Taiwan Earthquake Model

Summary of PSHA activities in TEM

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National Central University

Taiwan Earthquake Model (TEM), 2013-2014
=> PSHA 2014 and 1906 Meishan Earthquake Scenario

Hazard (PSHA)
(faulting & shaking)

- Active faults
- Instrumental quakes
- Historical earthquakes
- Geodetic strain
- Ground motion prediction equations
- Shaking amplification in soil and basins

Risk
(deaths & damage)

- Exposure
  - Population
  - Buildings
  - Remote sensing
- Vulnerability
  - Damage data
  - Fragility functions

Social Impact
(change actions)

- Decision tools
- Urban scenarios
- Risk transfer tools
- Building design codes

• 1906 Meishan Earthquake Scenario

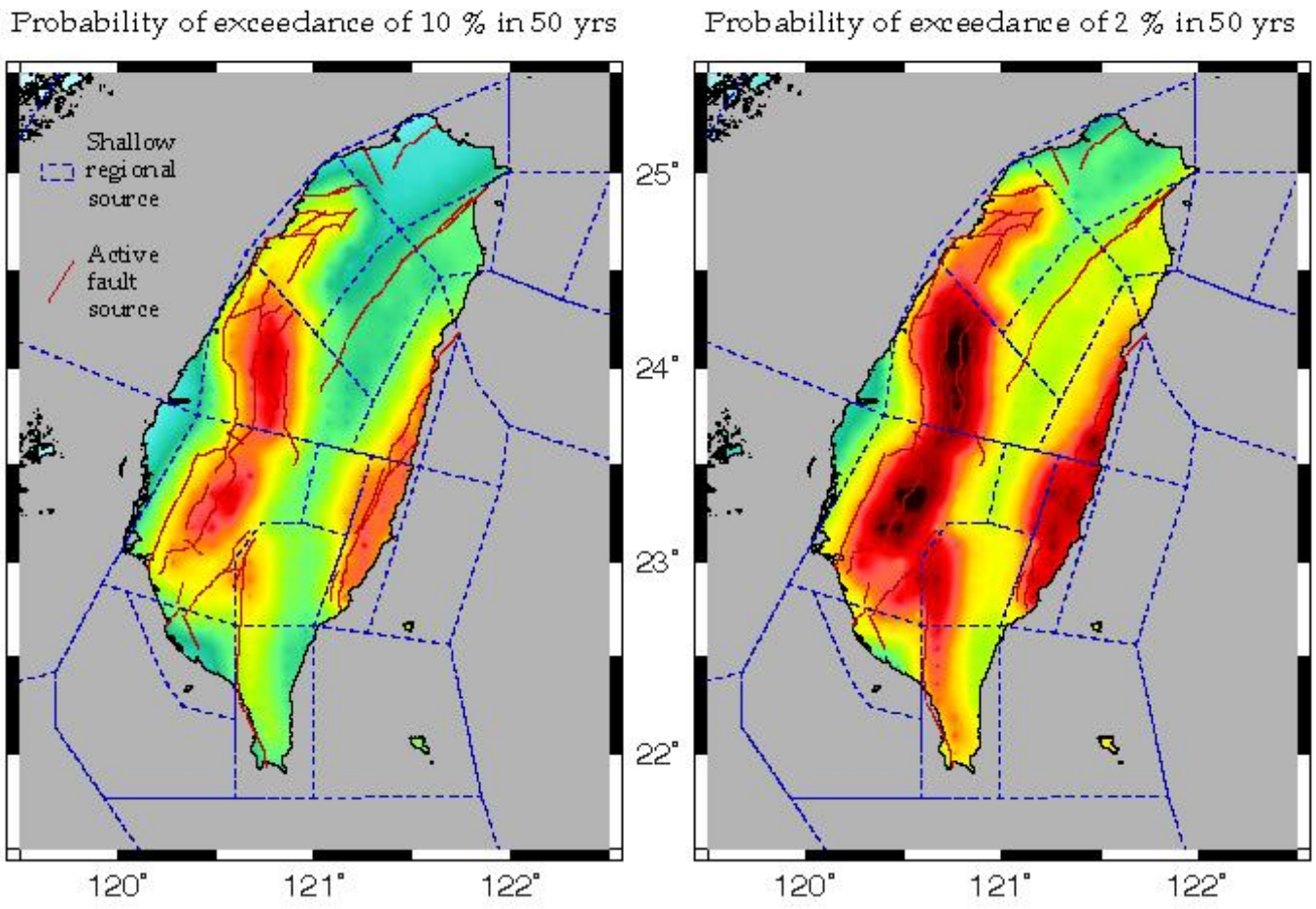
TAIWAN Earthquake Model

TEM Hazard Components
(2012-2014, PSHA2014 & 1906 Meishan Earthquake Scenario)

一、Hazard

中央大學 NCU	馬國鳳 教授 K.-F. Ma	溫國樑 教授 K.-L.Wen
成功大學 NCKU	饒瑞鈞 教授 R.-J. Rau	
中正大學 NCCU	李元希教授 Y.-S. Lee	
台灣大學 NTU	徐澔德 副教授 Bruce Shyu	詹忠翰 博士 C.H. Chan
中央研究院 IES, AS	李憲忠 副研究員 S.-J. Lee	清雲大學 鄭世楠 副教授 CYU S.N. Cheng
中興顧問社 Sino-Tech	鄭錦桐 博士 Thomas Cheng	林伯伸 博士 顏銀桐 博士 P.-S. Lin and Y.-T. Yen

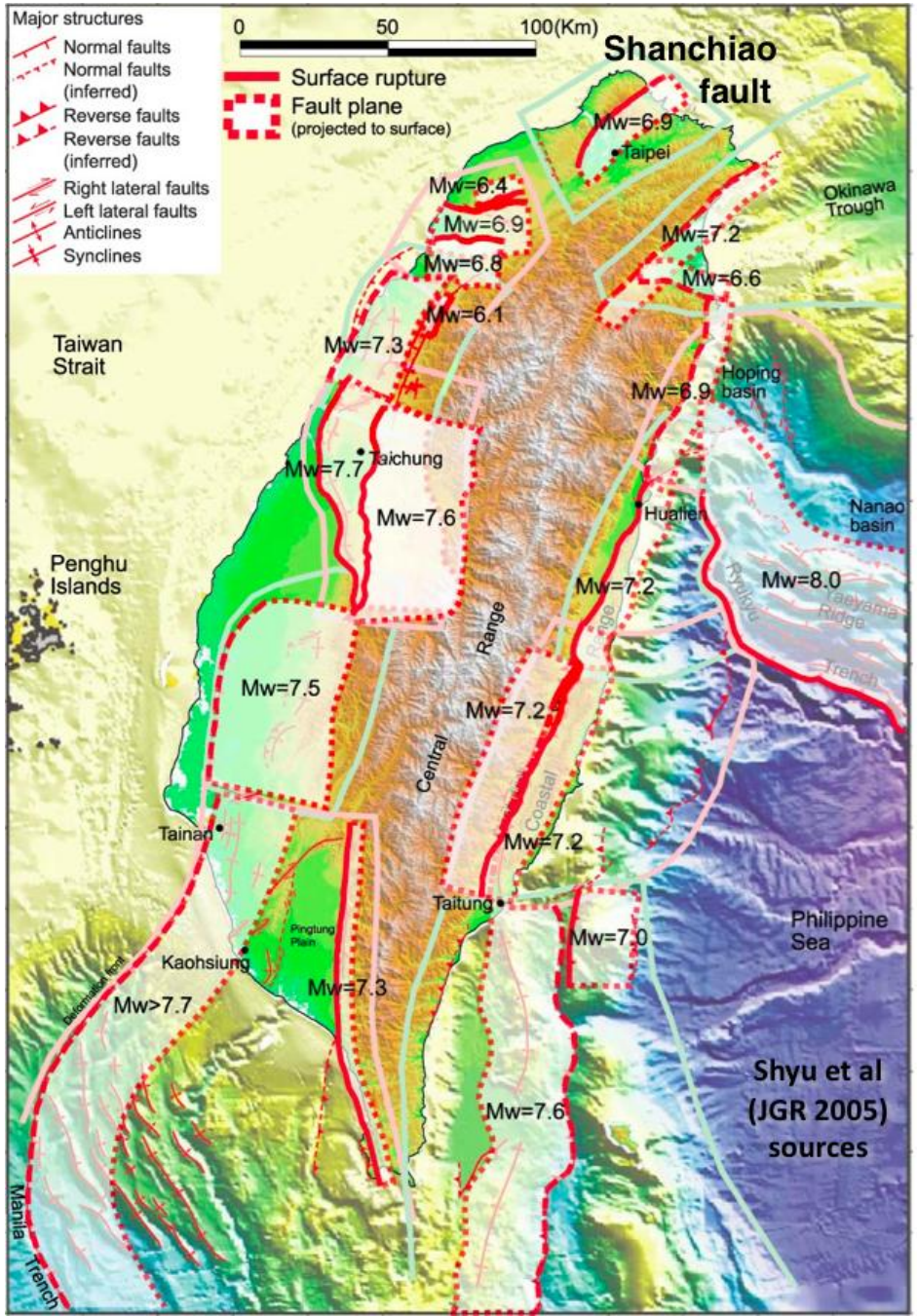
PSHA-Taiwan Exercise from GEM OpenQuake Model from Cheng et al., (2005)



TAIWAN Earthquake Model

Dr. Chan
Talk at 2A-5
June 18

Earthquake Source Model : Bruce Shyu



- **Taiwan Earthquake Model**
  II TEM-NIED Session,
  June 19th

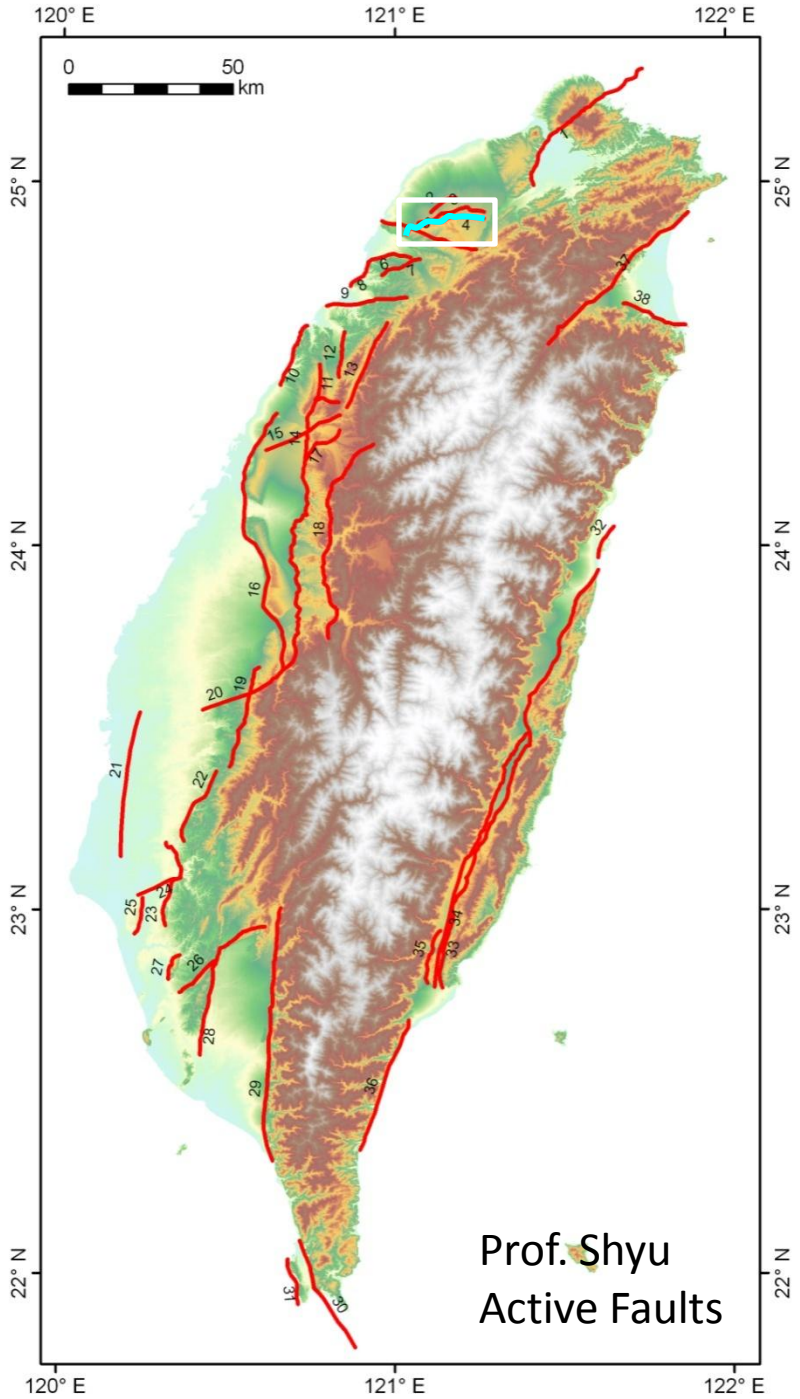
PSHA

-Earthquake Source Model

-Area Source

-Historical Earthquakes
using historical seismograms
Location and Focal mechanism

TAIWAN Earthquake Model



	Fault Name
	Shanchiao fault
2	Shuanglienpo structure
	Yangmei fault
4	Hukou fault
	fengshan river strike-slip structure
	Hsinchu fault
	Hsincheng fault
	Hsinchu frontal structure
	Touhuanping structure
	Miaoli frontal structure
	Tunglo structure
	east Miaoli structure
	Shihtan fault
	Sanyi fault
	Tuntzuchiao fault
	Changhua fault
	Chelungpu fault
	Tamaopu - Shuangtung fault
	Chiuchiungkeng fault
	Meishan fault
	Chiayi frontal structure
	Muchiliao - Liuchia fault
	Chungchou fault
	Hsinhua fault
	Houchiali fault
	Chishan fault
	Hsiaokangshan fault
	Kaoping River structure
	Chaochou fault
	Hengchun fault
	Hengchun offshore structure
	Milun fault
	Longitudinal Valley fault
	Central Range fault
	Luyeh fault
	Taimali coastline structure
	Northern Ilan structure
	Southern Ilan structure

TAIWAN Earthquake Model

Hukou Fault
湖口斷層

Vertical offset: 80-100 m

Age: 100-500 ka

→Uplift rate: 0.16-1 mm/yr

0.825±0.075（沈淑敏等, 2005; 陳于高等, 2006）

Fault dip (°): 30

→ Slip rate: 0.32-2 mm/yr

Displacement (m): 1.33

→Recurrence interval: 670-4160 yr

Fault type: reverse fault

Length (km): 25.8

Fault dip (°): 30

Depth (km): 15

Width (km): 30

Area (km^2): 774

M_w: 6.93

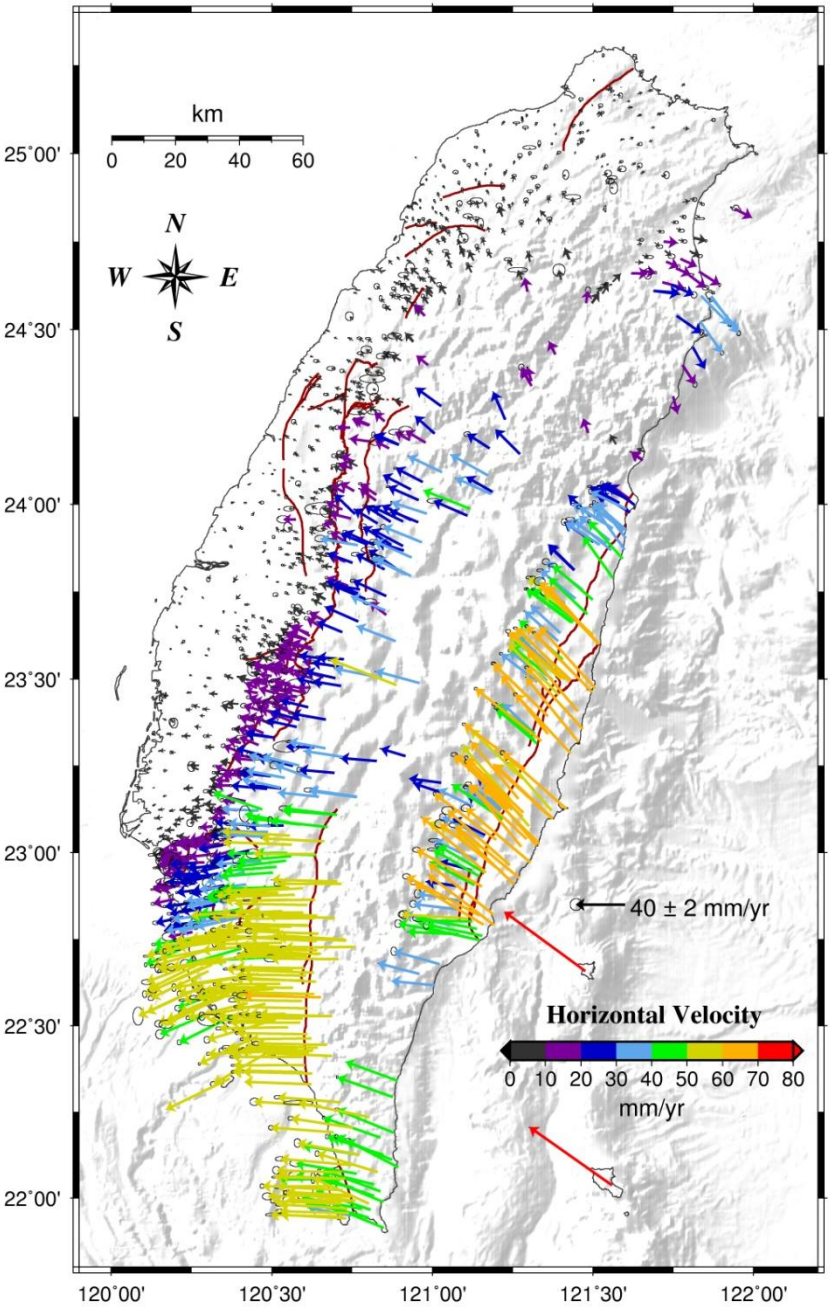
M_0 (10^{25} dyne-cm): 30.90

Displacement (m): 1.33

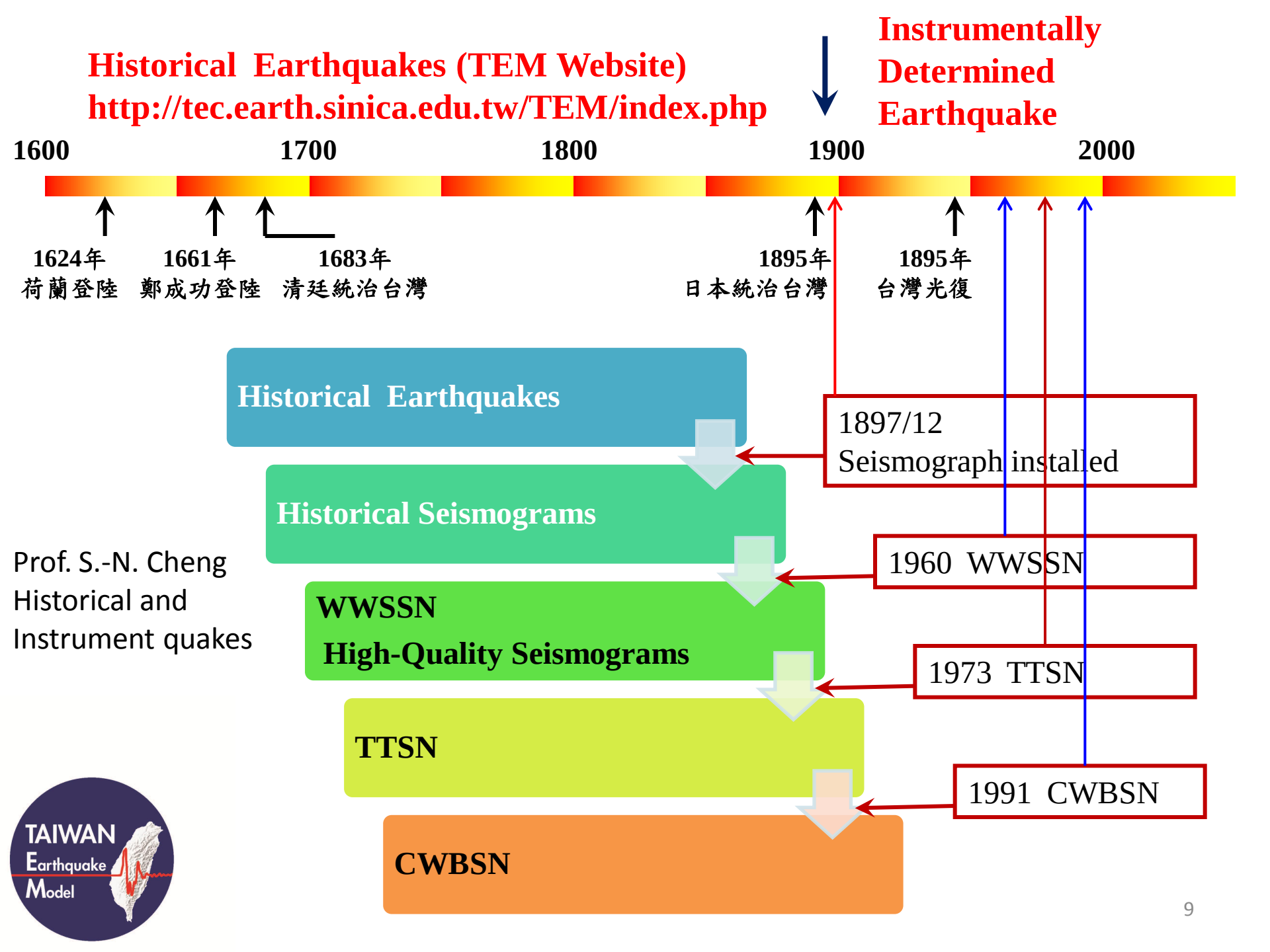
Slip rate (mm/yr): 1.16±0.84

Recurrence interval (yr): 670-4160

2002-2012 GPS velocity field



Prof. Rau
Geodetic Strain


Historical Earthquakes (TEM Website)
http://tec.earth.sinica.edu.tw/TEM/index.php
Instrumentally Determined Earthquake
1600
1700
1800
1900
2000
1624年 荷蘭登陸
1661年 鄭成功登陸
1683年 清廷統治台灣
1895年 日本統治台灣
1895年 台灣光復
Historical Earthquakes
Historical Seismograms
WWSSN
High-Quality Seismograms
TTSN
CWBSN
1897/12 Seismograph installed
1960 WWSSN
1973 TTSN
1991 CWBSN
Prof. S.-N. Cheng
Historical and
Instrument quakes
TAIWAN Earthquake Model

原始地震波形紀錄 (original)

↓

除濕、平整、編號 (numbered)

↓

去霉、除虫、修補 (refined)

↓

數化掃描(300 dpi) (scanned)

↓

確認日期、儀器、方向 (calibrated)

↓

重新編號進資料庫 (archived)

歷史地震波形紀錄處理程序

(Cheng et al., POSTER)

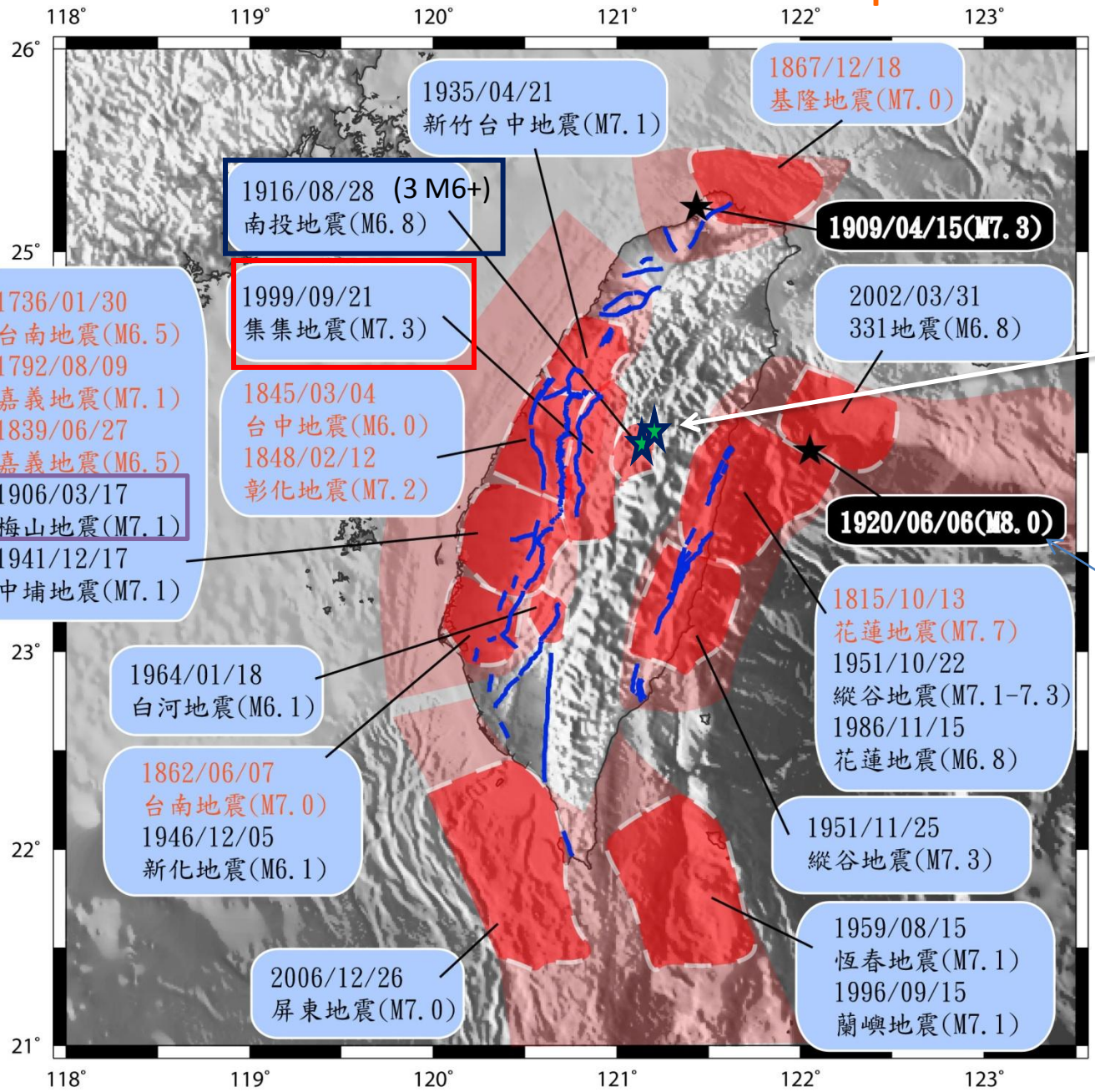
歷史地震波形紀錄發生變形、硬化、潮濕、發霉、蛀蟲、破損情形。

原始紀錄進行除濕、平整、去霉、除虫、修補等工作

微縮影片先還原為原尺寸再以300 dpi解析度進行數化

Historical Damaging Earthquakes in Taiwan since 1700s

Relative quiet in seismicity



Scenario
- Prof. Lee

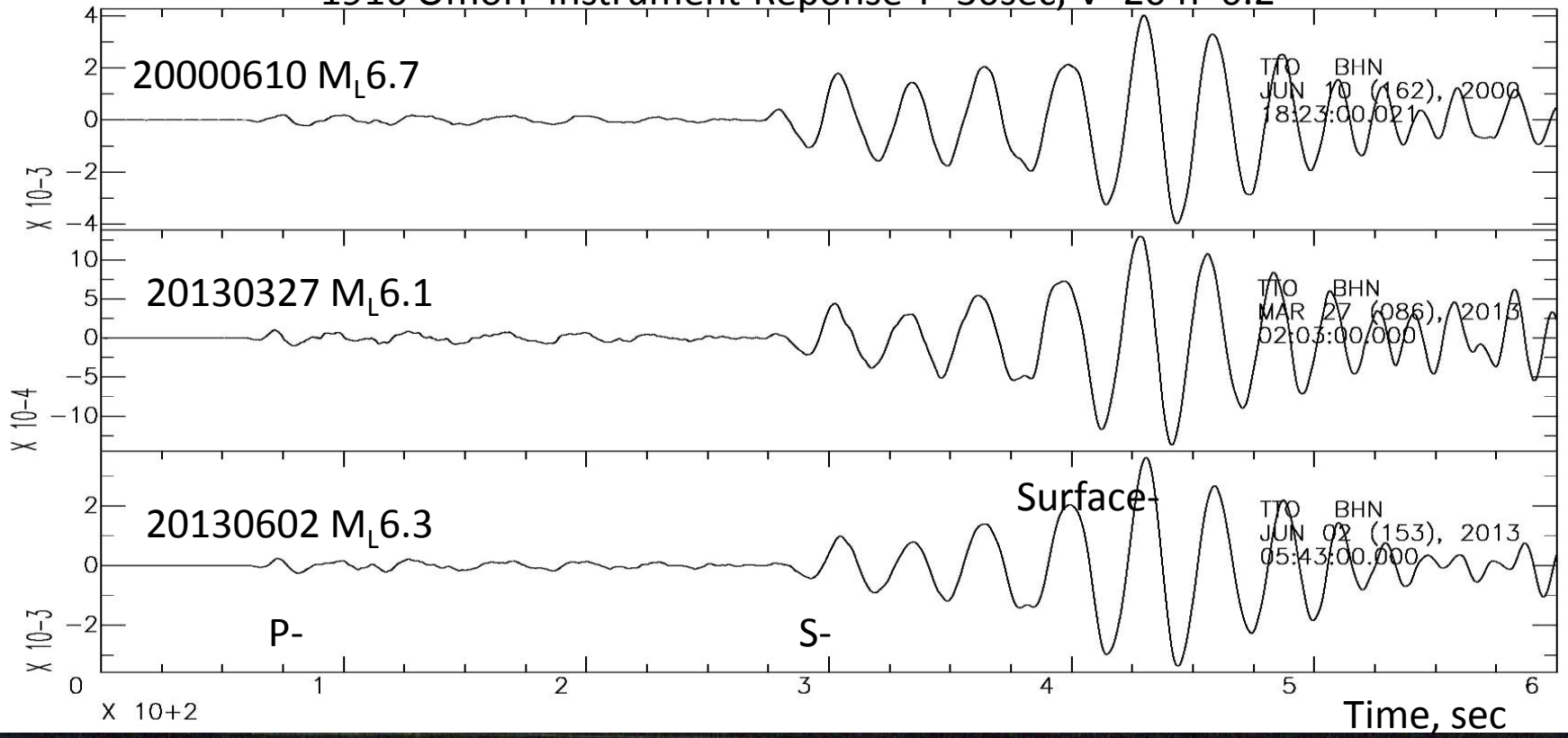
Modeling of 1920 Earthquake by Dr. Yen

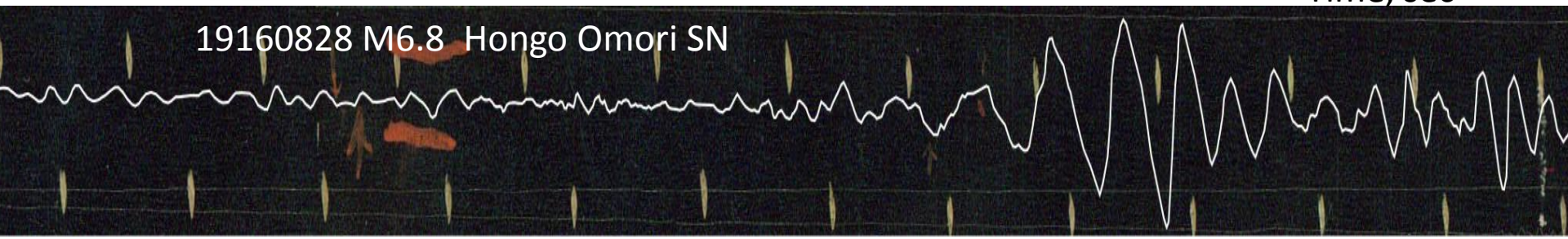
Prof. Ma
Re-visit of
Historical
Earthquakes

Comparison of modern events records to 1916 event

Simulated Omori records of Japan F-net TTO station for SN component

1916 Omori Instrument Reponse T=30sec, V=20 h=0.2

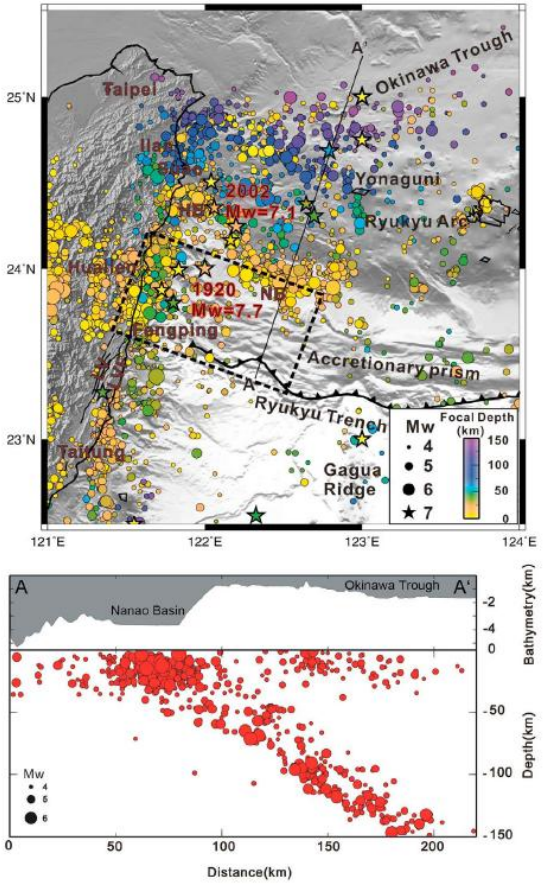




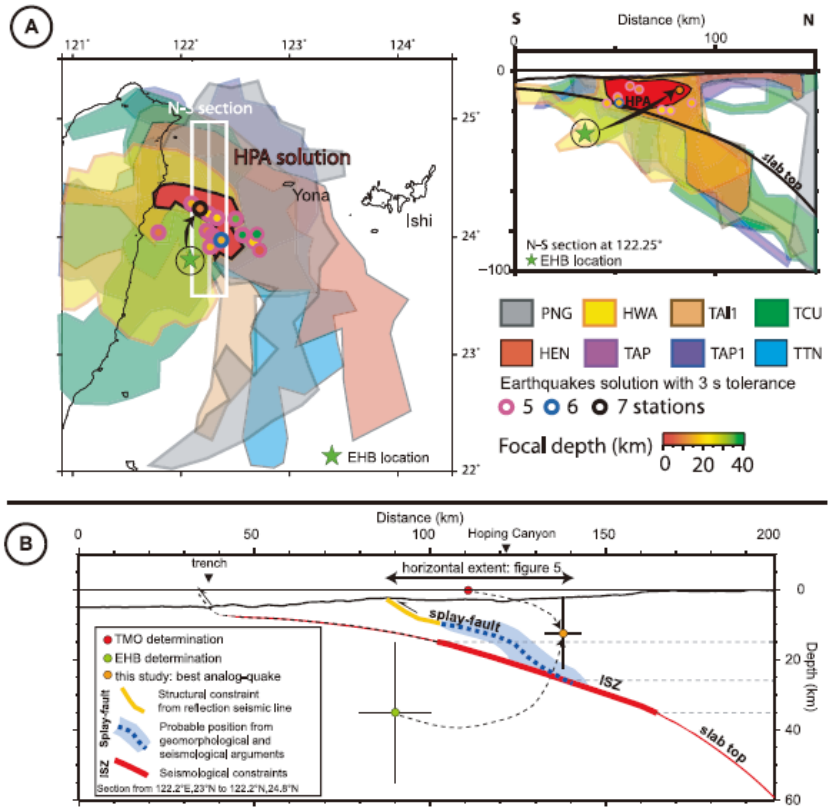
* First-order dislocation model
* Dip : 10^{o}
* Length : 70 km
* Depth : 13 km
* Mw 7.5-8.7

Dr. Yen Modeling

* location of high probability area
* S-P arrival time
* Dip : 20^{o}
* depth : 4 to 20 km
* Mw : 7.7±0.2



(Hsu et al., 2012)



(Thuenissen et al., 2010)

Crustal GMPE performance

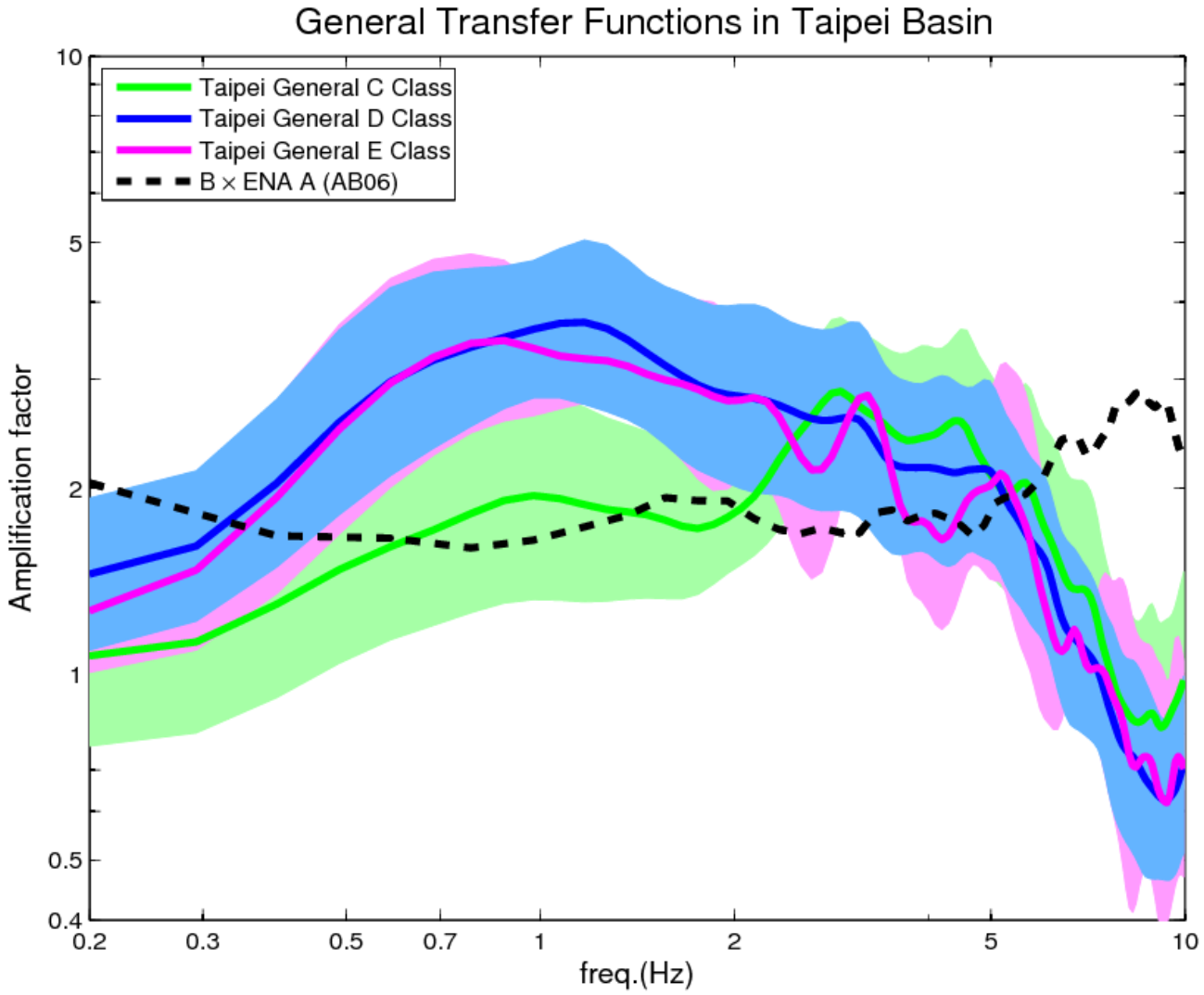
Dr. Lin
Ground Motion Prediction Equations

GMPEs	Acronym	SD	Mean	LH	LLH	EDR
Wu et al.(2001)	WU2001	0.7366	0.3042	0.5824	1.6059	0.9966
NCREE (2004) Campbell's form	CB	0.7619	0.5476	0.5245	1.6547	1.1796
Joyner and Boore's form	JB	0.7281	0.6311	0.4802	1.5892	1.3160
Kanai's form	JR	0.7711	0.0950	0.6064	1.6720	0.9651
Japan Rock Site's form	KA	0.6755	0.3013	0.6221	**1.4811**	0.9963
Chang et al.(2001)	CH2001	**0.6652**	**0.1462**	**0.6619**	**1.4588**	0.9881
Liu and Tsai (2005)	LT2005	0.6880	0.1742	0.6347	1.5074	0.9510
Tsai et al. (2006)	TS2006	0.6893	0.1411	0.6412	1.5101	**0.8849**
NCREE (2011)	NCREE2011	0.7392	0.2393	0.6125	1.6111	0.9582
Lin et al.(2011)	Lin2011	0.7165	0.3396	0.5852	1.5660	1.0095
Lin (2009)	PS2009	**0.6419**	**-0.0227**	**0.6660**	**1.4075**	**0.8421**
Sinotech (2011)	TNGA	**0.6566**	**0.0053**	**0.6566**	**1.4401**	**0.8306**

Subduction GMPE performance Dr. Lin (GMPE)

GMPEs	Acronym	SD	Mean	LH	LLH	EDR
Youngs et al.(1997)	YG1997	0.8025	-1.1229	0.2691	1.7296	1.9960
Si and Midorikawa (1999)	SM1999	0.8061	-1.0631	0.2898	1.7361	1.8795
Chang et al.(2001)	CH2001D	**0.7146**	-0.4367	**0.5652**	**1.5623**	**1.1483**
Atkinson and Boore (2003)	AB2003	1.4837	0.7491	0.2903	2.6162	2.0357
Kanno et al. (2006)	Kan2006	0.8938	-0.8347	0.3736	1.8850	1.5882
Lin and Lee (2008)	LL2008	**0.7814**	**-0.3311**	**0.5828**	**1.6912**	**1.1014**
Sinotech(2011)	TNGA.Sub	**0.6422**	**0.0668**	**0.6738**	**1.4082**	**0.8985**

Empirical Site Correction for Ground Motion Simulation



Prof. Wen
Site Amplification

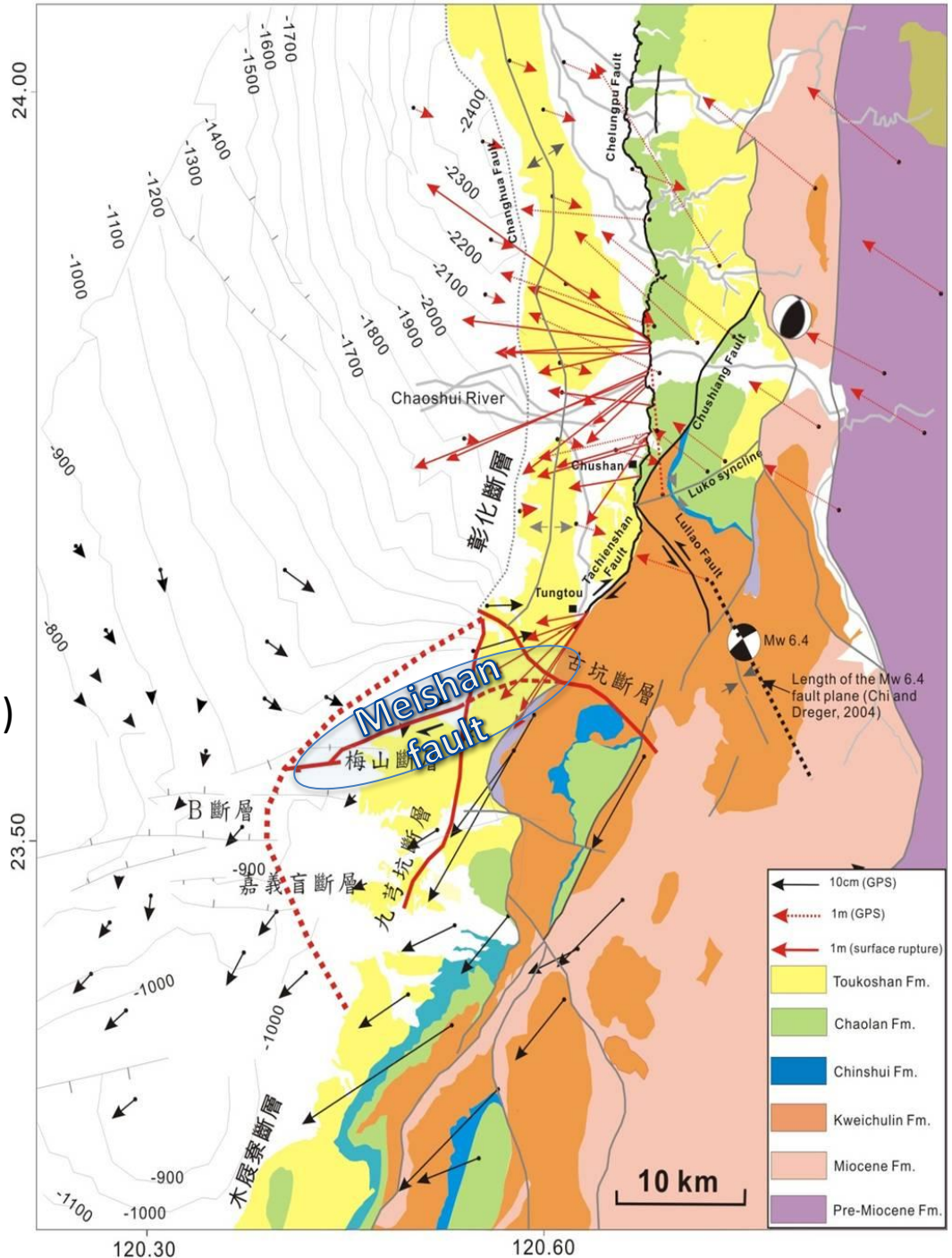
1906 Meishan Earthquake Scenario

Prof. Lee
1906 Meishan eartqhuake
-Meishan fault

-Compilation of the subsurface structure, seismic-reflection, logging, micro-temors
-Simulation (Dr. Lee, and Dr. Yen)

-Literature data (Prof. Cheng)

=>Validation the TEM Exercise
HAZARD, RISK, SOCIAL IMPACT



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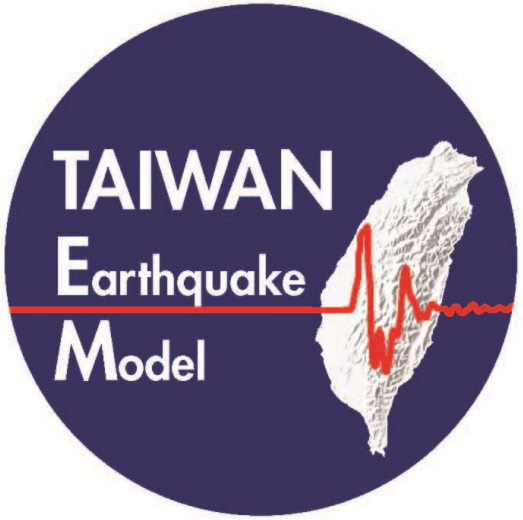
TAIWAN Earthquake Model

- **1906 Meishan Earthquake Scenario**



THANK YOU!