Vigyan Samachar: MoES News

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Ministry of Earth Sciences (MoES) attempt in mitigating devastating effects of earthquake through seismic hazard microzonation of vulnerable areas

We need no introduction to the devastation that can be caused by a large earthquake. Our country has witnessed several high-intensity earthquakes in the past where thousands of lives were lost. Uttarkashi (1991), Bhuj (2001) and the recent Nepal (2017) earthquake still haunt us as a vast part of India lies in the very high risk earthquake prone area. The magnitude 7.8 (in Richter scale) earthquake that struck Nepal on April 25, 2015, toppled many multi-stories buildings in Kathmandu, and created landslides and avalanches in the Himalaya Mountains. Nearly 9,000 people died and more than 22,000 suffered injuries.

The Richter magnitude scale is a scale of numbers used to tell the power (or magnitude) of earthquakes. Charles Richter developed the Richter Scale in 1935. His scale worked like a seismogram, measured by a particular type of seismometer at a distance of 100 kilometers (62 mi) from the earthquake.

The following image depicts the power of devastation of an earthquake depending on the level of its magnitude (in Richter scale)

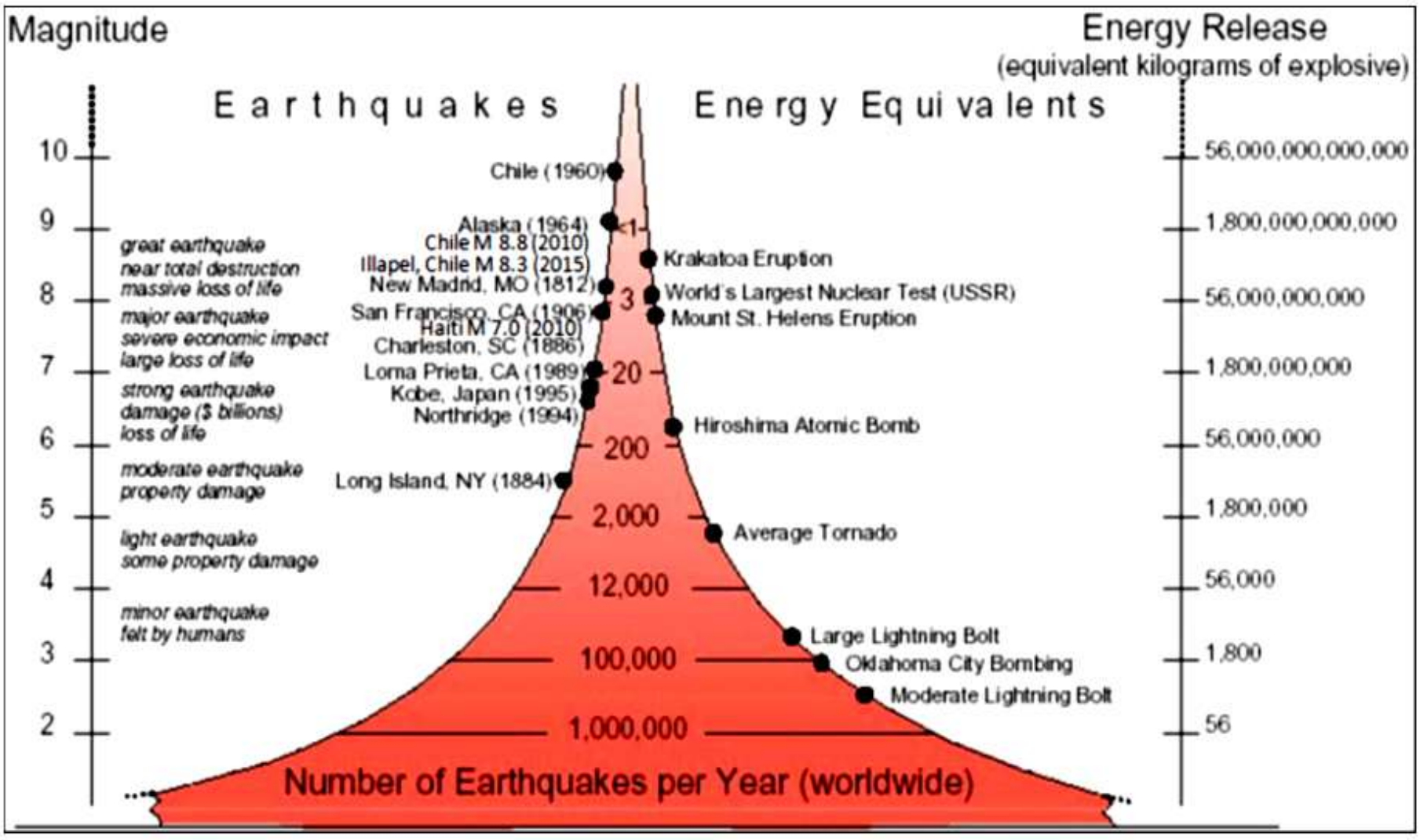
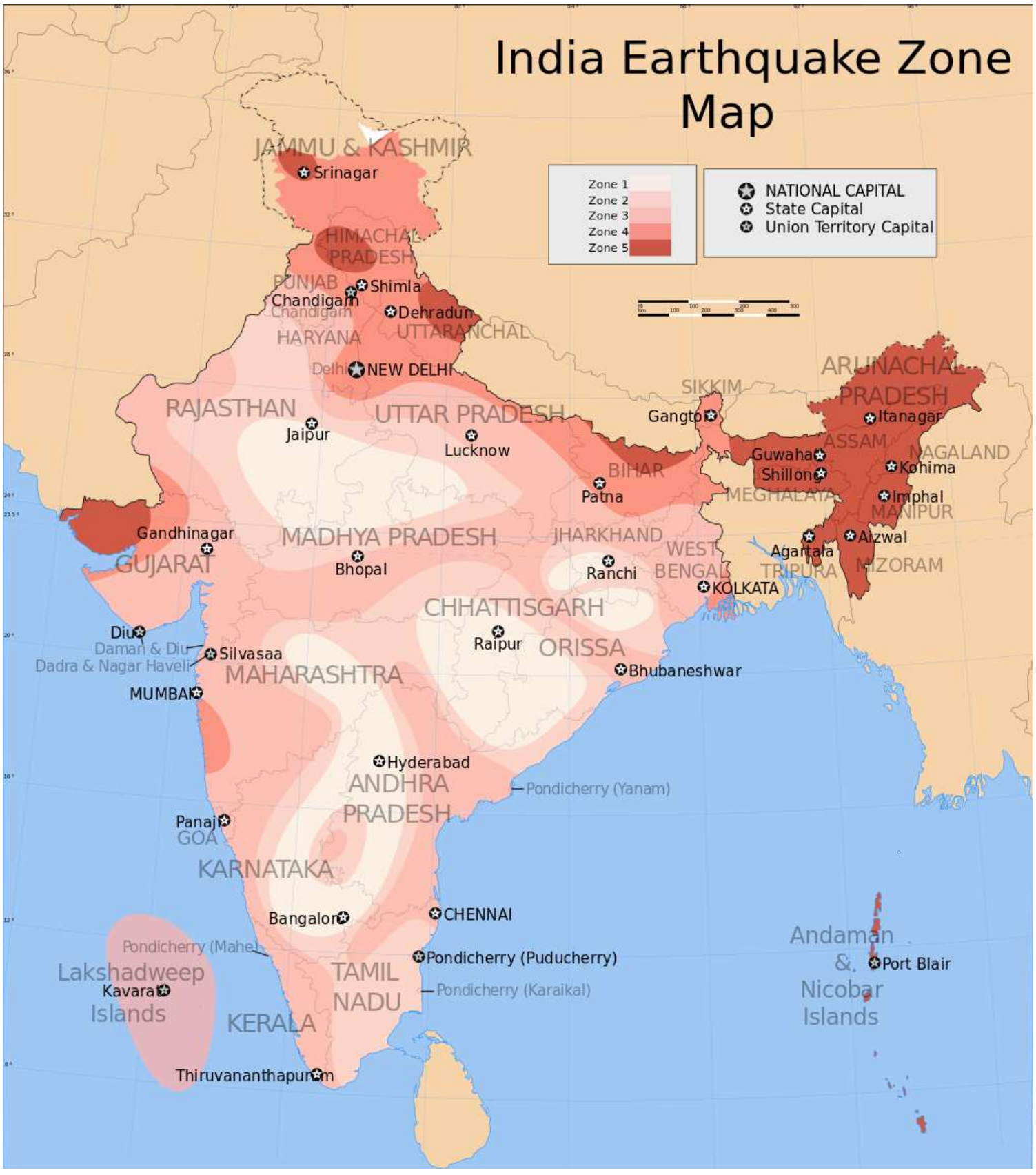


Image Courtesy: [Researchgate]

It is estimated 54% of the land area of India is vulnerable to earthquakes and 200 million people living in urban areas of India are vulnerable to earthquake damages. Depending upon the instensity of earthquake (seismicity) that can hit an area, India is divided into 4 seismic zones (Zone 2, 3, 4 and 5). Zone 5 expects the highest level of seismicity.



Earthquake Zone Map of India Courtesy: [Wikipedia]

Zone 5 covers the areas with the highest risks zone that suffers earthquakes of intensity MSK IX (Medvedev–Sponheuer–Karnik scale) or greater. The IS code assigns zone factor of 0.36 for Zone 5. Structural designers use this factor for earthquake resistant design of structures in Zone 5. The zone factor of 0.36 is indicative of effective (zero period) level earthquake in this zone. It is referred to as the Very High Damage Risk Zone. The region of Kashmir, the

Western and Central Himalayas, North and Middle Bihar, the North-East Indian region, the Rann of Kutch and the Andaman and Nicobar group of islands fall in this zone.

Zone 4 is called the High Damage Risk Zone and covers areas liable to MSK VIII. The IS code assigns zone factor of 0.24 for Zone 4 **Jammu and Kashmir, Himachal Pradesh, Uttarakhand, Sikkim, the parts of Indo-Gangetic plains (North Punjab, Chandigarh, Western Uttar Pradesh, Terai, North Bengal, Sundarbans**) and the capital of the country **Delhi fall in Zone 4**. In Maharashtra, the **Patan area (Koynanagar) is also in zone no-4**. In Bihar the **northern part of the state like Raxaul, Near the border of India and Nepal**, is also in zone no-4.

National Center for Seismology, Ministry of Earth Sciences is nodal agency of Government of India dealing with various activities in the field of seismology and allied disciplines. The major activities currently being pursued by the National Center for Seismology include

a) earthquake monitoring on 24X7 basis, including real time seismic monitoring for early warning of tsunamis,

b) Operation and maintenance of national seismological network and local networks

c) Seismological data centre and information services

d) Seismic hazard and risk related studies

e) Field studies for aftershock / swarm monitoring, site response studies

f) earthquake processes and modelling, The MSK (Medvedev-Sponheuer-Karnik) intensity broadly associated with the various seismic zones is VI (or less), VII, VIII and IX (and above) for Zones 2, 3, 4 and 5, respectively, corresponding to Maximum Considered Earthquake (MCE).

Each zone indicates the effects of an earthquake at a particular place based on the observations of the affected areas and can also be described using a descriptive scale like Modified Mercalli intensity scale or the Medvedev–Sponheuer–Karnik scale.

I. Not perceptible	Not felt, registered only by seismographs. No effect on objects. No damage to buildings.
II. Hardly perceptible	Felt only by individuals at rest. No effect on objects. No damage to buildings.
III. Weak	Felt indoors by a few. Hanging objects swing slightly. No damage to buildings.
IV. Largely observed	Felt indoors by many and felt outdoors only by very few. A few people are awakened. Moderate vibration. Observers feel a slight trembling or swaying of the building, room, bed, chair etc. China, glasses, windows and doors rattle. Hanging objects swing. Light furniture shakes visibly in a few cases. No damage to buildings.
V. Fairly strong	Felt indoors by most, outdoors by few. A few people are frightened and run outdoors. Many sleeping people awake. Observers feel a strong shaking or rocking of the whole building, room or furniture. Hanging objects swing considerably. China and glasses clatter together. Doors and windows swing open or shut. In a few cases window panes break. Liquids oscillate and may spill from fully filled containers. Animals indoors may become uneasy. Slight damage to a few poorly constructed buildings.
VI. Strong	Felt by most indoors and by many outdoors. A few persons lose their balance. Many people are frightened and run outdoors. Small objects may fall and furniture may be shifted. Dishes and glassware may break. Farm animals may be frightened. Visible damage to masonry structures, cracks in plaster. Isolated cracks on the ground.
VII. Very strong	Most people are frightened and try to run outdoors. Furniture is shifted and may be overturned. Objects fall from shelves. Water splashes from containers. Serious damage to older buildings, masonry chimneys collapse. Small landslides.
VIII. Damaging	Many people find it difficult to stand, even outdoors. Furniture may be overturned. Waves may be seen on very soft ground. Older structures partially collapse or sustain considerable damage. Large cracks and fissures opening up, rockfalls.
IX. Destructive	General panic. People may be forcibly thrown to the ground. Waves are seen on soft ground. Substandard structures collapse. Substantial damage to well-constructed structures. Underground pipelines ruptured. Ground fracturing, widespread landslides.
X. Devastating	Masonry buildings destroyed, infrastructure crippled. Massive landslides. Water bodies may be overtopped, causing flooding of the surrounding areas and formation of new water bodies.
XI. Catastrophic	Most buildings and structures collapse. Widespread ground disturbances, tsunamis.
XII. Very catastrophic	All surface and underground structures completely destroyed. Landscape generally changed, rivers change paths, tsunamis.

Medvedev–Sponheuer–Karnik scale (Ref: Wiki)

Ministry of Earth Sciences believes that the harmful effects of such high-intensity earthquakes can be reduced to a large **extent through seismic hazard microzonation of vulnerable areas and putting in place adequate mitigation measures.** Seismic hazard is the study of the expected earthquake ground motion at any point on Earth. Microzonation is the process of subdividing the number of zones based on the effects of earthquakes locally in the region. Seismic microzonation is the process of assessing the response of a soil layer under an earthquake stimulus and thus has many characteristics of ground motion on the ground surface. Geospatial site characterization and assessment of site response during an earthquake is one of the important stages of seismic microzonation in relation to ground intensity, attenuation and amplification ratings, and liquefaction sensitivity.

According to the Ministry plan, to reduce the seismic hazard of important cities with a population of half a million, it has to be done in a phased manner. This includes the capital of some states and vulnerable areas in some other cities. **This would provide an idea of the sites that are more prone to seismic hazards within a particular city and the type of mitigation measures that is required to be adopted to protect the public.**

So far, microseismic mapping of Sikkim and eight cities (Guwahati, Jabalpur, Bengaluru, Delhi, Kolkata, Ahmedabad, Dehradun, and Gandhidham) has been completed. Currently, work is going on in four other cities - Coimbatore, Chennai, Bhubaneswar and Mangalore. Microseismic mapping of Agra, Amritsar, Lucknow, Kanpur, Varanasi, Patna, Dhanbad and Meerut will be taken up soon.

Unlike the tsunami (**where early warning is possible**), there is no reliable predictive model for earthquakes, therefore it is only through well thought out and well-planned mitigation measures that can minimize the extent of damage and the loss of life. Dr. J.R. Kayal, Retd. Deputy Director General (Head, Geophys), Geological Survey of India; CSIR Emeritus Scientist, Jadavpur University, Kolkata; presently at the Institute of Seismological Research, Gandhinagar, said at a talk he delivered during the NEIST (North East Institute of Science & Technology) Science Forum (NSF) that microzonation maps can effectively give an idea about the areas which are more prone to seismic hazards and accordingly appropriate mitigation measures may be adopted

Dr. B.K. Bansal, Director, National Centre for Seismology, Ministry of Earth Sciences said that Seismic hazard micro zonation on a larger scale for selected cities is underway and developing appropriate mitigating measures for earthquake vulnerable area is in progress to achieve the target of minimizing the loss of life and property.

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