MyWRM Forum 2014: Water for Our Future
9-10 June 2014, Putrajaya

Disasters and Climate Extremes: Developing an Integrated Research Framework for Malaysia

Joy Jacqueline Pereira, FASc.
Southeast Asia Disaster Prevention Research Initiative
Universiti Kebangsaan Malaysia (SEADPRI-UKM)

CONTENTS

- INTRODUCTION
- IPCC FINDINGS ON ASIA
- CHALLENGES IN MALAYSIA
- PROPOSAL FOR A WAY FORWARD

Climate Variability refers to variations in the mean state and other statistics (such as standard deviations, the occurrence of extremes, etc.) of the climate at all spatial and temporal scales beyond that of individual weather events [IPCC-SREX, 2012].

Climate Change refers to change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer [IPCC-SREX, 2012]. Climate change may be due to natural variability or as a result of human activity.

Climate Change refers to "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods." (Article 1, UNFCCC)

Climate Change refers to any change in climate over time that directly or indirectly affects humans and their activities as well as natural systems and its processes. (National Policy on Climate Change, 2008)

Disaster Mitigation refers to the lessening of the potential adverse impacts of physical hazards (including those that are human-induced) through actions that reduce hazard, exposure, and vulnerability.

Climate Change Mitigation refers to a human intervention to reduce the sources or enhance the sinks of greenhouse gases.

Climate Change Adaptation. In human systems, the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities. In natural systems, the process of adjustment to actual climate and its effects; human intervention may facilitate adjustment to expected climate.

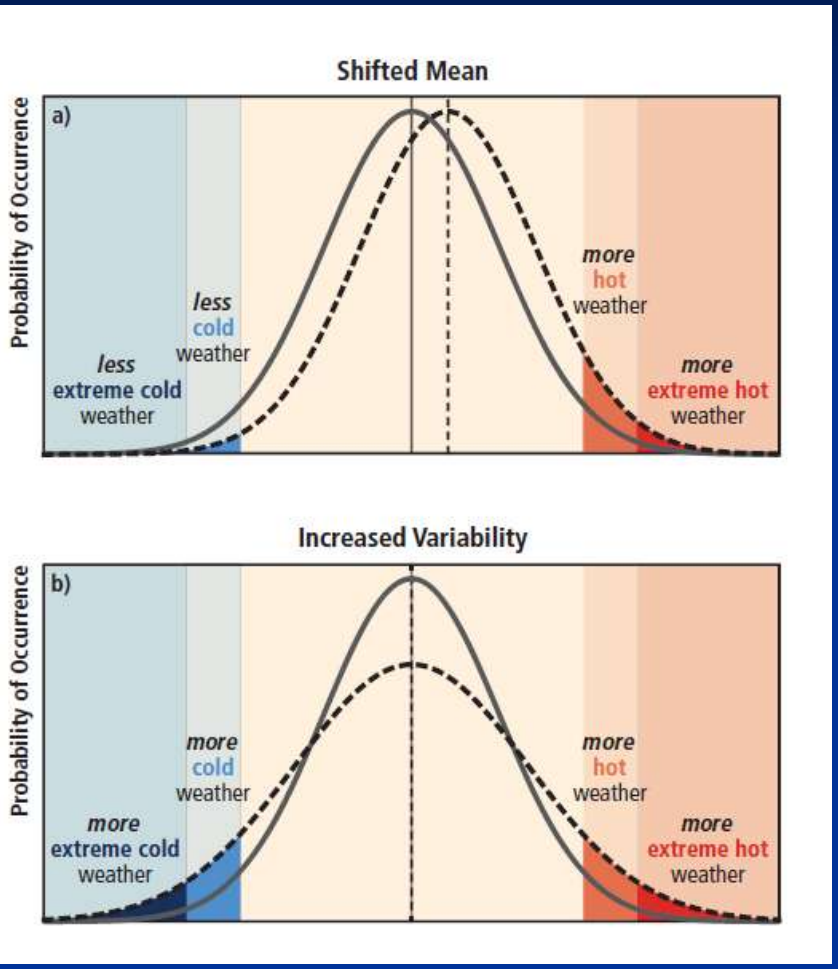
Susceptibility refers to the physical predisposition of human beings, infrastructure, and environment to be affected by a dangerous phenomenon due to lack of resistance and …….such systems once impacted will collapse or experience major harm and damage due to the influence of a hazard event.

Exposure refers to the presence of people; livelihoods; environmental services and resources; infrastructure; or economic, social, or cultural assets in places that could be adversely affected.

Vulnerability refers to the propensity or predisposition to be adversely affected.

Resilience refers to the ability of a system and its component parts to anticipate, absorb, accommodate, or recover from the effects of a hazardous event in a timely and efficient manner, including through ensuring the preservation, restoration, or improvement of its essential basic structures and functions.

Climate Extremes



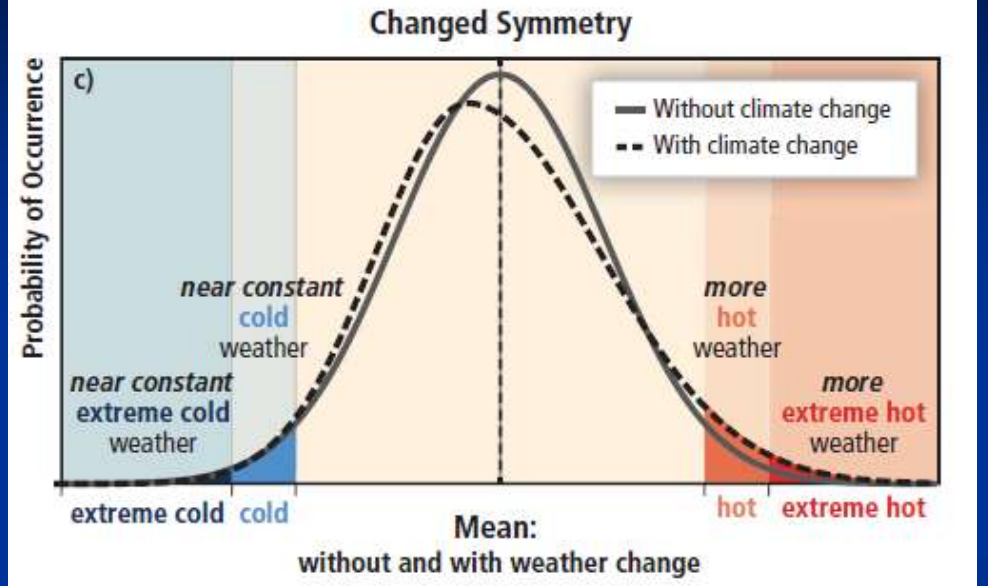


Figure SPM.3 | The effect of changes in temperature distribution on extremes. Different changes in temperature distributions between present and future climate and their effects on extreme values of the distributions: (a) effects of a simple shift of the entire distribution toward a warmer climate; (b) effects of an increase in temperature variability with no shift in the mean; (c) effects of an altered shape of the distribution, in this example a change in asymmetry toward the hotter part of the distribution. [Figure 1-2, 1.2.2]

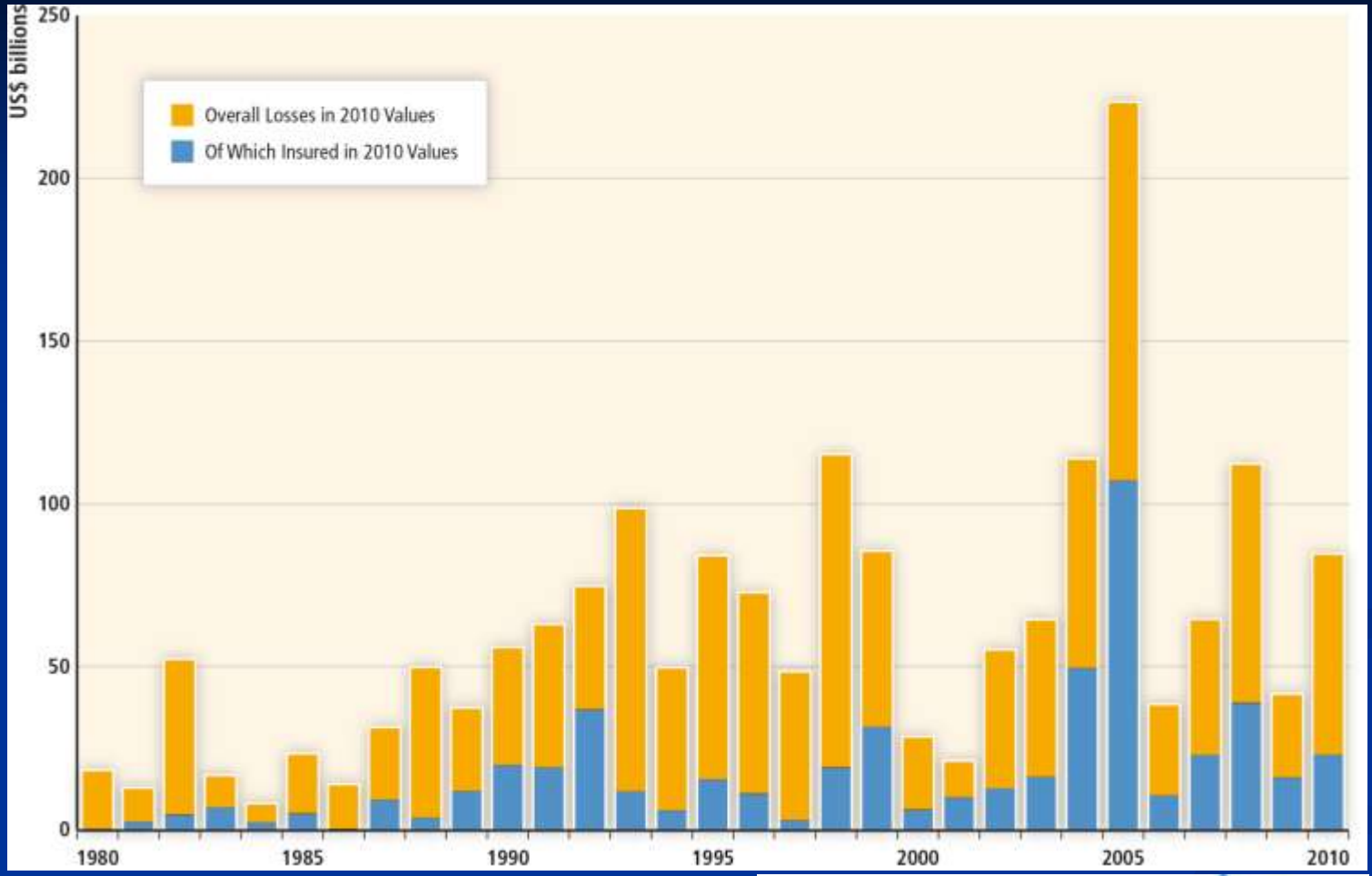
Climate Extremes (extreme weather or climate event) refers to the occurrence of a value of a weather or climate variable above (or below) a threshold value near the upper (or lower) ends of the range of observed values of the variable. [Source: IPCC-SREX, 2012]

Impacts of climate extremes can be felt locally or regionally

Source: IPCC, 2012

AGRICULTURE	"Mongolian herdsmen face starvation" *March 14, 2000, BBC World News*
ENERGY	"Heatwave hits French power production" *August 12, 2003, The Guardian*
WATER	"Drought returns to haunt Ethiopia"' *May 19, 2008, Reuters*
PUBLIC HEALTH	"Cholera confirmed in Pakistan flood disaster" *August 14, 2010, Associated Press*
TOURISM	"Alpine resorts feel heat during record warm spell" *December 08, 2006, CNN World News*
TRANSPORTATION	"Flash flooding causes train to derail" *July 30, 2001, Chicago Sun Times*

Economic losses from climate-related disasters have increased



- Fatalities - higher in developing countries (from 1970-2008, over 95%)

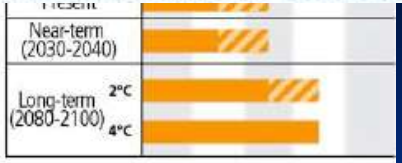
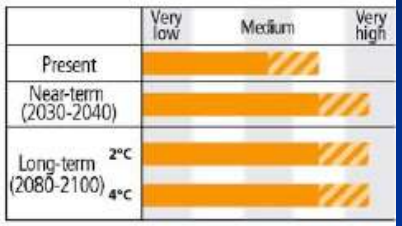
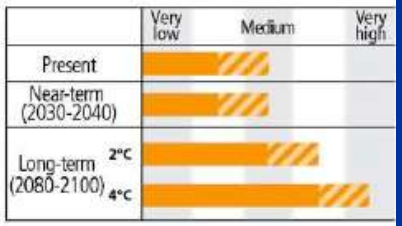
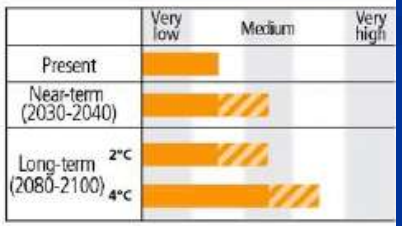
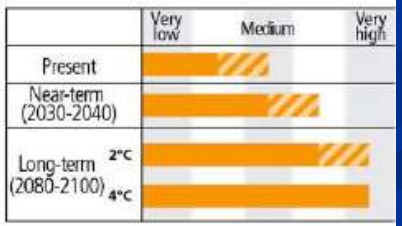
Source: IPCC, 2012

ipcc
INTERGOVERNMENTAL PANEL ON climate change

- Economic losses – highest in middle income countries [1%GDP:MI; 0.3%GDP:LI; 0.1%GDP:HI]

Source: IPCC, 2014

IPCC INTERGOVERNMENTAL PANEL ON climate change

Key risk	Adaptation issues and prospects	Climatic drivers		
Increased risk of crop failure and lower crop production could lead to food insecurity in Asia (*medium confidence*)	Autonomous adaptation of farmers on-going in many parts of Asia.			
Water shortage in arid areas of Asia (*medium confidence*)	Limited capacity for water resource adaptation; options include developing water saving technology, changing drought-resilient crops, building more water reservoirs.		24.4.1.3, 24.4.1.4	
Increased flooding leading to widespread damage to infrastructure and settlements in Asia (*medium confidence*)	Adaptation measures include extreme weather exposure reduction via effective land-use planning, selective relocation and structural measures; reduction in the vulnerability of lifeline infrastructure and services (water, energy, waste management, food, biomass, mobility, local ecosystems and telecommunications) and measures to assist vulnerable sectors and households.		24.4.5.1, 24.4.5.2, 24.4.5.3, 24.4.5.5,	
Increased risk of flood-related deaths, injuries, infectious diseases and mental disorders (*medium confidence*)	Disaster preparedness including early-warning systems and local coping strategies.		24.4.6.2, 24.4.6.3, 24.4.6.5	
Increased risk of heat-related mortality (*high confidence*)	Heat health-warning systems, urban planning to reduce heat islands and improvement of built environment.		24.4.6.2, 24.4.6.3, 24.4.6.5	

Climatic drivers of impacts

Risk & potential for adaptation

Source: IPCC, 2014

Key risk	Adaptation issues and prospects	Climatic drivers		
Increased risk of drought-related water and food shortage causing malnutrition (*high confidence*)	Disaster preparedness including early-warning systems and local coping strategies.		24.4.6.5	Near-term (2030-2040); Long-term (2080-2100) 2°C 4°C
Increased risk of water and vector-borne diseases (*medium confidence*)	Early-warning systems, vector control programs, water management and sanitation programs.		24.4.6.2, 24.4.6.3, 24.4.6.5	Very low; Medium; Very high; Present; Near-term (2030-2040); Long-term (2080-2100) 2°C 4°C
Exacerbated poverty, inequalities and new vulnerabilities (*high confidence*)	Insufficient emphasis and limited understanding on urban poverty, interaction between livelihoods, poverty and climate change.		24.4.5 24.4.6	Very low; Medium; Very high; Present; Near-term (2030-2040); Long-term (2080-2100) 2°C 4°C
Coral reef decline in Asia (*high confidence*)	The limited adaptation options include minimizing additional stresses in marine protected areas sited where sea surface temperatures are expected to change least and reef resilience is expected to be highest.		24.4.3.3, 24.4.3.5, CC-CR, CC-OA	Very low; Medium; Very high; Present; Near-term (2030-2040); Long-term (2080-2100) 2°C 4°C
Mountain-top extinctions in Asia (*high confidence*)	Adaptation options are limited. Reducing non-climate impacts and maximizing habitat connectivity will reduce risks to some extent, while assisted migration may be practical for some species.		24.4.2.4, 24.4.2.5	Very low; Medium; Very high; Present; Near-term (2030-2040); Long-term (2080-2100) 2°C 4°C

Climatic drivers of impacts

Warming trend; Extreme temperature; Drying trend; Extreme precipitation; Damaging cyclone; Storm surge; Sea level; Ocean acidification

Risk & potential for adaptation

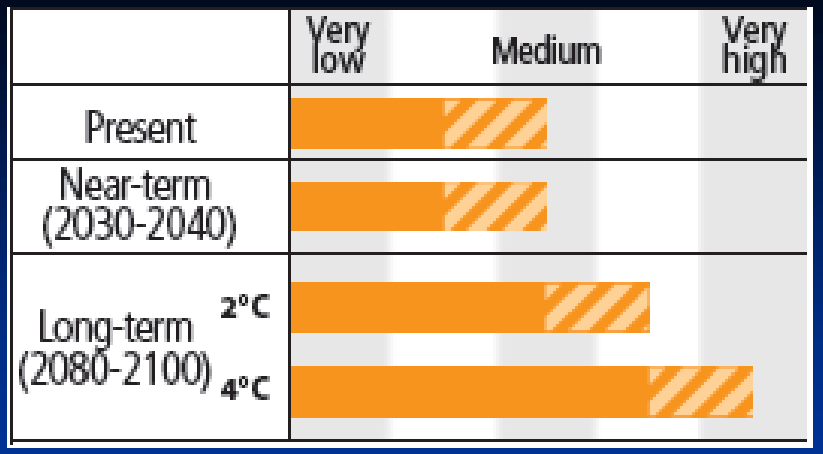
Potential for adaptation to reduce risk

Risk level with **high** adaptation

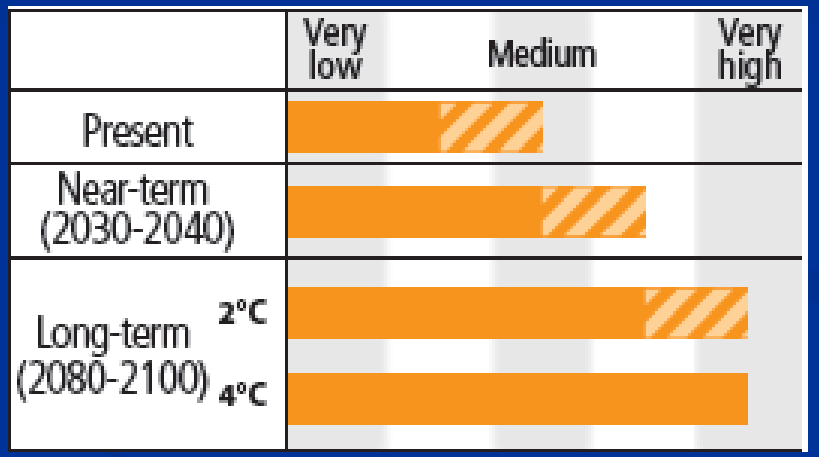
Risk level with **current** adaptation

Key Risks in Asia

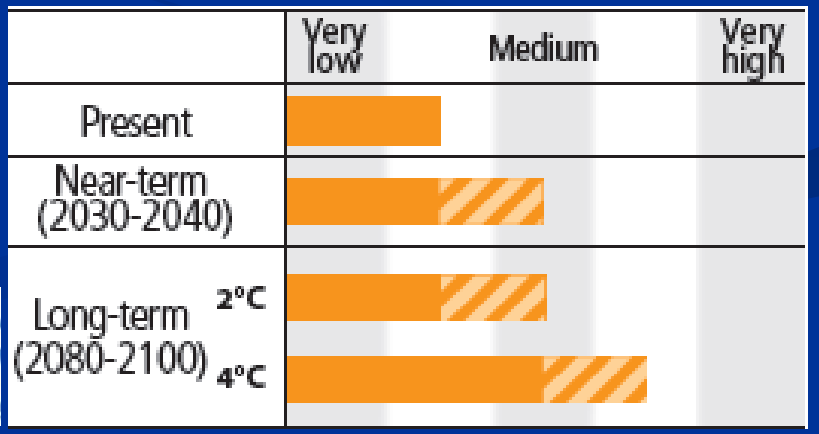
Increased [coastal, riverine and urban] flooding leading to widespread damage to infrastructure and settlements in Asia (medium confidence)



Increased risk of heat-related mortality (high confidence)



Increased risk of drought-related water and food shortage causing malnutrition (high confidence)



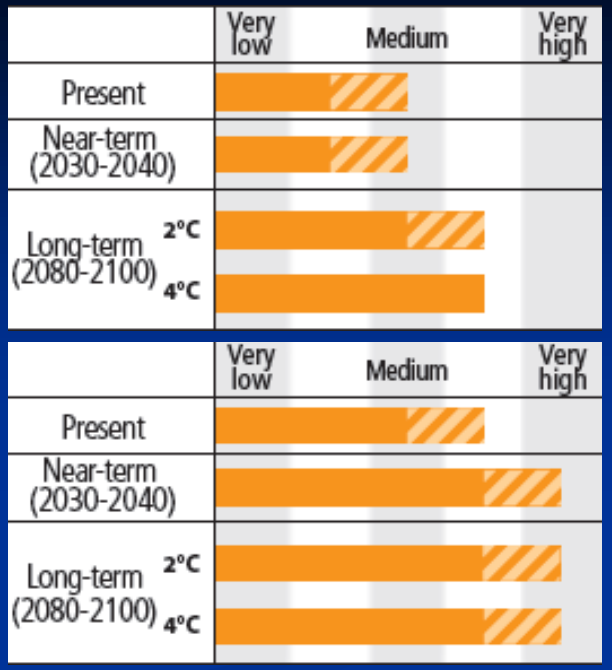
Source: IPCC, 2014

ipcc
INTERGOVERNMENTAL PANEL ON climate change

Key Risks in Asia

Increased risk of crop failure and lower crop production could lead to food insecurity in Asia (medium confidence)

Water shortage in arid areas of Asia (medium confidence)



KEY CONCLUSIONS ON WATER: IPCC-WG2: Ch 24, Asia

- Water scarcity is expected to be a major challenge for most of the region due to increased water demand and lack of good management (*medium confidence*)
- There is *low confidence* in future precipitation projections at a sub-regional scale and thus in future freshwater availability in most parts of Asia.
- Integrated water management strategies could help adapt to climate change, including developing water saving technologies, increasing water productivity, and water reuse.

Observations of Past Events

Source: IPCC, 2013

Climate Phenomenon	Asia	Southeast Asia
Heat Waves	It is likely that the frequency of heat waves has increased in large parts of Asia.	No Specific Observations
Drought	There is medium confidence that more megadroughts occurred in monsoon Asia and wetter conditions prevailed in arid Central Asia monsoon region during the Little Ice Age (1450–1850) compared to the Medieval Climate Anomaly (950–1250).	No Specific Observations
Floods	With high confidence, past floods larger than recorded since the 20th century occurred during the past five centuries in eastern Asia. There is medium confidence that in the Near East and India modern large floods are comparable or surpass historical floods in magnitude and/or frequency.	No Specific Observations

Future Projections

Source: IPCC, 2013

Climate Phenomenon	Asia	Southeast Asia
Precipitation	Future increase in precipitation extremes related to the monsoon is very likely in East Asia, South Asia and Southeast Asia.	Future increase in precipitation extremes related to the monsoon is very likely in Southeast Asia.
	Indian monsoon rainfall is projected to increase. For the East Asian summer monsoon, both monsoon circulation and rainfall are projected to increase.	There is low confidence in projections of future changes in the Madden-Julian Oscillation due to the poor skill in model simulations of this intraseasonal phenomenon and the sensitivity to ocean warming patterns. Future projections of regional climate extremes in Southeast Asia are therefore of low confidence.
		Reduced precipitation in Indonesia in Jul-Oct due to pattern of Indian Ocean warming (RCP 4.5 or higher end scenarios)
El Niño-Southern Oscillation	Natural modulations of the variance and spatial pattern of El Niño-Southern Oscillation are so large that confidence in any projected change for the 21st century remains low. Confidence is low in changes in climate impacts for most of Asia.	Low Confidence in any projected change for the 21st century.

Sea Level Rise (IPCC 2013)

Source: IPCC, 2013

- Projected climate change (based on RCPs) in AR5 is similar to AR4 in both patterns and magnitude, after accounting for scenario differences.

- Projections of global mean sea level rise has increased in confidence since the AR4 because of the improved physical understanding of the components of sea level, the improved agreement of process-based models with observations, and the inclusion of ice-sheet dynamical changes.

- Global mean sea level will continue to rise during the 21st century. Under all RCP scenarios the rate of sea level rise will *very likely* exceed that observed during 1971–2010 due to increased ocean warming and increased loss of mass from glaciers and ice sheets.

Sea Level Rise (IPCC 2013)

Source: IPCC, 2013

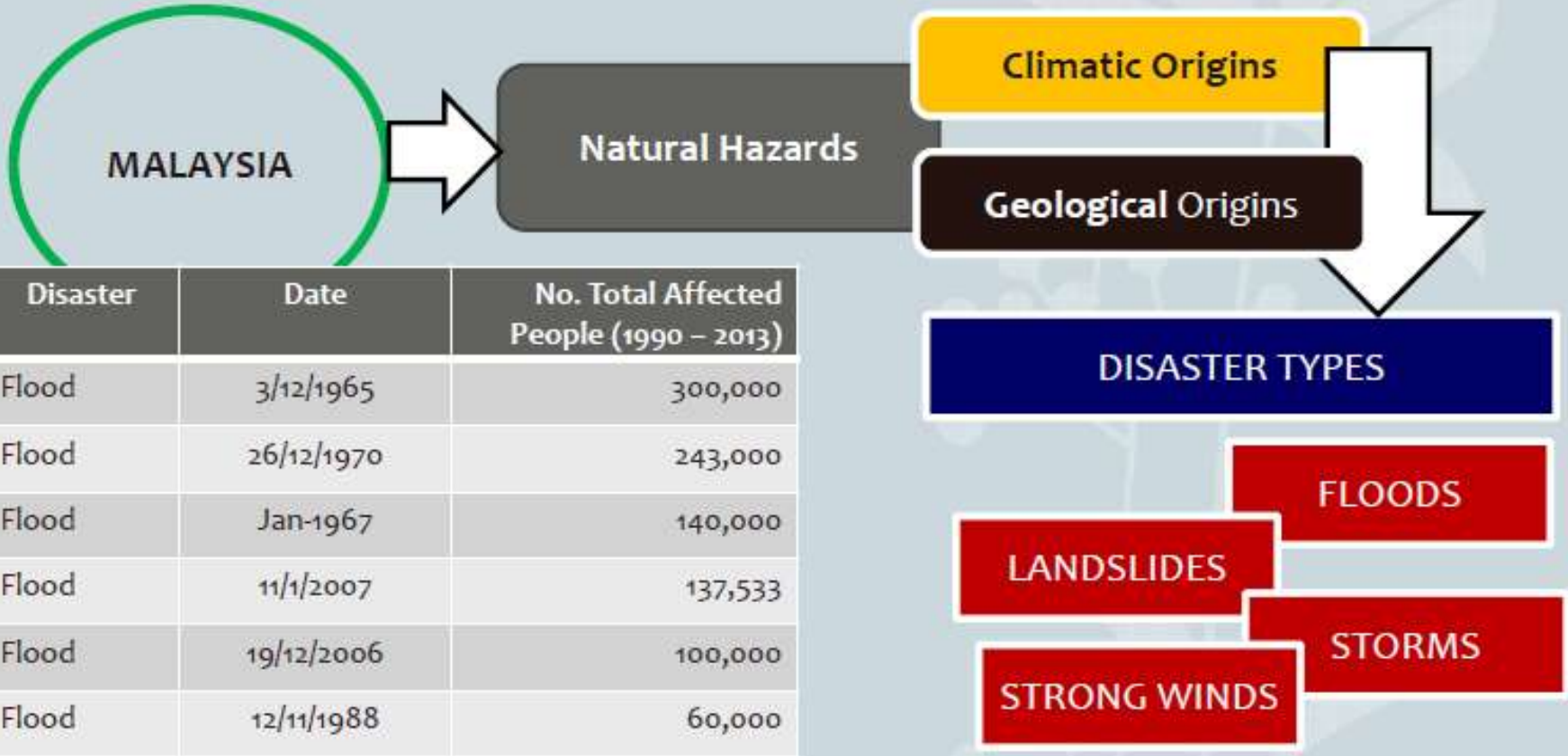
Global mean sea level rise for 2081–2100 relative to 1986–2005 will *likely* be in the following ranges:

- 0.26 to 0.55 m (RCP2.6)
- 0.32 to 0.63 m (RCP4.5)
- 0.33 to 0.63 m (RCP6.0)
- 0.45 to 0.82 m (RCP8.5) – medium confidence

Sea level rise will not be uniform. By the end of the 21st century, it is *very likely* that sea level will rise in more than about 95% of the ocean area.

About 70% of the coastlines worldwide are projected to experience sea level change within 20% of the global mean sea level change.

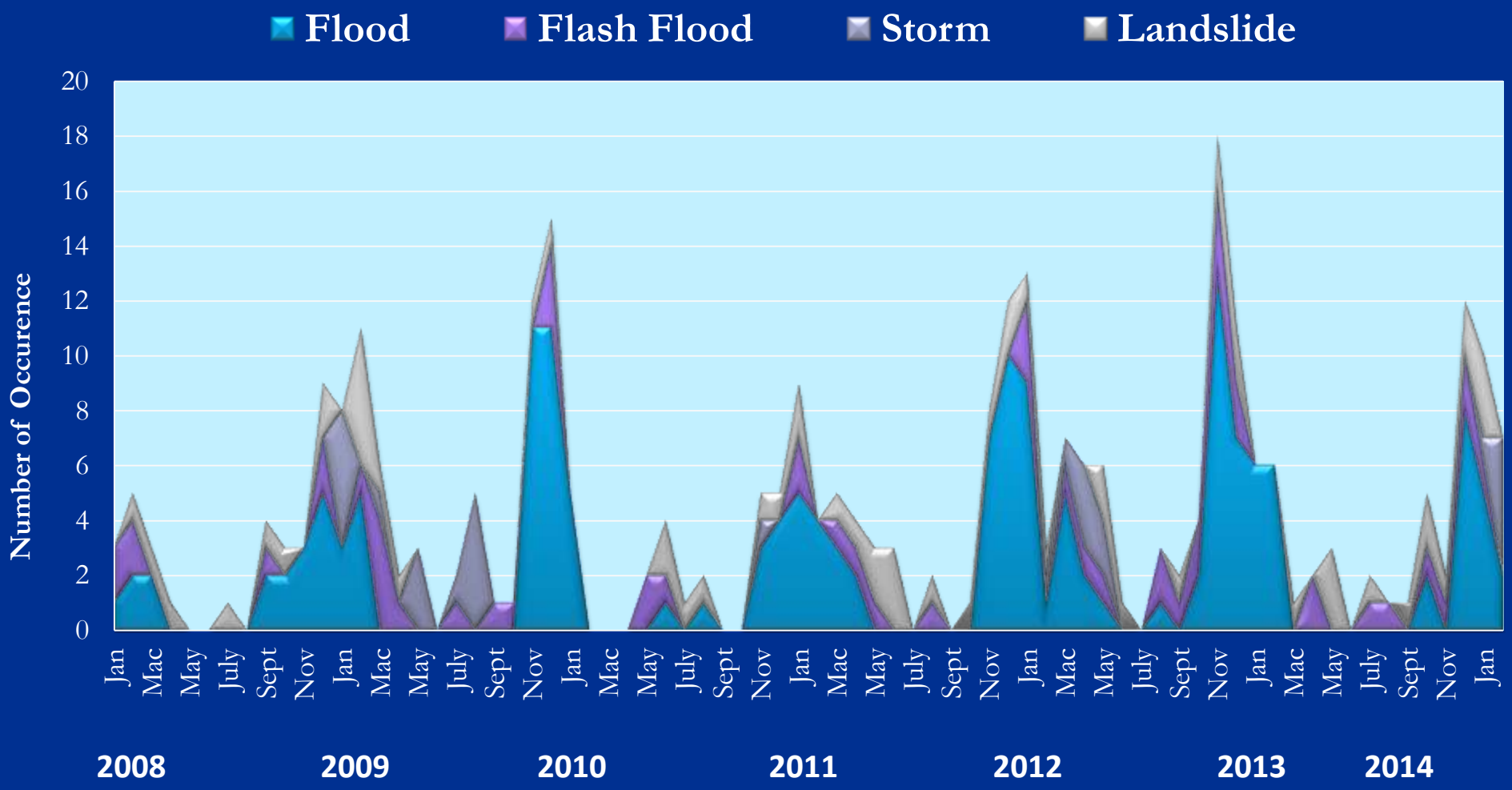
NATURAL HAZARDS IN MALAYSIA



Disaster	Date	No. Total Affected People (1990 – 2013)
Flood	3/12/1965	300,000
Flood	26/12/1970	243,000
Flood	Jan-1967	140,000
Flood	11/1/2007	137,533
Flood	19/12/2006	100,000
Flood	12/11/1988	60,000
Storm	6/11/2004	40,000
Flood	23/11/2005	30,000
Flood	7/12/2007	29,000
Flood	28/11/1986	25,000

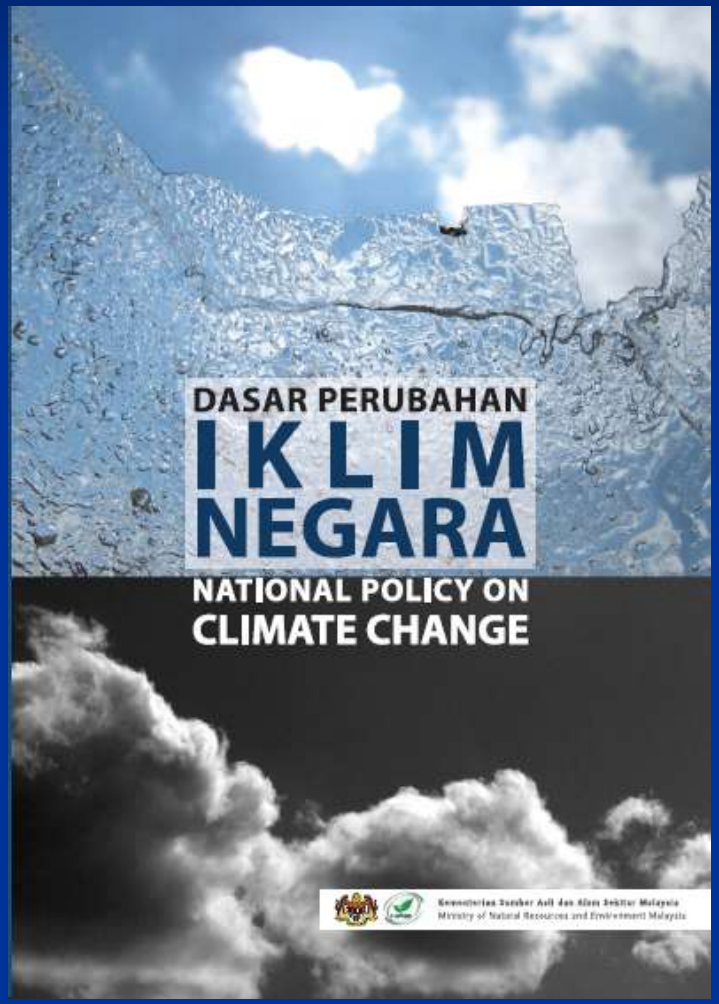
Source: http://www.emdat.be/result-country-profile

Frequency of Disasters in Malaysia



seadpri

National Policy on Climate Change

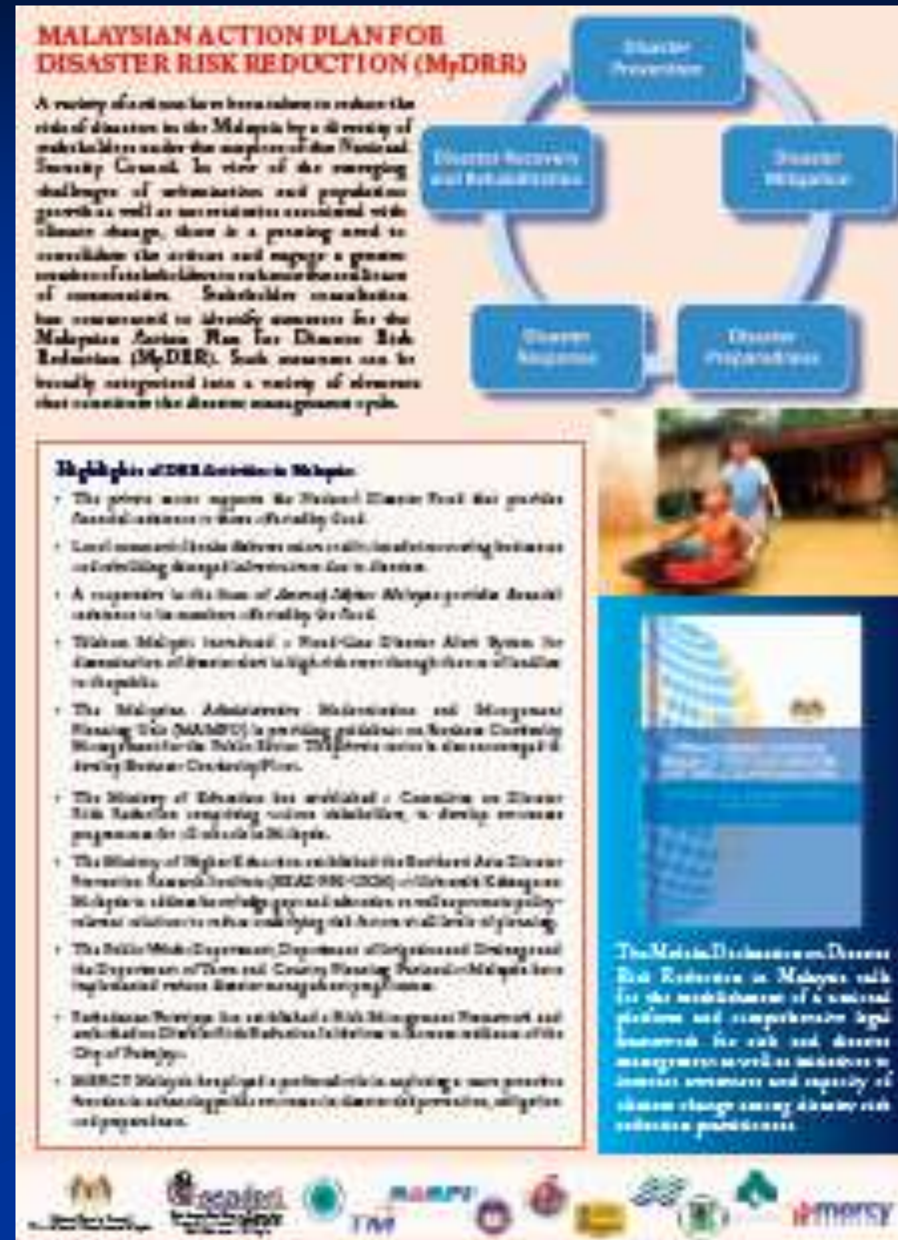


<u>Climate-resilient development</u> – development that takes into account measures to address climate change and extreme weather in line with national priorities.

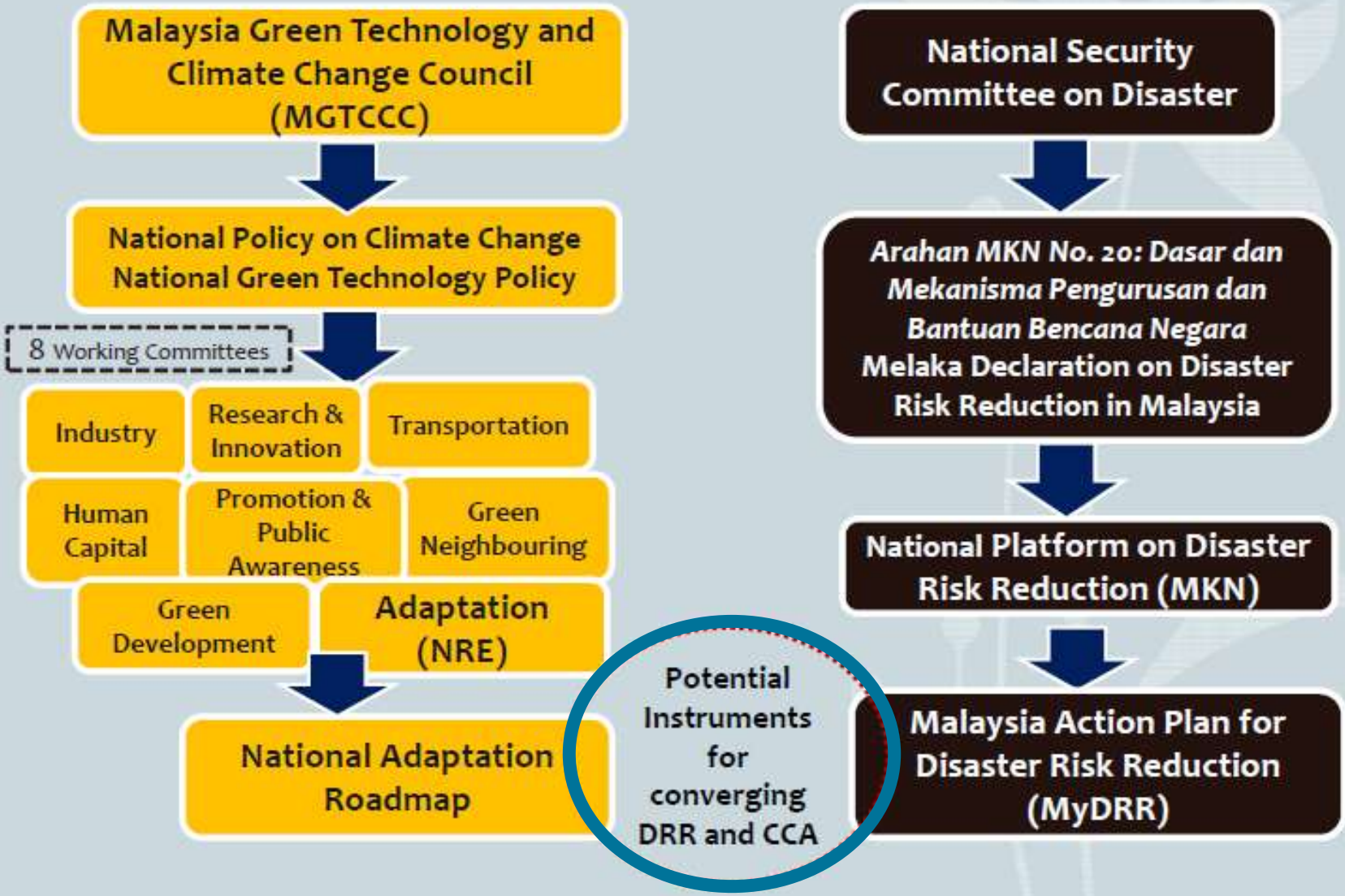
Broadened definition enables the National Policy on Climate Change to serve as an instrument to harmonise and integrate to the extent possible and in line with national priorities, measures on climate change adaptation, mitigation and disaster risk reduction

5 Principles, 10 Strategic Thrusts & 43 Key Actions

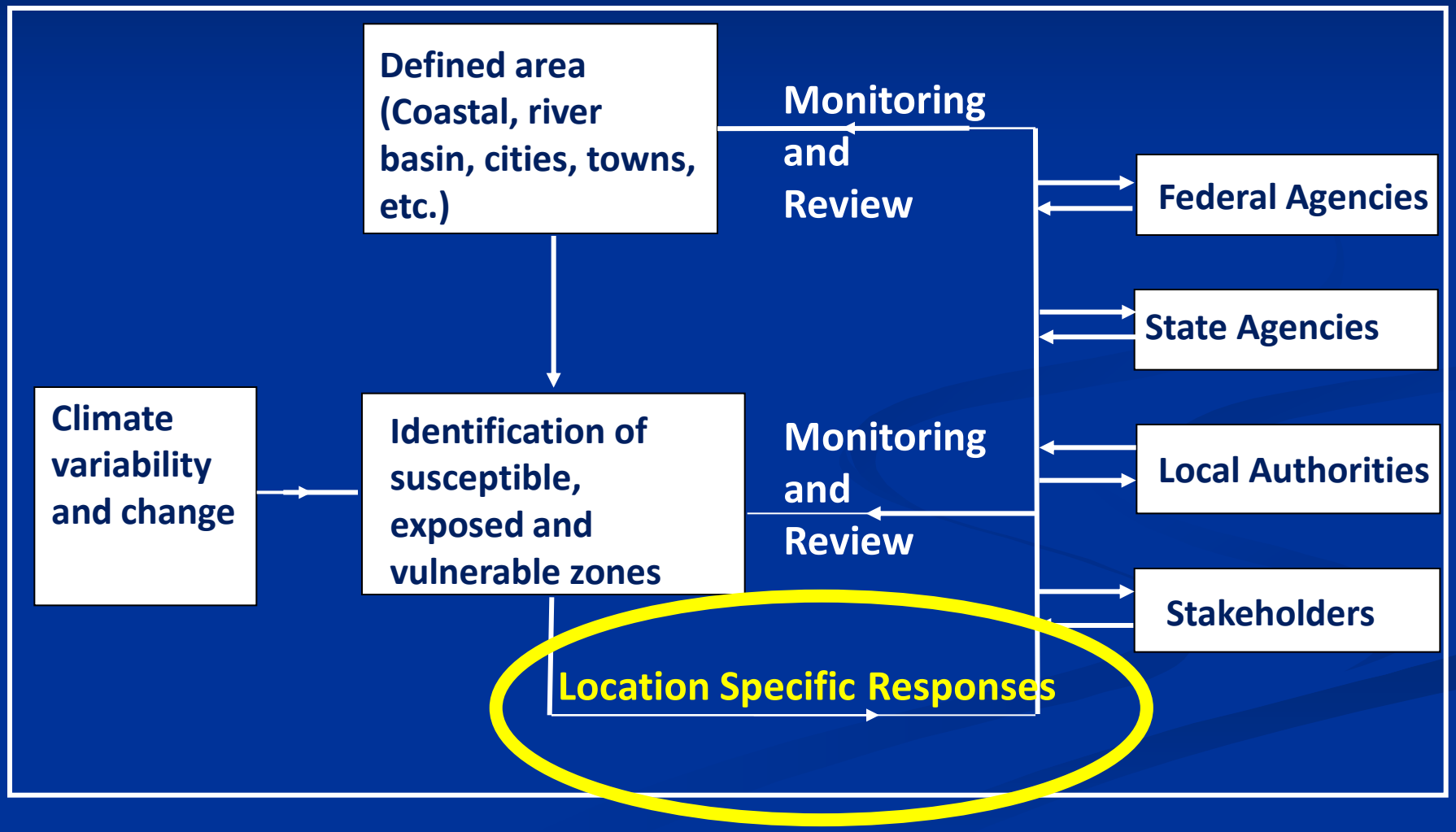

STRENGTHENING THE ARRAY OF RESPONSES IN MALAYSIA
NATIONAL PLATFORM AND ACTION PLAN FOR DISASTER RISK REDUCTION (MyDRR)
Malaysia
EVOLUTION OF THE NATIONAL PLATFORM


MALAYSIAN ACTION PLAN FOR DISASTER RISK REDUCTION (MyDRR)

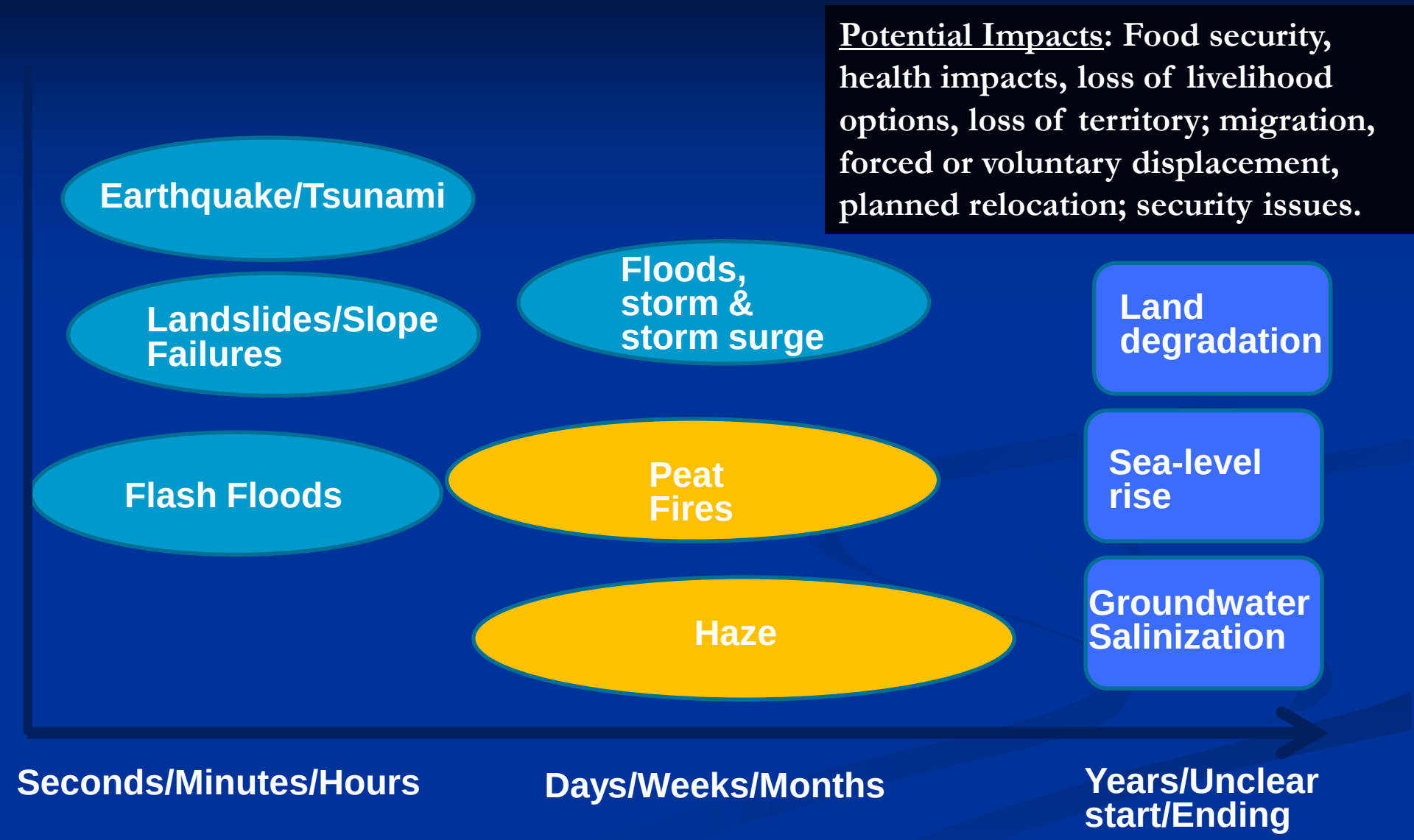
INSTITUTIONAL ARRANGEMENT



RECOMMENDED APPROACH FOR MALAYSIA: *"SPATIALLY CONTEXTUALISED" "COLLABORATIVE APPROACH" FOR ADAPTATION (AREA ADAPTATION PLAN)*

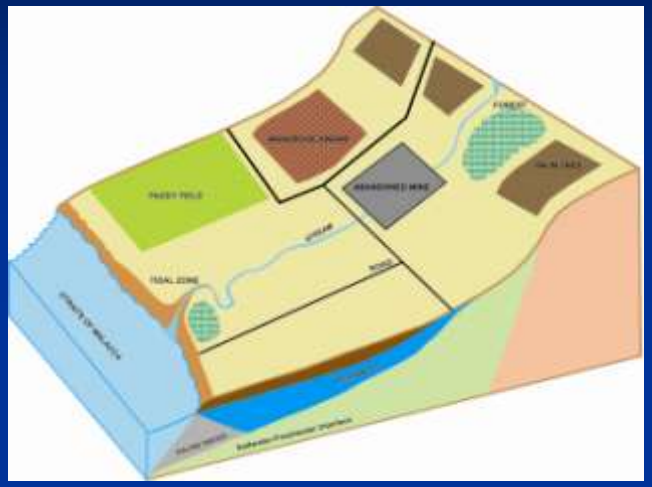


Fast & Slow Onset Events



Areas Potentially Affected by Sea-Level Rise in K. Selangor

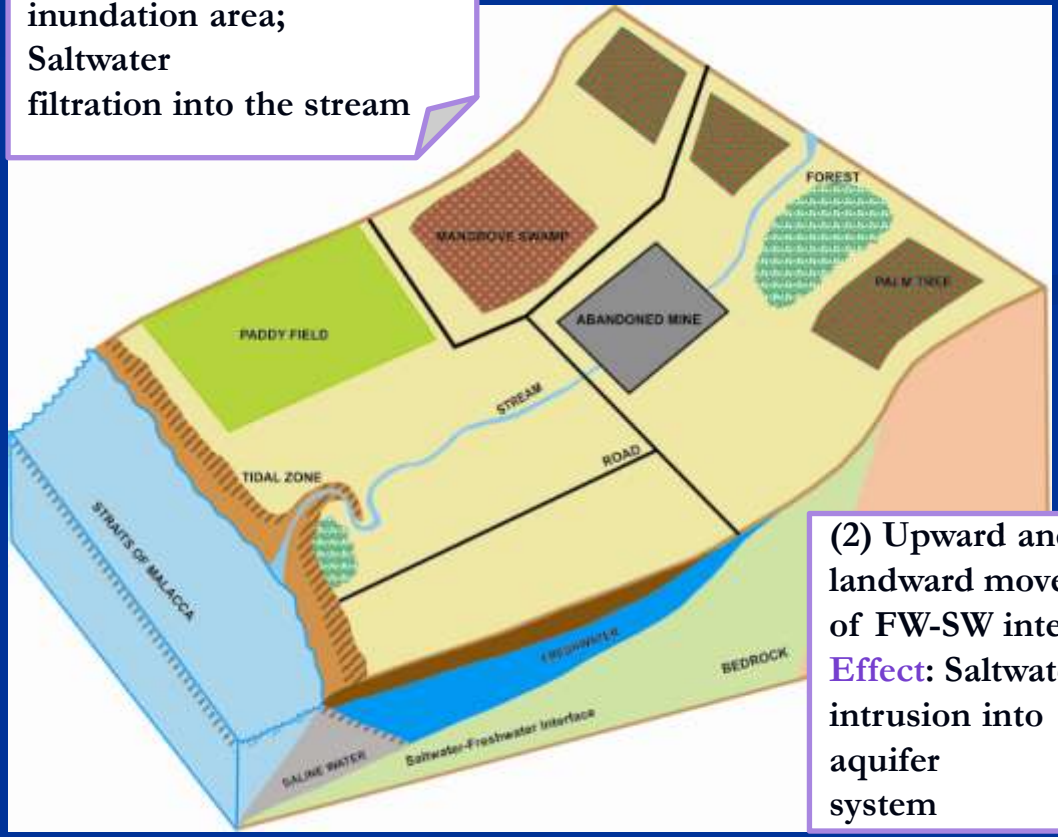
CURRENT SEA LEVEL



Source: Umi Amira et al. 2013

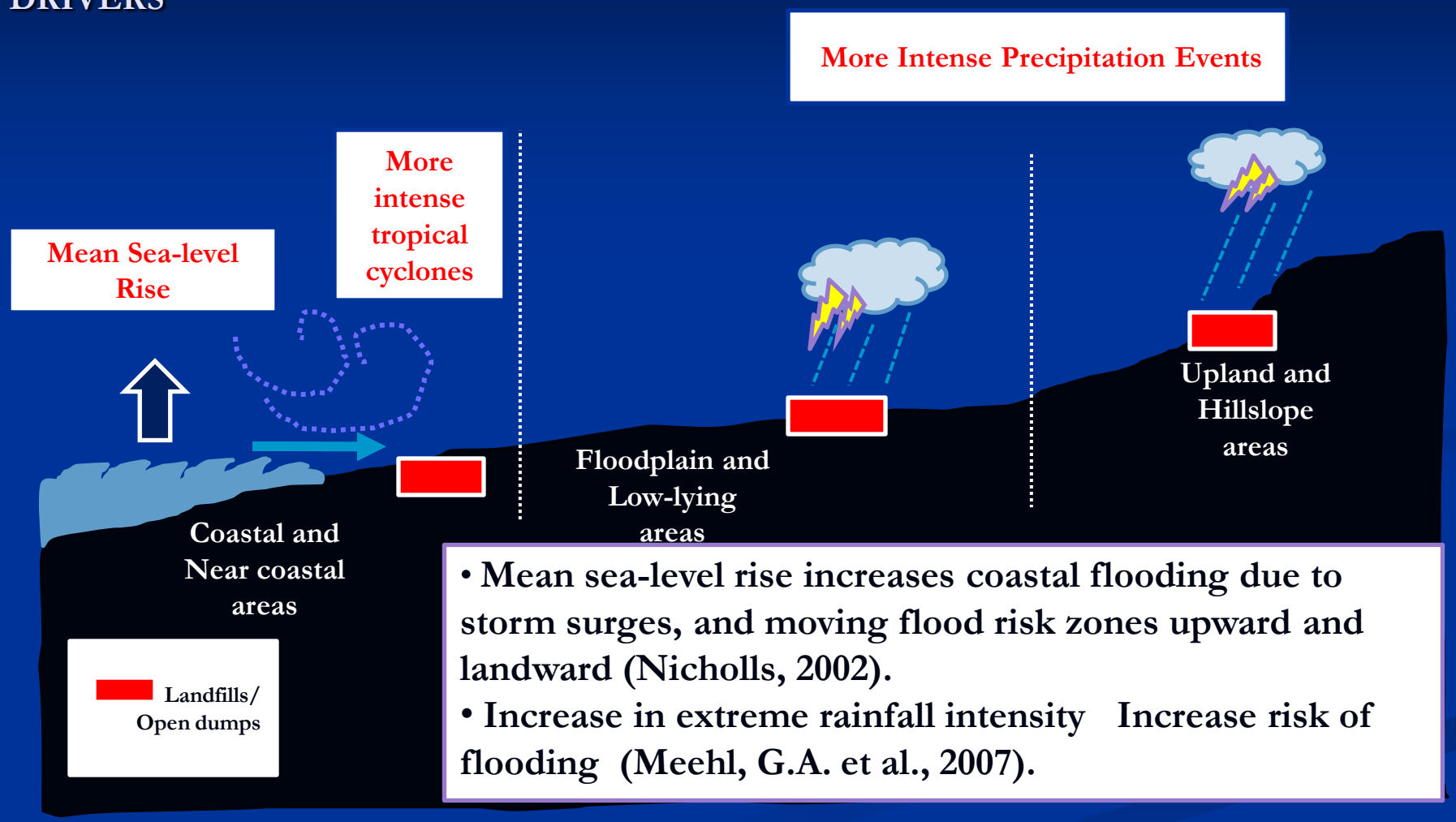
(1) Extension of Tidal Zone towards Upper stream
Effect: Extension of inundation area; Saltwater filtration into the stream

FUTURE SEA LEVEL



(2) Upward and landward movement of FW-SW interface
Effect: Saltwater intrusion into aquifer system

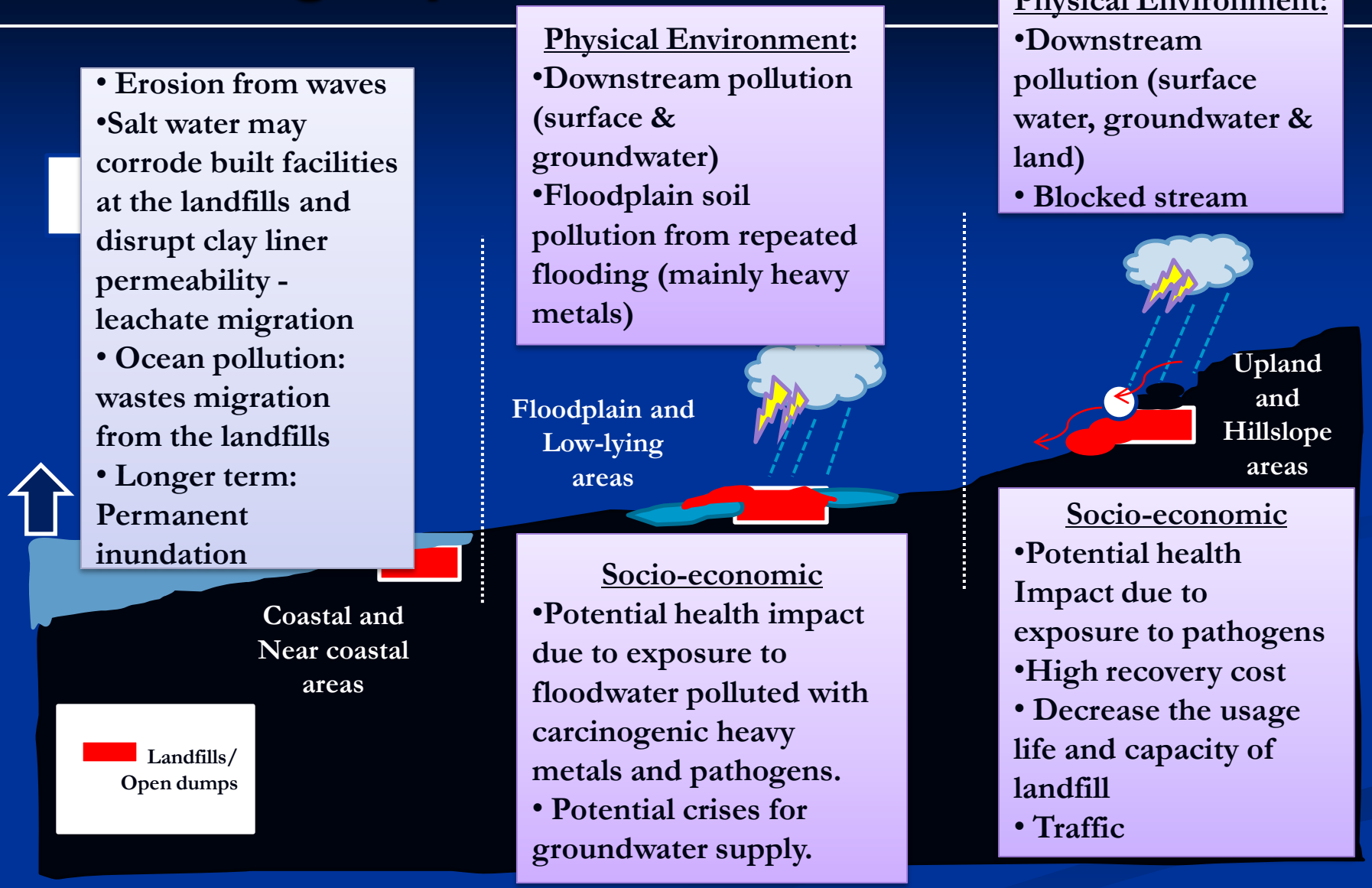
Cascading Hazards: Climate Drivers



- Mean sea-level rise increases coastal flooding due to storm surges, and moving flood risk zones upward and landward (Nicholls, 2002).
- Increase in extreme rainfall intensity Increase risk of flooding (Meehl, G.A. et al., 2007).

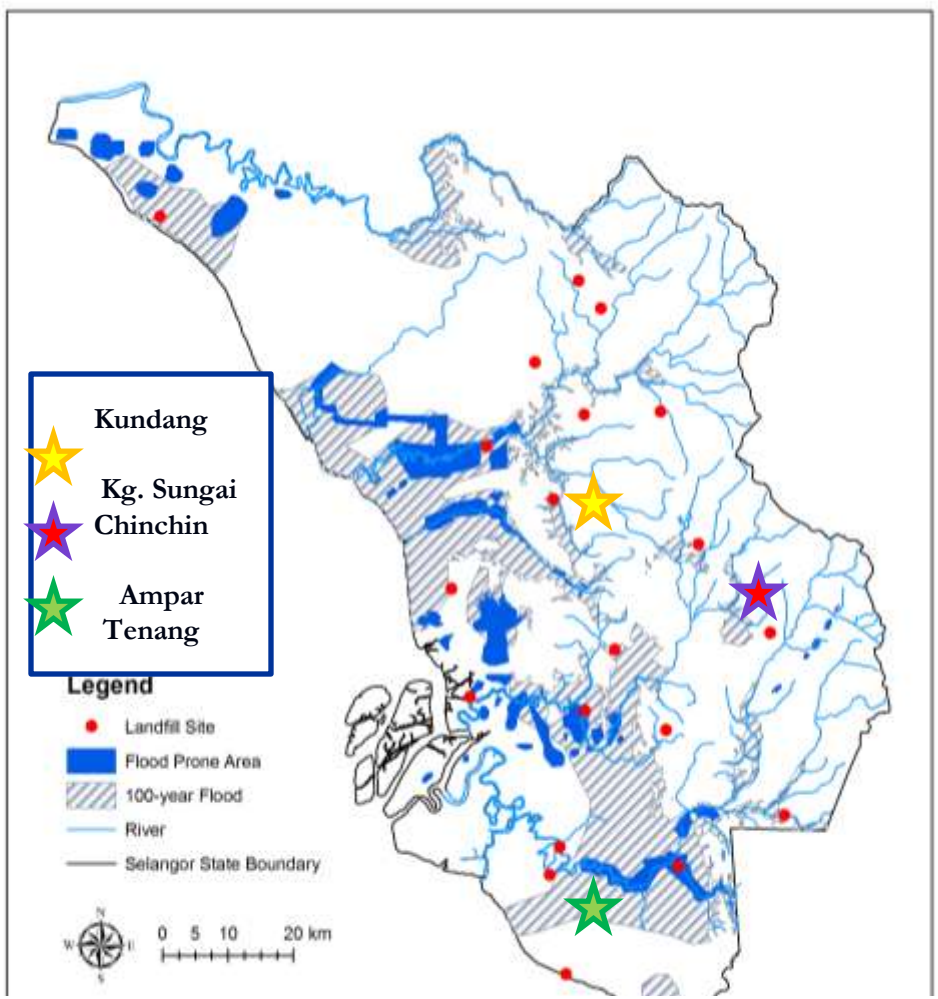
Source: Nurul, Lim and Pereira 2013

Cascading Impacts



Source: Nurul, Lim and Pereira 2013

Potential Cascading Hazards in Selangor



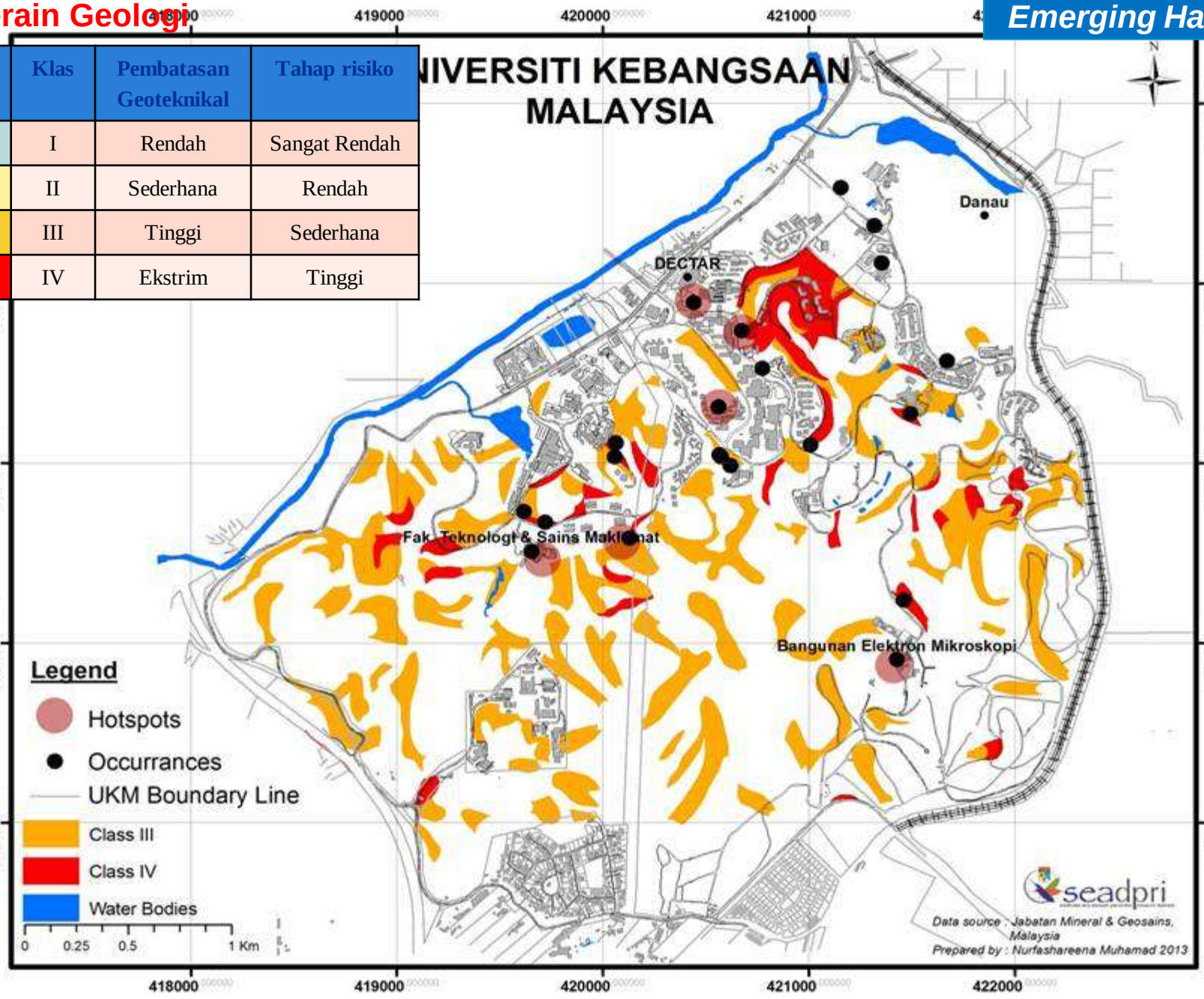
Flood prone area and 100-year flood map with identified active and closed landfill sites in Selangor. (Sources: Flood map adapted from RFN-2 Report 2009, landfill sites from NAHRIM and NRE 2010) **Source: Nurul, Lim and Pereira 2013**

Landfill Sites Exposed to Flooding:

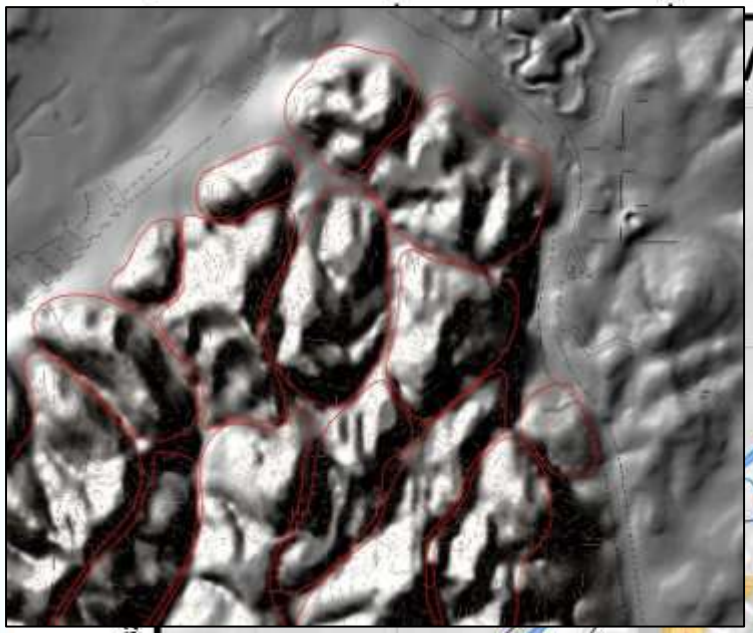
- Number of sites located within flood prone area: 4
- Number of sites located within 100-year flood: 9
- Number of sites potentially exposed to impacts from sea level rise: 3

Peta lokasi kejadian tanah runtuh bersama kedudukan binaan UKM ditindan-lapis bersama Peta Terain Geologi

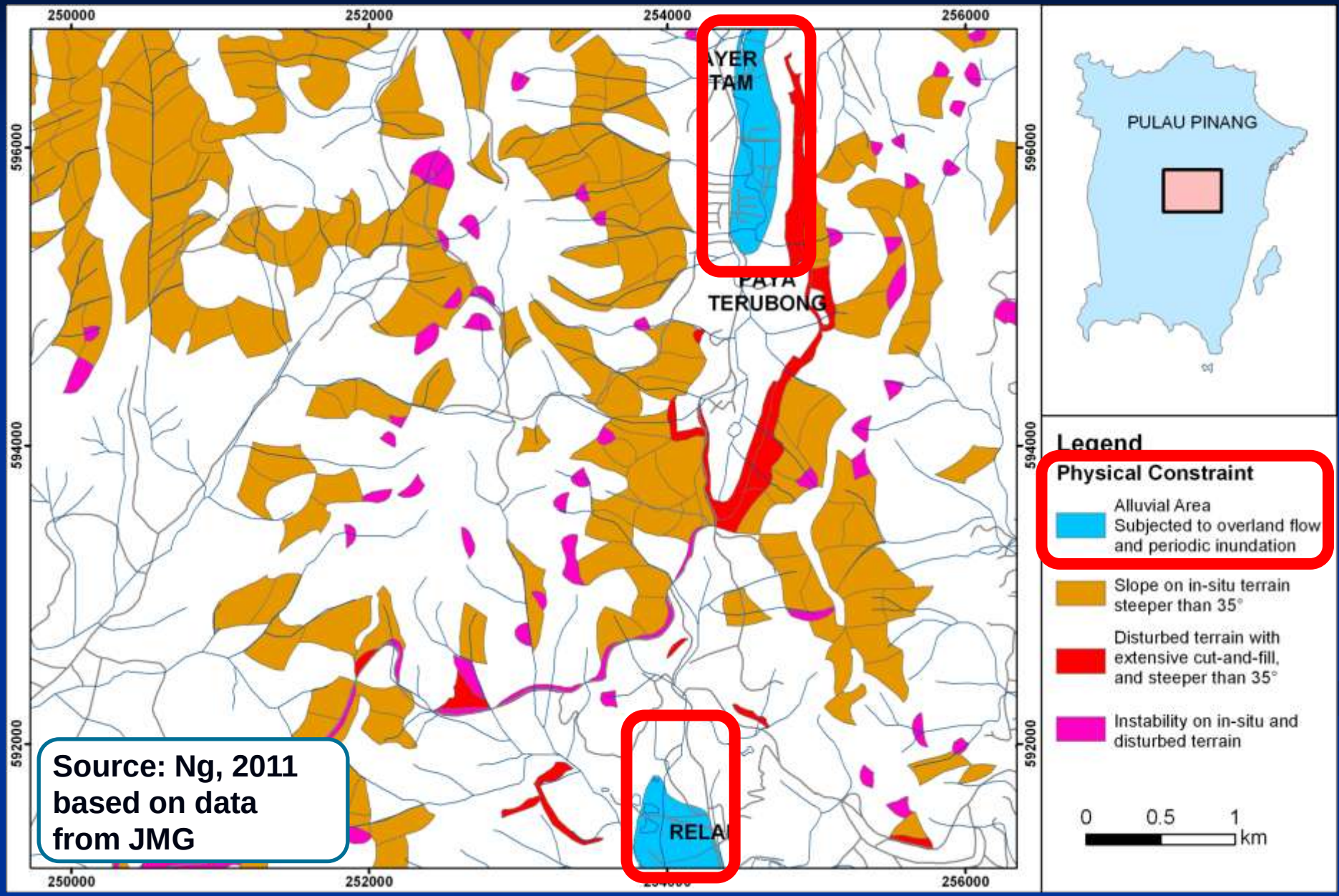
Colors	Klas	Pembatasan Geoteknikal	Tahap risiko
	I	Rendah	Sangat Rendah
	II	Sederhana	Rendah
	III	Tinggi	Sederhana
	IV	Ekstrim	Tinggi



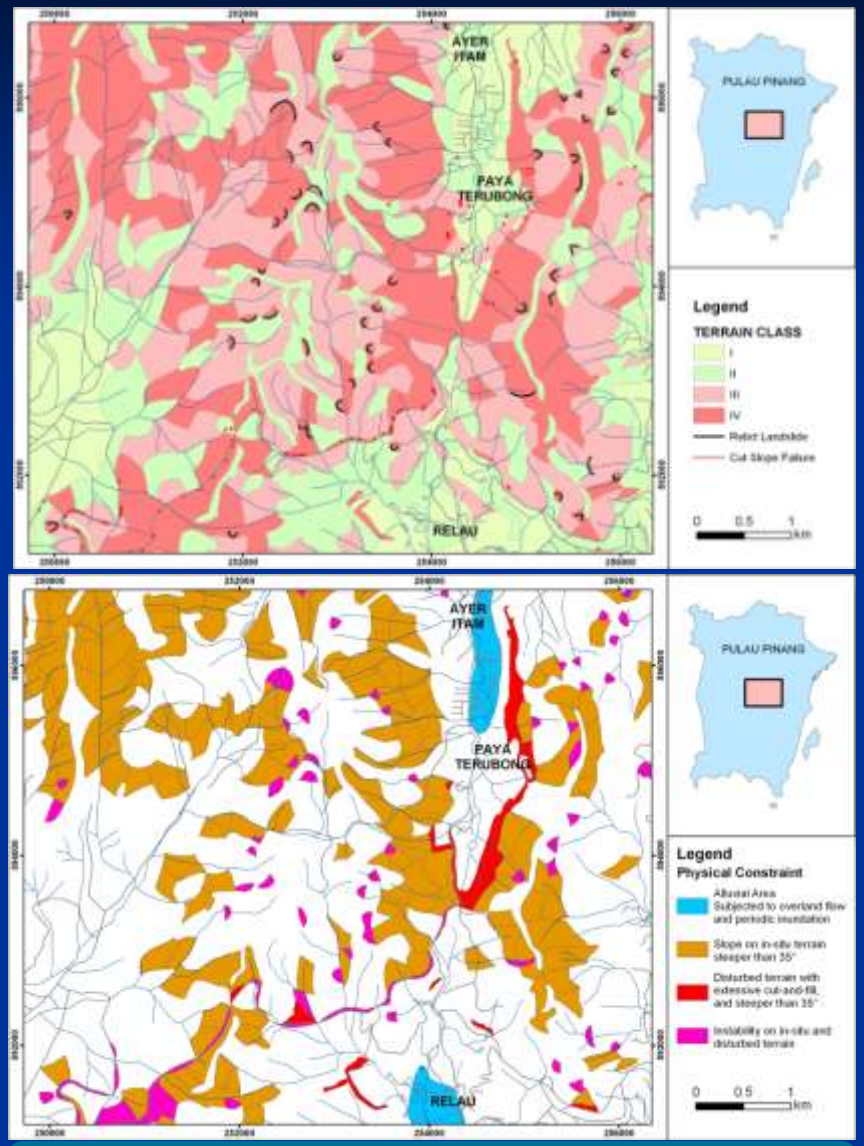
Peta jasad timbul / shaded relief bersama klasifikasi terain klas 3 dan 4



Landslide Susceptibility



Managing Risks



Source: Ng, 2011 based on data from JMG

Risk Factors:

- Uninformed planning
- Development in unsuitable terrain
- Cleared areas/blocked drainage

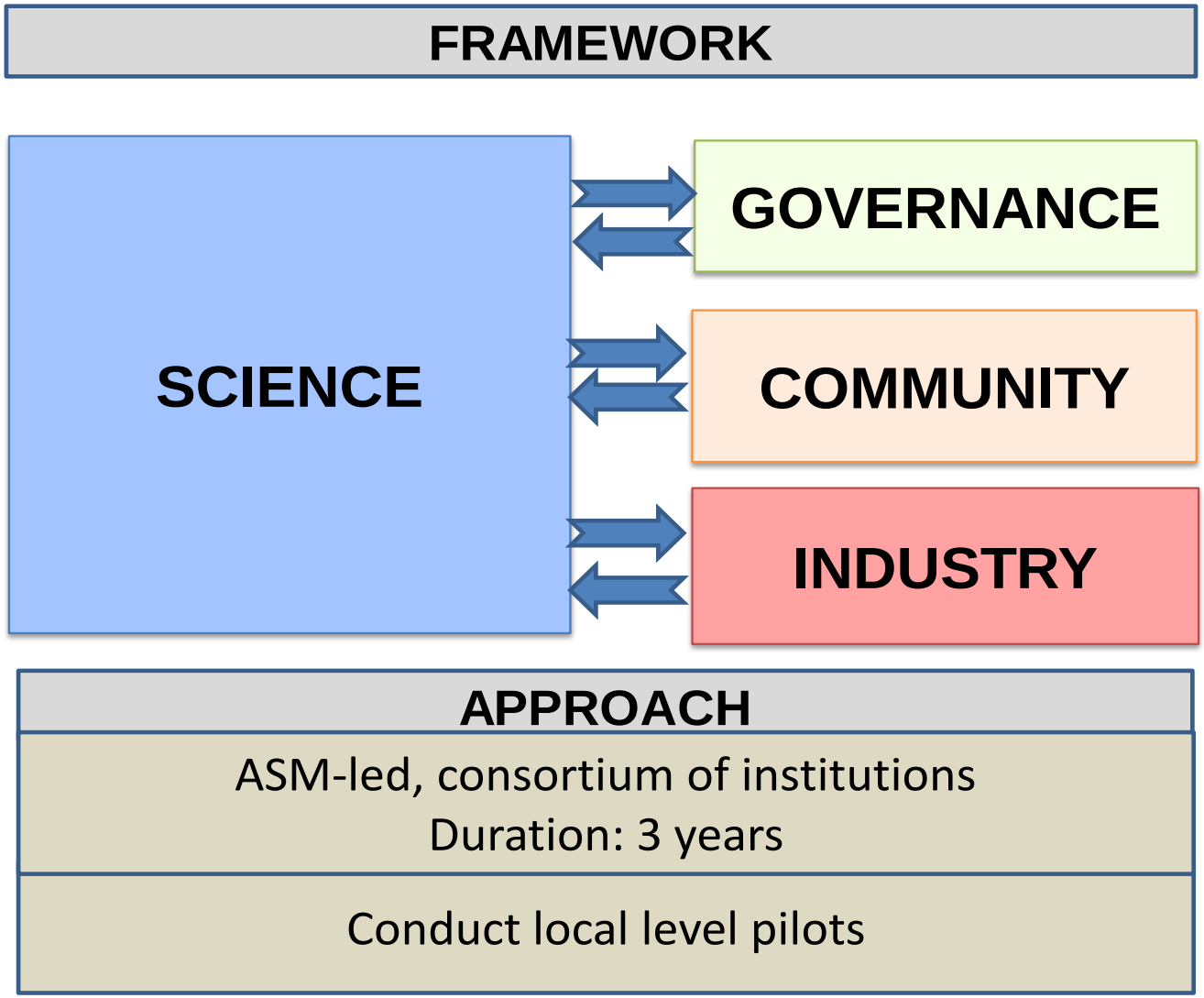
Adaptation Measures:

- Informed planning
- Regular slope/drainage inspection and maintenance
- Early warning systems
- Local community engagement
- Risk Pooling, etc.

CHALLENGES

- Excessive rainfall and increase in sea-levels, in conjunction with varying urban patterns within floodplains will see an increase in extent and frequency of flooding.
- The frequency and magnitude of rainfall-triggered landslides is expected to increase in rugged terrain and other susceptible areas.
- New approaches are required that take into account multiple hazards and delineate susceptible areas, exposed assets, vulnerable communities and high-risk zones.
- Communities in susceptible areas need to be the focus for building disaster and climate resilience in conjunction with relevant stakeholders, including the local authorities.
- Gaps in knowledge, policy and information management with respect to disasters and climate extremes have to be addressed.

A PROPOSED WAY FORWARD



KEY ELEMENTS

- Area specific focus on science, governance, community and industry serves as the basis for building a disaster resilient society.
- Near term projections and spatially explicit multi-hazards maps through crowd sourcing to support policy and decision makers reduce risks and build resilience.
- Integrated DRR Decision Support System has the potential to influence the banking and insurance sectors, promote area-based Business Continuity Plans and reduce economic losses. due to disasters and extreme climate.
- Web-based Tool-kits for local areas can be used for educational purposes, enhance disaster awareness, implement action oriented resilience building and indirectly enhance S&T awareness.
- Area specific, consortium approach, stakeholder participation and subject matter experts with ICT support .

Asian University Network of Environment and Disaster Management (AUEDM):

www.auedm.net

Kabul University, Afghanistan
BRAC University, Bangladesh
Royal University of Phnom Penh, Cambodia
Beijing Normal University, China
Tata Institute of Social Sciences, India
University of Madras, India
Jadavpur University, India
Institute of Technology Bandung, Indonesia
Kyoto University, Japan
University of Tokyo, Japan
Tokyo Polytectnc University, Japan
Universiti Kebangsaan Malaysia (UKM), Malaysia
Tribhuvan University, Nepal
University of Peshawar, Pakistan
University of Philippines Los Baños, Philippines
Nanyang University of Technology, Singapore
Inje University,South Korea
University of Colombo, Sri Lanka
University of Peradeniya, Sri Lanka
National Yunlin University of Science and Technology, Taiwan
Chulalongkorn University, Thailand
Danang University of Technology, Vietnam
Hanoi Architectural University (HAU), Vietnam
Hue College of Economics, Vietnam

Observers and /or Advisors

ADRRN, Myanmar Engineering Society
GTZ Pakistan, SEEDS, United Nations University

Updated list as of March 2011

APN

ASIA PACIFIC ADAPTATION NETWORK

Asian Network on Climate Science & Technology (ANCST)

- IPCC Workshop on AR5, 4 July 2014, Shangrila Putrajaya [100 participants]
- ANCST Workshop on Atmospheric Chemistry and Climate Change, 14-15 July 2014, UM, K.L. [50 participants]
- Asia Pacific Adaptation Forum, 1-3 October 2014, PWTC, K.L. [200 Malaysians + 600 International]

17 countries and region

CONCLUDING REMARKS

- **Networking among researchers, academics and practitioners of multidisciplinary background is critical for advancing science, technology & innovation in DRR and CCA.**
- **Communication among policy and decision-makers (at all levels), and with researchers and academics is critical for building capacity as well as developing policy relevant tools and techniques.**
- **Availability and access to data is a challenge, limited use of data from geological, archaeological, social and historical studies.**
- **DRR and CCA as an iterative process using the best available science; combine top-down and bottom-up approaches, participation of all stakeholders, and community engagement should be a priority.**
- **Future lies in collaborative research with an area-based approach: AREA BASED DISASTER RESILIENCE PLAN**

Terima Kasih!

Science: Southeast Asia Disaster Prevention Research Initiative (SEADPRI UKM), Malaysian Meteorological Department (MMD), Universiti of Malaya (UM), Universiti Malaysia Sabah, Minerals and Geoscience Department Malaysia (JMG), National Hydraulic Research Institute of Malaysia (NAHRIM), Drainage and Irrigation Department (JPS), University of Cambridge, City University of Hong Kong, etc.

Governance: National Security Council (MKN), Town and Country Planning Department Malaysia, Public Works Department, etc.

Community: MERCY Malaysia, Civil Defense Department of Malaysia (JPAM), Schools and Community/Youth Organizations of selected pilot sites, etc.

Industry: Malaysian Industry-Government Group for High Technology (MIGHT), Param Agricultural Soil Survey, etc.

seadpri
southeast asia disaster prevention research institute

AKADEMI SAINS MALAYSIA