Natural Causes of Cable Faults:

Hazard Occurrence, Trends and Case Studies

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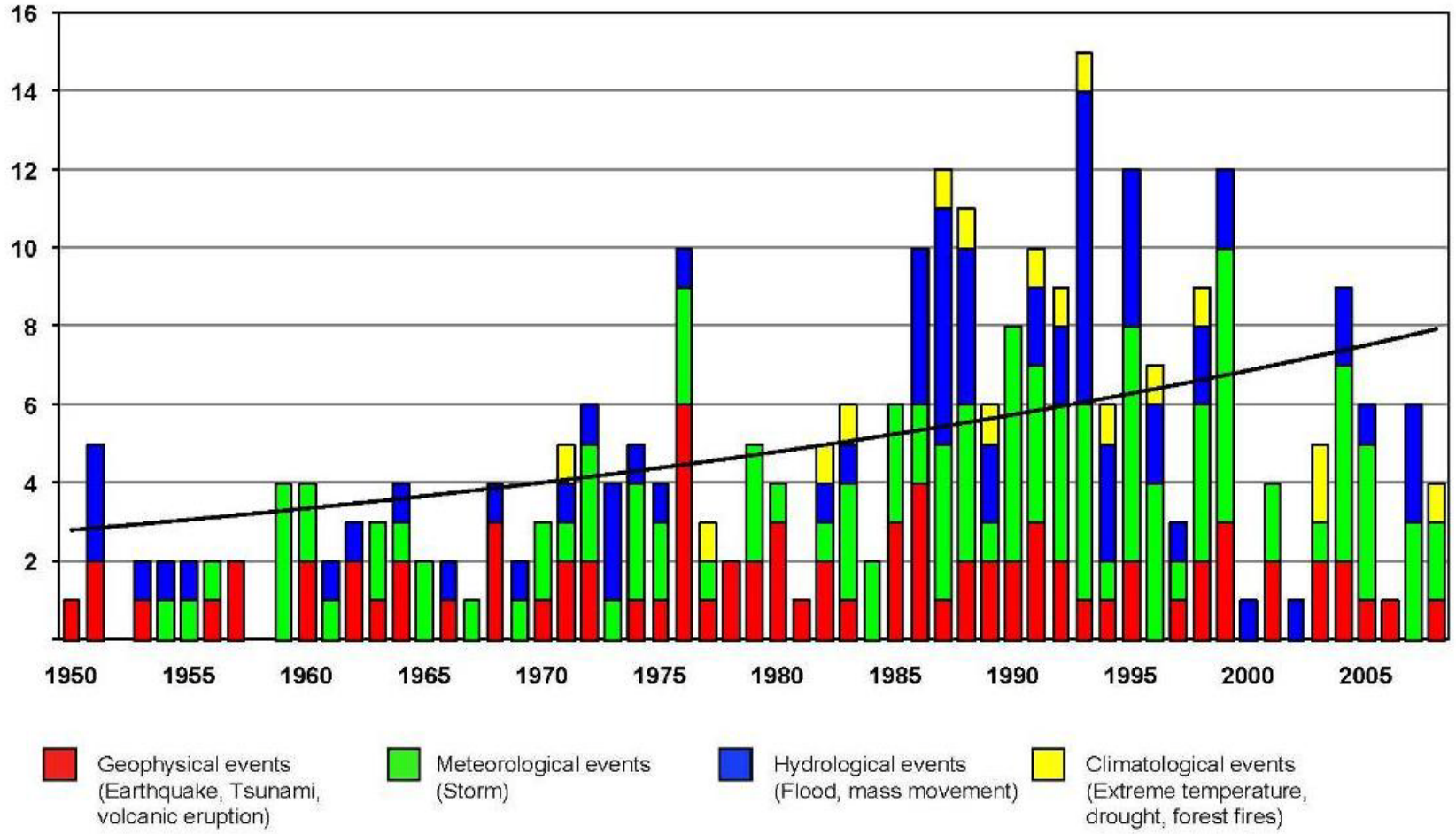
Outline

- Natural hazards - trends and cables
- Occurrence of hazards
- Earthquakes
- Meteorological events
- Secondary factors

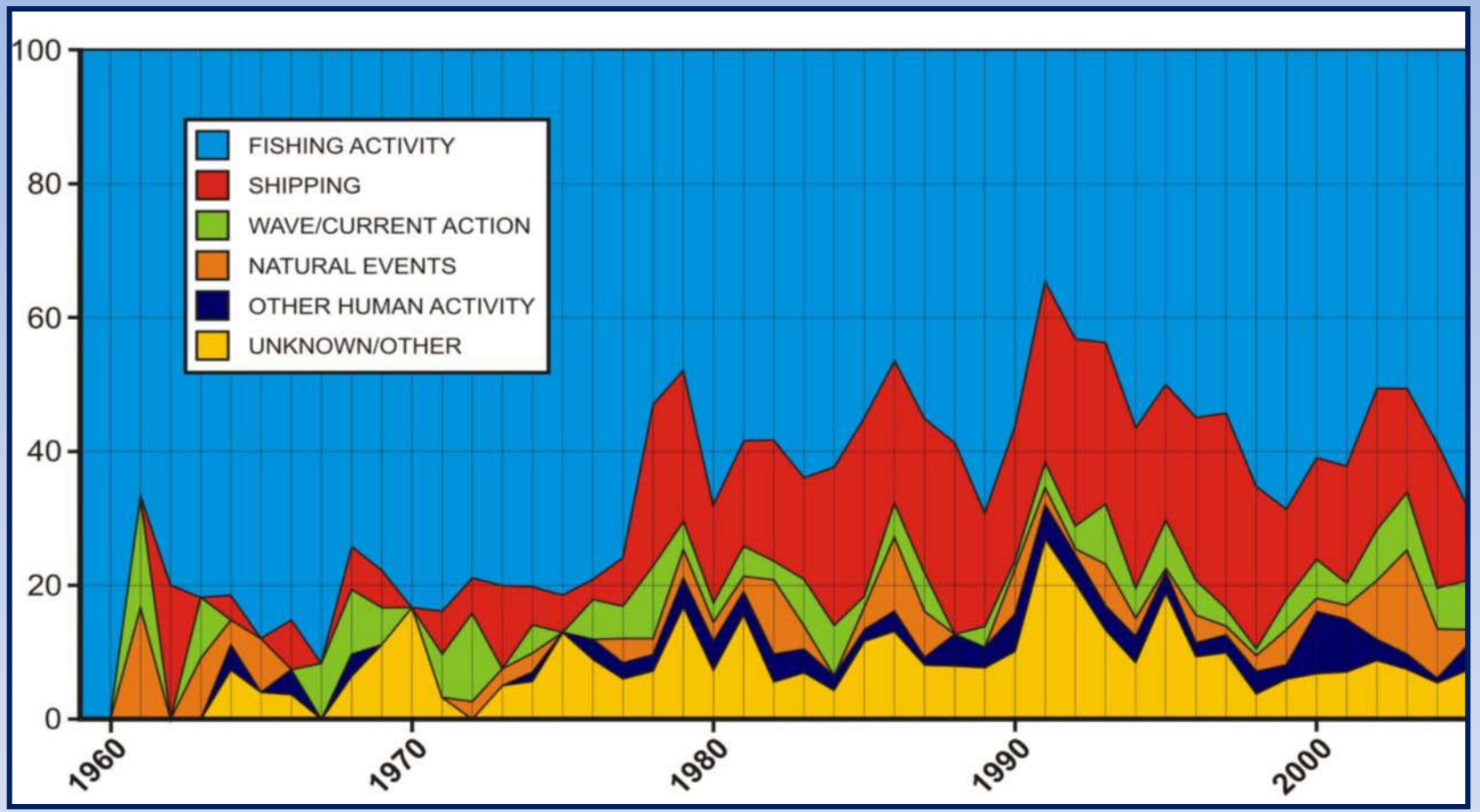
Natural hazard trends



- More natural disasters last 58 years.
- More weather-related events. + +
- Data reflect more energetic climate & more people in vulnerable areas.

Source: Munich Re, 2009

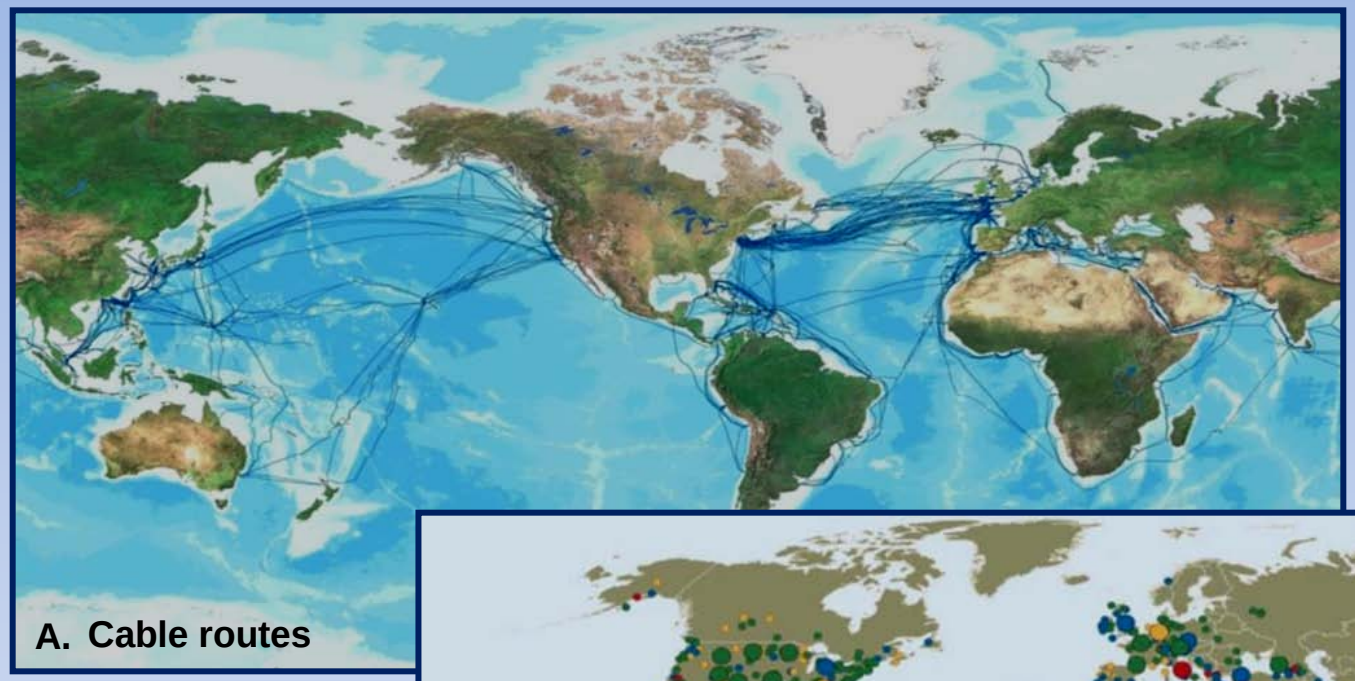
Natural hazards & cable faults



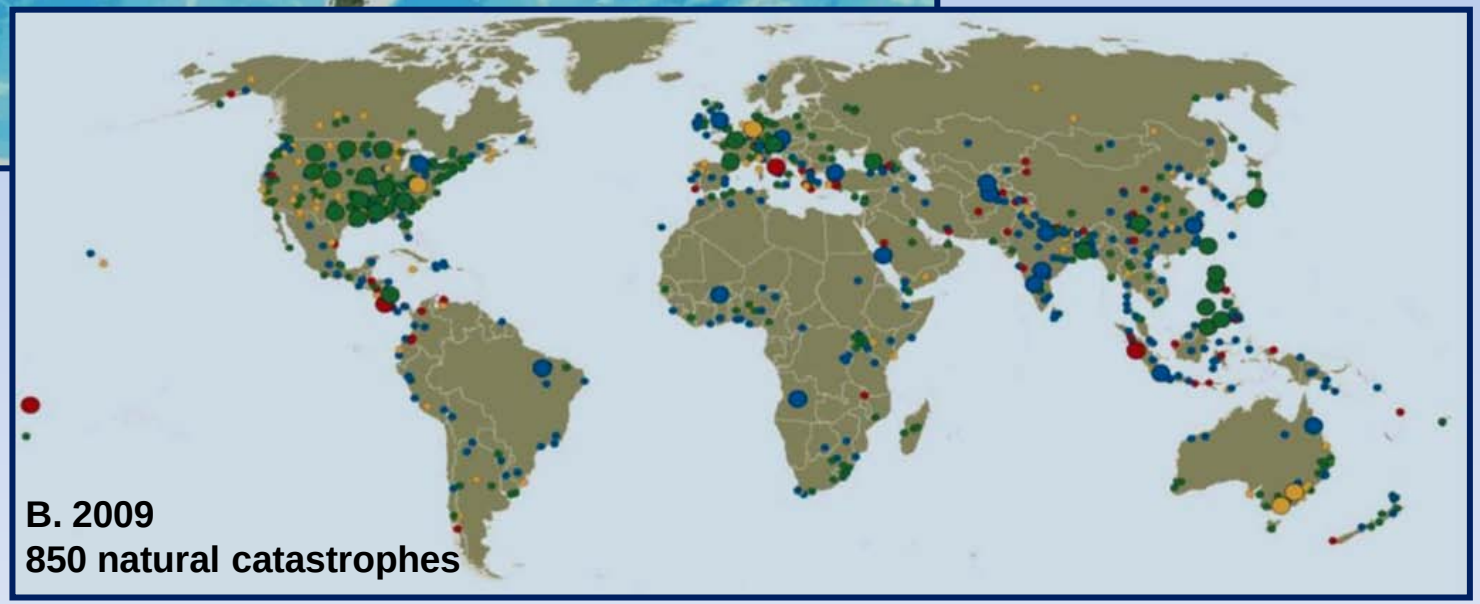
- **Human activities, e.g. shipping & fishing, are main causes of cable faults.**
- **Natural hazards cause <10% of all cable faults, but in deep water beyond main human activities, natural hazards ~30%.**
- **However, a major natural event, e.g. earthquake, can extensively damage cables.**

Source: Wood & Carter, 2008; Journal Ocean Engineering.

Hazard Occurrence



A. Cable routes



B. 2009
850 natural catastrophes

earthquakes/tsunami/eruptions
floods/landslides
storms
drought/fire/heat-wave

Sources: A = SubCom; B = Munich Re

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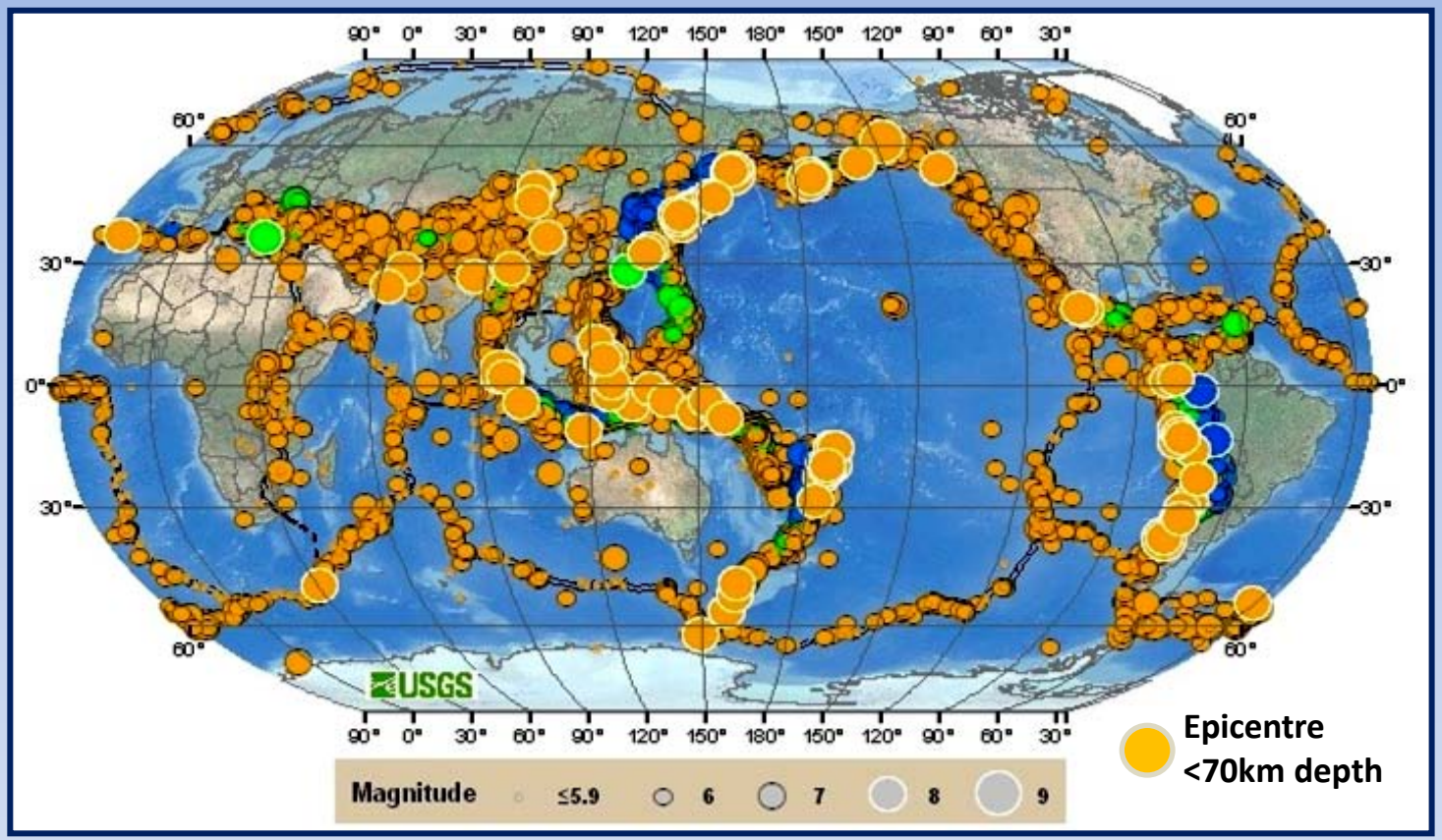
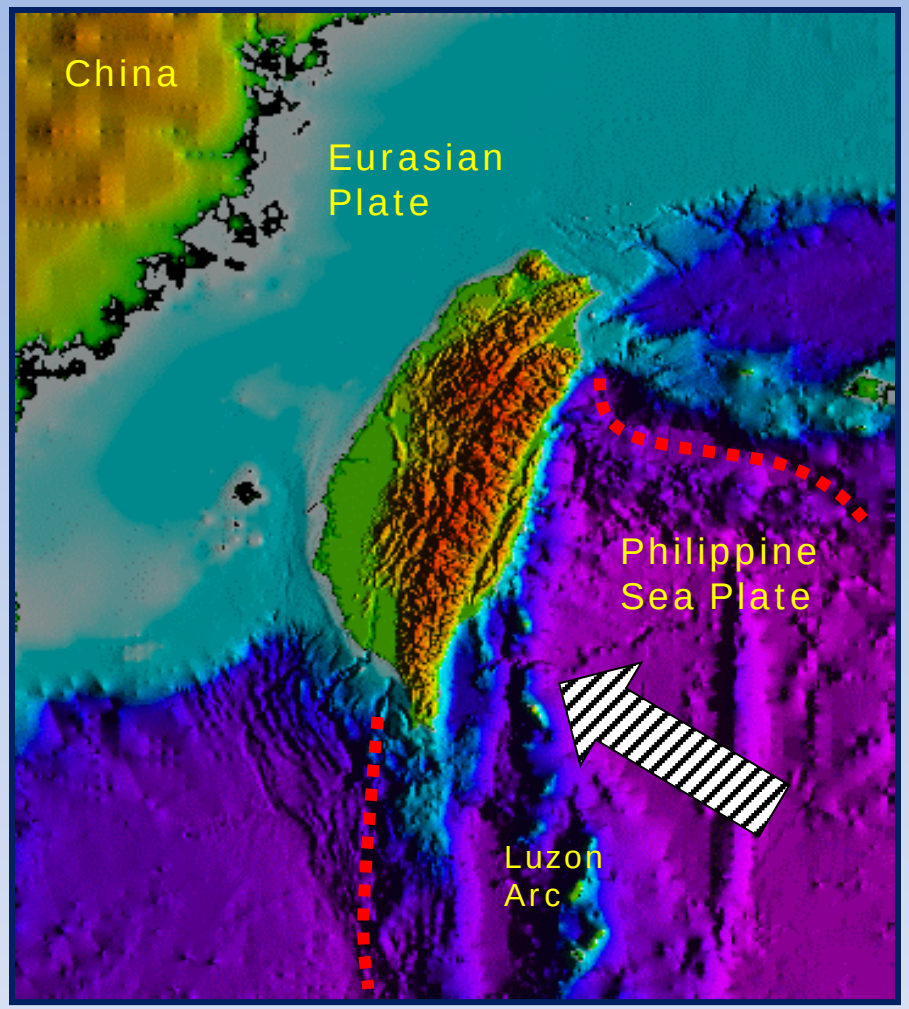
Earthquakes



- Cable damage by earthquakes most common at tectonic plate boundaries.
- Typical hazards are submarine landslides & mud-laden flows [*turbidity currents*], but also tsunami, creation of rugged ground, diversion of currents.
- Multiple cable faults occur in confined corridors.

Source: US Geological Survey

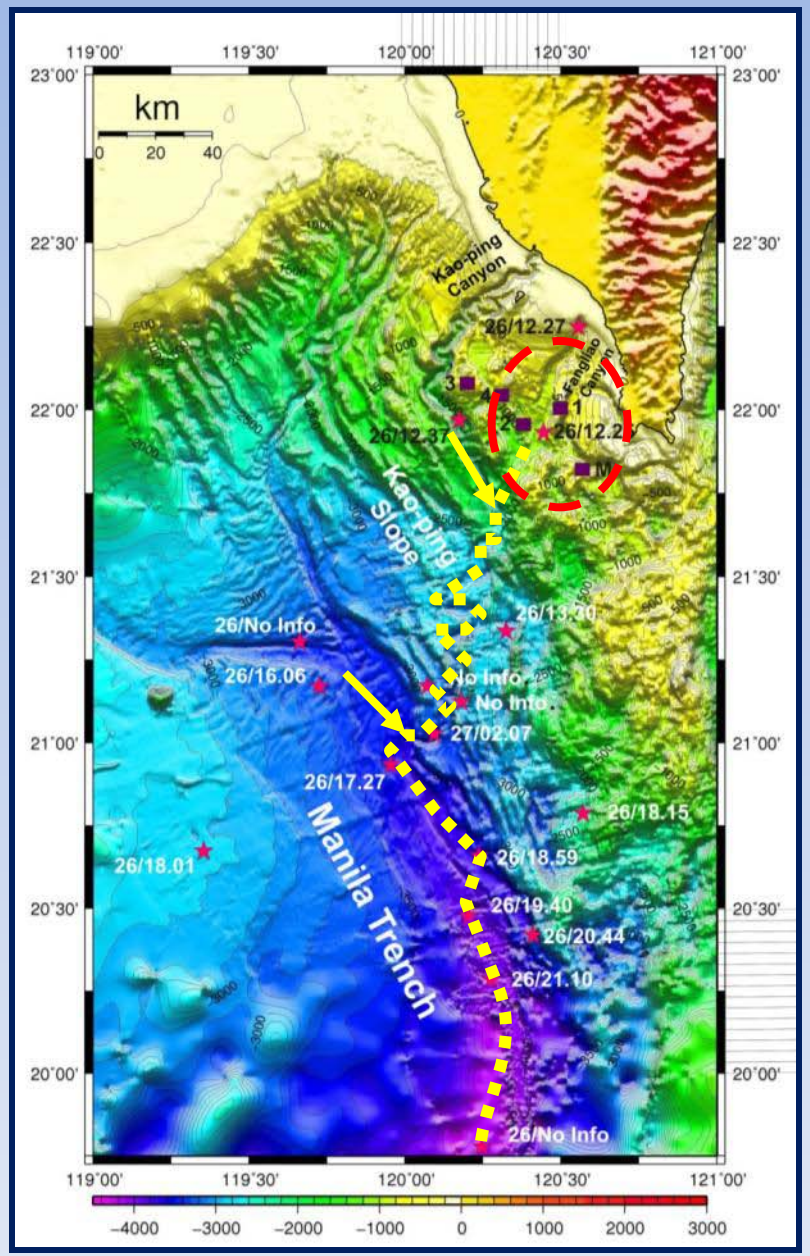
Earthquakes: Case Study – Chinese Taipei



- **Rapidly colliding tectonic plates = extreme earthquake activity.**
- **Rapid land uplift + vigorous climate + human impact = extreme discharge of mud to ocean.**
- **Conditions favour submarine landslides & turbidity currents.**

Source: Anderson M., U. Arizona Geosciences

Earthquakes: Case Study - Chinese Taipei



- 26.12.2006 magnitude 7.0 earthquake & after-shocks.
- Landslides caused instant cable breaks ~50 km epicentre.
- Multiple turbidity currents down Kaoping Canyon at ~55 km/h slowing to 16km/h in Manila Trench.
- Main turbidity current travelled 250-440km distance .
- 26 cable faults reported, 49 days to repair, involved 11 repair vessels.
- Voice & data traffic slowed but restored via re-routing.

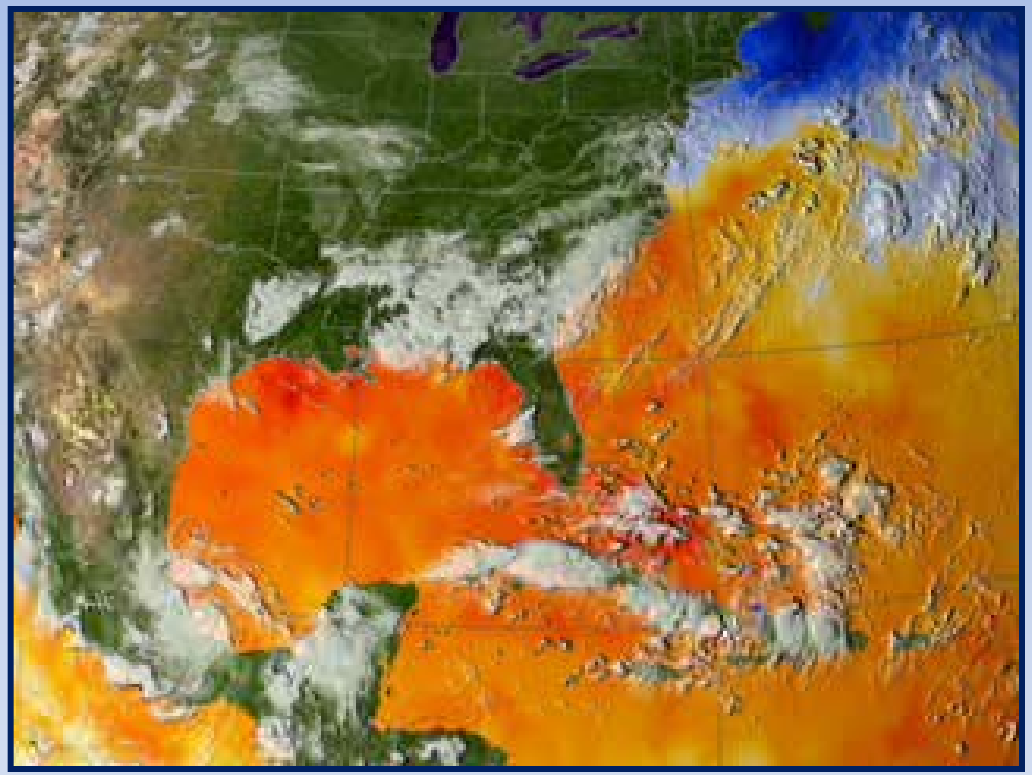
★ = cable break

Tsunami

- Tsunami formed by large earthquakes can damage shore facilities.
- Potential to damage submarine cables by seabed erosion, transfer of debris, formation of mud flows.

Source: Prof. Takashi Furumura &Takuto Maeda, Earthquake Research Institute, University Tokyo.

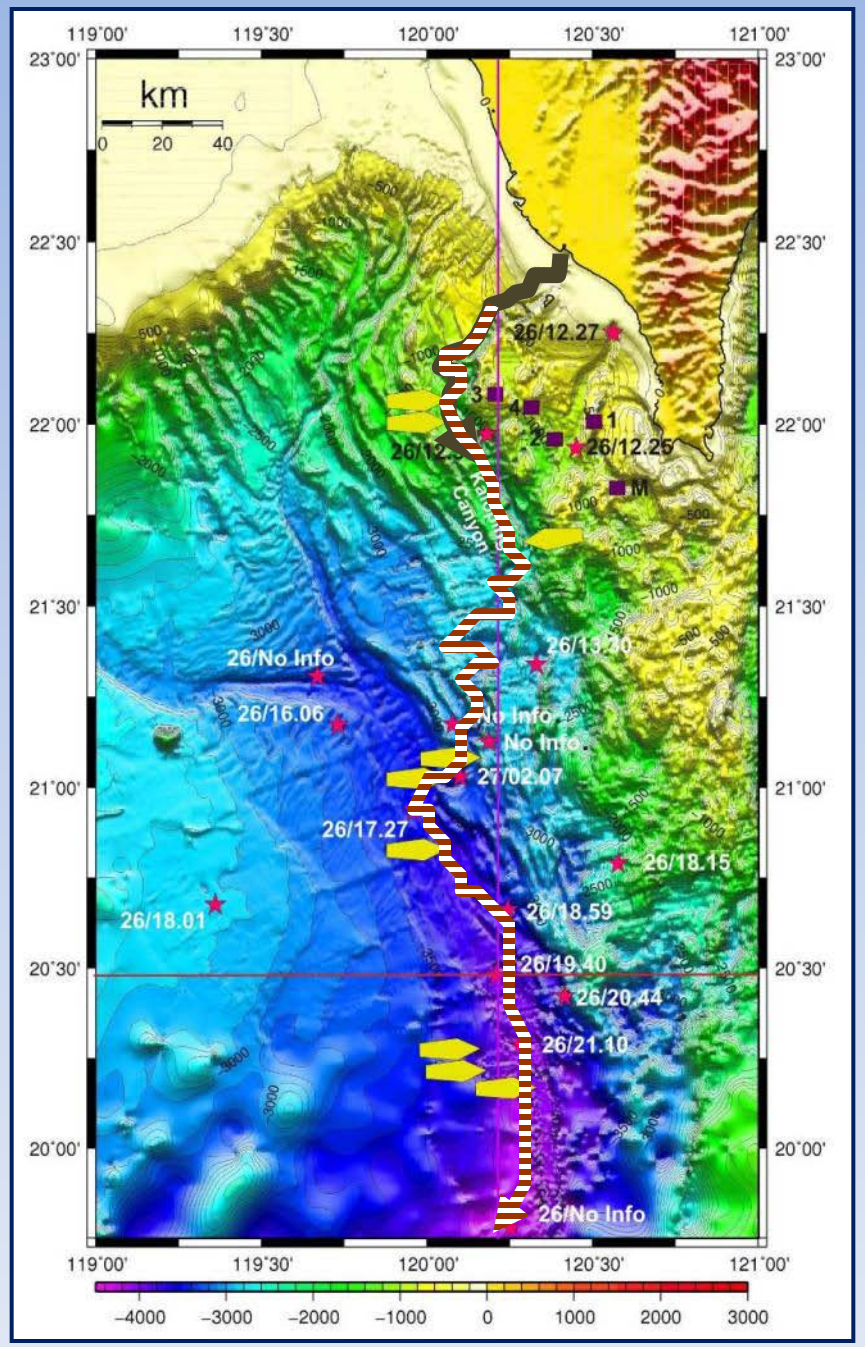
Meteorological events



- Major storms can effect cables from coast to deep ocean.
- Storm surge can damage land infrastructure & coastal cables – e.g. Cyclone Nargis, 2008.
- Storms create powerful waves & currents that erode the seabed & expose/suspend /fatigue cables.
- Storms can generate turbidity currents via extreme river discharge or destabilisation of seabed, e.g. Typhoon Morakot 2009.

Hurricane Katrina Source: NASA SVS.

Meteorological event: Case Study Chinese Taipei



- Typhoon Morakot dumped 3m rain to form record floods.
- River discharge sank into offshore canyon to form mud flow that broke 2 cables during peak flood.
- A second sediment flow occurred 3 days later, probably from slumping of flood sediment in canyon head – 8 cables broke.
- Absence of earthquakes.
- Interruption of voice & data traffic minimal due to effective re-routing.

= cable break Hengchun

= cable break Morakot

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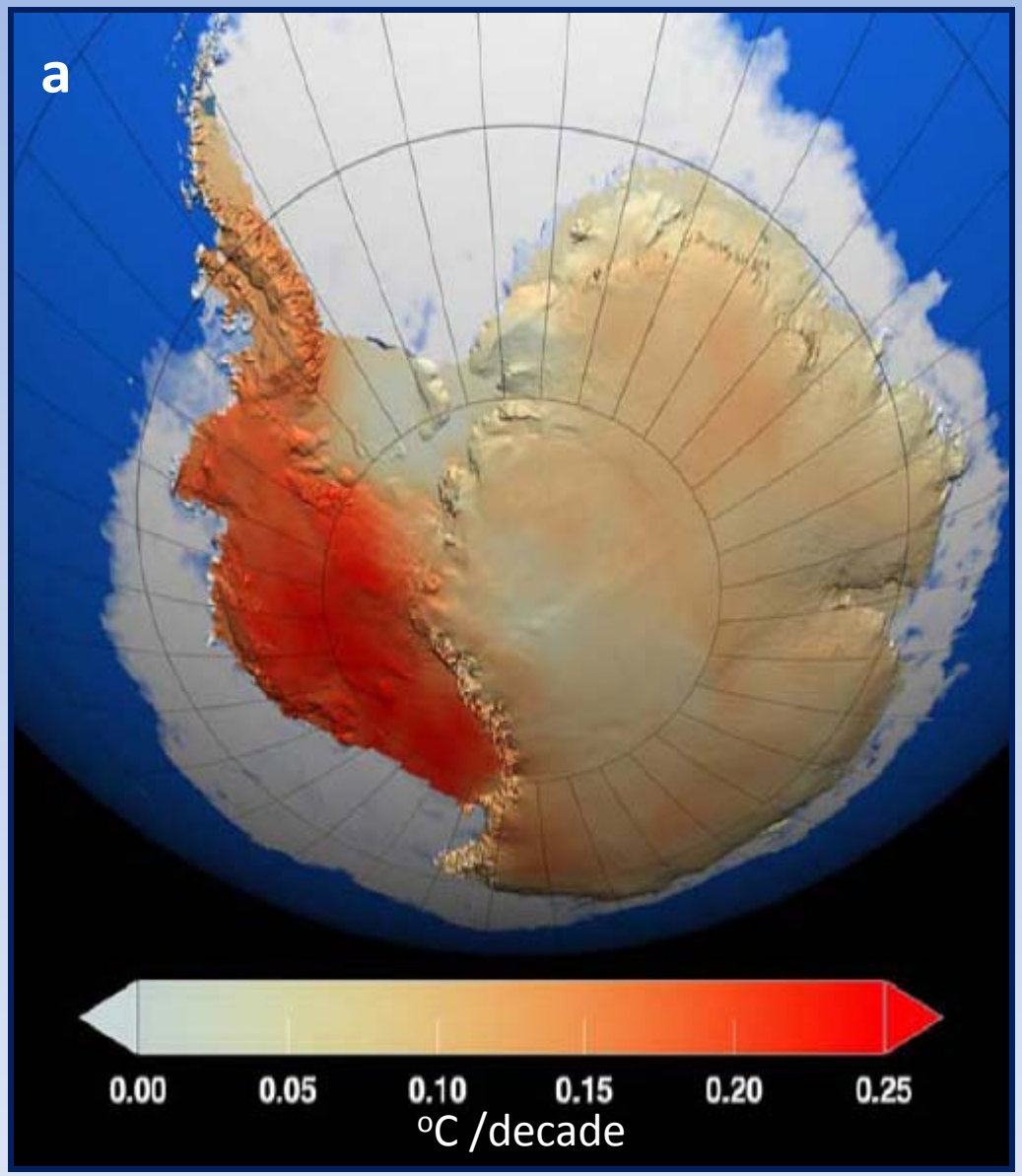
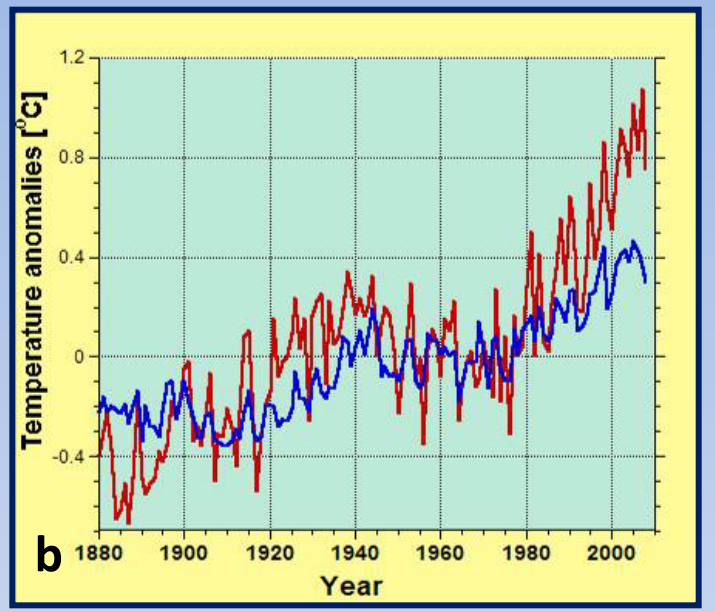
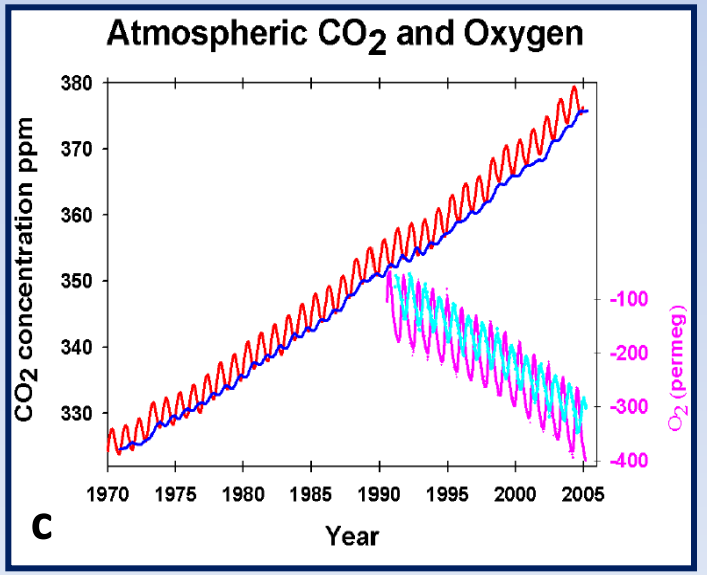
Climate Change - observations

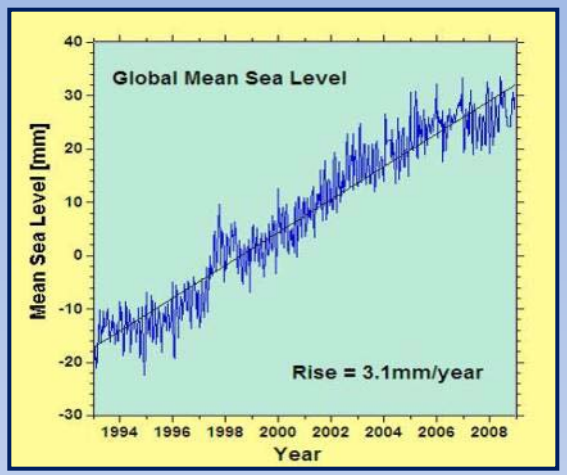


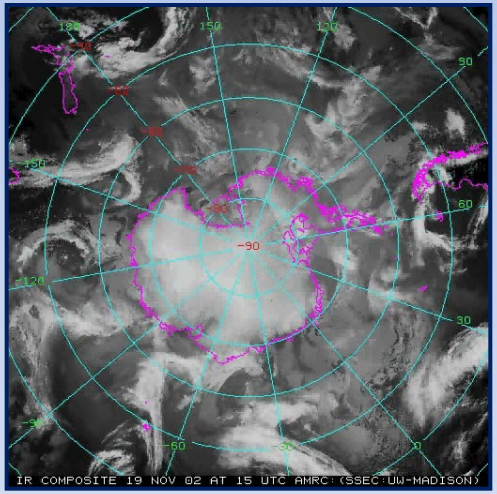




Sources: a. Steig, Nature 2009; b. U. Colorado c. Dave Lowe, VUW

Climate Change and Cables





- Sea level rising due to thermal expansion & >> ice melt.
- Weather systems shift to alter waves & currents.
- Rain locally increases to increase river discharge.
- More intense storms to damage coast & seabed.

ALL ABOVE WILL VARY IN SPACE & TIME.

Other natural hazards

Iceberg off New Zealand, 2006

- Icebergs in high latitudes.
- Terrestrial & submarine volcanic eruptions.
- Deep ocean currents.
- Deep ocean “storms”.
- Fish.

Source: Otago helicopters

Expect the unexpected

- Second order effects of hazards, including those from climate change, can impinge upon cables.

- Measures to reduce greenhouse gas emissions are increasing offshore development via renewable energy schemes and storage of carbon dioxide .

- Climate-related changes in agriculture and fishing may affect shipping traffic, bearing in mind that shipping and fishing are major causes of cable faults.

- Recent damage to nuclear reactors is turning public opinion towards renewable energy schemes.

Sharing the seabed in harmony