

Design and Implementation of the National Seismic Monitoring Network in the Kingdom of Bhutan

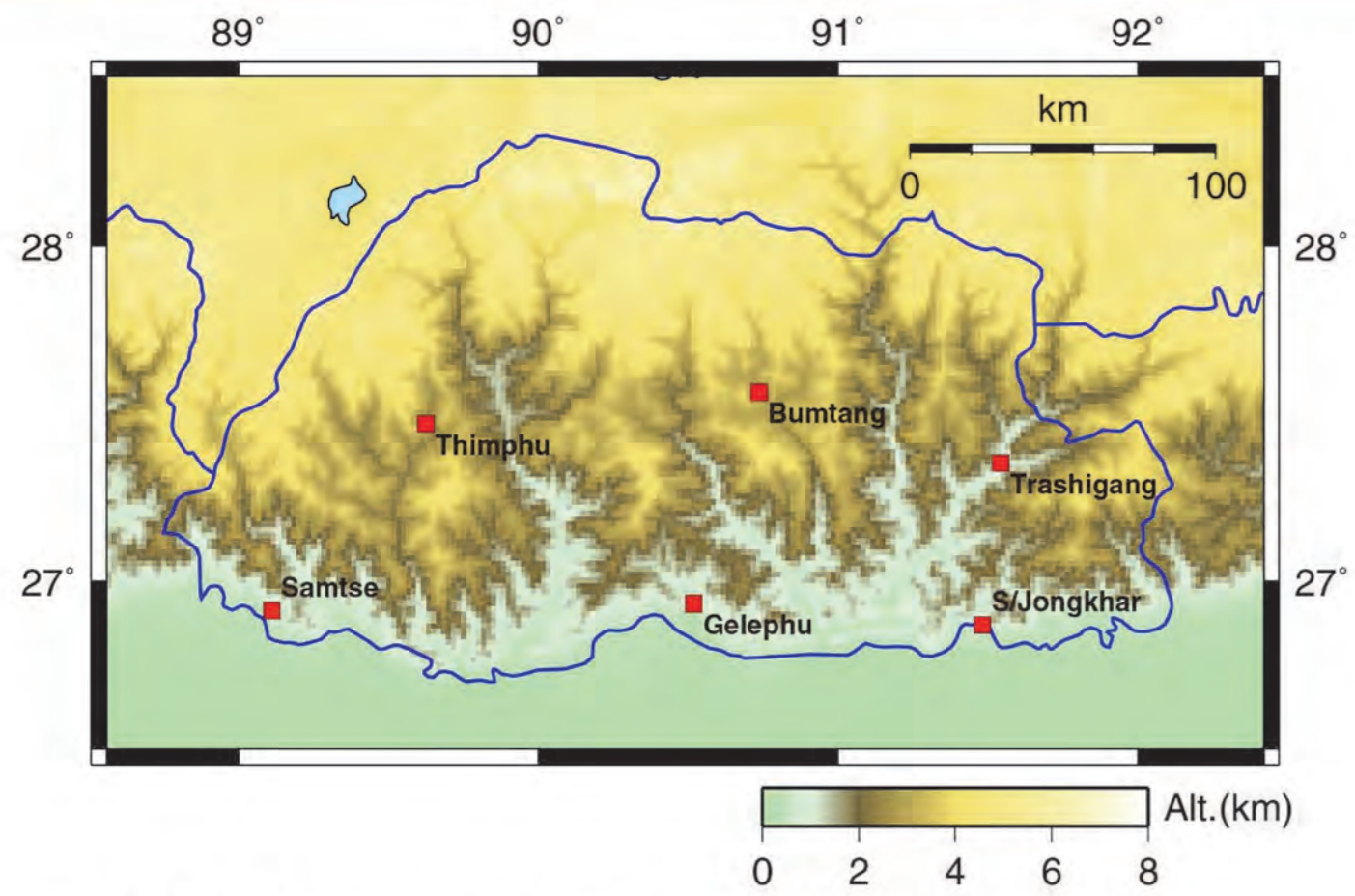
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Planned National Seismic Network in Bhutan

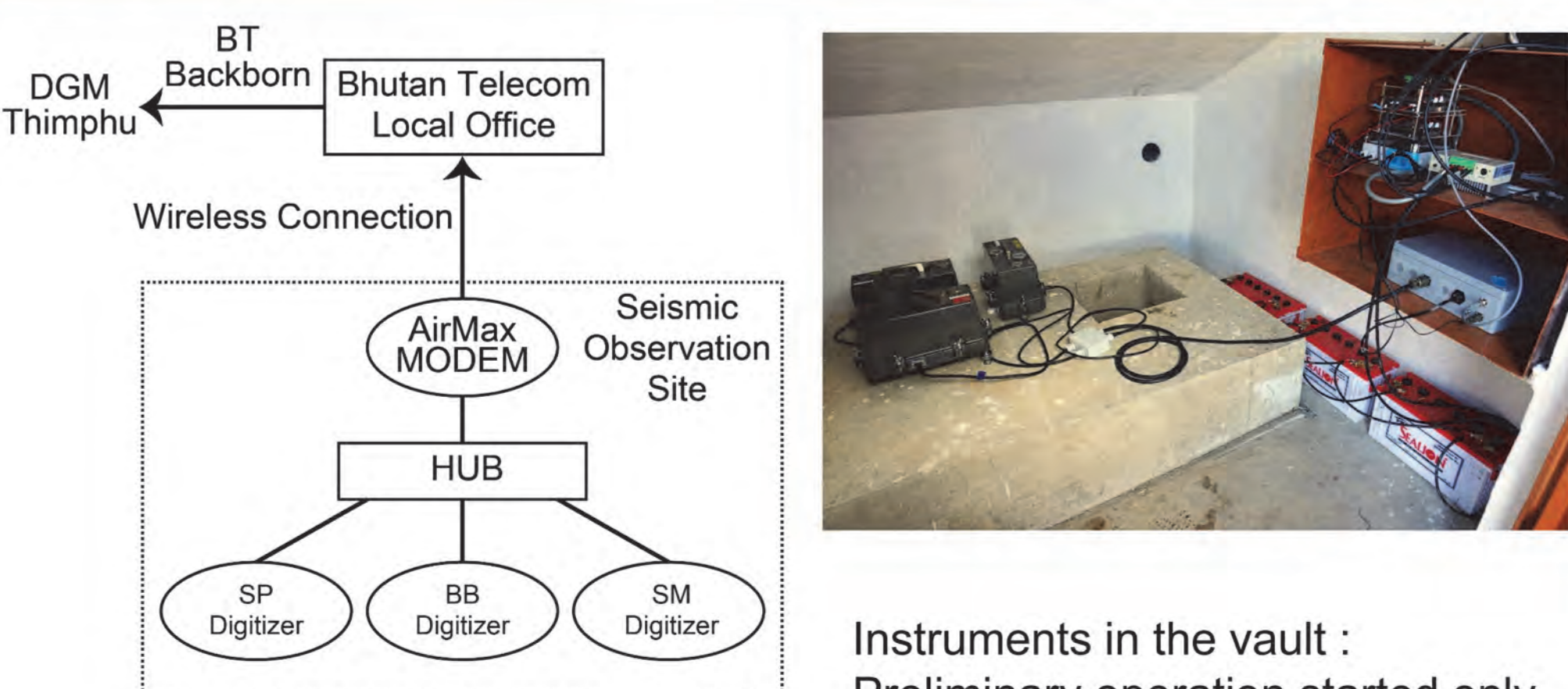
- Expected products of the network
 - Assessment of the seismic hazard in Bhutan
 - Seismic activity in Bhutan
 - Long term prediction together with active fault research
 - Damage assessment by earthquakes
 - 'Shake map' from intensity meter network
 - Research on seismotectonics in eastern Himalayan region
- Content of the network
 - Consists of Short period (SP), Broad band (BB), Strong Motion (SM) seismometers, and Intensity meters (IM)

National Seismic Network by DGM (Seismometers)



- Designed by DGM, DPRI, and NIED
- Short period, Broad band, and Strong motion seismometers will be equipped
- Operated with DC which is supplied by solar panel + batteries
- Telemetry with radio + optical fiber backbone provided by Bhutan Telecom
- Supported by World Bank Project

Schematic of datalink between observation site and DGM



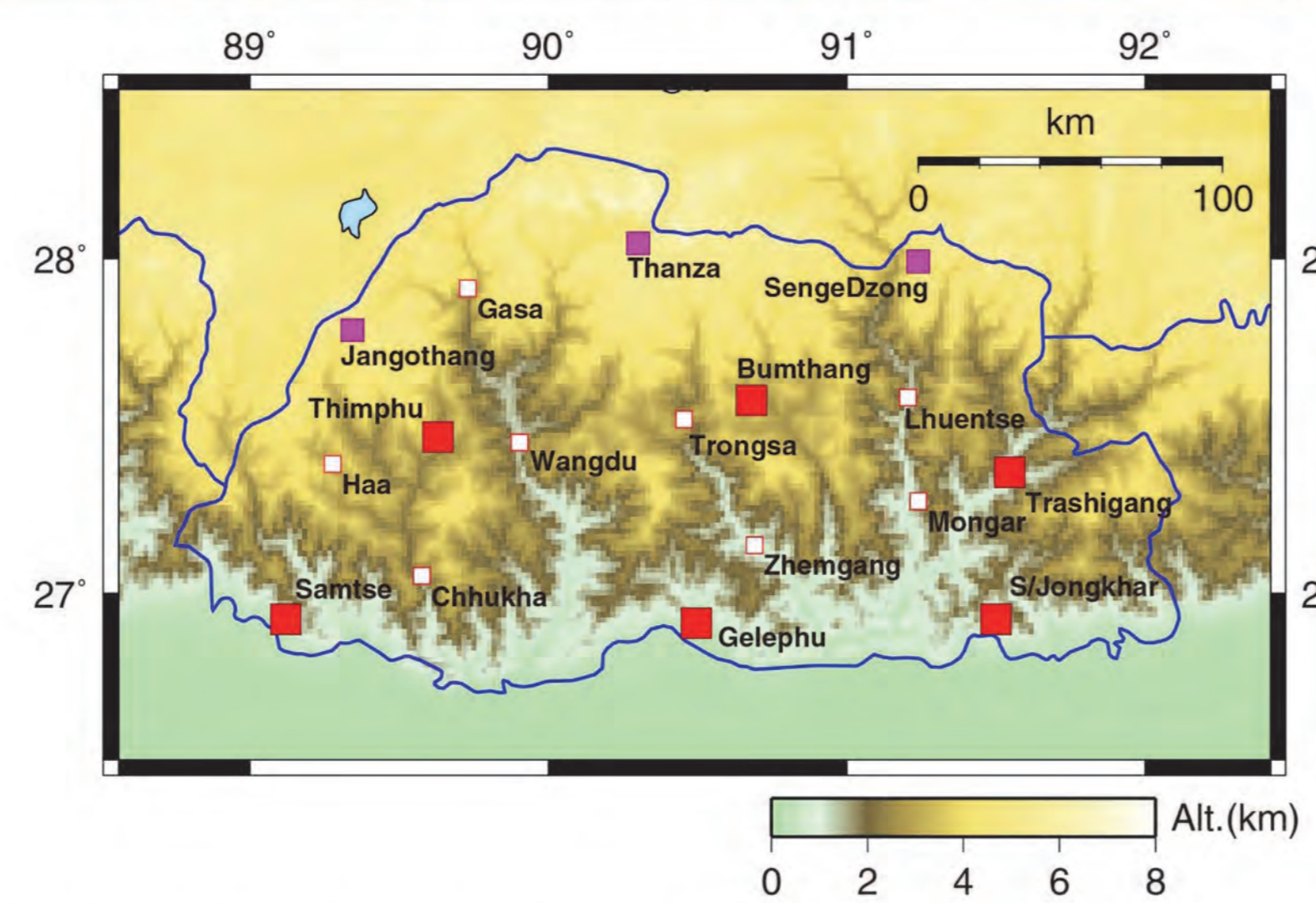
Datalink between observation site and DGM : SP, BB, and SM show ShortPeriod, Broadband, and StrongMotion seismometers, respectively.

Instruments in the vault : Preliminary operation started only with high sensitivity short period seismometers (Thimphu station)

Contents

- Tectonic background of Bhutan Himalayan region
- National seismic monitoring network in Bhutan
 - Micro earthquake monitoring
 - Seismic intensity & strong motion monitoring
 - Data processing
- Collaboration with other donors under discussion
 - RIMES (Regional Integrated Multi-hazard Early Warning System for Africa and Asia)
 - SATREPS (JICA/JST ; Science and Technology Research Partnership for Sustainable Development)

Future Plan: Combined Network by DGM, RIMES & SATREPS Projects

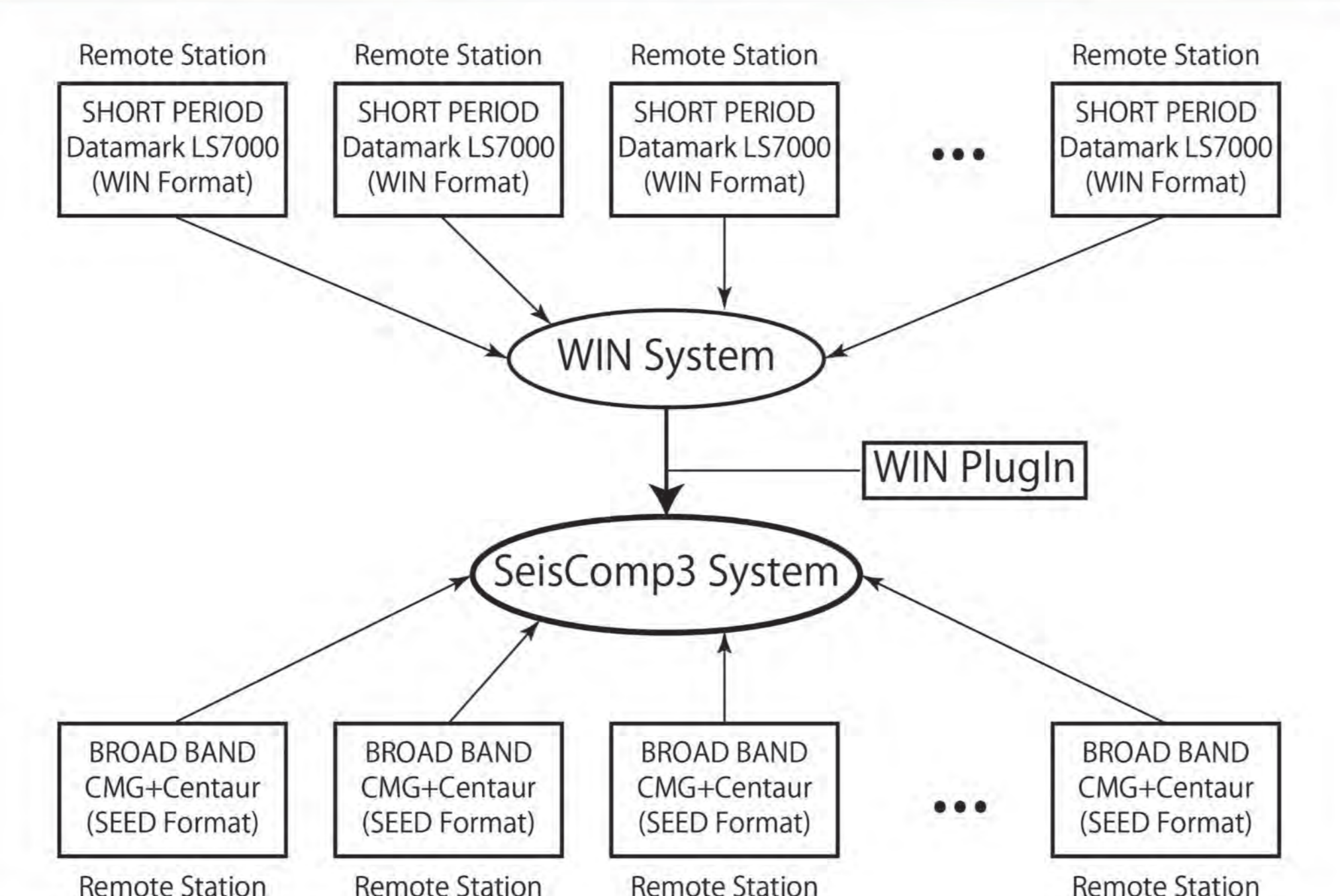


- DGM (6) (DPRI/NIED/WB); Online, SP, BB, and SMS
- RIMES(8) Broadband, Telemetry to Bangkok via Thimphu (under construction)
- SATREPS (JST/JICA) Offline (under planning) SP only

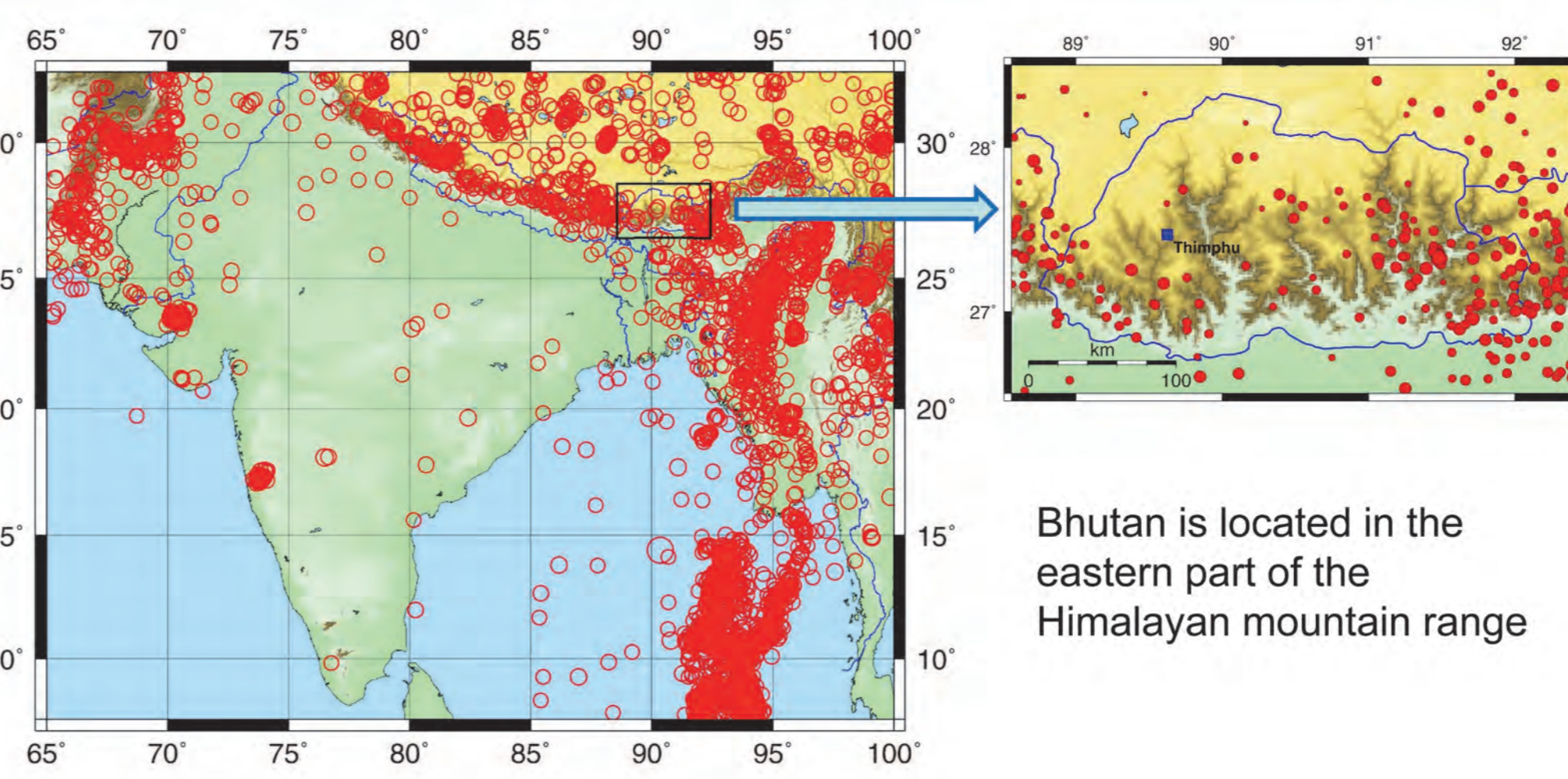
Seismic Stations in Operation



Data Processing Software (SeisComp3 and WIN)



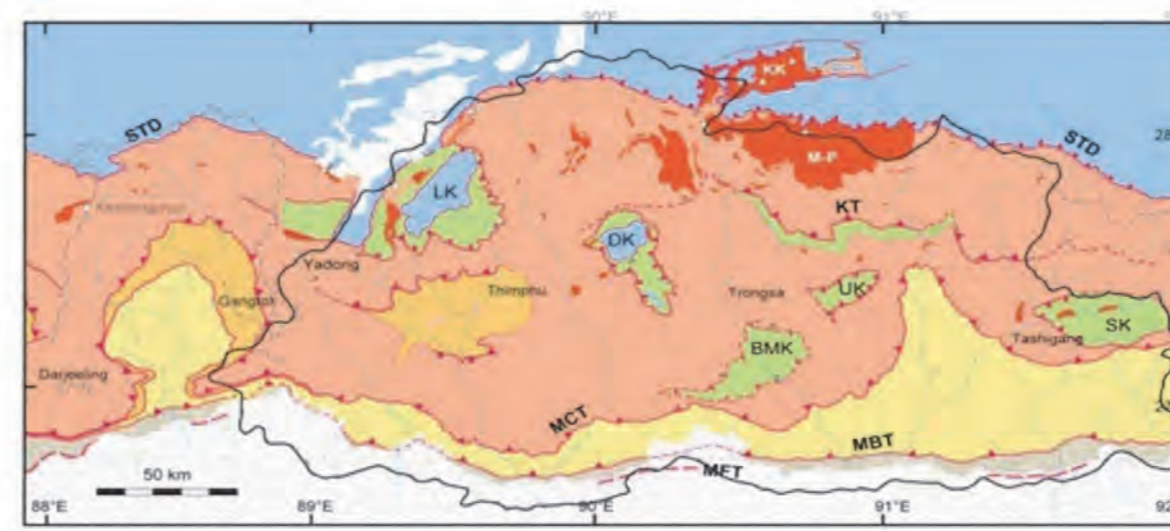
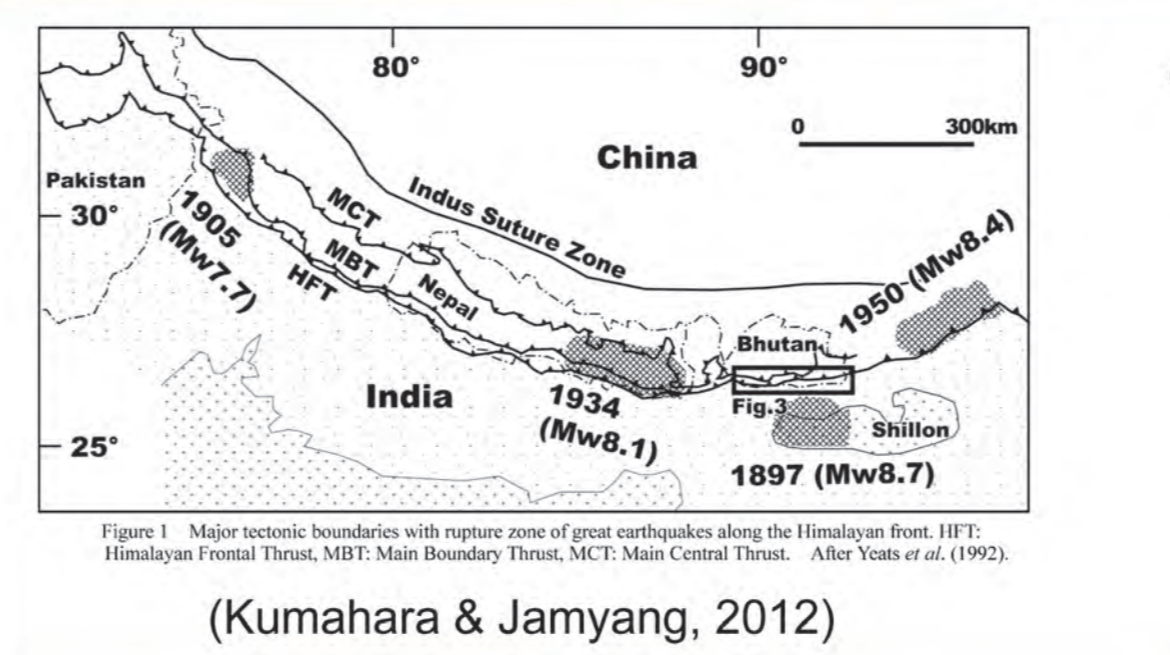
Location of the target area



Bhutan is located in the eastern part of the Himalayan mountain range

Left: Seismicity of the south Asia since 1960 (M>5, ISC)
Right: Seismicity in Bhutan since 1990 (ISC)

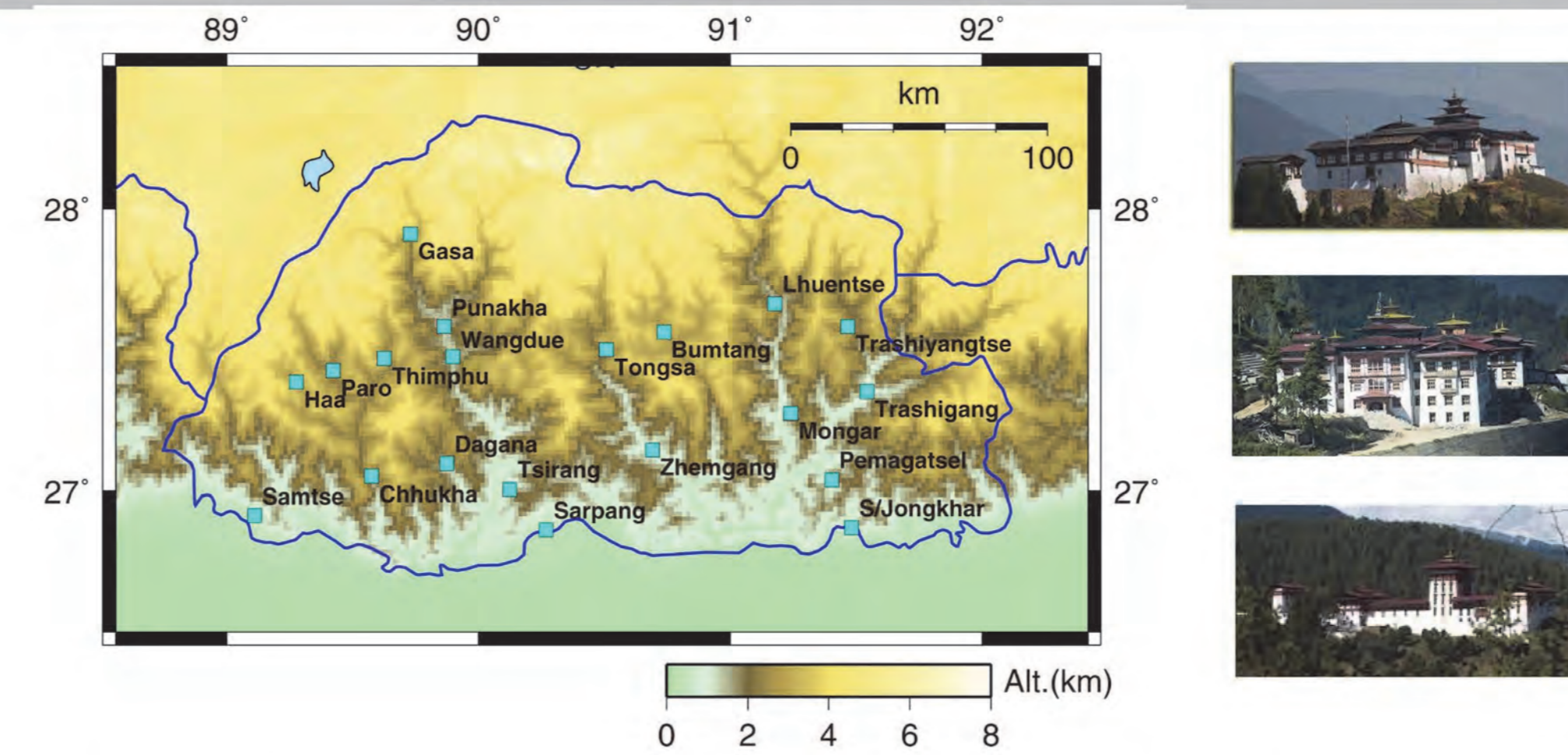
Bhutan Himalayan region



Location of MFT, MBT, and MCT in Bhutan (Drukpa, Pers. Comm., after Grujic, 2002)

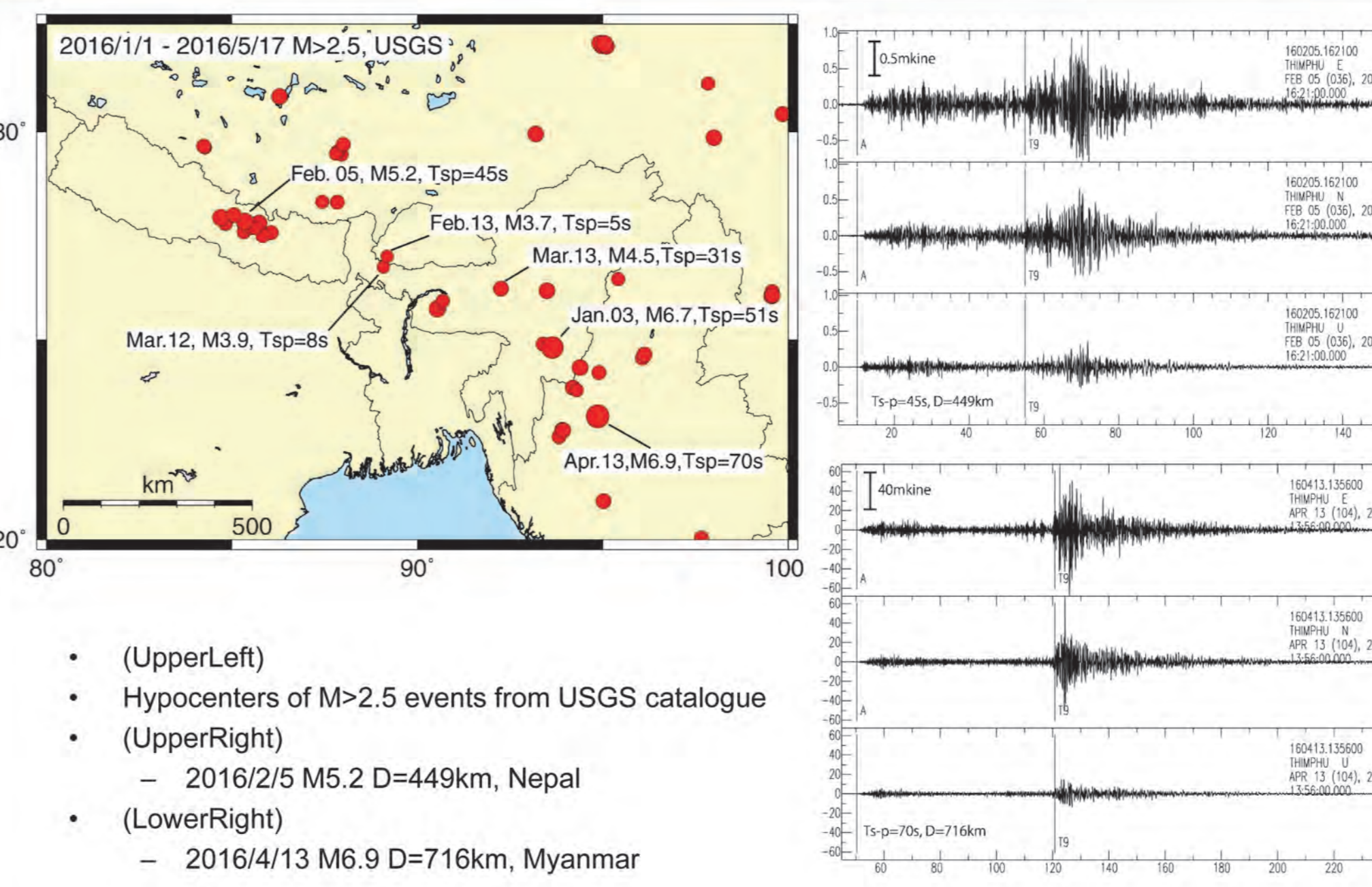
- Characteristics of the Bhutan Himalaya compared to Nepal Himalaya is ...
 - MFT is not clear
 - MCT is much undulated
 - MCT and MBT are located closely especially in the western Bhutan

National Seismic Network by DGM (Intensity meters)

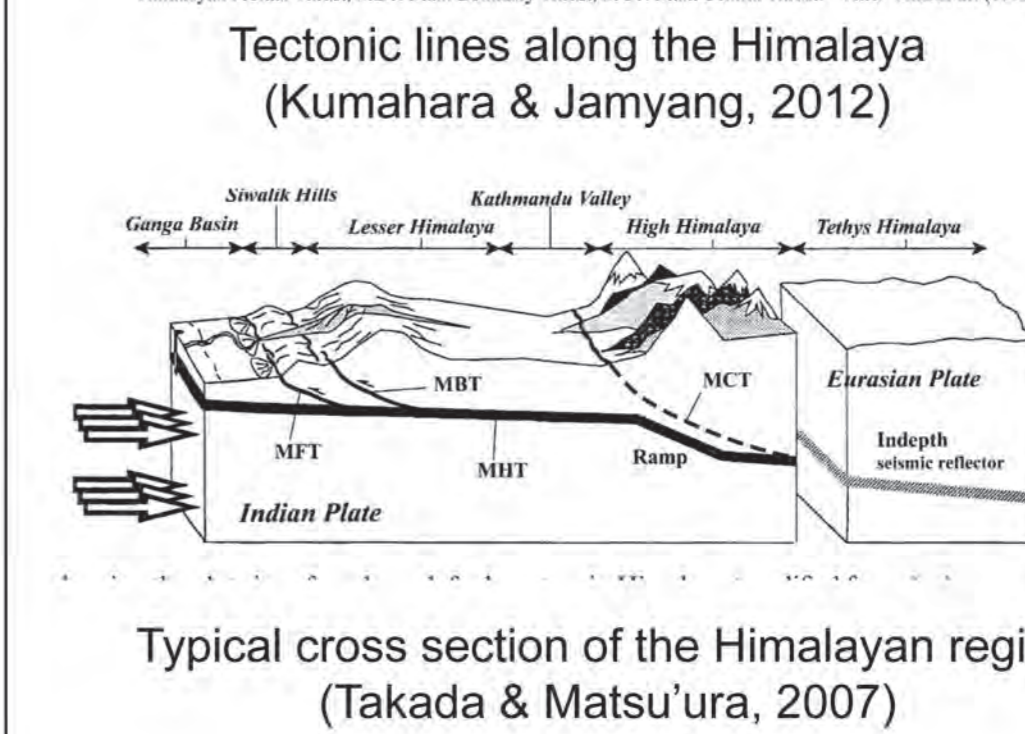
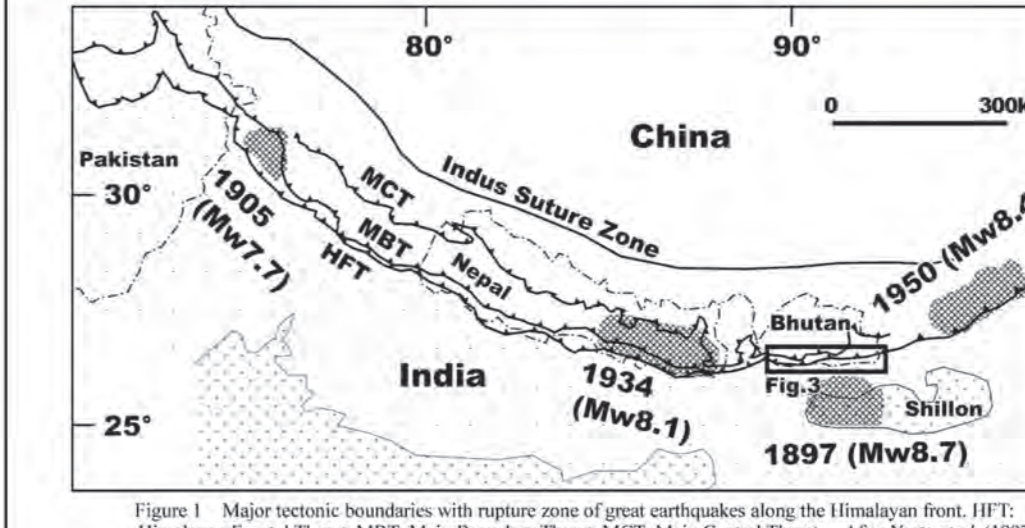


- Installed at provincial government offices (Dzong)
- Telemetry by Internet provided by Bhutan Telecom
- Supported by World Bank Project

Examples of earthquakes at Thimphu site

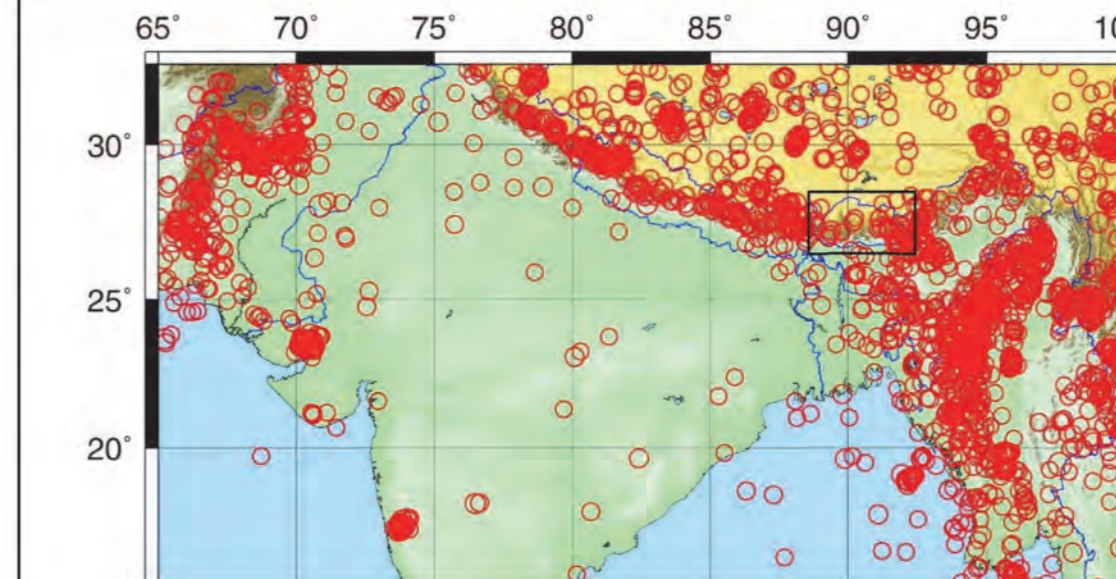


Seismotectonics along the Himalayan region



- Main features of the Himalayan region are ...
- MFT(HFT) - Main (Himalayan) Frontal Thrust
- MBT - Main Boundary Thrust
- MCT - Main Central Thrust
- Northern part of MCT is called - High Himalaya
- Between MCT and MBT is called - Lesser Himalaya

Seismicity around Bhutan



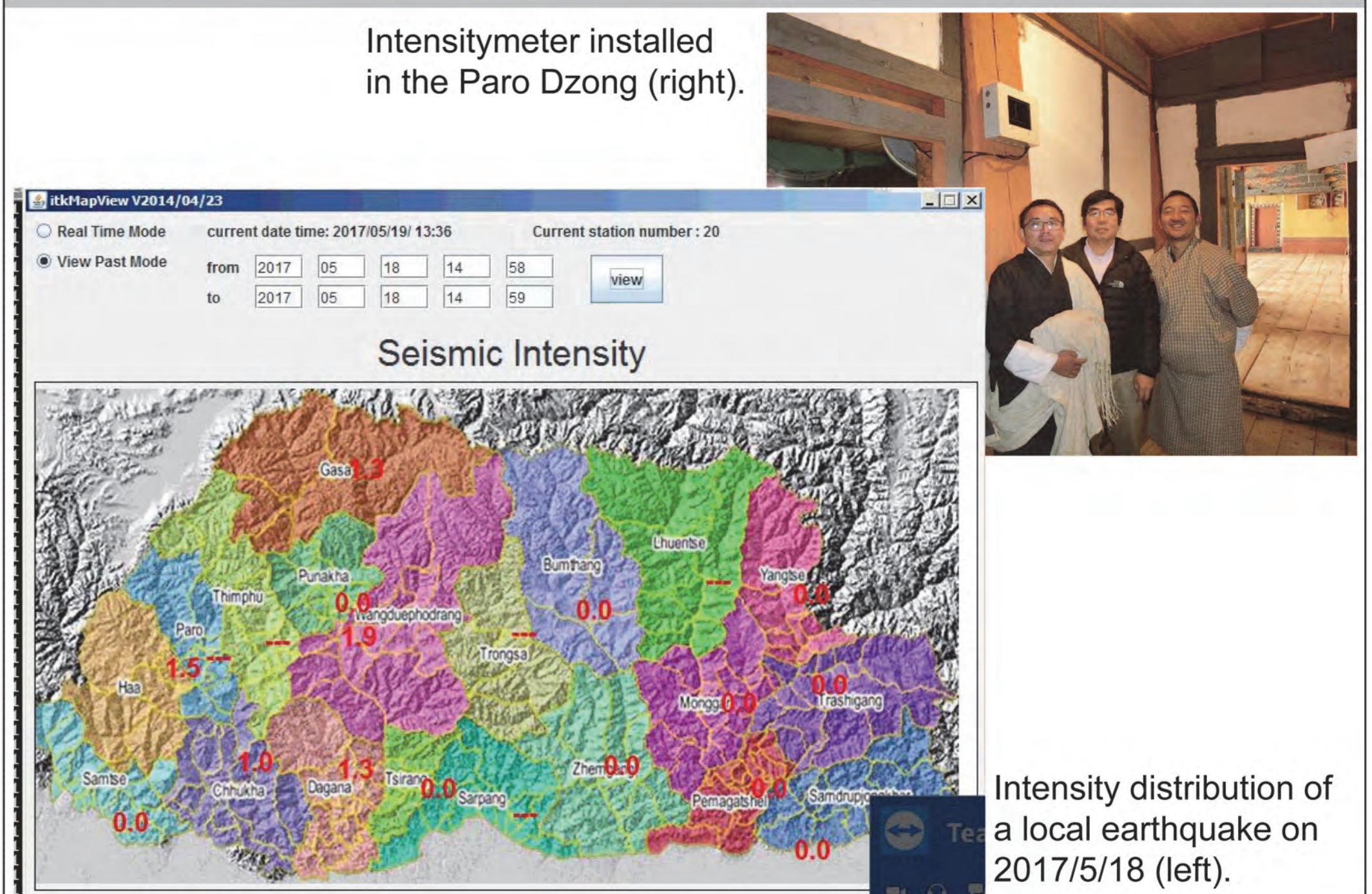
Damaged earthquake to Bhutan (after 19th century)

YEAR	M	REGION
1897	8.7	Shilong, India
1934	8	Bihar-Nepal
1950	8.6	Assam
2009	6.1	Eastern Bhutan
2011	6.9	Sikkim, India
2015	7.8	Nepal
2016	6.7	Imphal, India

No M>7 earthquakes in Bhutan ?!
→In the special tectonic environment?
→In the seismic quiescence period?

★ M>7 earthquakes after 19th century
○ Damaged earthquake to Bhutan

Intensitymeter Network in Operation



S-P time distribution at Thimphu site

