Eleventh Meeting of the ICG/PTWS Regional Working Group on Tsunami Warning and Mitigation System in the South China Sea Region (ICG/PTWS WG-SCS), Guangzhou, 25 - 27 September 2023

Report on Seismic and Sea Level Core Stations in the SCS Region for Tsunami Warning

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Outline

1 Background

2 Availability and Quality Evaluation of Seismic Stations in the core network

3 Availability and Quality Evaluation of Sea Level Stations in the core network

4 Summary, Concern and Recommdation

1.1 Purpose of Data Sharing

- Seismic and sea level measurements are critical for tsunami warning operation in the following aspects:
  - Earthquke and tsunami detection in time
  - Scale evaluation of earthquake and tsunami
  - Earthquake and tsunami analysis (i.e. Focal mechanism)
  - Tsunami forecast correction
  - Tsunami threat level upgrading and downgrading

1.2 History of core stations and actions

- **To strenthen tsunami warning capacity**

- **ICG/PTWS SCS-WG-IV Jakarta, Indonesia, 2015**

  Compiling the inventory of seismic and sea level stations in the SCS region

- **ICG/PTWS SCS-WG-V Manila, Philippine, 2016**

  Continuing to compiling the inventory of seismic and sea level stations

- **ICG/PTWS SCS-WG-VI Shanghai, China, 2017**

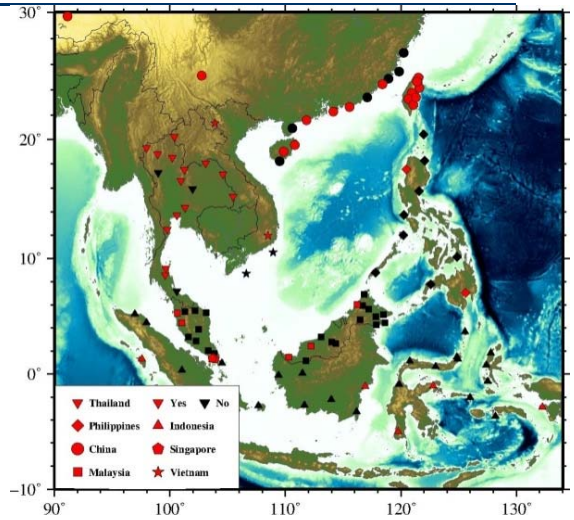
  Determination the lists of seismic and sea level stations

- **ICG/PTWS SCS-WG-VII Hanoi, Vietnam, 2018**

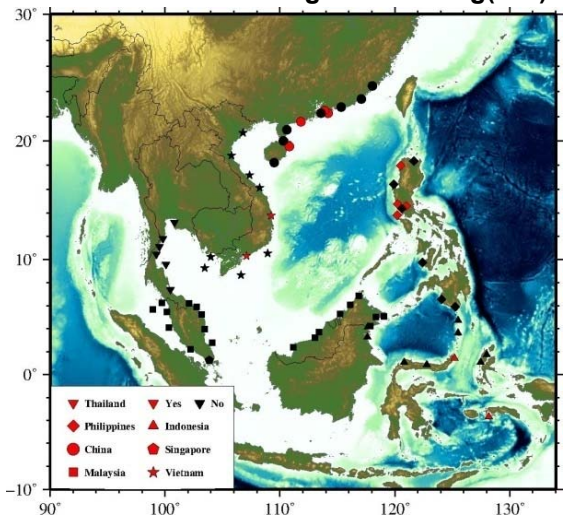
  Request SCSTAC to provide the reports on data availability of core stations

- **ICG/PTWS SCS-WG-VIII Jakarta, Indonesia,2019**

  SCSTAC provided the reports on data availability of core stations



Seismic Core Stations in the SCS region for further enhancing data sharing(115)



Sea Level Stations in the SCS region for further enhancing data sharing(69)

1.3 Encouragement and coordination from IOC

A training workshop on earthquake and tsunami monitoring and early warning capabilities and data sharing in the South China Sea Region was organized and hosted jointly by UNESCO-IOC and NMEFC in Hangzhou China, 21 - 26 October 2019. The aim is to improve the understanding of data acquisition, treating and management for operational staff of tsunami warning and data management, **most importantly promoting the data sharing.**

Seismic stations of the Core Network in SCS (115)

Sea level stations of the Core Network in SCS (69+2)

1.4 SCSTAC efforts on data exchange and sharing

- Seismic data

In 2018, SCSTAC built a data-flow server for seismic core stations, using SeedLink client for sharing seismic data stream from and for WG-SCS Member States.

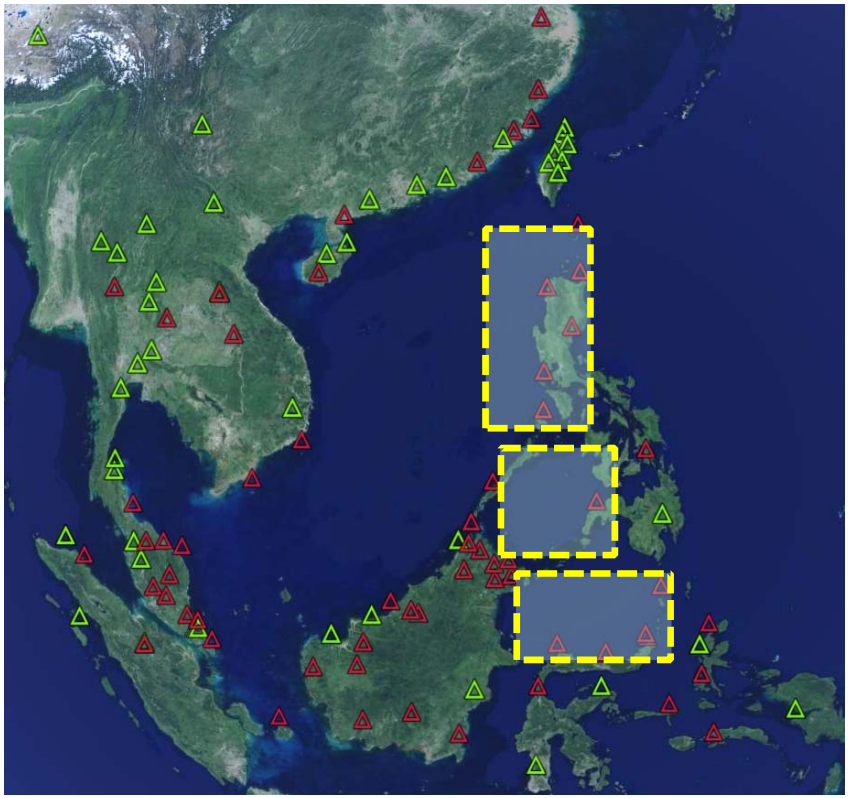
- Sea level data

In 2019, SCSTAC set up a data-sharing server for sea level core stations, Member States could share their sea level data via ftp protocol exclusively for tsunami warning.

Regrettably, almost no MS involved

2.1 Seismic stations in the core network in SCS

- Seismic Core Stations in the SCS region for further enhancing data sharing (115), public accessibility (49) in 2023



Green - accessible .vs. red - unaccessible

China: 22 [15Yes/7No]

Indonesia : 30 [10Yes/20No]

Malaysia : 25 [5Yes/20No]

Philippines : 10 [1Yes/9No]

Singapore: 4 [4Yes]

Thailand : 20 [12Yes/8No]

Viet Nam: 4 [2 Yes/2 No]

115 [49 Yes/66 No]

2.2 Arrival Rate of Accessible Seismic Stations

Quality of accessible seismic stations in the core network 2023										
No.	Source	Network	Station Code	Lon	Lat	Country	Arrival rate			
							Q1 (2023)	Q2 (2023)	Q3	Q4
1	IRIS	HK	HKPS	114.14	22.28	China	99.41%	99.72%		
2	SOA,China	OB	ZLG, Zhelang	115.57	22.65	China	95.44%	97.06%		
3	SOA,China	OB	ZPO, Zhapo	111.83	21.58	China	92.01%	96.88%		
4	SOA,China	OB	QLN, Qinglan	110.82	19.57	China	99.85%	93.43%		
5	IRIS	IC	KMI	102.74	25.12	China	98.55%	99.10%		
6	IRIS	IC	LSA	91.13	29.70	China	99.36%	98.37%		
7	IRIS	IC	QIZ	109.84	19.03	China	99.36%	98.37%		
8	IRIS	IU	TATO	121.50	24.97	China	99.35%	97.40%		
9	IRIS	TW	KMNB	118.39	24.46	China	99.40%	99.72%		
10	IRIS	TW	NACB	121.59	24.17	China	82.87%	92.57%		
11	IRIS	TW	SSLB	120.95	23.79	China	99.27%	98.66%		
12	IRIS	TW	TPUB	120.63	23.30	China	99.40%	96.55%		
13	IRIS	TW	TWGB	121.08	22.82	China	99.39%	98.49%		
14	IRIS	TW	YHNB	121.37	24.67	China	99.39%	99.72%		
15	IRIS	TW	YULB	121.30	23.39	China	99.40%	95.17%		
16	GEOFON	GE	BKB	116.90	-1.11	Indonesia	98.43%	94.51%		
17	GEOFON	GE	BKNI	101.04	0.33	Indonesia	99.59%	94.51%		
18	GEOFON	GE	FAKI	132.25	-2.92	Indonesia	99.59%	99.84%		
19	GEOFON	GE	GSI	97.58	1.30	Indonesia	99.95%	97.03%		
20	GEOFON	GE	LHMI	96.95	5.23	Indonesia	99.60%	99.99%		
21	GEOFON	GE	LUWI	122.77	-1.04	Indonesia	98.31%	87.85%		
22	GEOFON	GE	TNTI	127.37	0.77	Indonesia	99.99%	93.41%		
23	IRIS	II	KAPI	119.75	-5.01	Indonesia	99.29%	99.72%		
24	GEOFON	GE	Ternate (TNTI)	127.37	0.77	Indonesia	99.99%	93.41%		

2.2 Arrival Rate of Accessible Seismic Stations

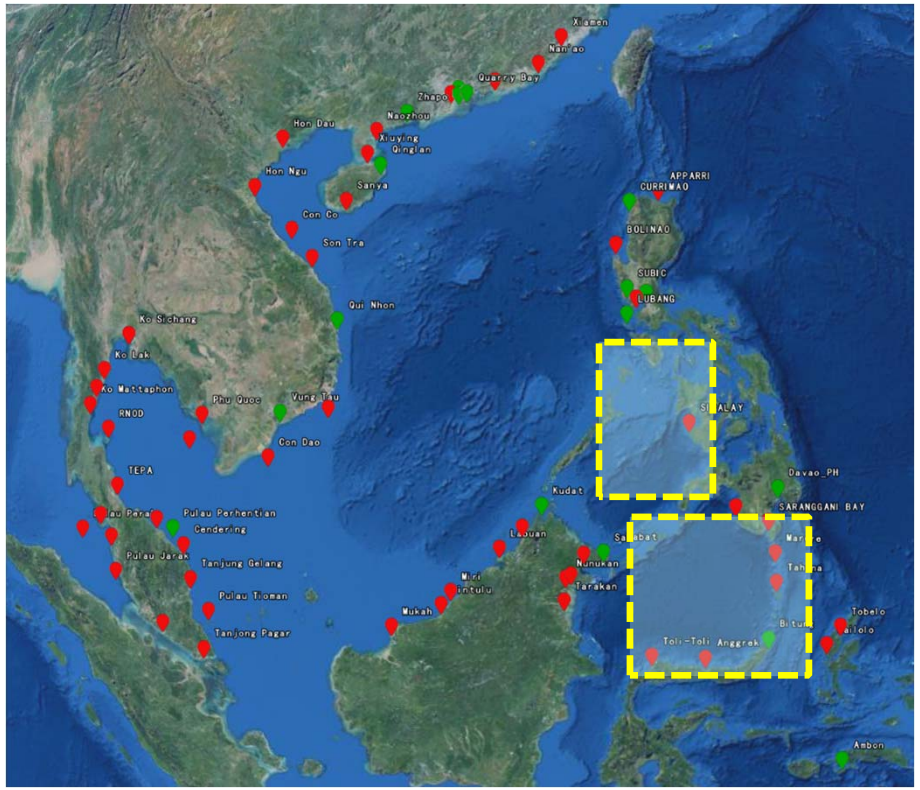
Cont. above table

25	GEOFON	GE	Lhok Sumawe (LHMI)	96.95	5.23	Indonesia	99.60%	99.99%		
26	IRIS	MY	IPM	101.03	4.48	Malaysia	94.31%	86.39%		
27	IRIS	MY	KKM	116.21	6.04	Malaysia	54.15%	57.67%		
28	IRIS	MY	KSM	110.31	1.47	Malaysia	94.66%	96.42%		
29	IRIS	MY	KUM	100.65	5.29	Malaysia	82.37%	25.11%		
30	IRIS	MY	SBM	112.21	2.45	Malaysia	47.51%	45.78%		
31	IRIS	IU	DAV	125.58	7.07	Philippines	99.30%	97.25%		
32	IRIS	MS	BESC	103.85	1.34	Singapore	97.74%	96.53%		
33	IRIS	MS	BTDF	103.77	1.36	Singapore	97.74%	96.53%		
34	IRIS	MS	KAPK	103.89	1.30	Singapore	97.74%	96.53%		
35	IRIS	MS	NTU	103.69	1.35	Singapore	97.74%	96.53%		
36	IRIS	TM	CMMT	98.95	18.81	Thailand	64.63%	71.73%		
37	IRIS	TM	CRAI	100.40	20.23	Thailand	87.40%	94.46%		
38	IRIS	TM	LOEI	101.26	17.51	Thailand	92.51%	94.46%		
39	IRIS	TM	MHIT	97.96	19.31	Thailand	87.40%	77.71%		
40	IRIS	TM	NAYO	101.30	14.32	Thailand	96.80%	92.09%		
41	IRIS	TM	PANO	104.61	17.15	Thailand	43.93%	98.70%		
42	IRIS	TM	PBKT	100.97	16.57	Thailand	92.51%	85.62%		
43	IRIS	TM	PRAC	99.79	12.47	Thailand	94.06%	97.17%		
44	IRIS	TM	SRIT	99.60	8.60	Thailand	94.91%	98.91%		
45	IRIS	TM	SURA	99.63	9.17	Thailand	94.44%	32.70%		
46	IRIS	TM	TMDB	100.61	13.67	Thailand	80.24%	96.00%		
47	IRIS	IU	CHTO	98.94	18.81	Thailand	99.36%	97.54%		
48	IRIS	RM	DLV	108.48	11.95	Vietnam	73.31%	97.81%		
49	IRIS	RM	SLV	103.91	21.33	Vietnam	96.78%	99.69%		

Note: Yellow background means less than 40%

3.1 Sea Level Stations in the core network in SCS

- **Availability of** Sea Level Stations in the SCS region **in 2022**
- **17(accessibility)** /71(total)



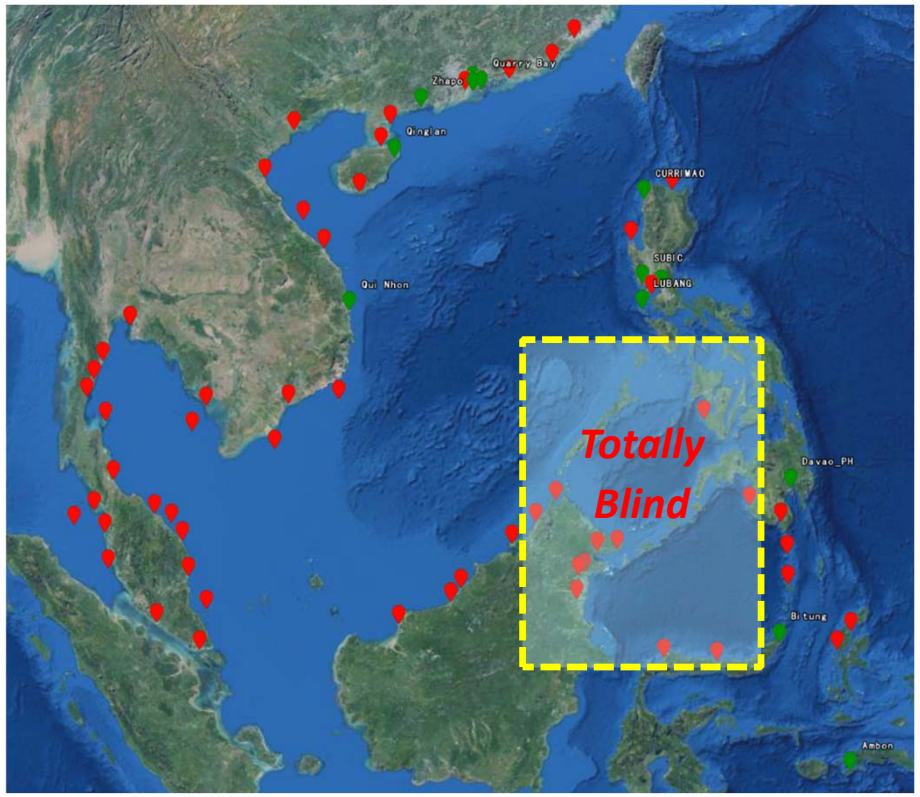
Green - accessible .vs. red - unccessible

China:	**12 [5 Yes/7 No]**
Indonesia:	**10 [2 Yes/8 No]**
Malaysia:	**20 [3 Yes/17 No]**
Philippines:	**11 [5 Yes/6 No]**
Singapore:	**1 [0 Yes/1 No]**
Thailand:	**7 [0 Yes/7 No]**
Viet Nam:	**10 [2 Yes/8 No]**

71 [17 Yes/54 No]

3.1 Sea Level Stations in the core network in SCS

- **Availability of** Sea Level Stations in the SCS region **in 2023**
- **13(accessibility)** /71(total) up to 20 Sep.



Green - accessible .vs. red - unaccessible

China:	**12 [5 Yes/7 No]**
Indonesia:	**10 [2 Yes/8 No]**
Malaysia:	**20 [0 Yes/20 No]**
Philippines:	**11 [5 Yes/6 No]**
Singapore:	**1 [0 Yes/1 No]**
Thailand:	**7 [0 Yes/7 No]**
Viet Nam:	**10 [1 Yes/9 No]**
	71 [13 Yes/58 No]

3.2 Status of Accessible Sea Level Stations in 2022

Quality of accessible sea level stations in the core network 2022									
NO.	Station Name	Code(GTS)	Lat	Lon	Country	Arrival Rate (%)			
						Q1(1-3)	Q2(4-6)	Q3(7-9)	Q4(10-12)
1	Quarry Bay	quar	22.29	114.21	China	84%	79%	83%	84%
2	Shek	shek	22.22	113.89		84%	78%	81%	84%
3	Shenzhen	shen	22.47	113.88		65%	69%	**9%**	52%
4	Zhapo	zhap	21.58	111.82		65%	70%	**10%**	52%
5	Qinglan	qing	19.57	110.82		65%	67%	**33%**	51%
6	Ambon	ambon	-3.68	128.18	Indonesia	63%	76%	**3%**	**0%**
7	Bitung	bitu	1.44	125.19		55%	50%	69%	72%
8	Pulau	ms004	5.93	102.77	Malaysia	**2%**	**5%**	53%	**0%**
9	Kudat, Sabah	ms005	6.88	116.85		56%	87%	48%	50%
10	Lahad Datu, Sabah	ms006	5.08	119.08		**21%**	74%	48%	**38%**
11	Currimao	curri	17.98	120.48	Philippines	74%	69%	86%	84%
12	Subic	subi	14.77	120.25		65%	67%	86%	84%
13	Manila	mani	14.58	120.97		94%	95%	96%	96%
14	Lubang	luba	13.82	120.2		53%	68%	88%	89%
15	Davao_PH	davo	7.15	125.66		94%	96%	96%	96%
16	Qui Nhon	quin	13.76	109.25	Vietnam	**27%**	**25%**	**31%**	**12%**
17	Vung Tau	vung	10.34	107.07		94%	95%	**10%**	**0%**

Note: Red fold font means less than 40%

3.2 Status of Accessible Sea Level Stations in 2023

Quality of accessible sea level stations in the core network 2023									
NO.	Station Name	Code(GTS)	Lat	Lon	Country	Arrival Rate (%)			
						Q1(1-3)	Q2(4-6)	Q3(7-8)	
1	Quarry Bay	quar	22.29	114.21	China	75%	72%	62%	
2	Shek	shek	22.22	113.89		75%	71%	60%	
3	Shenzhen	shen	22.47	113.88		70%	65%	63%	
4	Zhapo	zhap	21.58	111.82		72%	64%	61%	
5	Qinglan	qing	19.57	110.82		71%	60%	62%	
6	Ambon	ambon	-3.68	128.18	Indonesia	**16%**	**15%**	**10%**	
7	Bitung	bitu	1.44	125.19		**9%**	/	/	
8	Pulau	ms004	5.93	102.77	Malaysia	/	/	/	
9	Kudat, Sabah	ms005	6.88	116.85		/	/	/	
10	Lahad Datu, Sabah	ms006	5.08	119.08		/	/	/	
11	Currimao	curri	17.98	120.48	Philippines	92%	94%	45%	
12	Subic	subi	14.77	120.25		90%	96%	95%	
13	Manila	mani	14.58	120.97		90%	98%	97%	
14	Lubang	luba	13.82	120.2		70%	69%	75%	
15	Davao_PH	davo	7.15	125.66		97%	98%	98%	
16	Qui Nhon	quin	13.76	109.25	Vietnam	10%	2%	/	
17	Vung Tau	vung	10.34	107.07		/	/	/	

Note: Red fold font means less than 40%

4.1 Summary

- **Evaluation of core seismic stations**

  Total: 151

  Public Accessibility: 49 (~32%)

  Arrival rate: Good

- **Evaluation of core sea level stations**

  Total: 71

  GTS Accessibility: 17(2022: 24%) - 13(2023: 18%)

  Situation is getting worse!

  Arrival rate: Ordinary, unstable and need to be improved

4.2 Concern

- Available seismic stations in SCS are rare, especially on the Manila trench which is the most dangerous tsunami source, as well as around Sulu Sea and Celebes Sea, and in North Borneo

- Available sea level stations in SCS are sparse, especially in the east of Sulu Sea and Celebes Sea, and in the north of Borneo and Negros trench

- Seismic and sea level monitoring gaps are obvious in the SCS region, yet there is room for improvement based on the core station inventary

- No tsunami buoy is in service within the area

4.3 Recommendation

- Considering the deteriorating availability of the sea level stations and non-stable arrival rate, SCSTAC strongly recommendated WG-SCS Member States make their effores to maintain the data acquisition, quality and effective transmision of their sharing stations.

- Encourage Member States of the WG-SCS to share more seismic and sea level stations to further enhance the tsunami warning capability in the South China Sea region, especially for the Manila trench, the Sulu Sea, the Celebes Seas and North Borneo

Thank You!

Zongchen WANG

South China Sea Tsunami Advisory Center