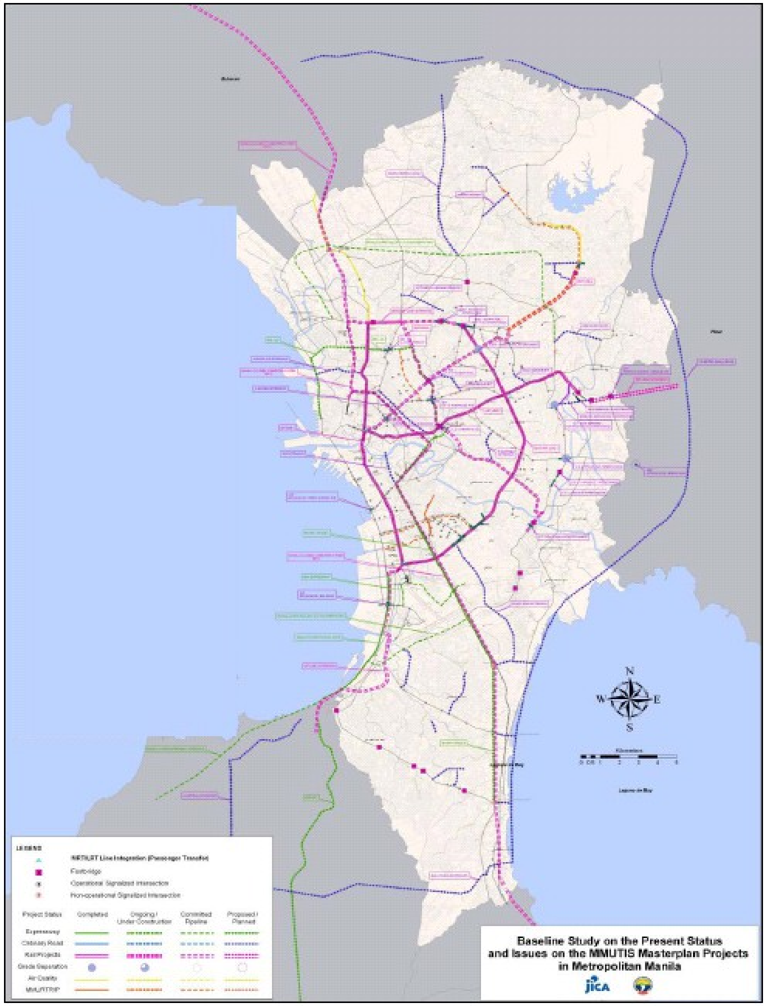
Type*	Residential Condo		Apartment Bldg.		Single Dwelling		Duplex/ Townhouse		Boarding House		Median Construction Cost	Finishing (25%)	Household Effects (35%)
1A	15,500	16,000	12,200	12,600	9,700	10,000	8,700	9,100	7,300	7,500			
1B	14,500	15,000	11,400	11,800	9,000	9,300	8,000	8,300	6,500	6,900	9,200	2,300	4,025
1C	13,500	14,000	10,600	11,000	8,300	8,600	7,300	7,600	5,900	6,200			
IIA	11,500	12,000	9,000	6,400	6,600	7,000	5,800	6,100	4,400	4,700			
IIB	10,500	11,000	8,200	8,600	5,900	6,200	5,100	5,400	3,700	4,000	6,150	1,538	2,691
IIC	9,500	10,000	7,400	7,800	5,200	5,500	4,400	4,700	3,000	3,300			
IIIA	-	-	-	-	3,600	4,000	3,500	3,800	2,400	2,700	2,550	638	1,116

Source: Assessor's Office City of Malabon (most updated schedule of base unit cost)
Note: * **I. Reinforced Concrete** (A= structural steel and reinforced concrete columns and beams with the remainder being the same as IB; B= Columns, beams, walls, floors and roofs all reinforced concrete; C= Same as "B" but walls are hollow block reinforced concrete or the building has tile roofing);
II. Mixed Concrete (A= Concrete columns, beams, and walls but wooden floor joists, flooring, roof framing and galvanized iron (GI) roofing even if walls are hollow concrete hollow blocks. Kitchen, toilet and bathroom are on reinforced concrete slabs; B= Concrete columns and beams but hollow block walls and GI roofing; C= Concrete columns and wooden beams, hollow block walls, wooden floor joists, floors and roof framing and GI roofing. Second floor walls are wooden.);
III. Strong Materials (A=First grade wooden structural framing, flooring, walls, and GI roofing)

Flood Damage Rates by Building Use and Inundation Depth

Building Use	Cost Item	<50 cm	100-200 cm	200-300 cm	>300 cm
Residential	Finishings	0.0920	0.119	0.580	0.834
	Household Effects	0.1450	0.326	0.928	0.991
Business Entities[1] (Commercial, Institutional, and Industrial)	Assets	0.2320	0.453	0.966[1]	0.966
	Stocks	0.1280	0.267	0.897[1]	0.897[1]

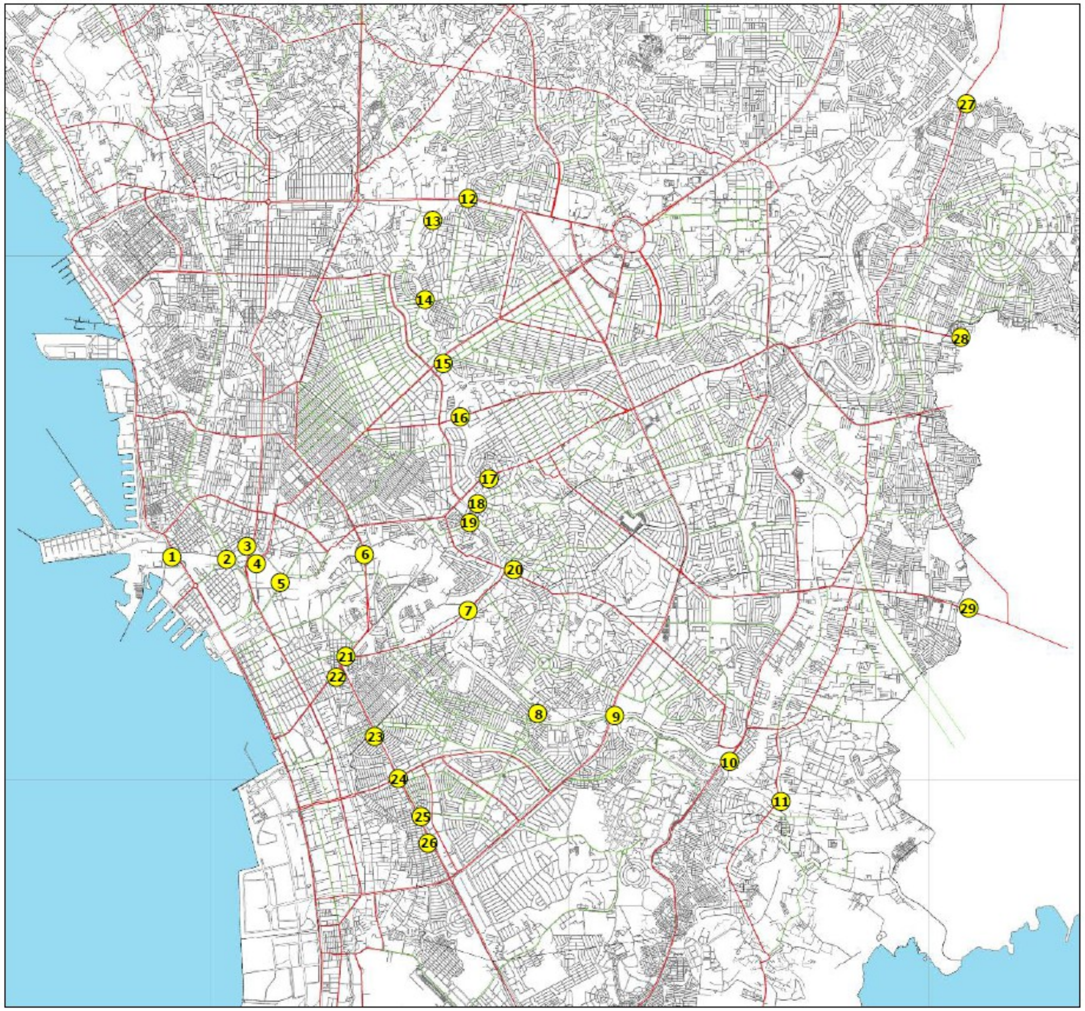
Metro Manila Transportation Infrastructure, 2015



Source: MMDA-JICA Baseline Study on the Present Status and Issues on the MMUTIS Master plan

Roadside

Counts



Source: MMUTIS

Trips Generated and Attracted by LGU, 1999

LGU	Generation			Attraction		
	Public Mode[1]	Private Mode[2]	Total Trips	Public Mode[1]	Private Mode[2]	Total Trips
City of Manila	2,107,588	803,715	2,911,303	2,123,166	798,571	2,921,737
Kalookan City	1,119,707	249,607	1,369,314	1,116,425	245,808	1,362,233
Las Piñas City	473,072	128,461	601,533	468,587	128,523	597,110
Makati City	804,786	474,891	1,279,677	810,382	463,654	1,274,036
Malabon City	365,452	84,032	449,484	362,822	89,222	452,044
Mandaluyong City	451,882	169,308	621,190	448,586	157,830	606,416
Marikina City	349,082	146,314	495,396	346,093	150,925	497,018
Muntinlupa City	544,349	117,259	661,608	539,842	122,818	662,660
Navotas City	192,807	50,049	242,856	188,634	52,295	240,929
Parañaque City	483,152	269,687	752,839	478,343	285,485	763,828
Pasay City	517,955	185,027	702,982	514,495	186,419	700,914
Pasig City	568,051	282,966	851,017	567,986	286,429	854,415
Pateros	65,940	8,884	74,824	65,012	12,069	77,081
San Juan City	118,930	70,968	189,898	116,865	73,748	190,613
Quezon City	2,906,580	1,239,448	4,146,028	2,912,567	1,225,501	4,138,068
Taguig City	394,253	60,536	454,789	400,295	61,093	461,388
Valenzuela City	496,615	243,127	739,742	493,927	241,251	735,178
Total	**11,960,201**	**4,584,279**	**16,544,480**	**11,954,027**	**4,581,641**	**16,535,668**

1/ Public mode includes Train, Bus, Jeepney, and Tricycle.
2/ Private mode includes Car, Taxi, Truck, and Others.
Source: MMUTIS

For road maintenance cost:

Affected Length of Road by Inundation Depth

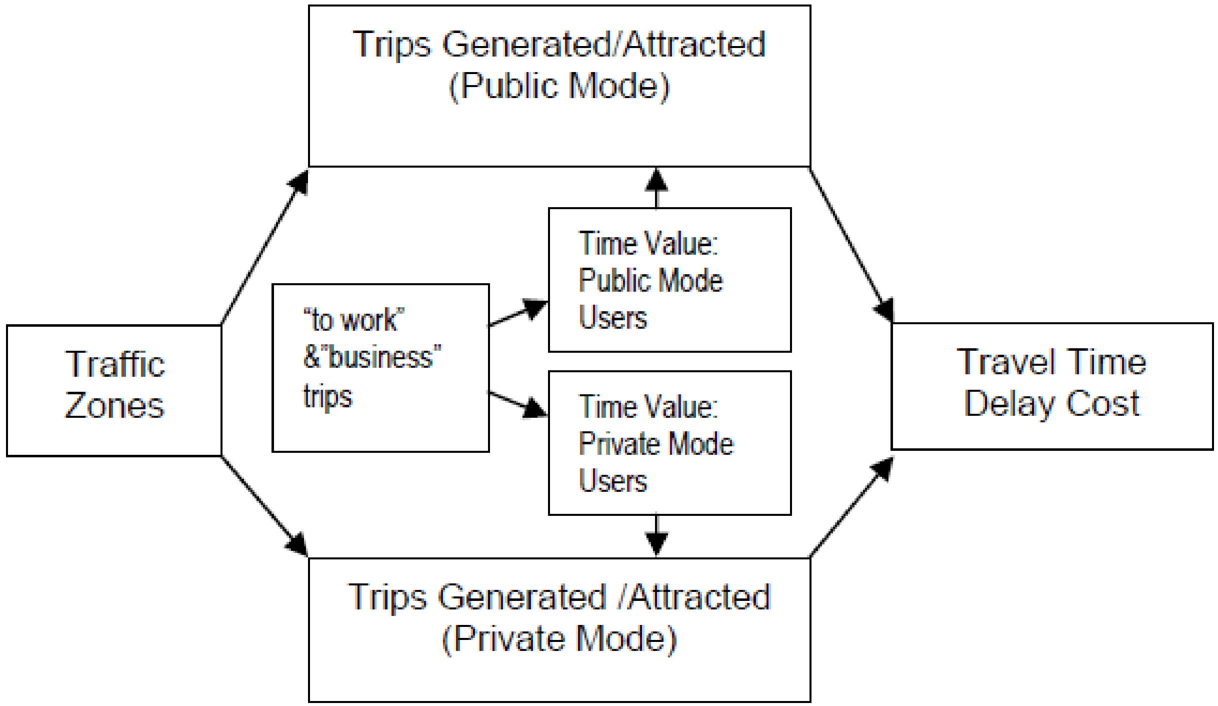
Existing Infrastructure	Road Length by Inundation Depth (km)						
	8-20 cm		21-50 cm		Above 50 cm		Total
	Major	Minor	Major	Minor	Major	Minor	
Status Quo	4.5	3.9	22.1	23.8	31.9	39.8	125.9
B1	5.4	9.7	13.6	15.1	47.9	55.6	147.3
A1FI	5.3	6.9	14.6	18.2	53.6	60.3	158.9

Master Plan Infrastructure	Road Length by Inundation Depth (km)						
	8-20 cm		21-50 cm		Above 50 cm		Total
	Major	Minor	Major	Minor	Major	Minor	
Status Quo	3.78	4.33	6.40	10.45	7.45	13.42	45.82
B1	7.24	8.15	9.54	15.73	12.07	20.82	73.55
A1FI	9.45	9.05	12.62	16.28	14.97	25.63	87.99

For vehicle operation cost:
Inundation Unit Cost for Vehicles in Metro Manila

Road Condition	Public Mode (Peso/km/vehicle)	Private Mode (Peso/km/vehicle)
Good/Fair	9,614	11,795
Inundated(Bad)	14,316	16,962
Incremental Flooding Cost	4,702	5,167

Travel Delay Costs (Passengers)



Passengers' Travel Delay Costs Based on 1999 Roadside Counts

(Php / hour)

City	No. of Trips		Cumulative Travel Time Delay Cost (per hour)	
	Public Mode	Private Mode	Public Mode	Private Mode
Manila	1,045,199	804,406	9,500,859	13,079,642
Quezon City	990,984	534,542	9,008,045	8,691,653
Makati	595,196	426,961	5,410,332	6,942,386
Mandaluyong	441,798	247,367	4,015,944	4,022,187
Marikina	115,169	77,803	1,046,886	1,265,077
Pasig	233,418	157,591	2,121,770	2,562,430
San Juan	108,698	104,849	988,065	1,704,845
Total	**3,530,462**	**2,353,519**	**32,091,900**	**38,268,219**

Source: MMUTIS

Travel Time Value

Mode Type	Time Value of Trip Makers (Pesos/hour) 2002[1/]	2050
Private	81.30	148.00
Public	45.45	83.00

Flood Scenario	No. of Trips		Cumulative Travel Time Delay Cost (Php/hr)	
	Public	Private	Public	Private
EXISTING INFRA: 2002				
Status Quo	855,935	217,645	38,517,064	17,629,240
B1	1,031,706	280,046	46,426,792	22,683,717
A1F1	1,058,941	295,015	47,652,359	23,896,185
EXISTING INFRA: 2050				
Status Quo	1,741,191	999,355	144,518,892	147,904,489
B1	1,903,258	1,223,565	157,970,385	177,993,032
A1F1	1,924,578	1,212,727	159,739,956	179,483,552
BUSINESS-AS-USUAL 2002				
Status Quo	335,728	121,971	15,107,760	9,879,688
B1	496,336	174,004	22,263,697	14,058,719
A1F1	613,269	229,933	27,597,116	18,624,607
BUSINESS-AS-USUAL 2050				
Status Quo	396,998	208,314	32,950,807	30,830,421
B1	622,938	341,766	51,703,832	50,581,344
A1F1	824,697	429,490	68,449,818	63,564,534

LGU	Flood-affected Generated/Attracted Trips by Purpose			
	School	Recreation	Medical	Religious
City of Manila	2,002,254	41,034	164,033	[redacted]
Kalookan City	92,195	284	3,339	5,507
Makati City	169,085	2,464	5,445	18,075
Malabon City	197,922	1,538	2,764	11,520
Mandaluyong City	143,333	1,275	4,052	6,639
Marikina City	173,042	2,820	4,878	16,313
Navotas	115,391	1,943	1,758	6,840
Pasay City	30,505	662	2,199	1,158
Pasig City	280,050	4,897	13,777	22,249
Quezon City	460,404	4,080	47,833	33,372
San Juan City	58,564	499	2,725	3,408
Taguig City	96,033	4,665	2,415	5,971
Pateros	52,406	600	522	3929
Total MM	**3,871,184**	**66,161**	**255,218**	**267,028**

Source: JICA-MMUTIS

With a trip rate of 2.2, approximately 1.8 M students affected

Income (Sales) Losses by Number of Employees

Sector	Average Income Loss				
	All	Number of Employees per Firm			
		10-19	20-49	50-99	100 <
Total	459,780	3,205,583	345,000	1,630,417	2,308,824
Manufacturing	513,611	623,333	206,250	159,167	1,158,824
Construction	242,857	-	50,000	800,000	-
Wholesale /Retail Trade; Repair Services	253,571	-	30,000	228,750	800,000
Hotels and Restaurants	121,250	70,000	53,750	150,000	250,000
Transport, Storage and Communications	816,357	2,512,250	5,000	292,500	50,000
Financial Intermediation	-	-	-	-	-
Health and Social Work	50,000	-	-	-	50,000

Income (Sales) Losses by Climate Scenario (Php)

Economic Activity	P30			P100		
	Status Quo	B1	A1Fi	Status Quo	B1	A1Fi
Commercial	235,869,171	315,841,154	339,832,748	435,028,313	488,021,795	537,161,205
Industrial	539,710,329	941,771,542	1,096,354,644	1,505,431,365	1,476,401,675	1,573,651,138
Institutional	13,875,000	14,925,000	15,600,000	22,824,071	28,397,679	32,147,679
Transport/Utilities	-	-	-	-	-	-
Total	789,454,500	1,272,537,695	1,451,787,392	1,963,283,749	1,992,821,148	2,142,960,022

Informal Residents' Income Loss (P100, EX)

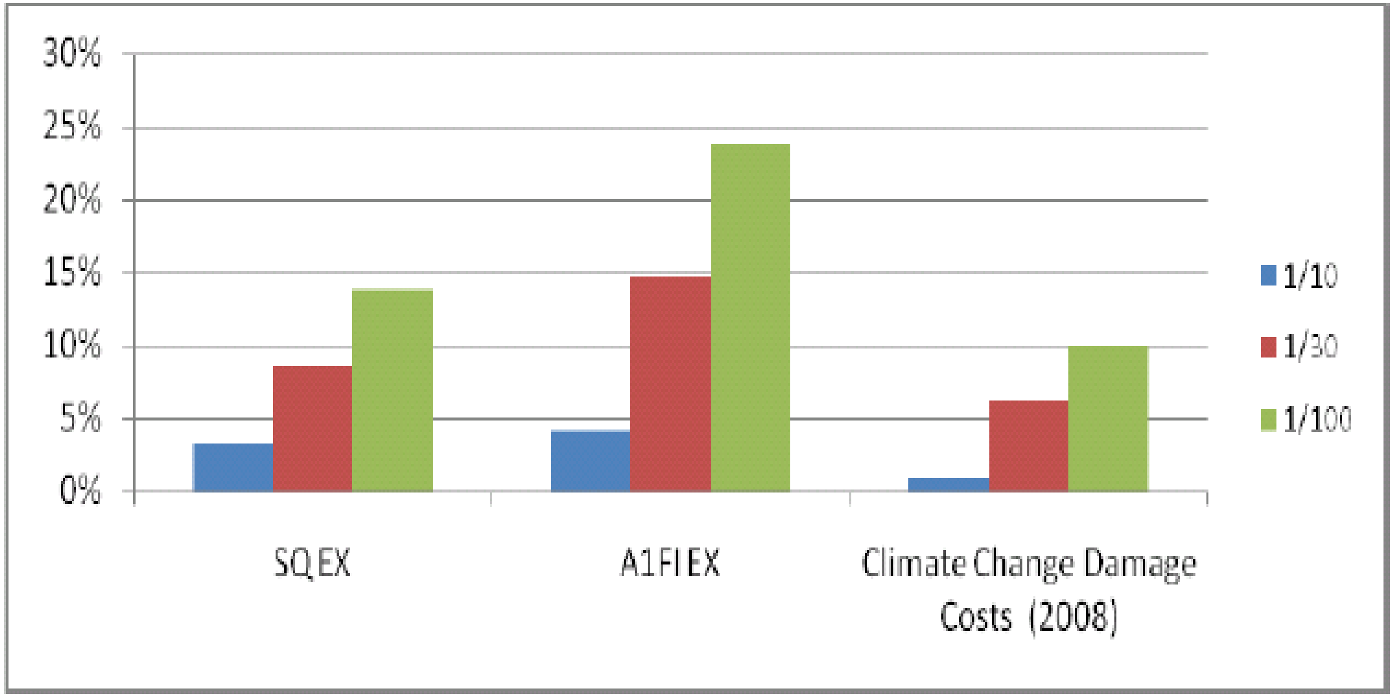
(100-Year Flooding, Existing Infrastructure)

LGU	Daily Income Loss to Informal Residents					
	Status Quo Flood Level		B1 Flood Level		A1FI Flood Level	
	Number of Structures	Income Loss/ day (Php)	Number of Structures	Income Loss/ day (Php)	Number of Structures	Income Loss/ day (Php)
City of Manila	2,620	1,393,840	4,063	2,161,516	4,294	2,284,408
Kalookan City	1,864	991,648	1,870	994,840	1,871	995,372
Makati City	1	532	1	532	1	532
Malabon City	2,425	1,290,100	2,425	1,290,100	2,425	1,290,100
Mandaluyong City	8	4,256	8	4,256	8	4,256
Marikina City	-	-	-	-	-	-
Navotas City	2,712	1,442,784	2,712	1,442,784	2,712	1,442,784
Pasay City	249	132,468	299	159,068	349	185,668
Pasig City	97	51,604	150	79,800	245	130,340
Municipality of Pateros	-	-	-	-	-	-
Quezon City	1,393	741,076	1,403	746,396	1,416	753,312
San Juan City	5	2,660	5	2,660	5	2,660
Taguig City	-	-	-	-	-	-
Total	11,374	6,050,968	12,936	6,881,952	13,326	7,089,432

Summary of Damage Costs

Damage as % of GRDP

Figure 4.8: Flood costs as a percent of 2008 GDP



5

Consider investment mix and their costs necessary for adaptation (focusing on flood control infrastructure)

Photo: The New York Times

Adaptation Measures to Climate Change in Metro Manila

Situation	Case	Study Area	A : Marikina Dam	B: Improvement of Embankment	C: Enhancement of Drainage Pomp	Cost	Total Cost
30 year return period A1FI	Pattern 1	Pasig	–	+0.2m	–	67,510,000	2,307,060,000
		Marikina	–	+0.5m	–	89,550,000	
		SanJuan	–	–	–	0	
		West Mangahan	–	–	+43m^3/s	2,150,000,000	
		KAVANAVA	–	–	–	0	
	Pattern 2	Pasig	–	–	–	0	9,577,640,000
		Marikina	Construction	less than +0.5m	–	7,427,640,000	
		SanJuan	–	–	–	0	
		West Mangahan	–	–	+43m^3/s	2,150,000,000	
		KAVANAVA				0	
30 year return period B1	Pattern 1	Pasig	–	–	–	0	1,439,550,000
		Marikina	–	+0.5m	–	89,550,000	
		SanJuan	–	–	–	0	
		West Mangahan	–	–	+27m^3/s	1,350,000,000	
		KAVANAVA				0	
	Pattern 2	Pasig	–	–	–	0	8,777,640,000
		Marikina	Construction	less than +0.5m	–	7,427,640,000	
		SanJuan	–	–	–	0	
		West Mangahan	–	–	+27m^3/s	1,350,000,000	
		KAVANAVA				0	
100 year return period A1FI	Pattern 1	Pasig	–	+0.6m	–	231,720,000	2,971,270,000
		Marikina	Construction	+0.5m	–	89,550,000	
		SanJuan	–	–	–	0	
		West Mangahan	–	–	+53m^3/s	2,650,000,000	
		KAVANAVA				0	
100 year return period B1	Pattern 1	Pasig	–	+0.4m	–	148,070,000	1,887,620,000
		Marikina	Construction	+0.5m	–	89,550,000	
		SanJuan	–	–	–	0	
		West Mangahan	–	–	+33m^3/s	1,650,000,000	
		KAVANAVA				0	

6

Conduct Net Present Value Calculations

NPV Analysis

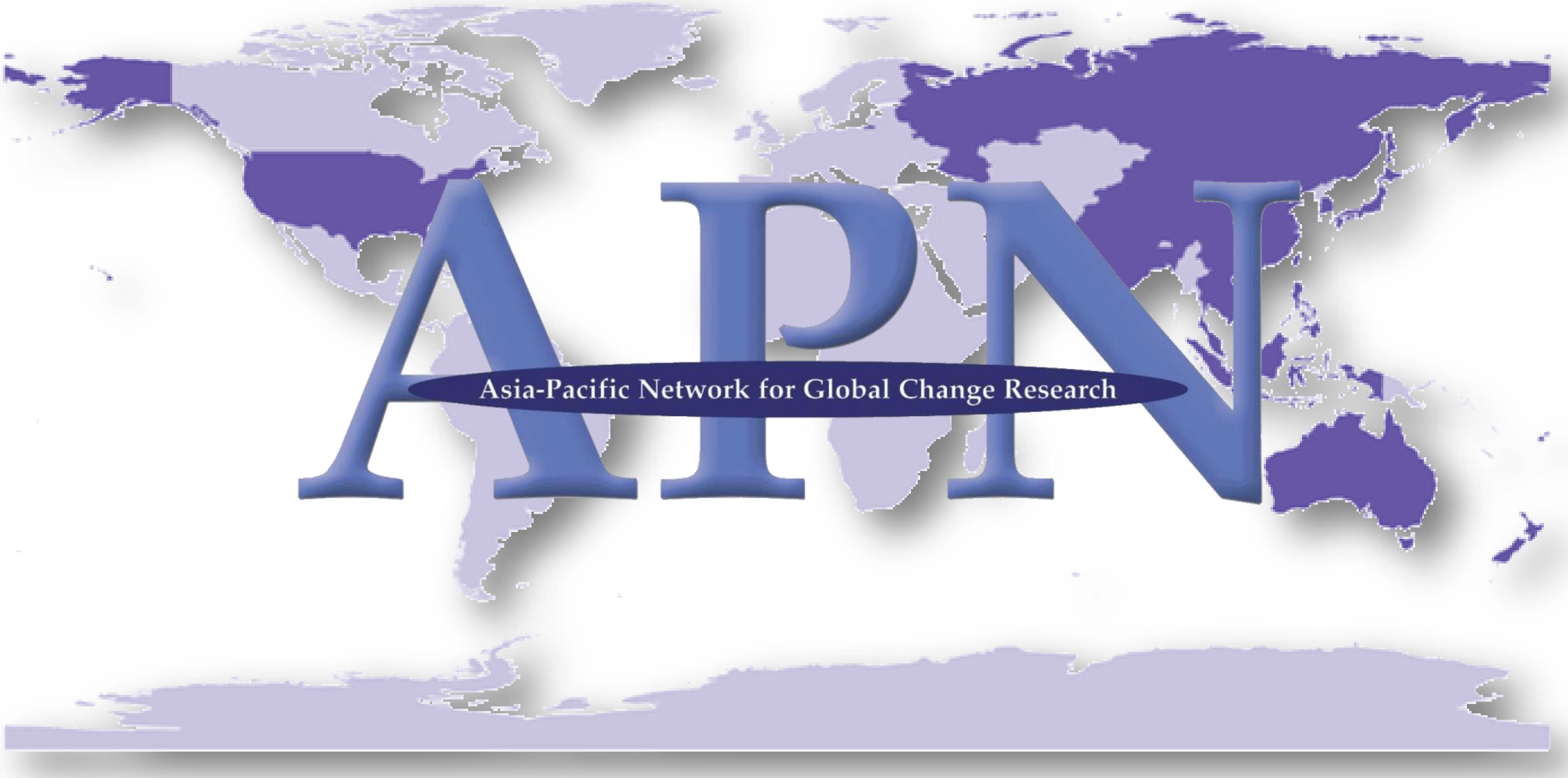
Potential Project/Adaptation Projects (for discussion only)

- 1) Additional embankment at Pasig-Marikina Rivers.
- 2)Enhancement of drainage pump at West of Mangahan area
- 3) Elevate the power rectifier substations (RSS) at LRT line 1
- 4) Drainage improvement
- 5)Adaptation of Manila Port Facilities
- 6)Adaptation of NAIA Facilities

Conclusion and way forward

- 1) Costs of damage will be substantial in Asian Coastal Mega-Cities
- 2)Urban plans and flood protection infrastructure need to take climate risks into consideration
- 3) Need to address other non-climate factors such as improved management of canals and drains
- 4) Potential cross-fertilization with disaster risk reduction community

Climate Change Vulnerability Assessment and Uran Development Planning for Coastal Cities, *Thailand, 22-28 August 2010*



Perlyn Pulhin
APN Secretariat

WHAT IS APN?

- Inter-governmental Network to foster **global change research** in the Asia-Pacific region
- Established in ‘96 as a result of the ‘90 White House Conference on Science & Economics Research Related to Global Change
- 22 Member countries
- Full time Secretariat in Kobe, Japan since ’99
- Major activities
  - ✓ Funding research projects (ARCP)
  - ✓ Funding capacity building projects (CAPaBLE)
  - ✓ Science-policy linkages

APN

What do we mean by "Global Change"?

- The set of *natural and human-induced changes in the Earth; in its physical and biological systems* that, when aggregated, are significant at a global scale……….
- **Global Change Research** is research regarding global change and its implications for sustainable development in the Asia-Pacific region

APN MEMBER COUNTRIES

- **Pacific Island Countries and Singapore are approved countries whose scientists are eligible to receive funding under APN awards.**

APN

FINANCIAL RESOURCES

The APN is sponsored by the governments of:

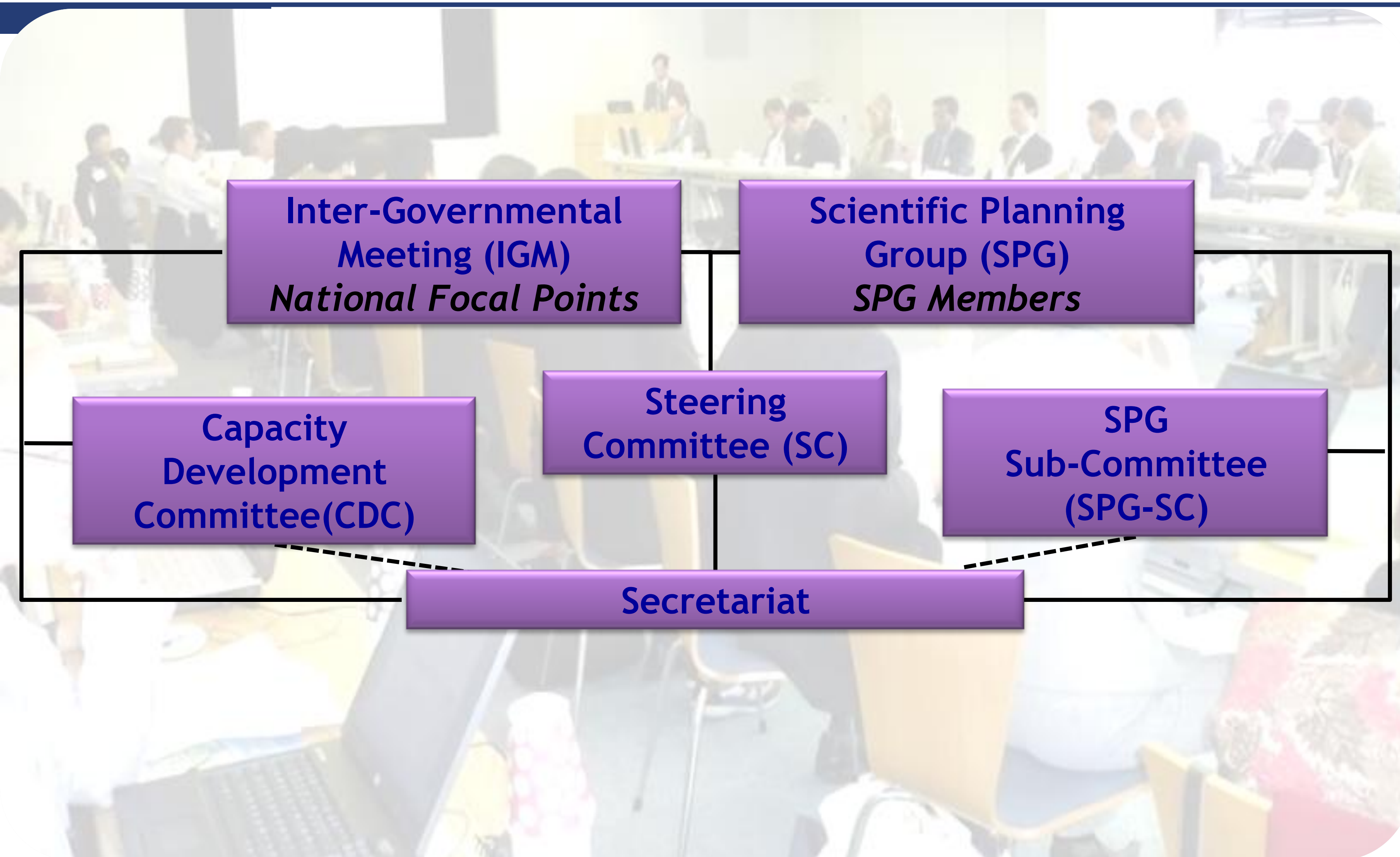
- Japan (Ministry of the Environment and Hyogo Prefecture)
- New Zealand (Ministry for the Environment)
- Republic of Korea (Ministry of Environment)
- United States of America (National Science Foundation, US Global Change Research Program)

Ministry for the Environment
Manatū Mō Te Taiao

Key Donor Members

United States Global Change Research Program

STRUCTURE


Inter-Governmental Meeting (IGM)
National Focal Points
Scientific Planning Group (SPG)
SPG Members
Capacity Development Committee(CDC)
Steering Committee (SC)
SPG Sub-Committee (SPG-SC)
Secretariat

APN
Asia-Pacific Network for Global Change Research

PARTNERS

DIVERSITAS
an international programme of biodiversity science

IAI
INTER-AMERICAN INSTITUTE FOR GLOBAL CHANGE RESEARCH

START
IHDP • IGBP • WCRP

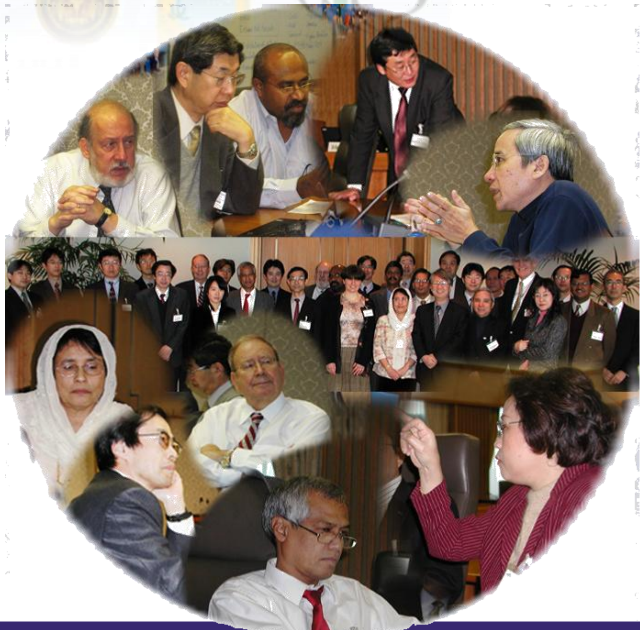
WCRP

ICSU
International Council for Science

GROUP ON EARTH OBSERVATIONS

GLOBAL CHANGE
IGBP

NCAR
NIWA
Taihoro Nukurangi
Government of Samoa
SPREP
INDEPENDENT UNIVERSITY
PMD
PICES
UNFCCC
UNITED NATIONS UNIVERSITY
UNU-INWEH
pace-sd



Department of Meteorology
Sri Lanka
GECAFS
Global Environmental Change and Food Systems
Agro-Dev International
CLIVAR
Climate Variability & Predictability
World Climate Research Programme
ERI
BUP
ASIAN INSTITUTE OF TECHNOLOGY
APSRU
IIM AHMEDABAD
GLOBEC
EAST-WEST CENTER

APN

Asia-Pacific Network for Global Change Research

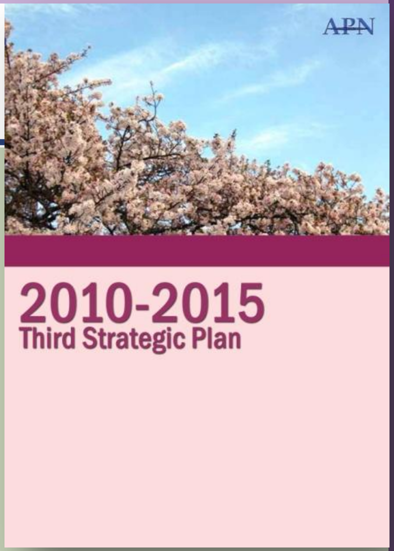
MISSION

The APN supports investigations that will:

- Identify, explain and predict changes in the context of both natural and anthropogenic forcing,
- Assess potential regional and global vulnerability of natural and human systems, and
- Contribute, from the science perspective, to the development of policy options for appropriate responses to global change that will also contribute to sustainable development

APN

3RD STRATEGIC PHASE



APN GOALS

- Supporting regional cooperation in global change research on issues particularly relevant to the region
- Strengthening appropriate interactions among scientists and policy-makers, and providing scientific input to policy decision-making and scientific knowledge to the public
- Improving the scientific and technical capabilities of nations in the region, including the transfer of know-how and technology
- Cooperating with other global change networks and organisations

Opportunities: Calls for Proposals

APN's 2010 Annual Calls for Proposals

Information on the Two Calls for Proposals

Download information on the two calls for proposals launched this year under the ARCP and CAPaBLE Programmes (PDF)

APN Advisory Service (Voluntary)

Download information on the Advisory Service, a voluntary component of the ARCP and CAPaBLE Calls for Proposals to assist proponents (PDF)

Download Advisory Service Letter of Intent Template (WORD)

ARCP

CAPaBLE

Downloads

- Timetable for the Proposals Process
- Advisory Service **Letter of Intent** Template
- ARCP Guide for Proponents
- ARCP Stage 1 **Summary Proposal** Template
- ARCP Stage 2 **Full Proposal** Template
- CAPaBLE Guide for Proponents
- CAPaBLE Stage 1 **Summary Proposal** Template
- CAPaBLE Stage 2 **Full Proposal** Template
- Example of a **Budget** (Click **here** to download pdf format)
- Example of a **Timeline** (Click **here** to download pdf format)

OPPORTUNITIES

Annual Regional Call for Research Proposals (ARCP)

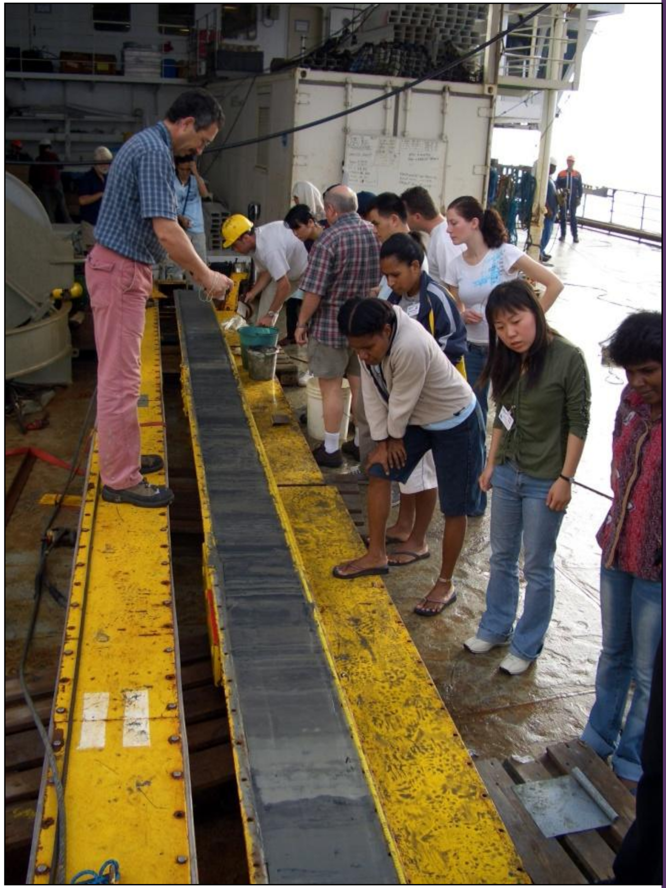
- One of the scientific pillars of the APN to support global change research in the Asia-Pacific region
- Competitive process launched in 1998 to select projects for funding under the Science Agenda of the APN

APN

ARCP

Types of Activities Eligible for Funding:

- New research which addresses knowledge gaps in key areas
- Synthesis and analysis of existing research
- Research planning/scoping activities
- The development of policy products such as integrated assessments, impact assessments, climate models, etc.



APN

Asia-Pacific Network for Global Change Research

CAPaBLE

Scientific Capacity Building and Enhancement for Sustainable Development in Developing Countries (CAPaBLE) Programme

- The second pillar of APN supporting **capacity development projects/ activities**
- Registered as a World Summit on Sustainable Development (WSSD) Type II Partnership/Initiative
- Launched in 2003 as a concrete initiative to realise part 107 to 114 of the Plan of Implementation for the WSSD

Three main objectives of CAPaBLE:

1. Capacity building of aspiring scientists through sharing of knowledge, experience, scientific information and data collection on climate change impacts, vulnerabilities, adaptation and mitigation

2. Capacity enhancement of leading researchers in developing countries to produce comprehensive scientific results on climate change impacts, vulnerabilities, adaptation and mitigation

3. Improvement of informed decision-making in developing countries by dissemination of the outcomes of research activities to policy-makers and civil society

CAPaBLE

Types of Activities Eligible for Funding:

- Scientific capacity development
- Scientific policy interfacing
- Awareness raising activities
- Dissemination activities

SRC Activities

- **Organising the PDTW back-to-back with the South Asia SRC Meeting and the Training Workshop on Downscaling of South Asian Climate Projections, 1-5 November 2010, Pune, India**

  ✓ ***Indian Institute of Tropical Meteorology will host and provide support for conducting these events***

SRC Activities

- **Organising the PDTW back-to-back with the APN 3rd Southeast Asia SRC Meeting, 8-12 November 2010, Manila, Philippines**

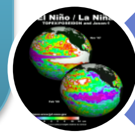
  ✓ ***Host institutions co-organising the events and providing support: Ecosystems Research and Development Bureau, Department of Natural Resources and Environment (DENR-ERDB)***

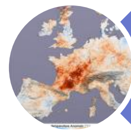
APN
Asia-Pacific Network for Global Change Research

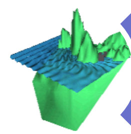
Synthesis Activity

- Two-year synthesis activity: *Climate in Asia and the Pacific* synthesising the work of over 50 APN-funded climate projects


Food, Agriculture & Climate


Seasonal Climate Predictions & Applications


Climate Variability, Trends & Extremes


Regional Climate Change Modelling


Vulnerability & Adaptation to Climate Change


Climate Change Mitigation


Coastal Cities & Climate Change


Climate Change Policy Outreach

Climate Change Challenges

- Climate change is the foremost concern particularly **vulnerabilities, impacts and adaptation**
- **lack of human & institutional capacity** & limited financial resources are the main challenges in implementing climate research
- **mainstreaming** climate research results into national policy

Risks and APN Response

Sectors Most at Risk

Agriculture, Water (floods, drought, security), Forests, Coastal zones, Mangroves, Maritime resources

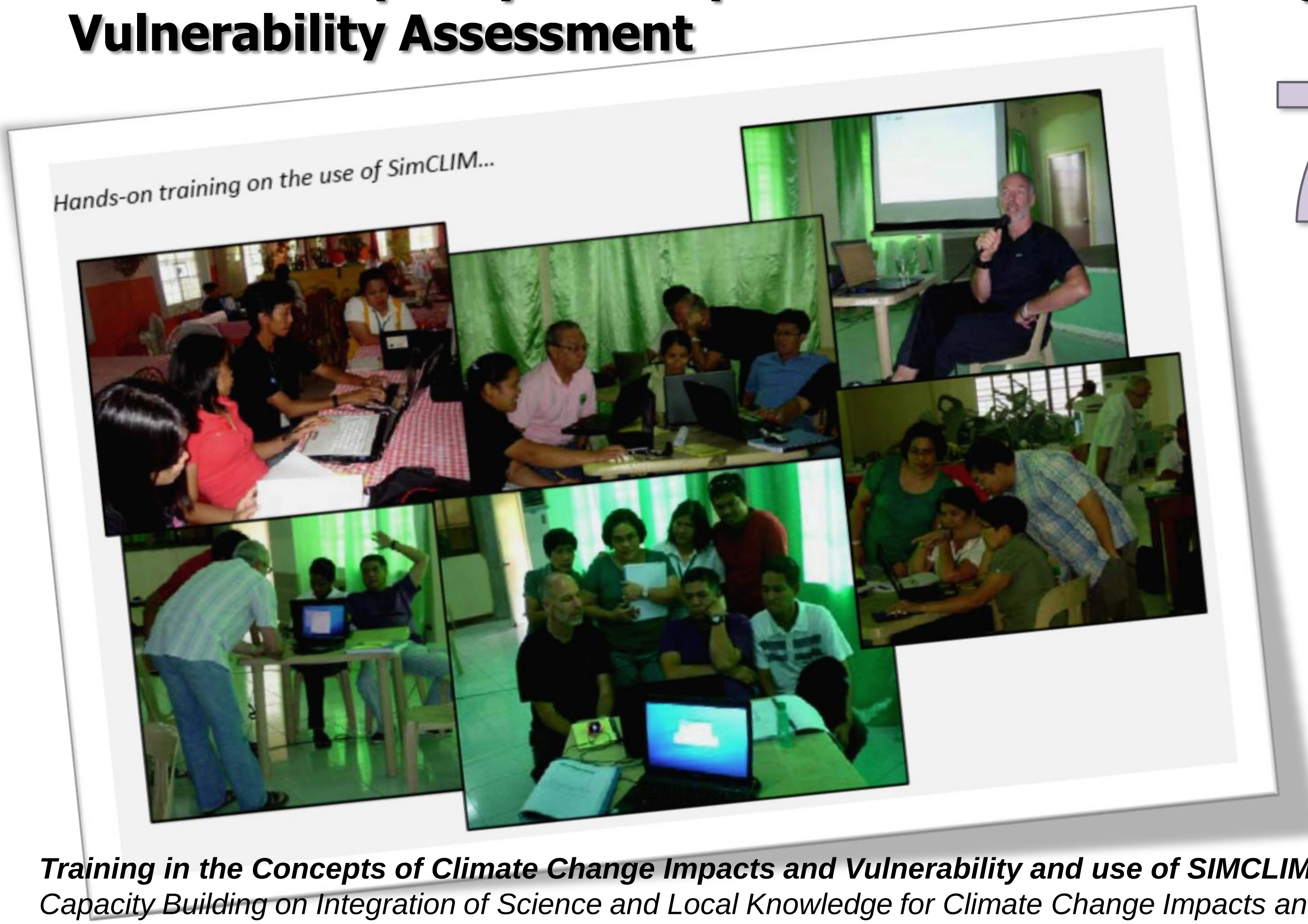
mainstreaming adaptation strategies most challenging

APN's Response

Scientific Capacity Building for Impact and Vulnerability Assessments

SCBCIA

Scientific Capacity Development for Climate Change Impact and Vulnerability Assessment



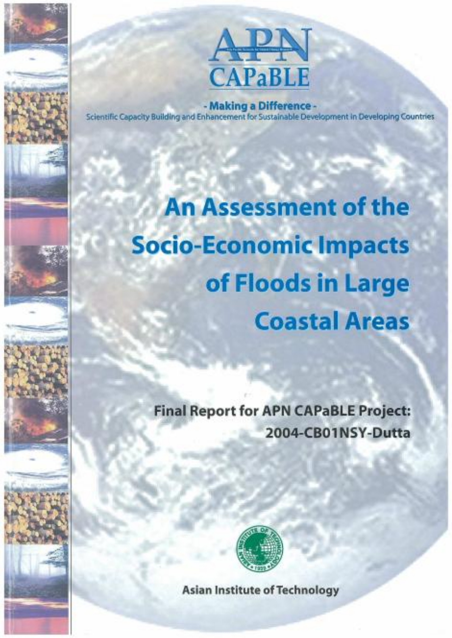
7 ***Ongoing projects***

Countries:

- China
- Indonesia
- Philippines
- Pakistan
- Viet Nam
- Thailand

Training in the Concepts of Climate Change Impacts and Vulnerability and use of SIMCLIM
Capacity Building on Integration of Science and Local Knowledge for Climate Change Impacts and Vulnerability Assessments

APN-supported projects



APN2004-CB01-NSY-DUTTA

An Assessment of the Socio-economic Impacts of Floods in Large Coastal Areas

APN2004-CB06-NSY-RHAMAN

Vulnerabilities Training Seminars on Methodological Issues Related to the Human Dimensions of Global Environmental Change

APN-supported projects

APN2005-14-NSY-CAMPBELL: Community Relocation as an Option for Adaptation to the Effects of Climate Change and Climate Variability in Pacific Island Countries (PICs)

Objective:
To undertake a pilot project on assessment of community resilience and the role of relocation as adaptive options

APN-supported projects

APN2004-CB02-CHINVANNO

Building Capacity of Mekong River Countries to Assess Impacts of Climate Change – Case Study Approach on Assessment of Community Vulnerability and Adaptation to Impacts of Climate Change on Water Resources and Food Production

CBA2006-12CMY-BOER

Increasing Adaptive Capacity of Farmers to Extreme Climate Change through Policy-Science-Community Networking

APN-supported projects

CRP2007-03CMY-Jintrawet

Climate Change in Southeast Asia and Assessment on Impact, Vulnerability and Adaptation on Rice Production and Water Balance

CBA2007-04NSY-Iino

Developing Chemical Analysis Capability in India and Pakistan and Risk Perception of Policy-Makers and People in Asia

APN-supported projects

CBA2007-02CMY-AALBERSBERG

Climate Change Variability Implications on Biodiversity – Youth Scenario Simulations and Adaptations

CBA2008-04NSY-Nakashizuka

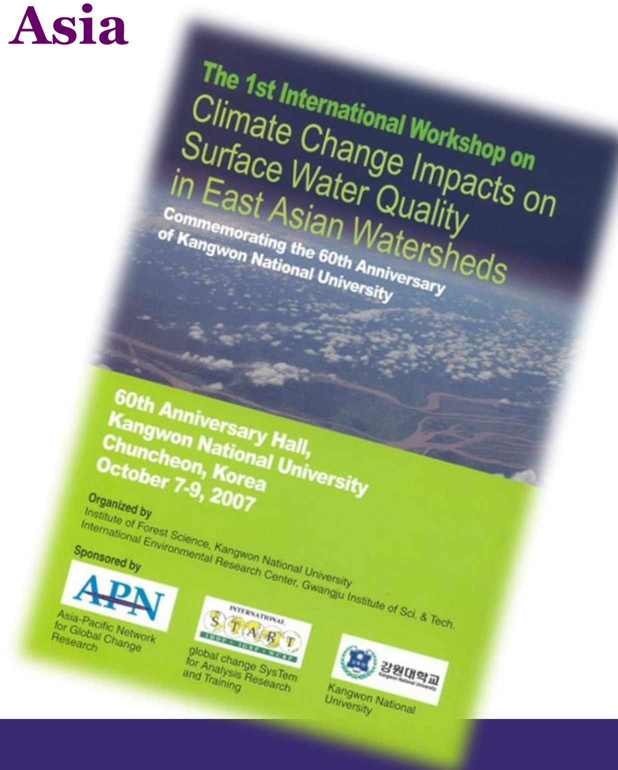
Training in Science-Policy Interfacing to promote the Applications of Scientific Knowledge on Adaptation of Forests & Management to Climate Change

APN-supported projects

Kick-off Meeting and Training Workshop on Agent-Based Modeling

ARCP2008-09CMY-Espaldon

Assessing Vulnerability of Communities and Understanding Policy Implications of Adaptation Responses to Flood-Related Landslides in Asia



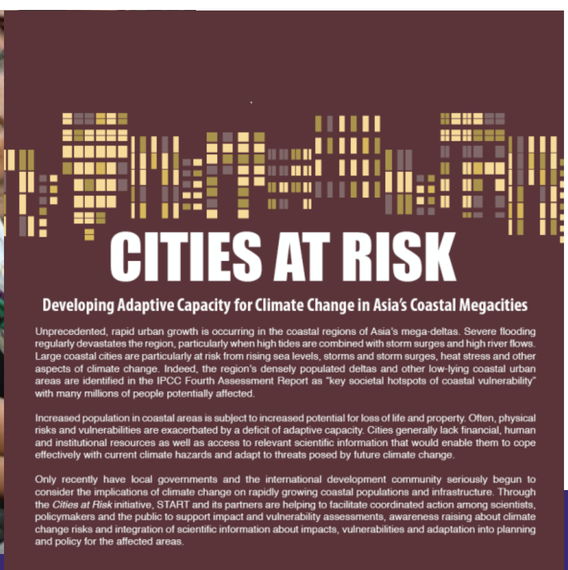
ARCP2008-04CMY-Park

Regional Collaborative Research on Climate Change Impacts on Surface Water Quality in Eastern Monsoon Asia: Towards Sound Management of Climate Risks

APN-supported projects

CBA2008-09NSY-Peñalba

Enhancing Climate Change Adaptation Capacity of Local Government Units and Scientists in the Philippines



CBA2008-06NSY-Fuchs

Cities at Risk: Developing Adaptive Capacity for Climate Change in Asia's Coastal Mega Cities

For more information, please visit:

Contact APN

www.apn-gcr.org

or email

info@apn-gcr.org

East Building, 4F
1-5-2 Wakinohama Kaigan Dori
Chuo-ku, Kobe 651-0073, Japan
Tel: +81-78-230-8017
Fax: +81-78-230-8018

THANK YOU!!!

CITIES AT RISK

Developing Adaptive Capacity for Climate Change in Asia's Coastal Megacities

Roland Fuchs,
Senior Fellow
Research Program

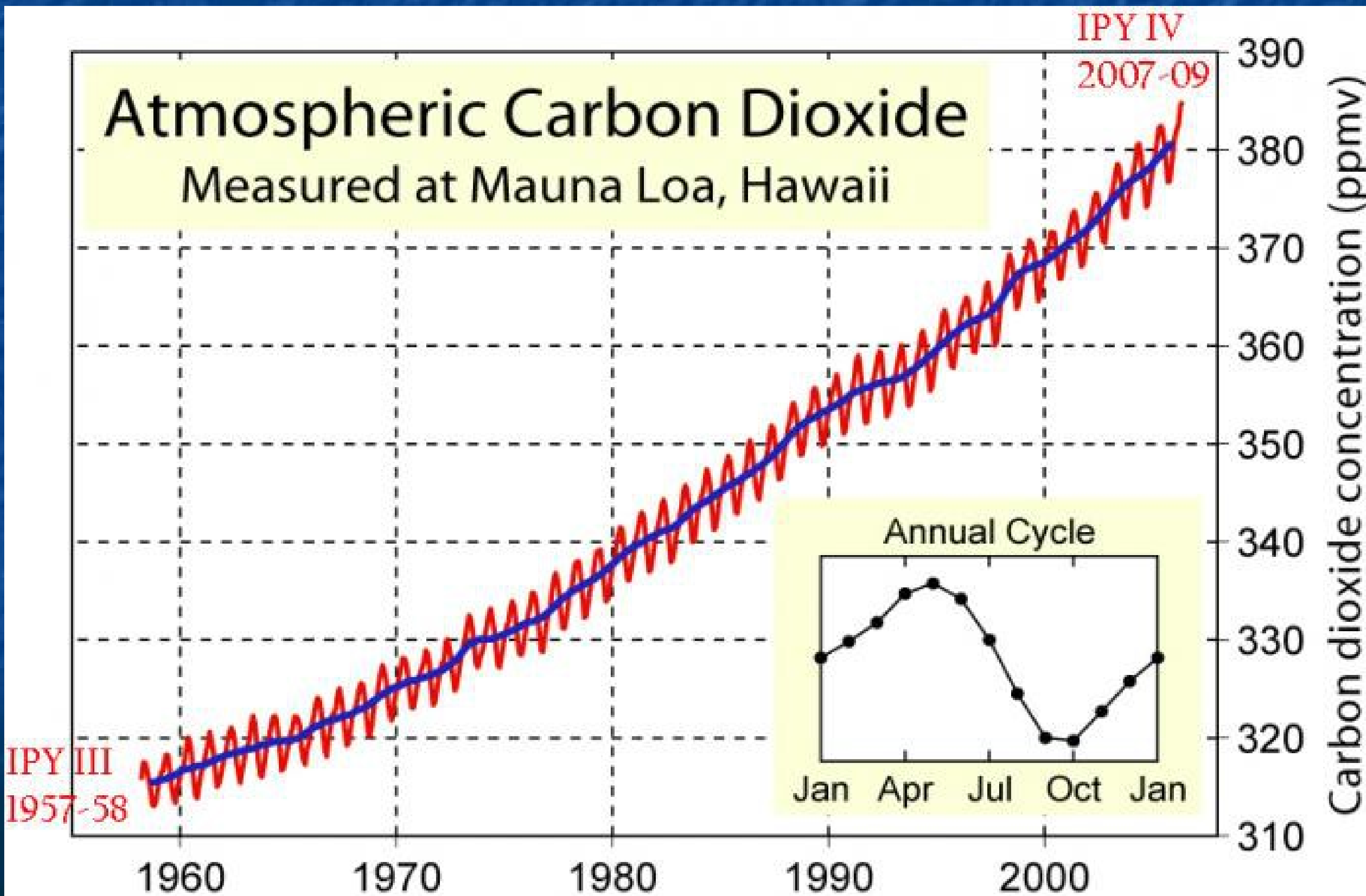
EAST-WEST CENTER
COLLABORATION • EXPERTISE • LEADERSHIP
50
SINCE 1960

Coastal vulnerabilities in light of global change

- Climate change
- Sea level rise
- Land subsidence
- Increasing settlement in coastal

Time series of global mean sea level, as a deviation from 1980-99 mean.

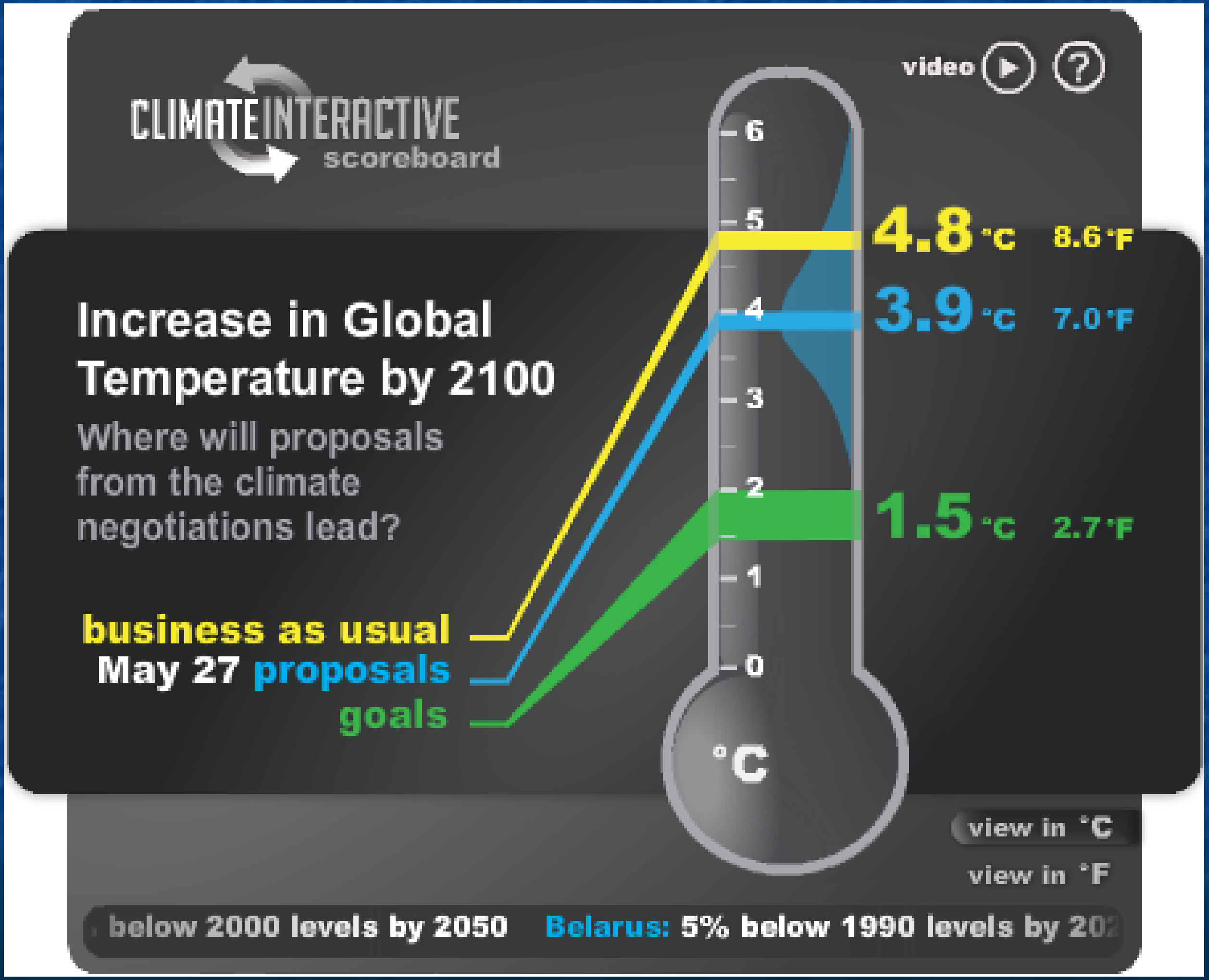
The Most Important Graph in the World: The Keeling Curve



Global Warming – Social and Environmental Disruption

"Temperature rises above 2 degrees centigrade are likely to cause major societal and environmental disruptions through the rest of the century and beyond"

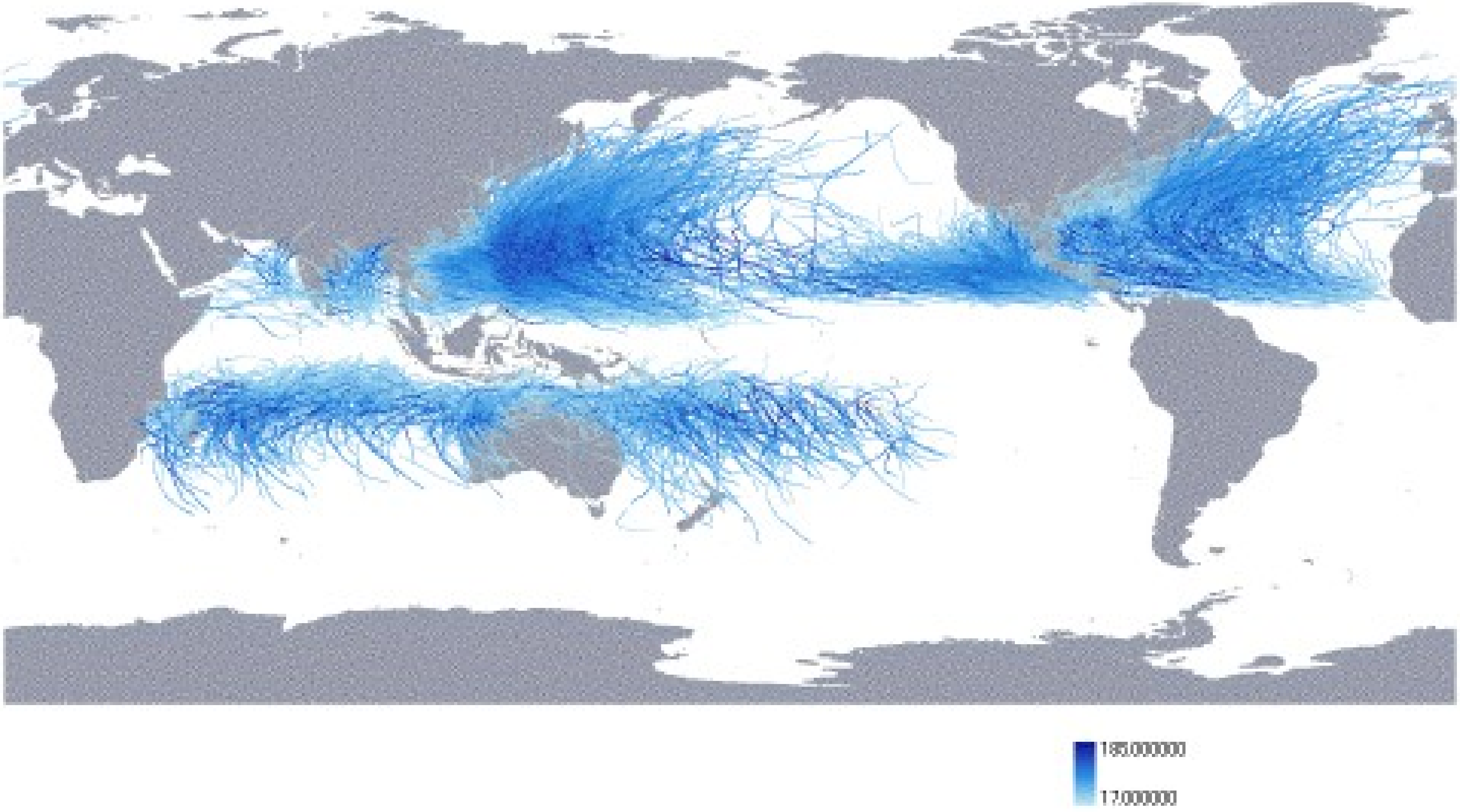
2100 Increase in Global Temperatures



Dangerous Warming Consequences

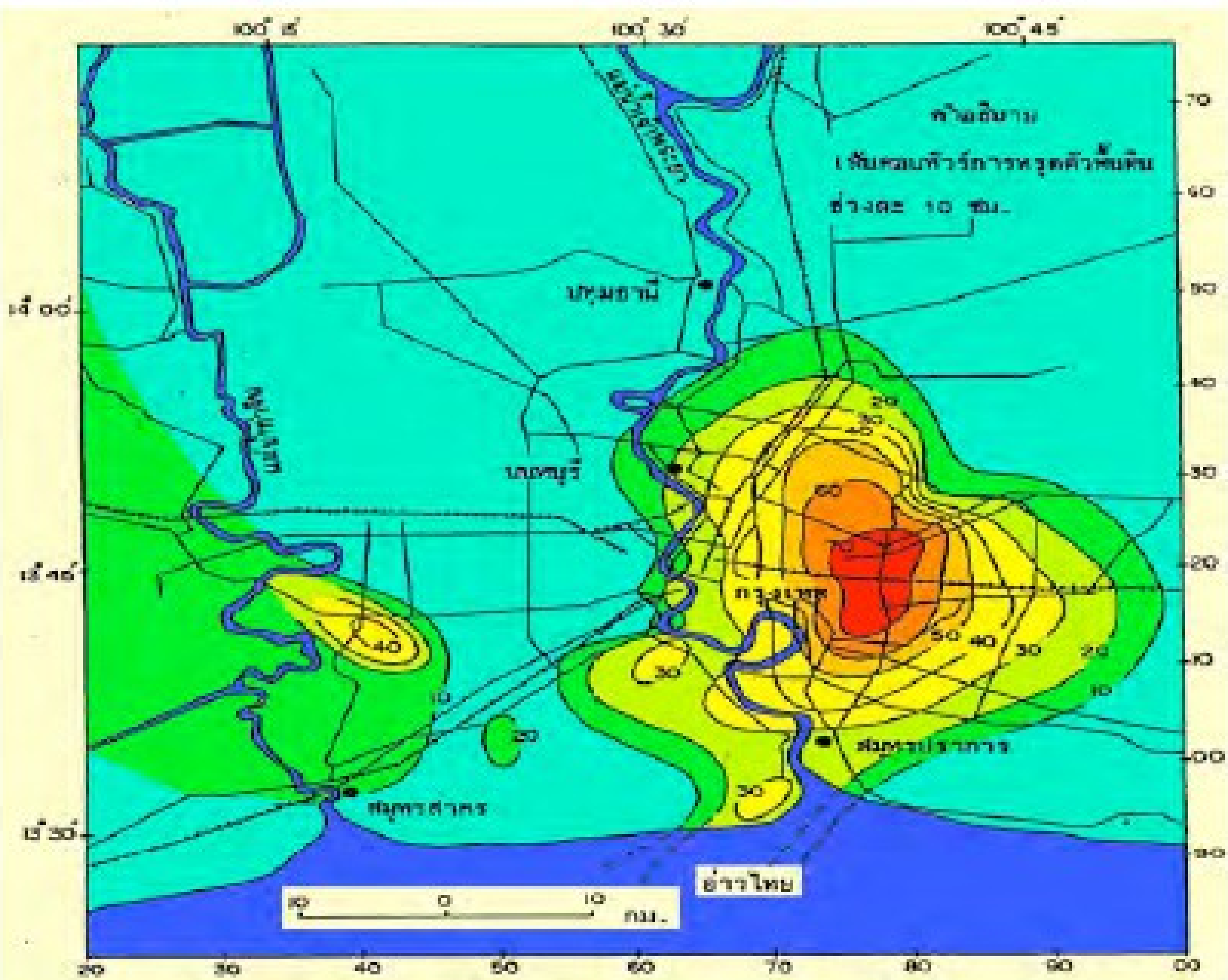
- Current CO_2 emissions are near (but not above) upper end of IPCC scenarios
- $4^{o}C$ global warming (relative to pre-industrial) is possible by the 2090s, especially under the high emissions scenario
- Many areas could warm by $10^{o}C$ or more
- The Arctic could warm by $15^{o}C$ or more
- Annual precipitation could decrease by 20% or more in many areas
- Carbon cycle feedbacks expected to accelerate warming
- With high emissions, best guess is $4^{o}C$ in 2070s
- Plausible worst case: $4^{o}C$ by 2060

Tropical Cyclones 1949-2007



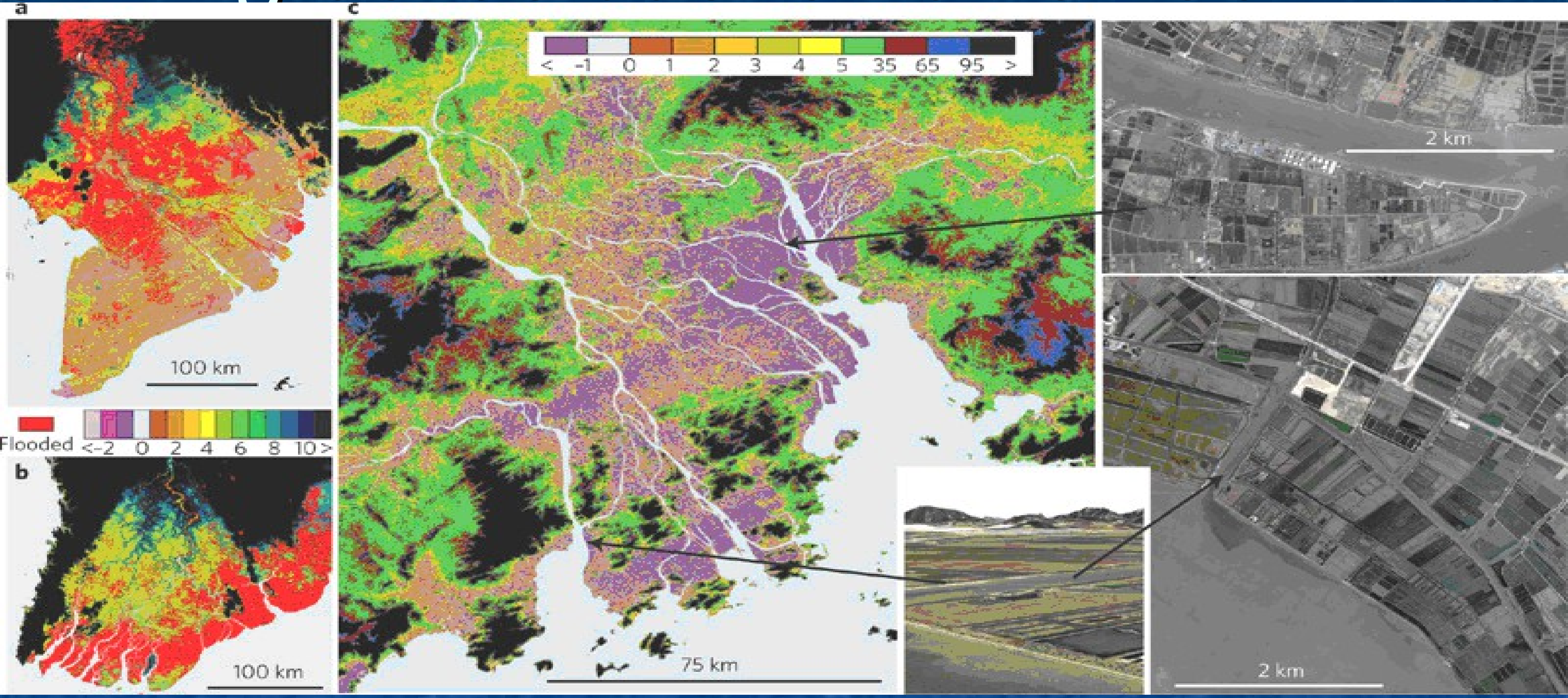
Why Strategic Retreat?

"Hurricanes are Nature's way of saying get off my property"– *Bill Maher*



Land Subsidence in Bangkok Source:Somkid(2002)

Sinking deltas due to human activities

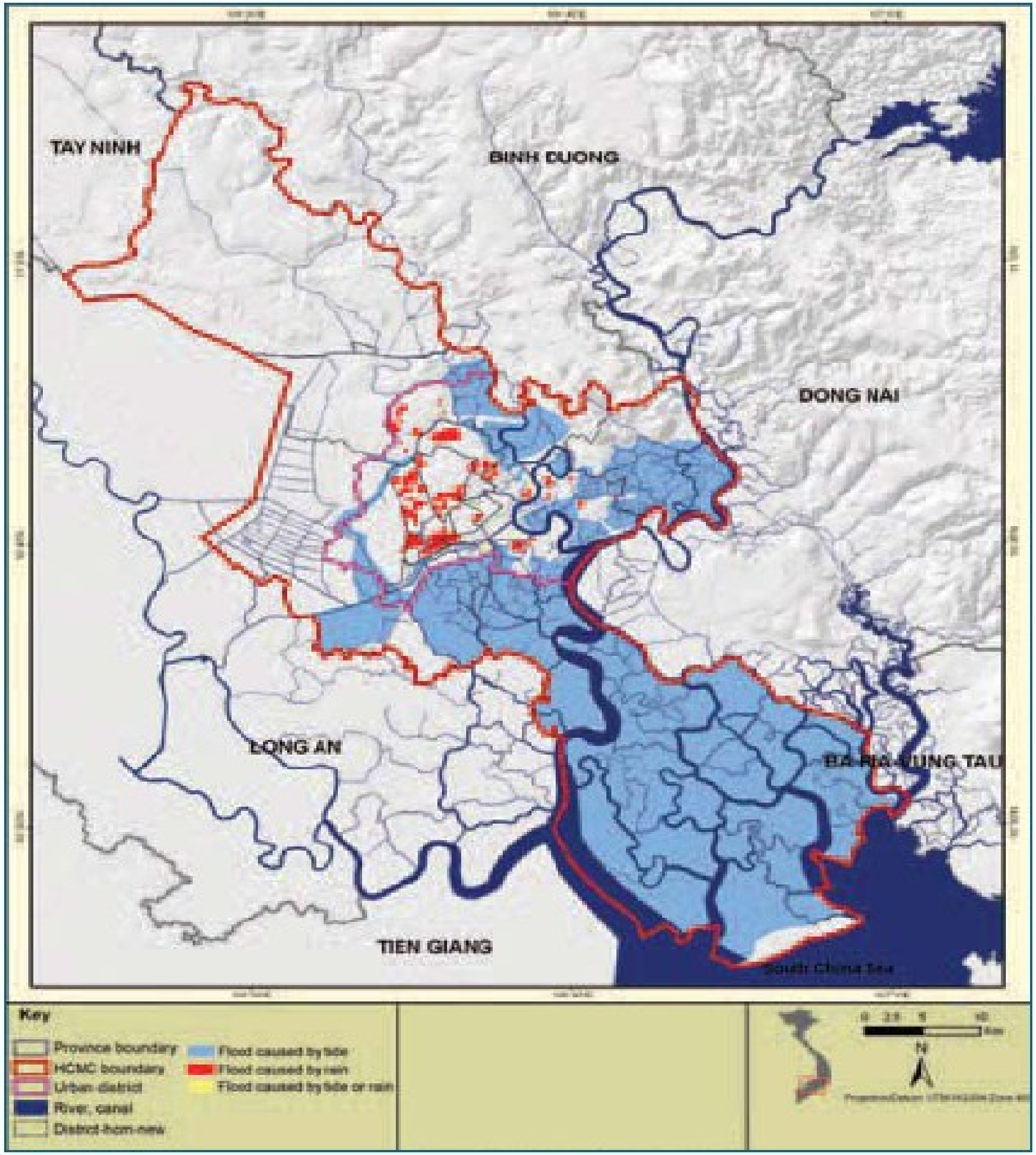


- Mekong
- Irrawaddy, Myanmar. Mekong River flooded, November 2007. Cyclone Nargis inundated the Irrawaddy, May 2008.
- The Pearl Delta, China, with areas below sea level shown in purple.

Impact Zones for 1 Meter Sea-Level Rise and Intensification of Storm Surges, and Likely Changes in Unprotected Shorelines

Illustrative Cases: Viet Nam

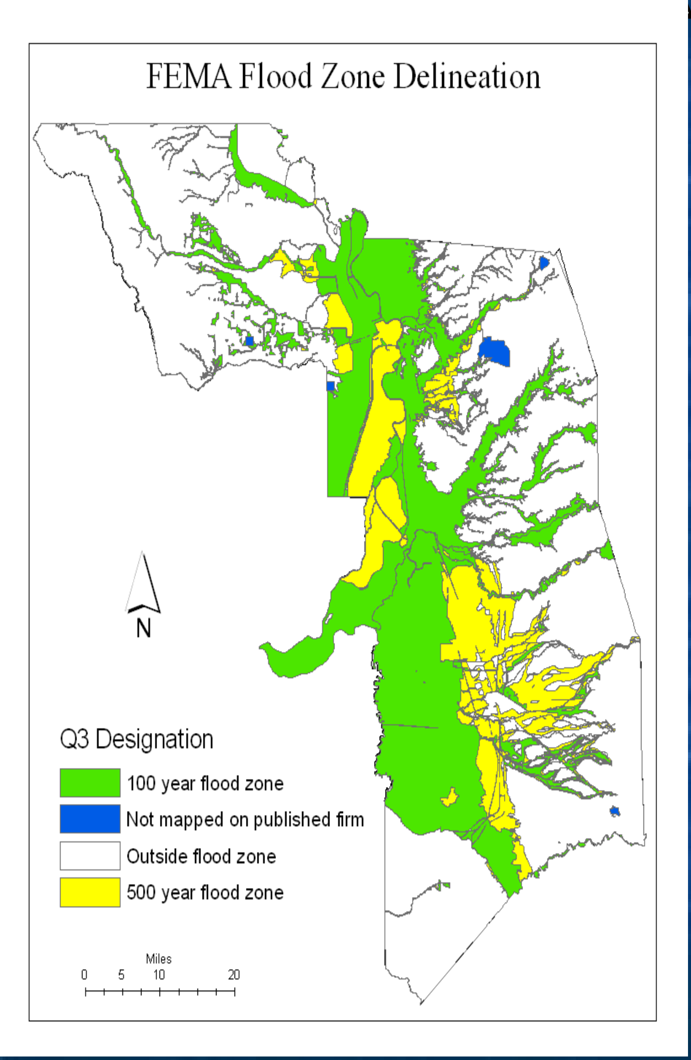
Map 1: Ho Chi Minh City Areas Subject to Flooding



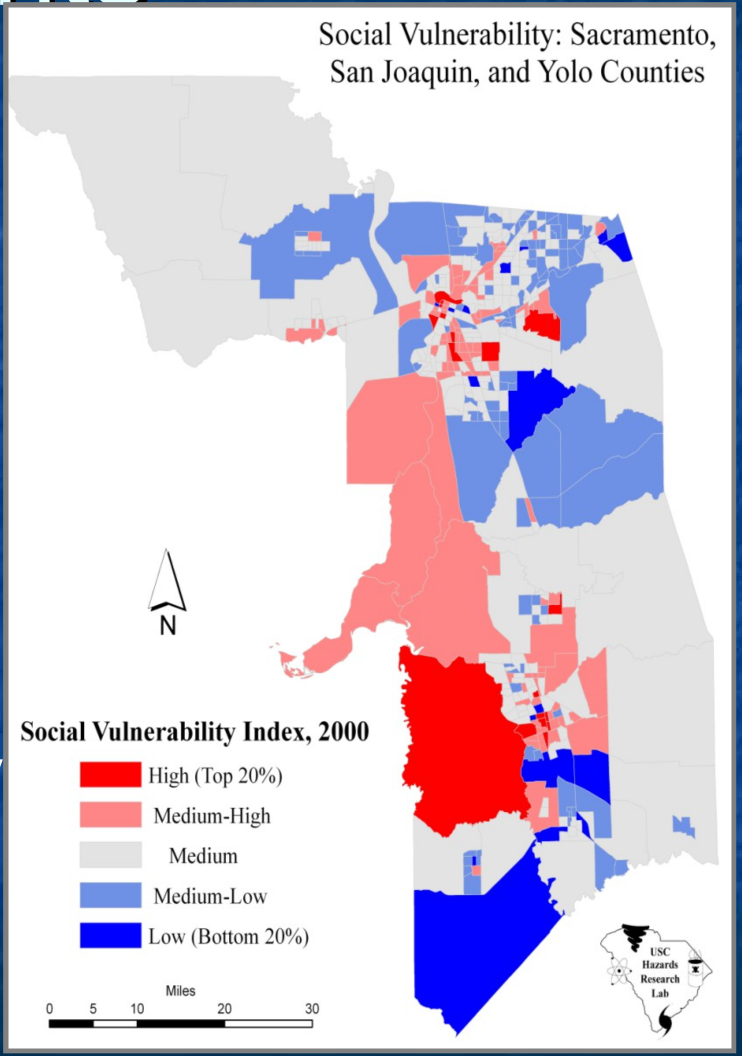
HCMC = Ho Chi Minh City.

Source: ADB, JICA–HCMC urban drainage and sewerage project.

Social Vulnerability Assessments

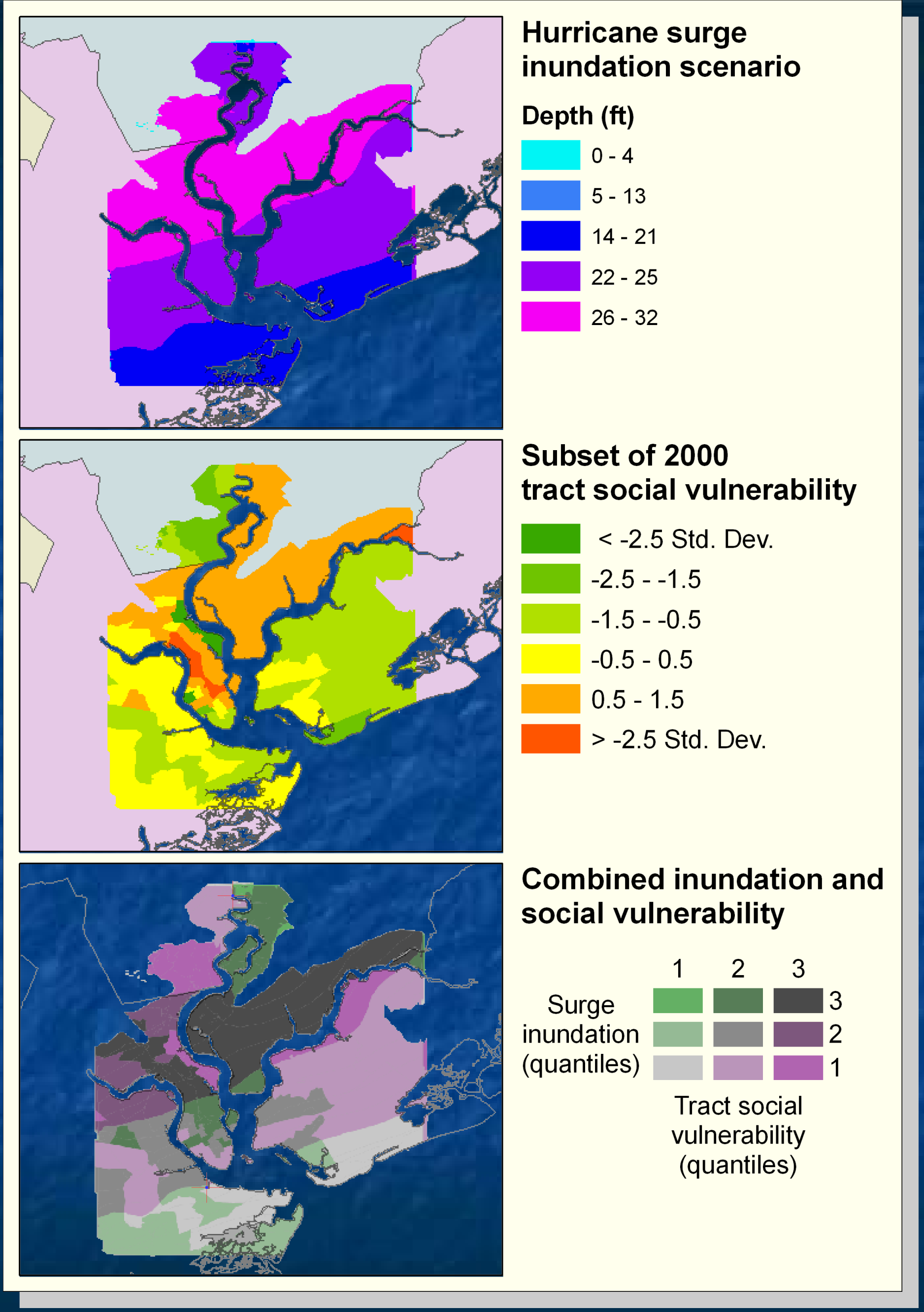


9 factors, 76.7% variance explained, socioeconomic status (poverty), race/ethnicity (Hispanics), age (elderly)

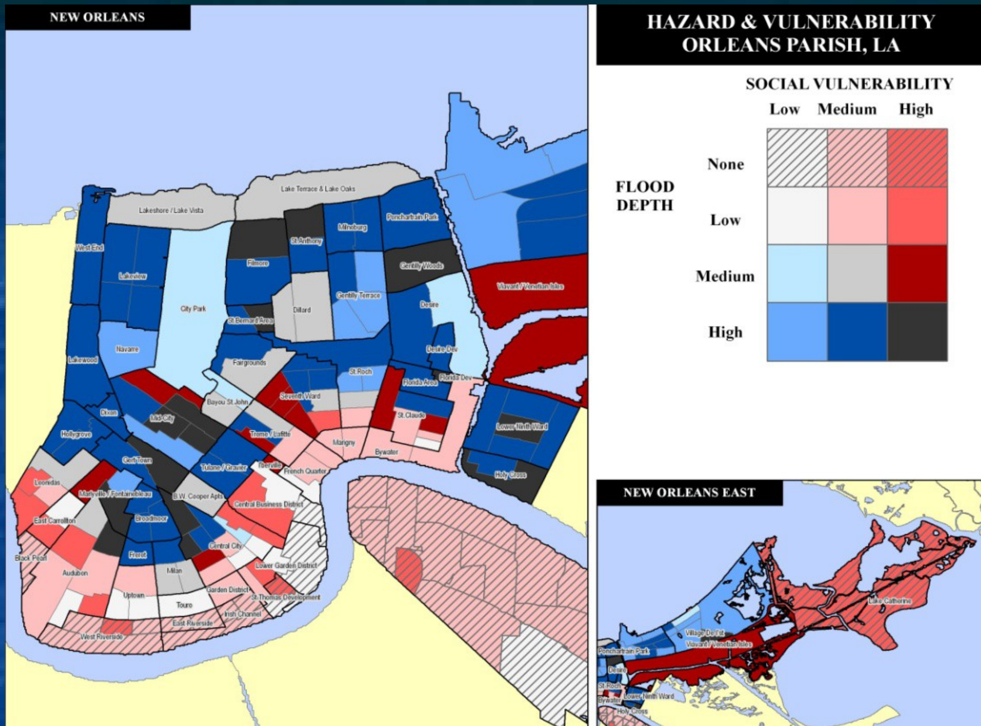


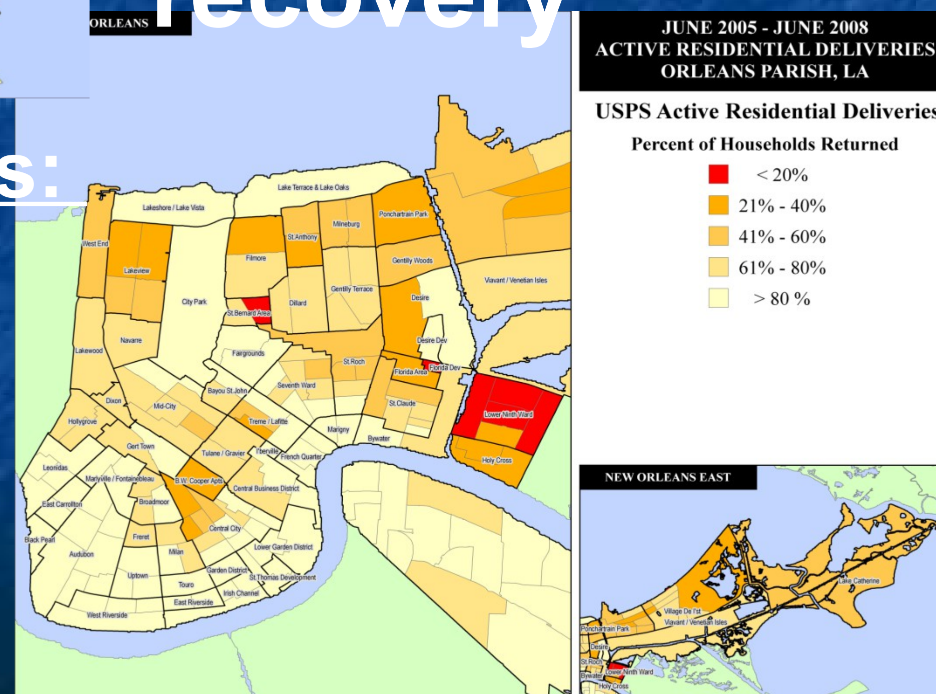
Developing "what if" scenarios

HAZUS-modeling



Assess and monitor social and spatial inequalities in impacts and recovery



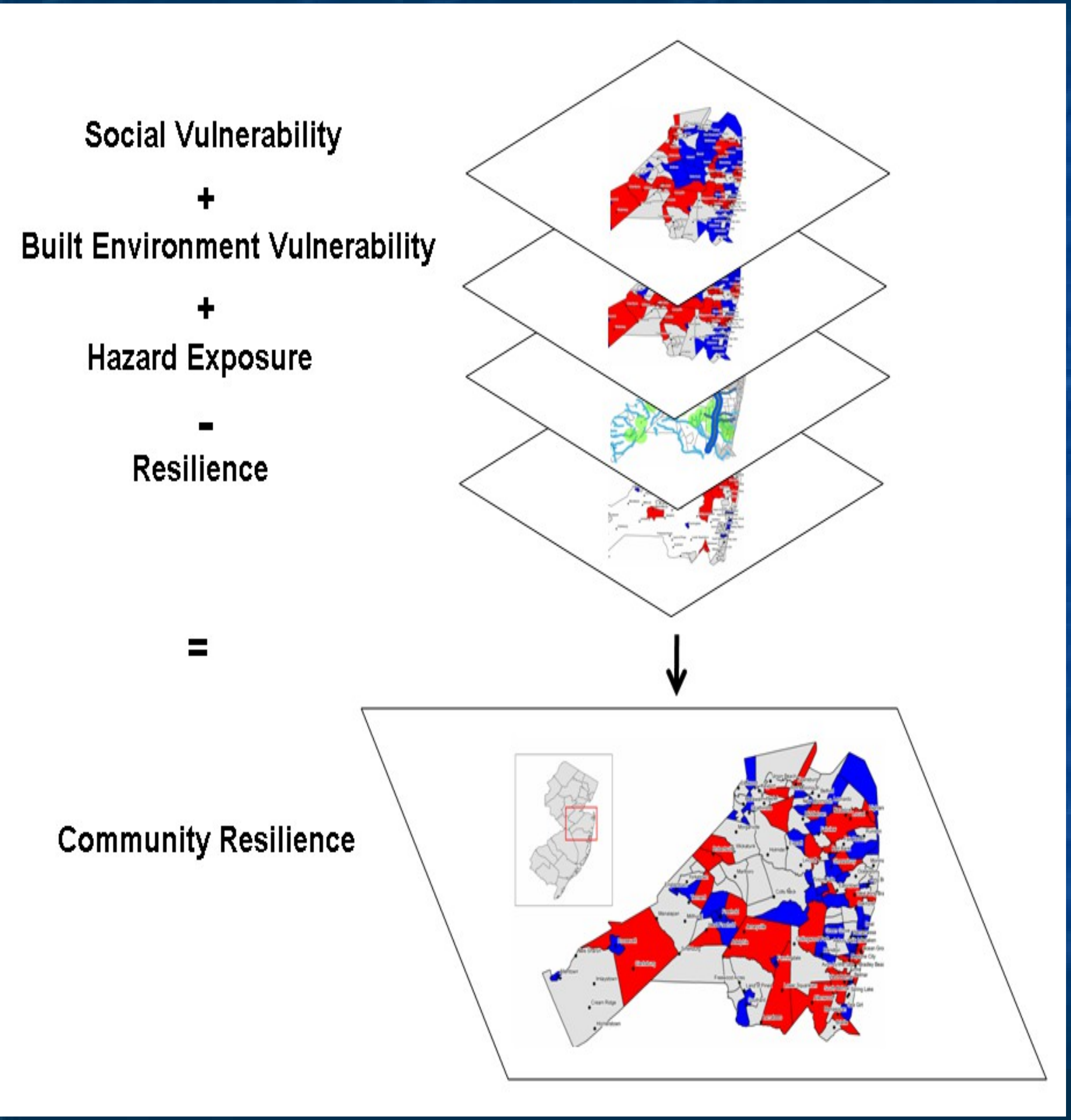


<u>Pre-event determinations:</u>

Vulnerability and resilience

Preparedness, response, recovery, and mitigation

Take home messages



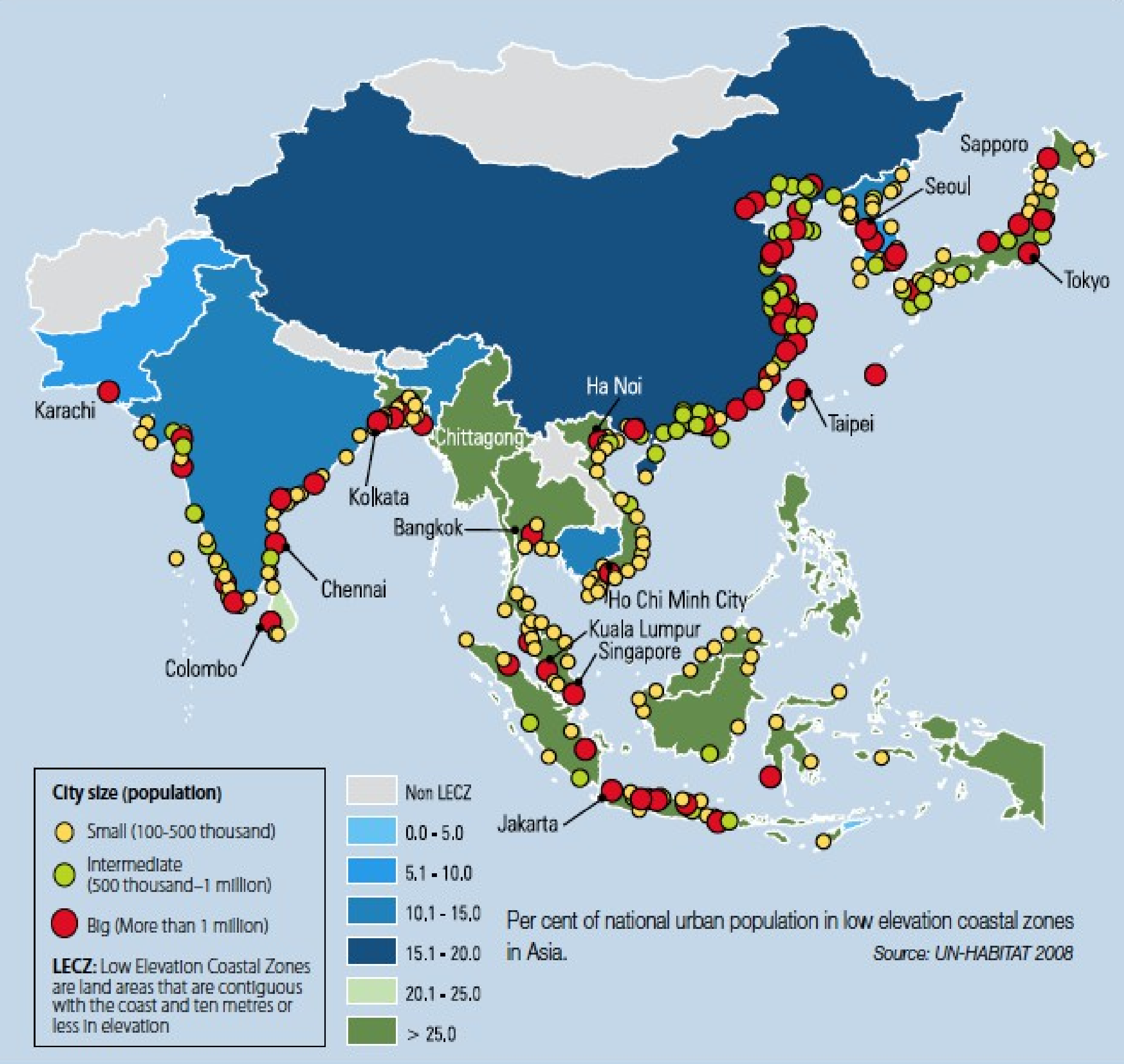
- Social metrics possible to construct and scale
- Intersection of social and physical process possible within a geospatial framework
- Improve built environment
- More work on social resilience (or adaptive capacity) within a geospatial environment
- Application to other venues (small island nations; mega

Vulnerability of Asian coastal cities

- Increasing urban settlement in low-lying coastal areas
- IPCC has identified Asian mega deltas as “hot spots of vulnerability”
- By 2070, nine of the top 10 cities in terms of population exposure will be found in Asia

(Kolkata, Mumbai, Dhaka, Guangzhou, Ho Chi Minh City, Shanghai, Bangkok, Rangoon, and Hai Phong)

Figure 2: Asian cities at risk from sea level rise



Per cent of national urban population in low elevation coastal zones in Asia.

Source: UN-HABITAT 2008

Cities at risk of coastal flooding, ranked by exposed population in 2070

Coastal City	Exposed population estimate (millions)
Kolkata	14.0
Mumbai	11.4
Dhaka	11.1
Guangzhou	10.3
Ho Chi Minh City	9.2
Shanghai	5.5
Bangkok	5.1
Yangon (Rangoon)	5.0
Miami	4.8
Hai Phong	4.7

Source: See note 2.

Coastal vulnerabilities in light of global change

- This is likely to translate into regular city-scale disasters at the global scale.
- Over a 5-year period there is a 99.9% chance of having at least one city (of 136 port cities, with over 1 million population) being affected by a 100-year flood event.

Vulnerability of Asian coastal cities (cont.)

- Exposed population (left) and assets (right)

To effectively manage risk, adaptation strategies must encompass a range of policy options, including:

- upgraded protection/infrastructure,
- managing subsidence (in susceptible cities),
- land use planning,
- selective relocation, and
- flood warning and evacuation

Nicholls, R.J., et al. 2008. Ranking Port Cities with High Exposure and Vulnerability to Climate Extremes. OECD.

The adaptation process:

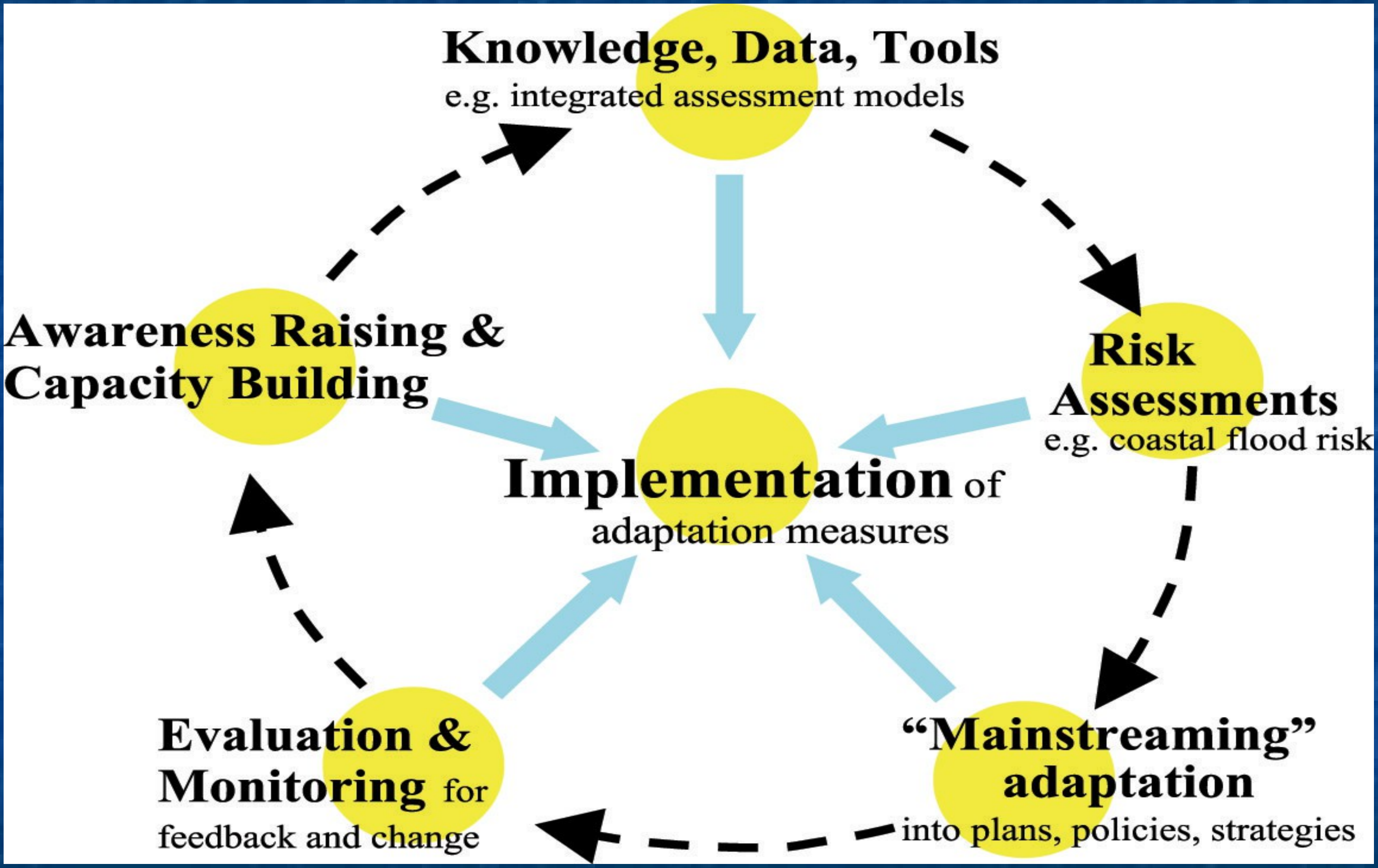


Figure 11.1. *Adaptation as a process (Warrick, 2000, 2006).*

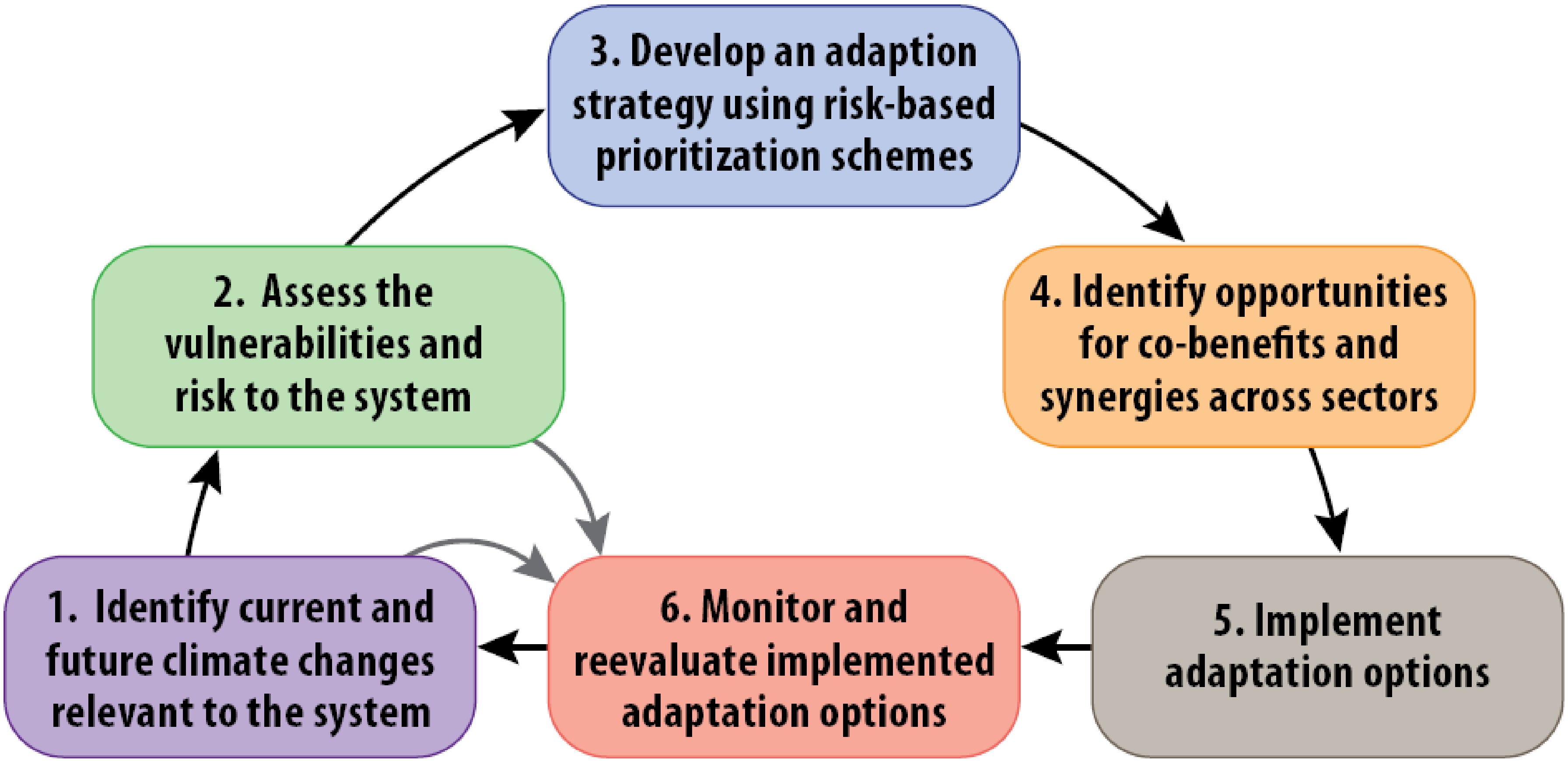


Figure 1. Adaptation planning is envisioned as a cyclical, iterative process incorporating these six steps.

Cities at Risk Project Objectives

To help develop capacity of Asian coastal cities to better cope with risks posed by the combined effects of sea level rise, climate change, and urban growth and development.

Awareness Raising Workshop
(CAR I Bangkok 2009)

Cities at Risk Workshop Key Recommendations

1) Move from conventional downscaling impact assessments to integrative socio-economic vulnerability assessments

2) Priority need for training urban planners in climate change risk and vulnerability assessment

3) Create urban “communities of knowledge” involving researchers, planners and urban officials

Cities at Risk Project, Current Activities

Capacity Building Workshop (Bangkok 2010)

Climate Change Vulnerability Assessment and Urban Development Planning for Asian Coastal Cities

22-28 August 2010

Rose Garden Riverside
Sampran, Nakorn Pathom,
THAILAND

APN
Asia-Pacific Network for Global Change Research

EAST-WEST CENTER
COLLABORATION • EXPERTISE • LEADERSHIP
50 SINCE 1960

Southeast Asia START
IHDP · IGBP · WCRP
Regional Center

茨城大学
Ibaraki University

Cities at Risk Project, Future Activities

- Locally generated research in context of international projects
- Research Conference (CAR II Taipei 2011)
- Publications, including policy papers
- Project partners and sponsors

International workshop on "Climate Change Vulnerability Assessment and Urban Development Planning for Asian Coastal Cities"

Bangkok, 22-28 August 2010

Infected Risk Assessment with Exposure to Pathogens in the Flood Water

Case of City of Manila

TRAN THI VIET NGA, Hanoi University of Civil Engineering, Vietnam

KENSUKE FUKUSHI, IR3S, the University of Tokyo, Japan

Background

- Waterborne diseases are defined as diseases infecting people through water contaminated by pathogens.
- Diarrhea outbreak after natural disasters in developing countries is more severe than that in developed countries (Bissell, 1983, Ivers *et al*., 2006).
- Weather-related or flood-related naturals disasters as impacts of climate change tend to increase (Kunii *et al*.,2002,Ivers *et al*., 2006, WHO, 2006).

Health risk assessment of infectious diseases related to flood is important.

Research Objectives and Area

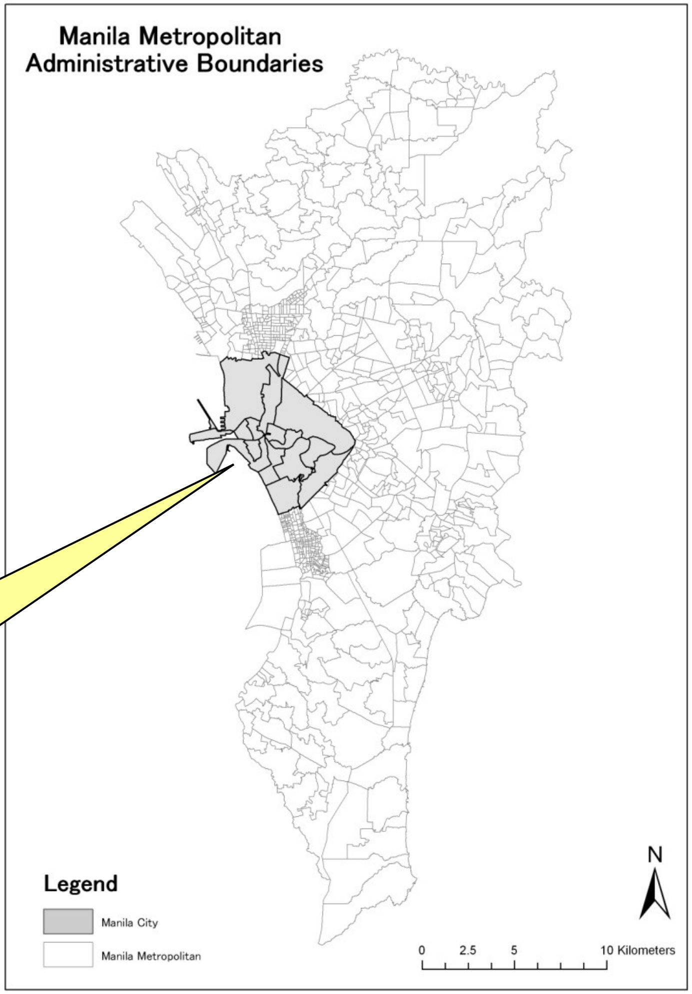
Research Objective

Characterize and quantify human health risks associated with exposures to pathogen in flood water

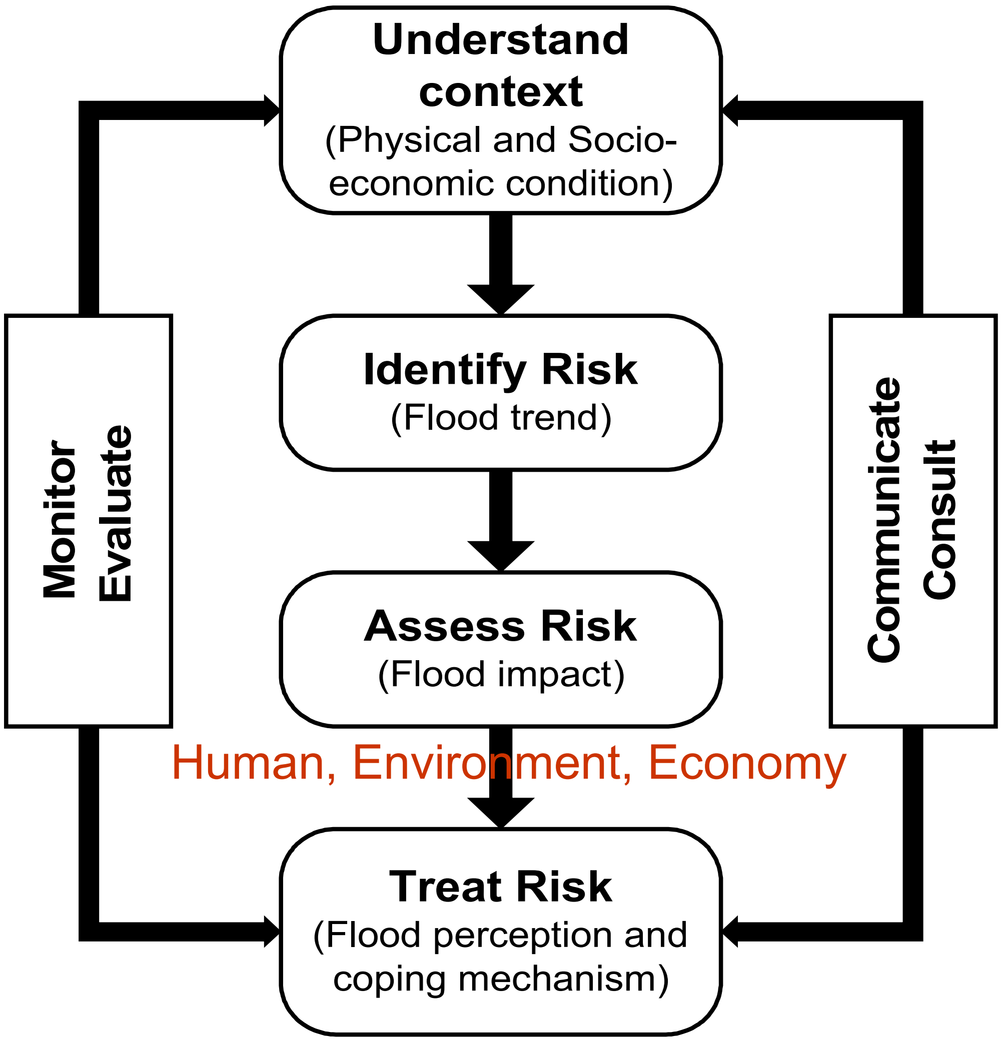
Research area selection

- Costal mega city in developing country
- Flood-prone area
- Low improvement of infrastructure

CITY OF MANILA
Area: 57km^2, population: 1,158,117 people (2003)

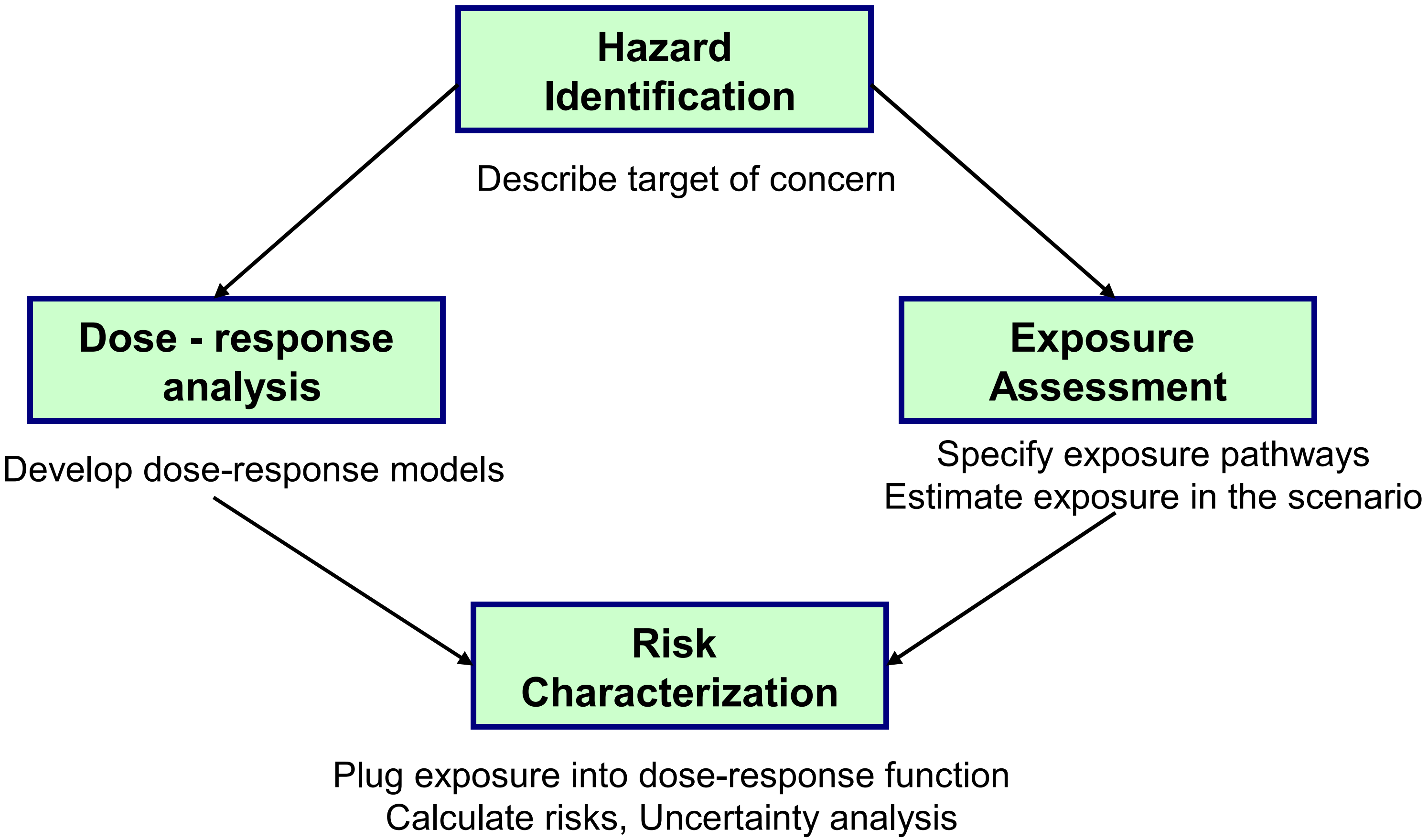


Risk Assessment Research due to Flooding Impact

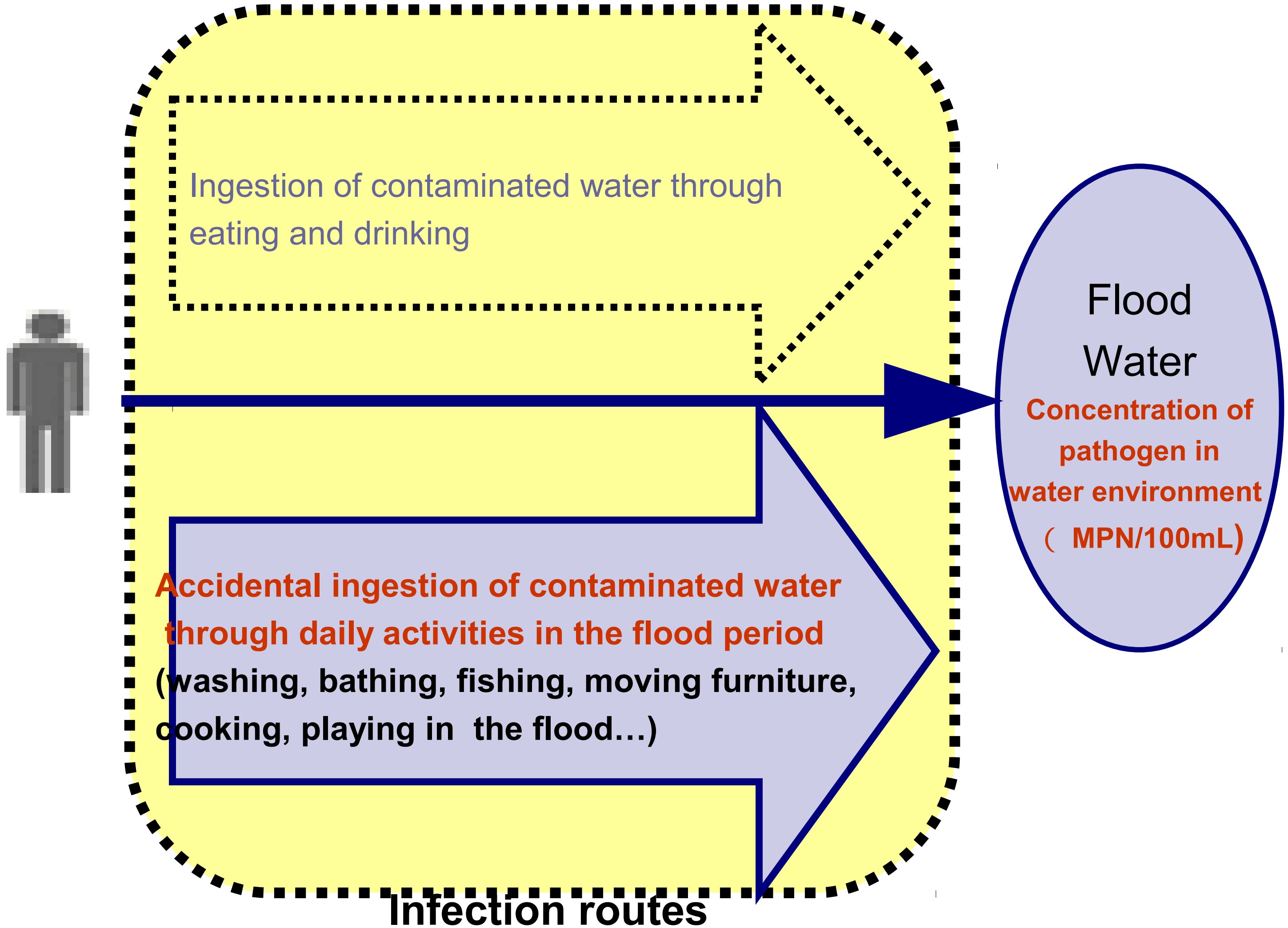


Methodology

Health Risk Assessment Framework (HAS, 1983)



Methodology: Risk identification



Methodology: Exposure assessment

Exposure Scenarios

1. Inundation depth of less than 50 cm
2. Inundation depth of 50-100 cm
3. Inundation depth of 100-200 cm
4. Inundation depth of above 200cm

Classification of inundation depth

Level	Inundation depth	Human behavior
I	0-50 cm	most houses will stay dry and it is still possible to walk through the water
II	50-100 cm	there will be at least 50 cm of water on the ground floor
III	100-200 cm	the ground floor of the houses will be flooded
IV	> 200 cm	both the first floor and often also the roof will be covered by water.

Note: Classification based on Flood Fighting Act, Japan, 2001

Methodology: Exposure assessment

- E.coli concentration in flood water: indicator pathogen
- Exposure route: accidental ingestion through daily activities
- Human behavior survey: base on group of age
- Default ingestion intake: US-EPA Risk Assessment Guidance (RAGS)

Methodology: Risk Calculation

POPULATION

< 4 year-old	5-14 year-old	15-59 year-old	> 60 year-old

Outdoor time → **Contact time** with flood water

Intake rate → **ingestion volume**

Dose

Infection risk → **TOTAL RISK**

6 %
11 %
19 %
64 %

0-4 year-old
5-14 year-old
15-59 year-old
over 60 year-old

Daily activities and behaviors of each groups of age were examined and studied through literature

Pathogen's dose-response model

Beta Poison model for *E.Coli* (Haas *et al*., 1999)

Single infection risk

$$P(d) = 1 - \left[1 + \frac{d}{N_{50}} \left(2^{1/\alpha} - 1 \right) \right]^{-\alpha}$$

d: dose
α = 0.1778
N50 = 8.6×10^{7}

Annual infection risk

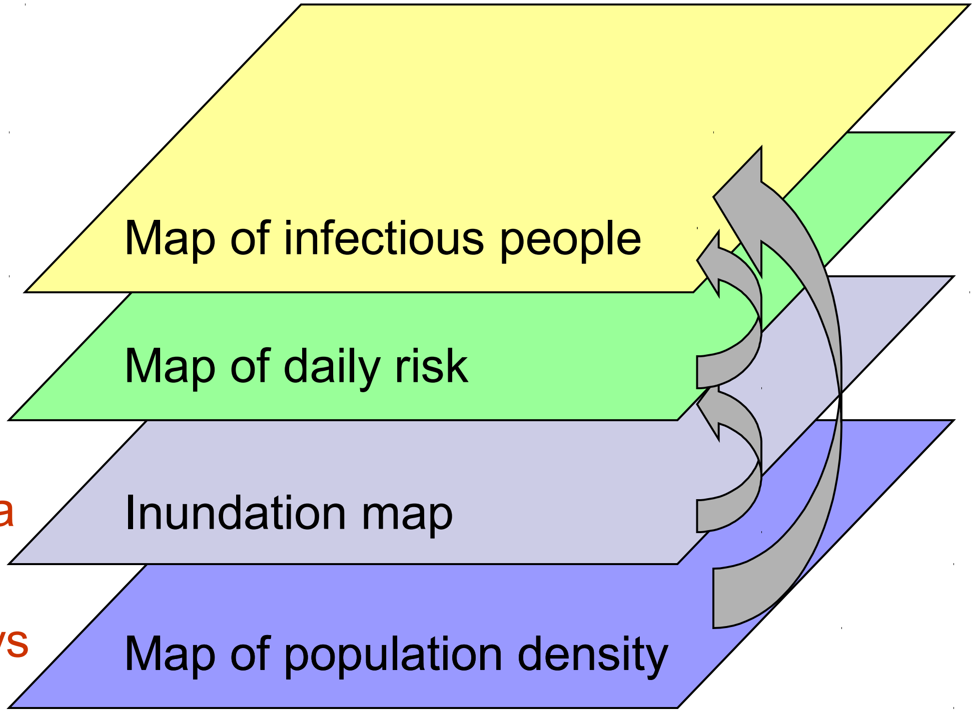
$$P_{annual} = 1 - \left[1 - P(d) \right]^{n}$$

n: number of exposure times per year

Case study: Manila

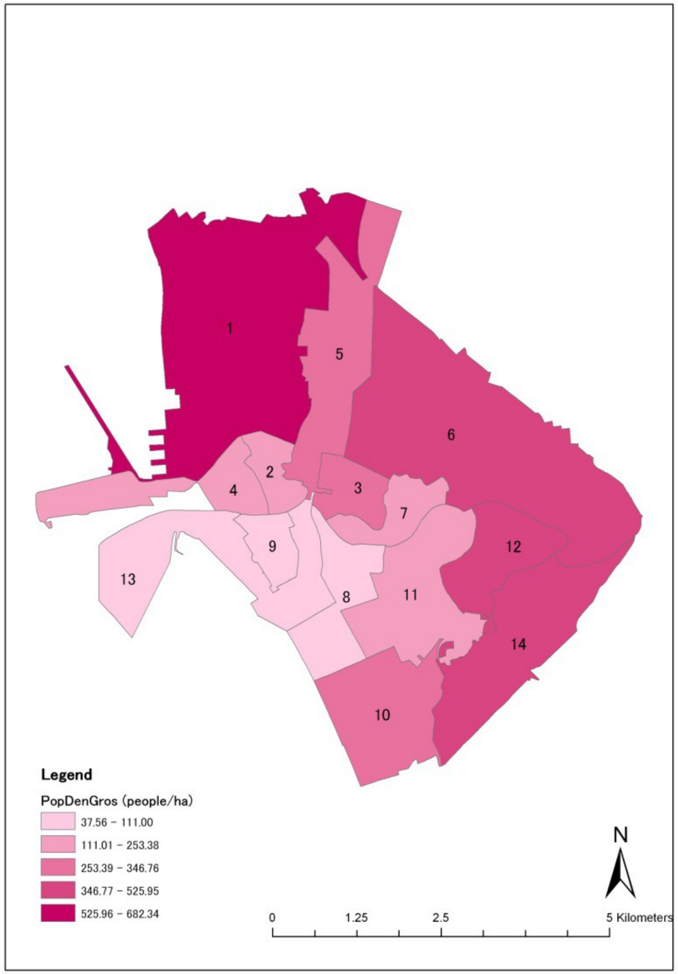
Status-quo 2003 inundation data

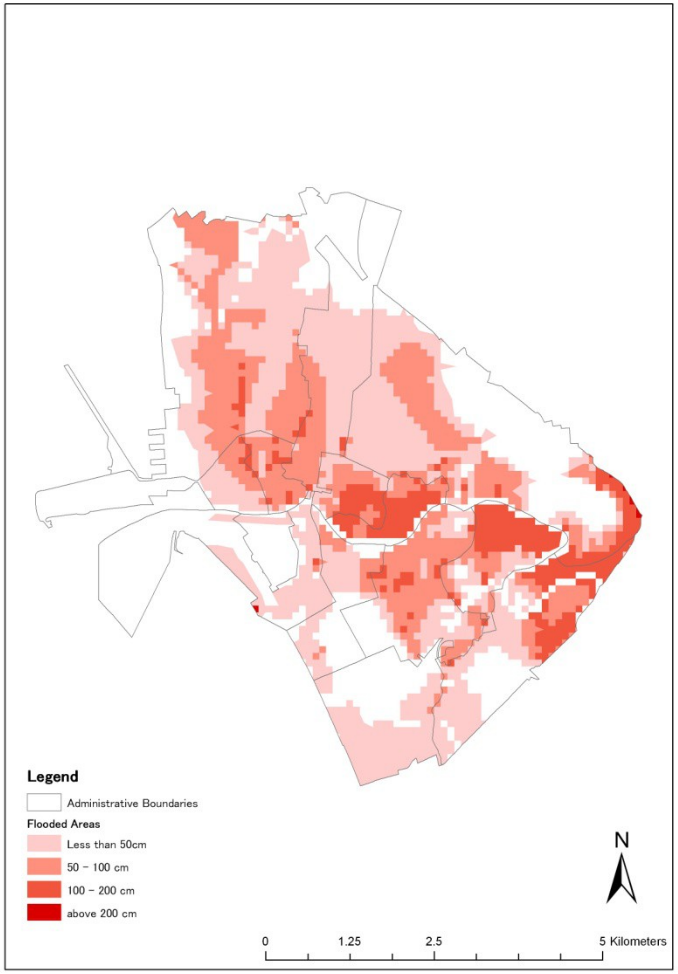
Population density by banranrays



City of Manila

Distribution of population and inundation water (from inundation data of year 2003)





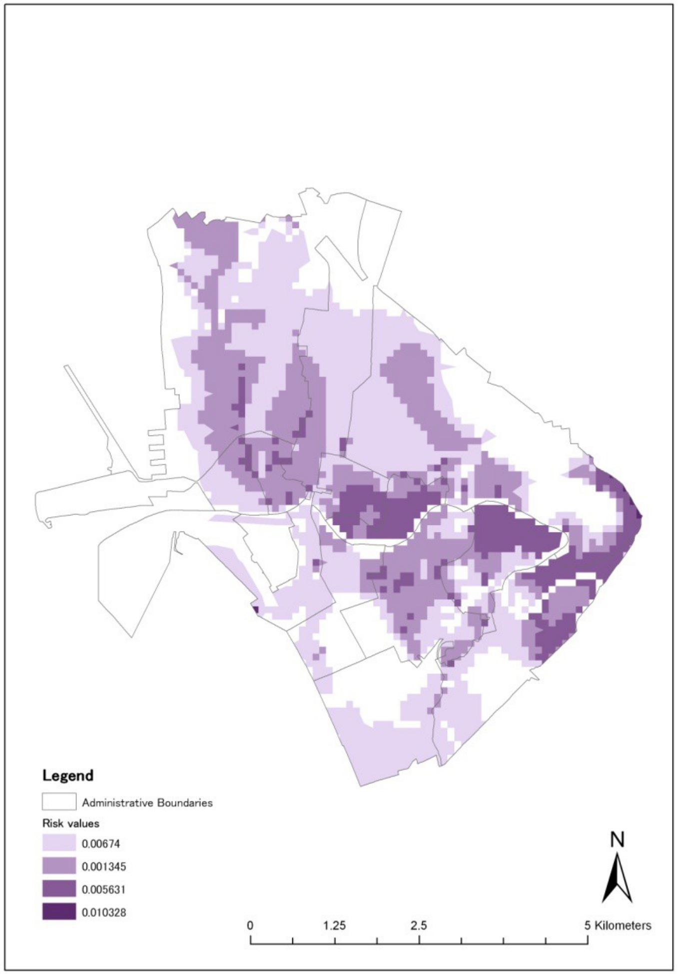
- The serious flood areas where have high inundation level and high population density are District 1, 6, 12, and 14.

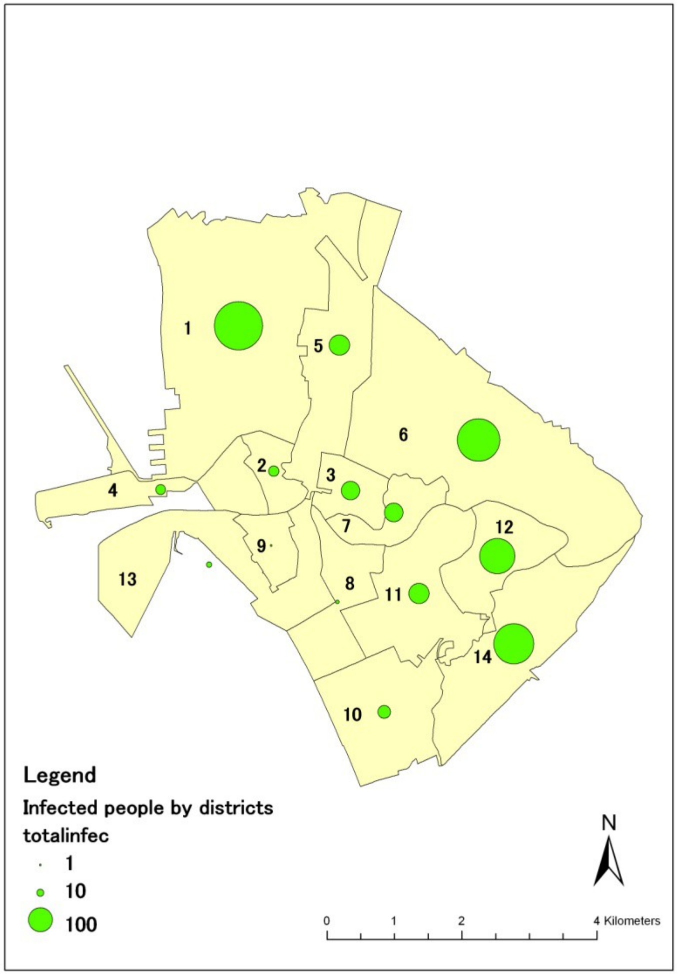
Estimated daily risk of infection via incidental ingestion of flood water in Manila City.

- Infected risk was calculated using the mean E.coli exposure level of 30,000 MPN/100 ml from the contaminated surface water data (Nga, 1998-2005)
- Daily risks of gastrointestinal illness via incidental ingestion:

Risk	Inundation level
0.000674	0-50 cm
0.001345	50-100 cm
0.005631	100-200 cm
0.010328	above 200 cm

Estimated daily risk and number of infected people by districts, City of Manila





Estimation of infected people per day due to gastrointestinal illness via incidental ingestion of flood water in City of Manila

District	Population	Infected people (person) according to inundation depth of				Total (person)
		0-50cm	50-100cm	100-200cm	>200cm	
1	590,307	142	223	37	0	402
2	11,619	1	10	10	0	21
3	24,615	4	13	46	0	63
4	41,517	6	7	6	0	19
5	107,154	33	29	12	0	74
6	352,329	83	105	119	6	313
7	16,798	0	5	55	0	60
8	5,969	2	1	0	0	3
9	7,466	1	0	0	0	1
10	77,398	28	1	0	0	29
11	64,184	9	42	22	0	73
12	79,003	11	19	193	0	223
13	25,243	5	0	0	0	5
14	177,480	41	34	208	0	283

Single risk and annual risk associated with pathogen exposure during flooding period, for different group of age

Group of Age	Infection Risk (x 10^{-4})	Inundation depth (cm) < 50	50-100	100-200	>200
0-4	daily risk	15	29	59	59
	total risk	294	577	1112	1112
5 to 14	daily risk	6	12	58	115
	total risk	119	236	1112	2071
15 to 59	daily risk	6	12	57	114
	total risk	119	236	1112	2071
>60	daily risk	1.5	3	15	15
	total risk	30	60	294	294
Total	daily risk	6.7	13	56	103
	total risk	**134**	**265**	**1068**	**1875**

Conclusions

- Exposure scenarios according to different inundation levels were developed in which direct and indirect contact with water was assumed to occur
- Risk estimates for gastrointestinal infection for different groups of ages were based on established dose-response relationships for indicator pathogen (E. coli) to be presented in the flood water
- In this analysis, the risks for gastrointestinal illness are considerable and reach the highest level in the group from 4 -15 year-old.
- A comprehensive investigations on human behavior during flood period, inundation water quality, and natural, socio and economic condition of study area is needed.

Measurable health effects associated with water related-activities in flood waters (Cabelli, 1982) email: nga.tran.vn@gmail.com

Thank you very much
for your kind attention

Data preparation and process for estimating flood and inundation areas

茨城大学
Ibaraki University

ICAS
Ibaraki University

Yuji Kuwahara and Hiromune Yokoki
IBARAKI University, Japan

Table of contents

1) Estimation process of future flood and inundation risks

2) Input data for calculation

Worldwide DEM(DSM) DSM : Land Surface information is expressed.

- GTOPO30 (USGS EROS Center EROS : Earth Resources Observation Science)
- SRTM (Shuttle Rader Tomography Mission data)
- GDEM

Land cover data : Remote sensing image

- LANDSAT (Global Landcover Facility)

Geographical information : Digital chart

- DCW : Digital Chart of the World (Penn State University Libraries)
- ISCGM : International Steering Committee for Global Map (GSI)

Estimation process of future flood and inundation risks

GIS software : ArcGIS (esri http://www.esri.com)

Input data:

1) Ground level data

Digital Elevation Model (GSI 50m)

2) Landuse data

Digital national land information (landuse 100m)

3) Map , Aerial photo , Satellite image

Topographic map 25000, IKONOS (1m)

4) Geographical information

Spatial data flame work 25000 (Water zone, Road etc.)

Pre-processing of input data on GIS:

1) Re-size processing (Practice:1)

Digital Elevation Model (GSI 50m)

Digital national land information (landuse 100m)

⇒ 100m to 50m (integration of resolution)

2) Format conversion (Practice:2)

Raster to Ascii (Deletion of data header)

Flood simulation

long time calculation!

Parameter:

1)Discharge data

2)Sampling pitch (Interval of computing time)

Presumption of infrastructure:

3) Overlay (Practice:3)

Spatial data flame work 25000 (Water zone, Road etc.) is overlaid on the flood region map.

4) Edit (Practice:4)

Editing of the region of interest using topographic map 25000 or IKONOS (1m) .

5) Extract by Mask (Practice:5)

To calculate the risk, geographic information of the flood region is extracted.

Input data:

1) Ground level data

Digital Elevation Model (GSI 50m)

2) Landuse data

Digital national land information (landuse 100m)

3) Map , Aerial photo , Satellite image

Topographic map 25000, EOS-Terra/ASTER (15m)

4) Geographical information

Spatial data flame work 25000 (Water zone, Road etc.)

USGS/EROS Find Data/Products and Data Available/GTOPO30 - Windows Internet Explorer

http://eros.usgs.gov/#/Find_Data/Products_and_Data_Available/GTOPO30

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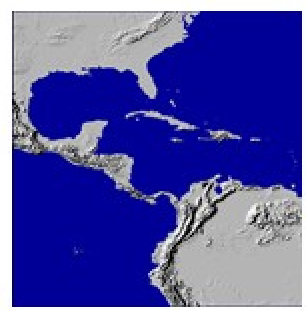
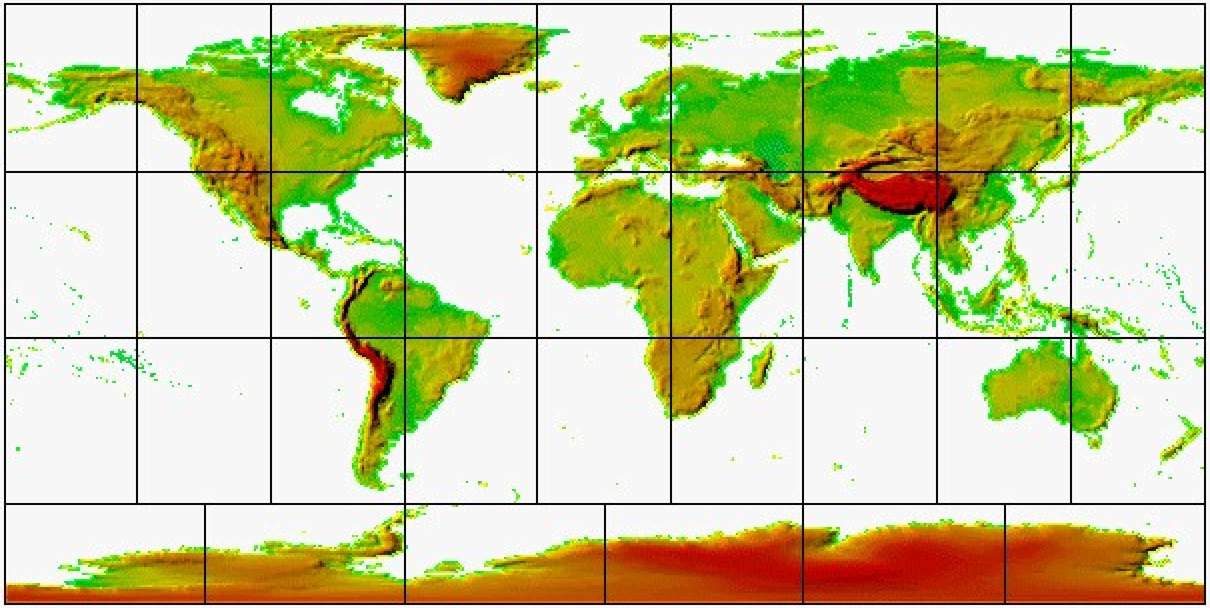


GTOPO30 shaded relief image
(Central America)

GTOPO30



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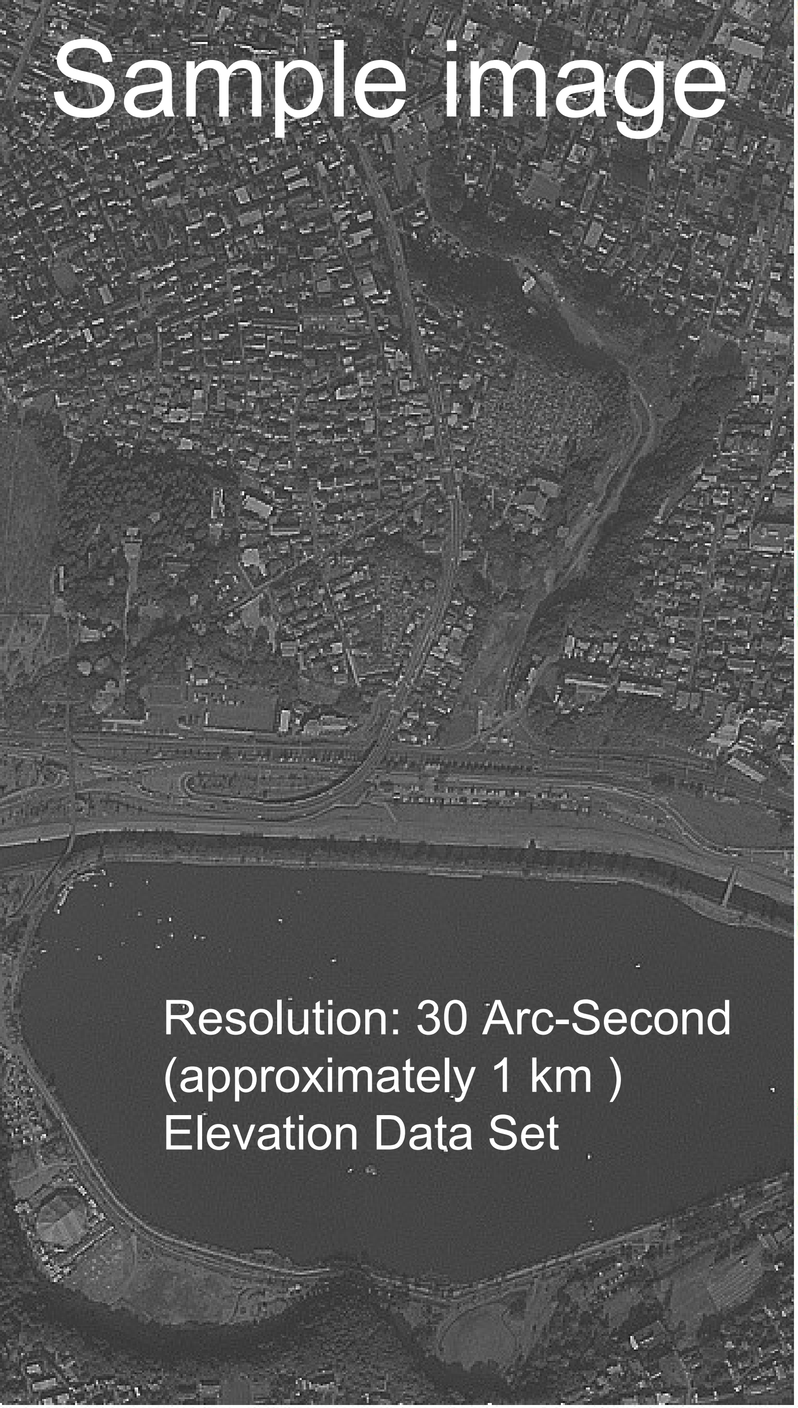
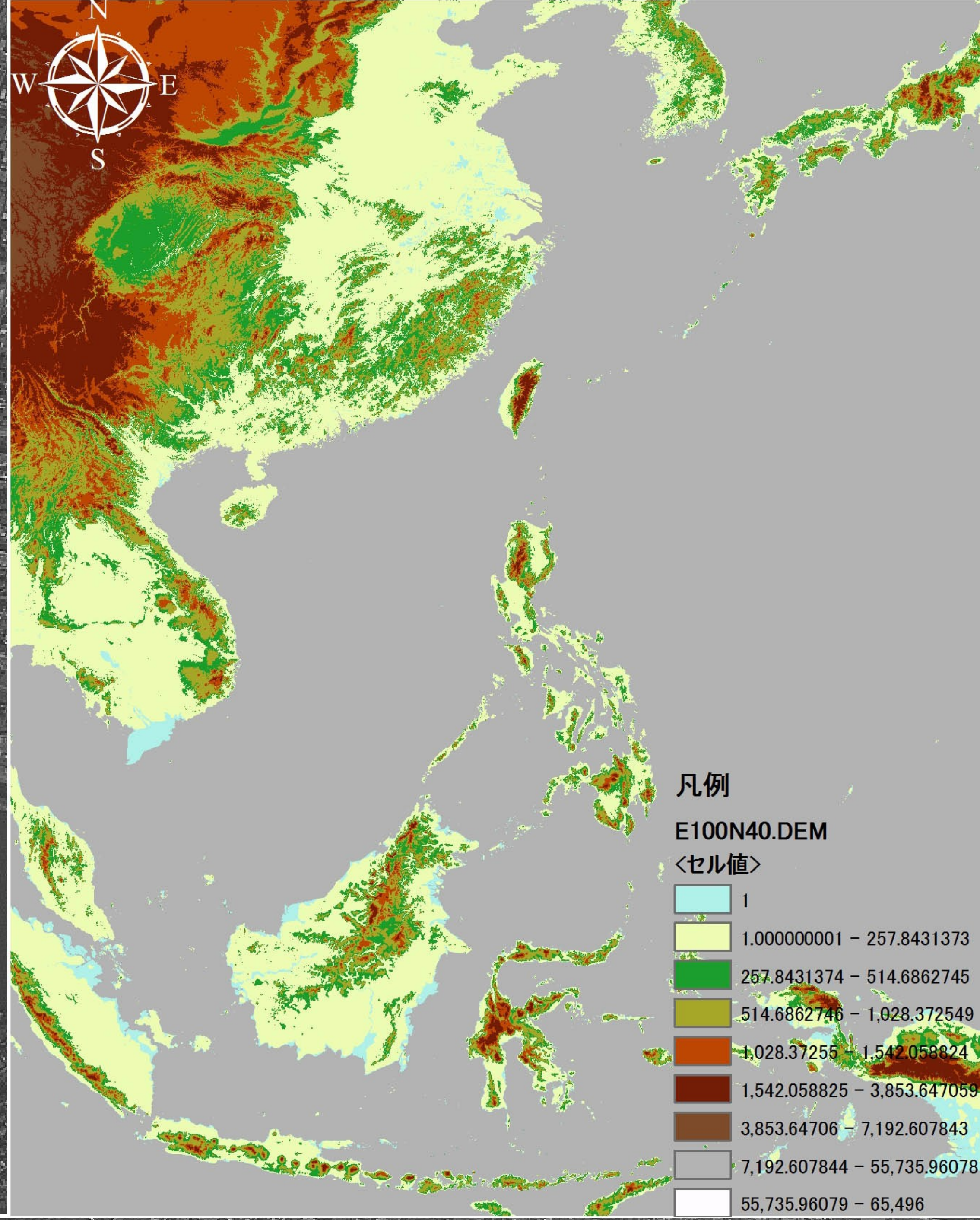
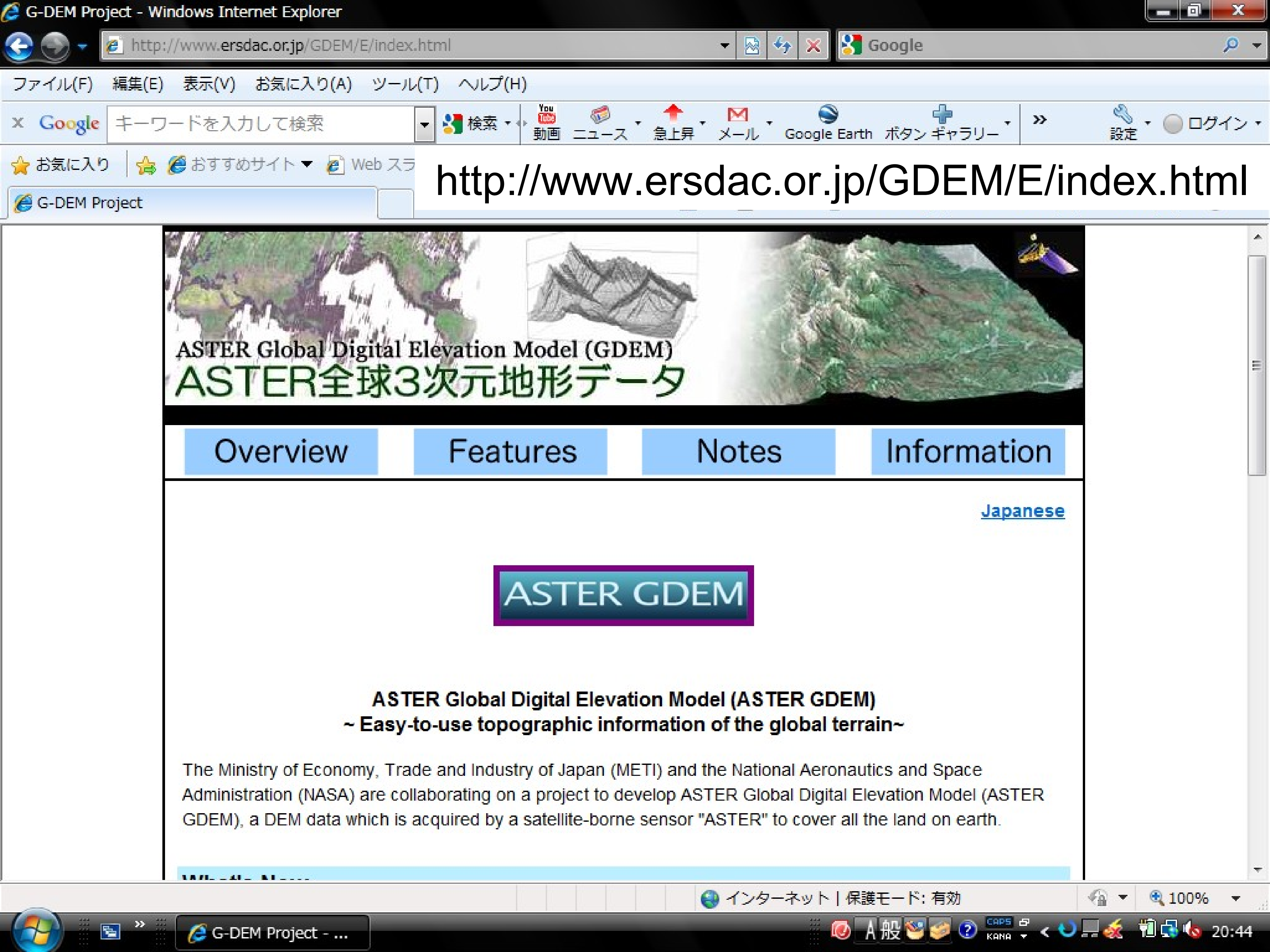




Resolution: 30 Arc-Second
(approximately 1 km)
Elevation Data Set

http://www.ersdac.or.jp/GDEM/E/index.html



ASTER GDEM - Windows Internet Explorer

http://www.gdem.aster.ersdac.or.jp/register.jsp

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Username should have 8-32 alphanumeric characters or symbols.
The first character should be alphabet and no space at Username and Password.

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Middle Name

Last Name *

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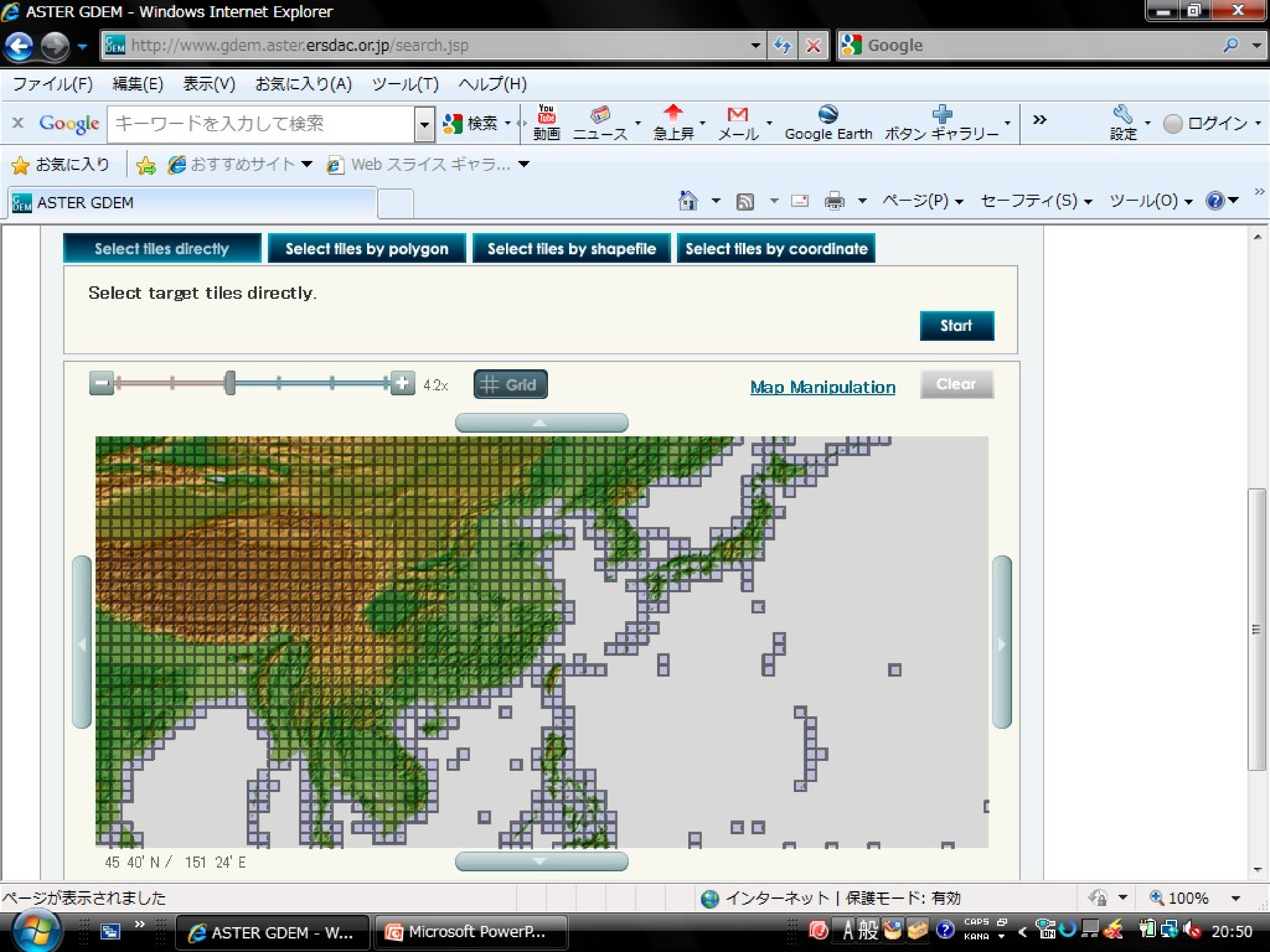
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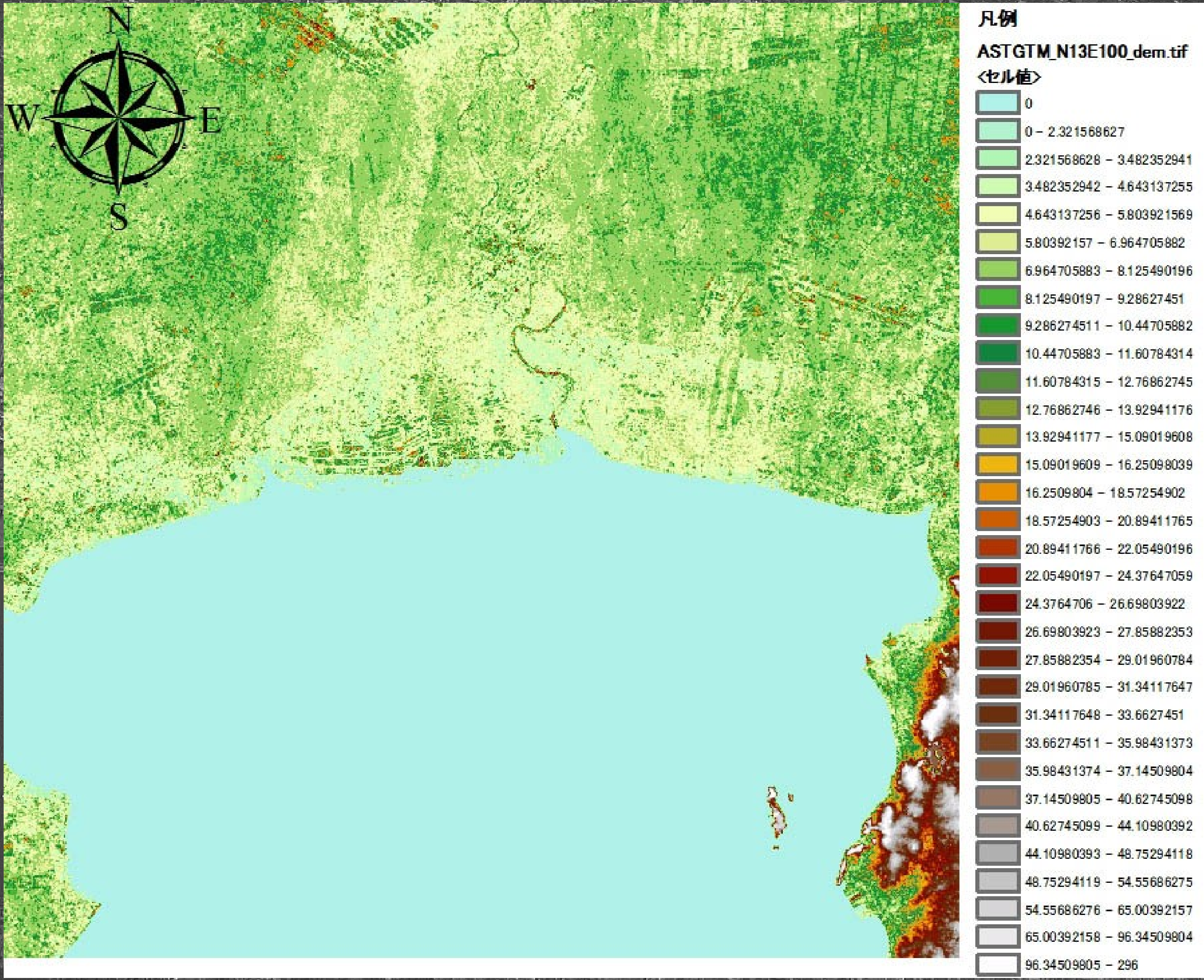
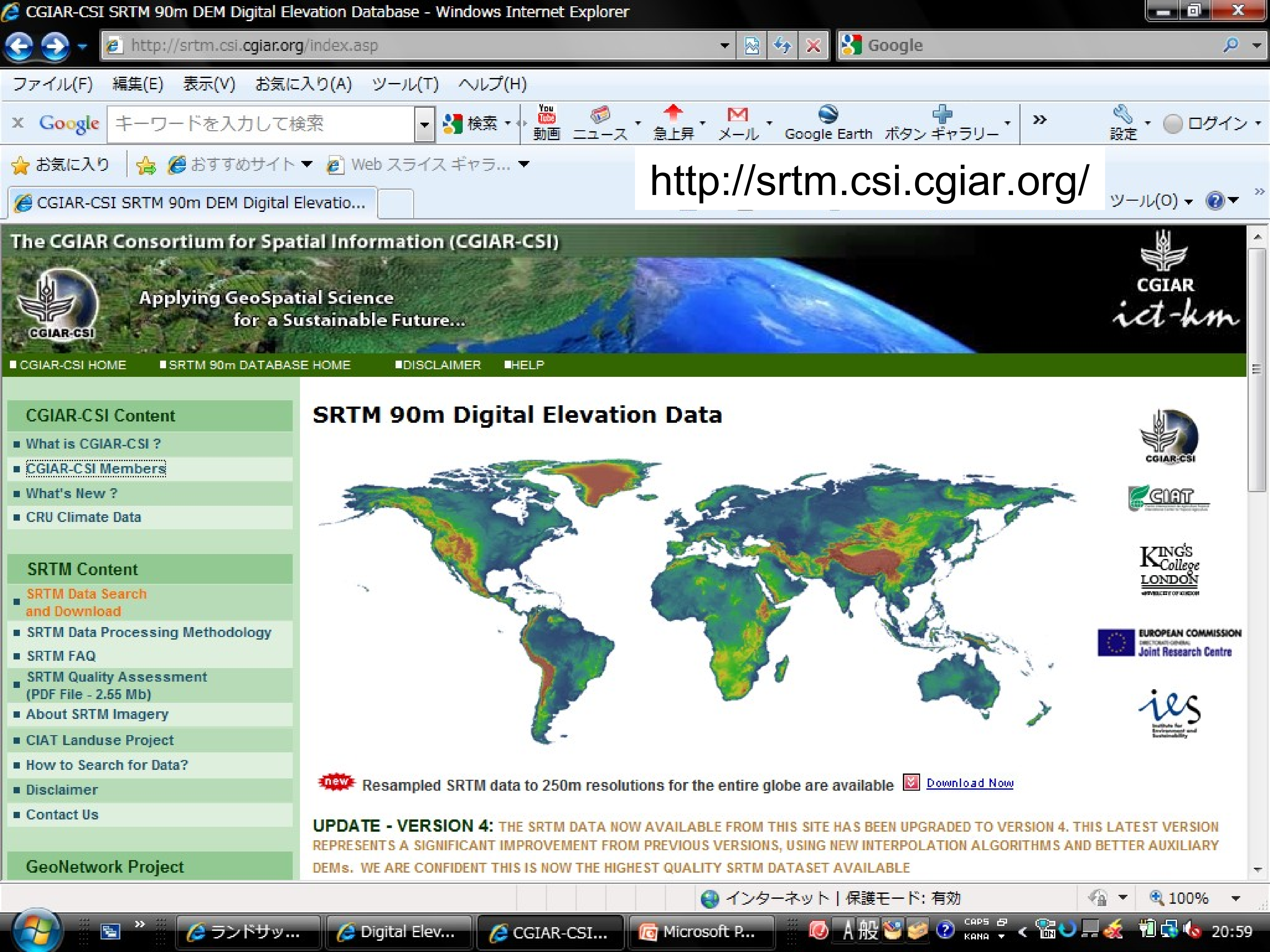


Resolution: approximately 30m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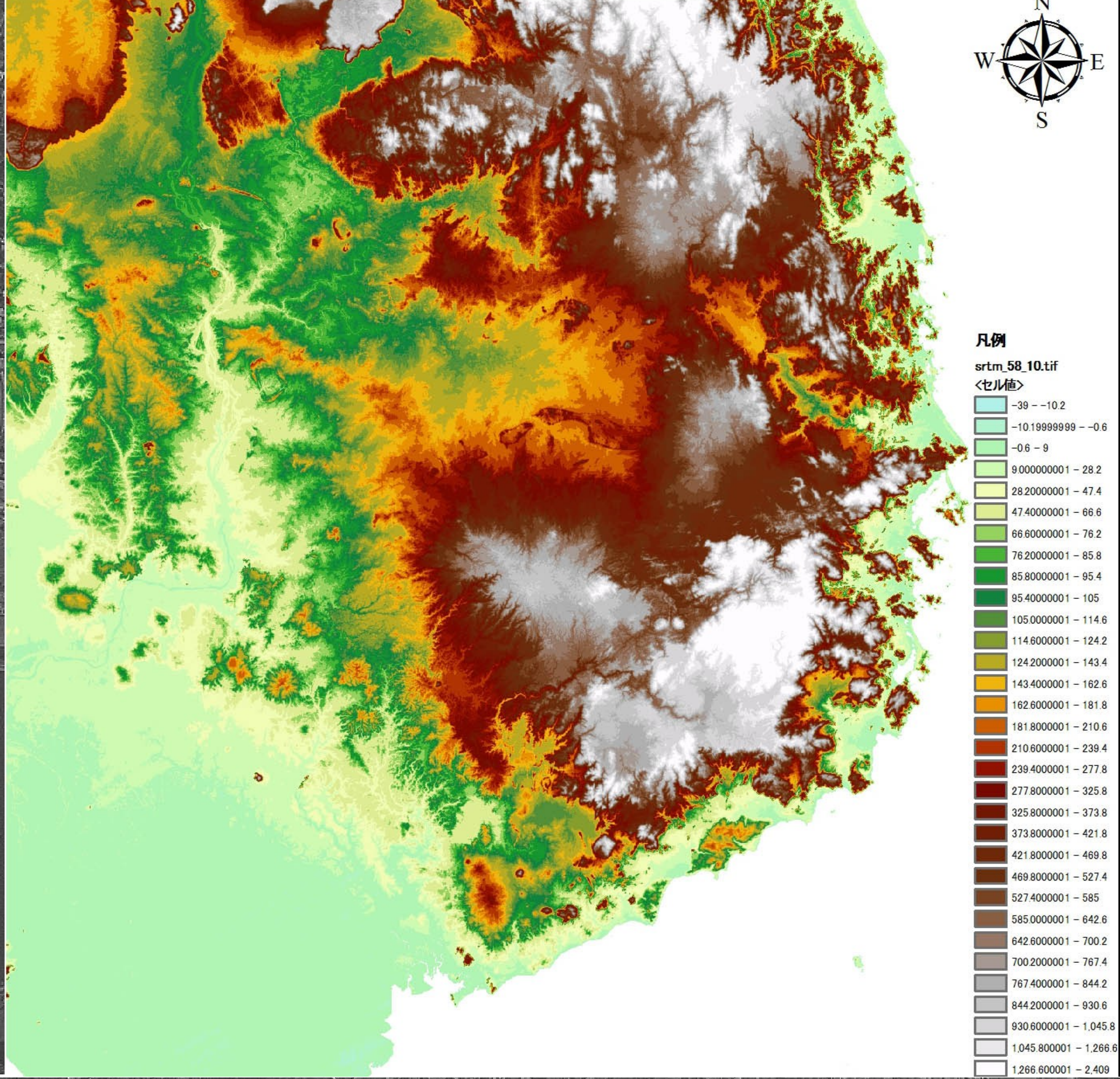
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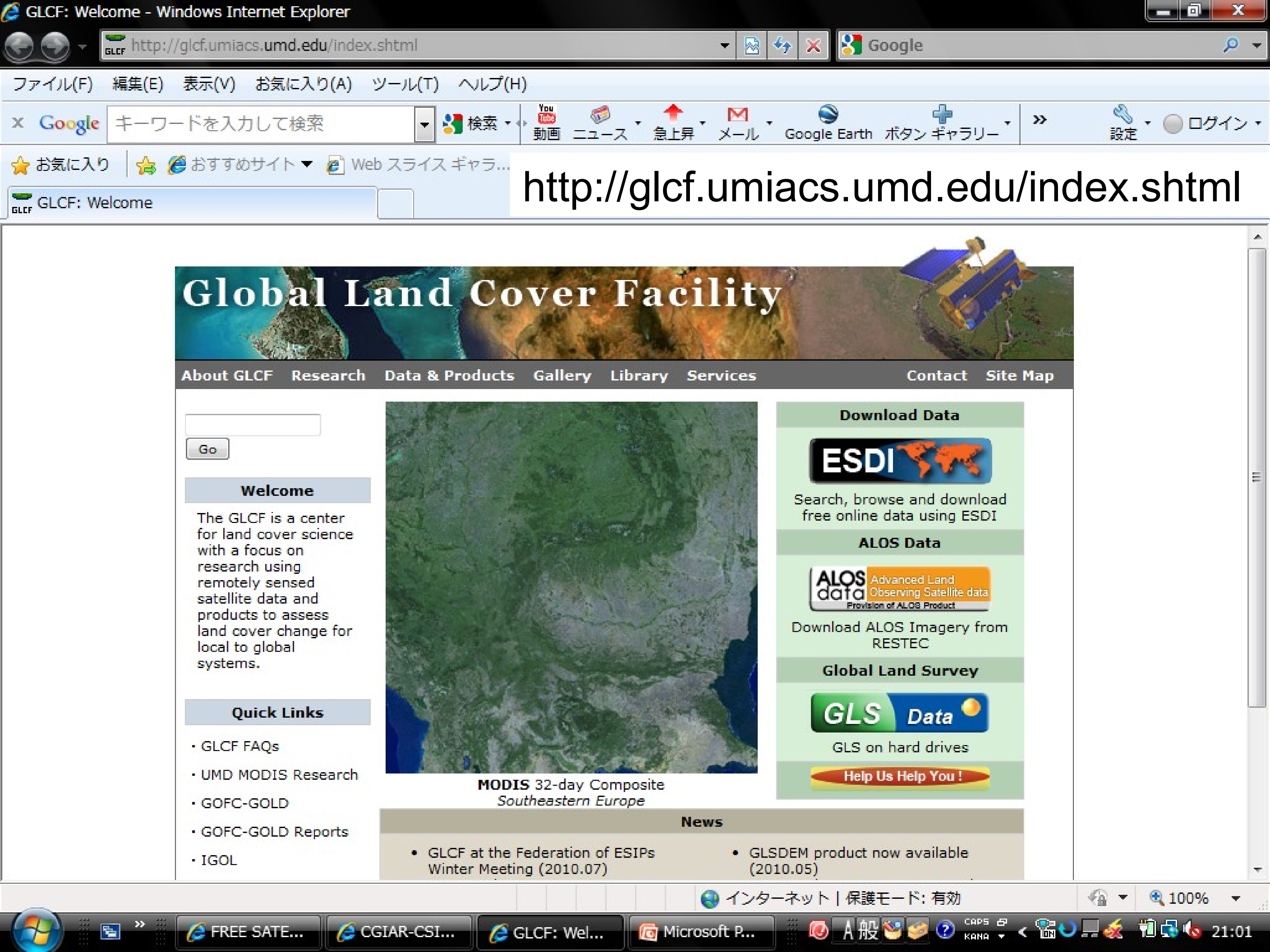
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http://www.maproom.psu.edu/dcw/

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NOTICE: The FTP service is currently WORKING!!!. You will need to download your dcw_data download files from ftp://maproom.dlt.psu.edu/.

NOTICE: THIS DATABASE IS NOT UP TO DATE. This database was developed in 1991/1992 and national boundaries reflect political reality as of that time. Modern country names and boundaries have not been added and their omission does not indicate support or non-support of any nation.

NOTICE: TECHNICAL SUPPORT IS NOT AVAILABLE. Although we are not responsible for the DCW data itself (see About DCW), we are trying to automate our responses, so please read our new "Frequently Asked Questions" section.

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This web site will allow you to download the boundaries and layers of different countries, in Arc/INFO export format, from ESRI's Digital Chart of the World data set. Our mapping function will give you a preview of the data. The entire data set is also available, on CD-ROM, at the Pennsylvania State University's Maps Library or from ESRI.

Click on the **GENERAL** area you wish to see or select one the 7 regions listed next to the world map.

Africa

Antarctica

Asia

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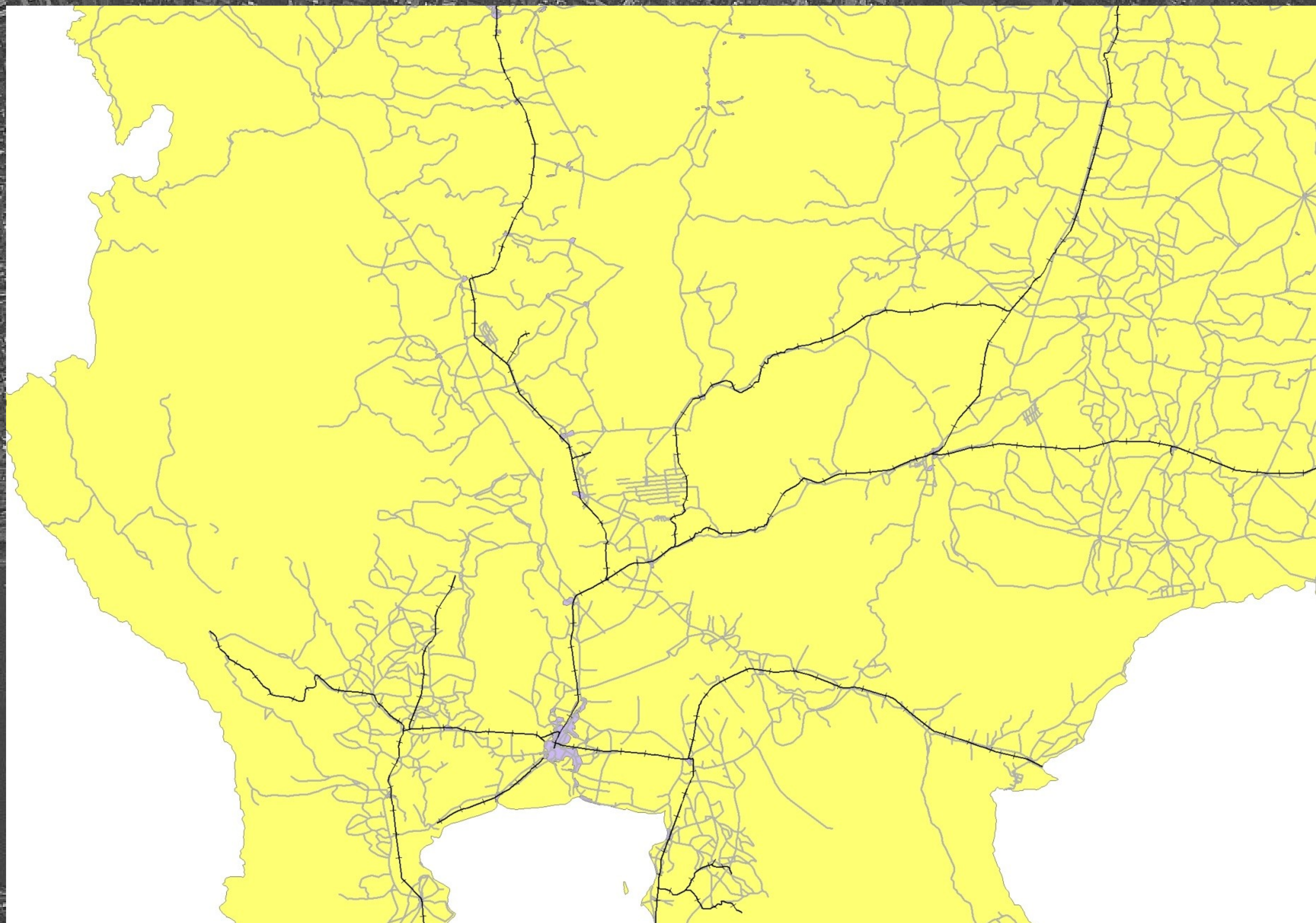

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News Archives
Summary
Schedule
About Us
Participants
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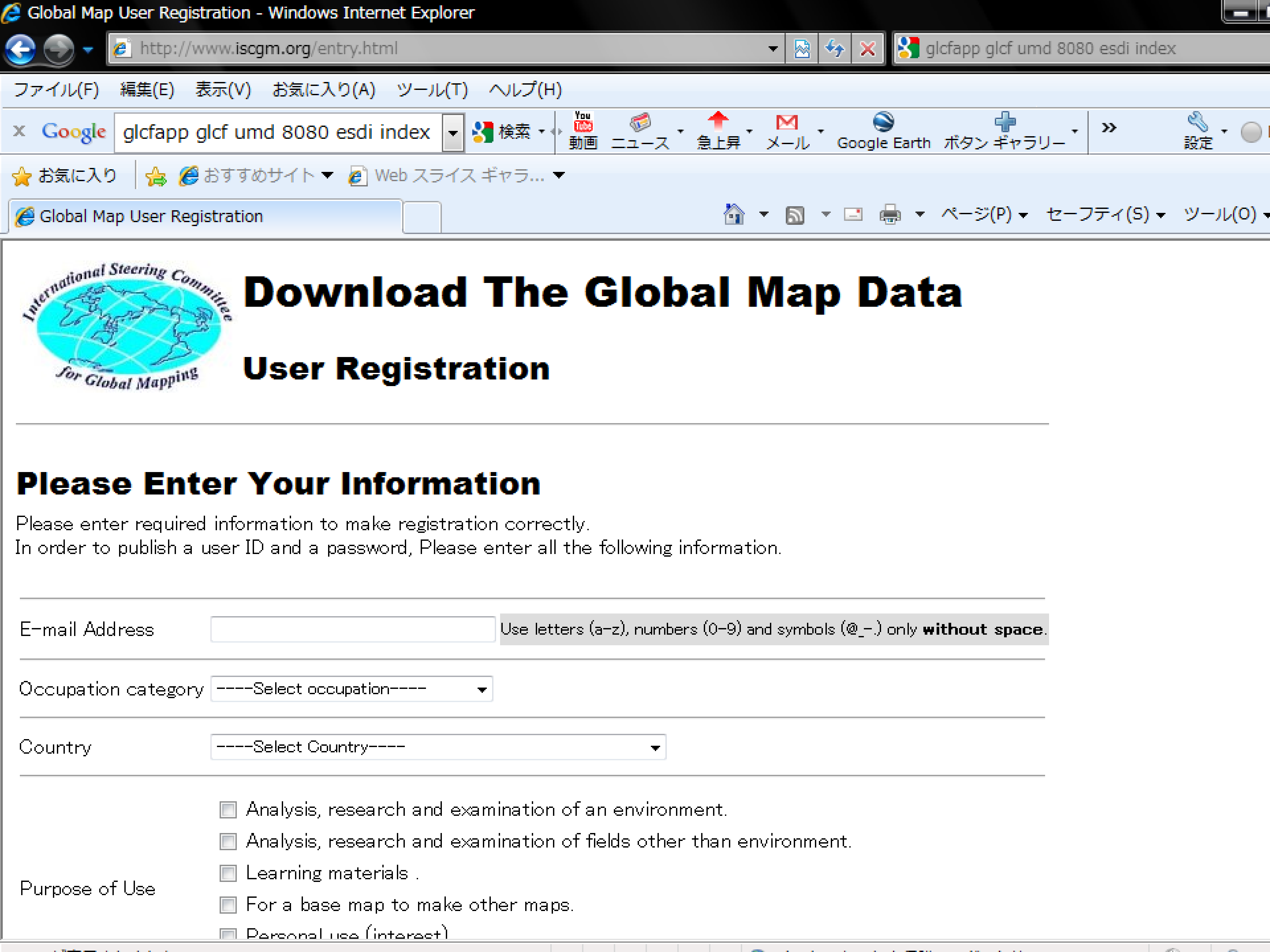
Browse
Download
Screenshot
Application
Documentation
History
Newsletter
FAQ
Links to
Sitemap
ISCGM/Top
Welcome to
Global Mappi
Home Page
Arabic Chinese French Russian S
Topics
★ 05-01-2010: Global Map Specifications Version 2 are up
★ 11-06-2009: The release of KML files for browsing Global Map V.1 (Global Version) with Google Earth
>> Go to Browse Page !!
What's New
8-08-2010: Disaster Situation Maps are up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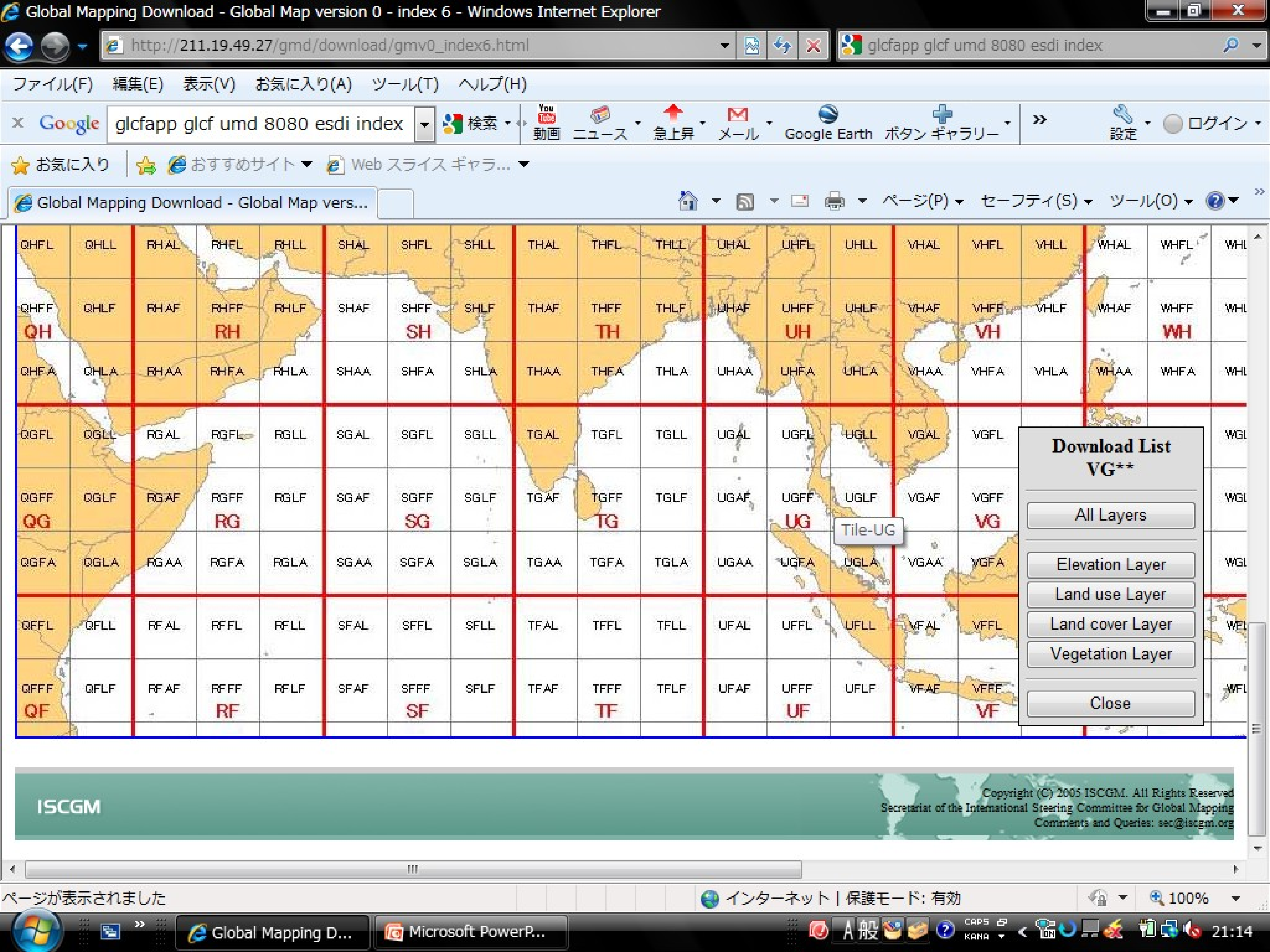

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Data Policy for Global Map Version 1

Country	Data Policy
Thailand	Commercial use of Global Map Thailand is not permitted. For more detail, please contact Royal Thai Survey Department.

The Global Map V.X is tentatively developed, and expected to be improved as Global Map V.1.

List of release data

Country & Regions	GM V.X	GM V.1											
		VPF and BIL Format											Shape and TIFF format
		National & Regional version									Global version		National & Regional version
		All at once	Trans	Boundary	Drainage	Population	Elevation	Vegetation	Land Cover	Land Use	LandCover	PercentTreeCover	All at once
Thailand		V1.0	V1.0	V1.0	V1.0	V1.0	V1.0	V1.0	V1.0	V1.0	GOTO DLpage	GOTO DLpage	SHP&TIFF

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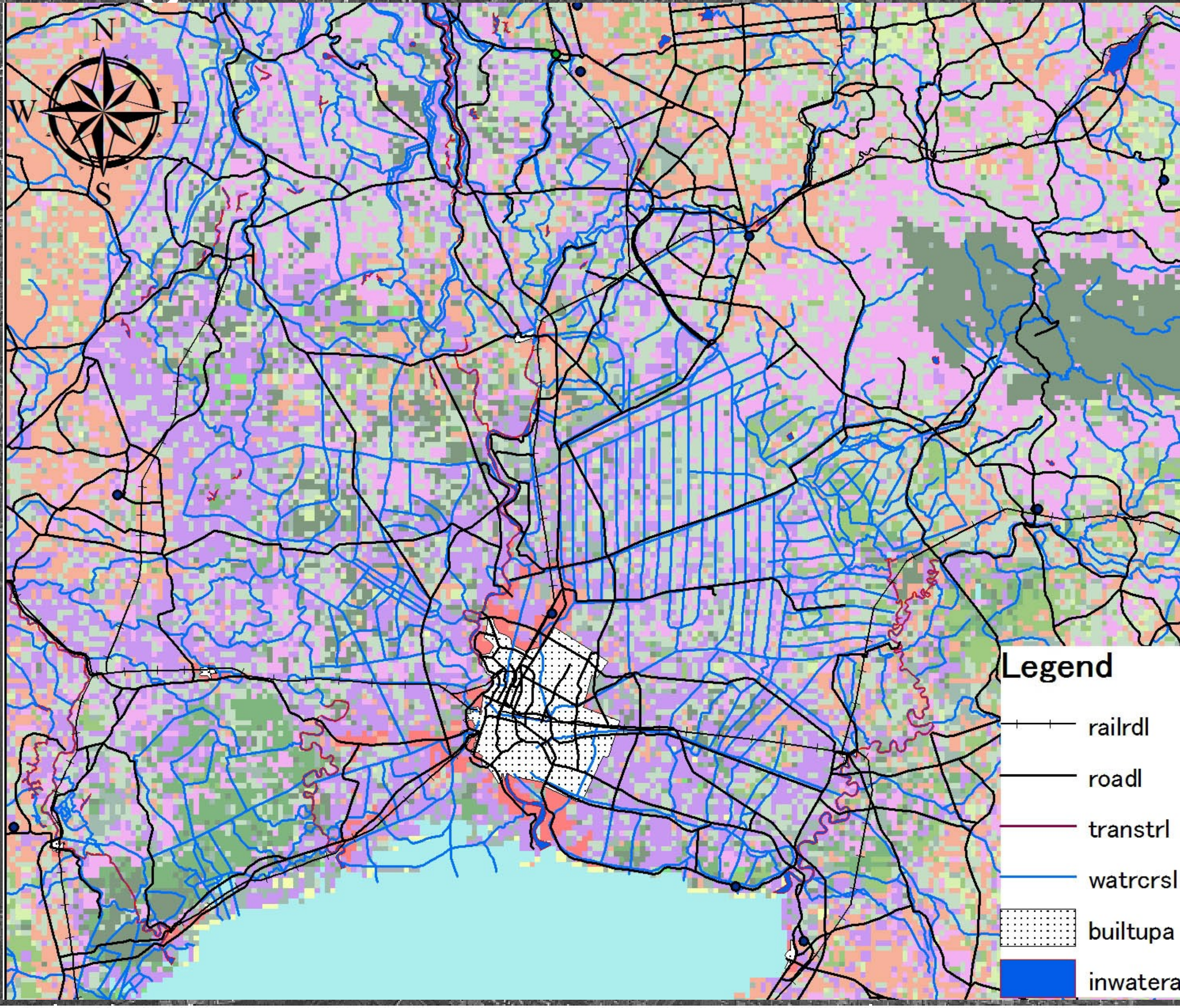

Landuse data:
Resolution 1(km)
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Class name of landuse Infomation

1 Broadleaf Evergreen Forest
2 Broadleaf Deciduous Forest
3 Needleleaf Evergreen Forest
4 Needleleaf Deciduous Forest
5 Mixed Forest
6 Tree Open
7 Shrub
8 Herbaceous
9 Herbaceous with Sparse Tree/Shrub
10 Sparse vegetation
11 Cropland
12 Paddy field
13 Cropland / Other Vegetation Mosaic
14 Mangrove
15 Wetland
16 Bare area,consolidated(gravel,rock)
17 Bare area,unconsolidated (sand)
18 Urban
19 Snow / Ice
20 Water bodies
255 No data

Thank you!

24 Aug. 2010
Risk assessment of river flood on GIS (Practice)
9:00-10:30

Bangkok

Knowledge Status

- Technical approach and studies.
- Focus on physical and infrastructural vulnerability and adaptation.
- Some studies are focused on specific livelihoods and communities.
- Existing sectoral studies on the status, issues and concerns of marginal groups.

3 Areas

- Framework
- Urban Development & Planning
- Marginal Groups

Framework - Gaps

- Limited understanding on the dynamic and complex processes of social vulnerability to climate change
- Understanding the barriers of linkage among agencies and sectors at different scales
- The communication of risk: the relationship between uncertainties in risk assessment and the perception of risk, leading to climate-related actions
- Framework for holistic assessment/evaluation of the consequences of the various adaptation measures proposed and implemented

Framework - Research Questions

- What are the causal processes of vulnerability? (resource, access, political ideology, economic system, etc.)
- What are the barriers to inter-institutional and inter-sectoral linkages?
- What are the assumptions, limitations, and uncertainties behind different risk assessments? How they are delivered to users? How people perceived risk and how their risk perceptions are related to their behavior and decision-making?
- How are the proposed adaptation measures evaluated? What are the impacts of those measures in the broader dimension? What should be the framework and methods to evaluate adaptation measures?

Urban Development & Planning - Research Questions

<u>Defining urban hazard factor:</u>

- What are other urban hazard factors that may impact BMR? What are multiple hazard factors?
- What should be the boundary of the study area? How should it be defined?

Urban Development & Planning - Research Questions

Understanding the current situation:

1. Urban form, density and structure:

- Tracing the land use dynamic and conflict, and its relation to climate - related factors?
- What is the pattern of human settlement characteristics (formal and informal) responding to which climate -related factors? What is the existing coping and adapting knowledge of the community?
- What is the impact of climate change on the urban livelihood, especially on informal settlers?
- What is the impact of climate change on tourism, especially on service sector?
- What is the gap in the current urban plans at different scales?

Urban Development & Planning - Research Questions

2. Urban infrastructure:

- What is the impact on health relating to comfort zone and sanitation? Who is most affected?
- What is the climate impact on fresh water quality? How does it impact on water consumption? Who is most affected?
- What is the impact of climate change on waste management?

3. Urban governance:

- How civil-society groups play a role in adapting to uncertainties? What are factors influencing their success? What are their challenges?
- How to institutionalize community adaptation and strategies? How can their capacity be strengthened?

Marginal Group - Gaps

- Lack of studies on socio-economic aspects of vulnerability and adaptation to climate change effects.
- Vulnerability and adaptation studies are not characterized in regards to people, place and hazards.
- Linking the urban sectoral studies to the impacts of CC and extreme events.

Marginal Groups - Research Areas

- Characterization of Hazards
  (In terms of social, economic, health, institutional and physical impacts.)
- Vulnerability assessment
- Adaptation pathways, strategies and practices

Marginal Group - Research Objectives

- to identify the major CC hazards facing the vulnerable groups.
- to link the future wellbeing of vulnerable groups to the impacts of climate change and extreme weather events.
- to link planned adaptation strategies with existing autonomous adaptation strategies.

Marginal Group - Research Questions

- How resilient are these groups to the impacts of CC and extreme events?
- What are the autonomous and planned adaptations?
- What factors constraint and enable adaptive capacities?

Tentative Activities

- Litt. review and synthesis in the context of CC effects on BKK
- Identifying knowledge gaps among research peers
- Document autonomous and planned adaptation strategies
- Conduct socio-economic vulnerability assessment
- Create climate disaster resilience index
- Building an institutional community towards the research

Future Plans

- Disseminating information and experience to colleagues and government officials;
- Screening climate risks/CC consequences which potentially affect natural and social systems;
- Identifying areas which are highly exposed and affected by CC impacts;
- Exploring major implications of CC, including:
  - ***Environmental:*** *natural resources (coastal, forest, biodiversity, etc)*
  - ***Economic:*** *water & energy security, and other sectors (industry, agriculture, tourism, etc)*
  - ***Social:*** *Pop. displacement, loss of livelihood, health problems*

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Multi-disciplinary fields

Future Research Plan

SOCIO-ECONOMIC VULNERABILITY ASSESSMENT OF RIVERINE COMMUNITIES IN HO CHI MINH CITY, VIETNAM

Ho Chi Minh City Team

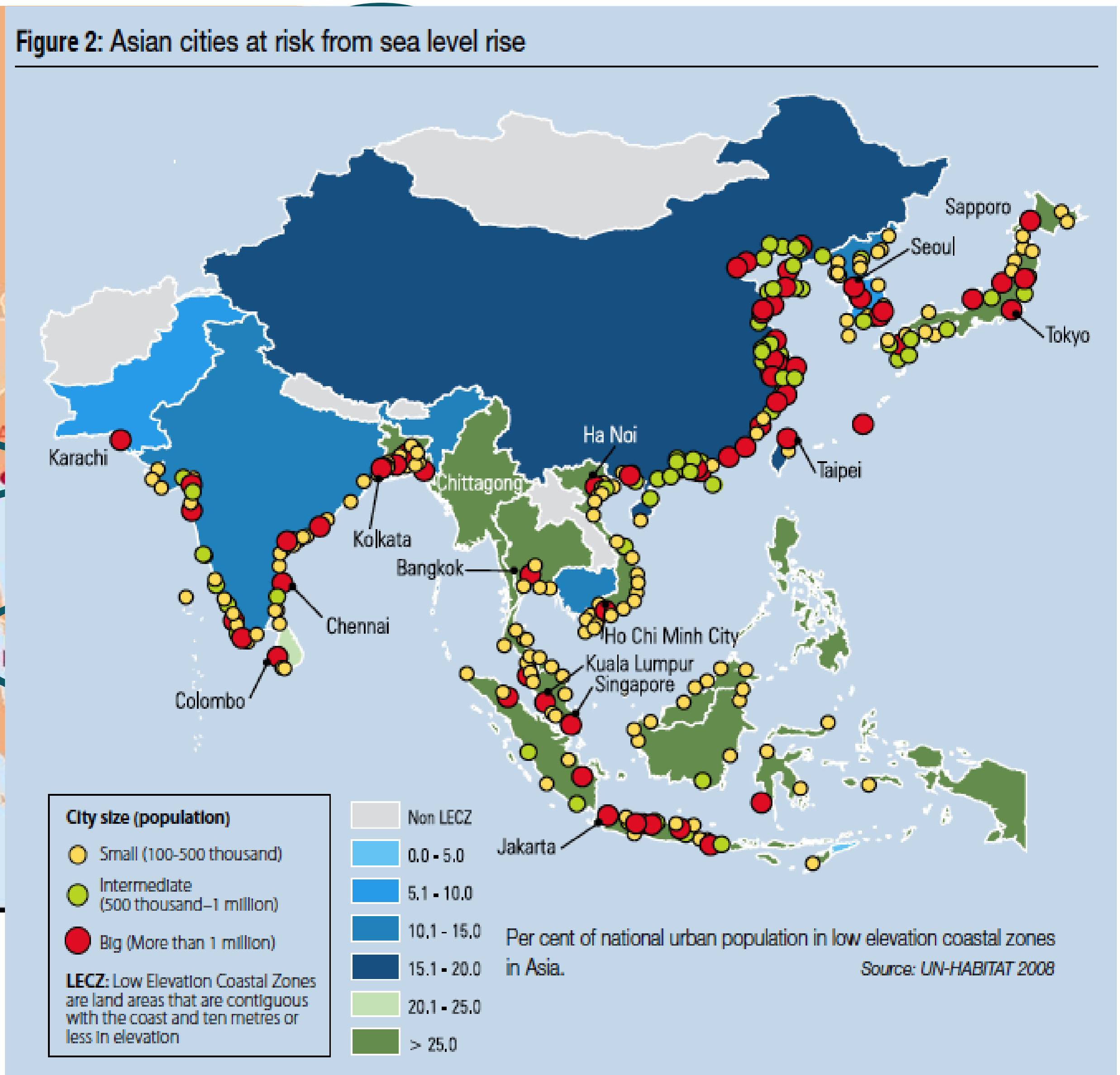
Vo Le Phu, Le Anh Duc

Dang Van Khoa and Lam Vu Thanh Noi

Contents

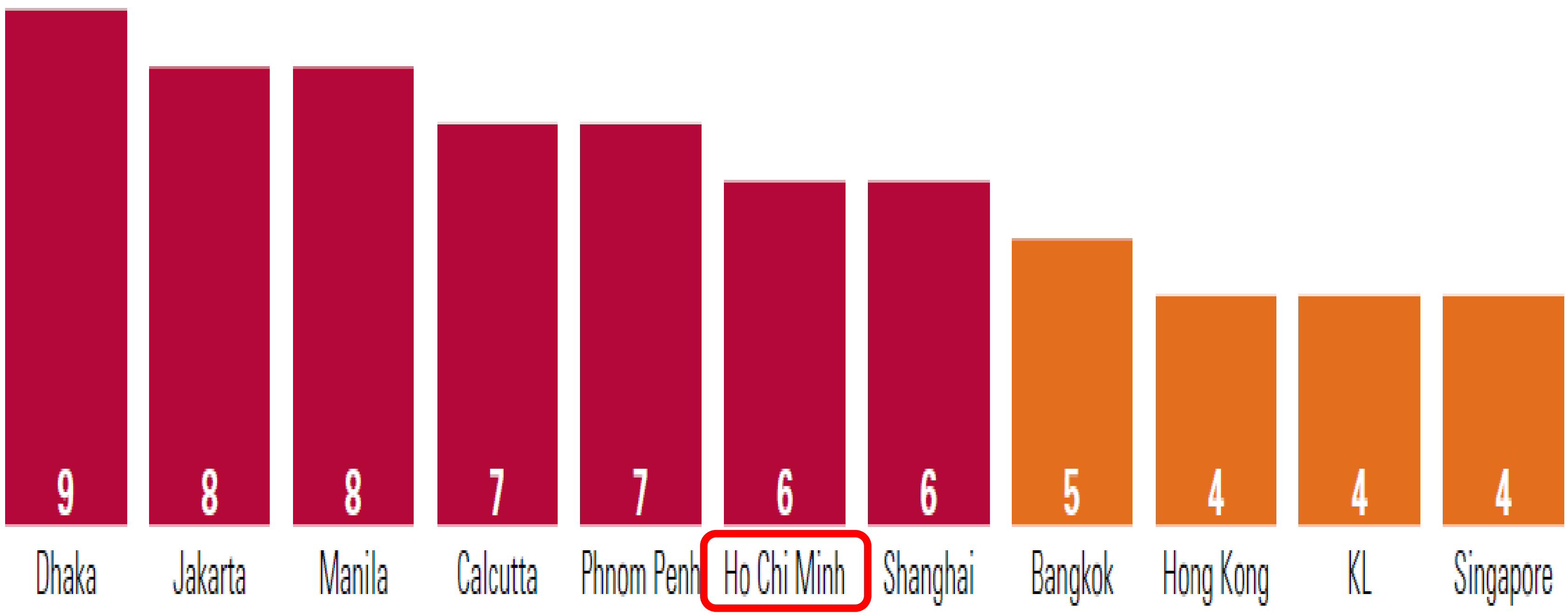
Why Ho Chi Minh City?

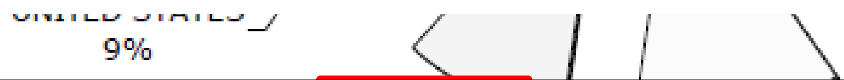
Source: WWF, nd



Source: Fuchs, 2010

Why Ho Chi Minh City?



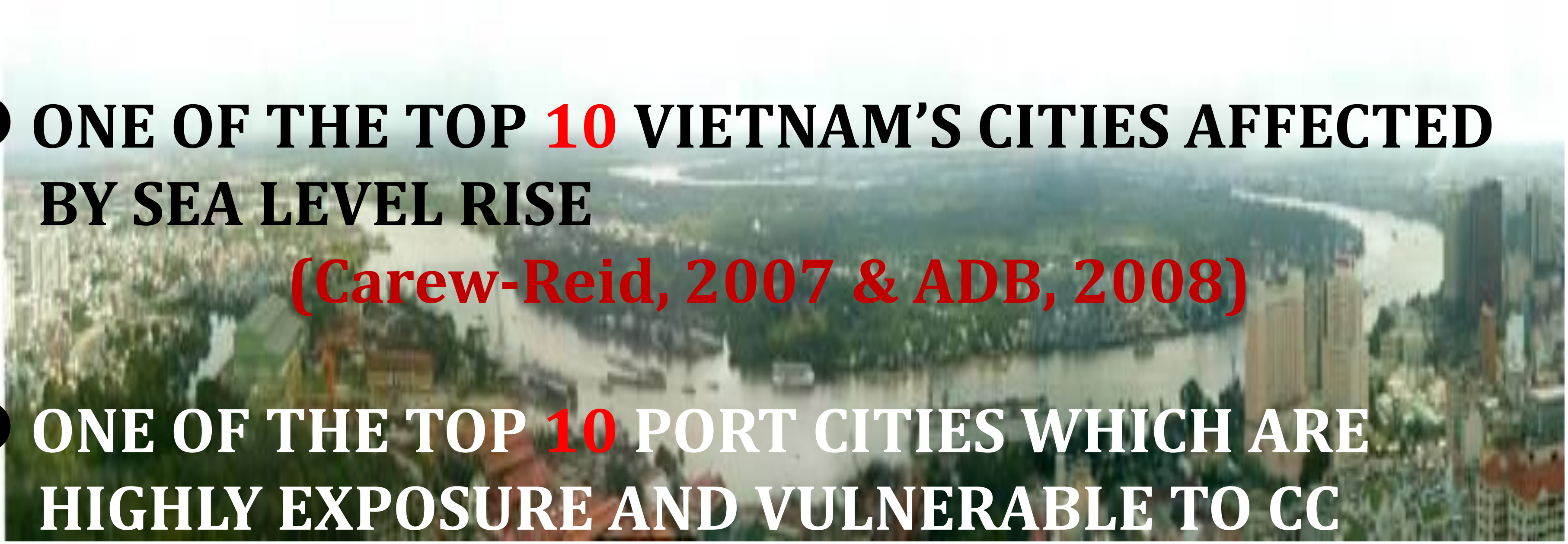


Source: WWF (nd). Mega-stress for Mega-Cities: A Climate Vulnerability Ranking of Major Coastal Cities in Asia

Source: Nicholls, et al., 2008

CLIMATE CHANGE
Climate Risk – Disaster - Vulnerability

Introduction: The Number 10



❶ **ONE OF THE TOP 10 VIETNAM'S CITIES AFFECTED BY SEA LEVEL RISE**

(Carew-Reid, 2007 & ADB, 2008)

❷ **ONE OF THE TOP 10 PORT CITIES WHICH ARE HIGHLY EXPOSURE AND VULNERABLE TO CC**

(Nicholls et al., 2008)

❸ **ONE OF THE TOP 10 ASIAN COASTAL CITIES WHICH ARE AT RISK OF COASTAL FLOODING**

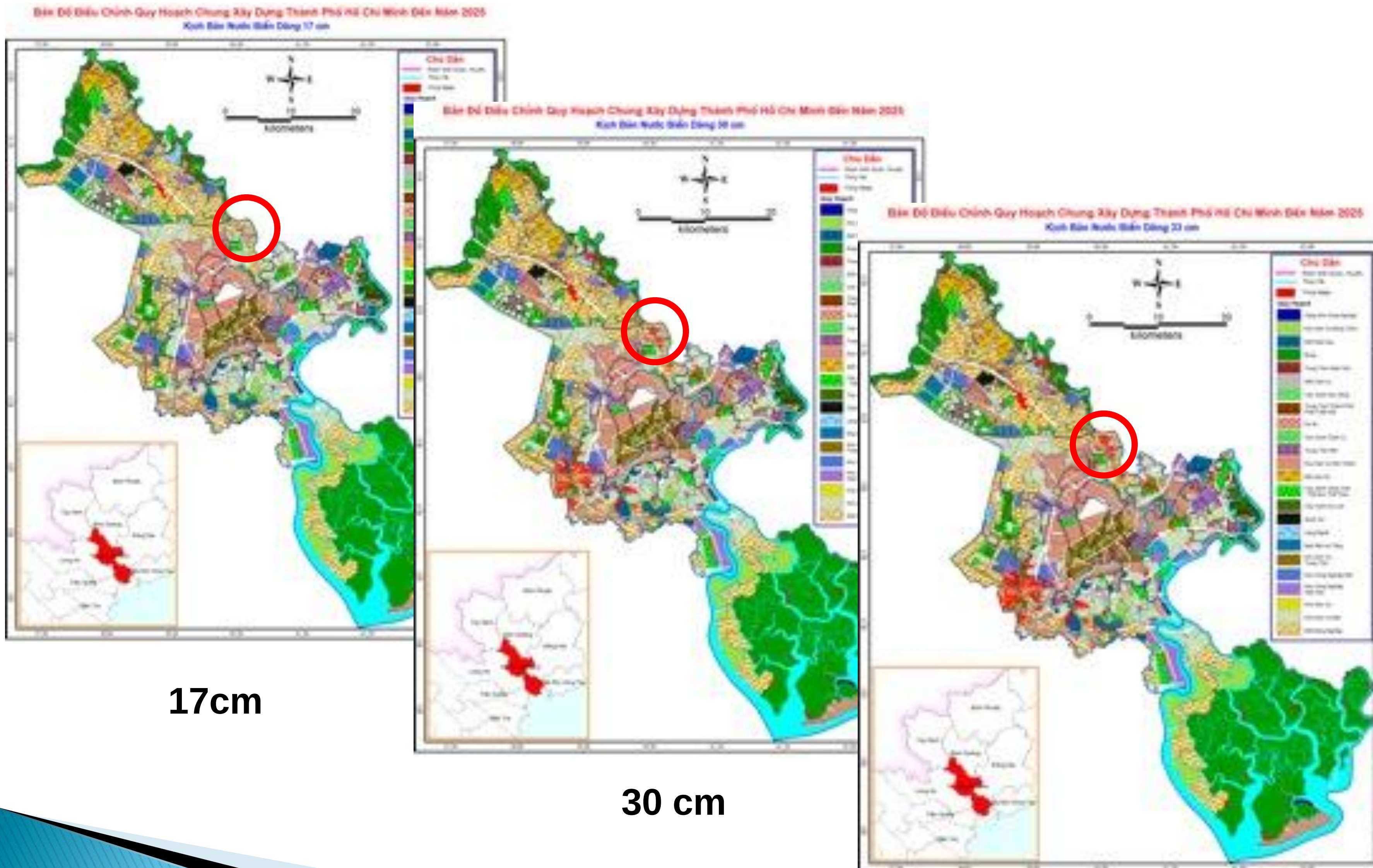
(WWF, 2009 & Fuchs, 2010)

Research Areas

❶ **Thu Duc District** (inner urban district)

❷ **Can Gio**, Sub-urban Coastal District

Why these communities?



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The Importance of the Research

❶ **Thu Duc District** (HBP & HBC)

- Total area: ~ 1,400 ha;
- Expanded inner district;
- Very highly pop. density;
- >100,000 inhabitants (>50% poor & temporary);
- Inadequate land use planning (residential, industrial, agricultural, new development);

The Importance of the Research

- ❶ **Thu Duc District** (HBP & HBC)
- Frequently inundated by tidal surge and heavy rain

Thu Duc District

The Importance of the Research

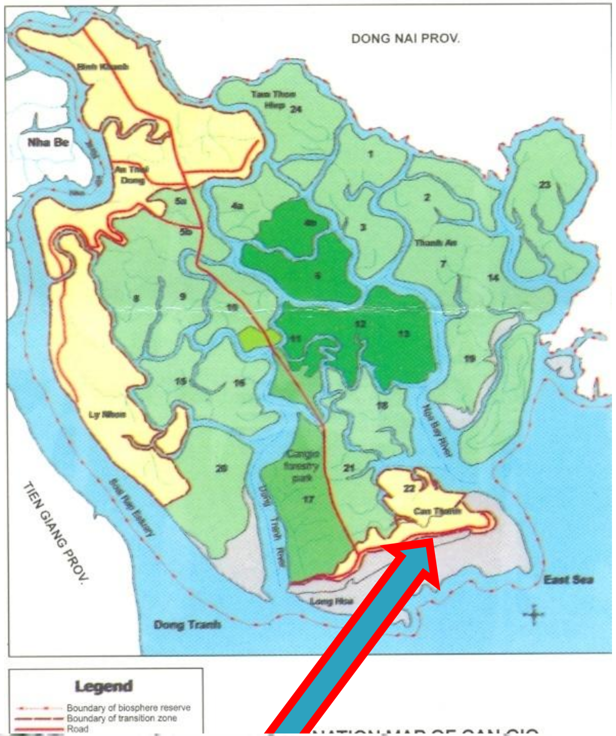
- Rapid and unplanned urban expansion:
  - Existing residential areas;
  - Landscape disruption;
  - Insufficient infrastructure;
  - Disparity of living conditions b/w temporary areas and new development areas

Existing floods and projected sea level rise/CC impacts → natural and social systems

The Importance of the Research

❷ Can Gio:

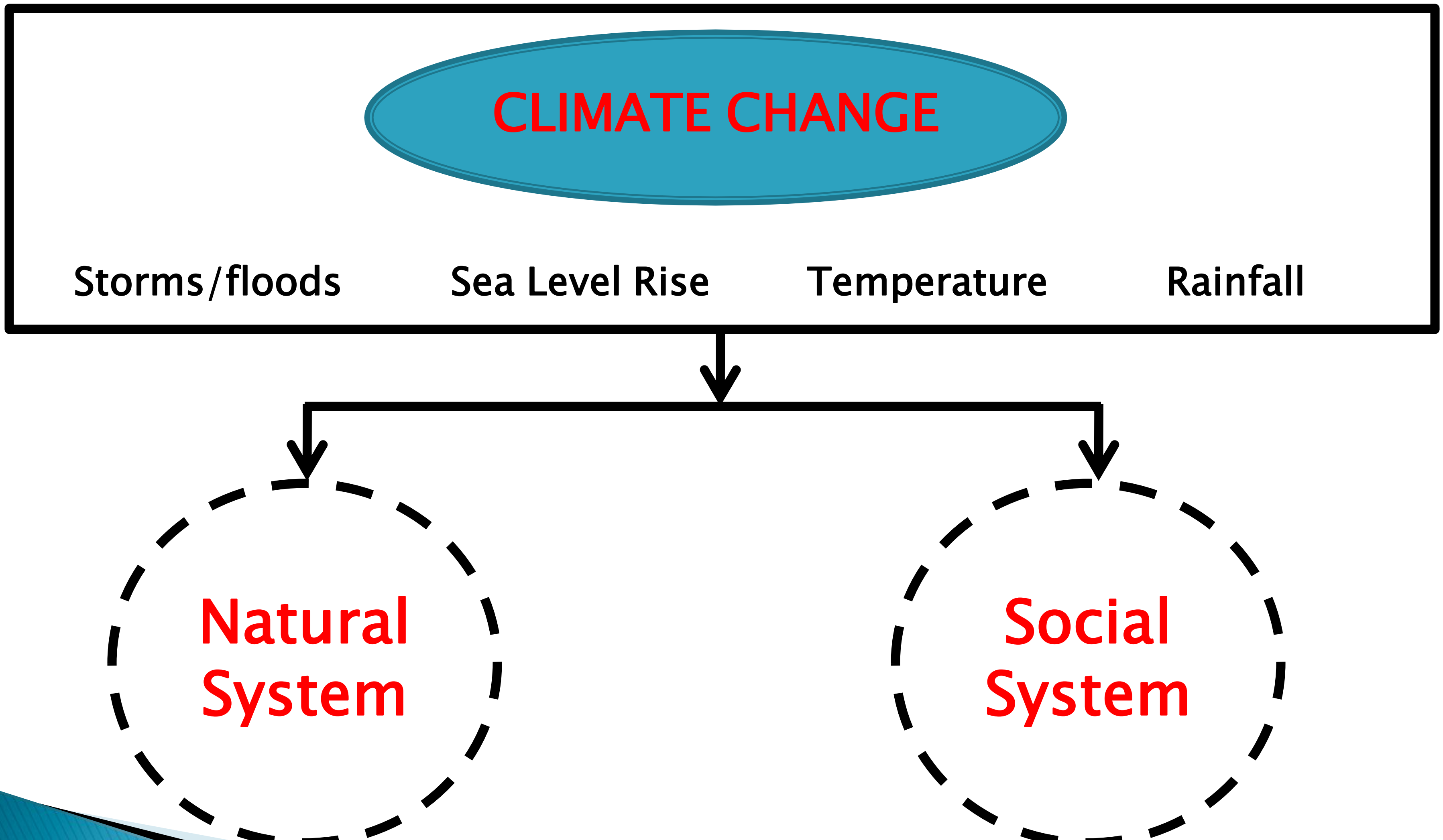
- A sub-urban coastal district;
- Total area: 71,000 ha (~1/3 water surface)
- A World Biosphere Mangrove Reserve Area (33,008 ha)
- >70,000 inhabitants (poor/farming);
- 300,000 people (2025)
- High GDP contribution of aquaculture sector (~ 1 billion/a)
- Expansion of urban area and harbor
- Ecotourism



The Importance of the Research

- The BMR area affected by the potential impacts of urban expansion
- Agricultural activities affected by sea level rise
- Land loss and subsidence
- Loss livelihoods
- The risk of the new development urban area and residence

FRAMEWORK



CLIMATE CHANGE
Storms/floods
Sea Level Rise
Temperature
Rainfall
Natural System
Social System

FRAMEWORK

CLIMATE CHANGE
(Flooding & Sea Level Rise)

Natural System

- Coastal resources
- Biodiversity
- Land, freshwater

Social System

- Built environment
- Infrastructure systems
- Land use value
- Culture values/asset
- Community livelihoods

Research Aim and Objectives

- Question: **How to develop/propose measures for climate change adaptation?**

- **Aim:** Developing adaptive measures for riverine communities in terms of socio-economic vulnerability in Ho Chi Minh City in the context of climate change.

Research Aim and Objectives

- **Objectives:**

➡ *Identifying existing and potential risks/disasters in Thu Duc and Can Gio communities;*

➡ *Assessing vulnerabilities of socio-economic aspects in these communities, including:* ***cultural values*** *and/or landscape –* ***community asset*** *–* ***public health****;*

➡ *Developing measures for adapting with climate change impacts in Thu Duc and Can Gio communities.*

Expected Outcomes

- A quantifiable profile of socio-economic vulnerabilities;
- Risk Maps of vulnerable Communities in Thu Duc and Can Gio (GIS Map);
- Building codes for inundation areas/low-lying areas;
- A set of guidelines for strengthening adaptive capacity in riverine communities;
- Recommendations for the city government in implementing measures/strategies for climate change adaptation in local contexts.

Schedule of Research Project

- The research project will be a case study and policy implication for similar places in Vietnam: Ben Tre, Nam Dinh, ...
- *Refining research proposal*
- *Implementing research objectives*
  - ➲ *Screening and scoping*
  - ➲ *Field Surveys*
  - ➲ *Information collection*
  - ➲ *Statistically data aggregating & analyzing*
  - ➲ *Developing and composing*

Proposed Research Partners

- Sub-Institute for Hydrological Meteorology & Environment ;
- Dept. of Urban Planning & Architecture of Ho Chi Minh City;
- Dept. of Nat. Resources & Environment (DONRE);
- University of Social Sciences & Humanities;
- Institute for Environment and Resources (IER);
- Southern Institute for Water Resources & Planning (SIWP);

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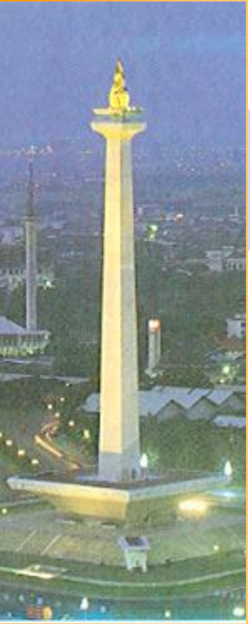
Acknowledgements

- The Workshop Organizing Committee;
- Dr. Anond Snidvongs, Director of SEA START for inviting the Team;
- East-West Center – APN – Ibaraki University – SEA START;
- Cities' Teams from Manila – Jakarta – Bangkok – Mumbai for their mutual discussions; and
- Various valuable stimulations, encouragements and comments from Dr. Roland Fuchs, Dr. Hassan Virji and other colleagues.


Thank You for Your Attention!
Comments and Questions



JAKARTA

PROPOSED FUTURE ACTIVITIES

PREPARED BY TEAM JAKARTA

NAKORN PATHOM, August 2010

PROPOSAL 1

Developing Measurements of Vulnerability to Climate Change

Indra Murty Surbakti

Nakorn Pathom, August 2010

RATIONALES

- There is a need to incorporate practical climate change indicators to assist government in development planning that take into accounts impacts of climate change
- There is a need to continuously monitor impacts of climate change on the social cohesion of the country
- The fact is that the Indonesian government lacks proper climate change indicators, particularly one which covers the social and impact of climate change for monitoring, mitigation and preparedness.

Objectives

- To develop macro and micro indicators of climate change impact, particularly social vulnerability index (SoVI), to assist local as well as national governments in planning mitigation and adaptation programs to climate change
- To combine physical and socio-economic indicators to climate change as to prepare a holistic approach to monitoring the impact of climate change, including using GIS to map vulnerability
- Particularly, to prepare the Social Vulnerability Index a nation-wide and regular measurement equivalent to the HDI or HPI

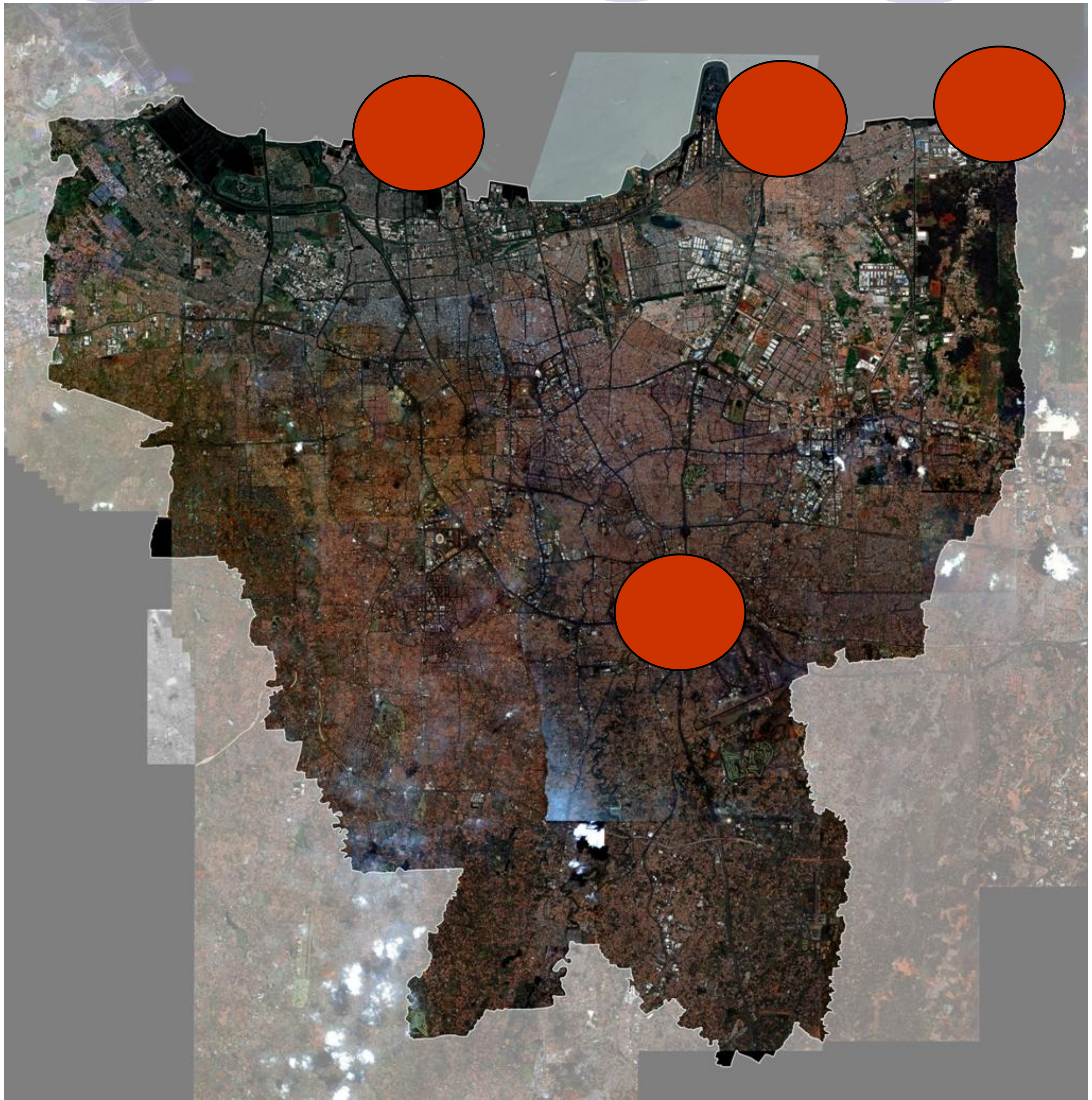
Constraints

- No one has properly developed proper social indicators of climate change impact, particularly social vulnerability index to climate change
- Available indicators are designed more for physical vulnerability than social or economic vulnerability
- The statistics office of Indonesia has experimented with social vulnerability index. However, the index is designed to assess the social impact of conflicts or socio-economic shocks, rather than environmental or climate change
- There is a lack of awareness and knowledge of climate change, and more importantly, lack of expertise in constructing proper instruments to monitor the social impact of climate change.
- There is currently no training available to develop the social vulnerability indicators, including GIS training
- There is no regional or national level climate change social indicators to assist local and national governments in environmentally-based development planning
- No budget available to develop the indicators

Methodology (1)

- Conducting a Study to prepare instruments for developing macro as well as micro socio-economic indicators of climate change impact, particularly the social vulnerability index
- Compile data needed to construct macro indicators
- Conduct training, including GIS training as well as climate change awareness, to develop the social vulnerability indicators
- Develop the vulnerability indicators and combining them to create GIS-based vulnerability mapping
- Conduct initial seminar to introduce the newly-constructed indicators
- Combine the social vulnerability indicators with other climate change indicators
- Conduct field visits for verification of the data collected for the macro indicators

Study Area (North & East Jakarta)

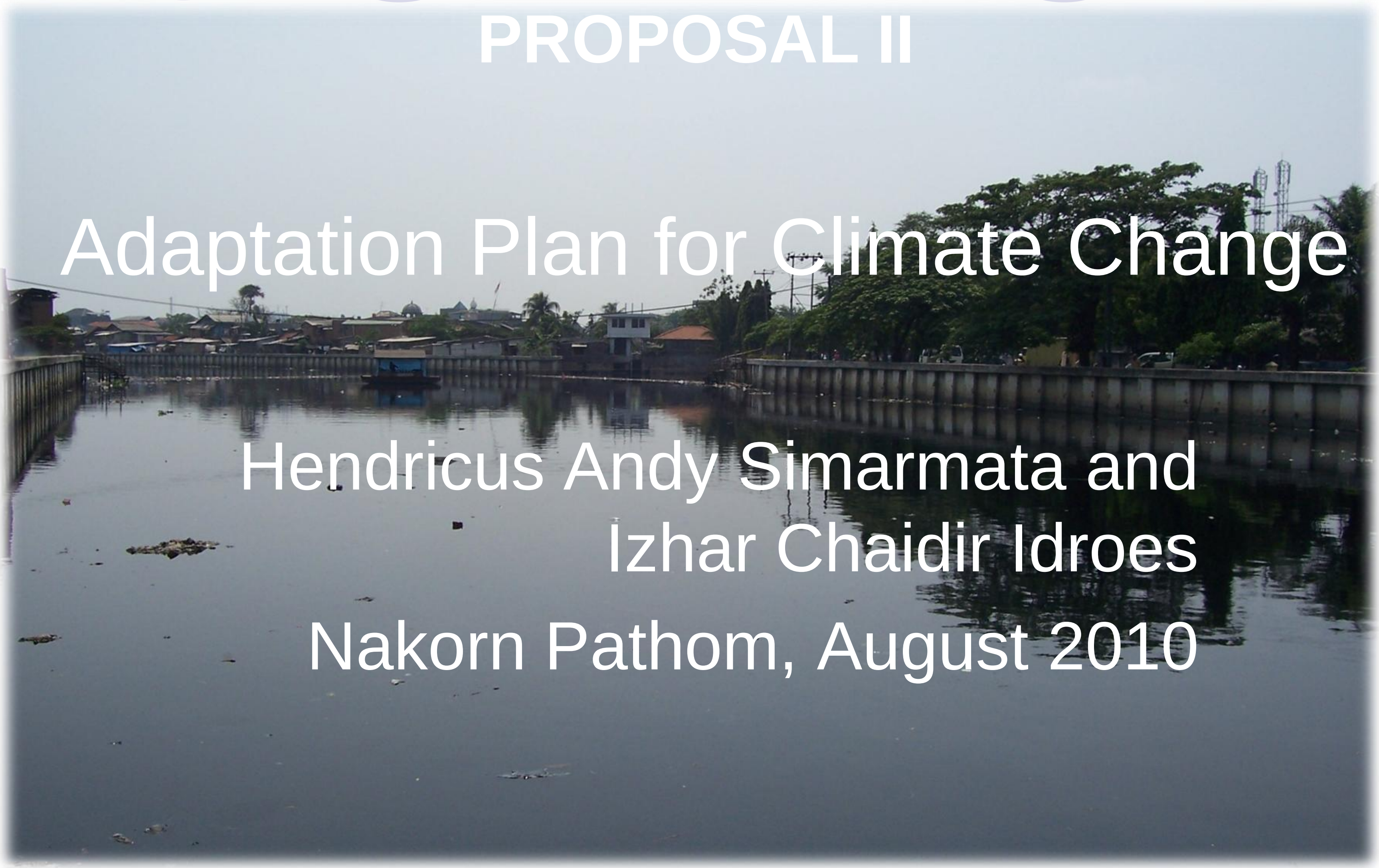


Methodology (2)

- Conduct micro study to compile data to construct micro level indicators (incl. public awareness & adaptive behaviour) Conduct national and international conference to promote the social vulnerability indicators to the public
- Using household level data produced by the national Statistics of Indonesia
  - The National Socio Economic survey (Susenas)
  - The Village Potential Survey (Podes)
  - The Labour Force Survey (Sakernas)
  - The 2010 Population Census
  - Other relevant data
- Using other data collected by other ministries and local government
- Using Arc GIS to map the social vulnerability indicators

EXPECTED RESULTS

- The formation of macro level social vulnerability indicators, especially the SoVI
- The construction of micro level indicators to obtain information on community awareness, coping and adaptive behavior as well as level of vulnerability of the climate change impact
- Raise awareness of the public on the vulnerability to climate change
- Provide contribution to more holistic approach to climate change impact
- Provide input for urban development planning based on climate change



PROPOSAL II

Adaptation Plan for Climate Change

Hendricus Andy Simarmata and
Izhar Chaidir Idroes

Nakorn Pathom, August 2010

Background

- Climate change has been acknowledged as a trigger to natural hazard event→ we can’t stop the forces of nature, but we can and must prevent them from causing social and economic disasters
- Jakarta may be hit by natural hazards, but has no information about the time and frequency. Are they accumulated and occurred in the same time and location?
- Some places in Jakarta are vulnerable, but no data about the scale. Can it be differed?
- The information needed to adapt the urban land use plan and/or building code in the micro level, especially for the most vulnerable area.
- The plan or the regulation should be addressed due to safety and resilient reason

Research question

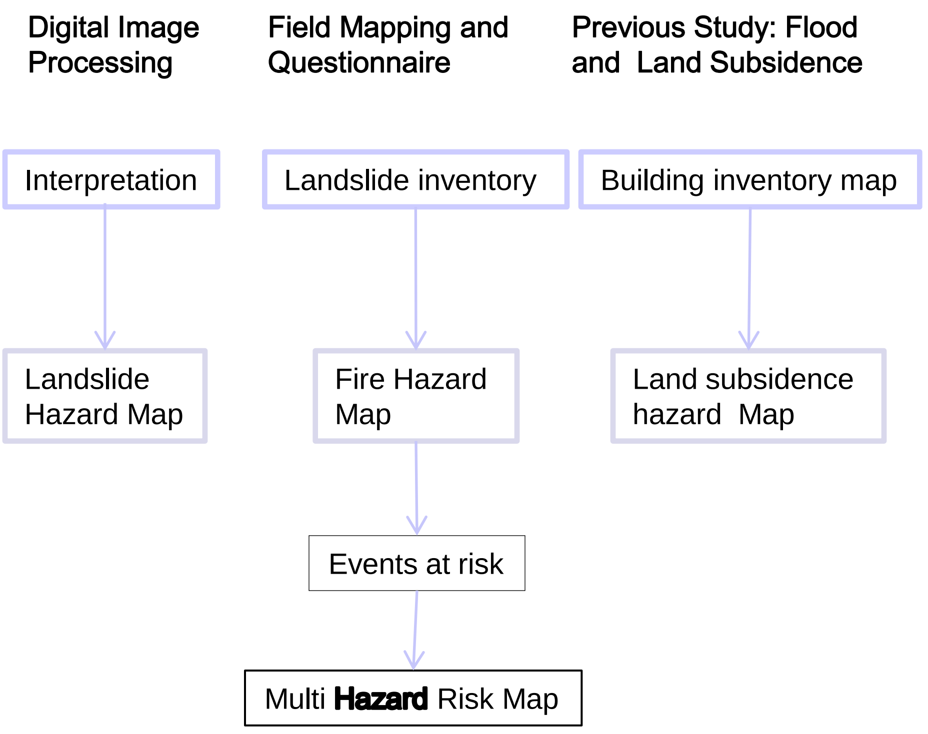
- What kind of hazard risks that may be present in Jakarta?
- What are the vulnerable areas prone to flood, landslide/subsidence, inundation, and fire hazard?
- What kind of adaptation plan that should be added on the land use plan and/or building code ?

Objectives

1. Conduct multi-hazard risk assessment (mHRA) for north coastal Jakarta
2. Develop climate-coastal city vulnerability index (C3VI) in Jakarta
3. Provide adaptation plan for the Jakarta Coastal City (APCC)
4. Re-formulate the zoning provision for the coastal city

Methodology-MHRA

1. Previous research collection– (CVI, JEDI, etc)
2. Flood, coastal erosion, and fire hazard analysis
3. Risk parameters: number of population and buildings
4. Multi hazard risk area classification
5. Hazard risk ranking



Source: Khatsu, 2005

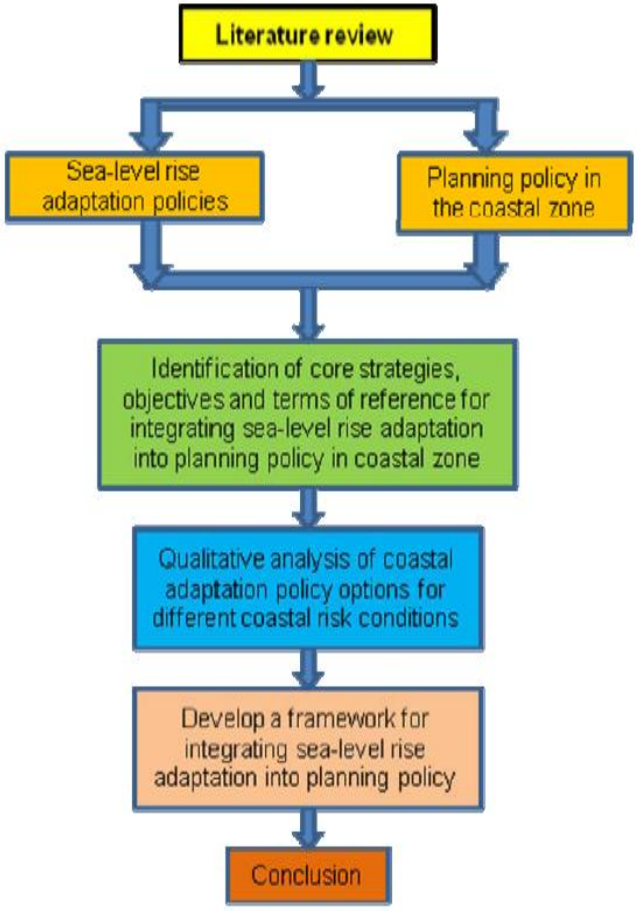
Methodology-C3VI

- Using previous study: CVI 2009 (USGS,2000)
- Socio-economic vulnerability assessment and SoVI Ranking
- Due to the range of values for CVI and SoVI, *z scores were first calculated for each index* as a means for creating comparable scales.
- the C3VI for all coastal sub-districts was mapped into three categories (low, medium, and high) using the standard deviations from the mean as the classification scheme.
- Combine MHRA with CCVI rank

to test the degree of physical and socioeconomic influences on C3VI, a standard linear regression was performed with C3VI as the dependent variable and all physical and socioeconomic variables as independents.

Methodology -- APCC

- Conduct participative planning process in the vulnerable neighborhood level
- Conduct several workshops to disseminate the plan product



Source: Boateng, 2009

Expected results

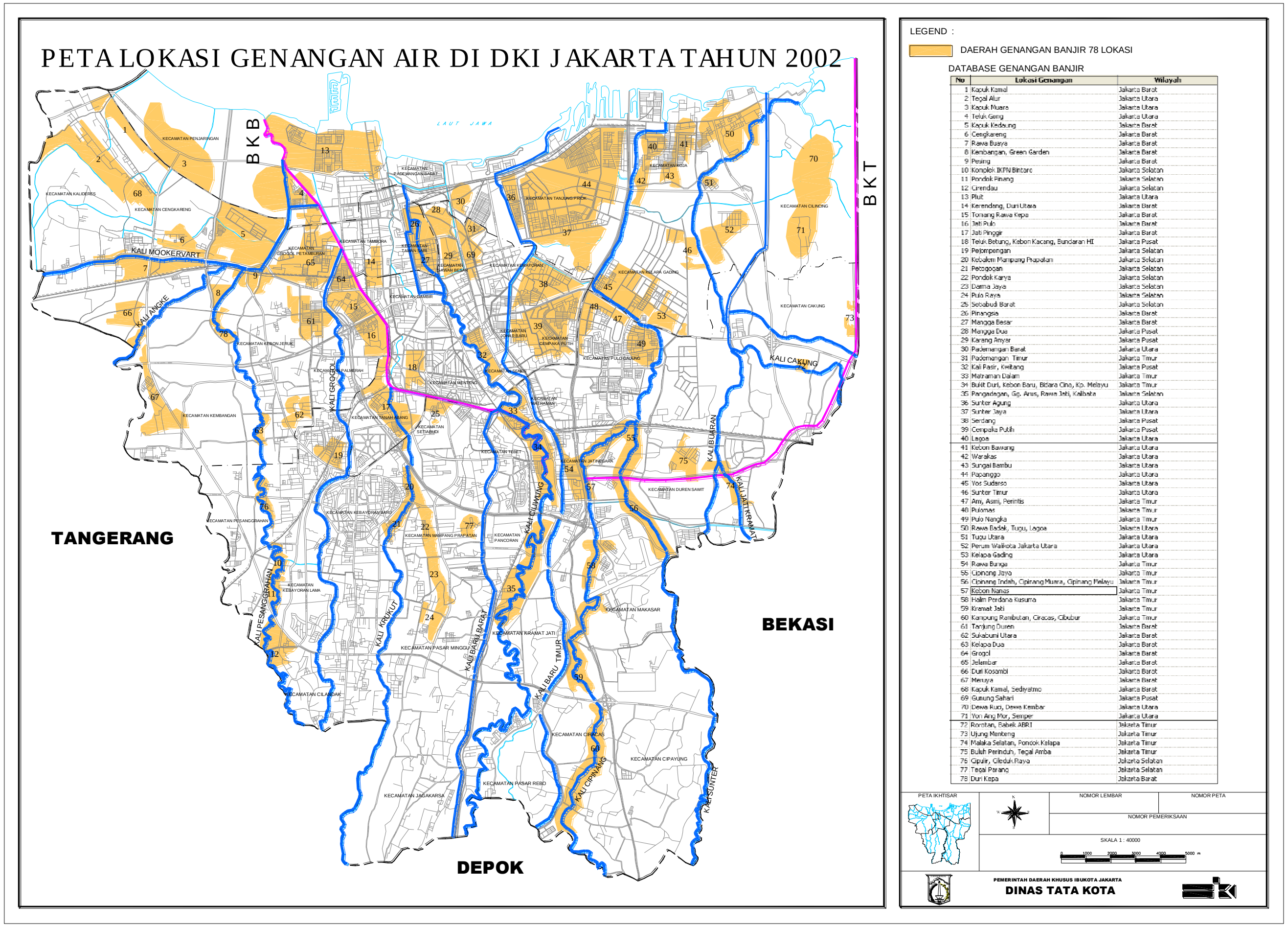
- Multi Hazard Risk Map and Rank
- Coastal City Vulnerability Index
- Adaptation Plan for Coastal City

Expected Result: Adaptation Plan (APCC)

- Adaptation Spatial Plan:
  - Evacuation Map, Based on Risk Map (Hazard Map + Vulnerable Map):
    - Location of Shelter
    - Evacuation Route
  - Determine Types of Land Use in Risk Area
  - Incentive and Disincentive for Development in Risk Area
- Adaptation Program (Preparedness, Response, Recovery, and Mitigation):
  - Increasing Awareness (Public and Government Officials)
  - Early Warning System
  - Building Dykes, Polder, etc.

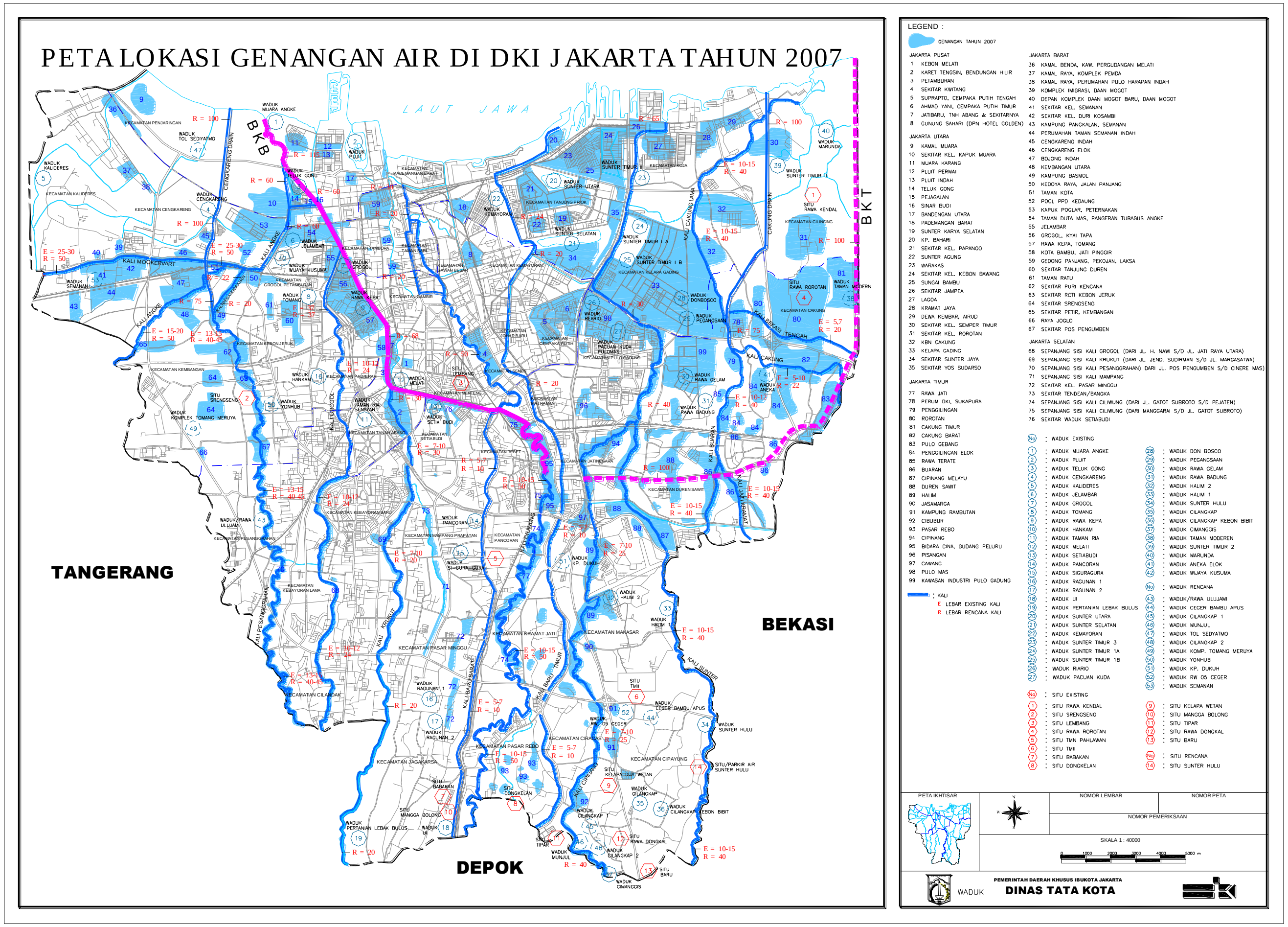
Hazard Map

Map of Inundation Area 2002

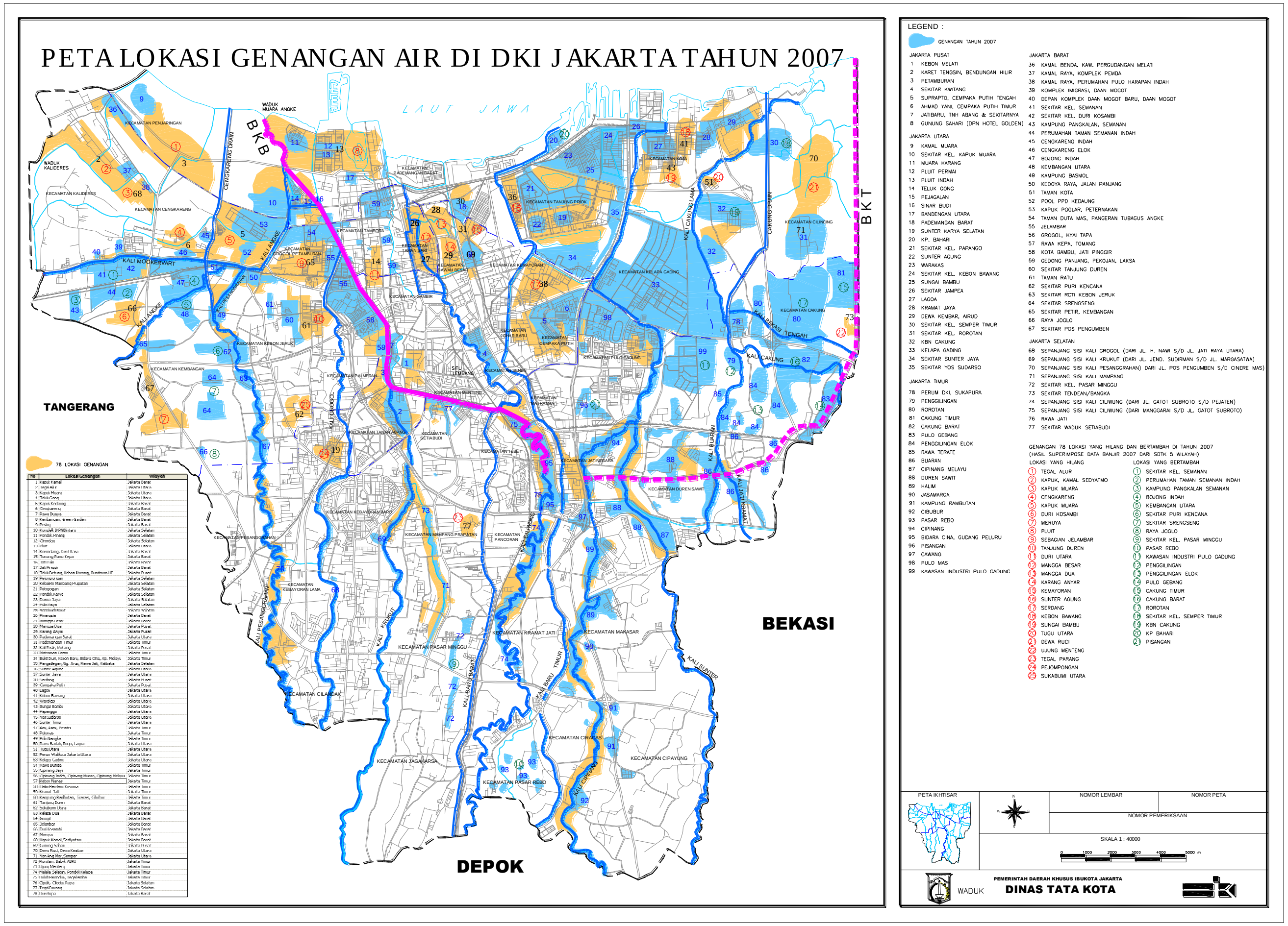


No	Lokasi Genangan	Wilayah
1	Kapuk Kamal	Jakarta Barat
2	Tegal Alur	Jakarta Utara
3	Kapuk Muara	Jakarta Utara
4	Teluk Gong	Jakarta Utara
5	Kapuk Kedaung	Jakarta Barat
6	Cengkareng	Jakarta Barat
7	Rawa Buaya	Jakarta Barat
8	Kembangan, Green Garden	Jakarta Barat
9	Pesing	Jakarta Barat
10	Komplek IKPN Bintaro	Jakarta Selatan
11	Pondok Pinang	Jakarta Selatan
12	Cirendau	Jakarta Selatan
13	Pluit	Jakarta Utara
14	Kerendang, Duri Utara	Jakarta Barat
15	Tomang Rawa Kepa	Jakarta Barat
16	Jati Pulo	Jakarta Barat
17	Jati Pinggir	Jakarta Barat
18	Teluk Betung, Kebon Kacang, Bundaran HI	Jakarta Pusat
19	Pejompongan	Jakarta Selatan
20	Kebalem Mampang Prapatan	Jakarta Selatan
21	Petogogan	Jakarta Selatan
22	Pondok Karya	Jakarta Selatan
23	Darma Jaya	Jakarta Selatan
24	Pulo Raya	Jakarta Selatan
25	Setiabudi Barat	Jakarta Selatan
26	Pinangsia	Jakarta Barat
27	Mangga Besar	Jakarta Barat
28	Mangga Dua	Jakarta Pusat
29	Karang Anyar	Jakarta Pusat
30	Pademangan Barat	Jakarta Utara
31	Pademangan Timur	Jakarta Timur
32	Kali Pasir, Kwitang	Jakarta Pusat
33	Matraman Dalam	Jakarta Timur
34	Bukit Duri, Kebon Baru, Bidara Cina, Kp. Melayu	Jakarta Timur
35	Pangadegan, Gg. Arus, Rawa Jati, Kalibata	Jakarta Selatan
36	Sunter Agung	Jakarta Utara
37	Sunter Jaya	Jakarta Utara
38	Serdang	Jakarta Pusat
39	Cempaka Putih	Jakarta Pusat
40	Lagoa	Jakarta Utara
41	Kebon Bawang	Jakarta Utara
42	Warakas	Jakarta Utara
43	Sungai Bambu	Jakarta Utara
44	Papanggo	Jakarta Utara
45	Yos Sudarso	Jakarta Utara
46	Sunter Timur	Jakarta Utara
47	Ami, Asmi, Perintis	Jakarta Timur
48	Pulomas	Jakarta Timur
49	Pulo Nangka	Jakarta Timur
50	Rawa Badak, Tugu, Lagoa	Jakarta Utara
51	Tugu Utara	Jakarta Utara
52	Perum Walikota Jakarta Utara	Jakarta Utara
53	Kelapa Gading	Jakarta Utara
54	Rawa Bunga	Jakarta Timur
55	Cipinang Jaya	Jakarta Timur
56	Cipinang Indah, Cipinang Muara, Cipinang Melayu	Jakarta Timur
57	Kebon Nanas	Jakarta Timur
58	Halim Perdana Kusuma	Jakarta Timur
59	Kramat Jati	Jakarta Timur
60	Kampung Rambutan, Ciracas, Cibubur	Jakarta Timur
61	Tanjung Duren	Jakarta Barat
62	Sukabumi Utara	Jakarta Barat
63	Kelapa Dua	Jakarta Barat
64	Grogol	Jakarta Barat
65	Jelambar	Jakarta Barat
66	Duri Kosambi	Jakarta Barat
67	Meruya	Jakarta Barat
68	Kapuk Kamal, Sediyatmo	Jakarta Barat
69	Gunung Sahari	Jakarta Pusat
70	Dewa Ruci, Dewa Kembar	Jakarta Utara
71	Yon Ang Mor, Semper	Jakarta Utara
72	Rorotan, Babek ABRI	Jakarta Timur
73	Ujung Menteng	Jakarta Timur
74	Malaka Selatan, Pondok Kelapa	Jakarta Timur
75	Buluh Perinduh, Tegal Amba	Jakarta Timur
76	Cipulir, Cileduk Raya	Jakarta Selatan
77	Tegal Parang	Jakarta Selatan
78	Duri Kepa	Jakarta Barat

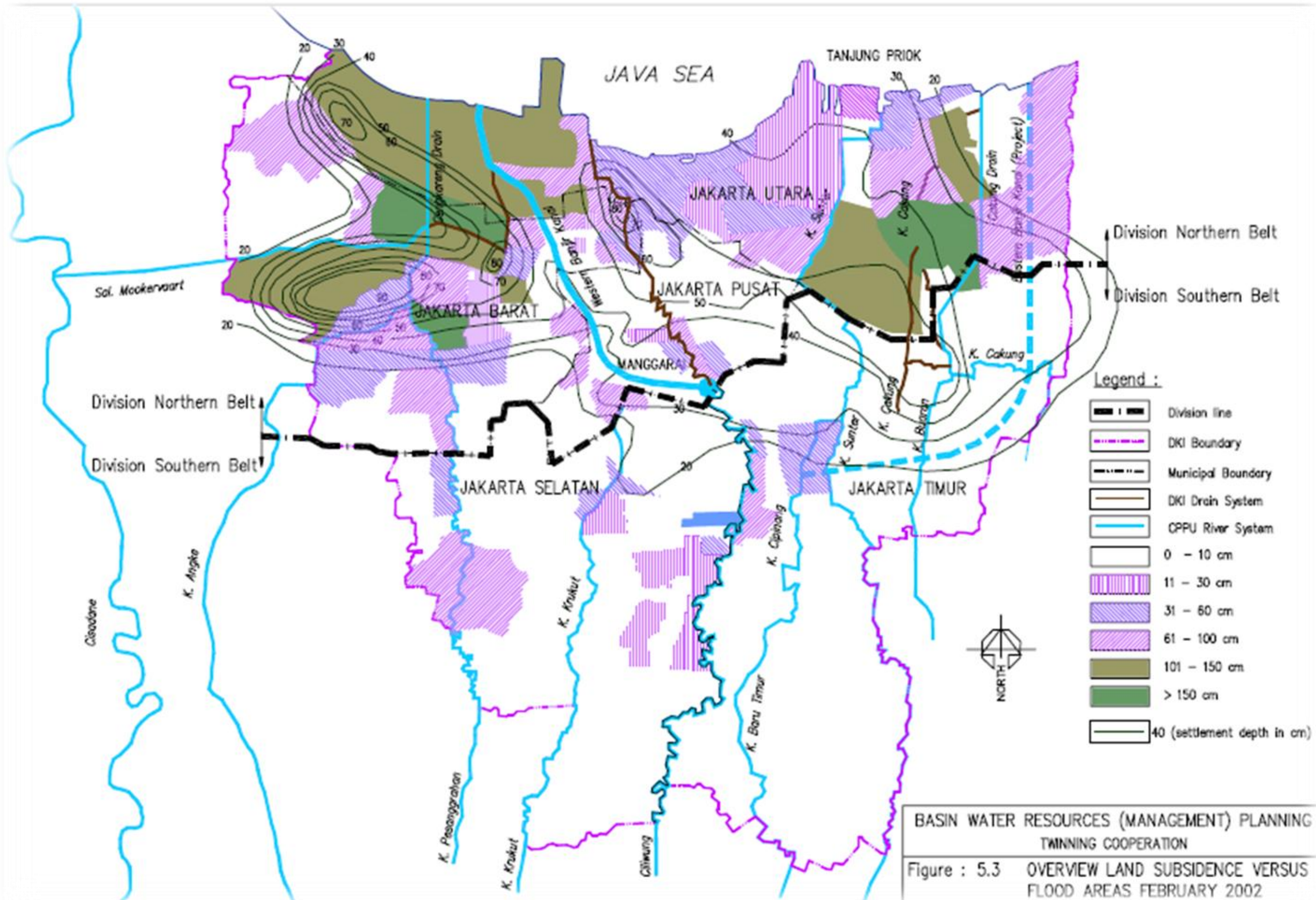
Map of Inundation Area 2007



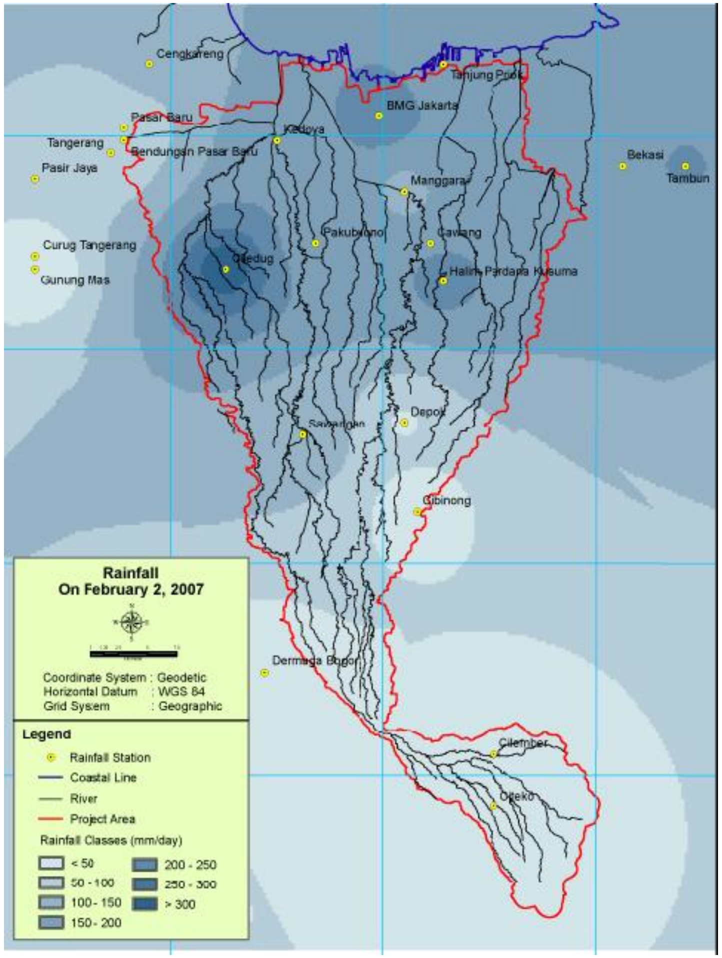
Map of Inundation Area (2002 &2007)



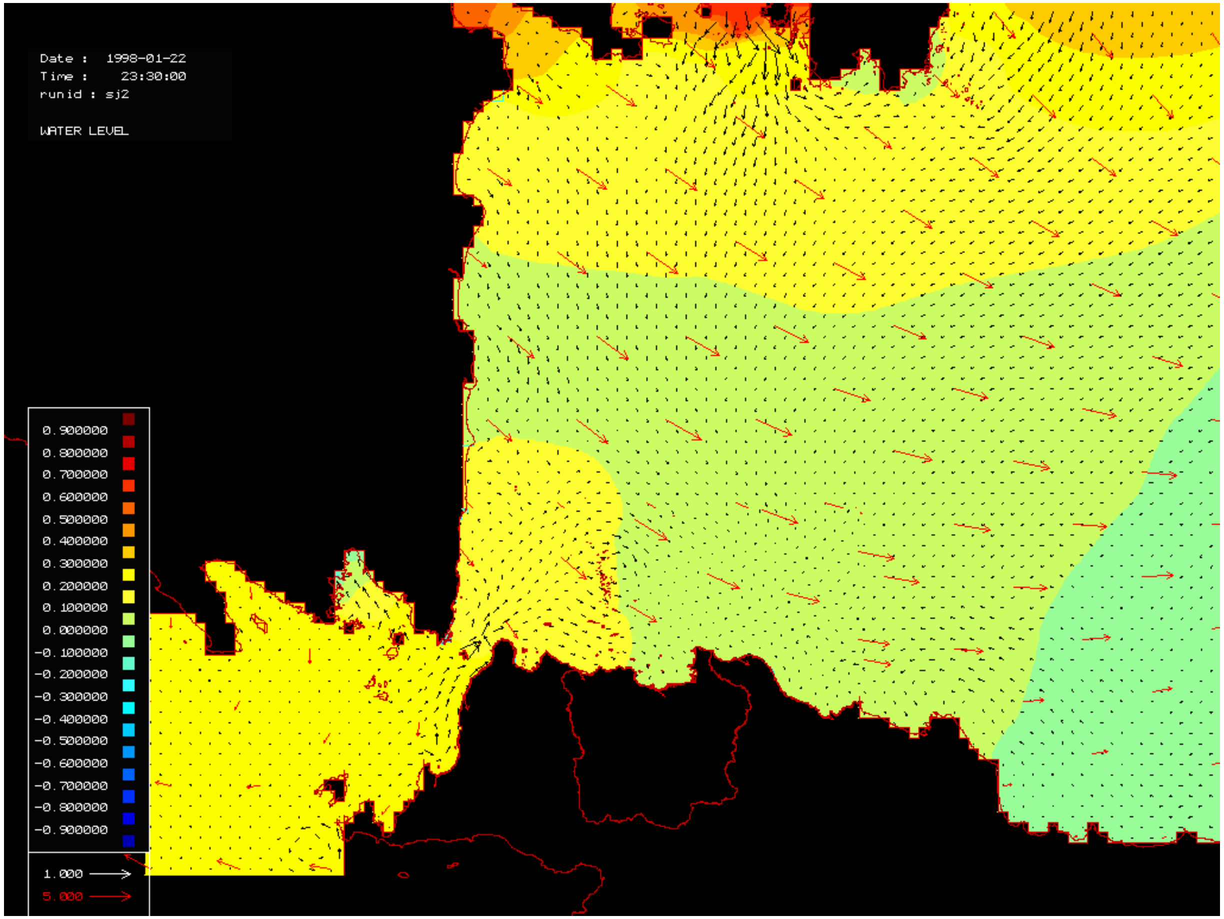
Map of Land Subsidence



Rainfall


Rainfall
On February 2, 2007
Coordinate System : Geodetic
Horizontal Datum : WGS 84
Grid System : Geographic
Legend
Rainfall Station
Coastal Line
River
Project Area
Rainfall Classes (mm/day)
< 50
50 - 100
100 - 150
150 - 200
200 - 250
250 - 300
> 300
Cengkareng
Tanjung Priok
BMG Jakarta
Pasar Baru
Tangerang
Kedoya
Bendungan Pasar Baru
Pasir Jaya
Bekasi
Tambun
Manggarai
Pakubuwono
Cawang
Curug Tangerang
Ciledug
Halim Perdana Kusuma
Gunung Mas
Depok
Sawangan
Cibinong
Dermaga Bogor
Cilember
Citeko

Hightide



Date : 1998-01-22
Time : 23:30:00
runid : sj2
WATER LEVEL
0.900000
0.800000
0.700000
0.600000
0.500000
0.400000
0.300000
0.200000
0.100000
0.000000
-0.100000
-0.200000
-0.300000
-0.400000
-0.500000
-0.600000
-0.700000
-0.800000
-0.900000
1.000
5.000

Research Area

Satellite Image of North Jakarta

Land Use Map of North Jakarta

PROPOSED COLLABORATION

- Urban Studies Department, University of Indonesia
- Regional and City Planning, Institute Technology of Bandung
- Spatial Planning Department, Government of Jakarta City
- National Board of Statistics
- CSIRO, Australia
- Board of Ocean and Fisheries Research, Ministry of Oceans

PROPOSAL III

Developing a Course on ‘Urban Development and Climate Change’

Tommy Firman

Nakorn Pathom, August 2010

RATIONALES

- There is a need to incorporate climate changes into urban development planning
- There is a need to increase awareness of students and young planners on impacts of climate changes on urban and regional development in developing countries
- The fact is that Course on urban and regional development and course on climate change in universities in Indonesia are taught in different departments for different purposes, not in an integrative manner.

Objectives

- To develop a coursework on ‘Urban Development and Climate Change’ (Introductory Course)

  (Intended for 4th year undergraduate students and 1st year of graduate students)
- To increase students’ and young Indonesian planners’ awareness on impacts of climate change on urban and regional development in developing countries, particularly in the Indonesian setting

Course Materials (1)

- Urbanization and Urban Development in Developing Countries (Population, Socio-economic activities)
- Coastal Cities and Small Island Development (geographic and socio-economic characteristics)
- Climate Change (what, why, Impacts, Why and What Planners need to understand)
- Sea Level Rise (SLR), Land Subsidence, Flooding, Inundation, Heat , Storm Surge
- Vulnerability , Risks and Socioeconomic Implications, especially for the poor.
- Prediction and Mapping (GIS and some other simple techniques),.
- Source of Data and Information (Global, National and Local Level)
- Mitigation and Adaptation (What, Why and How), land use and spatial planning, disaster management , infrastructure development etc
- Governance (Institutional Aspects, Stakeholders, Regulations)

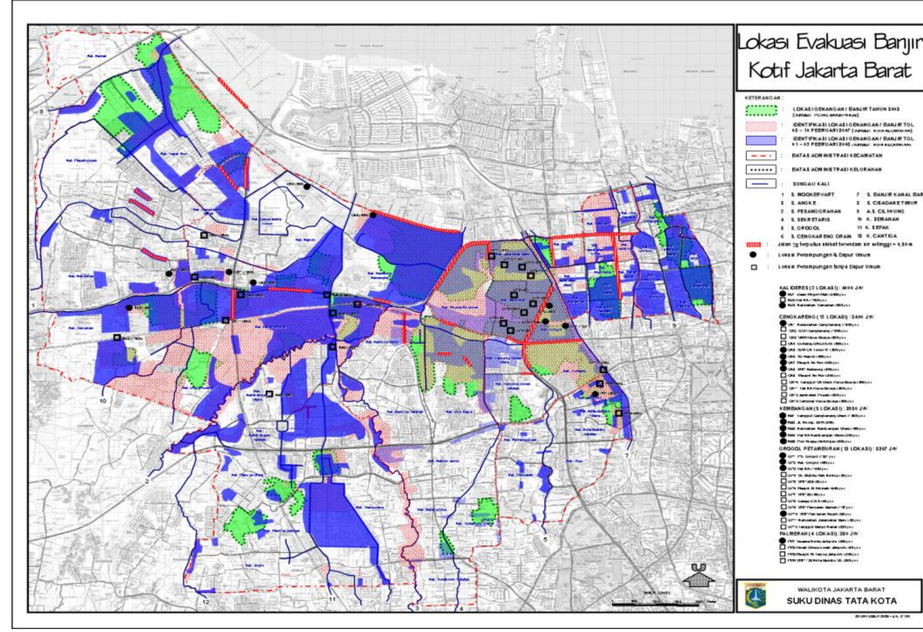
Course Materials (2)

- Financial Aspects (The Role of Global Financial Institutions, Central and Local Governments)
- Case Studies, especially Indonesian Cases
- Guest Lecturers (Experts, Government Officials etc)

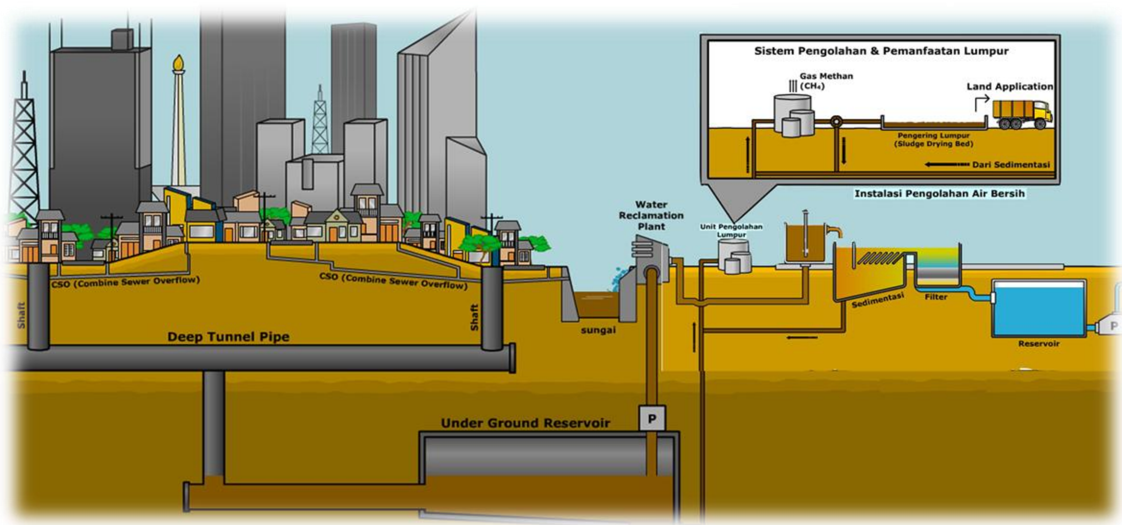
Methodology

- Conducting a Desk Study to prepare a first draft of course proposal
- Conducting a Workshop/ Seminar (with other Planning Department in Universities in Indonesia, Indonesian Planning School Association, Association of Indonesian Planners, Experts, Ministry of Environment, Ministries of Public Works, Home Affairs, Marine Affairs, Agency of Meteorology, Climate and Geophysics (BMKG), Central Board of Statistics, the National Planning Agencies, Local Governments, The Coordinating Agency for Surveying and Mapping
- Finalizing the course proposal (Expected Results)
- Launching the course (elective course and team teaching)
- Adoption and modification of the course materials (by Association of Indonesian Planners – IAP) for short course training for Indonesian Planners.


Banjir Lumpuhkan Jakarta


Lokasi Evakuasi Banjir
Kotif Jakarta Barat
WALIKOTA JAKARTA BARAT
SUKU DINAS TATA KOTA

THANK YOU

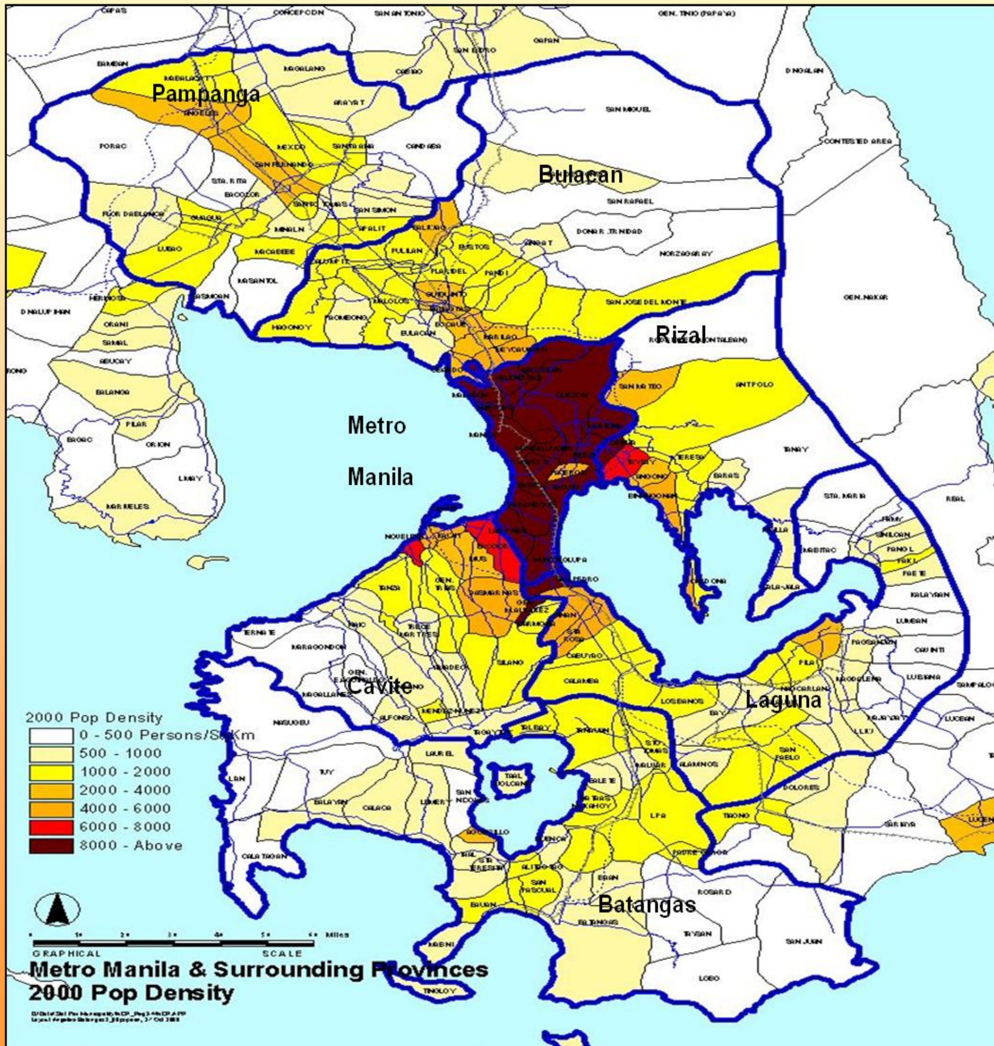

Sistem Pengolahan & Pemanfaatan Lumpur
Gas Methan (CH_4)
Land Application
Pengering Lumpur (Sludge Drying Bed)
Dari Sedimentasi
Instalasi Pengolahan Air Bersih
Water Reclamation Plant
Unit Pengolahan Lumpur
CSO (Combine Sewer Overflow)
CSO (Combine Sewer Overflow)
Shaft
Shaft
Deep Tunnel Pipe
sungai
Sedimentasi
Filter
Reservoir
Under Ground Reservoir
P

METRO-MANILA TEAM FUTURE RESEARCH PLANS

CLIMATE CHANGE VULNERABILITY ASSESSMENT AND URBAN DEVELOPMENT PLANNING IN ASIAN COASTAL CITIES

27 AUGUST 2010

METRO-MANILA: URBAN PRIMACY



1. REFINING Risk $\cong$ Hazard x Exposure x Vulnerability/ Capacity

a. FORMULA SETTING
b. MATCHING AND IDENTIFYING VARIABLES/ INDICES/ PROXIES OF THE HEV
c. WEIGHTING OF HEV BASED ON HISTORICAL EXPERIENCE OF DISASTERS
d. IDENTIFY/ MEASURE COPING CAPACITY C AND ADAPTATION STRATEGIES ACCORDING TO DIFFERENT INSTITUTIONAL LEVELS

2. CONSTRUCT A DYNAMIC RISK ASSESSMENT AND DECISION-SUPPORT FRAMEWORK/ TOOLS

a. ACROSS SECTORS OF PRIORITY
b. SENSITIVE TO FORMAL-INFORMAL DYNAMICS OF DIFFERENT COMMUNITIES AND STAKEHOLDERS
c. INTEGRATED RISK ASSESSMENT: QUANTITATIVE AND QUALITATIVE VALUES
d. NON-LINEAR COMPLEXITY

3. SEMANTIC RECONCILIATION

a. ACROSS DISCIPLINES

   - PHYSICAL-HUMAN GEOGRAPHY

b. CONVERGENCE

   - INSTITUTIONS

c. INTERSECTIONS

   - ADAPTIVE INTERACTIONS

4. HAZARDS

a. MULTI-HAZARD APPROACH
b. CLIMATE VARIABILITY DIFFERS FROM WEATHER
c. ASSOCIATED GEOPHYSICAL HAZARD

5. EXPOSURE

a. SCALE: TIME AND FUNCTIONAL SCALES
b. UNITS
c. OBSERVATION METHOD
d. METADATA
e. STRUCTURE OF THE SPATIAL DATABASE
f. ASSOCIATED WITH VULNERABILITY

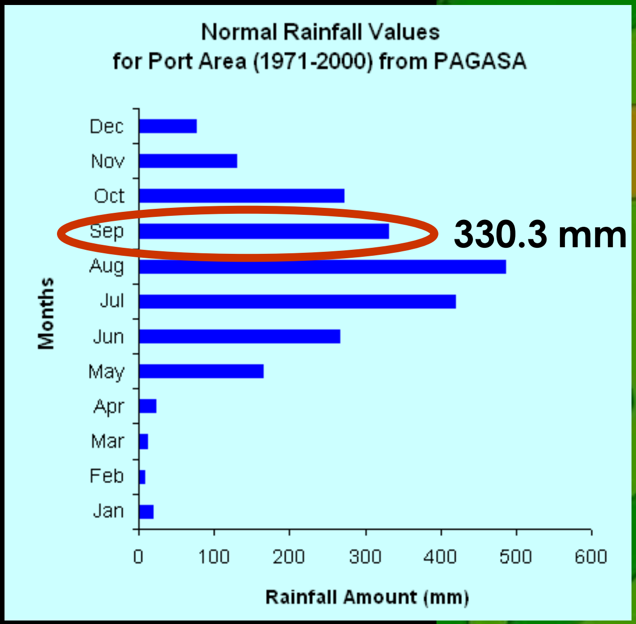
6. VULNERABILITY

a. REGIONAL CONTEXT
   - ECOSYSTEM
   - POLITICO-ECOLOGIC ZONE
   - SOCIO-ECONOMIC DRIVERS
b. SOCIO-CULTURAL DIMENSIONS
c. NATURE, STRUCTURE, SCALE
d. MULTI-TEMPORAL DIMENSION
e. ASSOCIATION WITH EXPOSURE UNITS
f. POSITION EWS ACCORDING TO THE STRUCTURE OF VULNERABILITY

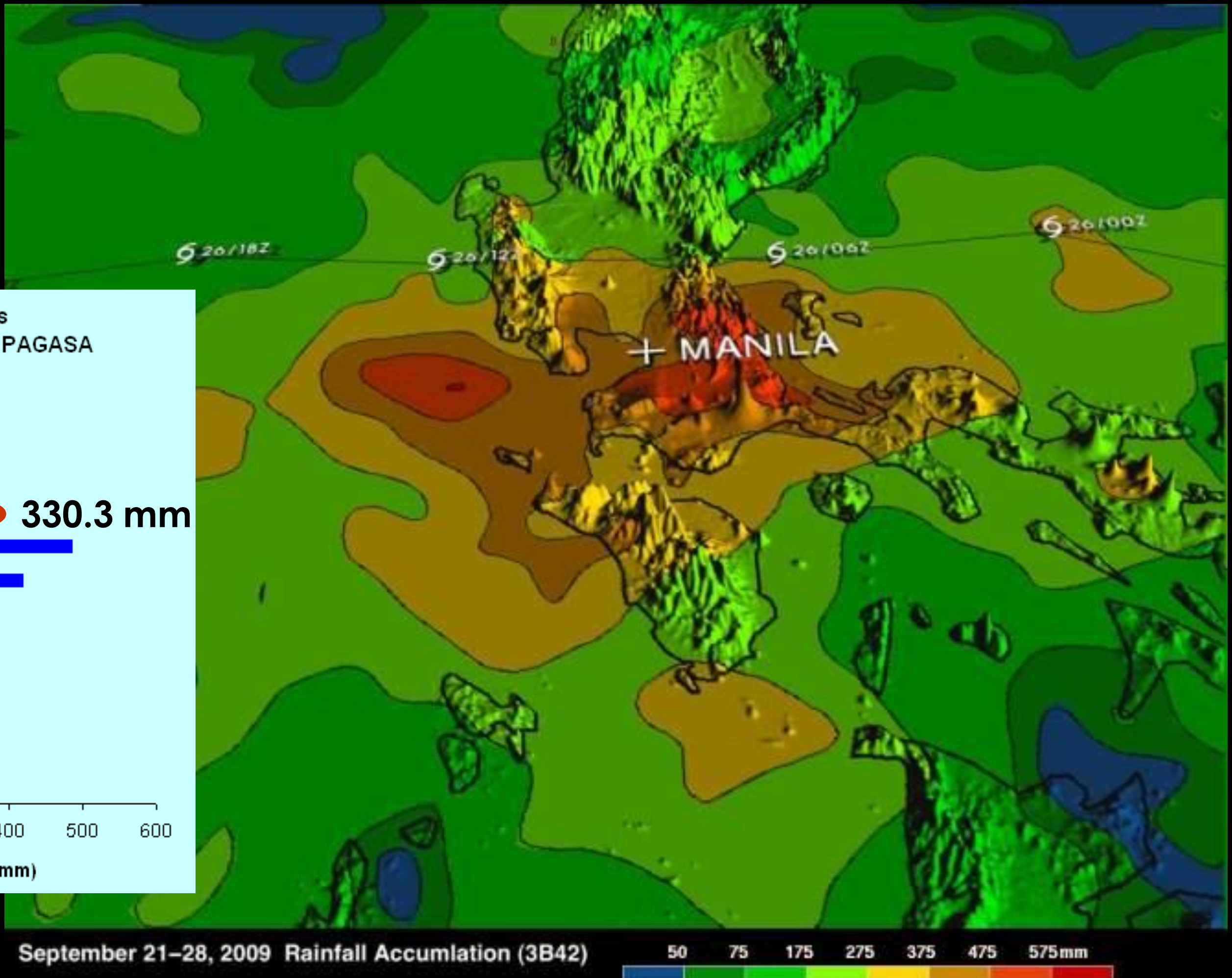
7. APPROACH

a. MULTIDISCIPLINARY SCIENTIFIC COLLABORATION
b. BUILDING COMMUNITIES OF PRACTICE
c. “ENGINEERING RESILIENCE: CONFRONTING RISKS BEYOND ADAPTATION” VIS-À-VIS THE SOCIO-INSTITUTIONAL RESILIENCE AND CAPACITIES AT DIFFERENT LEVELS
d. INFORMATION ARCHITECTURE AND INFRASTRUCTURE FOR INTEGRATED RISK ANALYSIS
e. RISK AND VULNERABILITY COMMUNICATION AND EDUCATION (INTEGRATION IN CURRICULA)

Rain Accumulated in Southern and Central Luzon (21-28 Sep 2009)



http://www.nscb.gov.ph/headlines/StatsSpeak/2009/030909_rav_climatechange.asp



http://trmm.gsfc.nasa.gov/trmm_rain/Events/manila_rainfall_perspective_21-28sep09.jpg

- Accumulated rainfall over a week measured by TRMM was over **500 mm** in Metro Manila. This value is higher than the monthly normal.

Flood Prone Areas in Metro-Manila

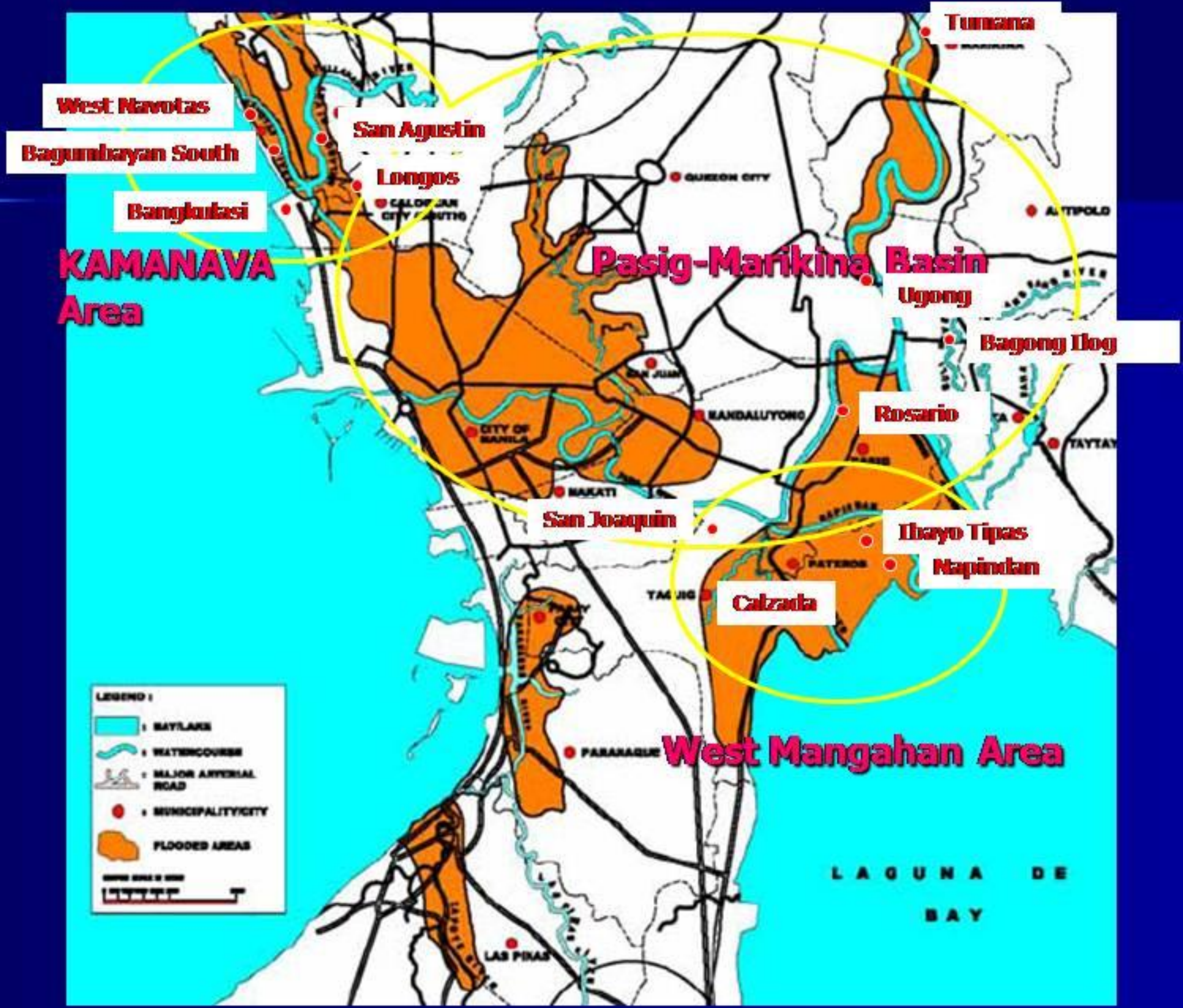
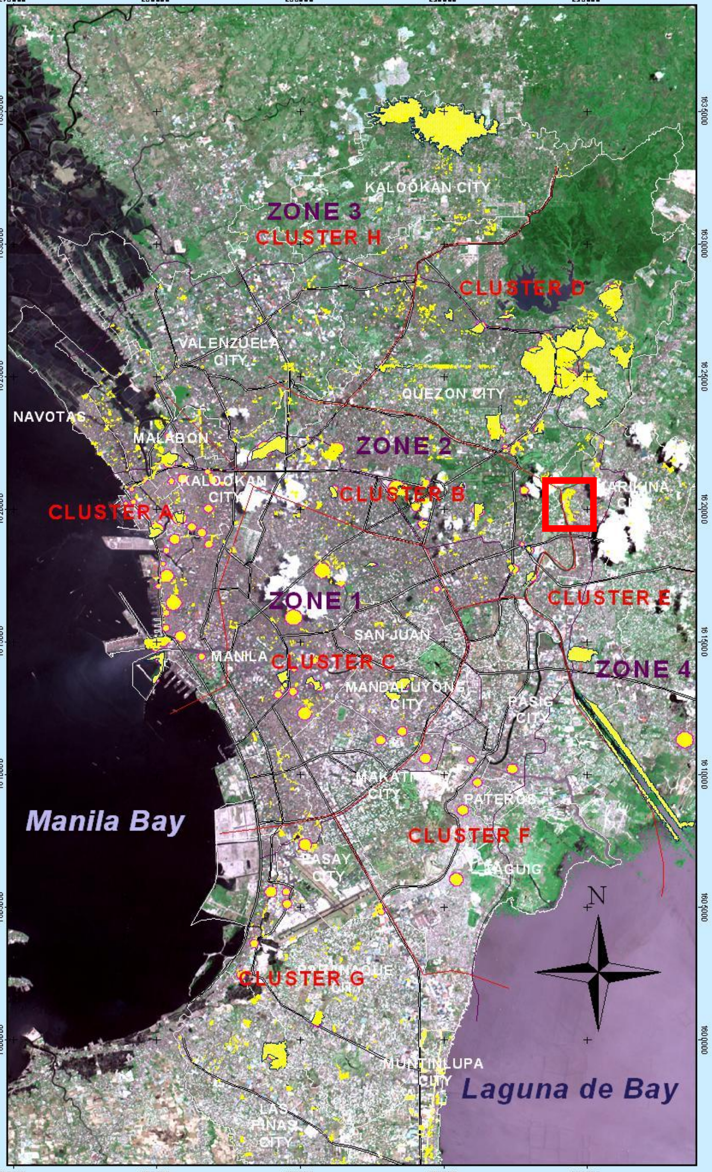


Plate 8

The Urban Poverty Morphology Project Phase III

Aggregate Map of Informal Settlers in Metro Manila (2000)



LEGEND

- Large Slum Areas detected from SPOT 2000
- Building Footprints of Slum Areas
- Muntinlupa Slums
- Spot Locations of Slum Areas from SPOT 2000
- Major Roads
- Slum Cluster
- Zones of Urbanization
  1 Urban Core
  2 Intermediate Zone
  3 Urban Fringe
  4 Hills

SCALE

1 0 1 2 3 4 5 Km.

1:80000

PROJECTION

Universal Transverse Mercator
Zone 51 Luzon Datum

REMARKS:

SPOT XS Image processed using Natural Color algorithm:

R = Red Band
G = ((Green Band) * 3 + NIR Band) / 4
B = Green Band

SOURCES:

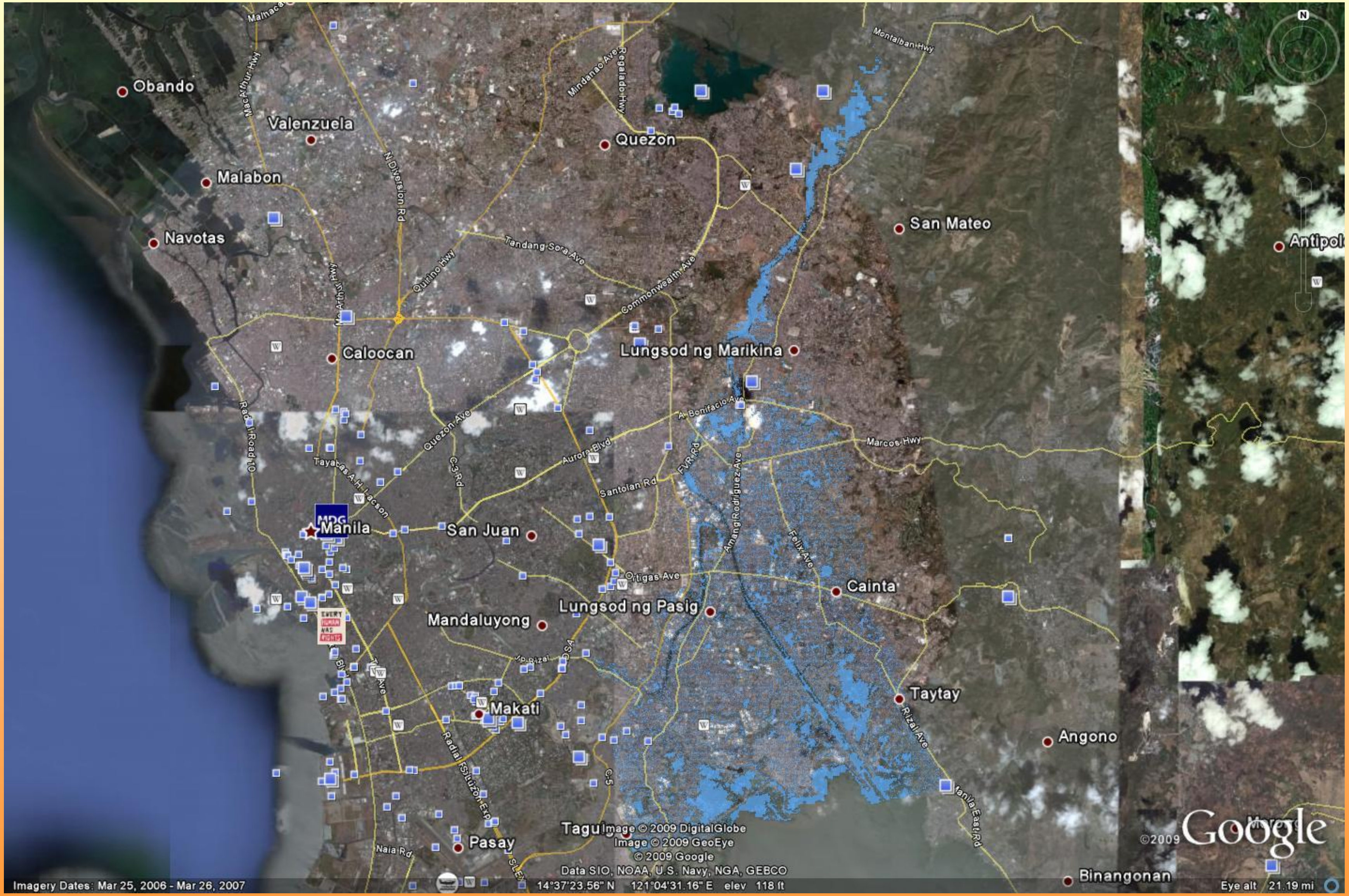
SPOT XS 2000 (© CNES) of Metro-Manila, Image courtesy of University of the Philippines Training Center for Applied Geodesy and Photogrammetry (UP-TCAGP)

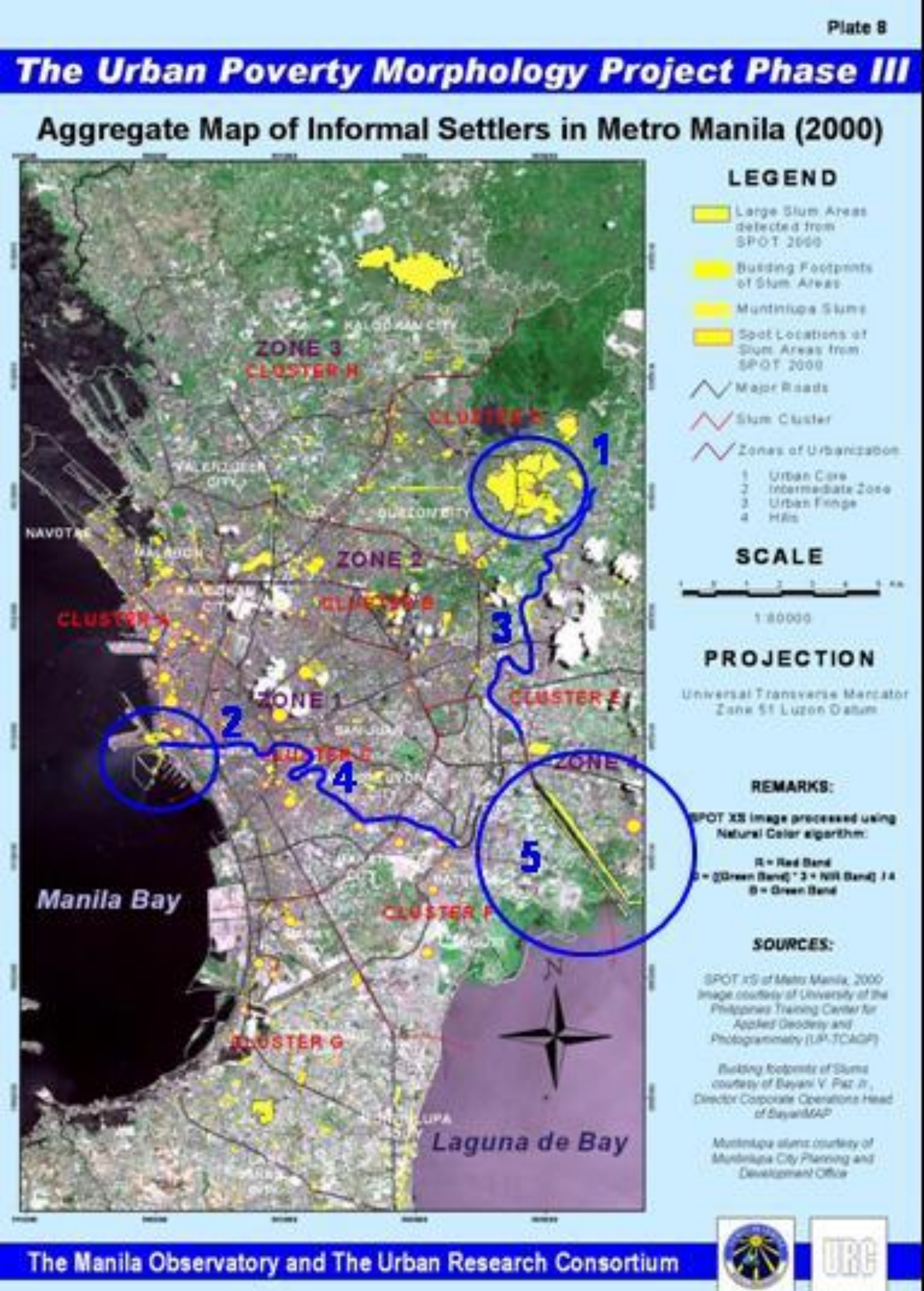
Building footprints of slums courtesy of Arch. Bayani V. Paz Jr., Former Director-Corporate Operations Head of BayanMAP; CEO, BVP Digital Quest

Muntinlupa slums courtesy of Muntinlupa City Planning and Development Office

The Manila Observatory and The Urban Research Consortium

Flood Map of Eastern Metro-Manila and Rizal





Estimated number of Informal Settlers

1 – Batasan: Batasan Hills, Const. Hills, Commonwealth, Holy Spirit, Payatas, Bagong Silangan in Quezon City: 2,891,987

2 - Port Area: Brgy 19-20 of Tondo, Brngy 275 of San Nicolas, Brgy 649 of Port Area: 309,355

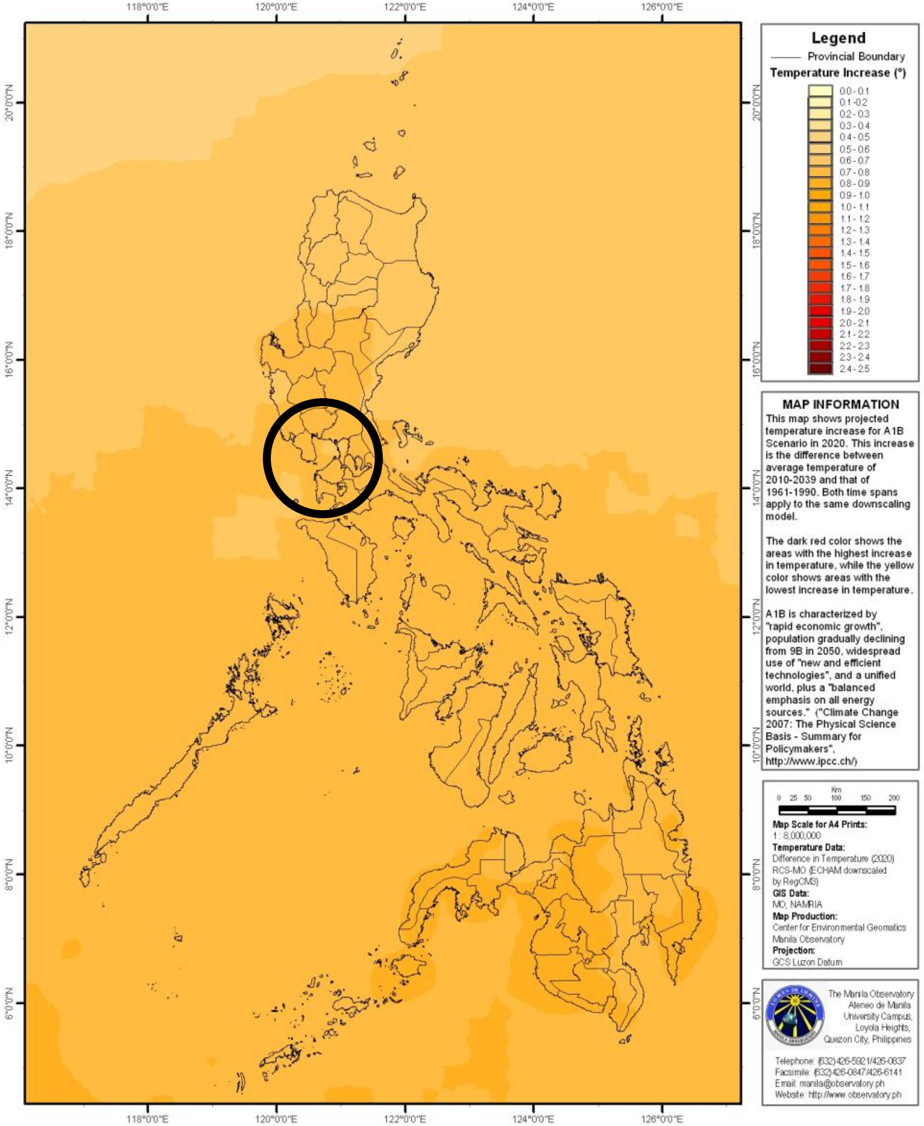
3 - Marikina River: Barangka, Industrial Valley of Marikina, Bagong Silangan of Quezon City: 299,286

4 - Pasig River: Brgy 900, 902-905 of Sta. Ana: 77,636

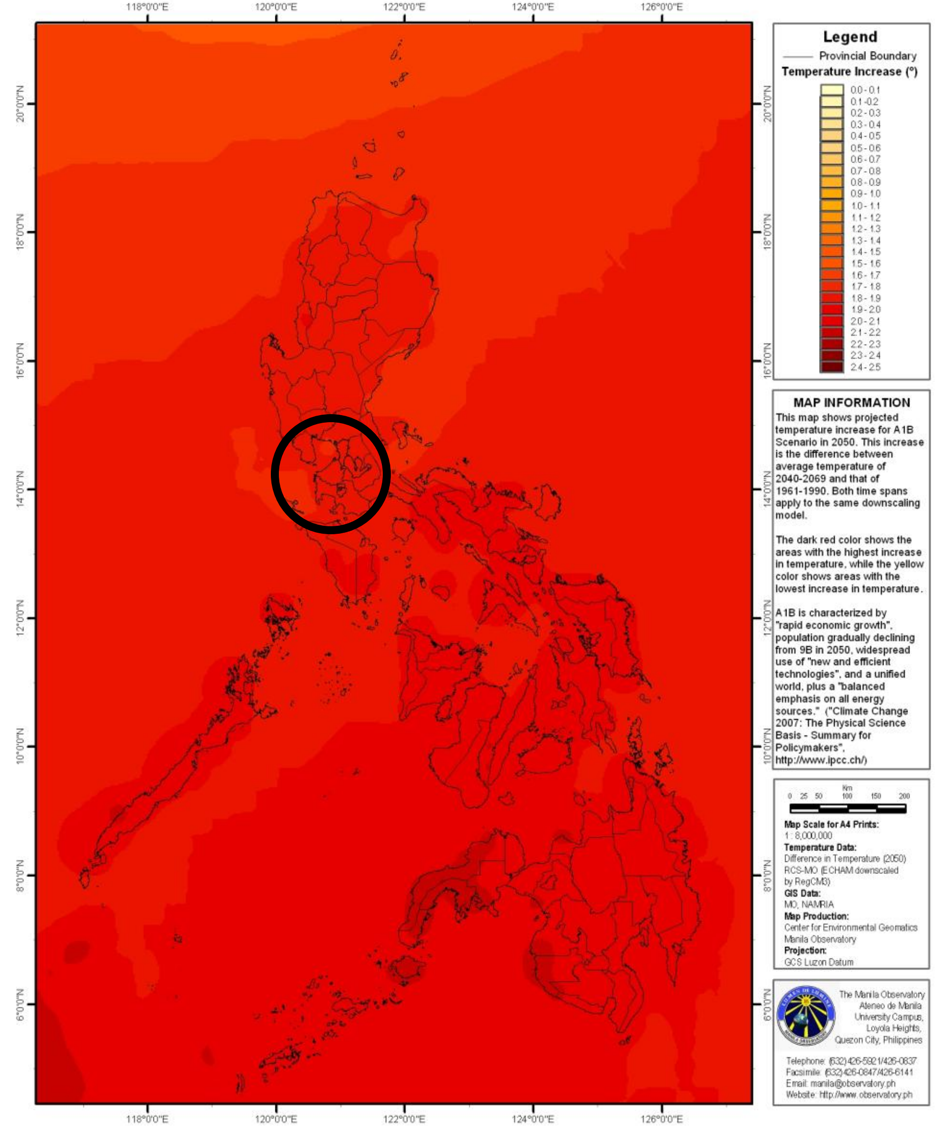
5 - Manggahan Floodway: 1,153,726

TOTAL: 4,731,989

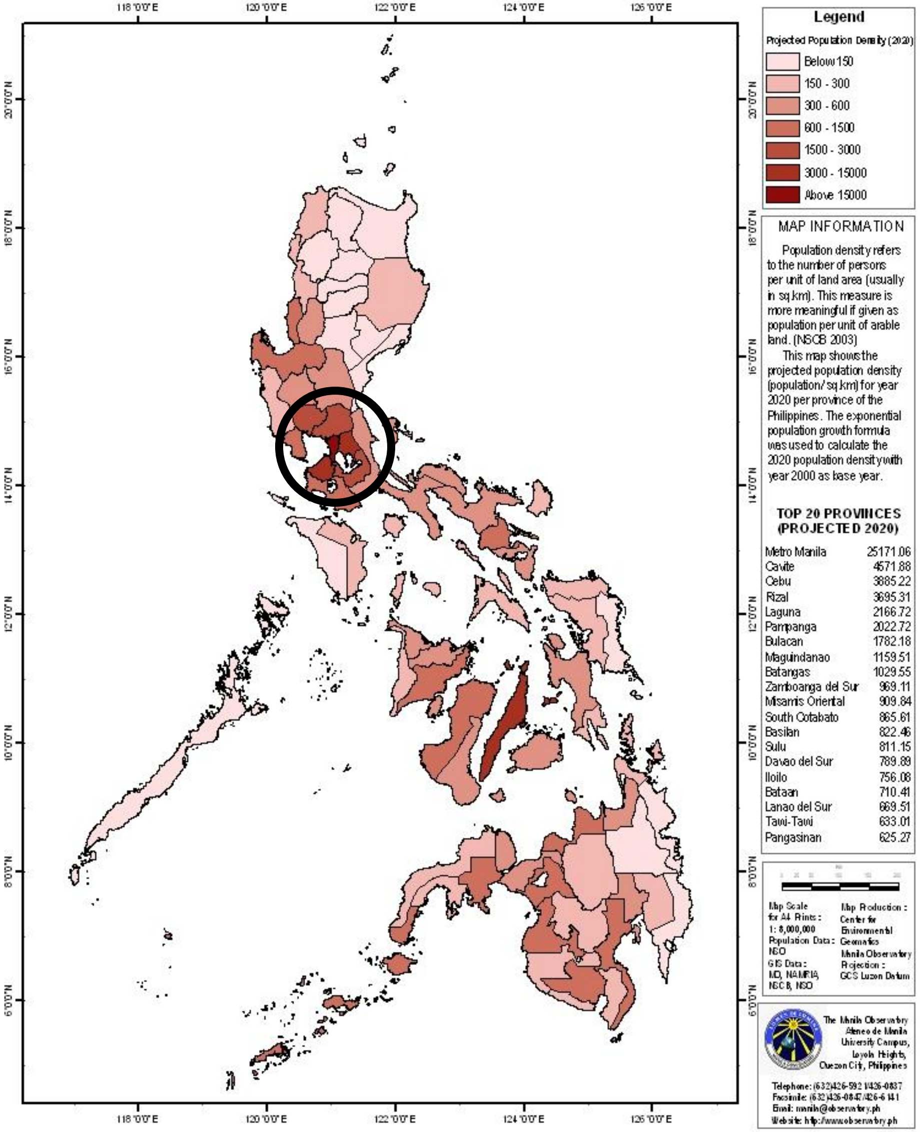
Projected Temperature Increase (SRES Scenario A1B Year 2020)



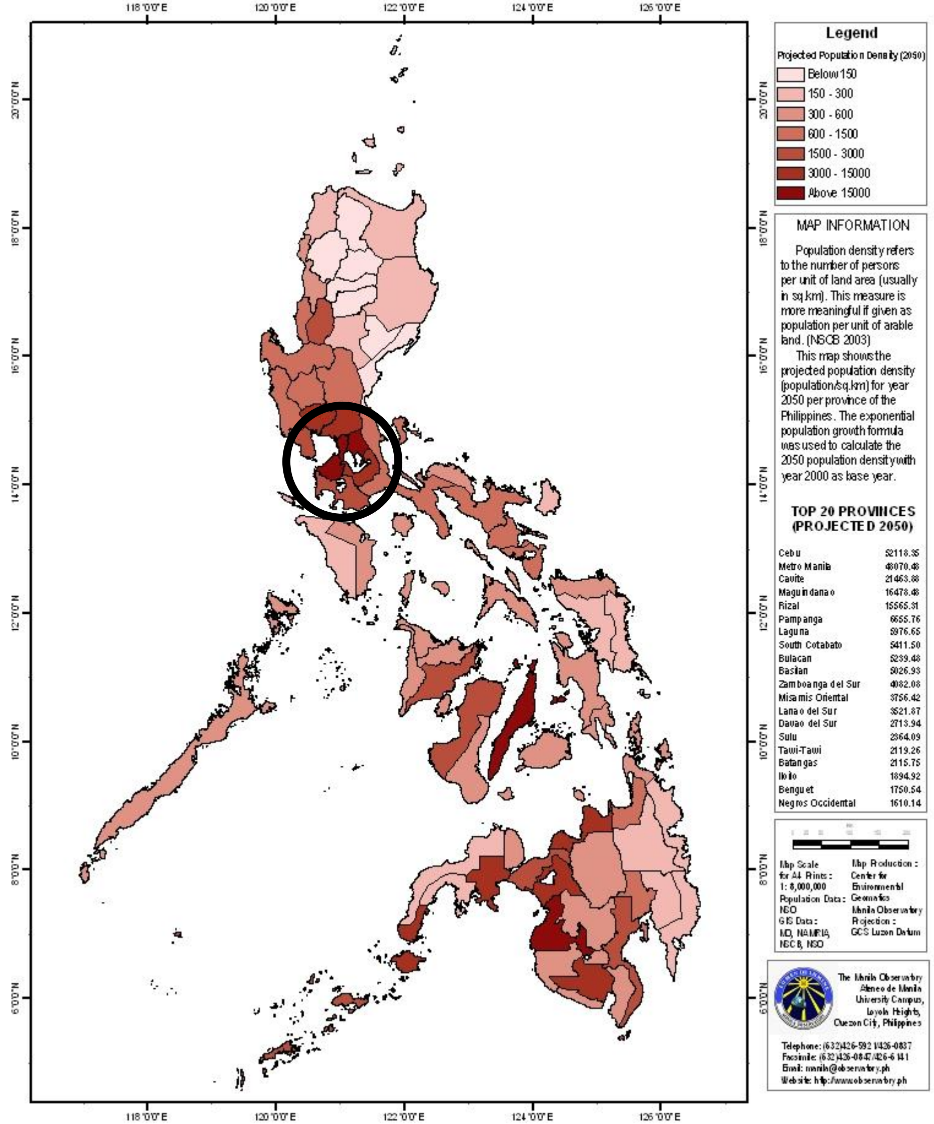
Projected Temperature Increase (SRES Scenario A1B Year 2050)



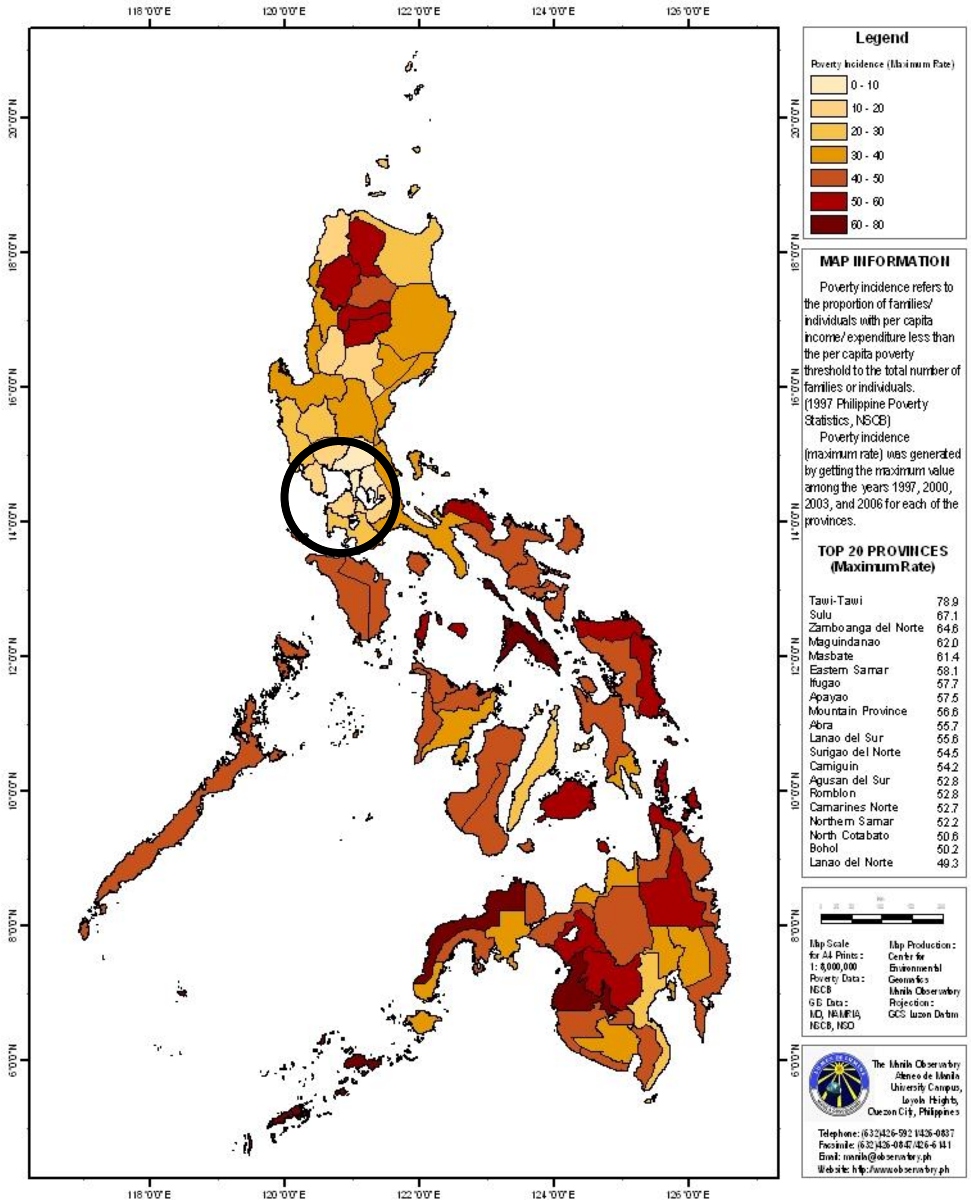
Projected Population Density (2020)



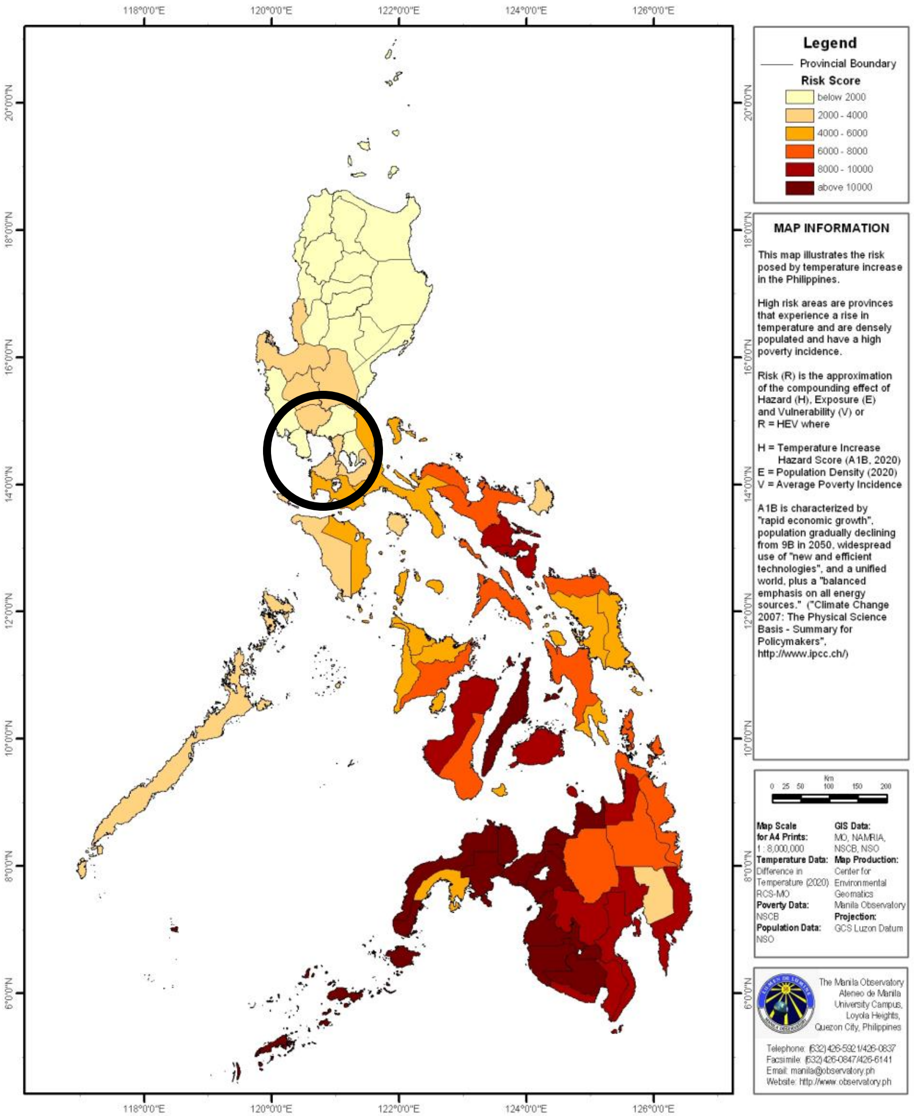
Projected Population Density (2050)



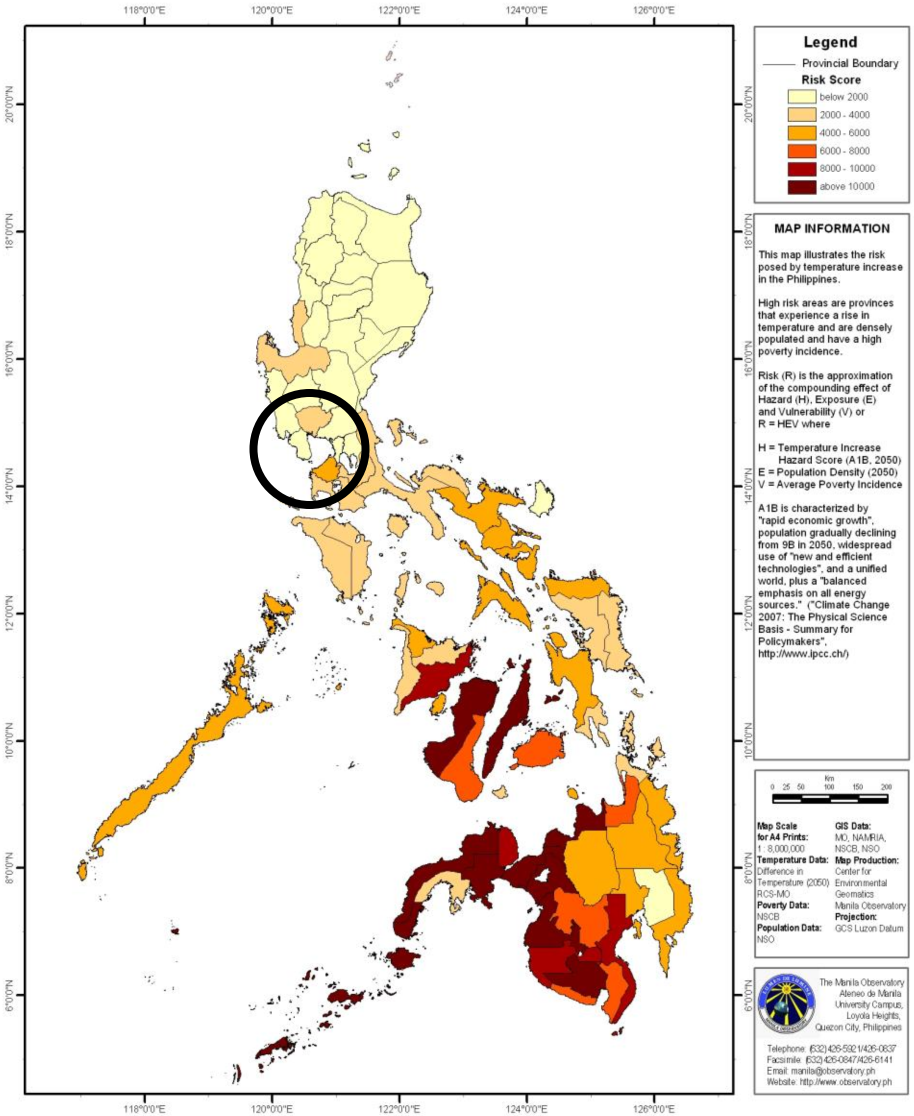
Philippine Poverty Incidence (Maximum Rate)



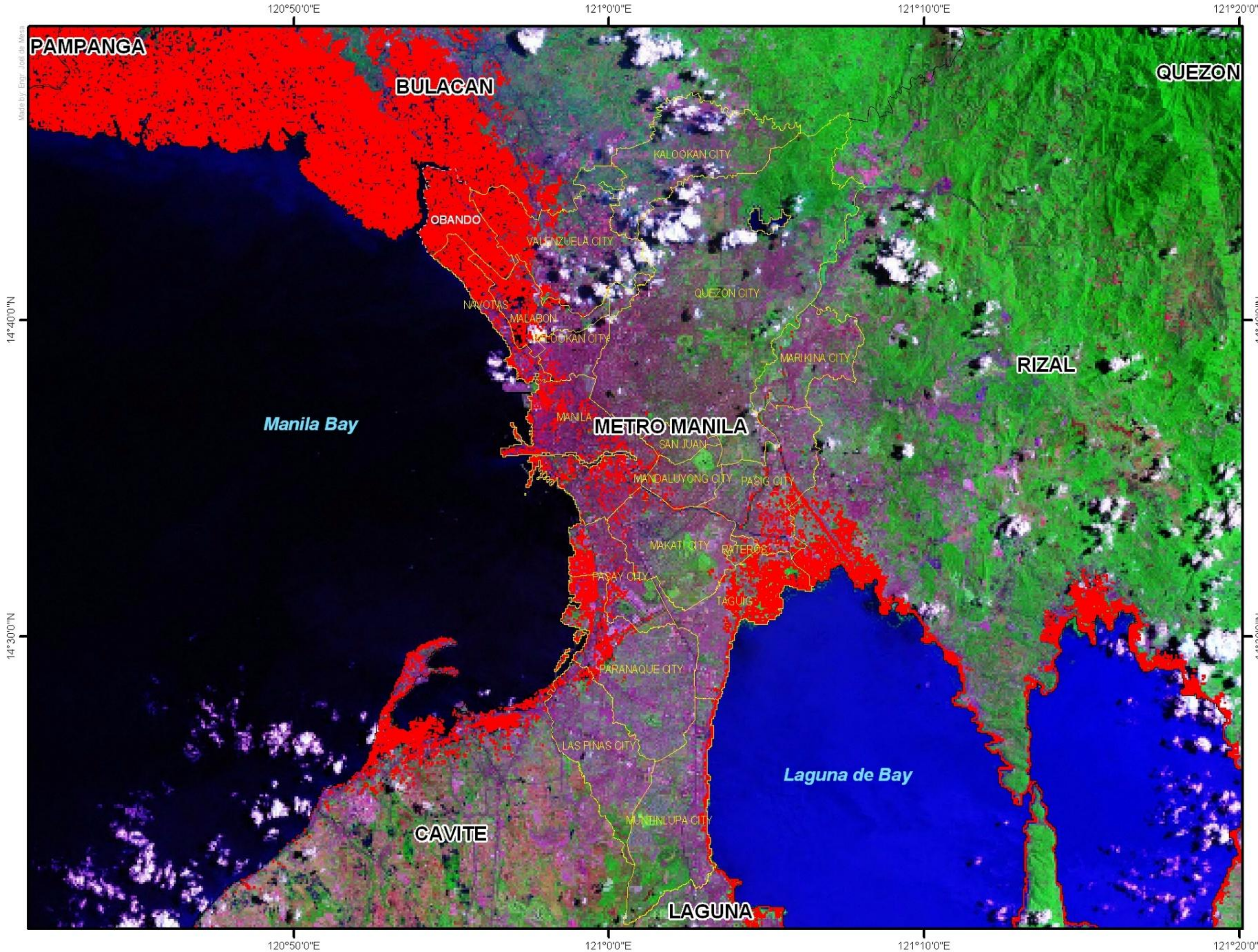
Temperature Increase Risk Map (SRES Scenario A1B Year 2020)



Temperature Increase Risk Map (SRES Scenario A1B Year 2050)



Areas Vulnerable to 1 Meter Sea Level Rise at Metro Manila, Philippines



LEGEND

- Provincial Boundary
- Municipal Boundary
- Areas Vulnerable to 1 Meter Sea Level Rise

MAP INFORMATION

This map shows the areas vulnerable to 1 meter sea level rise at Metro Manila, Philippines. Vulnerable areas are shown in red.

A 1 meter sea level rise will affect 57.96 square kilometers of Metro Manila's land area (approximately 9.73% of its total land area) while a 2 meter sea level rise will affect 85.98 square kilometers of Metro Manila's land area (approximately 14.43% of its total land area).

The top 10 municipalites prone (those with low lying coastal areas) to a 1 meter sea level rise are shown below with corresponding area in square kilometers:

1. Navotas (6.89)
2. Paranaque City (5.69)
3. Valenzuela City (9.01)
4. Manila (7.95)
5. Malabon (6.47)
6. Taguig (10.10)
7. Pasay City (3.24)
8. Pasig City (3.00)
9. Las Pinas City (0.88)
10. Makati City (1.19)

The base map was generated by using Landsat ETM+ image of Metro Manila, Philippines.

Km
0 1 2 4 6 8

Map Scale for A4 Prints:
1 : 300,000
Data Source:
SRTM version 4 (February 2000)
Landsat ETM+ Mosaics (1999-2003)
CGIAR-CSI, NASA, USGS
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GCS WGS84 Datum

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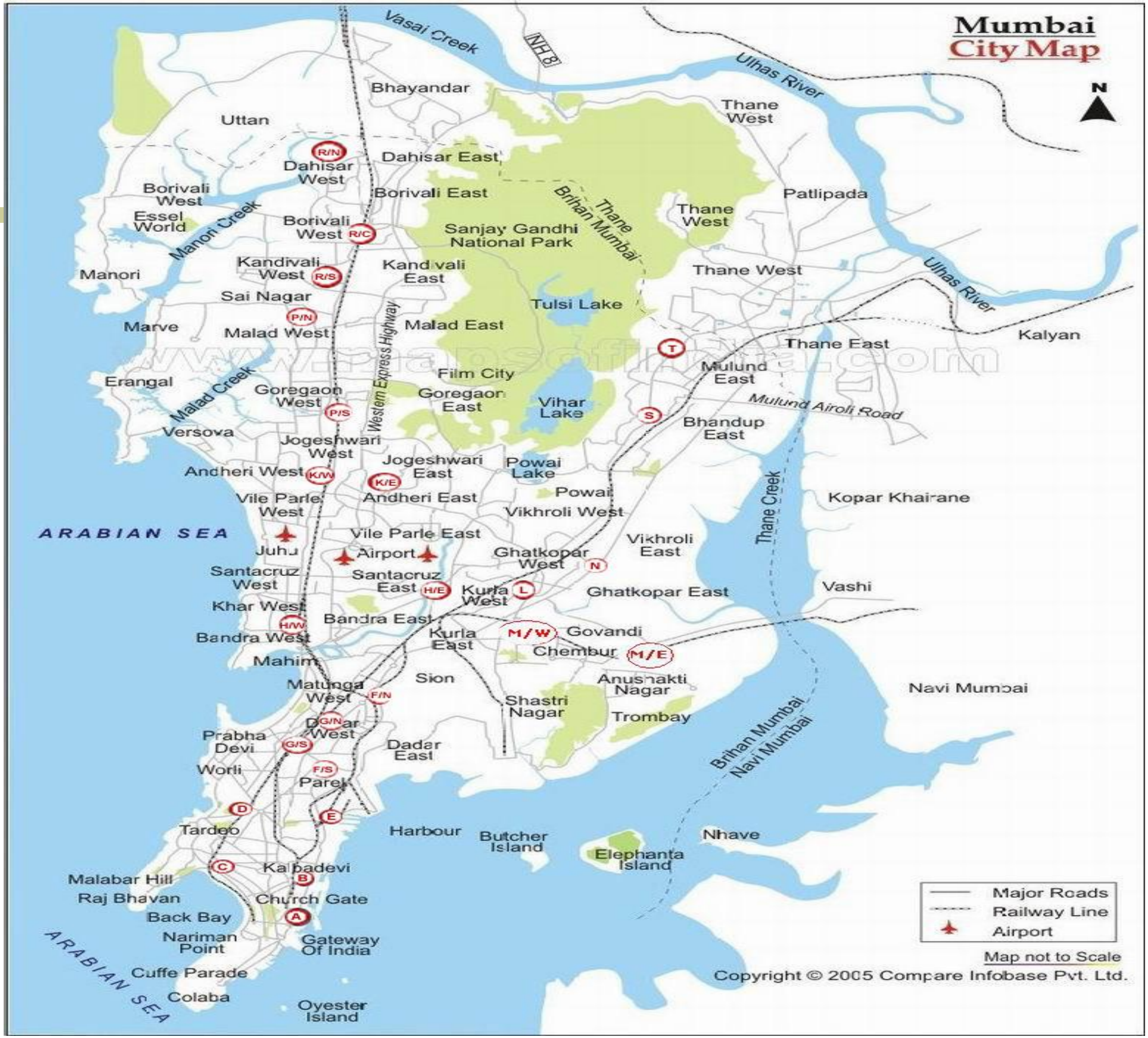
Climate risks, vulnerability and adaptation for Mumbai: The way forward

Outline

- Important city features
- Taking stock of vulnerabilities
- Current efforts
- Way forward
- Potential research network
- APN funded research activity


Mumbai
City Map
N
Vasai Creek
NH 8
Ulhas River
Bhayandar
Uttan
Thane West
Dahisar East
Dahisar West
Borivali West
Borivali East
Essel World
Manori Creek
Patlipada
Thane Brihan Mumbai
Sanjay Gandhi National Park
Kandivali West
Kandivali East
Manori
Thane West
Sai Nagar
Tulsi Lake
Marve
Malad West
Malad East
Western Express Highway
Thane East
Kalyan
Mulund East
Film City
Erangal
Malad Creek
Goregaon West
Goregaon East
Vihar Lake
Mulund Airoli Road
Bhandup East
Versova
Jogeshwari West
Jogeshwari East
Powai Lake
Andheri West
Powai
Vile Parle West
Andheri East
Kopar Khairane
Thane Creek
Vikhroli West
ARABIAN SEA
Vile Parle East
Vikhroli East
Juhu
Airport
Ghatkopar West
Santacruz West
Santacruz East
Kurla West
Ghatkopar East
Vashi
Khar West
Bandra East
Bandra West
Kurla East
Govandi
Chembur
Mahim
Sion
Anushakti Nagar
Navi Mumbai
Matunga West
Shastri Nagar
Trombay
Dadar West
Prabha Devi
Dadar East
Brihan Mumbai Navi Mumbai
Worli
Parel
Tardeo
Harbour
Butcher Island
Nhave
Elephanta Island
Kalbadevi
Malabar Hill
Raj Bhavan
Church Gate
Back Bay
Nariman Point
Gateway Of India
ARABIAN SEA
Cuffe Parade
Colaba
Oyester Island
Major Roads
Railway Line
Airport
Map not to Scale
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Important features

- 4^{th} largest mega-city in the world supporting more than 14 million
- Financial capital with a large commercial and trading base
- Strategic sea port on the western coast
- Host to industries, commercial complexes and residential areas
- Per capita income of INR 69, 696 (thrice of national PCI)
- Important source of tax revenue for the country with 35% contribution to total central taxes
- 4.4 million people employed in secondary & tertiary sector

Contd…

- 2 revenue districts – Mumbai city district & Mumbai suburban district
- Municipal Corporation of Greater Mumbai (MCGM) – primary agency responsible for governance of GMR
- City divided into 24 administrative zones known as wards
- Mumbai Metropolitan Region (MMR) comprising GMR and surrounding areas of Thane, Raigad and Navi Mumbai districts
- MMRDA as the planning & coordination agency for MMR
- Surrounding areas of MMR significant for Mumbai city from the economy and transportation perspective

Taking stock of vulnerabilities

- Physical vulnerabilities
  - Surrounded by water on 3 sides enhances
  - Prone to floods, cyclones, storm surges and sea-level rises
  - Reclaimed landmass
  - 10-12 meters above sea level
  - Development along low-lying & flood-prone zones
  - Tropical savanna climate with 2100 mm rainfall during 4 months
  - Moderate damage risk zone (seismic zone III), but 60% constructions are non-engineered
  - Squatter settlements and slums located in low-lying areas, along coast, bottom of hill
  - Extremely congested roads and railway network choked with ever-increasing vehicles and unidirectional movement in the city

Contd…

- Economic vulnerability
  - 13.4 million people residing in the city with population density of 30,803 per sq. km.
  - City attracting migrations due to better opportunities in commercial and trading sectors
  - Extremely difficult to find proper housing for low-income groups due to high property prices and space crunch
  - 4.4 million people employed in secondary & tertiary sector
  - First city corporation to allow industrial zones to be used for residential and commercial purposes
  - Changing land-use pattern during the last decade with industrial units giving way to huge commercial and residential complexes

Contd…

- Social vulnerability
  - 56% population living in slums with inadequate civic amenities and infrastructure
  - Slums non-existent on development plans with risk of regular displacements and movement towards low-lying areas and dumping zones
  - Overall life expectancy lower at 52.6 years and 58.1 years for males & females respectively
  - Inadequate public health facilities coupled with negligible coverage of health insurance

Note the convergence and interconnectivity among three vulnerabilities

Why are we concerned?

Climate vulnerability for Mumbai translates into a *huge threat* for the life and property with impact on the entire *development trajectory* of the city and economic losses to the country

Current efforts if any….

- Greater Mumbai Disaster Management Action Plan (DMAP) prepared by Govt. of Maharashtra in 2007
- Action plan identifies risks and vulnerabilities from floods, cyclones, earthquakes, etc.
- Action Plan
  - Infrastructure improvements – rail and road network, sanitation and storm water drainage systems, slum improvements, housing improvements programmes
  - Contingency plan – extra transportation in case of system failure, transit camps, wireless communication and public information system, NGO assistance
  - Land use policies and planning – Regional Plan for MMR region – protection of landfill sites, control on land reclamation, shifting hazardous units out of residential areas
- Comprehensive plan on paper but no specific strategies neither the timeframe for achieving them

What is the way forward?

- Recognizing that vulnerability reduction and adaptation are important in policy formulation at all levels
- Interdisciplinary approach to create an information and knowledge base to identify, develop and implement effective responses
- Identify the available adaptation options, climatic conditions under which they will work, anticipated benefits, resource requirements and requisite institutional structures and processes
- More fundamental research on themes for which no or very little knowledge base exists
- Mainstreaming disaster management and adaptation into long term development planning

Future agenda

- Information
- Assessment
- Knowledge

Information

Risk identification	■**Moving from broad and generic projections about future risks to the identification of specific risks** ■**Identifying exposure, sensitivity and capacity to cope for people and institutions** ■**Understanding interaction of climate change with other stresses to assess amplification or diminution of risks** ■**Risks at different spatial and temporal scales**
Vulnerability characterization	■**Specific risks to city infrastructure, civic amenities, economy and society and risk magnitudes** ■**Vulnerability of marginalized population, informal sectors** ■**Mapping current as well as future physical, economic, social and cultural vulnerability**

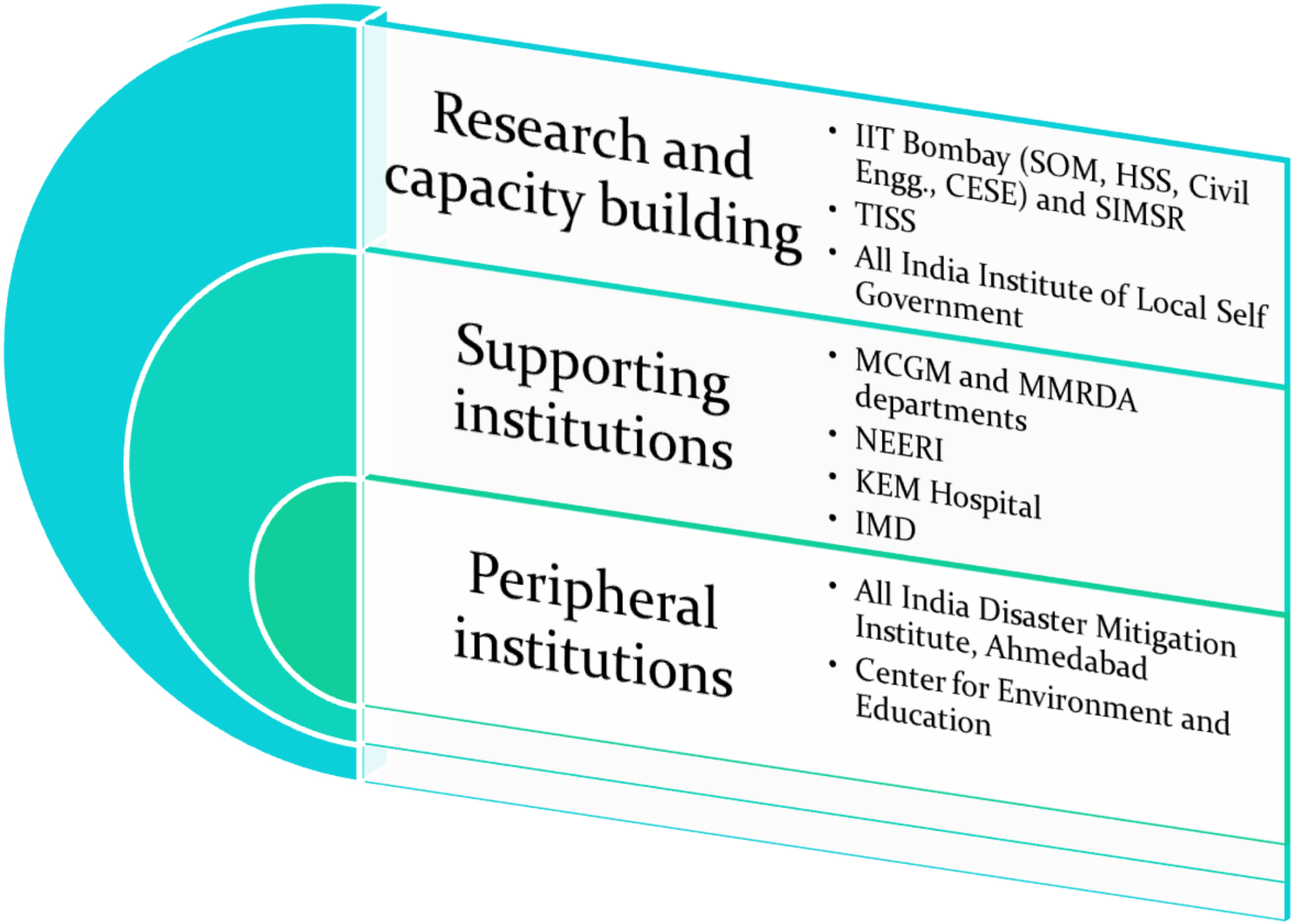
Assessment

Adaptation measures	**Identifying specific adaptation measures taking into account current and future technological, socio-economic, political and institutional conditions** **Identification, planning and implementation of adaptation responses considering the past experience of responses to climate risks**
Integrating adaptation into mainstream planning	**Identifying contexts such as disaster management or infrastructure development activities for mainstreaming adaptation into current planning and policies** **Carrying out policy oriented studies to understand where such integration is possible**
Institutional mechanism	**Mapping of current institutional capabilities and future requirements** **Identifying and defining specific roles of public and private stakeholders in adaptation** **Capacity building in institutions**

Knowledge

Health impacts studies	**▪Establishing the link between climate variability and health impacts** **▪Assessing the vulnerability of the city to water-borne and vector-borne diseases** **▪Sensitizing city stakeholders including health professionals, public health administrators, municipal officials and citizens' groups to health risks of climate change**
Geo-climatic studies	**▪Understanding the intra-seasonal variability in monsoon** **▪Studying the subsidence and stability of reclaimed land**

Research network for Mumbai



APN funded research activity

- “Enhancing adaptation to climate change by integrating climate risk into long-term development plans and disaster management”
- Disaster risk reduction and disaster management as an important context for integrating or mainstreaming adaptation into decision-making for the cities at risk
- A comparative analysis of the immediate to medium-term post-disaster recovery scenario in the aftermath of extreme weather events of flooding faced by three vulnerable Asian cities – Mumbai, Dhaka and Bangkok
- Examining the impacts on the magnitude and direction of the development trajectory of the cities

Proposed activities

- Jointly developing and applying a methodology for comparative analysis of immediate to medium-term physical, economic, environmental and social outcomes resulting from particular weather events (urban flooding).
- Examining the trends in impact indicators to identify the effects on the local development trajectory and characterizing vulnerability.
- Characterizing the response measures undertaken in terms of metrics such as cost, distributive effects, environmental & economic efficiency and their linkages with short and long-term development plans for the city including issues such as land-use planning.
- Identifying opportunities and the possible means for incorporating climate risk into specific local and regional decisions,
- Stakeholder workshops to initiate the process of integrating post-event recovery strategy with investment and development plans for long term reduction in vulnerability and enhancement of adaptive capacity

Desired outcome

- A tried and tested methodology for better characterization of post-event impacts.
- Further inputs for the estimation of costs of adaptation
- Identification of policy implications for long-term disaster management, city resilience and adaptation strategies
- Providing inputs in integrating them with long-term investment and development plans
- Deliberations from the stakeholder workshops would help in creating a mechanism for integrating post event recovery strategy with long-term development plans leading to reduction in vulnerability and enhancement of adaptive capacity of the cities at risk.

Relevance

- Better understanding of the process of responding to climate-related hazards, including aspects such as relief and recovery while planning and implementing adaptation interventions
- Project relevant to the climate agenda of the APN, to contribute to improving the understanding of vulnerability and the actual design and implementation of adaptation interventions by integrating climate risk considerations into decision-making at different levels – project, local and national
- To ensure that rapid growth of infrastructure enhances climate resilience and adaptive capacity and is done in a manner sensitive to the possibilities of mal-adaptation
- Findings expected to help inform the broader “Cities at Risk” theme developed by START and the ICSU international science project on Integrated Research in Disaster Risk (IRDR)

Thank you

Towards Disaster Resilience Index: A Case Study of Mumbai

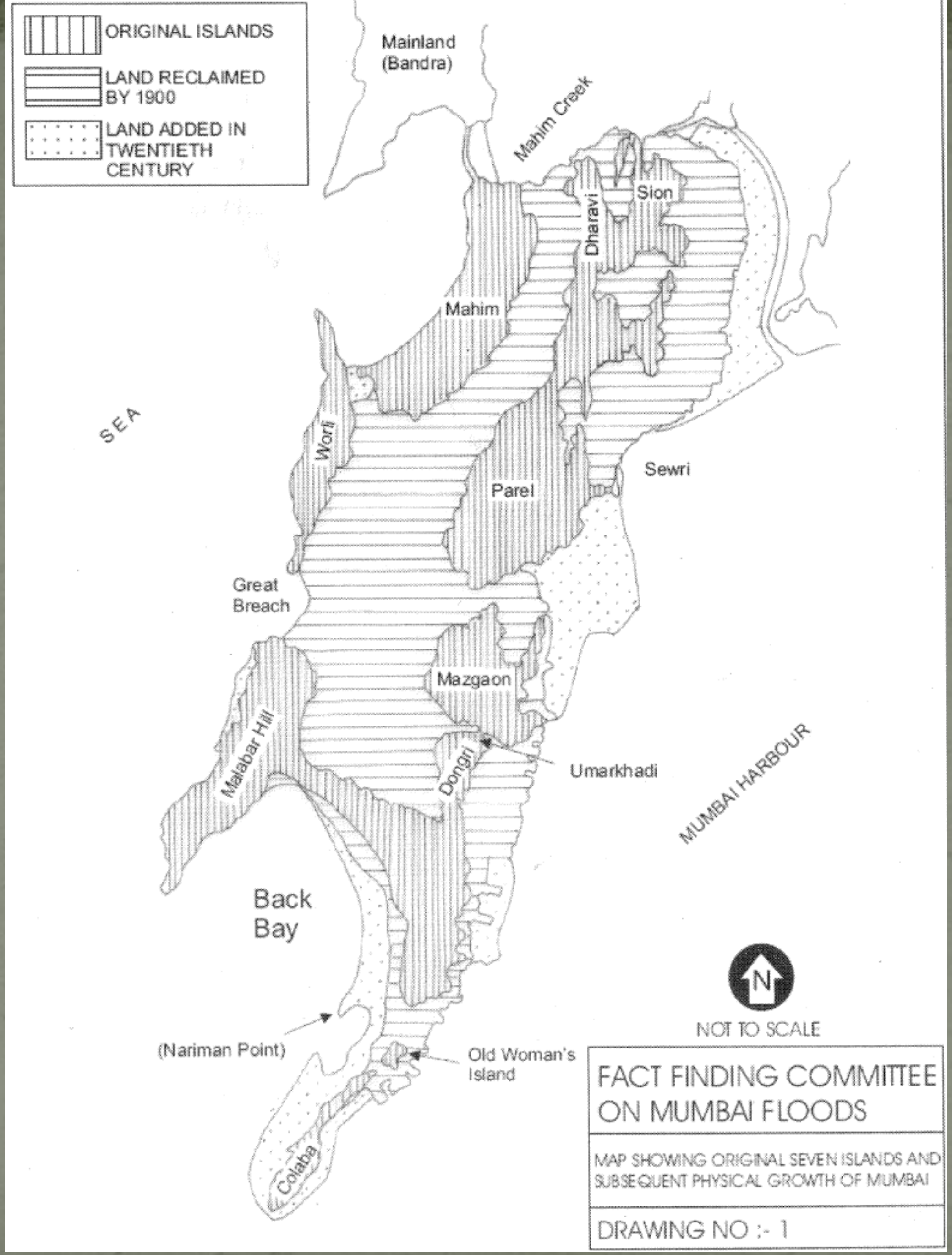
Date: 26/08/2010

Climate Change

- Multifaceted (drought to flood)
- Multidimensional (local to global)
- Short-, medium- and long-term effects
- Changing frequency & intensity of Hydro-meteorological hazards
- Unfamiliar results

Coastal Mega cities: The Case of Mumbai City

- Attempts to look at urban coastal area in a developing country
- Mumbai: high population density, geographical location and economic activities
- Mumbai most vulnerable to sea level rise (TERI, 1996)
- Topographical vulnerability (low-lying areas, landslide prone areas and coastal areas)



Reference - Gazetteer of India, Maharashtra State, History of Bombay, Modern Period 1987

Vulnerability of Slums

- High population density
- Economic conditions
- Settlements in disaster prone areas
- Forced eviction
- Increasing number of migrants and people working in informal sector

Concepts: Mitigation, Adaptation and Resilience

- ‘Mitigation’ & ‘Adaptation’ approaches represent forms of adjustments
- Mitigation more appropriate for sustainable development but not cost effective for developing countries (IPCC, 2007)
- Adaptation, identified as best strategy to face climate change for developing countries at international level
- “Mitigate we might, adapt we must” (Pielke, 1998)

Concepts Cont…

- ‘Resilience’ has Latin origin: ‘*resiliere*’, means bouncing back, or jump back
- Associated with adaptation and enhancing coping ability of a community
- Emphasize on community’s strengths rather than concentrating on needs in emergency (DFID, 2007)
- Resilience, “the capacity or ability of a community to anticipate, prepare for, respond to, and recover quickly from impacts of disaster” (Mayunga, 2007)

Towards developing Climate Disaster Resilience Index

- Focusing on ‘what is present’ rather than ‘what is missing’
- Quantifying resilience to analyze, compare and understand status of communities
- Simple method of predicting if a community will reach and maintain an acceptable level of functioning and structure after a disaster
- Help local planners, engineers and administrators to enable with the information regarding existing resources and vulnerabilities of a community

Objectives

- Overall Aim: Building greater resilience amongst communities esp. urban informal settlements where disaster impacts are likely to be severe

- To identify indicators determining Climate Disaster Resilience of communities in urban areas
- To develop Climate Disaster Resilience Index for urban communities
- To measure Resilience of urban slums using CDRI

Dimensions of Resilience

Dimensions

- 1. Physical capital
  - 1.1 Electricity
  - 1.2 Water supply
  - 1.3 Sanitation
  - 1.4 Solid Waste Disposal
  - 1.5 Internal road network
  - 1.6 Accessibility to roads
  - 1.7 Housing
  - 1.8 Land tenure status
  - 1.9 Disaster warning & evacuation
- 2. Economic capital
  - 2.1 Income
  - 2.2 Employment
  - 2.3 Debt
- 3. Human capital
  - 3.1 Year of Schooling
  - 3.2 Health status
  - 3.3 Community assets
  - 3.4 Infrastructure
- 4. Social capital
  - 4.1 Knowledge & awareness
  - 4.2 Social conflict
  - 4.3 Community involvement
- 5. Institutional capital
  - 5.1 Internal
  - 5.2 External

Selection of the sample

- A ward in which 40% or more of the population lives in slums.
- The slums must be spread across topographically vulnerable places such as coastal areas, low-lying areas and or landslide prone areas.
- The area must show proximity to specific risks.

Cont…

Wards	Population	% Of Slum population	Selected slums	Specific Risk
H West	336051	40.42%	Khar Danda	Proximity to Sea Coast
S ward	691107	82.73%	Jaibhim Nagar	Hillside slope & High Tension wires
			Gautam Nagar	Hillside slope & High Tension wires
M/E ward	672767	77.63%	Sathe Nagar (upper)	Low-lying area
			Sathe Nagar (lower)	Low-lying area

Sources: Census of India, 2001

Mumbai Disaster Management Plan, 2008

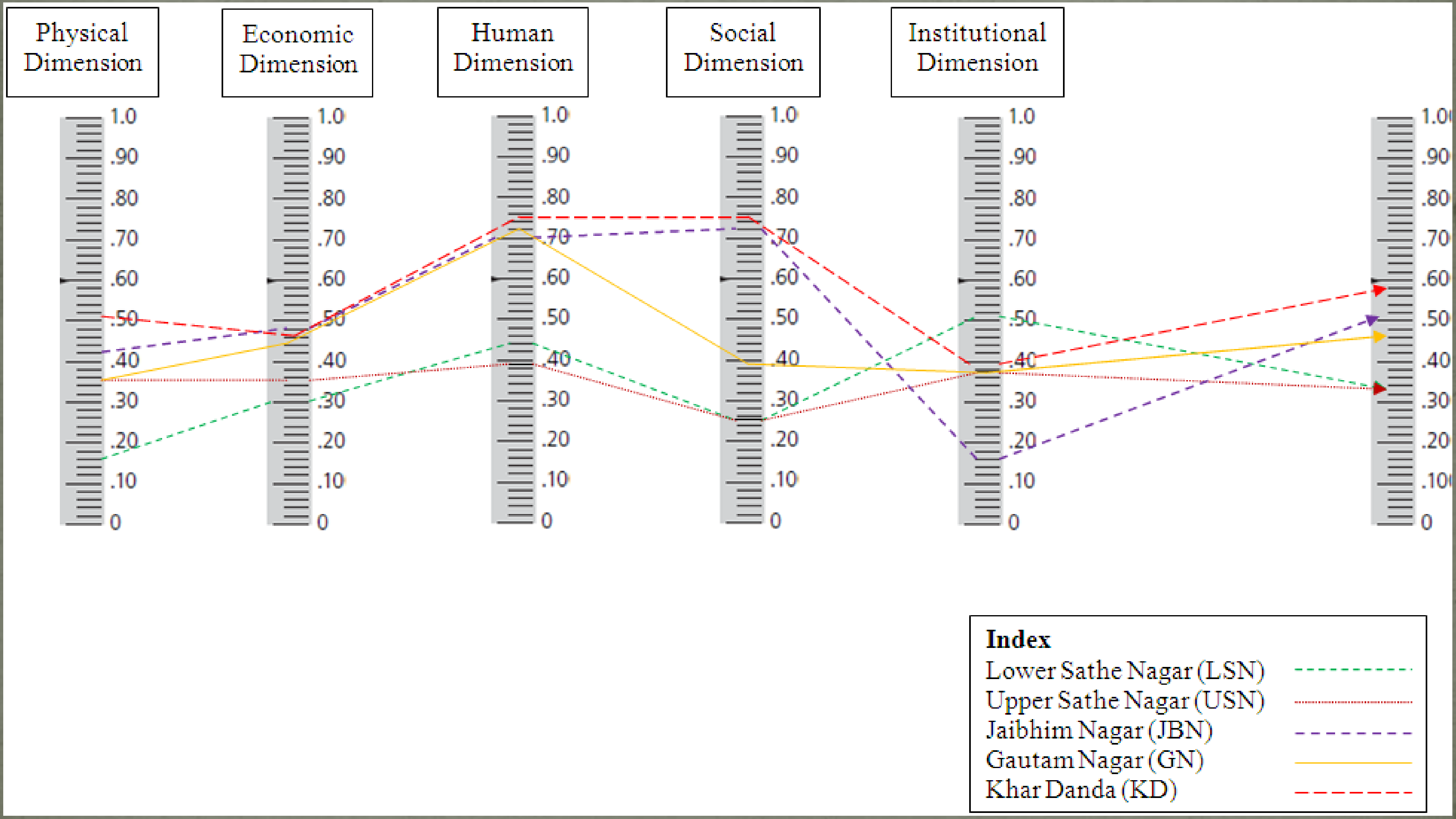
Developing CDRI

- Targeting key informants
- Questionnaire
- Pilot test
- Scoring
- Normalizing scores: $I_j = Max – X_{ij}/Max – Min$
- Disaster Index = $\sum I_j$ / No. of observations
- Disaster Resilience Index = 1 – Disaster Index

Findings of the study

	L Sathe Nagar	U Sathe Nagar	Jaibhimnagar	Gautamnagar	Khardanda
	DI	DI	DI	DI	DI
Physical Dimension	0.84	0.65	0.58	0.64	0.49
Economic Dimension	0.7	0.66	0.52	0.55	0.51
Human Dimension	0.56	0.61	0.3	0.29	0.25
Social Dimension	0.75	0.75	0.28	0.61	0.25
Institutional Dimension	0.49	0.63	0.83	0.63	0.6
Summation	3.34	3.3	2.51	2.72	2.1
Disaster Index (DI)	**0.67**	**0.66**	**0.50**	**0.54**	**0.42**
Disaster Resilience Index (DRI)	**0.33**	**0.34**	**0.50**	**0.46**	**0.58**

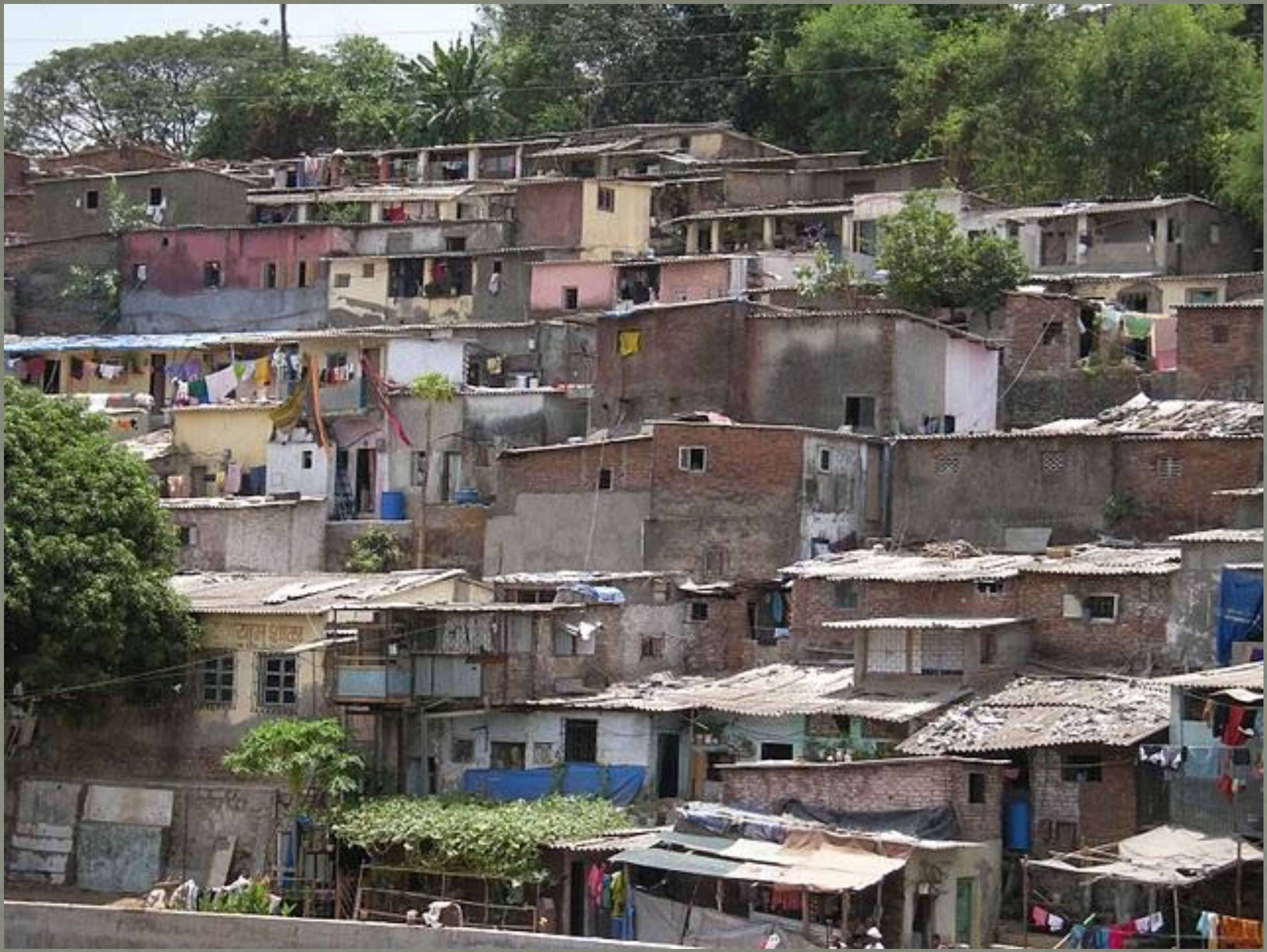
Resilience of the select communities on the scale



Conclusion

- The low Disaster Resilience Index demonstrates the need to address the vulnerability of a settlement
- In case of a disaster, or in case of climate change (floods, rising sea levels, landslides etc.), the damages could be immense to life and property
- The study is a small effort in creating a comparative picture across slums, some of which may be less resilient than others, pointing towards greater need for government's attention


PRADIP



Code Book for CDRI

Necessary Instruction

- Instructions for the researchers for analysis: Answers of the queries of this questionnaire have been assigned codes (i.e. 1, 2, 3, 4 and 99). Some queries contain two answers therefore, code 1 represent less resilient and code 2 represent more resilient. Also many queries are with three or four answers therefore, code 1 represent less resilient, code 2 represent more resilient, code 3 represent most resilient and code 4 represent highest resilient. In addition code 99 is for general information.

Range of Response Scores

Categories	Maximum Score	Minimum Score	Max-Min (Range)
Electricity	9	4	5
Water Supply	10	4	6
Sanitation	16	6	10
Solid waste disposal	15	6	9
Internal Road Network	10	4	6
Accessibility to the road network	7	3	4
Housing	16	6	10
Land tenure status	7	3	4
Disaster warning and evacuation	6	3	3
Income	10	4	6
Employment	4	2	2
Debt	2	1	1
Year of schooling	3	1	2
Health status	6	3	3
Community Assets	3	1	2
Infrastructure	24	9	15
Knowledge and awareness			
Social Conflict	3	1	2
Community Involvement	3	1	2
Internal Institution	6	2	4
External Institution	5	2	3

$$I_j = \frac{Max - X_{ij}}{Max - Min}$$

Where, I = responses and j = variable

Table: Illustration of calculation of Ij for a particular community, for Variable Electricity

Respondents of a particular community	Responses obtained (for Electricity)						Score (Xij)	Ij = Max – Xij/ Max – Min
	1.1	1.2	1.3	1.4	1.5	1.6		
1	1	1	1	2			5	0.80
2	1	1	1	2			5	0.80
3	1	1	1	1	1		5	0.80
4	2	1	1	1	1		6	0.60
5	2	1	1	2			6	0.60
6	2	1	2	1	1		7	0.40
Summation (∑Ij)								**4.00**

Disaster Index = ∑Ij / Items in the sub-scale (n)
Disaster Resilience Index = 1 – Disaster Index

Indicators of Physical Dimension	DI
Electricity	0.67
Water Supply	0.94
Sanitation	0.77
Solid Waste Disposal	0.72
Internal Road Network	0.86
Accessibility to Road Network	1.0
Housing	0.90
Land Tenure Status	0.88
Disaster Warning and Evacuation	0.83

Dimensions	DI
Physical	0.84
Economic	0.70
Human	0.56
Social	0.75
Institutional	0.49