Current Science Reports

Seismic Zonation Mapping
Using hazard response data

The northern and eastern parts of the Indian plate are subducting under other tectonic plates. The cratons that comprise the Indian plate are also mobile relative to each other. All these lead to a large number of earthquakes in the subcontinent.

Based on knowledge about past earthquakes, seismic zone maps have been created which form the basis for decisions about constructions that are appropriate for each zone to withstand the risks of earthquakes.

The advent of machine learning and artificial intelligence has led to further refinements in the seismic zone map of India. Recently, Bhargavi Podili and S. T. G. Raghukanth at IIT Madras developed a revised seismic zone map.

They used the OpenQuake Platform, a free web-based platform, to calculate seismic hazard levels at different locations in India with the probabilistic seismic hazard analysis method – a statistical method to estimate the probability of a certain level of ground shaking being exceeded at any given location in India, based on an analysis of ground shaking obtained for a 2475-year return period.

The results from probabilistic seismic hazard analysis were used to derive the uniform hazard response spectra – a measure of probable ground shaking that can be expected in an earthquake of a given magnitude and distance. The researchers covered the Indian map with a $0.1° \times 0.1°$ grid and calculated the values of the uniform hazard response spectra of each grid for durations of vibration ranging from 0.01 to 5 seconds.

Then they needed to cluster locations that were similar to each other. So they used the evolutionary particle swarm optimization algorithm, for the purpose. This helped them group areas with similar seismic hazard levels.

Based on the results of the cluster analysis, the researchers divided India into five seismic zones. Zone V is the most seismically active zone, and zone I, the least active. The newly developed seismic zonation map is more accurate than the previously published zonation maps.

This map will be useful for engineers and planners to design buildings and infrastructure in various zones taking into account the risks of earthquakes as a part of disaster preparedness. Of course, within each zone, the local conditions that amplify ground motions may also need to be considered while planning constructions.

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Landslide Prediction Model
North-West Himalayas

Landslides are frequent in the Uttarkashi Himalayas. This mountainous terrain is mostly in the seismic zone IV and the rest of the district is in zone V. The steep slopes there are unstable and may slide down when disturbed. When this happens along roads and highways, it causes havoc, stranding travellers and making remote populations inaccessible. What are the geological conditions and triggers for landslides in the region?

Heavy rainfall is often associated with landslides. But what are the other factors involved? And how do they correlate?

Researchers from the CSIR-Central Building Research Institute, Roorkee, and the Academy of Scientific and Innovative Research, Ghaziabad recently created an event-duration-based rain threshold model for landslide prediction in the region.

They collected rainfall and landslide occurrence data spanning almost a decade along a 50-kilometre road stretch along the Uttarkashi–Gangnani highway. At Uttarkashi, the National Highway 108 is at an elevation of a little more than a kilometre above mean sea level, but, at Gangnani, it is more than two kilometres above sea level.

The researchers identified 24 landslide locations and mapped them into a digital elevation model of the stretch along with geological features.

Between 2010 and 2018, the region had witnessed 242 high rainfall events and 764 landslides. Landslide occurrences and rainfall showed good correlation – more than 80% of the landslides had occurred during the monsoon.

However, some months with high rainfall had low numbers of landslides and there were large variations in rainfall events associated with landslides.

So the researchers analysed the effect of different periods of rainfall before landslide occurrences – the total rainfall for a specific period before the landslide is triggered. They also examined the geological characteristics of several landslide slopes along the highway.

Using the data on landslides and rainfall between 2010 and 2018, but excluding the data of 2014 when the maximum number of landslides occurred, they created a landslide prediction model. To validate the predictions of the empirical model, they used data from 2014.

The model suggests that most landslides in the region are due to cumulative rainfall with 15 days of rainfall accounting for about 99% of the landslides.

To find out what causes a landslide, one needs to look at the soil, water and weather conditions in the area. This can be done by taking measurements in the field and looking at historical records.

The model can now be used to assess landslide risk and develop early warning systems in the region, say the scientists.

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Wilson's Storm-petrel
Phylogeny and genetic status

Wilson's storm-petrel, *Oceanites oceanicus*, is a small seabird. The bird is a top predator in the Southern Ocean food web, preying upon small invertebrates and even small fish near the ocean surface. The species breeds in the narrow rock crevices of ice-free Antarctica and migrates to the northern oceans during the non-reproductive period to avoid cold winters. It is one of the most abundant seabird species in the world's oceans. But does it have the high genetic diversity required to withstand evolutionary pressures?

Image: J. J. Harrison via Wikimedia Commons

Researchers from the Wildlife Institute of India, Dehradun, the Wildlife Conservation Society, Bengaluru, MoES-NCPOR, Goa and Pondicherry University collaborated to study the molecular phylogeny and population genetics of the Wilson's storm-petrel.

During Indian scientific expeditions to Antarctica in 2015–16 and 2019–20, they collected thirty-one bird carcasses and used the mitochondrial gene cytochrome b for genetic analysis.

First, they established the phylogenetic positioning of the Wilson's storm-petrel. They found that this bird belonging to the family Oceanitidae formed a separate group within the order Procellariiformes in the phylogenetic tree.

Other families in this order include albatrosses, petrels, shearwaters and the northern storm-petrel.

To determine genetic diversity and structure within the Wilson's storm-petrel, the team performed a median-joining network analysis and a Bayesian analysis for population structure.

Seven different sets of DNA variants, or haplotypes, were found. In the Larsemann Hills in East Antarctica, there were six different haplotypes, but in sub-Antarctica, there was only one.

Coastal Antarctic populations shared similar haplotypes indicating higher genetic connectivity.

However, the researchers found a strong genetic differentiation between the East Antarctic and sub-Antarctic populations. This could be due to the Antarctic circumpolar current, which flows clockwise from west to east around Antarctica.

The researchers found low overall genetic diversity, and low heterozygosity in the collected samples. This could be due to the small breeding population along the East Antarctica coast.

Further studies with larger samples and more genetic markers are needed to test the potential of population bottlenecks, especially the haplotype in the sub-Antarctic, say the researchers.

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Seasonal and Annual Precipitation
Long term trends in West Bengal

In the last two years, West Bengal has experienced heavy rainfall. Some areas received more than 400 millimetres of rain in a day, resulting in flooding, landslides and other disasters.

Such events could be part of a pattern. However, we lack an understanding of rainfall trends there.

Recently, researchers from the University of Calcutta collaborated with a colleague from Ravenshaw University, Cuttack to examine the long-term trends in annual and seasonal rainfall in West Bengal.

They divided the map of the region into 27-kilometre-wide squares and examined rainfall data between 1901 and 2020 in each grid – how much rain had fallen over time and how much rain fell in each square.

Annual rainfall, they found, increased slightly in West Bengal from the beginning of the last century to now. However, the increase was not statistically significant. A district-wise examination showed that the increase was significant in most districts but that was concomitant with a significant decrease over the districts of sub-Himalayan West Bengal.

The researchers examined changes in seasonal rainfall and found that rainfall during the monsoon has increased significantly over most districts in the Gangetic plain, except in the sub-Himalayan district, Dakshin Dinajpur, where it actually decreased.

Though winter rainfall showed a slight decrease, it was not statistically significant, except in Dakshin Dinajpur.

To understand the long-term deviations in rainfall, the researchers used normalized rainfall anomalies. This suggested that 17% of the study period had surplus precipitation, 17% had deficit precipitation and that the rest of the period had normal monsoon rainfall.

Understanding rainfall trends will help devise policies related to crop planning and water security to help farmers in West Bengal. The researchers suggest that there is a high potential for rain harvesting to address the water crisis and crop water stress in these regions, especially due to decreasing winter rainfall.

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Dengue Virus Serotype 2
Higher transmission rates

In central India, in 2019 and 2021, there were several dengue outbreaks. But, during the COVID-19 pandemic and lockdown, many cases were undiagnosed and under-reported.

Based on antigens on the surface of the virus and the differences in the antibodies detected in the patient's serum, dengue viruses are classified into four serotypes.

Which serotypes were responsible for the dengue outbreaks in Central India?

Researchers from Gandhi Medical College, Bhopal collected blood samples of patients suspected of having dengue fever.

They extracted serum from the blood samples and used the enzyme-linked immunoassay to detect antibodies against the four dengue virus serotypes. Out of more than 1400 suspected samples from the 2019 samples, about 600 were serologically positive. In 2021 samples, about 500 of nearly 1400 were seropositive.

About 15% of serologically positive samples in 2019 and 2021 had viral RNA.

The researchers found that all four serotypes were prevalent in Central India, while the dengue serotype 2 was the most dominant and was often found to coinfect with other dengue serotypes.

Such coinfections and cross reactions between the antibodies against dengue viruses are known to drive the evolution of the virus.

So the researchers started investigating genetic variation in serotype 2. They extracted viral RNA, used a reverse polymerase to create DNA that was complementary to the RNA, amplified the DNA using polymerase chain reaction and then sequenced the DNA.

To understand evolutionary changes in the serotype, the researchers downloaded Indian and global dengue virus sequences from GenBank and aligned

the sequences using MEGA 7.0 software for comparison with the sequences from their own samples.

They found that the dengue serotype 2, detected in 2019 and 2021, had diverged from previous strains detected in Central India in 2016 and 2018, which could be attributed to its higher transmission potential.

To understand the viral evolution, continuous surveillance and monitoring are needed. Timely testing, treatment as well as vector control measures are also required for outbreak management.

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Paediatric Adenovirus
Repurposing antiviral drugs

The human adenovirus causes respiratory tract infections in children, leading to bronchiolitis and pneumonia. So far, there are no drugs to treat the adenoviral infection which makes it difficult to manage. So researchers from the University of North Bengal thought of repurposing existing antiviral drugs – a strategy to quickly find a treatment without going through extended studies on toxicity and side effects.

From the Protein Data Bank, the team downloaded the three-dimensional crystal structure of human adenovirus 2 protease – the protein that facilitates the entry of the adenovirus into human cells. They also downloaded the structures of antiviral drugs used for children, from the PubChem database, a database of chemicals.

They then started molecular docking and molecular simulation studies using GROMACS software to identify drugs that can inhibit human adenovirus 2 protease. Among the 11 known antivirus drugs they chose, 6 compounds were found to dock with the protease.

To narrow down the selection, they used the Molecular Mechanics Poisson–Boltzmann Surface Area approach to predict the binding-free energy of the small ligand molecules. They also analysed the drug-likeness properties and pharmacokinetics of the drugs. Thus, the researchers identified two antiviral agents, balosavir marboxil and sofosbuvir, as candidate drugs against paediatric adenovirus.

Baloxavir marboxil is approved for use to treat influenza A and B infections and sofosbuvir for Hepatitis C in-

fections. However, clinical trials have to be conducted to determine the efficacy of these drugs for treating paediatric adenovirus.

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Tasty and Healthy Idlis
3 : 1 rice dal ratio batter

Image: Keka De via Wikimedia Commons

Idlis are made with black gram dal and parboiled rice. Dal provides protein and rice carbohydrates. Different types of rice and proportions of rice and dal are used to prepare idli batter. Such variations influence the idli's taste, texture and digestibility. What is the best proportion of the ingredients?

Researchers from the National Institute of Food Technology, Entrepreneurship and Management – Thanjavur, experimented with six different types of batter recipes.

Batter with three portions of parboiled rice and one portion of black gram dal with 2% salt had the best texture, colour, appearance, taste, aroma and overall acceptability.

We know that the carbohydrate in rice is starch. The structure and composition of the starch in the batter change due to fermentation and storage.

In the batter with three portions of rice and one of dal, reducing sugars showed a gradual increase during five days of storage. This batter also had the highest protein content.

A higher proportion of rice provides more starch for starch fermentation. Therefore, the appropriate ratio of rice and dal is important to increase batter quality and shelf life, explain the researchers.

Amylase, a starch catalysing enzyme and protease, a protein catalysing enzyme, showed higher activity. However, starch degradation was limited due to the association of the amylose sugar

with the proteins of dal. This restricted access to enzyme activity. Thus, this batter showed better resistance to starch degradation. Idlis from this batter had a relatively low glycaemic index.

The researchers also analysed the role of particle size. The larger the starch granules in the batter, the lower the glycaemic index.

The team's tips for making good idlis: three portions of rice and one of dal; use parboiled rice; grind it coarser than the dal; ferment for a shorter period.

'Batters with this recipe can be stored in the fridge for up to seven days,' says Jeyan Arthur Moses, National Institute of Food Technology, Entrepreneurship and Management – Thanjavur.

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Deep Fake Videos
Do we fall for them?

Videos created with the aid of artificial intelligence and machine learning are hard to differentiate from real ones. In social media, many such videos are circulated, reaching thousands of people and possibly influencing decisions such as choice of tourist destination.

When we decide to have a holiday, we often surf Instagram reels and YouTube videos about the possible destination. What if these videos were created using artificial intelligence, and made to look very realistic? Would we still make those intended visits?

To investigate, Rajasshrie Pillai and Mahek Mahtta from the Pune Institute of Business Management collaborated with Brijesh Sivathanu from the College of Engineering Pune and Angappa Gunasekaran from the US.

The researchers surveyed around 1400 bus, train and aeroplane travellers at 20 different locations across the coastal destinations of Maharashtra, Karnataka and Goa, and the popular hill destinations such as Himachal Pradesh and Uttarakhand.

They introduced the respondents to deepfake technology and then showed them two travel destination videos. One was a real depiction and the other, a deep fake.

The respondents then filled a questionnaire about their travel intentions.

As deep fake videos employ advanced tools and artificial sources, the videos can contain a high cognitive

load and media richness along with manipulated data. However, these factors may be perceived differently by each individual: perceived deception or trust may be influenced by media richness.

The researchers used a five-point Likert scale to measure each of these factors via multiple related questions. To get the average value from the respondents' data, they used Cronbach's Alpha test.

All the data was fed into Smart PLS 2.0 software for partial least squares structural equation modelling to find any correlations among the constructs. The results suggest that cognitive load does not influence the decision to visit a destination.

The factors, perceived trust, information manipulation and media richness entice the viewer and positively influence the destination visit intention. However, when people recognize that the video is deceptive, it negatively affects their intention to visit a destination.

The manipulation of shots in movies using special effects was a costly and time consuming process. Machine learning and artificial intelligence technologies are making it accessible to social media users. Social media users need media literacy and fake detection technologies to overcome the problems that may crop up.

Optical Manometers
For standardizing pressure units

To improve the accuracy of measurements, the units of various physical quantities are standardized regularly. In India, the CSIR-National Physical Laboratory is responsible for the calibration and standardization of units for measurements.

Elizabeth Jeessa James and colleagues at the CSIR-National Physical Laboratory, New Delhi recently came up with a new method to develop a standard for pascal, the unit used for measuring pressure. Accurate pressure measurements are important for environmental monitoring, quality control and industrial purposes.

Traditionally pressure is measured by a manometer, a U-shaped tube containing mercury. Mercury is a toxic metal and its use poses the threat of environmental contamination. Besides, the surface of mercury is influenced by any vibrations of the equipment, creating inaccuracies in measurement.

So the researchers at CSIR-NPL came up with an optical interferometer-based method which does not use mercury for the standardization and calibration of pressure measurement equipment.

When a laser beam is reflected by a mirror and the reflected beam is bounced back by another mirror, a standing wave forms an interference pattern of concentric rings where the rays in the same phase create bright rings and the rays in opposite phases cancel each other and create dark rings. The pattern depends on the resonant frequency which is determined by the distance between the mirrors, the speed of light in vacuum and the refractive index of the medium between the two mirrors.

The researchers leveraged on the fact that the refractive index of the medium is determined by the pressure of the gas in between the two mirrors. They designed and created an instrument with two cavities, one in vacuum and the other containing a gas where the pressure has to be measured.

A laser light is passed into each cavity and the frequencies are tuned to match the resonant frequency of the cavity. The light reflects back and forth, confined to the cavity. The pressure of the test gas can then be calculated using the difference between the resonant frequency of the two cavities.

The all-fibre optical setup and low-maintenance design of the dual cavity system ensure long-term reliable operation of the instrument, reducing the need for frequent calibration and maintenance.

The instrument can now be used to calibrate other instruments that measure the pascal in the range of 1–100 kilopascal pressure values – the range that is relevant in most pressure measurements.

The optical manometer is accurate, eco-friendly and can be used for maintaining Indian standards of pressure. Scientists and manometer manufacturers can adopt the design to improve the accuracy and reliability of pressure measuring devices.

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