

Science Last Fortnight

Cyclones Over Coastal Cities

No benefit for fisheries?

When cyclones pass, they leave behind colder waters mixed with nutrients from the depths. This leads to increased primary productivity and fisheries catch. But not when cyclones make landfall near cities, say V. R. Kumari and other scientists from the National Institute of Oceanography, Visakhapatnam.

Last fortnight, they reported the effects of the strongest and most destructive tropical cyclone of 2014 in the North Indian Ocean. *Hudhud* made landfall near Visakhapatnam on 12 October. Three minutes of wind at 217 kilometres per hour and intense rainfall created havoc.



Image: Keith Edkins via Wikimedia Commons

The team investigated the cyclone's influence on phytoplankton production and compared the data with pre-cyclone conditions. Surprisingly, they found that *Hudhud* suppressed phytoplankton blooms instead of leading to productivity.

Analysing the hydrography and biogeochemistry of nutrients they found that freshwaters carrying overflow from the city made the sea less saline and more turbid, inhibiting the population of photosynthetic organisms. This is perhaps why the upwelling of nutrients in the sea and the cold core eddy offshore did not lead to the expected increase in fisheries catch.

Landfall location and characteristics govern how cyclones affect coastal waters, says V. S. N. Murty, NIO Regional Centre, Vishakhapatnam.

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Arsenic in Groundwater

Identifying hazard regions

Detecting arsenic in each hand pump and bore well consumes energy, manpower and time. Predicting arsenic hazards using artificial intelligence can reduce efforts and costs. However, available models for predicting the risk of arsenic in groundwater consider too many variables and yet have low accuracy.

Recently, Sonal Bindal and Chander Kumar Singh from the TERI School of Advanced Studies, New Delhi reported developing a more accurate model. They conducted investigations in Uttar Pradesh, a highly populated state with pockets of arsenic-affected groundwater.

The team used the arsenic data of 952 wells/hand pumps from earlier literature. They collected additional data from 728 household hand pumps. Aggregating and reducing these 1680 geotagged data points to 1473, they retained one data point per grid size of 100 metres \times 100 metres. To categorise the data points, they followed the WHO standards limit of 10 micrograms per litre of arsenic in water.

The researchers considered twenty independent proxy variables that could help predict arsenic in groundwater. But, using univariate feature selection, they found only eight variables significant. This reduced the complexity of computations further. The researchers collected data on these variables from different databases for modelling.

They chose hybrid random forest, a machine learning model that more accurately addresses complex high magnitude problems. To create the model, they used R, open-source statistical software. For training and testing, they randomly split all data points.

Evaluating the model's accuracy, sensitivity and performance, they found that it predicted arsenic concentration in groundwater precisely. Overall accuracy was about 85 per cent – much more than the 40 to

67 per cent accuracy of other models.

The prediction map shows high arsenic in groundwater in 40 of the 72 districts in Uttar Pradesh. North-eastern districts are more affected. Barabanki and Gonda are high-risk and require blanket testing, say the researchers.

The map demarcates high, moderate and low-risk regions making targeted mitigation measures in high-risk regions possible. As arsenic removal is costly and complicated, as an immediate measure, the researchers suggest switching to nearby wells that are not contaminated.

The model can be used to predict arsenic contamination in groundwater elsewhere.

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Ecological Niche Modelling

Assessing impact of future dams

In the Arunachal Pradesh–Sikkim region, there are ten major river basins. So, 114 hydroelectric projects have been proposed in the region. However, the ecological and environmental impact of dams poses concerns. Arunachal Pradesh and Sikkim are biodiversity hotspots. These projects can be the death knell for many indigenous species.

Last fortnight, a group of scientists from NEHU, Shillong, the Sikkim University, IIM Jammu, and NBRI, Lucknow collaborated with the forest department of Arunachal Pradesh and other concerned organisations to come up with a method for measuring the cumulative environmental impact of the projects.

As a case study, they took *Lagerstroemia minuticarpa*, an endangered flowering tree endemic to the region. The species could be easily located from a hundred metres because of its height and typical bole shape. A survey using the belt transect of 20 \times 100 metres in the region provided the scientists a count of trees, saplings and seedlings. They collected occurrence data using a

geographical positioning system. They also used HabitApp, from Google Play, to characterise the plant's habitat.

Back at the lab, they used ENVIREM, an online tool, to reconstruct the environmental niche. The dataset consists of 16 climatic and 2 topographic variables relevant to species ecology and physiological traits. Using correlation analysis the researchers identified seven most relevant variables. For example, they found that west and south facing slopes are preferable for the tree.

Using the Maximum Entropy software they modelled the environmental niche to predict the distribution of *L. minuticarpa*. Ecological niche modelling-based projections with GIS-overlays helped identify potential habitats. The model suggested 35 localities of *Lagerstroemia minuticarpa*.

They evaluated the model's performance using the online Niche Toolbox. They also did a field survey in the predicted area for onsite validation. And they discovered six new populations.

The Lohit and Dibang basin in Arunachal Pradesh and the Teesta river basin in Sikkim had relatively higher population densities. The researchers categorised the areas into five environmental suitability classes based on vulnerability. They found that 19 of the 114 proposed hydro-electric projects are located in high and very high potential habitats of *L. minuticarpa*. And nine are in areas of medium suitability for the tree.

The model is now a guide for the species' *in situ* conservation. It has also identified sites for their introduction. And it can help plan field surveys and assess the impact of infrastructure projects on keystone and threatened species.

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Extending Vegetable Shelf-life *Starch-glucose coating*

Fruits and vegetables deteriorate rapidly in terms of taste and texture upon storage. To keep them fresh is a challenge. Controlled atmosphere packaging, or using chemical preservatives and fungicides may extend

shelf-life and maintain quality. But we need safer methods.

Recently, Charmi and Jitendriya from the Shri A. N. Patel Post Graduate Institute of Science and Research, Gujarat reported using an edible coating for extending the shelf-life of vegetables. Gum arabic and guar-based coatings have been tried earlier. Charmi and Jitendriya chose easily available starch and glucose.

For their experiments, they used cucumber. Cucumbers normally lose water, shrivel and become yellow within five to ten days. The researchers dipped the cucumbers in different concentrations of starch-glucose mixture and stored them at 4°C.

Cucumbers dipped in a solution of about one milligram of starch and 450 micrograms of glucose per litre of water had a post-harvest shelf-life of thirty days. The cucumbers retained skin colour and did not suffer much weight loss. Total soluble sugar and protein, as well as catalase and peroxidase activity were also good. The researchers found that the treated cucumbers had increased proline content as well, indicating more tolerance to stress. Moreover, ferrous ion chelating activity was increased, suggesting a reduction in the pro-oxidative actions of ferrous ions.

Farmers and traders can now use this simple, safe and economical starch-glucose coating for improving the shelf-life of fruits and vegetables.

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Crop Suitability Clustering

Crop yield from a field depends on soil characteristics such as pH, nutrient availability, water and sunlight. Requirements differ for each crop. Since data on these factors are not easy to get, farmers find it difficult to decide which crop to grow in their fields and often choose crops that are unsuitable, leading to low yield or even crop failure.

Now S. Poongodi from the Dr SNS Rajalakshmi College of Arts and Science and M. Rajesh Babu from the Karpagam College of Engineering, Coimbatore propose a low-cost method to overcome the problem,

using data mining and a clustering algorithm.

With Coimbatore as case study, they mined soil, crop, temperature, and rainfall data. But data from different sources may differ. So they created a system to generate each data point's mean if there is duplication. This reduced the data's complexity.

Then they extracted features that determine suitability for ten different crops: differences between actual and optimum pH, differences in availability of macro- and micronutrients and optimum water and temperature requirements.

For each crop, they classified different parts of Coimbatore as most suitable, less suitable and least suitable, using hierarchical clustering based on similarity of requirements. Thus, they came up with the most suitable crops for each area. Farmers in Coimbatore who do not have adequate data about their fields can now use the results to reduce chances of low yield and crop failure.

The team says that they plan to carry out similar analyses for the whole of Tamil Nadu.

When a team from engineering colleges uses data mining and artificial intelligence to predict the best crops for specific regions, agriculture departments and colleges would do well to collaborate, validate findings and replace the mean in mined data with more accurate data to make such models more precise and widely useful.

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Moringa Leaf Extract *Anti-obesity potential*

Obesity is linked with hypertension, cardiovascular disease, Type-II diabetes and cancers. In obesity, fat accumulates in adipocytes. The number of adipocytes is determined by precursors or preadipocytes that proliferate and differentiate into mature fat cells.

Normally, the level of adipocytes is balanced by adipogenesis and apoptosis or cell death of about 10 per cent of these cells. In obesity, more preadipocytes differentiate into mature

adipocytes increasing their total number. Therefore, if adipogenesis can be controlled, obesity and obesity-linked diseases can also be controlled.

There are a few therapeutic anti-obesity drugs available. But they are costly and have side-effects.

Recently, Anuj Ranjan from the Amity University, Noida, collaborated with researchers from South Korea to come up with a natural method to control obesity: *Moringa oleifera* leaf extract. Previous studies report that the anti-obesity and anti-diabetic effect of *M. oleifera* is due to isothiocyanates that inhibit rate-limiting steps in the production of glucose in the liver and improve insulin sensitivity.

The researchers evaluated the ability of the moringa leaf ethanolic extract as well as the active principle, isoquercetin, to reduce adipogenesis and promote apoptosis in mouse cell lines. They found that the extract induced apoptosis in adipocytes. Several tests confirmed the results. The treatment also enhanced the activity of caspase 3, an indicator of apoptosis, in adipocytes. The team also confirmed the anti-obesity and apoptotic effect of isoquercetin using molecular docking studies.

As little as five micrograms of isoquercetin or 280 micrograms per millilitre of the leaf extract show anti-proliferative activity, says Sivasubramanian Ramani, a member of the research team.

Increasing the concentration of the extract further down-regulated the expression of adipogenesis-related genes and reduced the accumulation of triglycerides, says Haribalan Perumalsamy, another team member.

The molecular study of the genes related to the apoptosis pathway revealed up-regulation of a gene that codes for the proteins that lead to programmed cell death and down-regulation of another, coding a protein that allows cells to survive.

The study suggests that moringa leaves are a potential functional food for controlling obesity, says Sri Renukadevi Balusamy, the lead author.

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Yeast Probiotics?

From traditional foods

Probiotics, bacteria in the human gut, have anti-inflammatory and healing properties. Gastric ulcer, a condition of recurring lesions in the stomach, is accompanied by chronic gastric inflammation. The condition is ameliorated by probiotics.

Keshab C. Mondal and team from the Vidyasagar University, West Bengal were curious. Traditional fermented foods with high health and nutritional benefits are also rich probiotic sources. Do these fermented foods have antiulcer activity? The team collaborated with researchers from the Midnapore City College and the Sikkim University to find out.

They collected *harira*, a rice-based ethnic fermented beverage, from villages in West Bengal and *chupri*, a traditional form of cottage cheese and *khambir*, wheat-based leavened bread, from Leh. And they isolated 48 yeasts from the three foods.

Would the yeasts be able to survive the stomach's harsh physiological pH? Can they survive variations in pH? The onslaught of acids, the bile salts? The researchers selected 10 yeasts belonging to *Zygosaccharomyces*, *Candida*, *Saccharomyces*, *Pichia* and *Metschnikowia* species, based on the tests.

Now the question was whether these organisms are useful for treating gastric ulcers. The researchers induced ulcers in rats by keeping them hungry and cold – after getting permission from the ethical committee. They mixed the yeasts in food fed to rats with ulcers to check the therapeutic value. Among the ten yeast strains, *Saccharomyces cerevisiae* AKP1 from *harira* turned out to be a clear winner.

So far, only *Saccharomyces boulardii* is permitted as probiotic for commercial use. So it will take more tests and clinical trials for the *Saccharomyces cerevisiae* AKP1 strain to be used as adjuvant in ulcer therapy. However, people with ulcers need no permission to consume traditional fermented foods.

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Potato Peel

Not waste anymore

Potato peel has been explored for use as packaging as an alternative to plastic. Cellulose nanoparticles in potato peel determine the quality of the packaging. However, so far, the particle size used was 400 nanometres. What is the ideal size of potato peel starch nanoparticles for the purpose?

Recently, R. Preetha and Shruthy Ramesh from the SRM Institute of Science and Technology, Kattankulathur took potato peel from local restaurants and extracted cellulose nanoparticles from the peel using an arduous process of alkaline treatment, bleaching, and acid hydrolysis to remove the lignin, hemicellulose, etc. They got a yield of about forty per cent of cellulose nanoparticles.

They also determined the morphology, size and nature of the particles using different microscopy techniques. Though the individual nanoparticles are needle shaped, flexible and about 100 to 200 nanometres long, the nanoparticles tend to aggregate into spherical shapes with diameter between 50 and 100 nanometres.

To check the properties of the cellulose nanoparticles when incorporated into packaging film, the team prepared biopolymers with three different compositions: cellulose–chitosan, cellulose–polyvinyl alcohol and cellulose–chitosan–polyvinyl alcohol.

They added fennel seed oil to all three. The oil is antimicrobial and is accepted for packaging highly perishable products such as meat and fish.

The cellulose nanoparticle, polyvinyl alcohol and fennel seed oil combination was as transparent as food grade plastic. With sufficient tensile strength and elongation property to compete with plastic.

The researchers found that incorporating fennel seed oil enhanced the film's antioxidant and antimicrobial activity.

Soil burial method showed that the film lost 98 per cent of its weight in

20 days. So the film biodegrades relatively fast.

Considered kitchen waste, potato peel actually has high fibre content and antioxidant activity. The peel protects the potato against a vast array of soil microbes. Though we may not be able to reconstruct the natural packaging, we can definitely use some of the ingredients.

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Automatic Music Classification *With genetic algorithm*

We know that some like sad songs and some prefer peppy soundtracks. Some love hard rock and others classical music. But, in a world with millions of musical pieces, how do we find music that suits our taste – the particular genre and specific emotion that we seek?

Automatic classifications of genres and emotions in music have been tried using different kinds of algorithms. But none has reached the accuracy demanded by connoisseurs of music.

So R. Geetha Ramani from the College of Engineering and K. Priya from the Rajalakshmi Engineering College, Chennai teamed up to investigate a method that reaches almost 100 per cent accuracy in classifying music.

They took a dataset of 1608 Western music pieces of 30 seconds duration with emotions identified by human annotations. To this they added another 150 songs annotated by more than 40 individuals. They also included 250 Tamil songs composed by maestro Ilayaraja, again with identified emotions.

Training a support vector machine with this huge database would have been easy. But Geetha and Priya knew that such attempts have not achieved the required results. So they took one minute clips of songs and extracted features such as MEL frequency, pitch, and zero crossing rate using short-time fast Fourier transform. MEL frequency is more useful for speech and music recognition than absolute frequency. Zero crossing rate is a measure of the number of times a pitch reduces its

volume to zero. It provides clues about rhythm.

Though there are parameters such as beat, harmony, tempo, centroid, and timbre, the researchers found that they are not necessary if the genetic algorithm is used to classify music. Genetic algorithm, as the name suggests, introduces mutations and cross over, at every iteration, to find the best fit. So it can, over a few iterations (generations), identify the category into which a musical piece can fit.

The team says that 80% selection, 20% cross over, and 20% mutation works best for emotion and genre detection. They obtained an emotion prediction accuracy of 99.72% for both western and Carnatic music.

Earlier researchers had tried fast Fourier and wavelet transforms, support vector machines, neural networks, Gaussian Process and Gaussian Mixture models and kNN classifiers to classify music. But no model could reach more than 90% accuracy.

Is the success of the genetic algorithm an indication that the evolution of musical genres follows the same laws as the evolution of life?

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Knuckle-based Biometric Security *Outdoes existing models*

Biometric security is becoming quite the staple of high-security applications like personal identification, validation and profile authentication – systems based on traits such as voice, gait, facial features, fingerprints, and iris for validation. While systems based on fingerprint and voice are gaining a lot of traction in the consumer electronics industry, those based on iris and gait find use in more commercial applications.

In recent years, a relatively new method of biometric security, based on knuckle print – a method that characterises knuckle properties – is on the rise. This field is invariant to emotional changes, easy to use, and richer in texture data than most other hand-based biometric security systems. However, a major drawback in this process is that the current algo-

rithms for pre-processing are inaccurate; the system is, therefore, susceptible to errors due to changes in orientations, angles and lighting. Gabor filter, a pre-processing technique used widely in these systems, has high false rejection rate, which reduces efficiency.

A new methodology proposed by R. Vidhyapriya and Rose S. Lovelyn from the PSG College of Technology, Coimbatore attempts to tweak the system's existing shortcomings. The duo suggests using a modified Gabor filter and the Expectation Maximisation Algorithm to extract patterns and creases from the knuckle.

By using a K-means algorithm to extract local features, the system becomes immune to human errors due to rotation and orientation, and performs accurately under any lighting condition, say the researchers. The extracted data is later authenticated by comparing it with the trained template from the database before granting access to the user.

The engineers claim that the proposed method outperforms existing hand-based modalities by increasing the Genuine Acceptance Rate by more than 10%, reaching 99% accuracy. Consequently, this method also reduces the False Rejection Rate by the same amount.

This setup, when deployed in a multimodal architecture – a cascade of multiple biometric security systems – significantly increases accuracy, claim the researchers.

Knuckle print-based systems employing this method are as reliable as fingerprint-based security models, if not more. They can also be used where fingerprints are not available.

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