

Current Science Reports

Carbon Management Zones Northeastern Himalayas

Tripura, in the north-eastern Himalayan region of India, is one of the 36 biodiversity hotspots of the world. Because of extreme climatic variability, high-intensity rainfall, irregular topography and steep slopes, the region is vulnerable to soil erosion. Erosion reduces the amount of carbon that has been sequestered. So there is a need to manage carbon sequestered in soils in the region to not only improve productivity but also to mitigate climate warming.

Scientists from the ICAR-National Bureau of Soil Survey and Land Use Planning, Kolkata set out to identify carbon management zones in the region for climate change mitigation.

They collected 68 georeferenced soil samples from three administrative blocks covering most of the Sepahijala district of Tripura. The samples were analysed for soil organic carbon content, soil depth and other relevant properties.

Using the quantile regression forest algorithm, an advanced version of the random forest, they modelled soil organic carbon at six different depths. As expected, it varied from location to location. The organic carbon at different depths showed even more variation. The highest variation in soil organic carbon stock was observed at a 30–60 centimetre soil depth, perhaps due to erosion and deposition.

The researchers collected local environmental variables such as mean annual temperature and mean annual precipitation. Elevation, slope, orientation and so on were derived from digital elevation models. From LANDSAT 8 Operational Land Imager data of five years, they deduced the vegetation indices and other factors.

They used all the available data to create a digital soil map of the area using the Google Earth Engine cloud computing platform for geospatial analysis. The depth of valleys was the most important predictor variable affecting carbon stock.

Using the data, the researchers prepared digital maps of soil depth and

soil organic carbon stock at a high resolution of 30 metres in the Sepahijala district of Tripura.

They delineated three carbon management zones in the region using a combination of the minimum fuzzy performance index and normalized classification entropy values. The minimum fuzzy performance index provides insights into the structure and patterns within heterogeneous datasets such as this one. Normalized classification entropy values quantifies the quality and accuracy of classification or clustering results, providing knowledge about the uncertainty in the data.

Identifying carbon management zones with reasonable certainty helps prioritize areas for carbon-rich site-specific input management, and implement site-specific carbon management programmes, including precision agriculture. The Sepahijala administration can now take informed action.

'The north-eastern Himalayas are a crucial region for carbon sequestration. The region is rich in organic matter and has complex ecosystems,' says S. K. Reza, ICAR-National Bureau of Soil Survey and Land Use Planning, Kolkata.

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Endometrial Cancer RNAs in diagnosis, prognosis

Endometrial cancer is the most common cancer of the uterus. If diagnosed early, it is easily curable. However, despite medical advancements, we still lack biomarkers for endometrial cancer.

Researchers from the Mohanlal Sukhadia University, Udaipur, the Manipal Academy of Higher Education, and the Central University of Haryana recently came up with a method to identify such biomarkers which can do more than merely detect and diagnose endometrial cancer.

They leveraged on circular RNAs and microRNAs. Both do not code for proteins. But both form complex networks and regulate messenger RNA activity. MicroRNA has the potential to act as either a tumour suppressor or an oncogene, depending on speci-

fic contextual factors. And circular RNAs can act as sponges for microRNAs.

To identify circular RNAs associated with endometrial cancer, the researchers used Circad, a manually curated database for circular RNAs associated with diseases. They identified two.

To identify the microRNAs associated with these two circular RNAs, they used Circular RNA Interactome, an online tool that scans for the target microRNAs. They found one miRNA sequence binding to one of the circular RNAs and two miRNA sequences that bind to the other circular RNA.

Now the researchers turned to molecular techniques such as reporter assay, western blotting, qPCR and microarray analysis to predict the targeted mRNAs of the three identified microRNAs. Interactions between the microRNAs and mRNAs were verified using MirTarBase. The three microRNAs targeted 23 mRNAs.

The researchers labelled the identified genes using the DAVID Bioinformatics resources. Thus they homed in on 18 genes most enriched as per gene ontology.

One of the microRNAs targets the RNA of the SETD8 gene, a methyltransferase that contributes to stem-like cell properties, suggesting additional genomic/epigenomic molecular targets for therapeutic interventions in endometrial cancer.

It also interacted with TRAF2, the tumour necrosis factor receptor-associated factor 2, which, in turn, is known to interact with many signalling proteins in cell membranes.

Among the targets for the second microRNA were an oncogene and a gene regulating apoptosis or programmed cell death. The third microRNA also had associations with oncogenes. The upregulation of the third microRNA in endometriosis may be used for diagnosing endometrial cancer in the early stages.

The researchers then assessed the predictive response, link gene expression and response to therapy using transcriptome-level data of endometrial

cancer. The second microRNA, hsa-miR-433-3p, showed significant predictive relevance in assessing patient response to chemotherapy in endometrial cancer.

By identifying specific microRNAs with potential diagnostic and prognostic relevance, the study offers insights for personalized treatment approaches to endometrial cancer.

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Oleander Leaf

Fatal poisoning in children

Nerium oleander is a common ornamental plant with vibrant pink and, in some cases, white blooms. But the plant has a potent toxin, oleandrin. A single bite of its leaves can prove lethal.

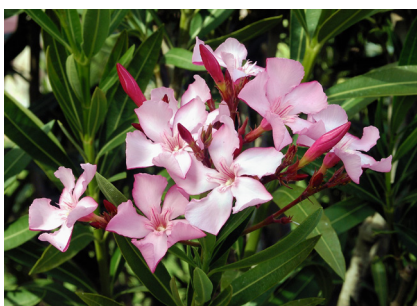


Image: Joaquim Alves via Wikimedia Commons

Recently, researchers from AIIMS Jodhpur, Arunai Medical College and Hospital, Tamil Nadu and JIPMER, Puducherry reported investigating the aftermath of such a case.

A child, while playing in a garden, ate an oleander leaf, mistaking it for a guava leaf. The child started vomiting and was taken to the casualty department with vomiting, poor sensorium, hypotension and shock.

The child developed hyperkalemia, acute kidney injury, myocardial dysfunction and bleeding manifestations. Urine output decreased and, after 36 hours, the child died.

The researchers investigated the child's medical history, analysed clinical symptoms and examined the post-mortem tissues. Autopsy and toxicology analysis revealed oleander poisoning.

The chewing of a single oleander leaf triggered a cascade of toxic effects. The first ominous signs were nausea, vomiting and abdominal pain, followed by a rapid decline in heart function, leading to fatal cardiac arrest.

To understand oleander poisoning, the researchers investigated the plant's chemistry. They found a group of potent cardiac glycosides, cardenolides in its leaves. These molecules mimic the action of digitalis, a medication used to regulate the heart's rhythm.

In high doses, as found in oleander, cardenolides disrupt the heart's delicate electrical circuitry, throwing it into a chaotic rhythm, ultimately leading to heart failure.

This information sheds light on the dangers of oleander poisoning and equips us with crucial knowledge to prevent similar tragedies.

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Nitrogen-doped Carbon Dots

To screen diseases

Glutathione, a tiny molecule found within every cell, acts as a silent guardian, shielding us from oxidative stress and harmful toxins. When its levels fall, it can signal the onset of a range of devastating diseases, from Alzheimer's to cancer.

Recently, Aswathy and Sony George from Kerala University, Thiruvananthapuram came up with a method to detect and quantify glutathione.

They thought of carbon dots, nanomaterial typically with a diameter of less than ten nanometres, easily made from carbon sources like citric acid, sucrose, or even food waste. Carbon dots possess unique optical properties, bright fluorescence and tunable emission colours. They are also biocompatible. These features make them ideal candidates to detect biological molecules like proteins and DNA.

The surface of carbon dots can be tailored with specific molecules such as antibodies or enzymes, which can act like recognition units, permitting the carbon dots to bind to target molecules of interest. This binding event triggers a change in the carbon dot's optical properties, like fluorescence intensity or wavelength, serving as a clear and measurable signal.

Nitrogen-doped carbon dots have brighter and more stable fluorescence because nitrogen atoms introduce new energy levels within the carbon structure. The type and amount of nitrogen incorporated into nitrogen-doped carbon dots can be controlled to adjust

their fluorescence emission wavelength. So the researchers synthesized nitrogen-containing carbon dots using microwave-assisted pyrolysis.

They dissolved citric acid and an equal amount of urea in water. The contents were subjected to microwave radiation. When a golden-yellow-coloured mass, signalling the formation of carbon quantum dots, appeared, they kept it at room temperature for cooling.

They re-dissolved the mass in water, and centrifuged and filtered it to remove larger particles. To this sample of nitrogen-doped carbon dots, the researchers added picric acid.

Glutathione has a strong affinity for picric acid molecules and can effectively displace picric acid from nitrogen-doped carbon dots. This restored their bright fluorescence and provided a clear and quantifiable signal of the presence of glutathione.

To test the method, the researchers collected urine and serum samples from healthy volunteers. The nitrogen-doped carbon-dot-based sensor could accurately detect even minute changes in glutathione levels, differentiating it from other biomolecules found in cells.

Early detection of glutathione imbalances could lead to faster diagnoses and personalized treatment plans for a multitude of diseases. Medical entrepreneurs now need to come forward to use this information to make diagnostic kits for the benefit of patients and healthcare professionals.

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Collagen-based Hybrid Bioscaffold

For tissue engineering

Three dimensional porous structures, designed to mimic the extracellular matrix of tissues, are major scaffolds for tissue engineering. They are usually made from biocompatible natural or synthetic polymers.

The natural polymer, collagen, is the most abundant protein in our body. In the extracellular matrix, it provides structure and support to tissues. So collagen may be the first choice for making bioscaffolds. But such scaffolds have limited strength and rapidly degrade when used in a complex physiological environment.

Cellulose is another abundant natural polymer with adequate strength and stability. Why not combine collagen and cellulose to create a bioscaffold?

Balaraman Madhan, CSIR-Central Leather Research Institute, Chennai collaborated with researchers from Slovenia, Austria and Portugal to test the idea.

They collected collagen extracted from cow skin and mixed it with nanofibrillated cellulose obtained from wood pulp. Nanofibrillated cellulose is stiff and has high mechanical strength to bear loads.

The team added carboxymethylcellulose, a water soluble form of cellulose which tends to adhere to nanofibrillated cellulose. To crosslink the components, they used citric acid.

The researchers then made an ink with their mixture, and loaded it on to a 3D bioprinter to create a scaffold. The printed scaffolds were freeze dried to remove water content and to preserve the structure.

They then exposed the scaffolds to elevated temperatures to promote ester bond formation between the polymers and citric acid and neutralized the scaffolds with a buffer later, to remove the residual acidity.

'The porosity of the scaffolds varied depending on the concentrations of collagen. So it is easy to control the porosity for meeting specific needs,' says Tamilselvan Mohan, University of Maribor, Slovenia.

The scaffolds exhibited good thermal stability. The ester bonds enhanced their mechanical strength.

The researchers investigated the degradation profiles of the scaffolds. The degradation was slow and gradual.

To check if the scaffolds were toxic to cells, the researchers cultured human bone osteosarcoma cells on the scaffolds. They were not. Instead, they supported cell growth and proliferation.

'The 3D printed hybrid collagen bioscaffolds now need to be tested for tissue engineering in animal models,' says Balaraman Madhan, CSIR-Central Leather Research Institute, Chennai.

Healthcare professionals may soon start using such bioscaffolds for tissue engineering and repair, reducing the need for transplantations.

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Disparities in Menstrual Hygiene *National Family Health Survey*

There is a disparity in the use of hygienic materials during menstruation between rural and urban areas, between the rich and the poor.

This casts a shadow over the well-being and educational achievements of many young girls in India.

Mahashweta Chakrabarty and a team of researchers from BHU set out to understand the extent of the problem.

They used data from the fifth round of the National Family Health Survey conducted during 2019–21. The data comprised a nationally representative sample of Indian households.

The researchers focused on the data related to menstrual hygiene practices among adolescent women. The sample contained nearly 115,000 adolescent women, mostly from rural areas, but with adequate representation of urban adolescents.

During the survey, women were asked about the methods of protection they use during their menstrual cycle to avoid bloodstains.

To understand the various socioeconomic and demographic factors that might have played a role in the variations in the responses, the researchers used bivariate analysis.

To identify and quantify contributors to the gaps in hygienic material use, they applied the Fairlie decomposition method.

Only half of the adolescent women in India use hygienic materials during menstruation. But in rural areas it was only 43%, while in urban areas it was 68%.

The rural–urban divide widened among women with no education, varying education levels, and wealth quintiles.

The gap persisted even among different social groups.

Unmarried adolescent women faced a notably higher gap than their married counterparts.

The central and north-eastern regions faced the highest rural–urban gap, while the southern and western regions exhibited smaller gaps.

State-wise variations showed Tamil Nadu and Telangana leading in the use of hygienic material. Bihar, Uttar Pradesh and Manipur lagged behind.

The researchers found that the most critical contributor to this divide between rural and urban populations was household wealth.

This was followed by region of residence, mass media exposure and education level.

'Initiatives to promote awareness, education and provision of subsidized hygienic products are needed to bridge this gap,' says Mahashweta Chakrabarty, BHU.

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Financial Fraud Detection *Using semi-supervised learning*

Internet banking allows us to manage our financial transactions anytime from our phone or computer. But, banks struggle with fake loans and that costs them money.

Supervised and unsupervised machine learning models can help us detect fake loans. In supervised learning, data is labelled by humans initially and the model learns to predict the outcome for new data without labels. However, this method calls for large amounts of correctly labelled data. And labelled data is scarce in the case of fraud.

In unsupervised learning, the data input is without labels, and the model detects patterns or structures within the data. However, data imbalance and the complexity of patterns in fraud pose limitations on the accuracy of unsupervised machine learning.

There is, therefore, a need for a smart AI detective to sniff out fake transactions.

Can semi-supervised machine learning perform better using data without labels?

Suvasini Panigrahi and her Ph.D. scholar from the Veer Surendra Sai University of Technology, Odisha gave it a try. The basic idea was to integrate the strengths of existing models.

XGBoost, for example, is a gradient boosting algorithm that tackles imbalanced data, a common challenge in fraud detection.

BiGRU is a recurrent neural network that remembers the history of each loan application.

The self-attention network, SAN, focuses on the most important clues, ignoring distractions like a good detective.

To assess the effectiveness of integrating these components and to check whether self-attention indeed improves performance, the duo compared the combinations of the machine learning models. XGB-BiGRU-SAN had better fraud detection accuracy than the other models.

To evaluate the benefit of incorporating unlabelled data, which is typically abundant in fraud detection scenarios, they compared the performance of XGB-BiGRU-SAN with and without using unlabelled data for semi-supervised learning. The semi-supervised version achieved a higher metric, indicating better performance.

To ensure the best performance of the model, the researchers tuned various parameters such as learning rate, number of hidden units, and dropout rate – the parameters that control how the models learn and make decisions. This helped optimize the configuration for accuracy.

The optimized XGB-BiGRU-SAN improved the metric score further compared to the original configuration, highlighting the importance of parameter tuning for optimal performance.

Lastly, to discover the model's decision-making process and to understand how it identifies fraud, the researchers analysed specific cases.

The cases revealed that XGB-BiGRU-SAN effectively captures temporal dependencies and focuses on relevant features within loan application sequences, contributing to accurate fraud detection. XGB-BiGRU-SAN correctly identified fraudulent applications.

'Tuning the parameters made the model work best and helped identify the loan crooks,' says Venkata Lak-

shmi Narayana Gorle, Veer Surendra Sai University of Technology, Odisha.

'XGB-BiGRU-SAN can catch sneaky loan crooks even if they try to hide their tracks,' adds Suvasini Panigrahi, her research supervisor.

Now financial institutions, technology developers and regulators can create a more secure and reliable financial ecosystem.

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Motivation for Posting WhatsApp statuses

WhatsApp is a popular social media application. People use it for instant messaging and for sharing media. It is also used to post statuses that remain online for a limited time. Unlike in conventional messaging, statuses can be either in text, or as a photo or even a video. Emojis or stickers can also be added.

Every day, about 5 million statuses are posted around the world. What motivates a user to post a status?

To find out what drives WhatsApp users to post a status, Murugan Pattusamy, University of Hyderabad, and Prasanta Kr Chopdar, Indian Institute of Management, Shillong collaborated. They conducted a focus group discussion with WhatsApp users to list all possible motivations for posting a status.

Then, they conducted an open ended online survey to collect all other possible reasons for posting status updates. The average age of the 88 survey participants was 29 years, with an almost even number of males and females.

To determine the validity of the motivation factors identified, the researchers presented all the motivation items

to eight experts in marketing and psychology. After accepting the suggestions of the experts and removing redundancy, a total of 58 items remained.

To check if the motivation factors were applicable to a larger cohort, the researchers conducted another survey with the remaining items using a 5-point Likert scale. They analysed the factors in the 225 responses received. Items with communality values of less than 0.5 were removed as they do not represent common factors adequately. The 37 items that remained were used in yet another survey of 335 respondents.

From this data, the researchers identified seven main gratification factors which drive people to post WhatsApp statuses. The main reasons, they found, were to maintain social relations, to express views, and to share life updates and inspiration. The other reasons were for social good, for attention-seeking and for entertainment.

'Our study offers practical applications for marketers and influencers to tailor messages, and leverage WhatsApp as a tool for customer engagement,' says Prasanta Kr Chopdar, IIM Shillong.

Murugan Pattusamy, University of Hyderabad, acknowledges the study's relevance to the Indian population, suggesting the need for future cross-cultural comparisons to enhance generalizability.

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