07 – 18 August 2023: ITIC Training Programme - Hawaii (ITP-HAWAII) on Tsunami Early Warning Systems and the PTWC Enhanced Products, Tsunami Evacuation Planning and UNESCO IOC Tsunami Ready Recognition Programme, Honolulu.

TSUNAMI WARNING SYSTEM AND MITIGATION PLANS IN MALAYSIA

MUNIRAH BINTI ARIFFIN
Malaysian Meteorological Department (MET Malaysia)
Ministry of Natural Resources, Environment and Climate Change (NRECC)

10 AUGUST 2023 | INOUYE REGIONAL CENTER (IRC) - NOAA

SCOPE OF PRESENTATION


Photo courtesy of Hezron G. Koro (MET Malaysia)


Photo courtesy of AFP/BERNAMA)

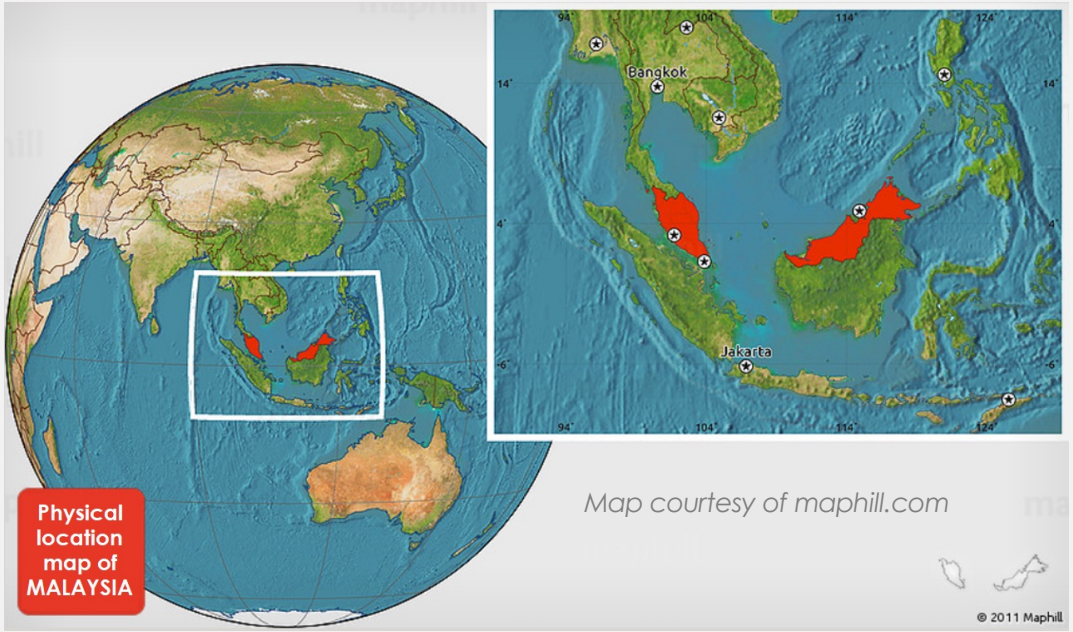
01 Earthquake & Tsunami Threats
Seismic and tsunami hazards and risks study in Malaysia

02 Tsunami Early Warning System
MNTEWS and the architecture of the early warning system

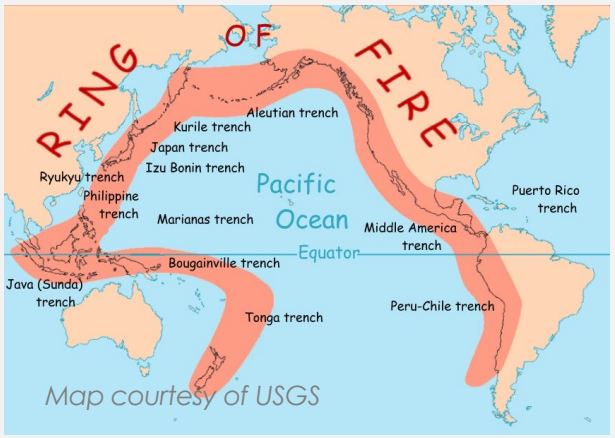
03 Disaster Management (DM)
Tsunami warning chain and the mechanism of DM in Malaysia

04 Mitigation Plans
Status, challenges and way forward

Overview



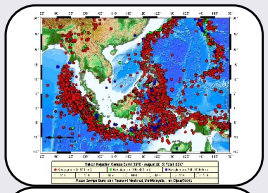
- Located in the Southeast Asia region
- Divided in **two geographic parts**; West Malaysia (Malay Peninsular) and East Malaysia (northwestern part of Borneo Island)

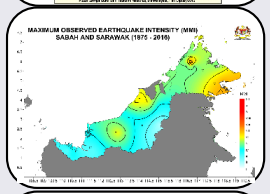


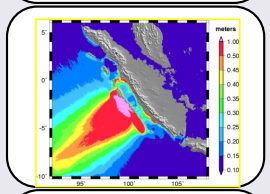
- Lies outside of the Ring of Fire and of historical tropical cyclone paths
- Frequent grapples with **floods**, **storms**, **landslides**, **heatwaves**, **haze**, **drought** and **earthquake**.

Main Components
Tsunami Early Warning System in Malaysia

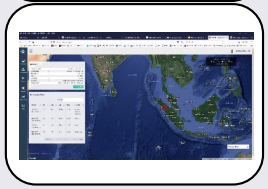
RISK & HAZARD KNOWLEDGE



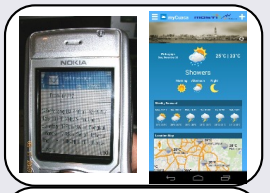




MONITORING & ANALYSES



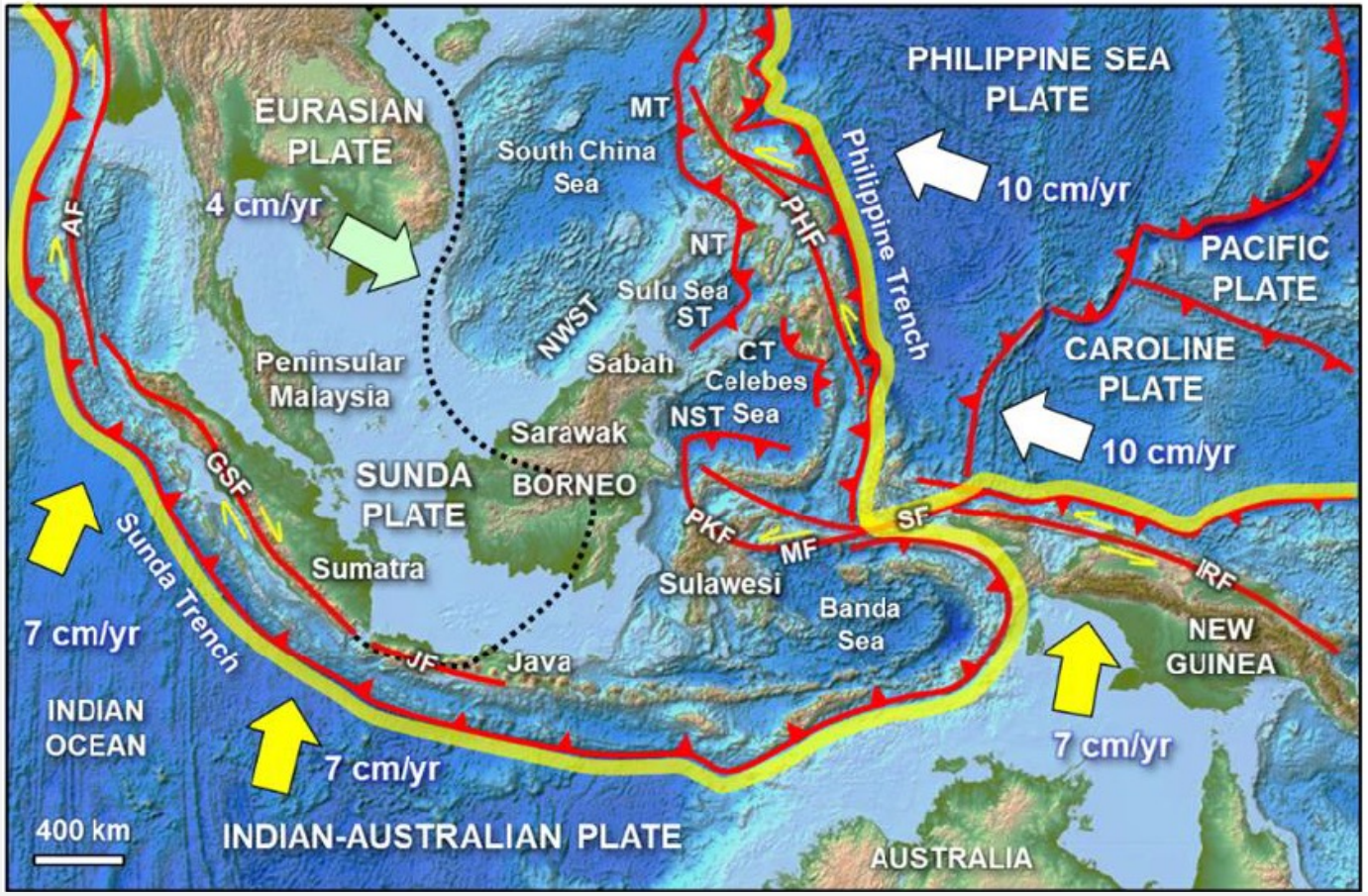
EFFECTIVE DISSEMINATION



RESPONSE CAPACITY

SEISMIC AND TSUNAMI HAZARDS AND RISKS IN MALAYSIA

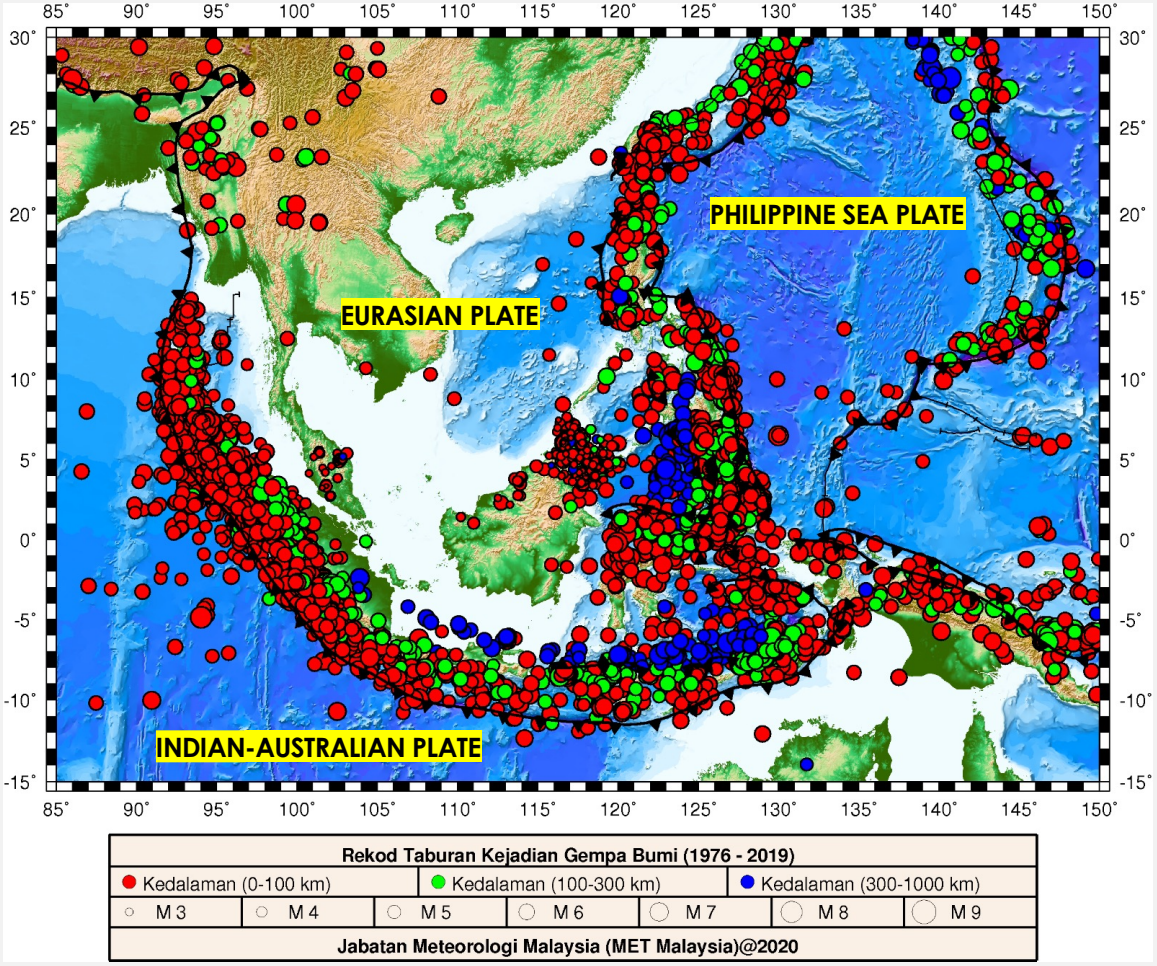
Seismotectonic setting around Malaysia



Map courtesy of Natural Disaster Research Centre, University Malaysia Sabah, Malaysia (NDRC – UMS)

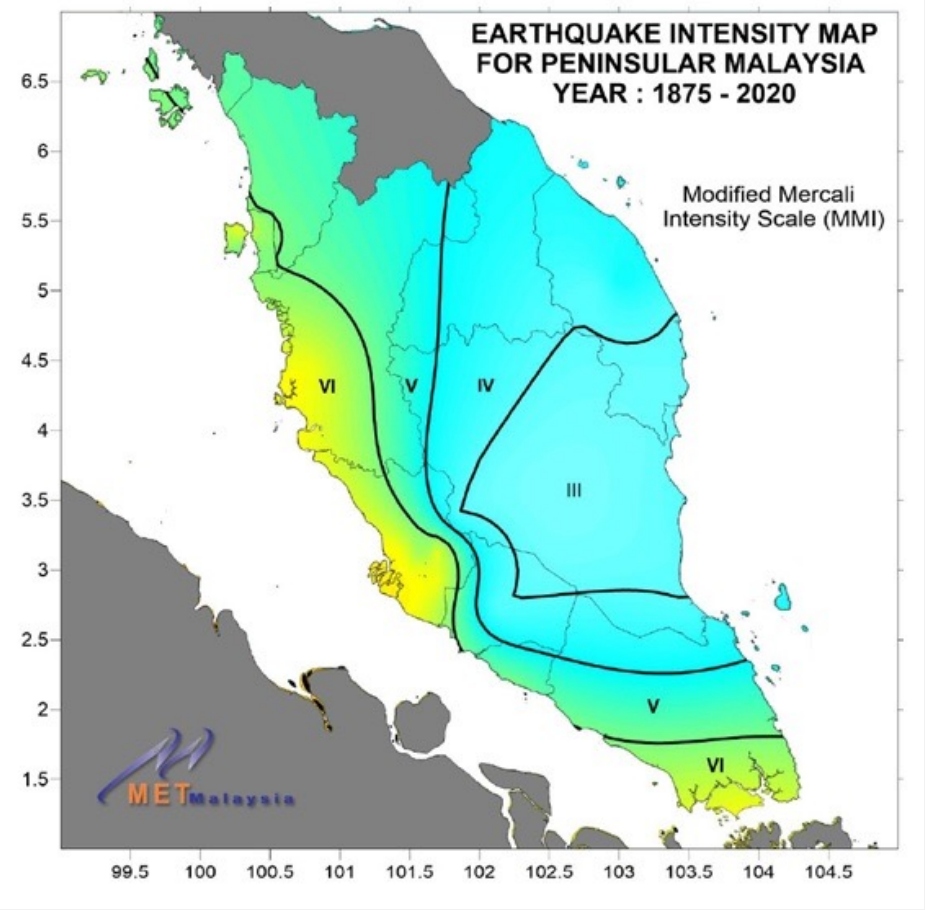
- Earthquake in Malaysia are closely associated with the **plate movement** in this region
- **Peninsular Malaysia** sitting on the Sunda Shelf lies passively behind Great Sumatran Fault Zone and Sunda Trench Subduction Zone.
- **Sabah and Sarawak** sitting on the semi-stable South China Sea Basin, influenced by active mobile belts in Celebes and Philippines.

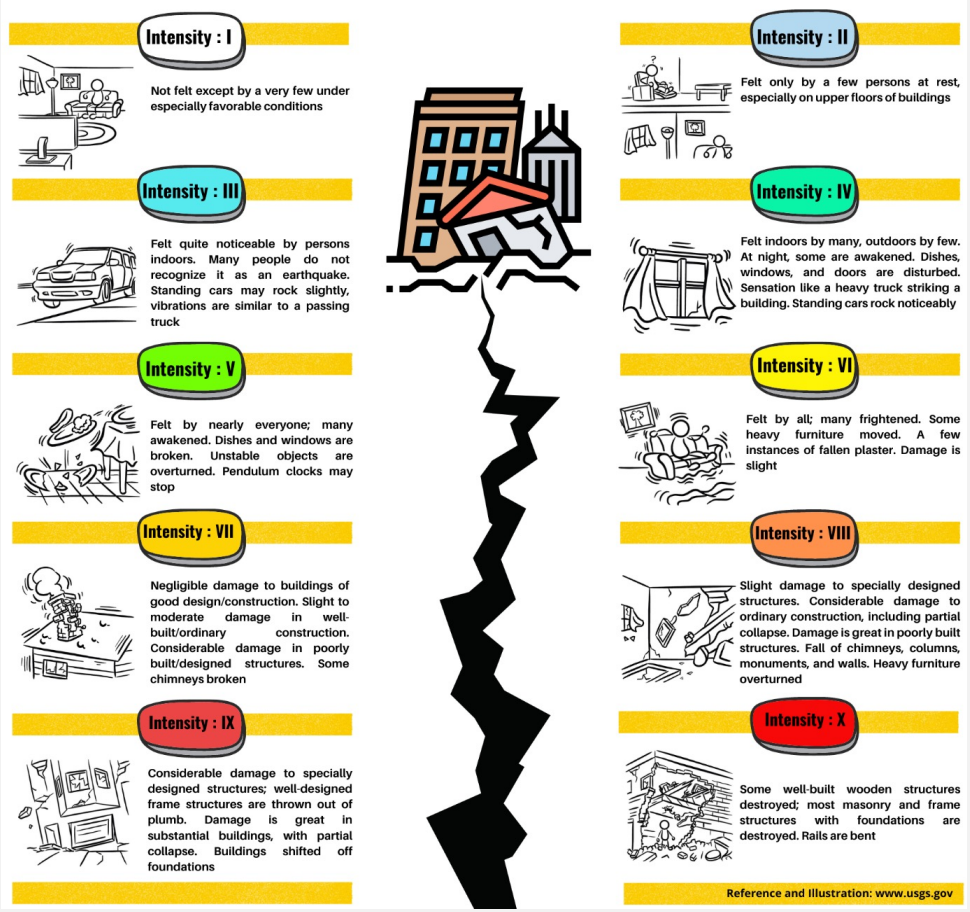
Earthquakes distribution in Malaysia



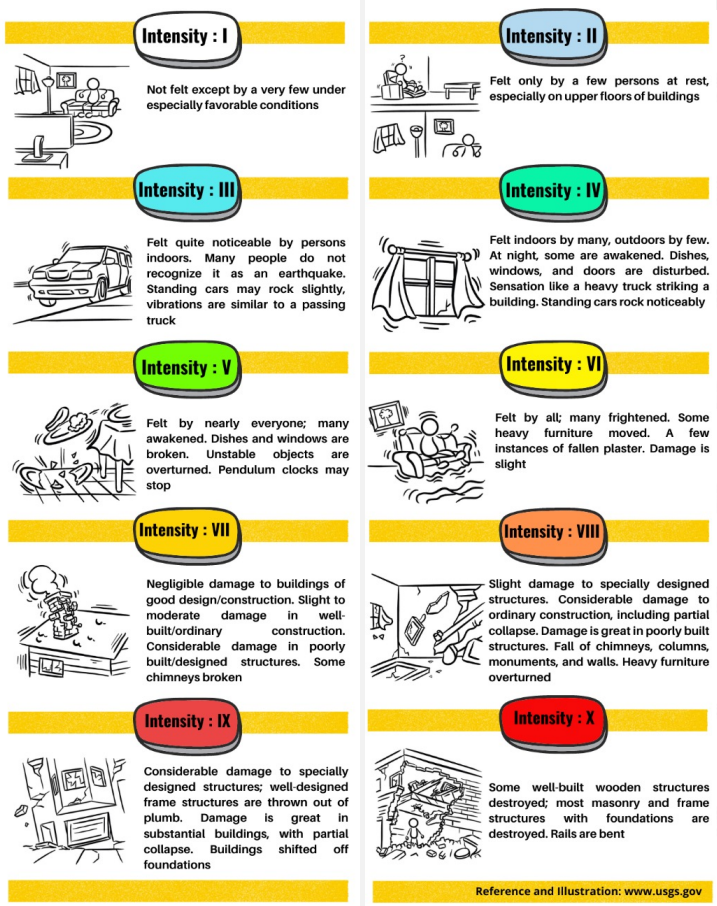
- Malaysia affected by both **local** and **regional** earthquakes.
- Major earthquakes originating from Sumatra - Indonesia have been felt several times in **Peninsular Malaysia**. The effect is small, but it is still of concern, especially to vulnerable high rise buildings.
- Earthquakes from the Sulu and Celebes seas are periodically felt as slight tremors in **Sabah**.
- Rare earthquake occurring in Kalimantan - Indonesia is felt as slight tremors in **Sarawak**.

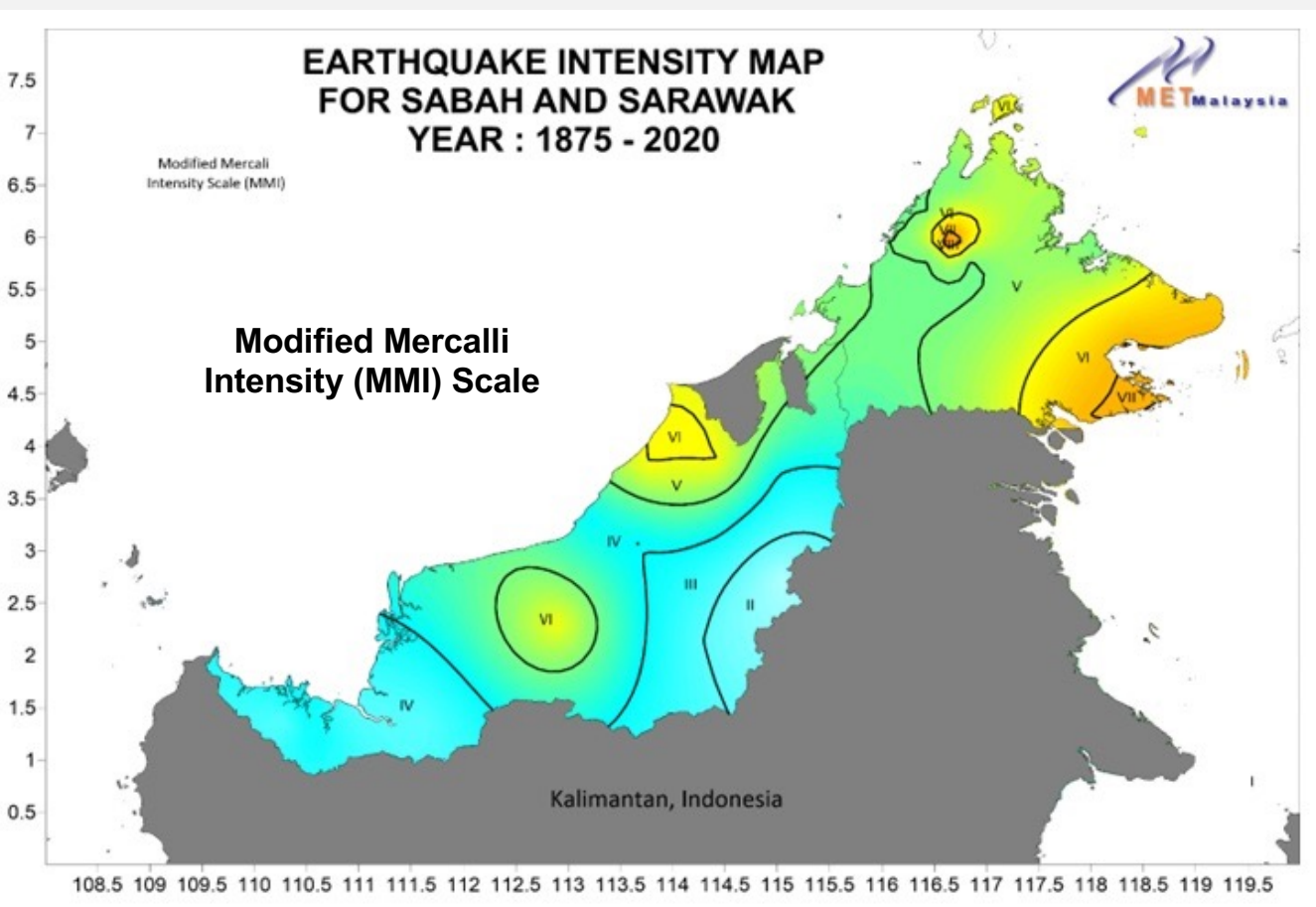
Earthquake Intensity Map



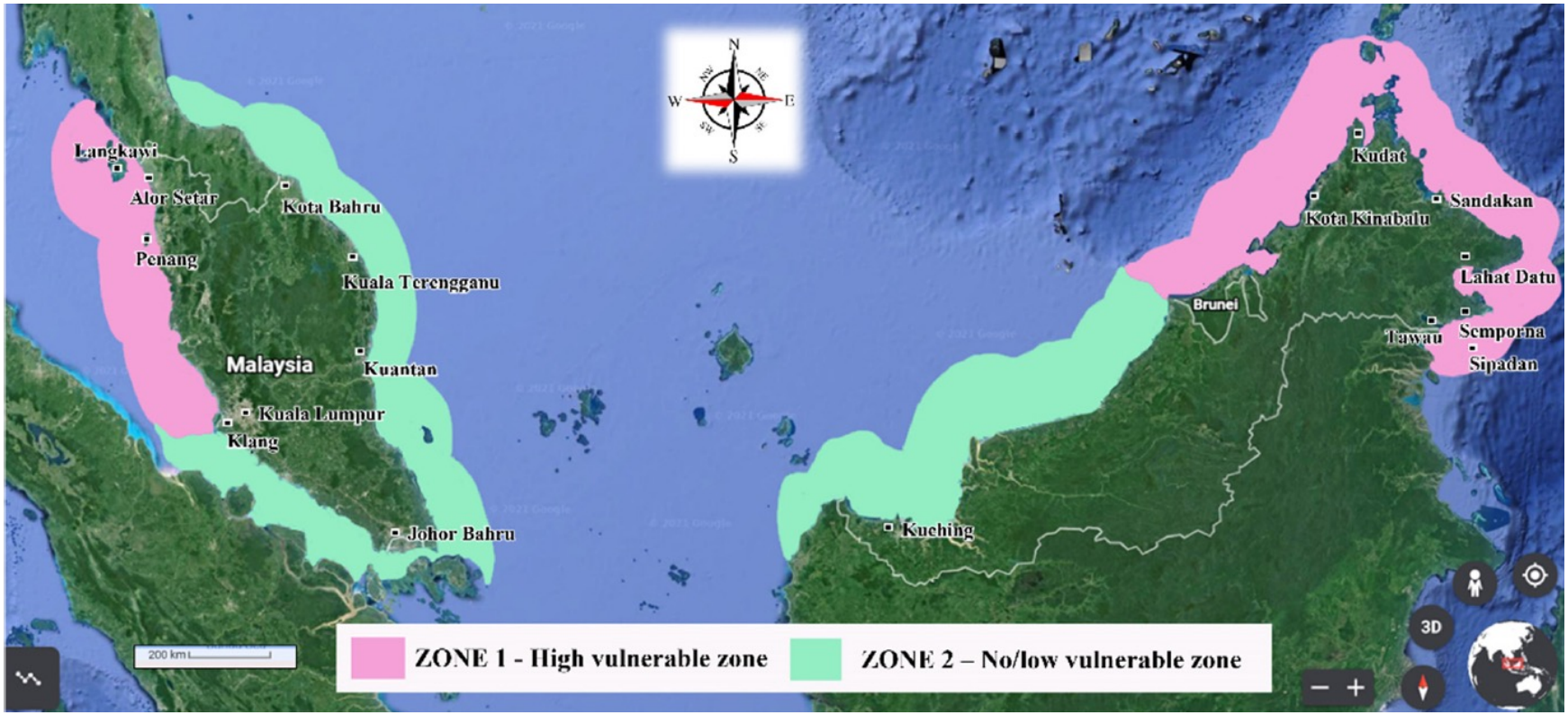


Earthquake Intensity Map





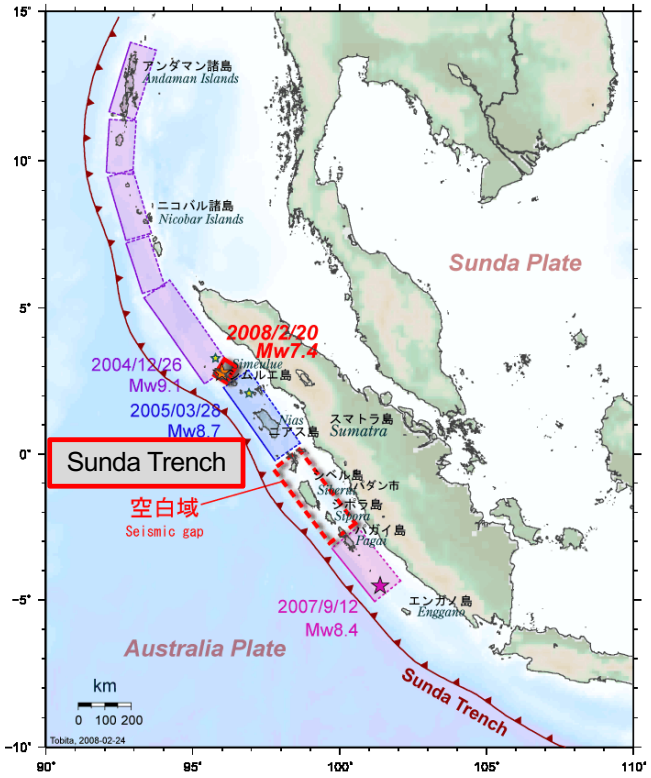
Tsunami risk zones in Malaysia

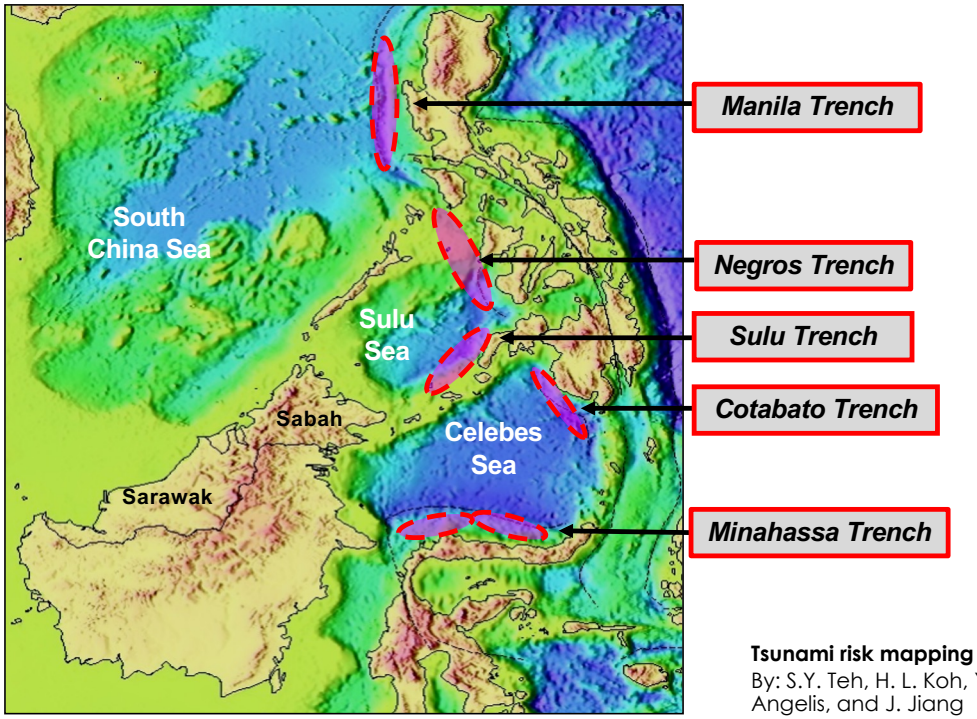


MOSTI. Seismic and Tsunami Hazards and Risks Study in Malaysia; Academy of Sciences Malaysia (ASM): Kuala Lumpur, Malaysia, 2009; pp. 1–46.

Potential tsunamigenic zones

Of particular concern to Malaysia are **tsunamigenic earthquakes** occurring along the northern part of the Sunda Trench. Further, the Manila Trench in the South China Sea has been identified as another source of potential tsunamigenic earthquakes that might trigger large tsunamis.





Felix et al. (2010)

Tsunami risk mapping simulation for Malaysia
By: S.Y. Teh, H. L. Koh, Y.T. Moh, D. L. De Angelis, and J. Jiang
https://doi.org/10.2495/DMAN110011

DEVELOPMENT OF TSUNAMI EARLY WARNING SYSTEM IN MALAYSIA

Tsunami Early Warning System in Malaysia

2005 **MNTEWS was established**

- Early warning system for tsunami was not in place prior to 2004
- Only after Indian Ocean Tsunami of 26 Dec 2004, MNTEWS was established in **2005**
- Main objective is to warn early detection, assessment and rapid alerting to various stakeholders and public so that effective respond can be made to save lives

Malaysian National Tsunami Early Warning System (MNTEWS)

Lessons learnt from 26 Dec 2004 Earthquake and Tsunami

- MNTEWS was established in 2005.
- To detect, locate, and determine the magnitude of earthquakes occurring inside and outside Malaysia
- Real-time continuous monitoring of earthquake occurrences and tsunami on a 24/7 basis.
- Issuance of information, advisory, early warning and warning on the occurrence of earthquake and tsunami that threaten the security and safety of Malaysia.

Architecture of MNTEWS

MNTEWS

DATA ACQUISITION

DATA

DATA PROCESSING

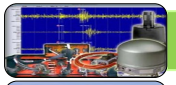
PROCESS

DISSEMINATION AND RESPONSE CAPACITY

OUTPUT

8 MIN

REAL TIME MONITORING


• SEISMIC NETWORK

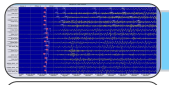

• TIDE GAUGE NETWORK


• COASTAL CAMERA SYSTEM


• PTWC/NWPTAC/JMA/SCSTAC


• GSN/IRIS

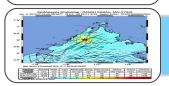
SOFTWARE & APPLICATION


• SEISMIC SOFTWARE


• ADMIS SYSTEM


• TIDE TOOL SYSTEM


• IDMS SYSTEM


• SHAKEMAP

RESPONSE CAPACITY


• SMS, EMAIL & FAX

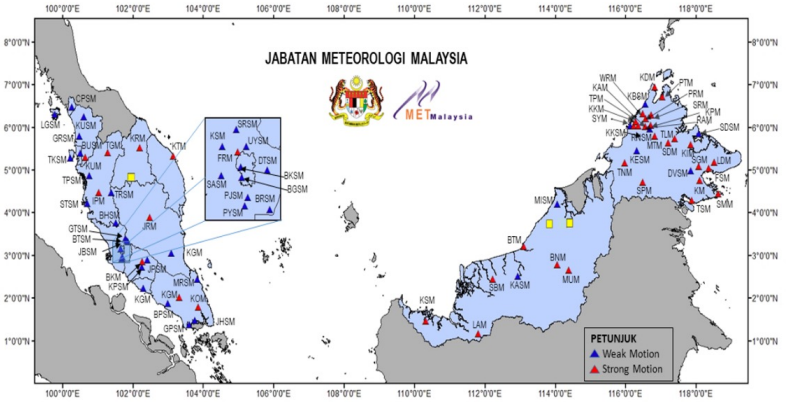
• MYGEMPA/WEBSITE


• TSUNAMI SIREN


• RESPONSE CAPACITY


• TV & RADIO

SEISMIC PROCESSING SOFTWARE



Local seismic station

International seismic stations

INPUT

OUTPUT

JABATAN METEOROLOGI MALAYSIA
KEMENTERIAN SUMBER ASLI, ALAM SEKITAR DAN PERUBAHAN IKLIM

Jalan Sultan,
46667 Petaling Jaya,
Selangor Darul Ehsan
Malaysia

Tel : +603-79678000
Faks : +603-79578052
Emel : seismo@met.gov.my
Web Site: www.met.gov.my

JMM/POCGN(O)/BK-27B

Ruj. kami: JMM.APL15/442/19 JId (68)/(91)

Dikeluarkan pada pukul **9:12 pagi, 31 Mei 2023**

MAKLUMAT GEMPA BUMI

Satu gempa bumi sederhana telah berlaku dengan maklumat parameter berikut:

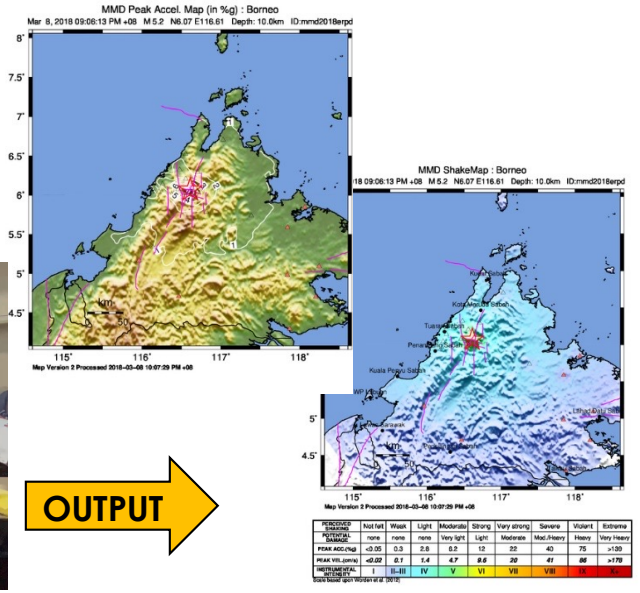
Waktu Kejadian	: 8:58 pagi, 31 Mei 2023
Koordinat	: 0.9° Selatan 98.7° Timur
Lokasi	: Selatan Sumatera, Indonesia
Magnitud	: 5.0
Jarak	: 55km Barat Laut dari Siberut,Indonesia
Kedalaman	: 52 km

Penilaian
Tiada ancaman tsunami kepada Malaysia

Ini adalah maklumat akhir yang dikeluarkan oleh jabatan berkaitan kejadian gempa bumi tersebut melainkan jika terdapat perkembangan lanjut atau maklumat tambahan.

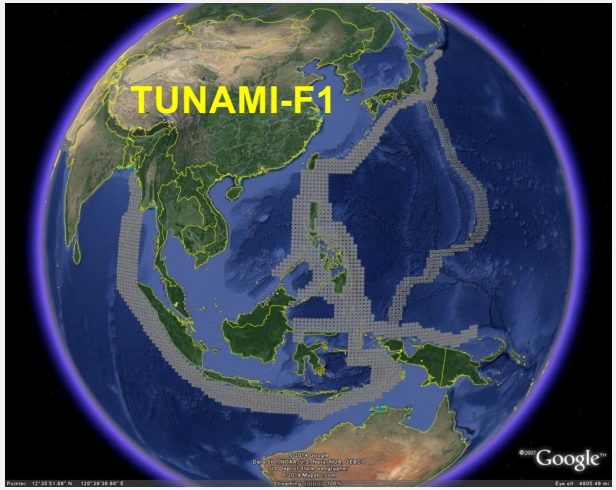
Earthquake Bulletin

OUTPUT



ShakeMap (Intensity, PGA)

TSUNAMI MODELLING AND DATABASE



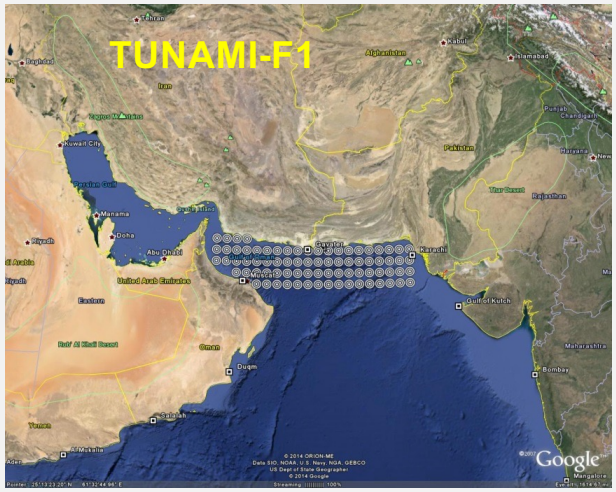
TUNAMI MODEL, TOHOKU UNIVERSITY, JAPAN

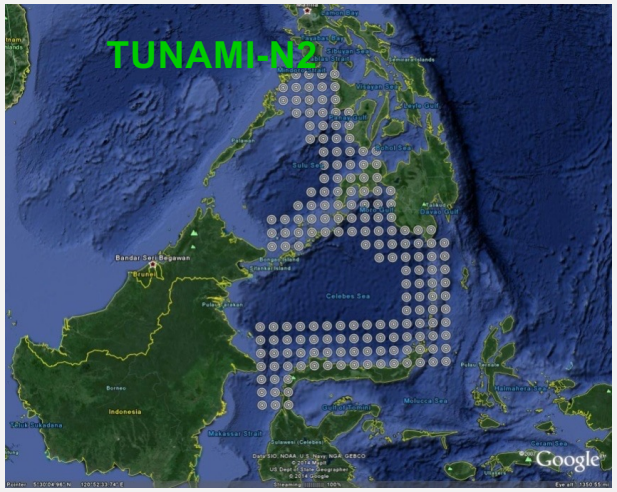
TUNAMI-N2 Simulation

- 181 Simulation Points x 20 scenarios
- Total scenarios = 3,620

TUNAMI-F1 Simulation

- 2,233 Simulation Points x 20 scenarios
- Total scenarios = 44,660





∑: 48,280 scenarios

(M_w)
6.5
7.0
7.5
8.0
8.5

Depth (km)
0
20
40
60

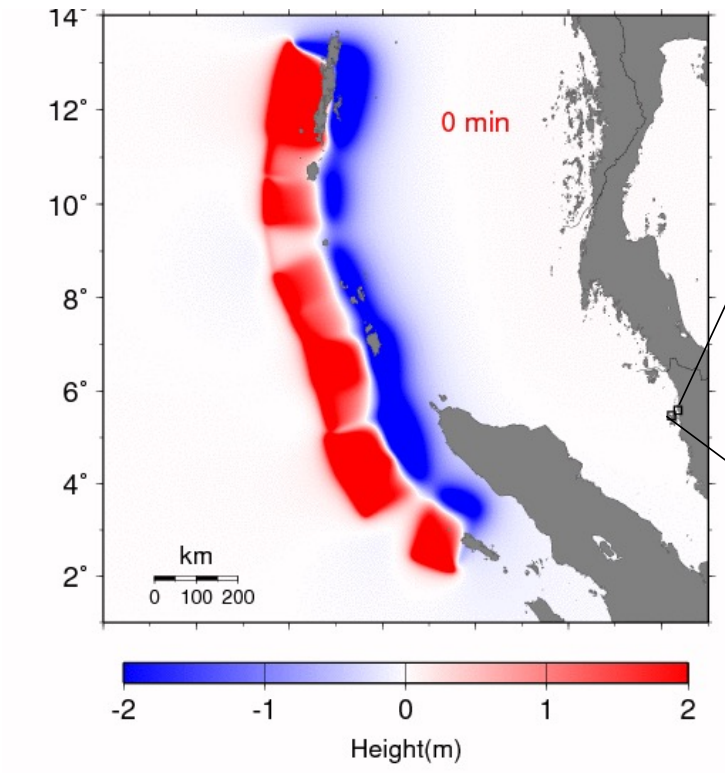
Forecasting: Pre-computed tsunami database using TUNAMI codes & Tsunami Travel Time (TTT).

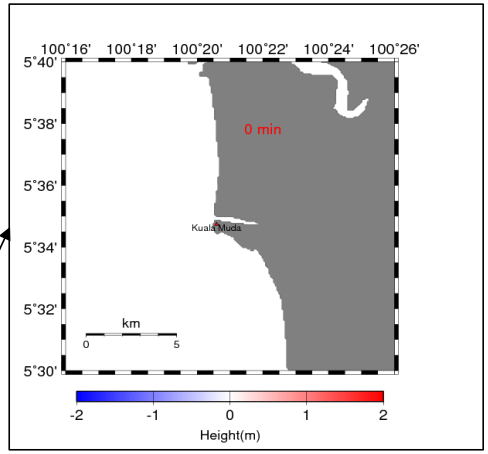
Tsunami modeling

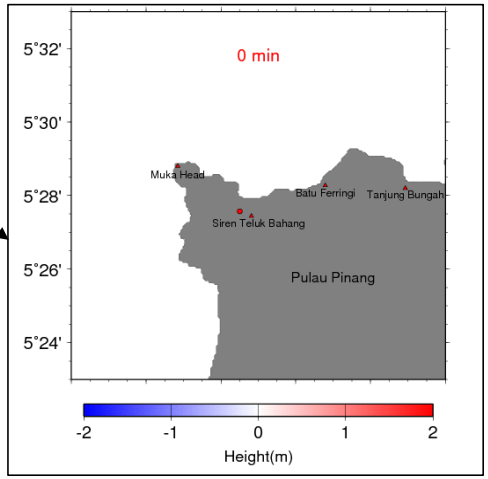
example of Indian Ocean Tsunami (M9.3, 26 Dec 2004)

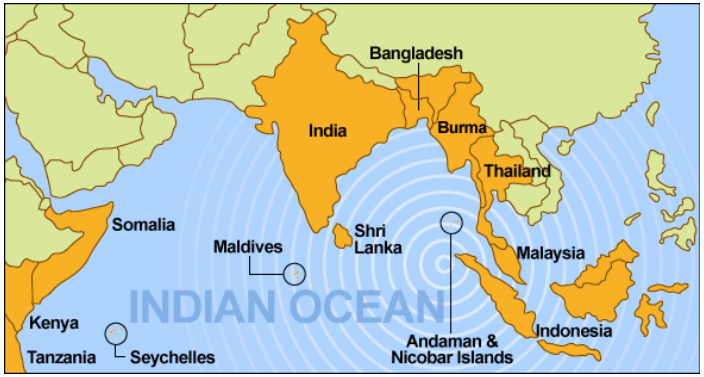
- Kedah, P. Pinang, Perak & Selangor
- 68 dead, 5 missing
- Loss and damage amounting > RM100M

Source: Laporan Penyiasatan Pasca Tsunami 26 Dis 2004 (JPS)

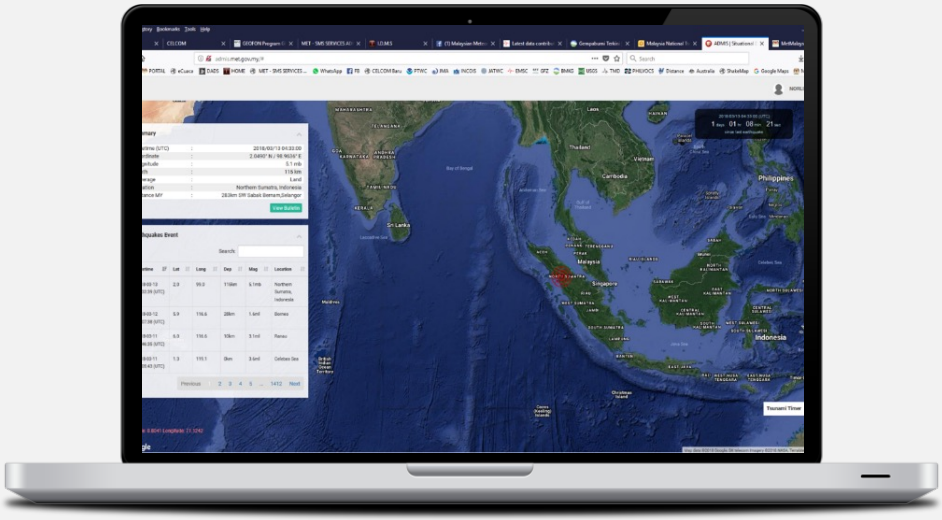








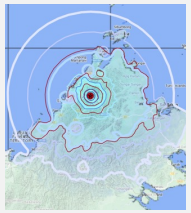
ADMIS | Decision support system

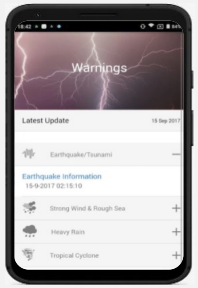


Advanced Decision and Dissemination Malaysian Seismic and Tsunami Information System (ADMIS)

- Integration of decision support system and dissemination of information and warning according to the SOP
- Automatic solution, to reduce mistake in generating earthquake bulletin and tsunami warning
- Dissemination of earthquake bulletin / information and tsunami warning via muti-channel platform example SMS, fax, website, e-mail and social media
- Able to generate tsunami travel time and tsunami height in real time

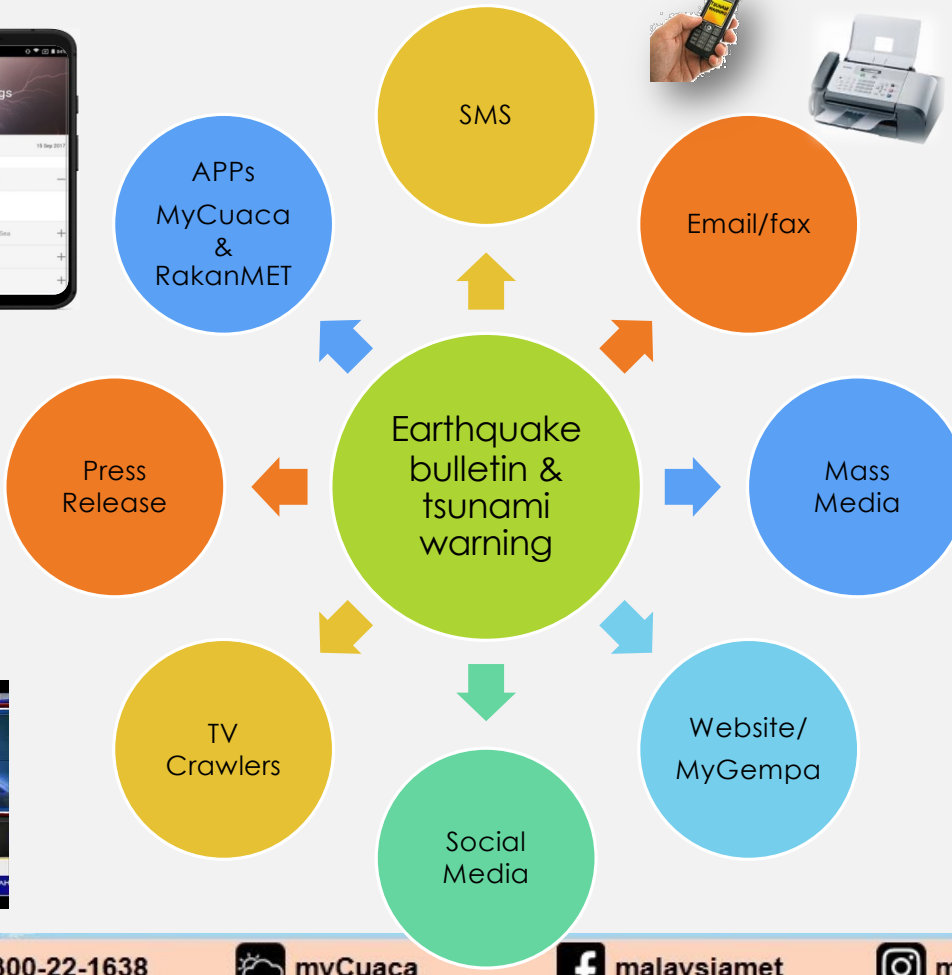
DISSEMINATION COMPONENT



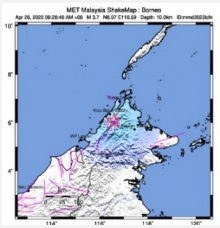


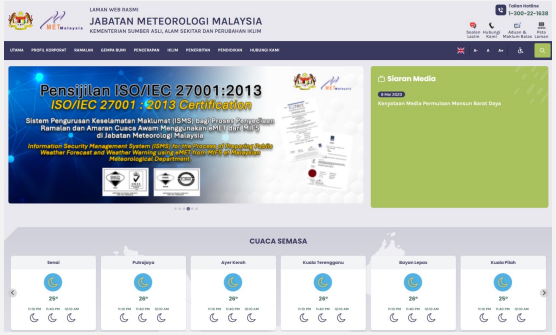
Jabatan Meteorologi Malaysia
@metmalaysia

Gempa bumi sederhana telah berlaku di Semenanjung Minahassa, Sulawesi pada jam 9:25 pagi, 29 Mei 2021
Koordinat : 1.3° Utara dan 120.2° Timur
Magnitud : 5.5 skala Richter
Jarak : 245km Utara dari Palu,Indonesia
Kedalaman : 12 km
Tiada ancaman tsunami kepada Malaysia.MET Malaysia.



Kategori	Petunjuk	Tindakan
AMARAN TSUNAMI	Ketinggian tsunami dijangka 0.5 meter atau lebih di pantai Malaysia.	Berpindah ke tempat selamat seperti ke tempat yang lebih tinggi atau tempat perpindahan sementara yang telah ditetapkan.
NASIHAT TSUNAMI	Ketinggian tsunami dijangka kurang daripada 0.5 meter di pantai Malaysia.	Menjauhi kawasan pantai dengan segera.
PEMBATALAN/ PENAMATAN TSUNAMI	Tidak terdapat ancaman tsunami atau ancaman tsunami telah berakhir.	Patuhi arahan pihak berkuasa: - Pulang ke rumah jika selamat - Berpindah ke tempat perpindahan sementara jika terdapat kerosakan.

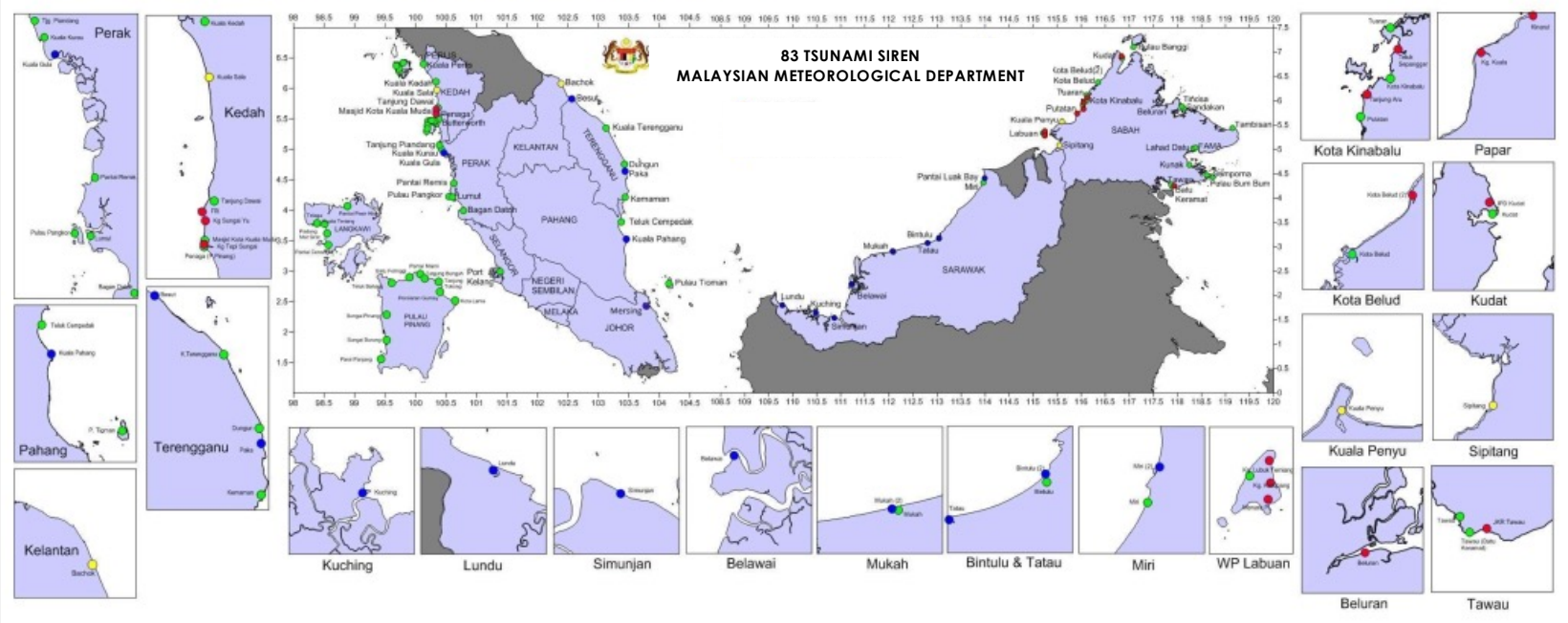




www.met.gov.my | 1300-22-1638 | myCuaca | malaysiamet | metmalaysia | metmalaysia

Response Capacity

TSUNAMI SIREN



83 TSUNAMI SIREN

LOCATION

42 *PENINSULAR*

11 *SARAWAK*

30 *SABAH & WP LABUAN*

Tsunami Siren

Different siren tone or sound and voice message in both language Malay and English

PERCUBAAN PERCUBAAN 1 2 3 4 5

TESTING TESTING 1 2 3 4 5

NASIHAT TSUNAMI
Jauhi daripada pantai dan muara sungai.

TSUNAMI ALERT
Keep away from the beach and river mouth.

AMARAN TSUNAMI
Pindah ke tempat selamat dengan serta-merta.

TSUNAMI WARNING
Evacuate immediately to a safe location.

AMARAN TSUNAMI ditamatkan.
Tiada lagi ancaman tsunami.

TSUNAMI WARNING Is cleared.
There is no more tsunami threat.

DISASTER MANAGEMENT SYSTEM IN MALAYSIA

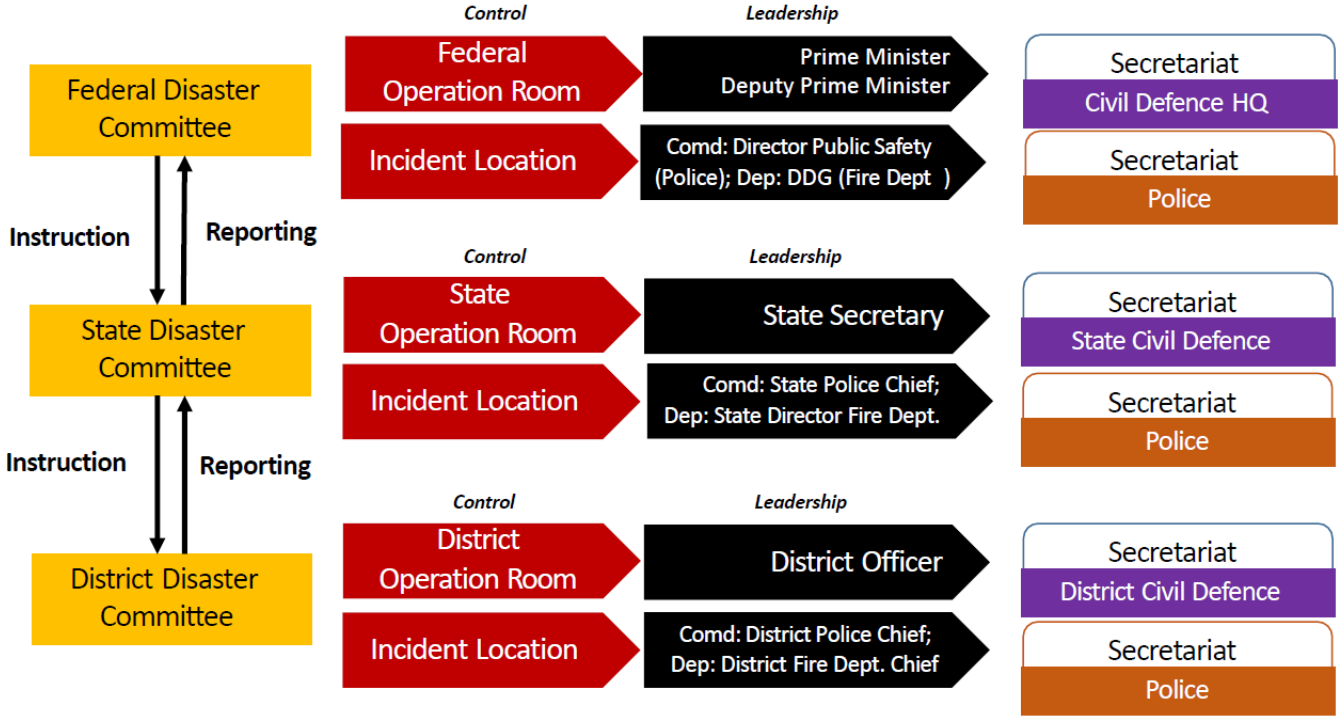
MECHANISM OF DM IN MALAYSIA

National Disaster Management Agency (NADMA Malaysia) is the Lead Government Agencies in Disaster Response

Level III disaster response involves more than one state or is of a complex nature that requires federal-level resources, coordination, or foreign aid.

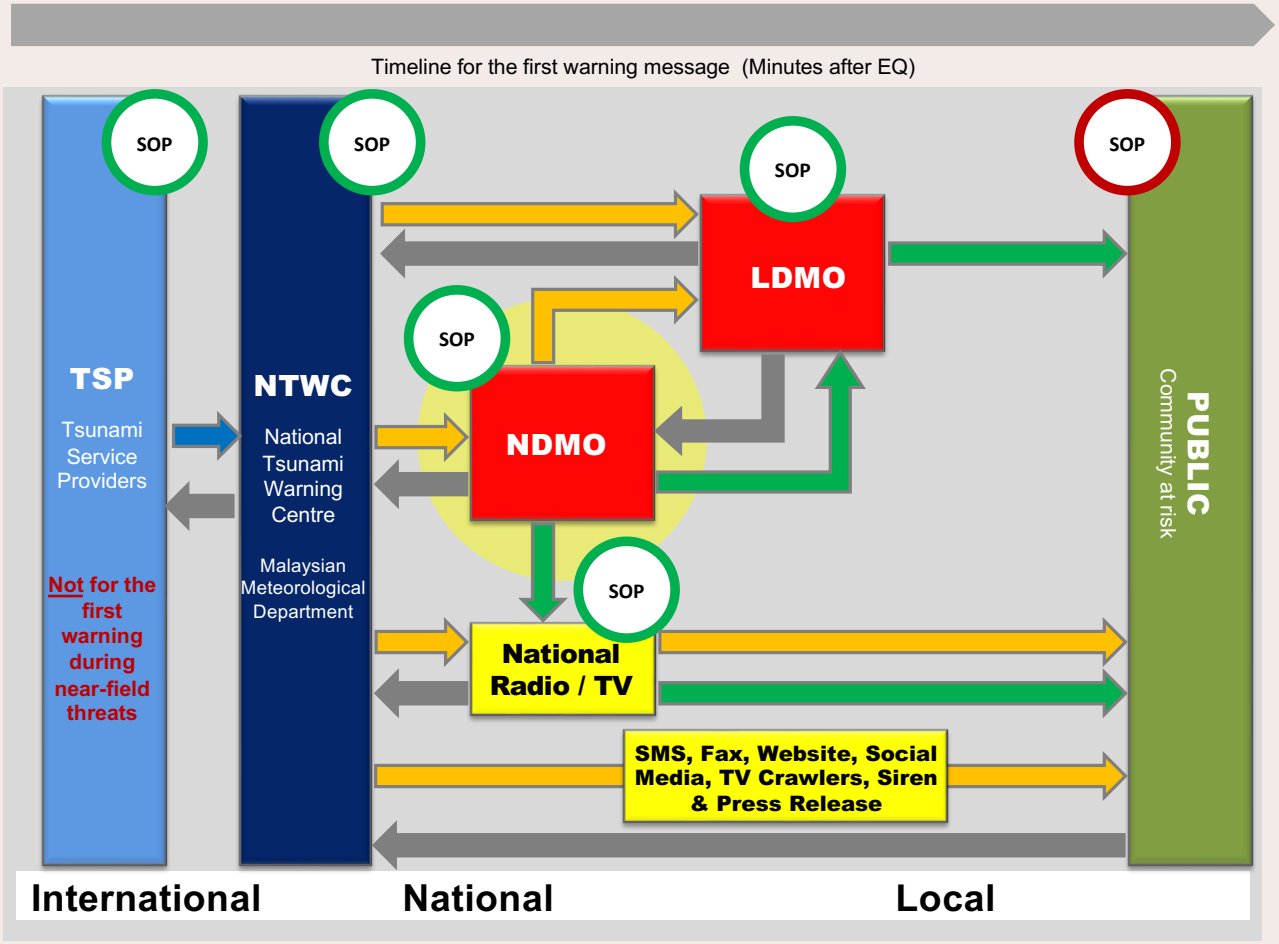
Level II describes a disaster response that involves more than one district in the same state and requires pooled state resources with limited federal assistance.

Level I signifies that agencies within one district are able to respond to a disaster in their area with little or no outside help.



Disaster Response by Federal, State, and Local Level

Diagram Concept of Tsunami Warning Chain in Malaysia



Information

Warning

Warning and Advice

Official call for evacuation

Feed Back

Agency responsible to decide on official call for evacuation

Malaysia

Updated May 2023

MITIGATION PLANS

Mitigation Plan

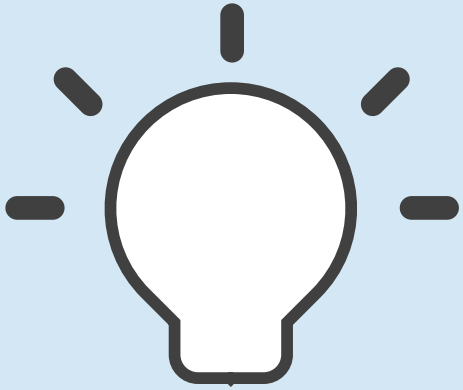
01 **Development of Seismic Hazard Map**
Lead by Department of Mineral and Geoscience

02 **Development of National Seismic Building Code**
Lead by Department of Standards Malaysia (EU8) Design for Structures for Earthquake Resistance

03 **Awareness & Standard Operating Procedure**
Lead by National Disaster Management Agency of Malaysia

04 **Planning Guideline in High-Risk EQ Area**
Lead by Department of Town and Country Planning PLANMalaysia

05 **Research, Scientist & Technical Agencies**
University, technical agencies, task team etc



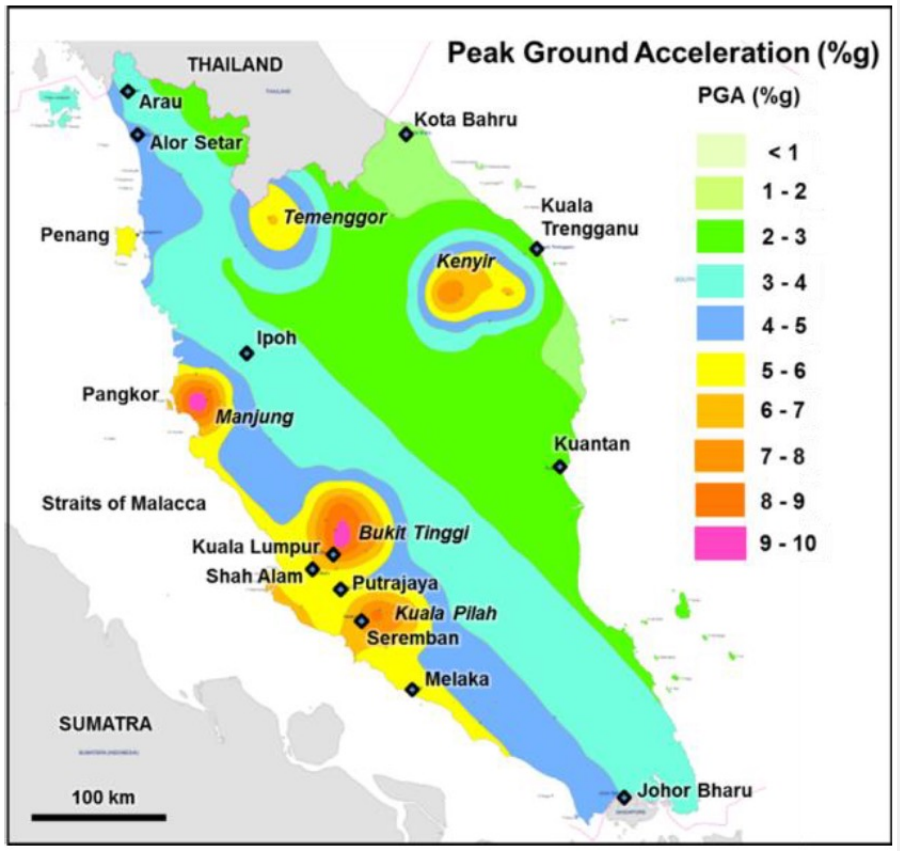
Risk Management

Development of Seismic Hazard Map

- The seismic hazard map shows the probable peak ground acceleration (PGA) values for different parts of Malaysia.
- The seismic hazard map was developed by a group of local experts on earthquake comprising of various government agencies, non-government agencies and universities.
- The analysis is based on **Probabilistic Seismic Hazard Assessment (PSHA)** using active fault lines mapped by JMG and earthquakes from the MET Malaysia database and the United States Geological Survey (USGS) earthquake database.
- In **late 2017 the first edition of seismic hazard map of Malaysia was published** by JMG and used in the Malaysia National Annex MS EN1998:2015 Eurocode 8; Design for Structures for Earthquake Resistance – Part 1: General Rules, Seismic Actions and Rules for Buildings.

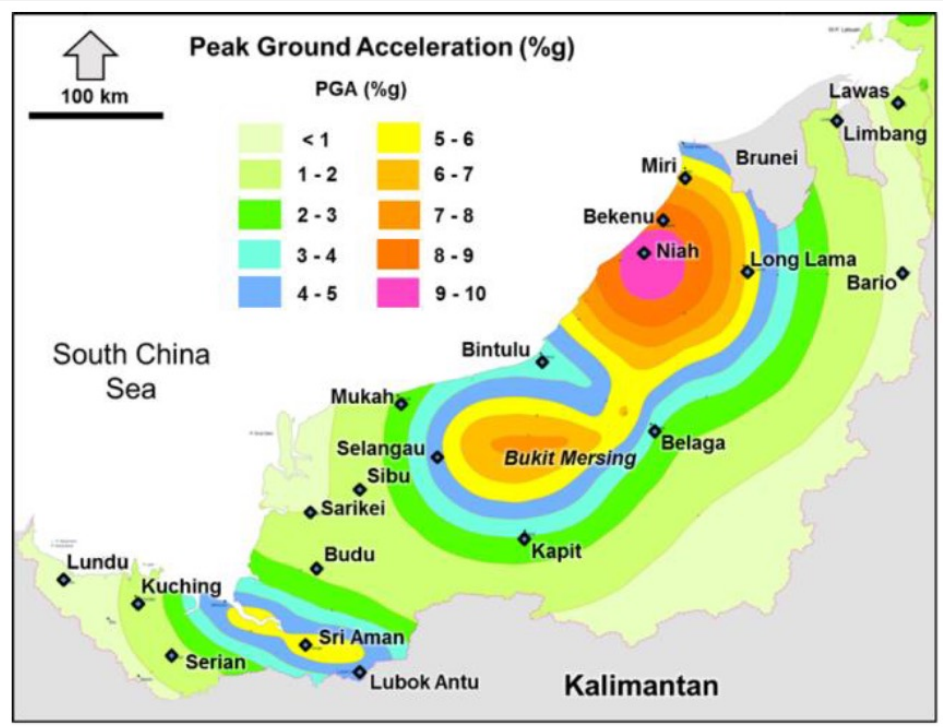
Seismic Hazard Map: Peninsular

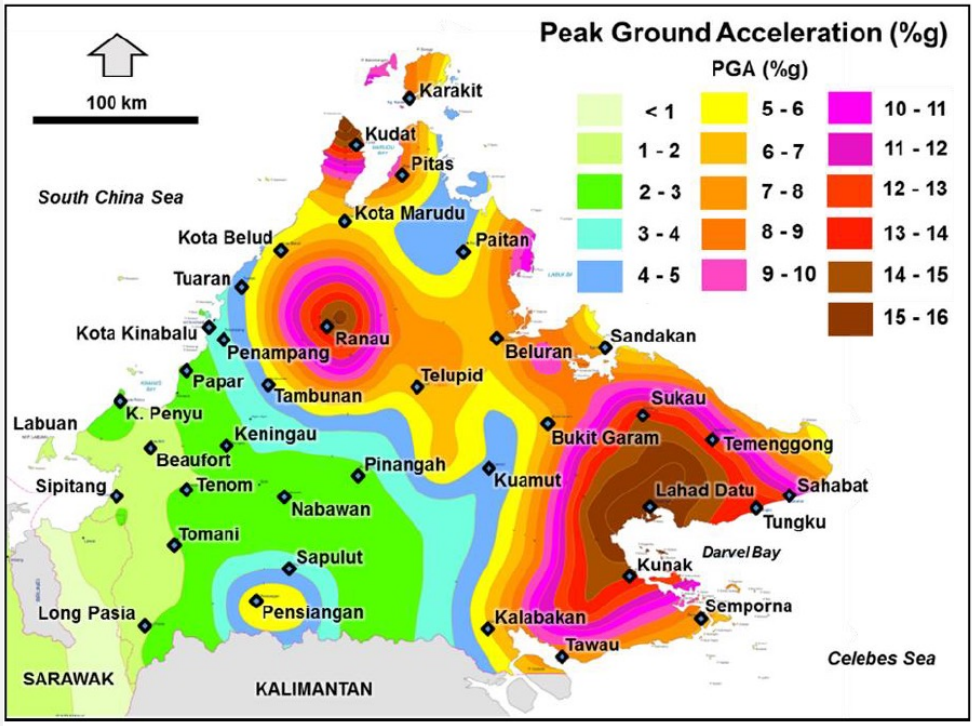
- Seismic hazard is the hazard associated with potential earthquakes in a particular area.
- The JMG produce the regional Seismic Hazard Map of Malaysia.
- The map is used by various stakeholders for land-use planning, mitigation, and emergency response. For example:
  - local town planners/building officials – to set appropriate building & retrofitting standards
  - Government/civil defense – to plan for disaster recovery
  - Professionals – to conduct detailed site assessments.
- Seismic hazard map shows the relative hazards in different areas. The maps are made by considering what we currently know about:
  i. Past faults and earthquakes,
  ii. The behavior of seismic waves as they travel through different parts of the crust, and
  iii. The near-surface site conditions at specific locations of interest.



Seismic hazard map of 475 year return period PGA on rock for Peninsular Malaysia.
Source: Department of Minerals and Geoscience - JMG (2018)

Seismic Hazard Map: Sabah & Sarawak



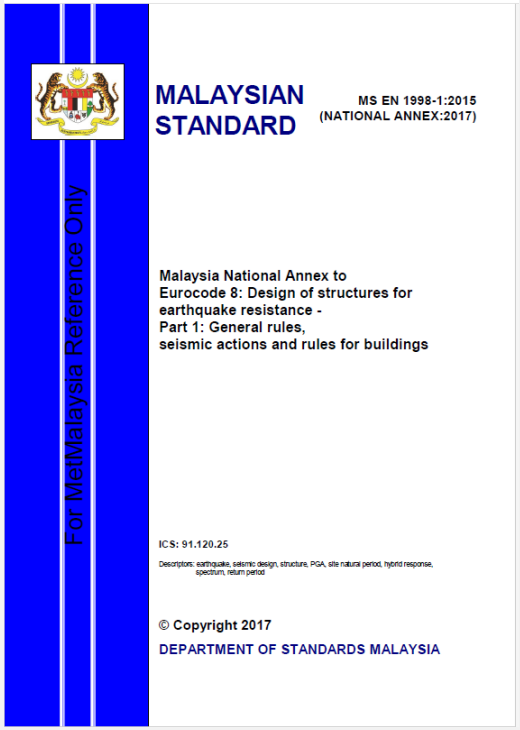


Seismic hazard map of 475 year return period PGA on rock for Sarawak and Sabah.
Source: Department of Minerals and Geoscience - JMG (2018)

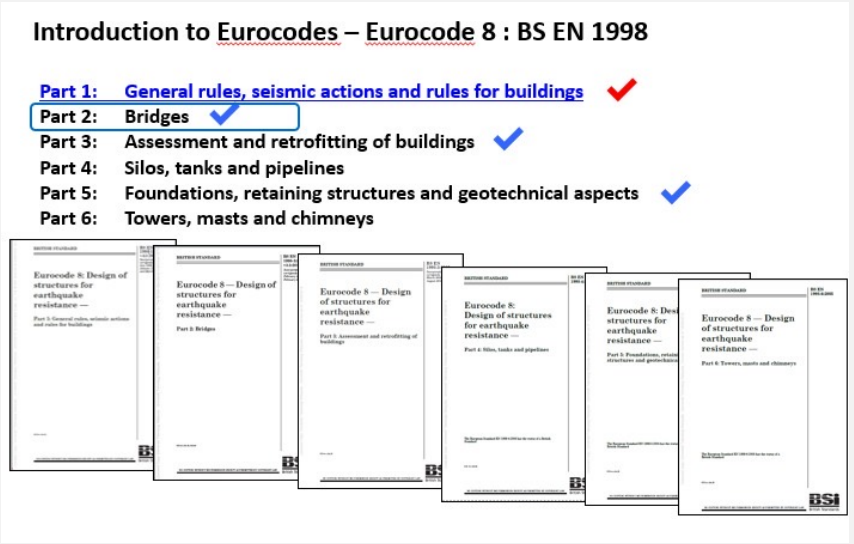
Malaysian Standard & National Annex

Development of National Seismic Building Code

Building codes are designed to create quality assurance and durability, with the objective to minimize economic loss due to material and structural deterioration and to provide basic comfort and safety conditions.



In earthquake-prone areas, building codes are complemented by seismic codes, specifying the calculation methods and strength values of key structural elements to avoid building collapse during an earthquake.



Public Awareness Programme | 2006 - 2022

Year	Tsunami Drill		Awareness Campaign	
	No. of Series	Involvement	No. of Event	Involvement
2006	1	2,000	0	0
2007	1	1,000	5	480
2008	0	0	15	2,169
2009	1	1,000	13	2,694
2010	0	0	3	438
2011	4	2,500	5	793
2012	2	1,480	7	1,208
2013	2	1,372	7	1,014
2014	2	1,674	8	1,488
2015	0	0	6	1,159
2016	1	1,200	2	1,550
2017	2	1,150	2	1,150
2018	2	5,200	4	3,129
2019	1	1,200	10	2,900
2020	0	0	12	7,997*
2021	0	0	13	22,918*
2022	0	0	7	6,930*
∑	19	19,776	119	58,017

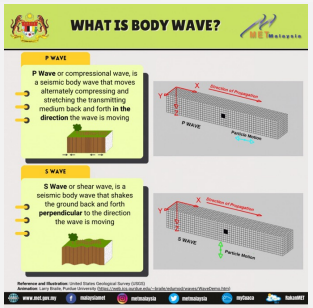
*virtual programme (pandemic)

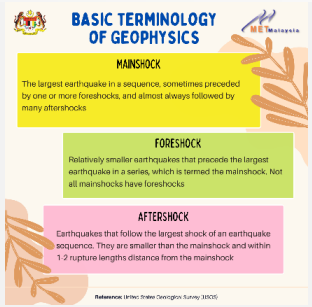
Tsunami Drill | Putatan Sabah 2016

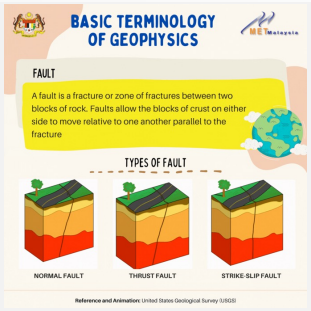
Tsunami Drill | Tawau Sabah 2018

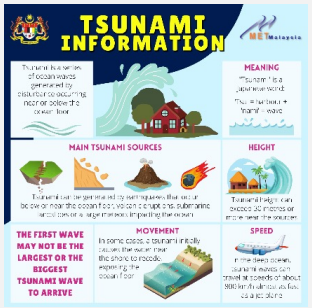
Public Awareness Programme | 2006 - 2022

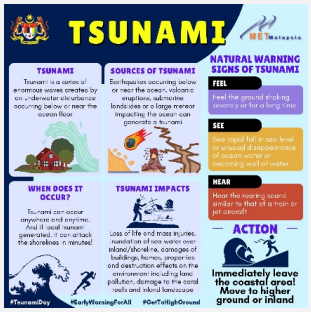
Awareness Materials

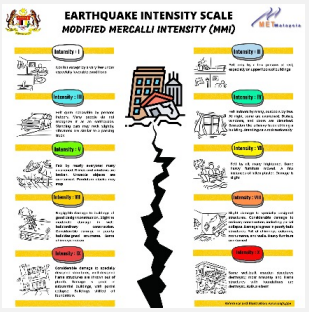


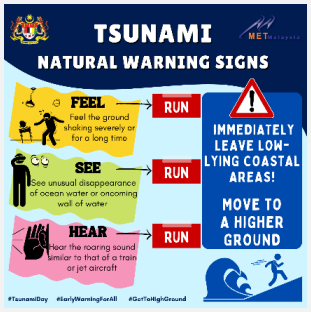


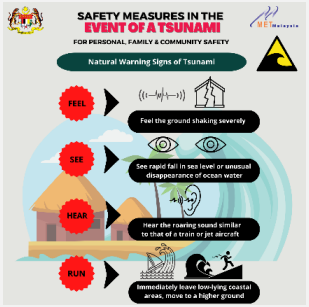


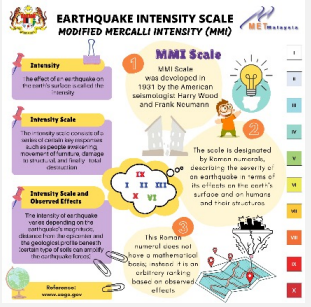


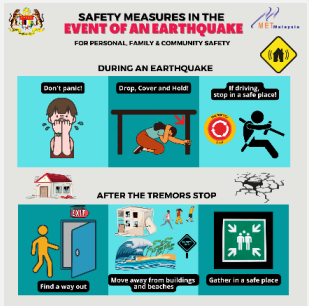


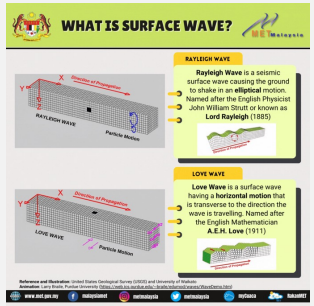




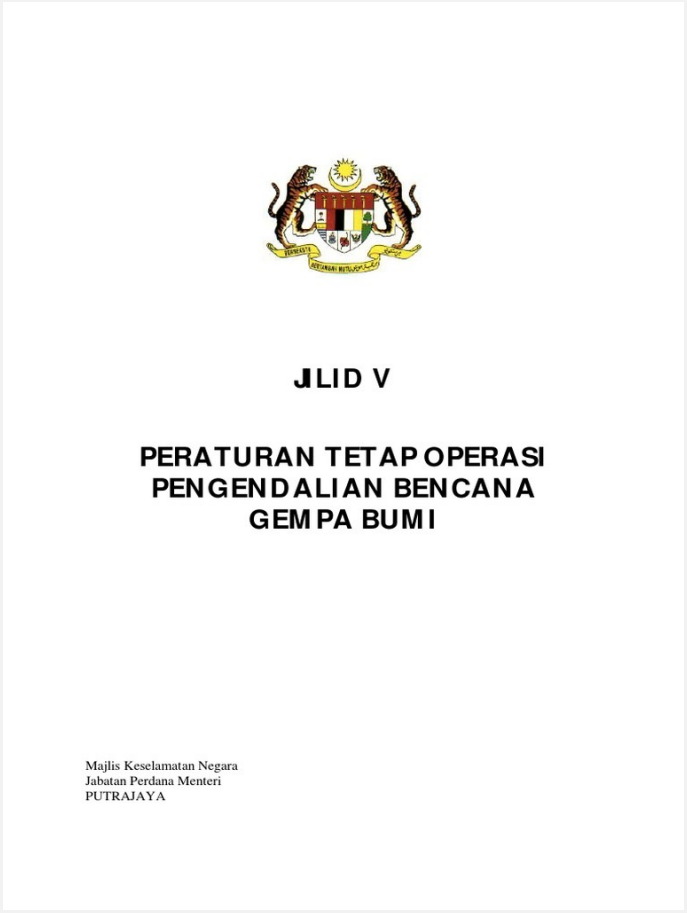


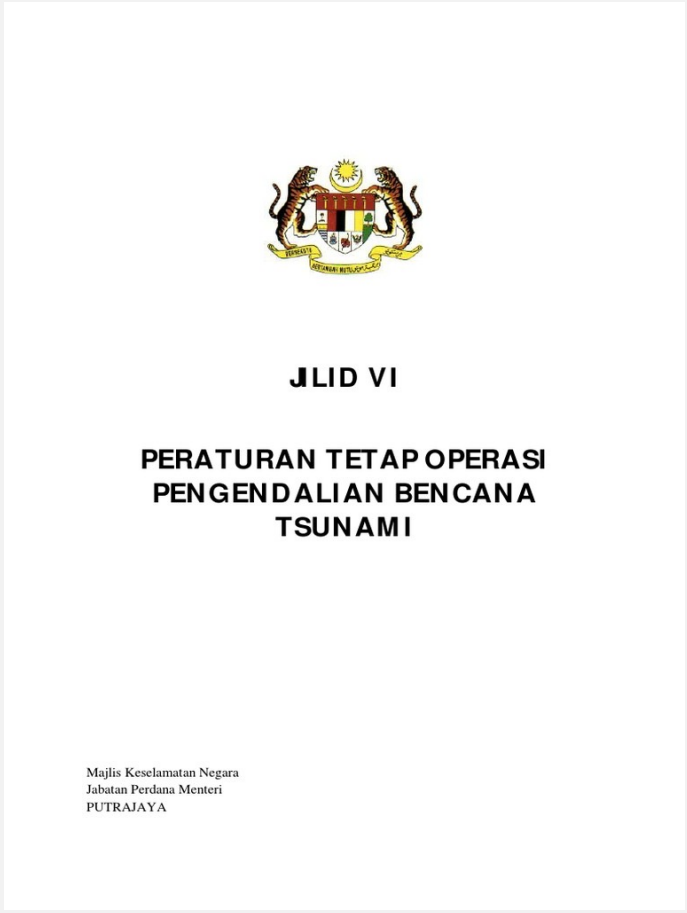






National SOP on Disaster Management Earthquake & Tsunami



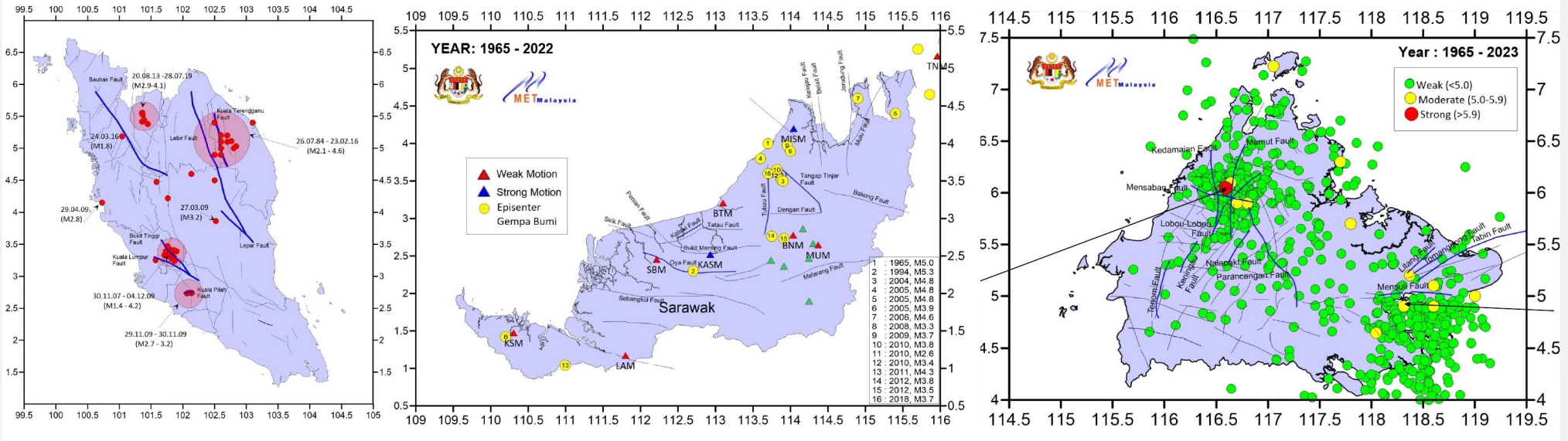


Under **Directive No. 20**, disasters are to be managed by DM committees at three levels including the federal level, as well as the state and district level committees.

National SOP – revised on 2022 (tsunami) and 2023 (earthquake)


Thank you

Distribution of local earthquakes



❑ Peninsular

- ❑ Kenyir, Terengganu (1984-2016, M2.1 - 4.6)
- ❑ Bukit Tinggi, Pahang (2007-2009, M1.4 - 4.2)
- ❑ Kuala Pilah, N.Sembilan (2009, M2.7 - 3.2)
- ❑ Temenggor, Perak (2013-2019, M2.9 - 4.1)

Minor tremors and shaking of high rise buldings, but have not resulted in any significat damage.

❑ Sarawak

- ❑ EQ felt are mostly related to local EQs
- ❑ 14 weak EQs & 2 moderate EQs; M5.0 (1965) and M5.3 (1994)
- ❑ The EQs appear to be related to the local faults line; mostly located around Niah & Selangau area.

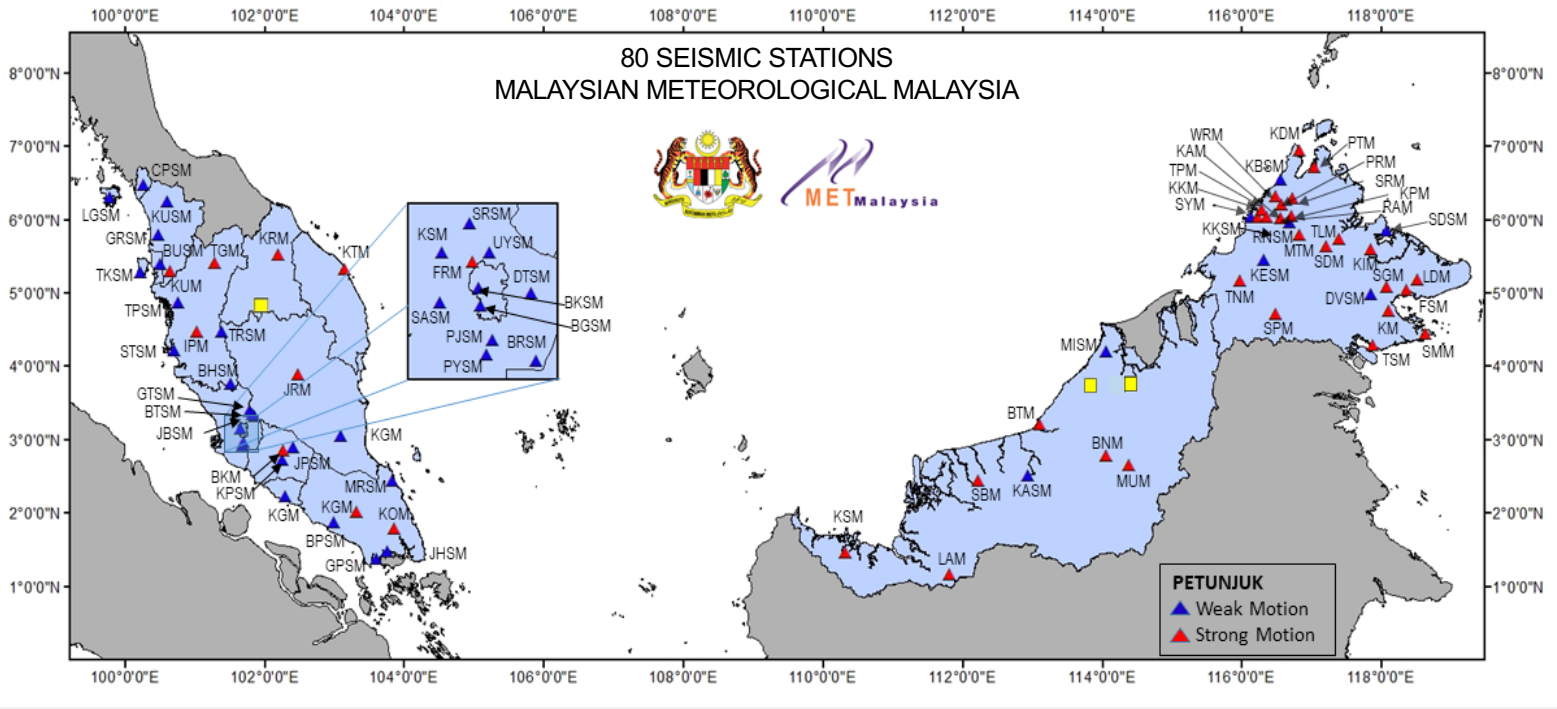
Caused minor damage to buildings.

❑ Sabah

- ❑ Mostly generated locally; some located over the Sulu and Celebes seas.
- ❑ Most EQs have magnitude less than 5.0
- ❑ Jun 2015 at Ranau - strongest EQ of M6.0
- ❑ Majority of the EQ concentrated in Lahad Datu, Ranau and Kudat area.
- ❑ Associated with active fault faults lines

Caused considerable damage to buildings and killed 18 people

SEISMIC STATIONS NETWORK



LOCATION

42 PENINSULAR

28 SABAH

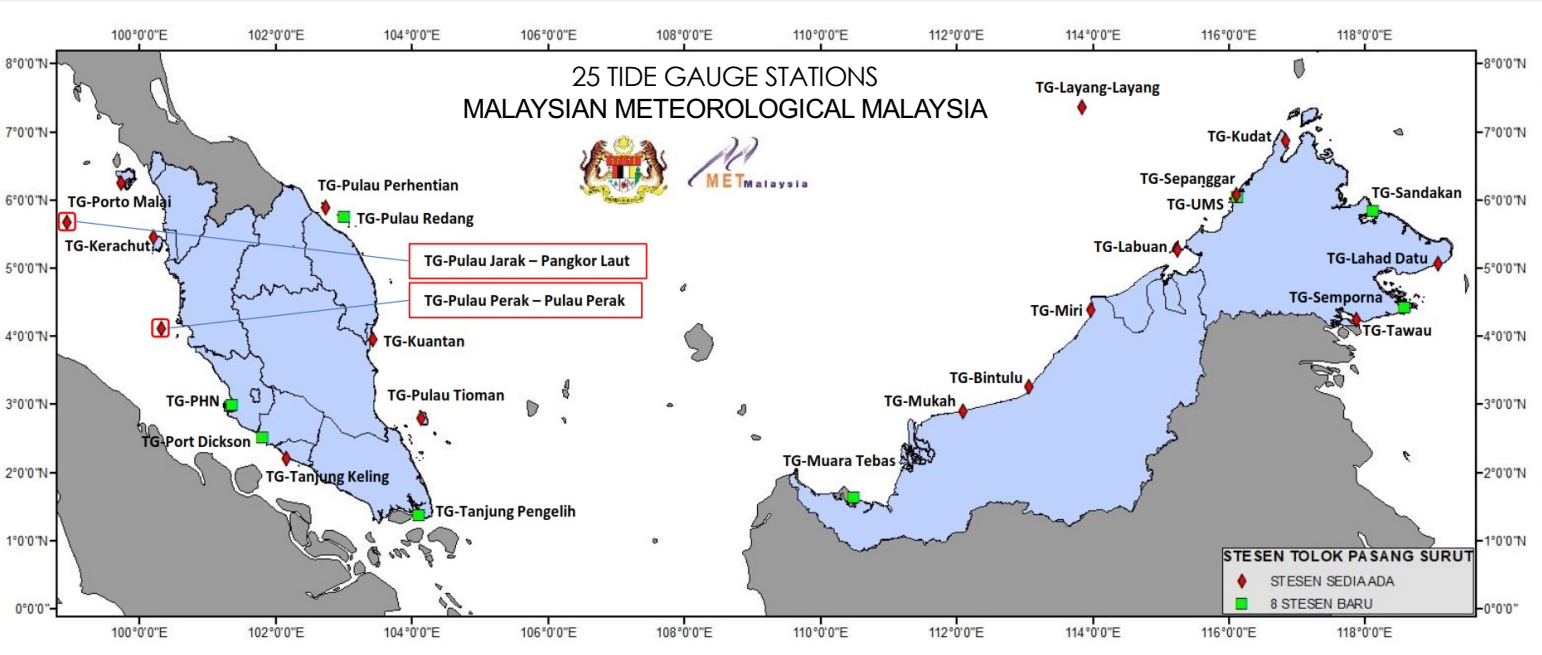
10 SARAWAK

80 SEISMIC STATIONS

43 *WEAK MOTION (3C)*

37 *STRONG MOTION (1C)*

TIDE GAUGE STATIONS NETWORK

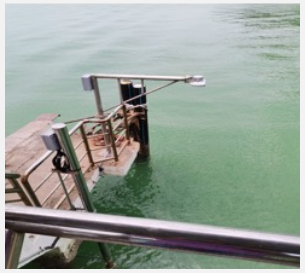


LOCATION

12 *PENINSULAR*

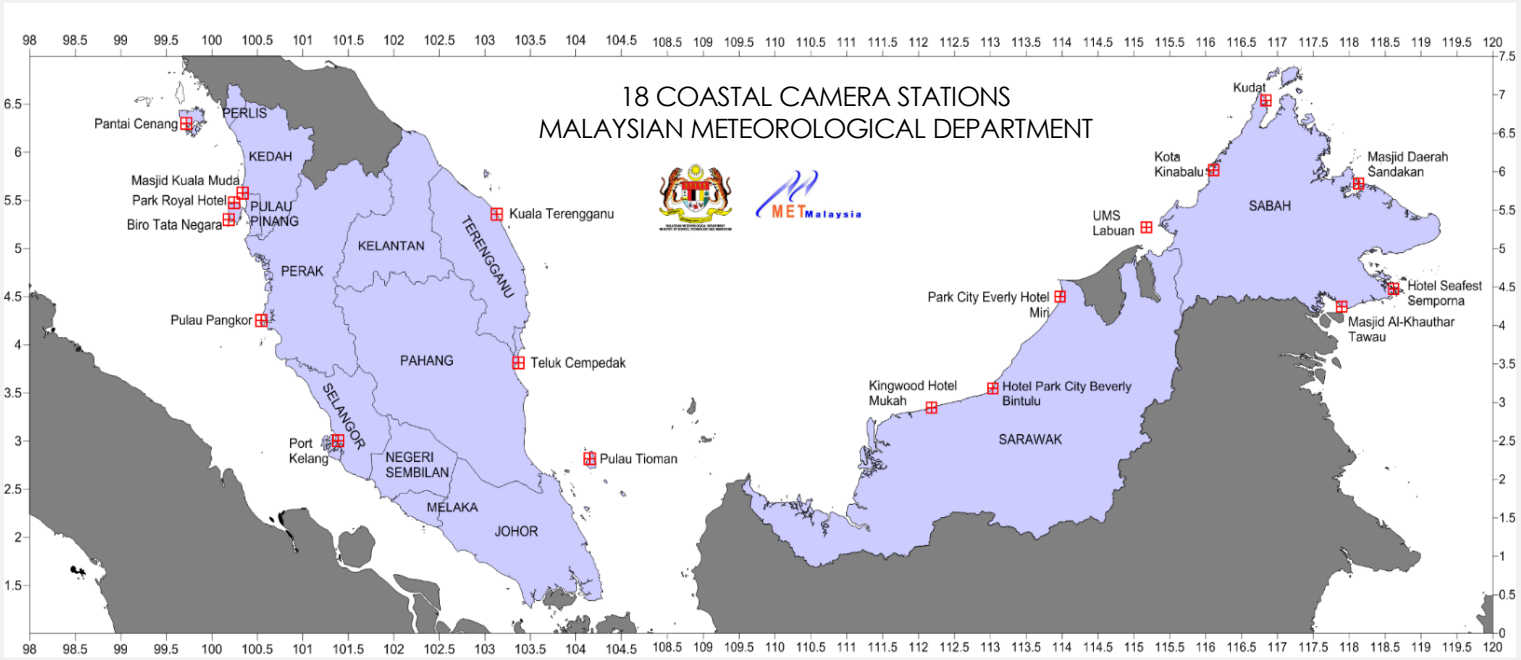
4 *SARAWAK*

9 *SABAH*



25 **TIDE GAUGE STATIONS**

COASTAL CAMERA (CCTV) SYSTEM



LOCATION

9 *PENINSULAR*

3 *SARAWAK*

6 *SABAH*

18 CCTV COASTAL CAMERA

ORGANIZATIONAL STRUCTURE
FOR DISASTER MANAGEMENT IN MALAYSIA

National Disaster Management Agency (NADMA Malaysia) is the Lead Government Agencies in Disaster Response

- NADMA oversees all facets of management of disaster risks in Malaysia.
- NADMA is also the secretariat of the Central Disaster Management Committee (JPBP) and plans preparedness activities.
- NADMA is in charge of disaster management (DM) at the national level.

The roles of NADMA Malaysia

SMART: Special Malaysia Disaster Assistance and Rescue Team

DIRECTIVE ORDER NO. 20

Under **Directive No. 20**, disasters are to be managed by DM committees at three levels including the federal level, as well as the state and district level committees.

- During a disaster, the district offices in the affected areas coordinate evacuation activities with the support of the Malaysian Fire and Rescue Department and Malaysian Civil Defence Force.
- The Malaysia Red Crescent Society (MRCS), NGOs, non-profit organizations, and various other agencies may be involved.
- The Malaysian Armed Forces, Royal Malaysia Police, and other local government agencies conduct evacuations, establish emergency shelters, operationalize evacuation centers, and provide relief assistance.
- During a response operation, authorities may deploy the SMART into affected areas to carry out search and rescue operations (SAR).

The main agencies involved in DM include:

- Malaysian Armed Forces
- Royal Malaysian Police
- Malaysia Civil Defense Force (APM)
- Fire and Rescue Department
- Social Welfare Department
- Malaysian Meteorological Department (MET Malaysia)
- Department of Irrigation and Drainage (DID)
- Ministry of Health (MOH)
- Civil Aviation Authority Malaysia
- Ministry of Science, Technology, and Innovation
- Atomic Energy Licensing Board
- Malaysian Remote Sensing Agency
- Department of Mineral and Geosciences Malaysia
- Malaysian Maritime Enforcement Agency