



Earthquake and GLOF Disaster Risk in Bhutan

PEMA SINGYE

CHIEF PROGRAM OFFICER

DEPARTMENT OF DISASTER MANAGEMENT

ROYAL GOVERNMENT OF BHUTAN

BHUTAN

Area: 38,394 Sq. Km

Population: 734,374 (NSB 2019)

Topography: Steep mountains



Earthquake Risk

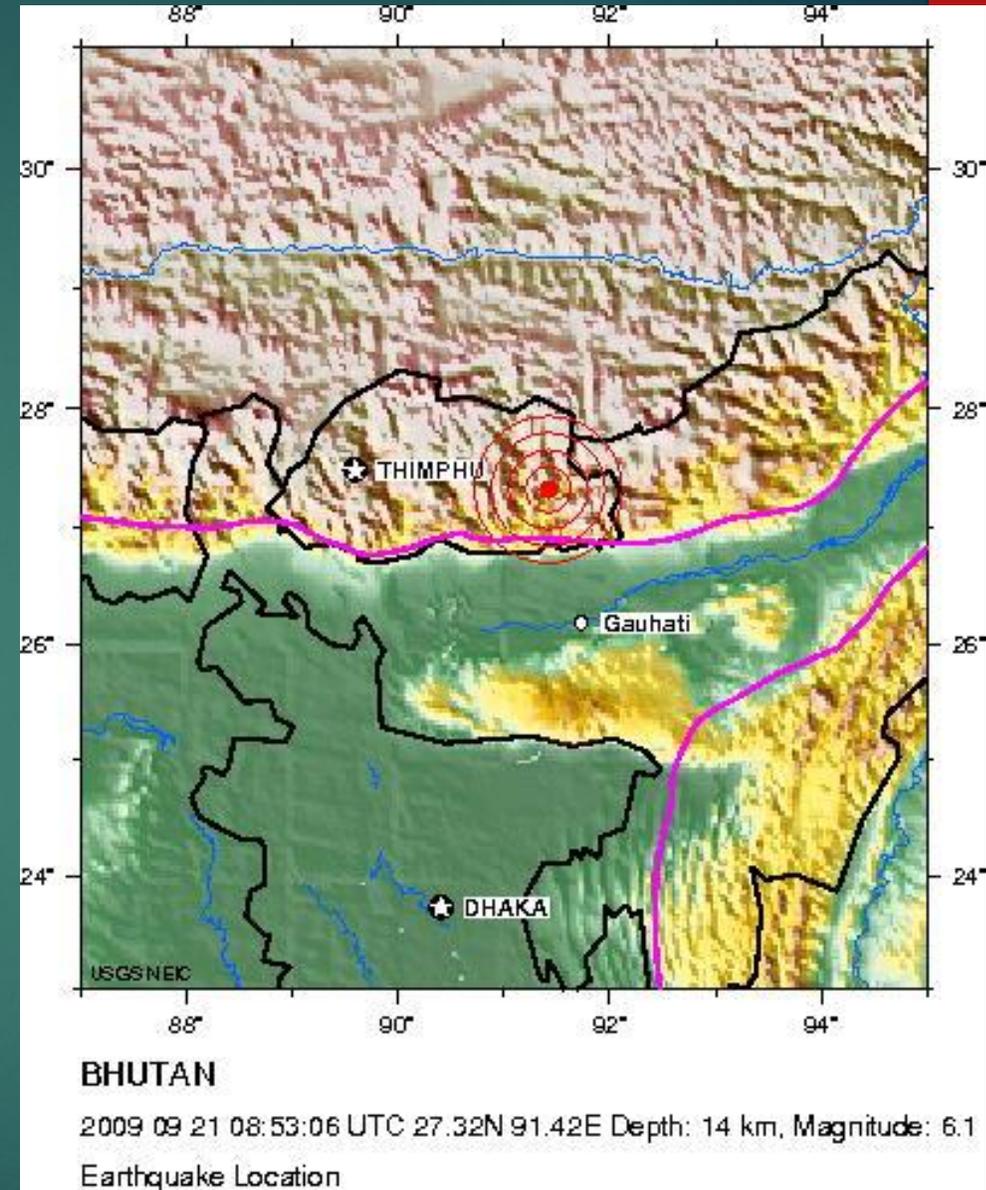
- ▶ Bhutan still does not have an earthquake hazard map
- ▶ Based on close proximity to neighboring areas in India, we assume that our country also falls under Earthquake Hazard Zone 4 and 5.
- ▶ Moreover, Bhutan had experienced severe earthquake in the past and strong ones recently with epicenters within the country
- ▶ The Department of Geology and Mines has done some studies which indicated that fault lines in eastern Bhutan are active while those in western Bhutan are locked thereby accumulating increasing stress.

Earthquakes in Bhutan

- ▶ The 1714 Earthquake was the furthest history of earthquake recorded in Bhutan
- ▶ The 17th Chief Abbot of Bhutan, Shakya Rinchen recorded that the dust in the atmosphere took over a week to settle, indicating that it was a severe one
- ▶ He also recorded that there were many casualties.
- ▶ The author with his mother was buried when his house collapsed
- ▶ He could hear the neighbours digging on their top to rescue them.
- ▶ His mother did not survive.

21st September, 2009 Mongar Earthquake
Magnitude: 6.1 (10 km)
Time: 2:53 PM

12 human lives lost and damaged :
4950 houses
45 Basic Health Units
117 schools
29 Renewable Resource Offices
800 temples and cultural monuments
26 Block office buildings
The total loss estimated at USD=42
Million



18th September, 2011 (Sikkim Earthquake)
Magnitude : 6.9 (19.7 km)
Time: 6:41 PM

One life lost

14 people injured and damaged:

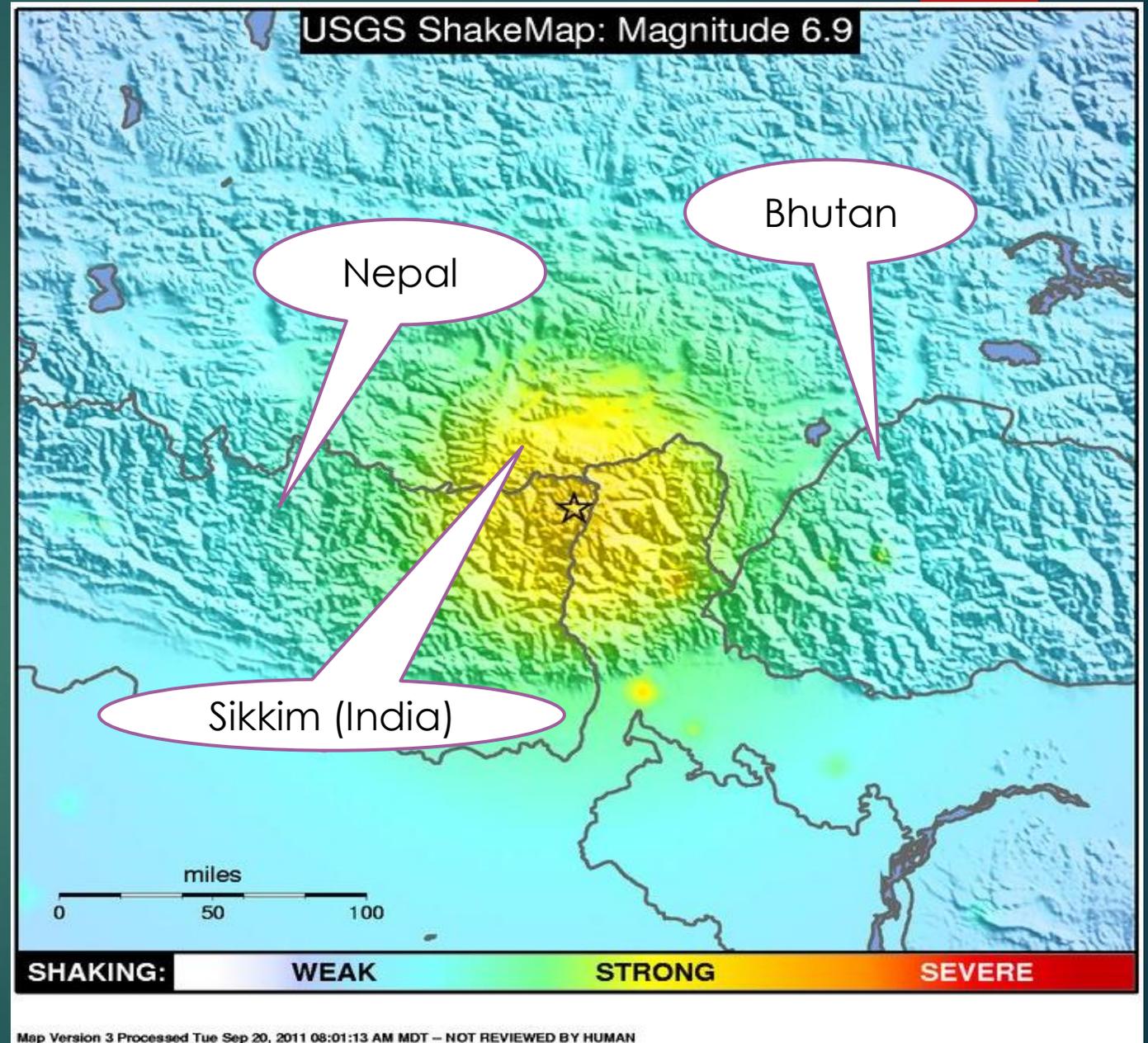
6977 homes

36 schools

22 hospitals

286 heritage sites

27 agricultural offices

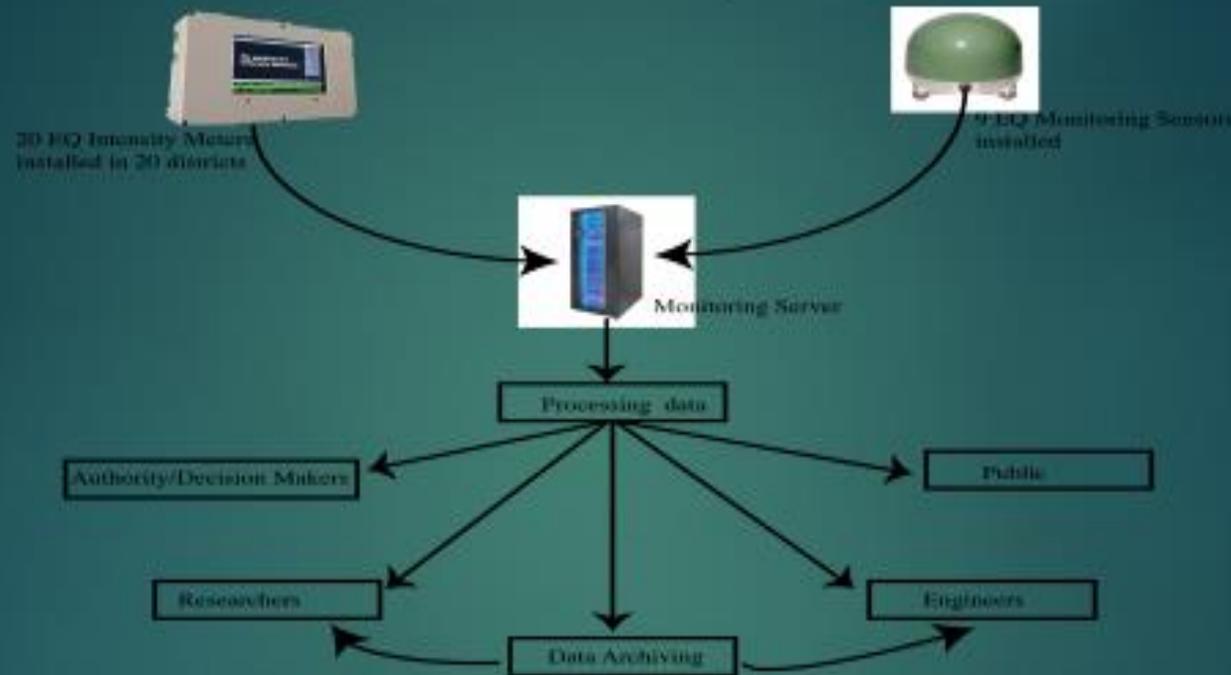


Other minor earthquakes with epicenter in Bhutan

Year	Richter Scale	Epicentre
2003	5.5	Gunitsawa, Paro
2006	5.8 and 5.5 within 3 minutes	Dewathang, Samdrupjongkhar

Earthquake Risk Studies by DGM

Current Network System under NEMN



Key Objectives:

- Prompt damage assessment for emergency relief measures
- Provide damage predictions for a given earthquake scenario
- Provide real time EQ source information for emergency response
- Develop EQ hazard maps based on recorded seismic activities

Earthquake Disaster Mitigation

► Structural Mitigation

- Building Codes for urban areas have been further revised(2002 / 2018)
- Guidelines developed for safe rural home construction (following 2009 and 2011 earthquakes)
- Further improvement of Construction Guidelines for rammed earth and stone masonry buildings (SATREPS: Project for Evaluation and Mitigation of Seismic Risk for Composite Masonry Buildings)

Developing seismic technology for constructing and strengthening composite masonry buildings (SATREPS Project)



Earthquake Disaster Mitigation

▶ **Non-structural Hazard Mitigation**

-Guidelines developed and distributed /disseminated in the schools

-Public awareness is being raised during DMCP trainings

Capacity Development

- ▶ Trained engineers, carpenters, masons on safe construction of rural homes.
- ▶ Further training on safe construction practices (rammed earth and composite masonry) under SATREPS Project
- ▶ Disaster response training for monastic institutions
- ▶ National Search and Rescue Training Centre (EU Project)
- ▶ Basic Search and Rescue training to all Districts (basic equipment maintained)

Search and Rescue Training by UK ISAR instructors



Briefing by the instructor



Water Rescue



Rope Rescue

Response Preparedness



Disaster Management and Contingency Plans:

- ▶ 20 Districts and the follow
 - ▶ Four Municipalities
 - ▶ 512 schools
 - ▶ All Hospitals
 - ▶ Three ministries
 - ▶ Sector plans under process
- 

Response Preparedness (Continued)

- ▶ NEOC established. NEOC building under process.
- ▶ National Earthquake Contingency Plan finalized
- ▶ Incident Command System customized and adopted
- ▶ SIMEX conducted where district administrators and District Disaster Management Officers participated
- ▶ Prepositioning/ stockpiling of food items by Food Corporation Of Bhutan
- ▶ Prepositioning/ stockpiling of non-food items (Districts and Regional Education Stores)
- ▶ Emergency Communication

Mock drills and simulations

- ▶ 21st Sept. every year- Earthquake mock drill in all schools involving communities
- ▶ Hospitals
- ▶ Airports
- ▶ 8 districts and 3 municipalities

Disaster Information

- ▶ Developed Disaster Management Information System
- ▶ Earthquake Impact Model with Durham University



Glacial Lake Outburst Flood (GLOF)

GLACIAL LAKE OUTBURST FLOOD



Glacial Lake Outburst Floods

- ▶ 2674 glacial lakes

17 potentially dangerous glacial lakes

- ▶ 9 located in Phochhu basin
- ▶ 3 in Mangdechhu basin
- ▶ 2 in Mochhu basin
- ▶ 2 in Chamkharchhu basin
- ▶ 1 in Kurichhu basin

Four incidents of outburst in the last 40 years

- ▶ 7th October, 1994 GLOF from Lugge Tsho
- ▶ 28th June 2015 GLOF from Lemthang Tsho
- ▶ 29th April, 2009 GLOF from Tshoju
- ▶ 20th June, 2019 GLOF from Subsidiary Lake II of Thorthormi Lake

GLACIAL LAKE OUTBURST FLOOD

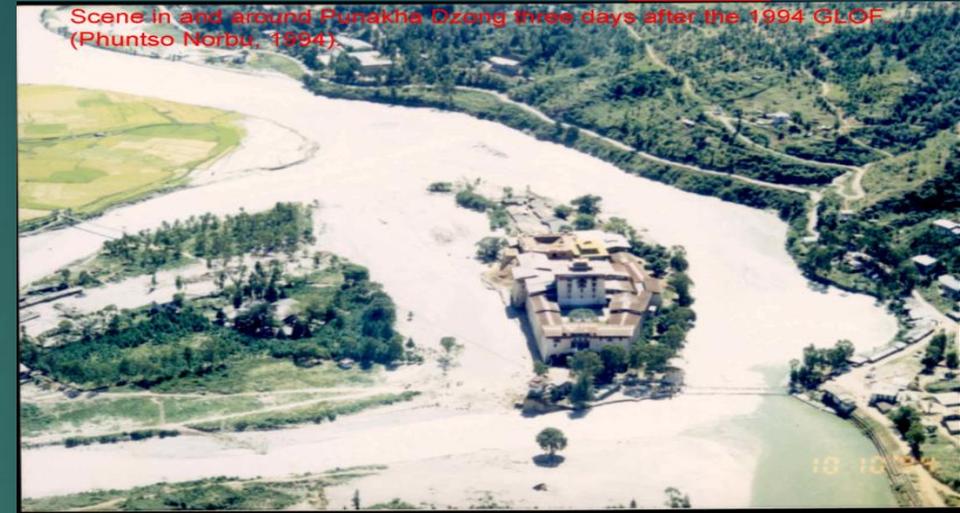
7th October, 1994 GLOF from Lugge Tsho

Partial burst and released 18 Cumecs of water

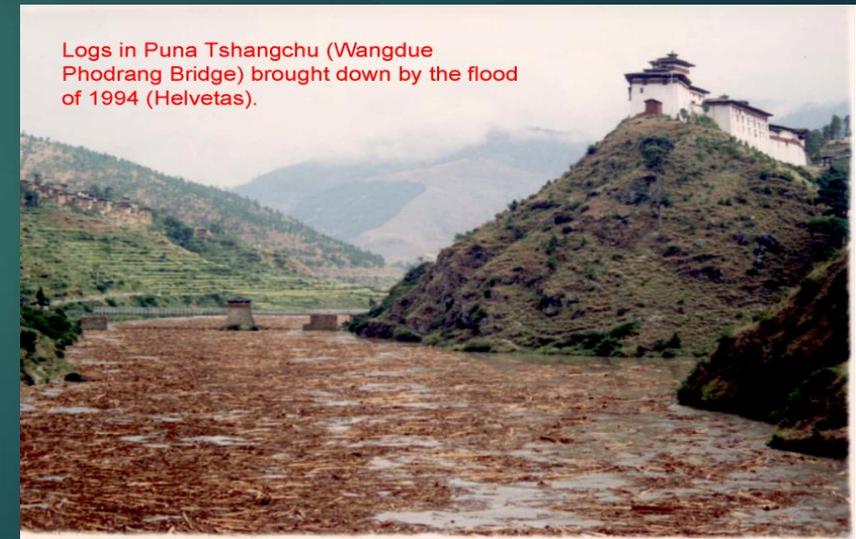
20 lives lost

Partial damage of Punakha Dzong

Loss of pasture land and livestock



Scene in and around Punakha Dzong three days after the 1994 GLOF (Phuntso Norbu, 1994).



Logs in Puna Tshangchu (Wangdue Phodrang Bridge) brought down by the flood of 1994 (Helvetas).

28th June 2015 GLOF from Lemthang Tsho



20th June 2019 GLOF from Subsidiary Lake II of Thorthormi Lake



Rehabilitation of Automatic Water Level Sensors 23/6/219 at Thorthormi Lake after the breach on 20/6/2019.



GLOF Preparedness Activities

- ▶ Lowering of Thorthormi Lake by 5 meters (2008-2013)
- ▶ GLOF hazard zonation done in Punakha and Wangdue districts
- ▶ Evacuation routes and sites identified
- ▶ Automatic/manual sirens installed
- ▶ Communities made aware of the risk
- ▶ Mock drills carried out in Punakha

Lowering of Thorthormi Lake under NPA-I Project

Budget USD 4 million

300 laborers

Fully manually and no
machines



Source: NCHM, Bhutan

Early Warning System

- ▶ Automatic water level sensors installed in the lakes and rivers
- ▶ Water level observation stations
- ▶ Water level information is relayed to the Flood Monitoring Station in Wangdue and the HQ on real time from the sensors and at regular intervals from the manned observation station
- ▶ EWS for GLOF- Automatic sirens located in the valleys downstream
- ▶ EWS available for Punatsangchhu, Mangdechhu and Chamkharchu

Challenges

- ▶ Lack of Earthquake risk map for Bhutan
- ▶ Lack of earthquake experts
- ▶ Inadequate participation by decision makers and the communities
- ▶ Inadequate resources for structural mitigation
- ▶ Implementation of Bhutan Building Codes
- ▶ Rural area- Construction Guidelines not compulsory

Thank you