

Current Science Reports

Western Ghats Soil Erosion

Predicting using satellites

Due to deforestation, changes in land use in the last few decades and high intensity rainfall events, the topsoil in the Western Ghats is losing its binding capacity. The water accumulated loosens the soil and this leads to mudslides and landslides. This has been going on for some years. Can remote sensing be used to estimate long-term variations in soil loss across the Western Ghats?

Pennan Chinnasamy from the Indian Institute of Technology Bombay and Vaishnavi Honap from the College of Engineering, Pune, study these events using satellite data. With their expertise in remote sensing, the researchers did a spatiotemporal analysis across the bio-diversity hotspots of the Western Ghats.

They used satellite data from LANDSAT-8 and rainfall records from 1990 to 2020. Using a digital elevation model, they visualised the topographic surface of the Western Ghats.

Unlike other disasters, which may be triggered by a key factor, multiple factors, spread over a long period of time, contribute to landslides. The researchers used rainfall patterns, soil types, and topography to formulate the universal soil loss equation. The model provides a long-term average annual rate of erosion across the Western Ghats.

To account for human factors, the team added crop systems and management practices as variables in the equation. The equation predicts an almost 95% increase in soil loss rates across the Western Ghats in the last 30 years.

The researchers also determined a rainfall erosivity index factor, which quantifies the effect of rainfall. The highest rates of soil erosion were Tamil Nadu, followed by Gujarat and Maharashtra for the Western Ghats region.

Long-term monitoring of soil erosion rates across the Western Ghats requires high-resolution remote sensing data and ground-based measurements. The soil erosion recorded in the last 30

years was due to deforestation, climate change extremes and unsustainable agricultural practices.

The Western Ghats, a UNESCO World Heritage Site, needs conservation for biodiversity to thrive. Such soil erosion studies would be helpful to understand the spatiotemporal variations.

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Little Ice Age in Kashmir

Evidence from tree rings

The Little Ice Age in the 17th century impacted the hydroclimate of the northern hemisphere. Speleothems, mineral deposits formed from groundwater in underground caverns, suggest that the Himalayan regions experienced higher winter precipitation during the Little Ice Age.

But a recent study on the reconstruction of droughts shows contrasting hydroclimatic conditions in the western Himalayas and the adjoining Karakoram regions.

What exactly was the moisture variability during and after the Little Ice Age? And why is there a difference between nearby regions?

Parminder Singh Ranhotra from the Birbal Sahni Institute of Palaeosciences, Lucknow, collaborated with other researchers to develop a new tree ring chronology of a Himalayan fir to reconstruct past climates in the western Himalayan region.

From two sites in South Kashmir, more than 2300 metres above sea level, they extracted around 100 cores from Himalayan fir trees. The tree rings in the cores, they found, represented a time period of more than 450 years.

Using the self-calibrated Palmer drought severity index, a standardised index based on a simplified soil water balance that estimates relative soil moisture conditions, they reconstructed the past 350 years from the tree rings.

An analysis of the reconstruction showed a wet phase with more rain between 1656 and 1816 and a dry phase after the Little Ice Age, from 1817 to 2016.

Using DENDROCLIM2002, a C++ programme that statistically calibrates

climate signals in tree-ring chronologies, the researchers examined the Himalayan fir's growth response to climate, to establish relationships between the regional standard chronology and different climate variables.

The results indicated a strong and positive correlation with the North Atlantic Oscillation in the western Himalayas which played a dominant role in winter and spring precipitation during the Little Ice Age.

What led to such variations in the contributions of rainfall from the summer monsoon and the western disturbance in the western Himalayas? Further research will reveal the details.

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Google Earth Engine

A tool to monitor forest cover

Chittagong Hill Tracts in Bangladesh shares borders with Mizoram, Tripura and Myanmar. Forest cover changes here have not been evaluated for the last two decades. The Google Earth platform provides several satellite products. The Google Earth cloud platform has high efficiency for analysis without storing data locally. Can we use Google Earth for analysing forest cover change?

To find out, S. Kalaivani, Vellore Institute of Technology, Tamil Nadu collaborated with scientists from the US, Malaysia, Saudi Arabia and Bangladesh. They downloaded data of five-year intervals from 1996 to 2021 from six Landsat satellites. They also collected rainfall data for 1996–2021 from the Bangladesh Meteorological Department. Using the Google Earth Engine platform, they derived the region's vegetation index and normalised difference vegetation index – indices crucial to analyse forest cover change.

To produce land usage and land cover maps, they used the maximum likelihood supervised image classification, an algorithm that classifies land maps. More than 500 sample points for each study year, collected from Google Earth imagery, were used to investigate land use. The researchers found that vegetated areas reduced by about 20%, water bodies by about 15%. An

increase in built-up and agricultural land accounted for the loss.

This method can be cost effectively implemented in other regions to monitor forest cover and forest degradation due to land usage.

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Carbon and Water Footprints

Rice, wheat and maize

In India, cereal production accounts for about 95% of the food grown. Of this, nearly 90% is from the cultivation of rice, wheat and corn. Crop production uses a lot of water and releases nearly one-sixth of total greenhouse gases. To develop methods for more environment-friendly agriculture practices, we need to determine the amount of water required for growing the main crops and estimate the emissions of greenhouse gases.

So researchers from several ICAR laboratories collaborated to investigate the carbon and water footprints of rice, wheat, and corn across India. They divided India's croplands into north, south, east, west and north-east India, based on geomorphology and demographic characteristics.

From different databases and government reports, they collected relevant secondary data of processes from land preparation to crop harvest – field area, rainfall, fertiliser use, irrigation practices and machinery use.

To estimate the water footprint they took into account water from lakes, rivers, and reservoirs, used for irrigation, the water content in the soil, and agricultural runoff along with fertilisers.

In India, they found, the total water footprint is maximum for rice farming. Rice farming requires almost 750,000 litres of water per hectare. Water footprints are lower for maize and least for wheat.

The use of water from water bodies was highest in Rajasthan, while water in soil was highest in Meghalaya. The footprint of runoff with fertilisers was higher in northern India.

To estimate the carbon footprint, the researchers considered the total greenhouse gas emissions. This includes direct emissions of nitrous oxide and methane from soil, straw burning, tillage, seeding, mechanical harvesting,

indirect emissions based on fertiliser application and the use of machinery for irrigation.

Rice has the highest carbon footprint. Rice farming produces around 2.5 tonnes of carbon dioxide equivalent greenhouse gas per hectare. This is almost three times higher than greenhouse gas emissions from corn and two times higher than from wheat cultivation.

Among greenhouse gas emissions, methane contributes to more than 60% in rice cultivation. In wheat farming, fertilisers contribute 60% of the greenhouse gases. Fertilisers and nitrous oxide combined contributed to almost half of greenhouse emission in maize cultivation.

The total carbon footprint for rice farming is highest in south India with almost four tonnes of carbon dioxide equivalent greenhouse gas per hectare. Wheat and maize farming in west India had higher total carbon footprint than the rest of our country. The total carbon footprint from agriculture was highest in the south followed by the west, north, east and northeast of India.

Different geographical regions had varied carbon and water footprints, due to variation in soil conditions, water availability, and fertiliser use. In most Indian states, the carbon and water footprints showed positive correlations for rice, wheat and maize.

The researchers suggest better crop and water management for reducing the carbon and water footprints. A system of rice intensification which promotes the use of organic manure, intermittent irrigation to keep the soil moist but not inundated, and drip irrigation can be useful. Similarly, using fertilisers based on soil characteristics and crop rotations can reduce the need for fertilisers.

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COVID Variants

Comorbidities and outcome

The Omicron variant of the SARS-CoV-2 is a highly mutated form. The WHO classified it as a variant of concern. This variant has become dominant in several countries due to its high transmissibility. However, it causes fewer deaths than the Delta variant. How do

the two variants affect people with comorbidities?

Vikas Manchanda and team from Maulana Azad Medical College, Delhi conducted a cohort study of 100 cases hospitalised with the Delta or Omicron variants. Cohort studies follow participants who share a common characteristic.

The median age of patients infected with both variants was similar – about 47 years. However, the team observed that most patients admitted with Delta variants were females, whereas most Omicron patients were males.

Thirty patients with the Omicron variant were smokers. For the Delta variant, it was only ten. Both variants infected more male than female smokers.

The comorbidities of the patients included hypertension, diabetes, chronic kidney, liver, pulmonary and heart diseases as well as cancers.

Patients with comorbidities had an increased proportion of mortality when infected with either of the variants. This proportion was higher in patients with hypertension and diabetes in cases of Omicron infection. With Delta infection, patients with pulmonary disease had increased mortality.

At least one comorbidity was present in 70% of patients infected with the Delta variant, whereas only 50% of patients with the Omicron variant had comorbidities. Overall, 25% of Delta-infected patients admitted to the hospital died, while only 10% died due to Omicron infection. The research suggests that patients with comorbidities are associated with a higher proportion of mortality with the disease, irrespective of the variant.

The research did not evaluate the efficacy of vaccination in patients with comorbidities.

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Pancreatic Surgery Complications

Managing and preventing

To improve survival rates in pancreatic cancer patients, the duodenum, the gallbladder, the bile duct and the head of the pancreas are removed by pancreaticoduodenectomy, a surgical procedure. But this can affect the patient's quality of life. And in some cases, complications such as pancreatic dysfunction,

diabetes and pancreatic exocrine insufficiency can also occur.

What is the frequency of postoperative complications affecting pancreatic functions after one year of surgery?

Shradha Kanwat and team from the Post Graduate Institute of Medical Education and Research, Chandigarh collected data from 64 patients who had undergone pancreaticoduodenectomy at least a year earlier to assess complications and quality of life.

They examined the endocrine function of these patients using blood sugar levels. Fifty per cent of the patients had endocrine insufficiency, including worsening of preoperative diabetes or the onset of diabetes.

The researchers assessed pancreatic exocrine function with faecal elastase-1, a digestive enzyme. Approximately 90% of the patients had decreased pancreatic secretions; some had severe pancreatic insufficiency. This led to improper digestion of food, and, as a result, even a small amount of fat intake led to steatorrhea, a fatty stool condition.

Forty-five per cent of the patients had both exocrine and endocrine insufficiencies. In these patients, the researchers measured the volume of the remnant pancreas, its thickness and duct diameter. They did not observe any association between morphological changes in the remnant pancreas and patients with pancreatic insufficiency.

The team assessed the patient's quality of life using a questionnaire. The patients scored lower than the general population, especially in role limitation due to physical health, emotional problems and fatigue.

The high frequency of pancreatic insufficiency in patients after pancreaticoduodenectomy can be managed by supplementing with pancreatic enzymes. Healthcare providers should routinely screen these patients for complications.

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Classifying Early Psychosis *From brain images*

Psychotic symptoms are common in schizophrenia. And in about half of those with Parkinson's disease. Studies report that structural changes in the brain's grey matter can be used as a

biomarker for the early identification of psychotic symptoms. But how can we classify grey matter structure for early disease detection?

Recently, Shyam S. Arumugham at NIMHANS, Bengaluru, collaborated with scientists from Germany, the UK, the USA, Australia, Spain and Singapore to see how it could be done. They used data from datasets on early schizophrenia and Parkinson's disease images from six projects across the UK, Singapore, Australia and India. The datasets included about 700 brain images from early schizophrenia and Parkinson's disease patients, along with images from healthy individuals for comparison.

The researchers then connected all the grey matter maps to create a 4D file and performed independent component analysis, a computational method for separating a multivariate signal into additive subcomponents. They identified 30 morphometric networks that clearly involve separate subcortical regions in the grey matter. And analysed scan images based on age, gender, scan site, etc.

To investigate the differences between the data of schizophrenia and Parkinson's, they used common statistical methods such as analysis of covariance and post hoc tests to identify which groups showed the difference. There were significant differences between groups.

To classify the disease stages, the researchers used a morphometric network-based classification algorithm. They found that the algorithm can classify and identify the possibility of psychosis in healthy individuals.

'This method may help us identify schizophrenia and Parkinson's early,' says Shyam S. Arumugham. Psychiatrists can use this method after successful clinical trials.

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Natural Compounds with Aspirin *Preventing secondary complications*

Aspirin, an effective pain killer, has anti-inflammatory properties. But in chronic diseases, the effective dose required is high. And long-term use of aspirin can result in gastrointestinal adverse effects. There is a change in the pH of

blood which may lead to increased risk of cardiovascular complications. Can we reduce this high aspirin-mediated risk by combining the drug with natural anti-inflammatory compounds?

To find out, Rangaswamy Lakshminarayana, Bangalore University collaborated with researchers from different departments and institutes. They came up with the idea of combining lower doses of aspirin with carotenoids.

They isolated four carotenoids from different sources: beta-carotene and lutein from spinach, astaxanthin from shrimp, and fucoxanthin from seaweed. For testing, they used carotenoids equivalent to the serum carotenoid concentration in healthy individuals.

In vitro studies suggest that macrophages treated with lipopolysaccharide, a component of the bacterial cell wall, had low viability. This is due to inflammation caused by increased reactive oxygen species inside the cells. When the infected macrophages were treated with aspirin, it reduced the inflammation and thereby increased the viability of the cells. However, the use of a minimal inflammatory dose of 0.8 micro molar of aspirin along with different carotenoids significantly improved the viability of the infected cells by 70% compared to aspirin alone.

The data from the viability and reactive oxygen species experiments suggested that fucoxanthin, isolated from seaweed, is the most effective candidate. Further studies done with fucoxanthin suggested that it reduces lipopolysaccharide-mediated inflammation by decreasing the expression of pro-inflammatory markers and cytokines such as interleukin-1 β and tumor necrosis factor- α .

'Aspirin is a common, low-cost drug. Combined with nutraceutical agents, it holds promise for treating chronic diseases. But we still have to explore the proper dose of aspirin for a potential anti-inflammatory effect in animals through clinical trials,' says Rangaswamy Lakshminarayana.

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Mesenchymal Stem Cell Culture *Using human-derived supplements*

Mesenchymal stem cells isolated from human umbilical cord tissue serve as

an ideal, non-invasive, and ethical source for cell-based therapy. They can be used to treat various diseases such as osteoarthritis, kidney injury, Crohn's disease, liver failure, etc. The culture of human cord tissue mesenchymal stem cells using conventional foetal bovine serum poses the threat of non-specific activation of cells. Moreover, the risk of transmitting zoonotic pathogens is increased. Can growth factor- and cytokine-rich human platelets from a blood bank be used to culture stem cells?

To evaluate this approach, T. G. Nithya and team at the SRM Institute of Science and Technology, Chennai collaborated with Angeline Julius from the Centre for Materials Engineering and Regenerative Medicine, Chennai.

Since the platelets have a shelf life of five days, Nithya and team used freeze-dried human platelets. The lyophilized platelets can be dissolved in double-distilled water and used as and when required.

The researchers compared the lyophilized platelets with foetal bovine serum in stem cell culture. Platelet-derived supplements did not hinder the ability of stem cells to differentiate into fat-storing adipocytes, bone-forming osteoblasts, or matrix-secreting chondrocytes. Both were comparable in terms of maintaining the potential for differentiation into all three lineages.

Platelet-supplemented stem cells, however, expressed unaltered characteristics of surface markers, and the expression levels too, were not reduced. Stem cells co-cultured with immune cells showed no activation-induced proliferation of immune cells. This suggests that the anti-inflammatory properties of stem cells are preserved under platelet supplementation.

'Such lyophilized platelet lysates could be the solution to avoid problems with growth supplements obtained from other species. The shelf life of the platelet supplement is also good enough

for supporting optimal mesenchymal stem cell culture,' says T. G. Nithya.

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Assessing Language Learning Using real world situations

Mastering a new language after adolescence is reported to be harder. How can adults learn English as a second language quickly and effectively?

To find out, K.D.V. Prasad, Symbiosis Institute of Management, Hyderabad collaborated with researchers from Saudi Arabia and Iran. They devised a method for better self-learning.

After a literature survey, they hypothesised that incorporating authentic, real-world-like assessments in the training period enhances learning abilities. Authentic assessments help learners deal with the language in the real world. Oral interviews, retellings and presentations improve the learner's speaking ability and help absorb the concepts taught. Similarly, writing, editing and commenting on exercises can engage the learner cognitively and emotionally.

To compare the impact of assessments of oral, verbal and presentation skills with non-authentic assessments, passage reading, writing and self-learning, the team divided 57 adult male students with Persian as their first language into two groups.

The data from the experiments in teaching and learning show that participants in the experimental group with real world-like assessments had increased confidence and efficacy in learning English. Such assessments provide a clue to a student's competency or weakness in particular areas.

The researchers suggest that evaluators involved in language training should monitor the learner's work via everyday interactions. Course modules for English language learning need to be altered to cover more real world situations and interactions, they say.

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Electronic Smelling To identify food spoilage

All food items have a specific shelf life. However, depending on the environment it is kept in, food might spoil sooner than expected. Spoiled foods emit pungent odours, which can be easily detected. But, when there are lots of food samples to be tested, it is not possible for humans to smell each of them with the same sensitivity. Can electronic devices help detect food spoilage?

When spoiled, seeds are known to release methane and other hydrocarbon gases. So, Smriti Gaur and Shubhi Singh from the Jaypee Institute of Information Technology, Noida developed an electronic nose to detect spoilage in edible seeds using Arduino Uno R3, a microcontroller.

They programmed four different gas sensors, with a threshold for smell detection. To test the sensors, the team used six different powdered edible seed samples and stored them in an airtight container at room temperature. On this box, the researchers installed programmed gas sensor modules.

They used the setup to monitor all the samples for 150 days. At the 120-day mark, the sensors picked up the odour of methane and hydrogen and indicated the spoilage of the seeds with a display message. At the same time, there was an increase in the growth of spoilage microorganisms in the samples.

The electronic nose was developed with low cost sensors and can be built into food packaging. Alternatively, consumers can buy portable e-noses to check the freshness of food items before buying or using them.

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