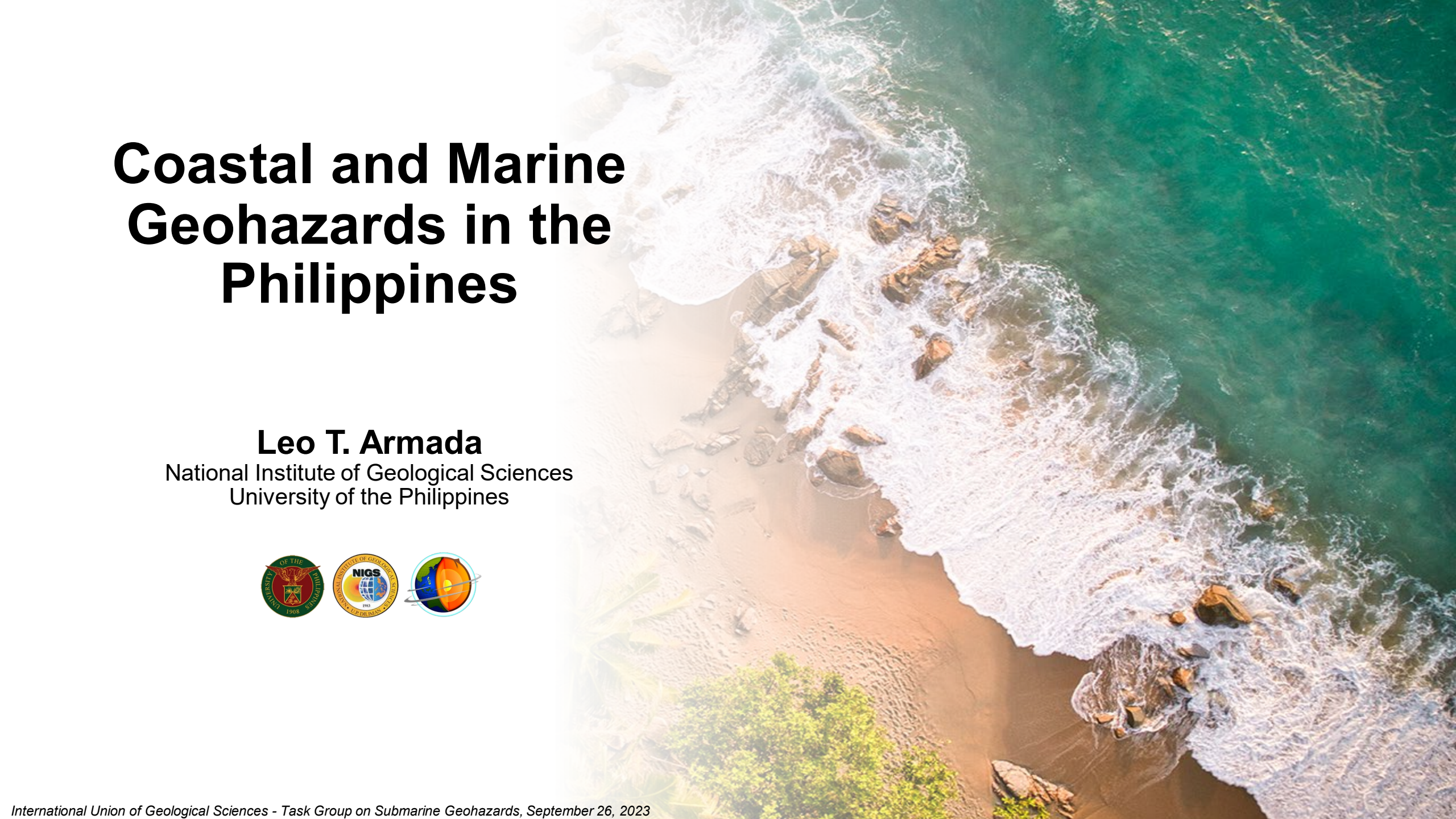
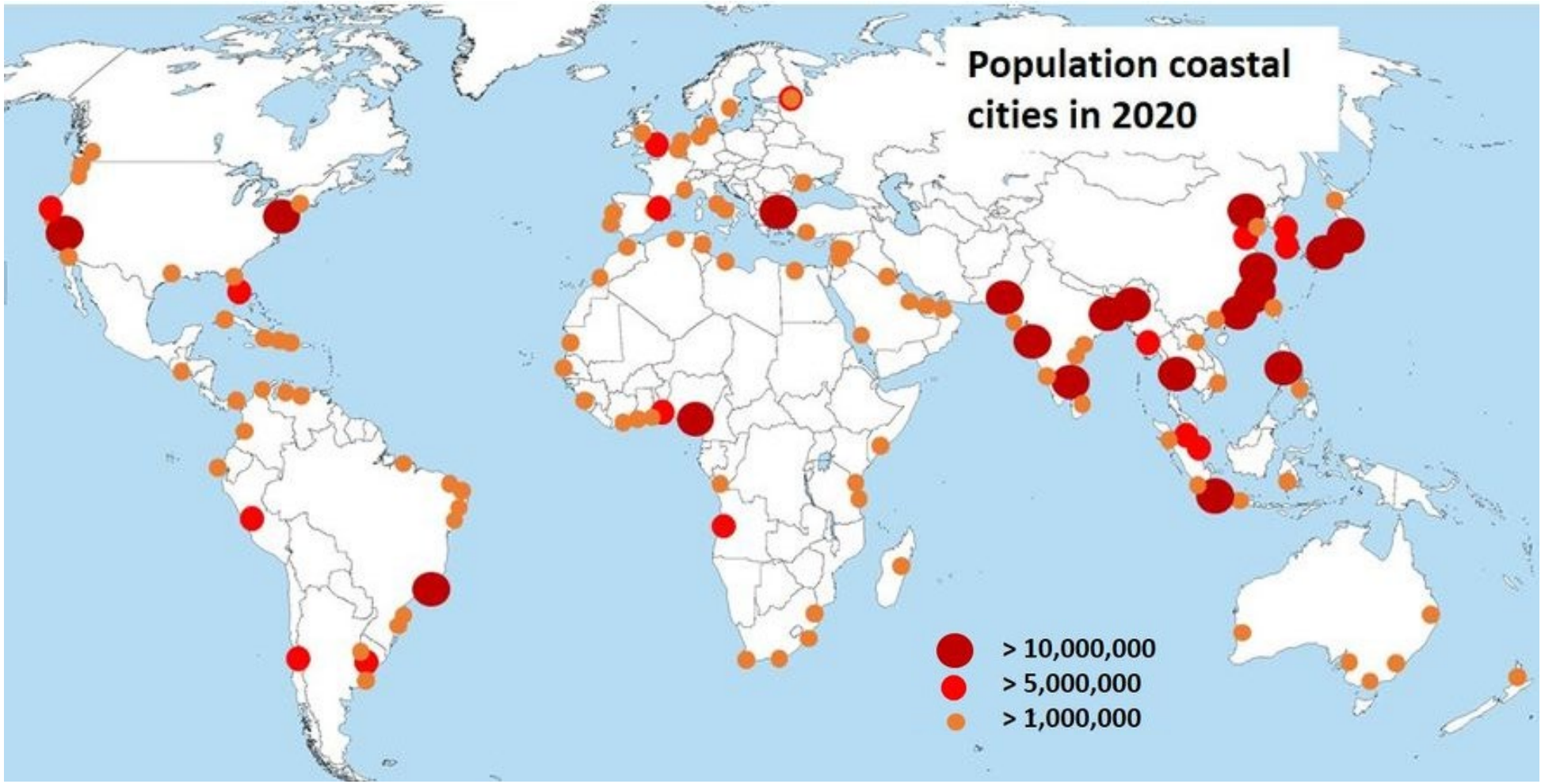
Coastal and Marine Geohazards in the Philippines

Leo T. Armada
National Institute of Geological Sciences
University of the Philippines

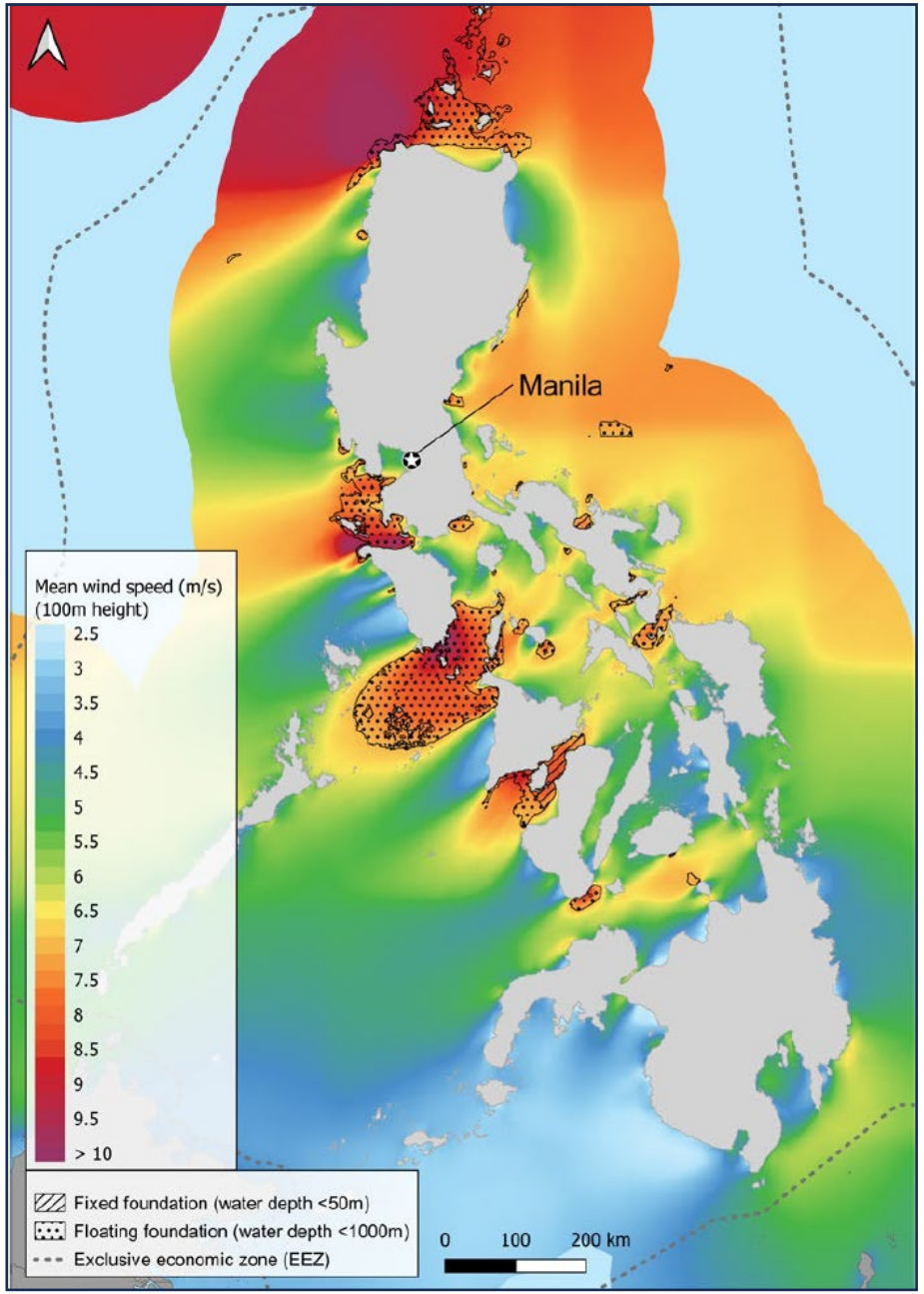


Coastal cities & communities are some of the most vulnerable to geohazards.



Barragan et al. (2015)

FIGURE 9.1 OFFSHORE WIND TECHNICAL POTENTIAL IN THE PHILIPPINES

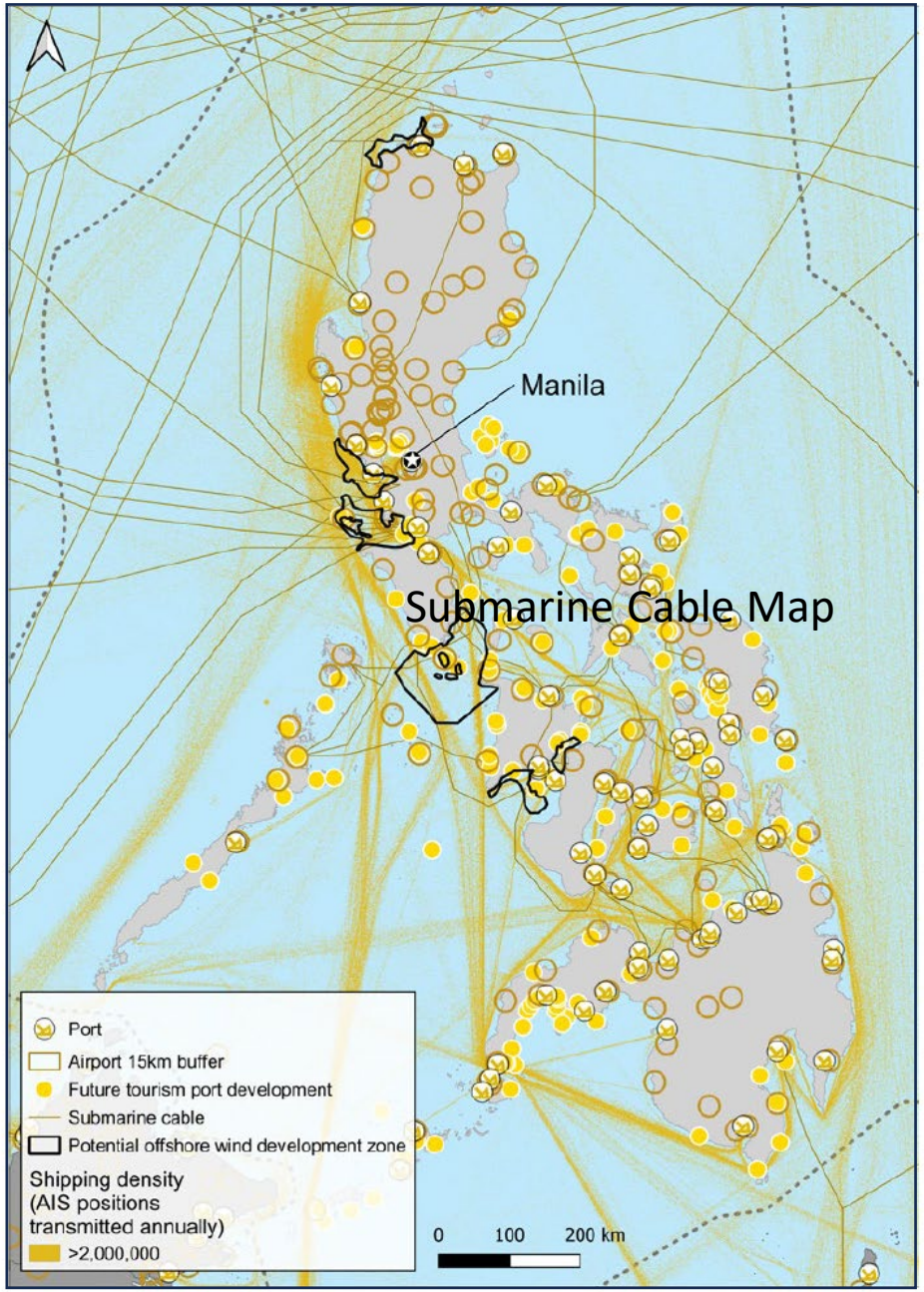


Context

Critical infrastructure (both existing and for future development) is vulnerable to coastal and marine geohazards.

Offshore windfarms

(World Bank, 2022)



Submarine communication cables

(World Bank, 2022)

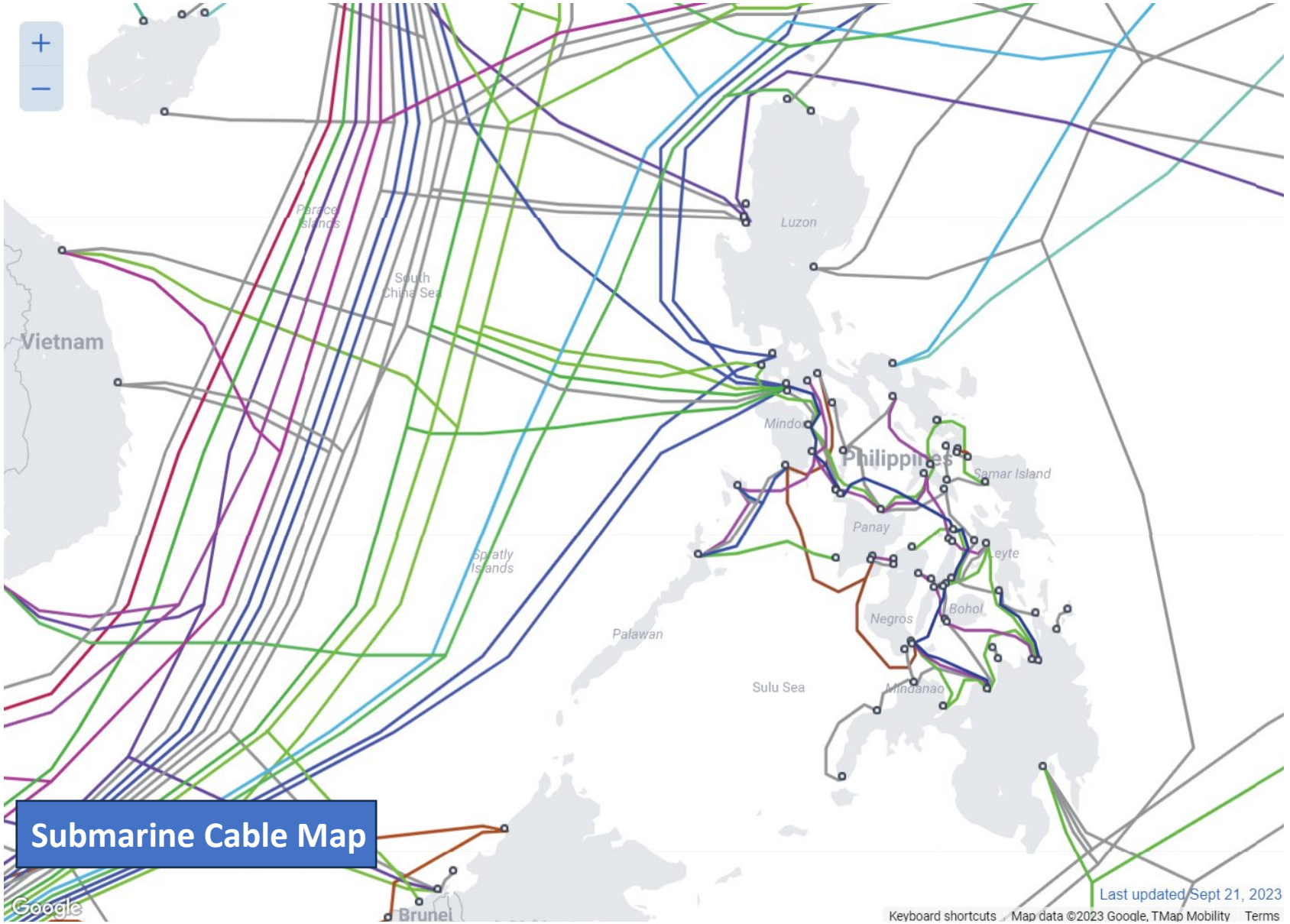
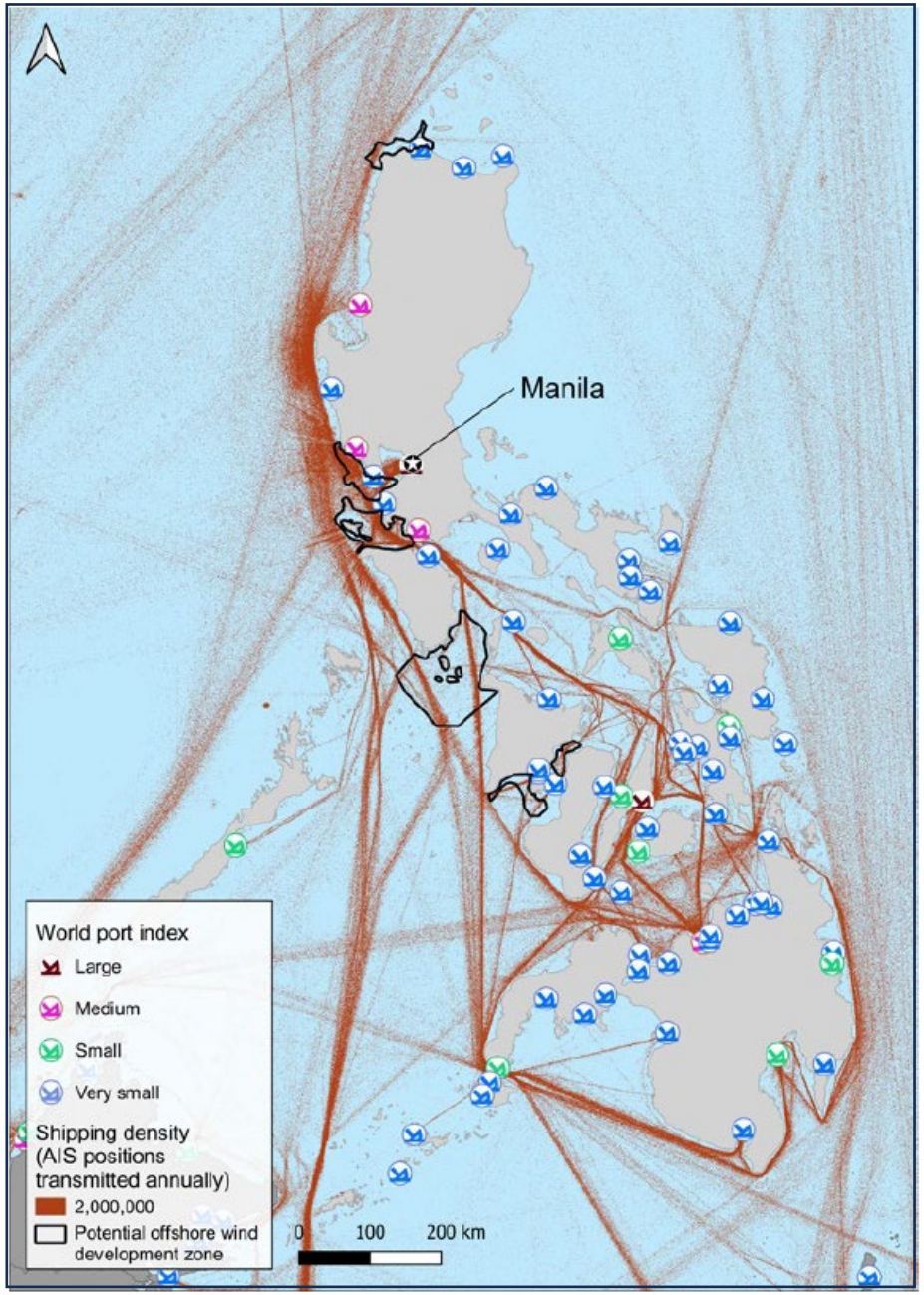

Submarine Cable Map
Vietnam
Luzon
Philippines
Samar Island
Panay
Leyte
Bohol
Negros
Palawan
Mindanao
Sulu Sea
Spratly Islands
South China Sea
Brunei
Last updated Sept 21, 2023
Keyboard shortcuts
Map data ©2023 Google, TMap Mobility
Terms

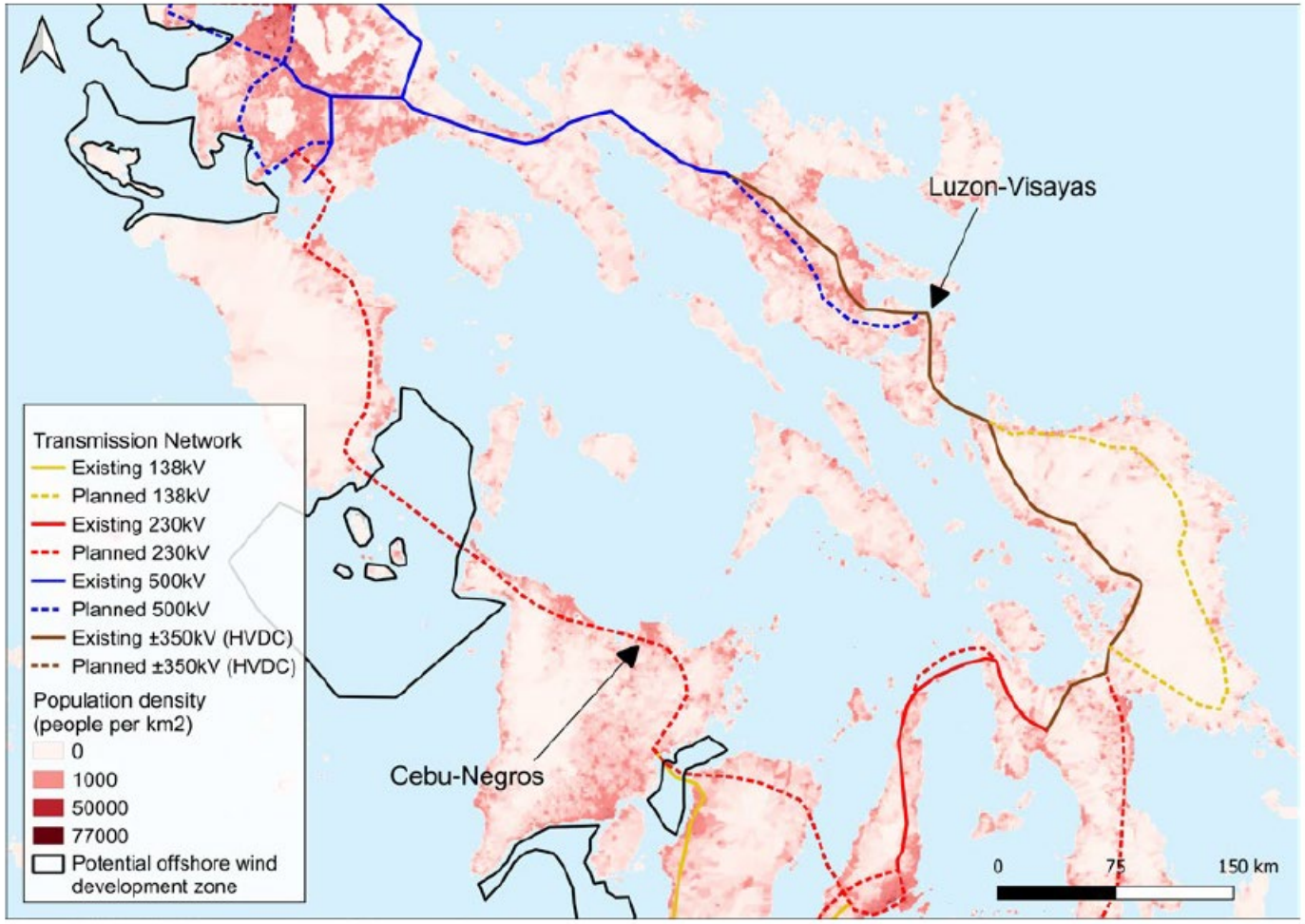
FIGURE 14.19 PORTS AND SHIPPING ROUTES



Ports and sea lanes

(World Bank, 2022)

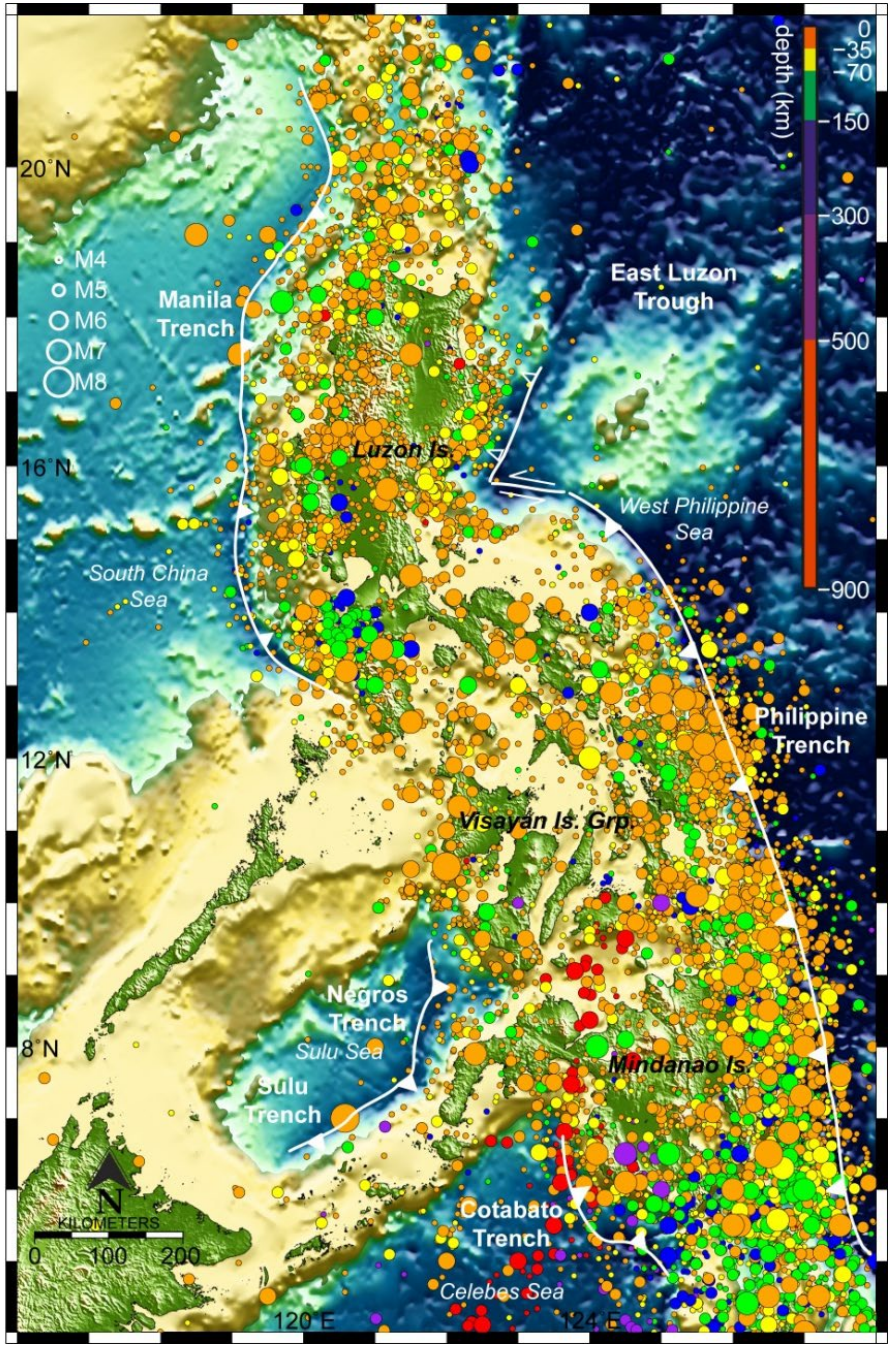
FIGURE 18.8 SOUTHEAST LUZON TRANSMISSION LINE AND LUZON-VISAYAS INTERCONNECTION OUTLOOK

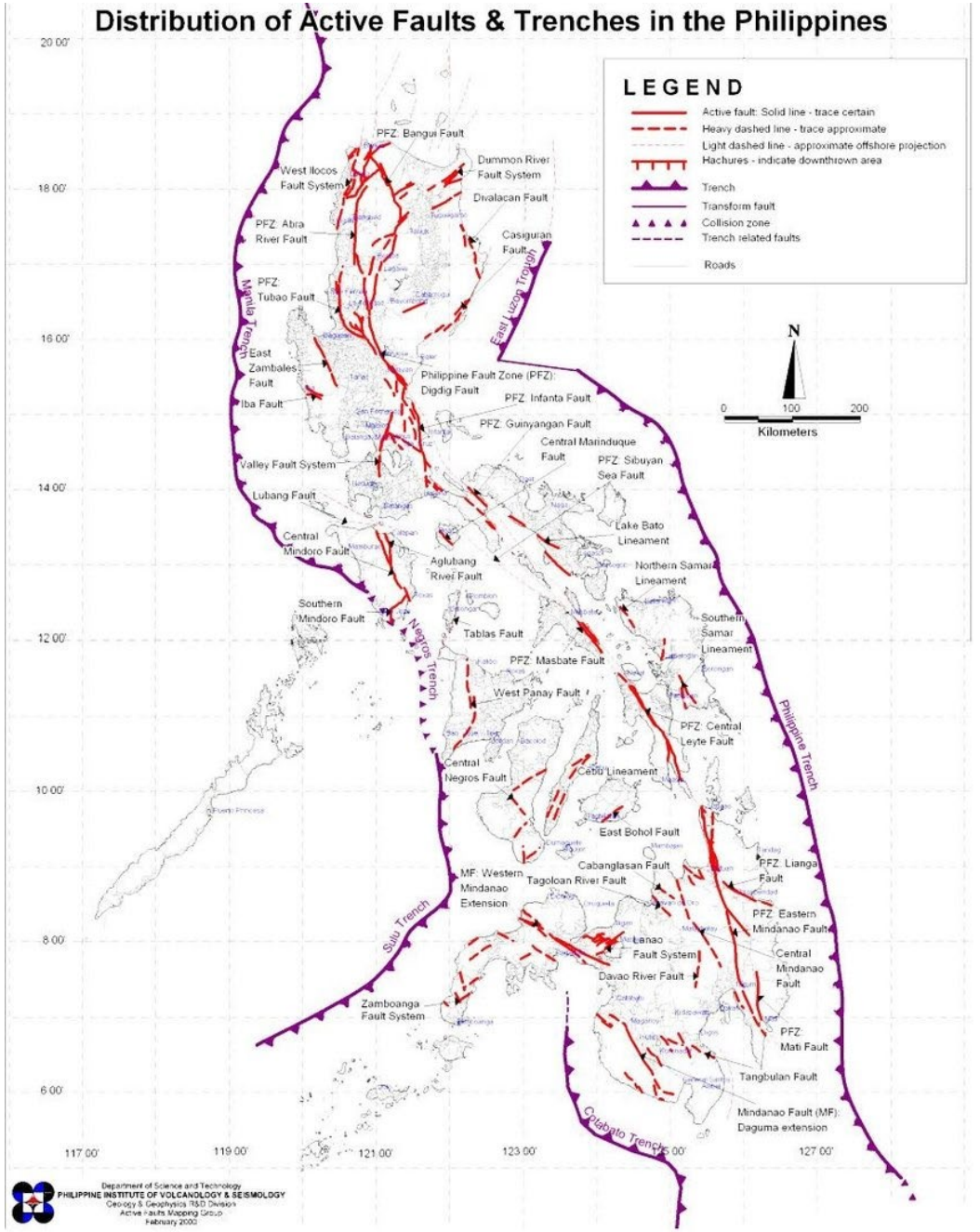


Future submarine power lines

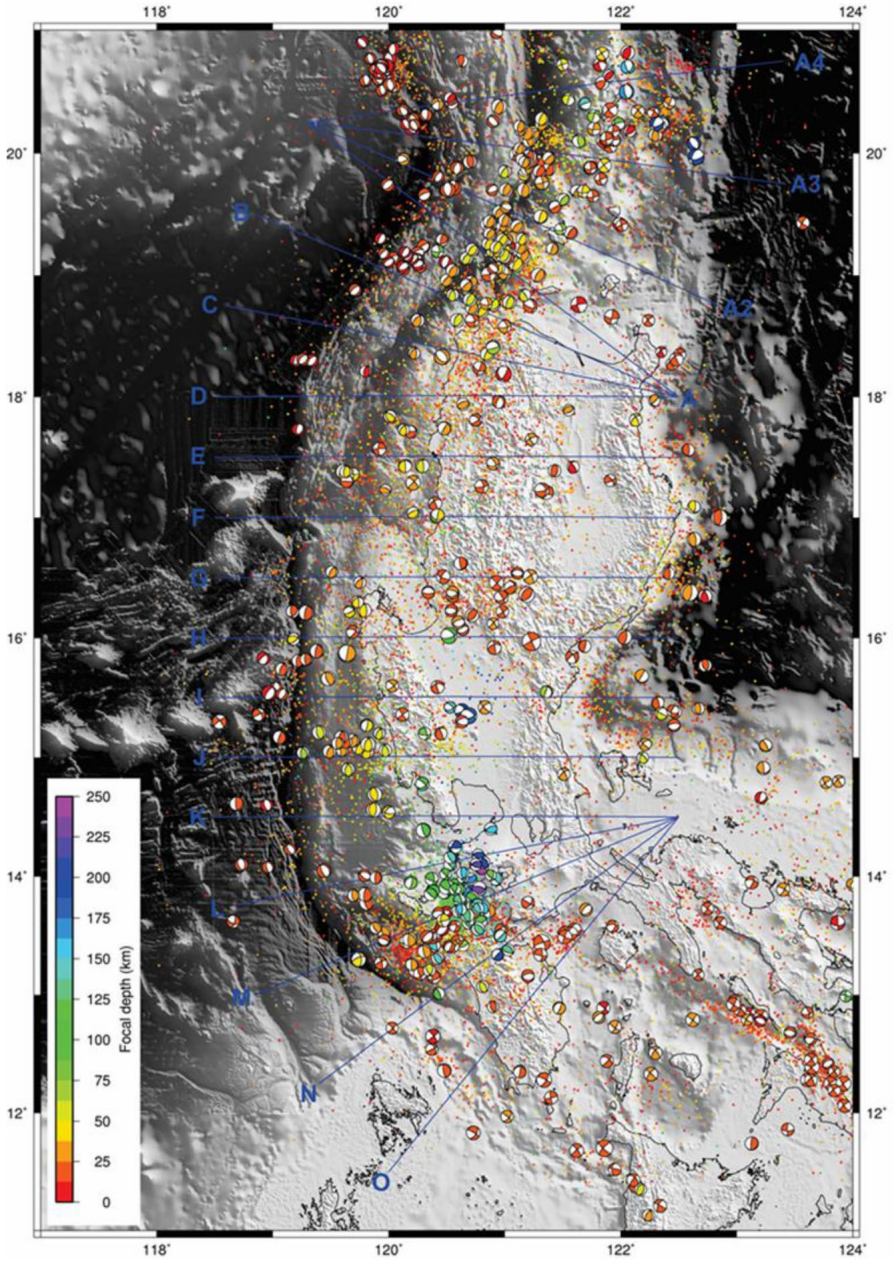
(World Bank, 2022)

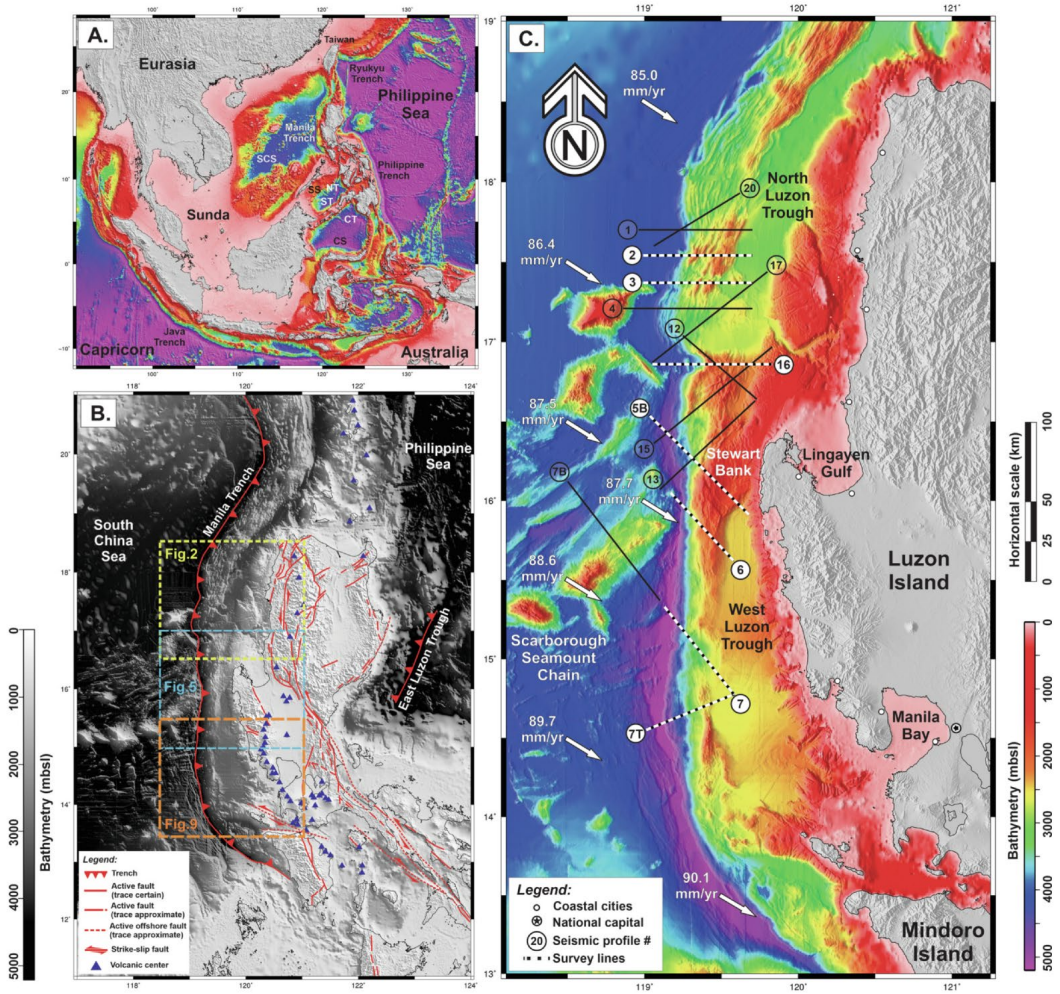
(Ramos et al., 2010)





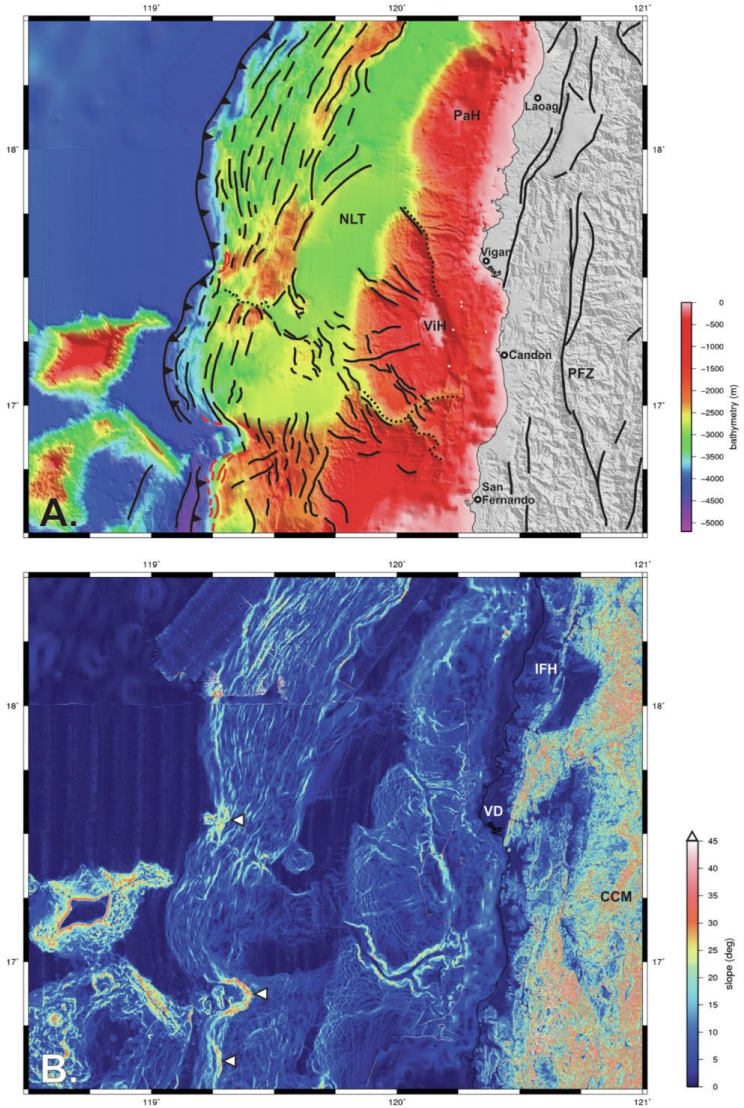
Manila Trench

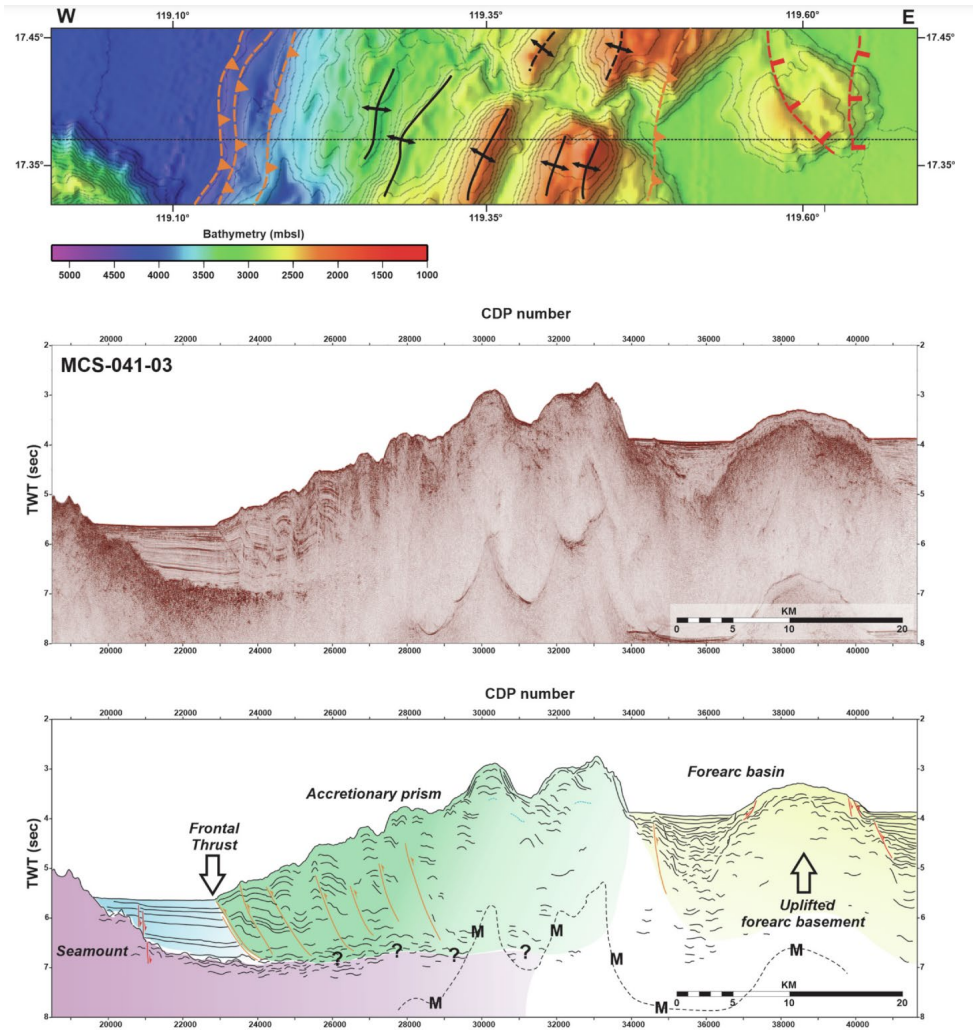




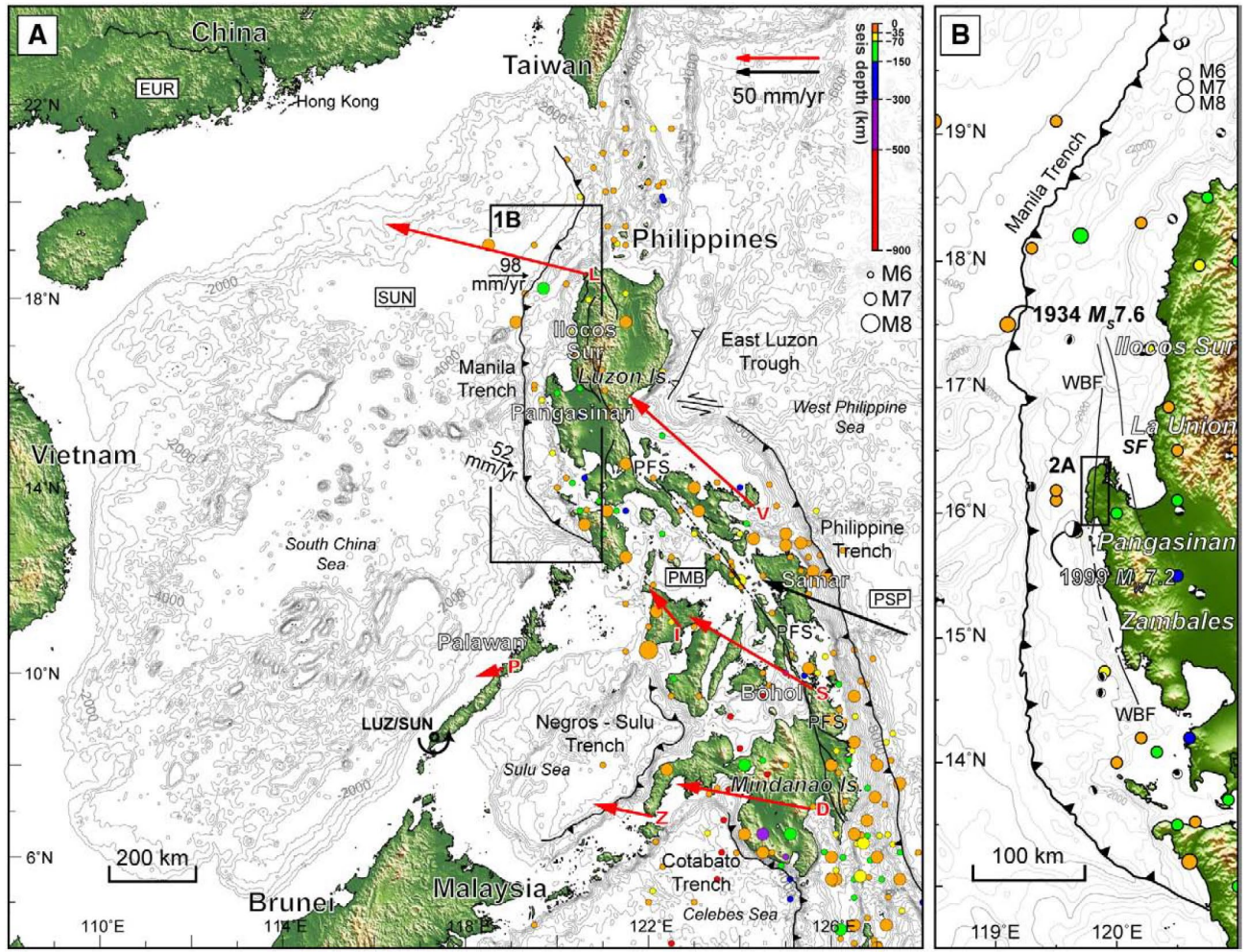
(Armada, 2020)

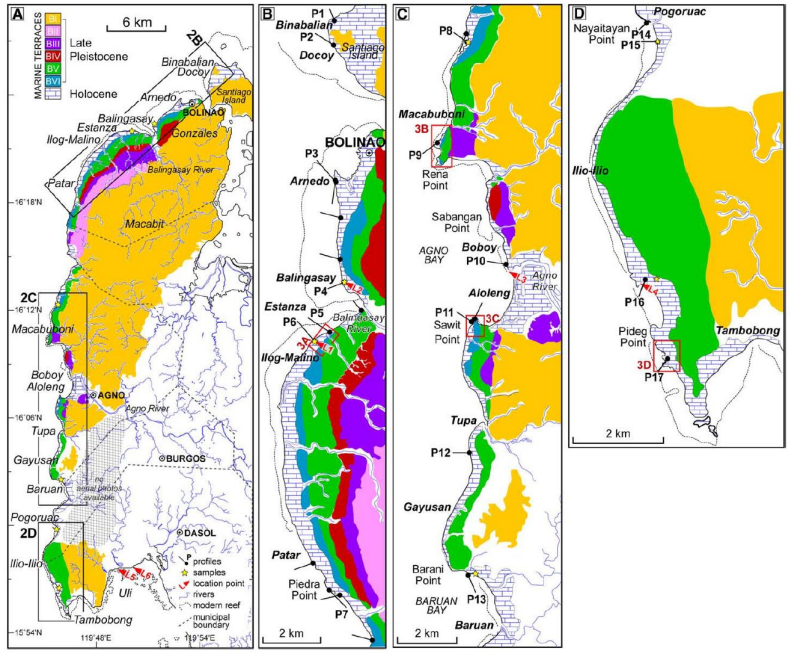
Manila Trench

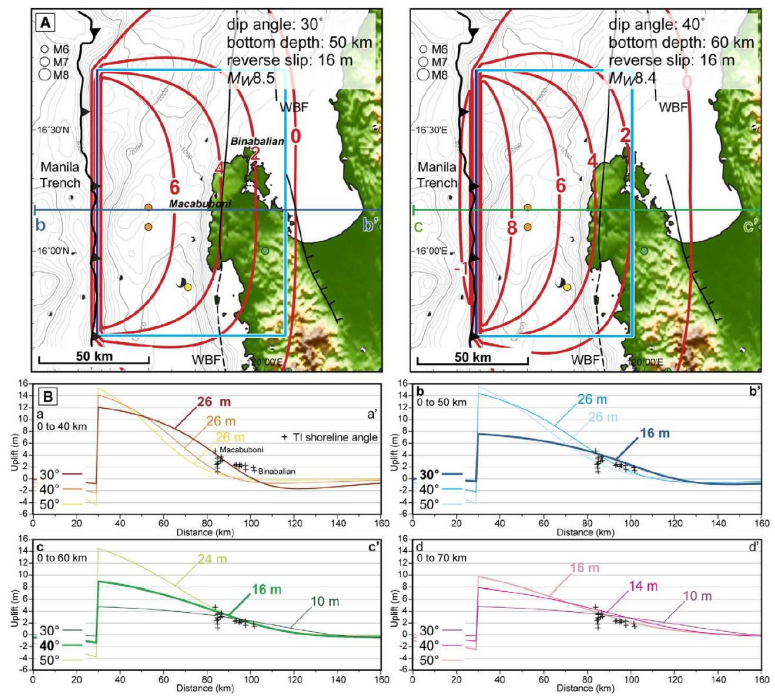


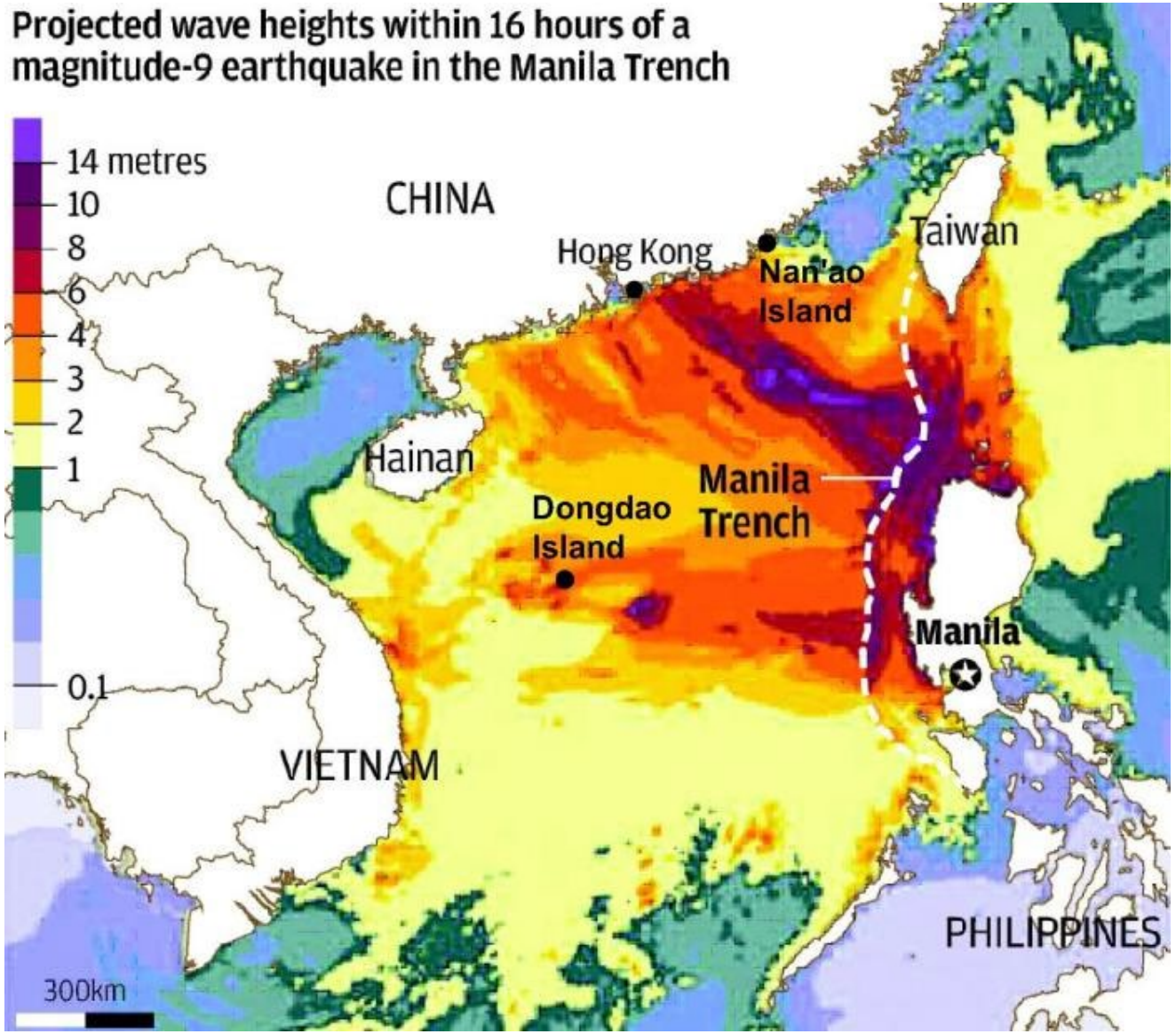


(Armada, 2020)


A
China
Taiwan
Hong Kong
EUR
SUN
LUZ/SUN
1B
98 mm/yr
50 mm/yr
52 mm/yr
Philippines
Ilocos Sur
Luzon Is.
Pangasinan
Manila Trench
East Luzon Trough
West Philippine Sea
Philippine Trench
Samar
PSP
PFS
PMB
Palawan
Negros - Sulu Trench
Sulu Sea
Bohol
Mindanao Is.
Cotabato Trench
Celebes Sea
Malaysia
Brunei
Vietnam
South China Sea
seis depth (km)
M6
M7
M8
200 km
B
1934 Ms7.6
1999 Mw7.2
WBF
SF
2A
La Union
Zambales
100 km


A
MARINE TERRACES
Late Pleistocene
Holocene
6 km
Binabalian
Docoy
Arnedo
Santiago Island
BOLINAO
Balingasay
Estanza
Ilog-Malino
Gonzales
Patar
Balingasay River
Macabit
2C
Macabuboni
Boboy
Aloleng
AGNO
Agno River
Tupa
Gayusan
BURGOS
Baruan
Pogoruac
2D
Ilio-Ilio
DASOL
Uli
Tambobong
profiles
samples
location point
rivers
modern reef
municipal boundary
B
P1
P2
P3
P4
P5
P6
P7
Piedra Point
2 km
C
P8
3B
P9
Rena Point
Sabangan Point
P10
P11
Sawit Point
3C
P12
Barani Point
P13
BARUAN BAY
D
Nayaitayan Point
P14
P15
P16
Pideg Point
3D
P17

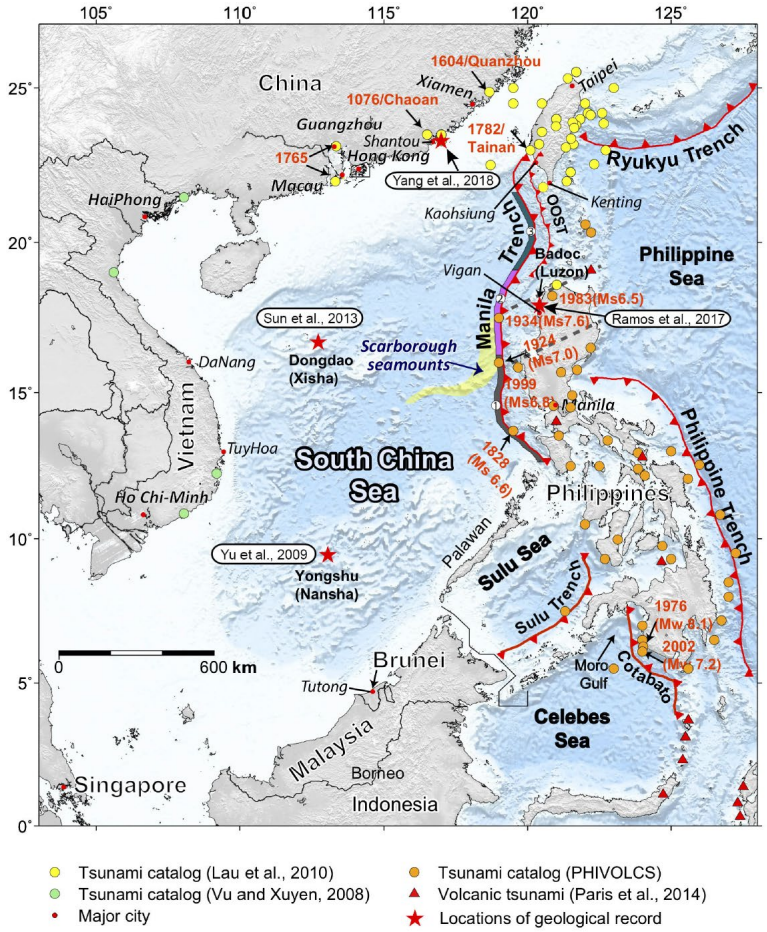

A
dip angle: 30°
bottom depth: 50 km
reverse slip: 16 m
Mw8.5
dip angle: 40°
bottom depth: 60 km
reverse slip: 16 m
Mw8.4
WBF
Manila Trench
Binabalian
Macabuboni
50 km
B
a
0 to 40 km
26 m
+ TI shoreline angle
b
0 to 50 km
16 m
c
0 to 60 km
24 m
10 m
d
0 to 70 km
14 m
Uplift (m)
Distance (km)



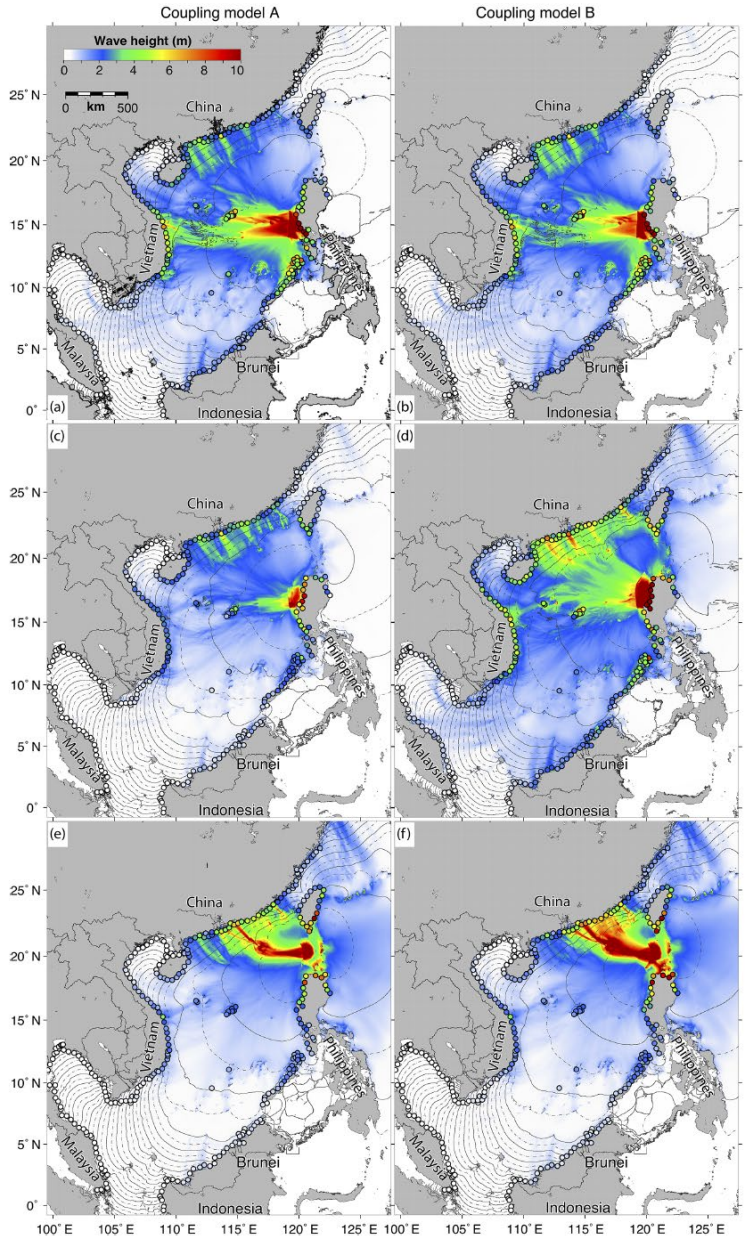
Dao et al. (2009)

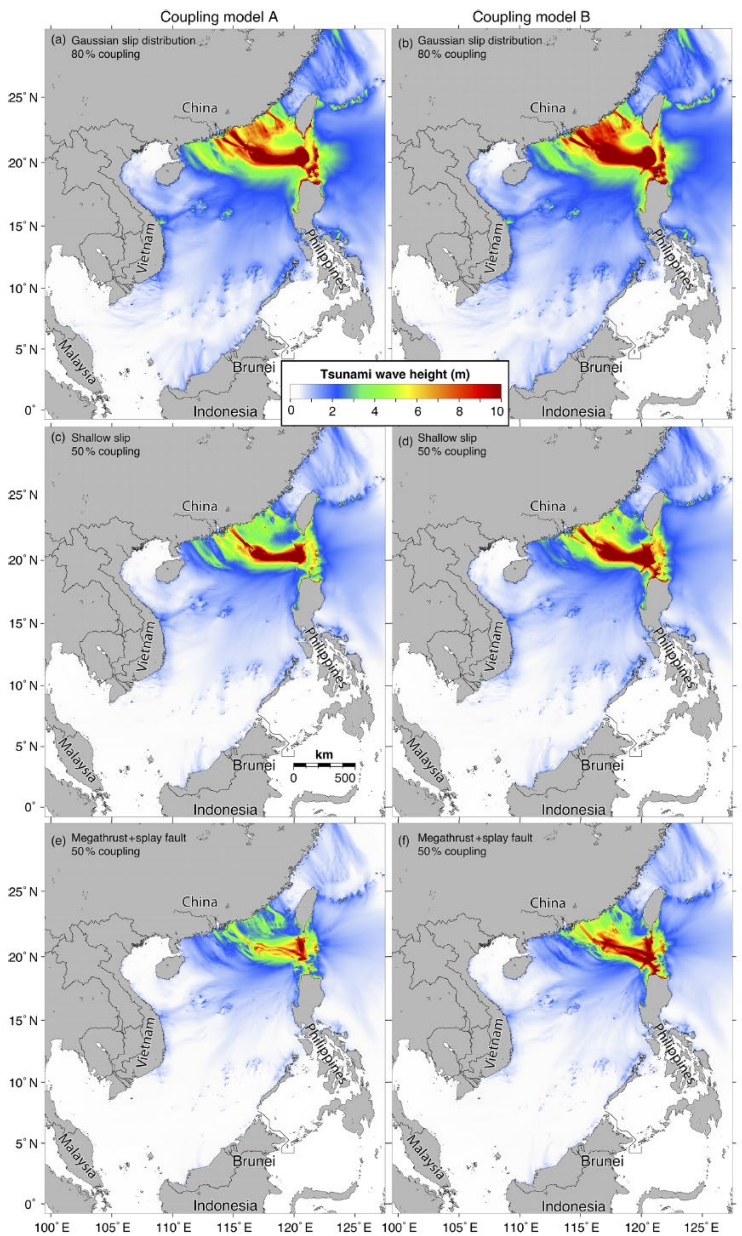
Earthquake recurrence interval:
500 years

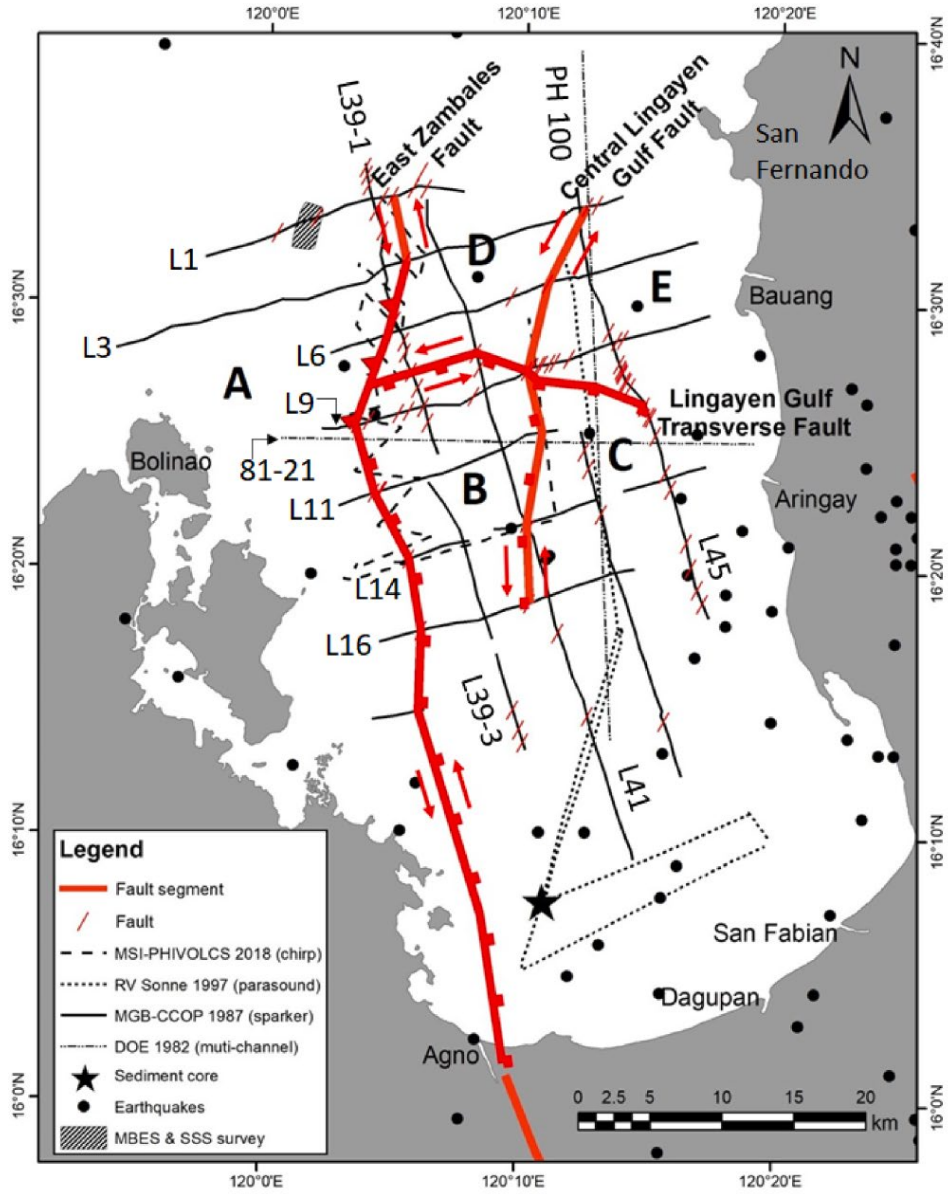
Last big earthquake:
~1,000 to 500 years ago

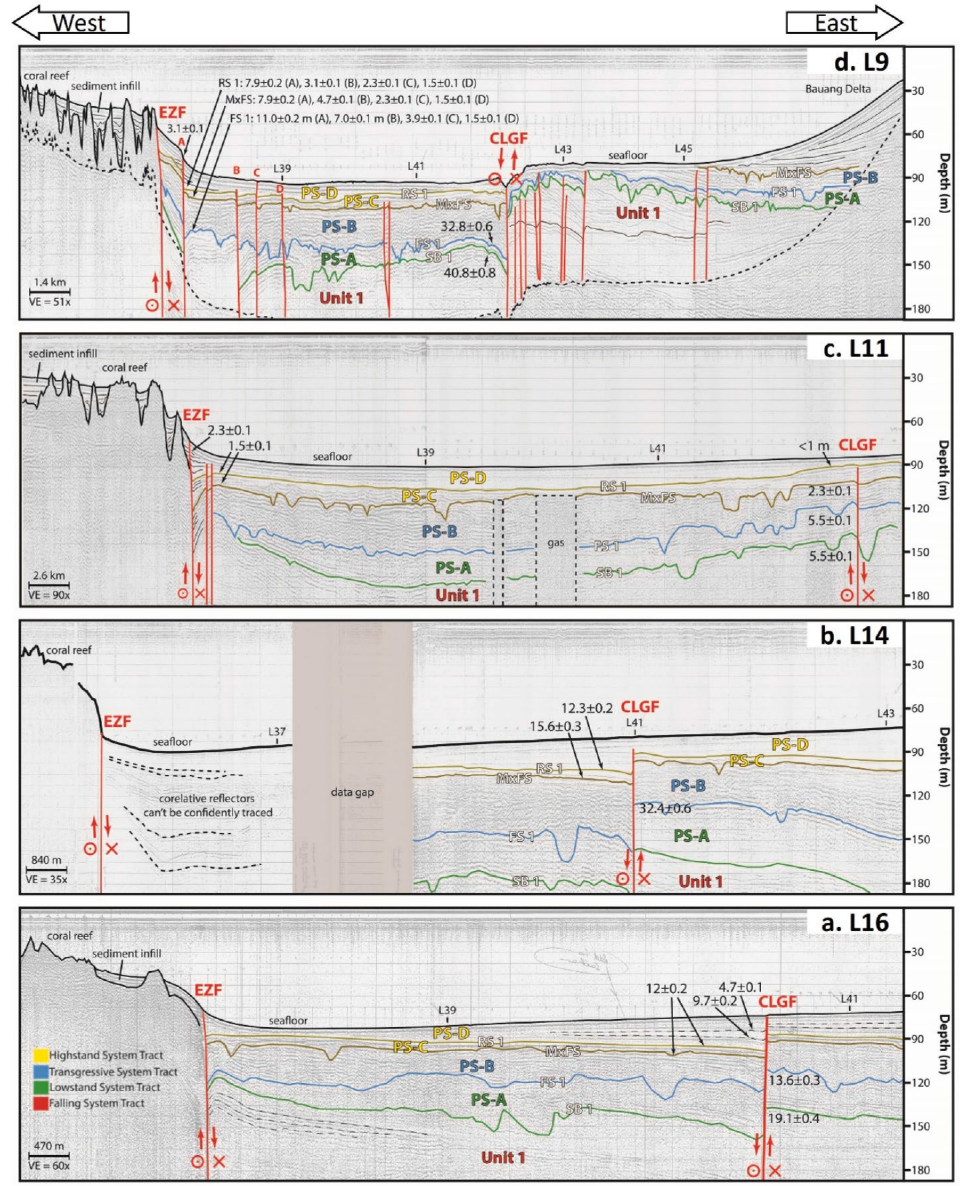


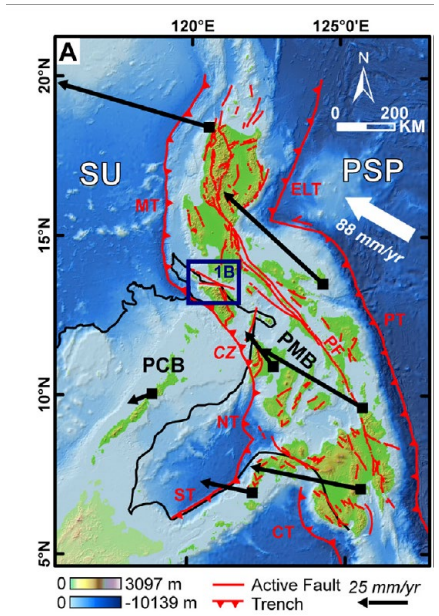
- Tsunami catalog (Lau et al., 2010)
- Tsunami catalog (Vu and Xuyen, 2008)
- Major city
- Tsunami catalog (PHIVOLCS)
- Volcanic tsunami (Paris et al., 2014)
- Locations of geological record

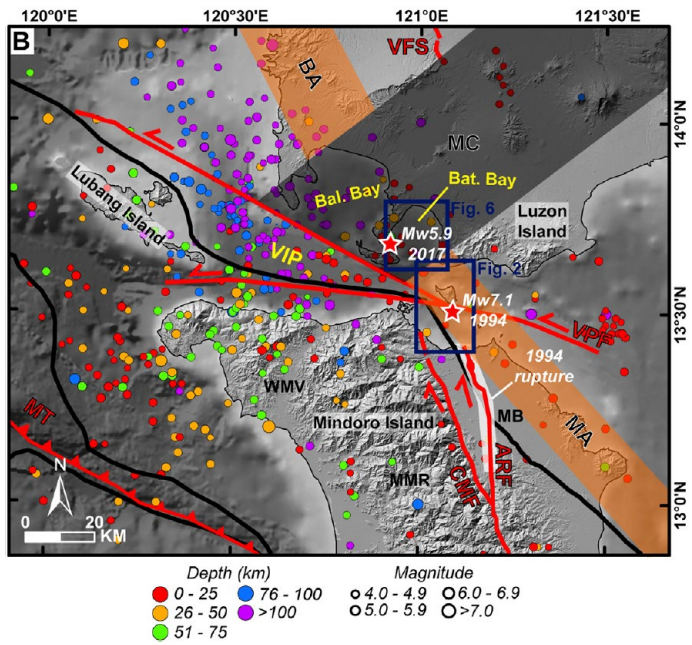




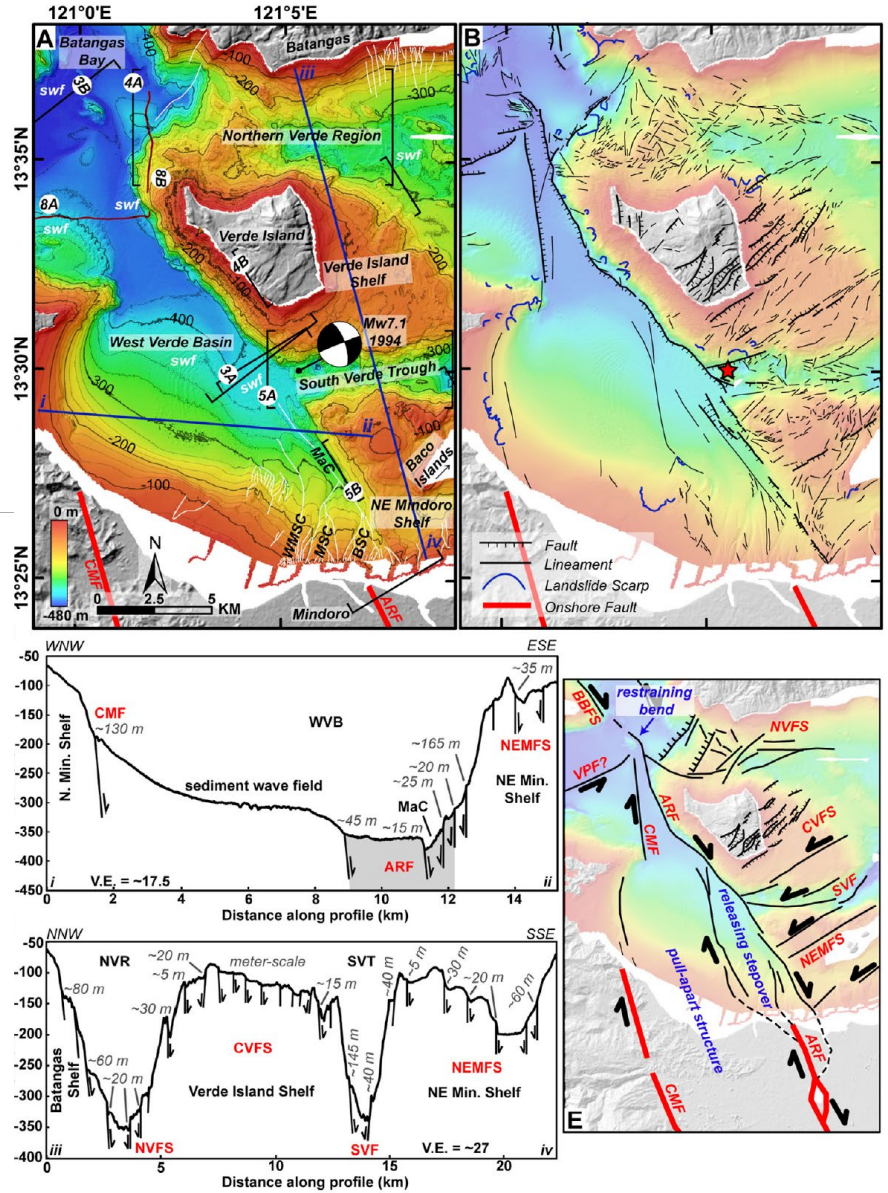

120°0'E
120°10'E
120°20'E
16°40'N
16°30'N
16°20'N
16°10'N
16°0'N
N
East Zambales Fault
Central Lingayen Gulf Fault
Lingayen Gulf Transverse Fault
L39-1
PH 100
L1
L3
L6
L9
81-21
L11
L14
L16
L39-3
L41
L45
A
B
C
D
E
San Fernando
Bauang
Aringay
Bolinao
San Fabian
Dagupan
Agno
Legend
Fault segment
Fault
MSI-PHIVOLCS 2018 (chirp)
RV Sonne 1997 (parasound)
MGB-CCOP 1987 (sparker)
DOE 1982 (muti-channel)
Sediment core
Earthquakes
MBES & SSS survey
0 2.5 5 10 15 20
km

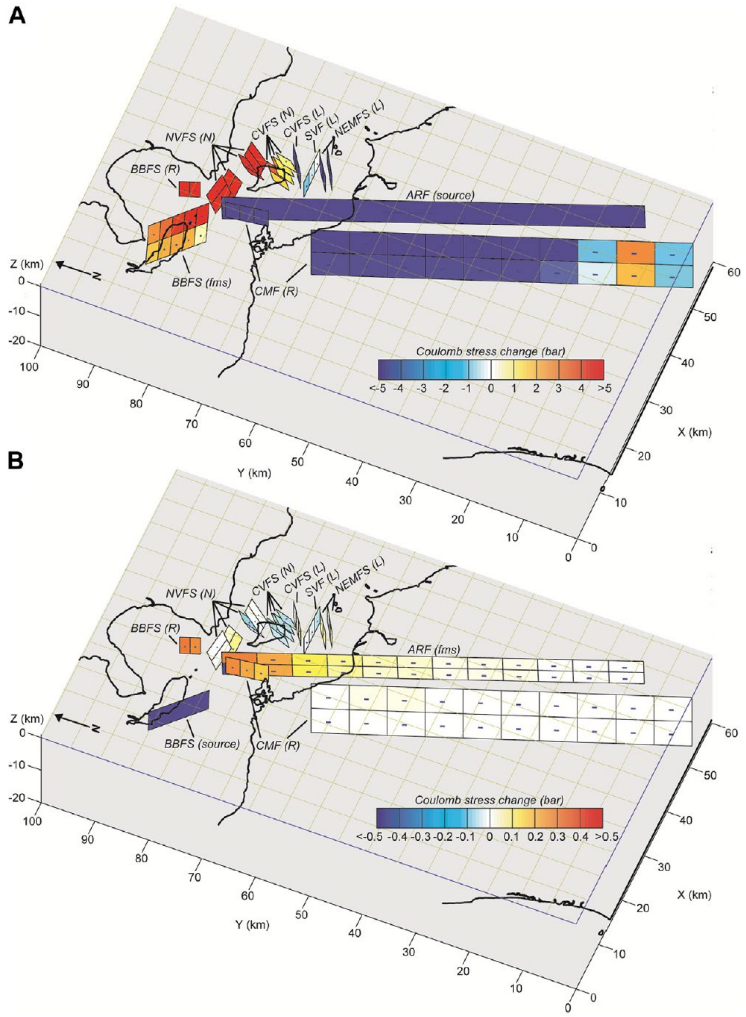

West
East
d. L9
coral reef
sediment infill
RS 1: 7.9±0.2 (A), 3.1±0.1 (B), 2.3±0.1 (C), 1.5±0.1 (D)
MxFS: 7.9±0.2 (A), 4.7±0.1 (B), 2.3±0.1 (C), 1.5±0.1 (D)
FS 1: 11.0±0.2 m (A), 7.0±0.1 m (B), 3.9±0.1 (C), 1.5±0.1 (D)
Bauang Delta
EZF
3.1±0.1
CLGF
seafloor
PS-D
PS-C
PS-B
PS-A
RS-1
MxFS
FS-1
SB-1
Unit 1
32.8±0.6
40.8±0.8
1.4 km
VE = 51x
c. L11
2.3±0.1
1.5±0.1
<1 m
gas
2.6 km
VE = 90x
b. L14
12.3±0.2
15.6±0.3
corelative reflectors can't be confidently traced
data gap
32.4±0.6
840 m
VE = 35x
a. L16
12±0.2
4.7±0.1
9.7±0.2
13.6±0.3
19.1±0.4
Highstand System Tract
Transgressive System Tract
Lowstand System Tract
Falling System Tract
470 m
VE = 60x
Depth (m)

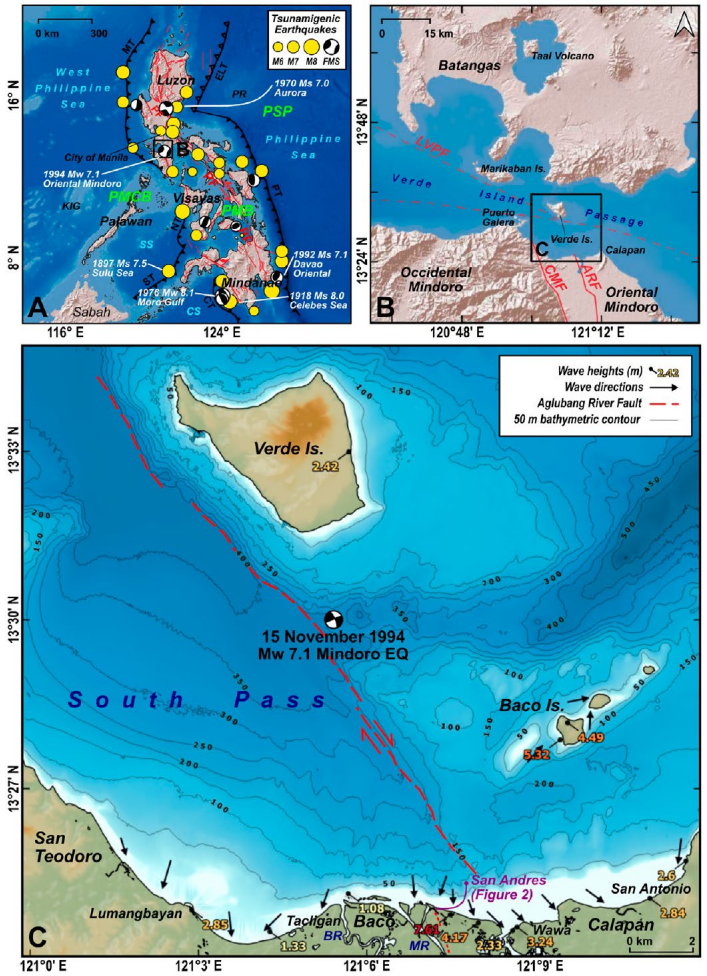


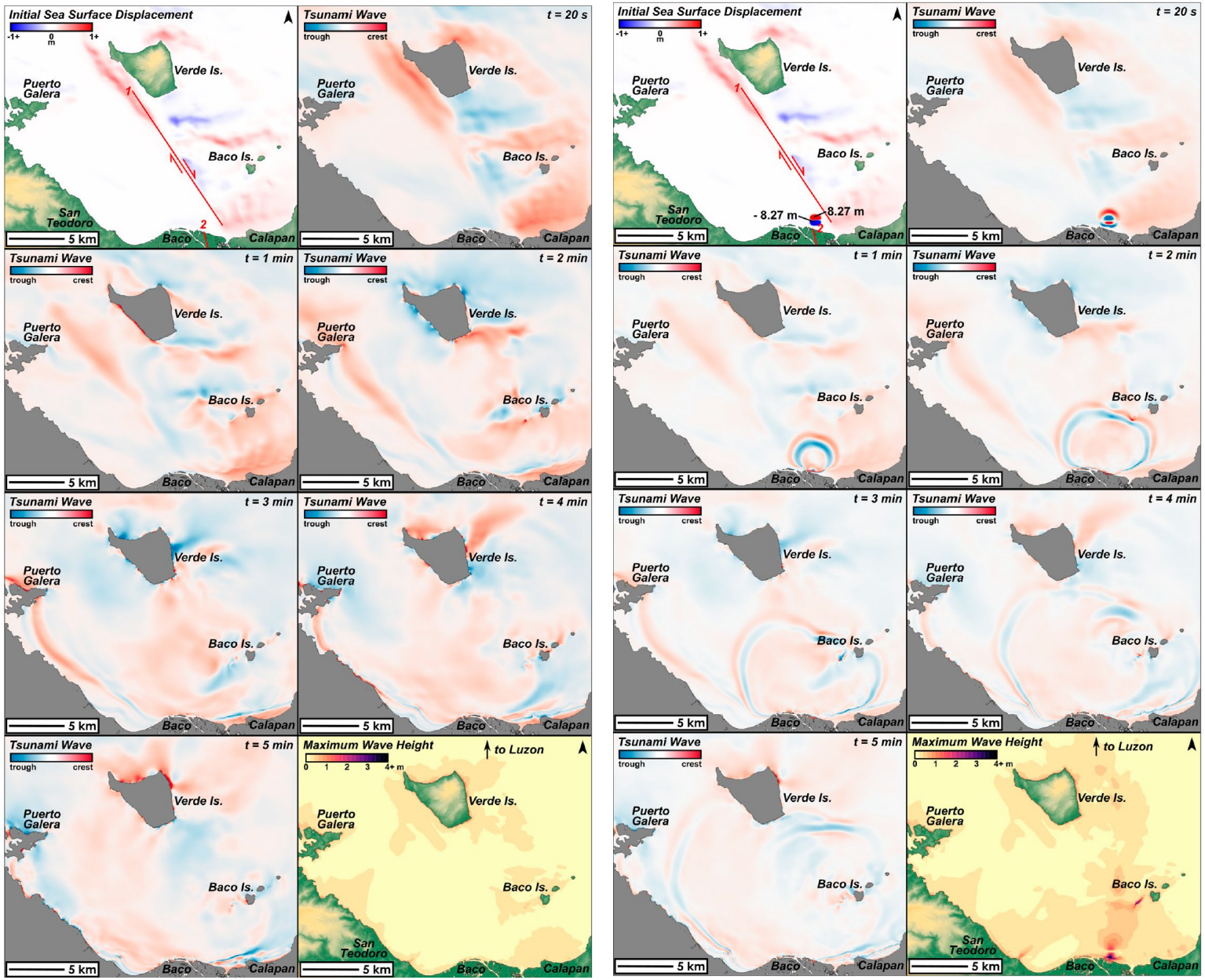


(Sarmiento et al., 2022)









(Ramirez et al., 2022)

Thank you for your attention!