

Current Science Reports

Predicting Tropical Cyclones

Towards earlier detection

The north Indian Ocean basin, especially the Bay of Bengal, is a hot spot for frequent tropical cyclones. The early detection of cyclones in the region can save lives and reduce impact. But predicting tropical cyclones using satellite images is possible only after low pressure forms above a warm ocean surface.

Recently, Jiya Albert from IIT Kharagpur and collaborators proposed a method for the early prediction of cyclones.

They took the satellite data of six major cyclones formed in the Bay of Bengal between 2009 and 2018. Four were post-monsoon and two were from the pre-monsoon period.

The team simulated the data to reveal the formation of pre-cyclonic eddies in the upper atmosphere and their evolution with height and time.

To detect these eddies, the team used the Okubo–Weiss parameter which distinguishes rotation-dominated and shear-dominated regions in atmospheric disturbances. A negative value of the parameter indicates rotation-dominated eddies which can eventually develop into a cyclone.

The researchers used wind speed and atmospheric pressure data to calculate the parameter. They found that pre-cyclonic instabilities and eddy movements had developed one and a half kilometres above sea level well before the formation of cyclonic low pressure.

What is more, these features were visible about 100 hours before satellites could detect changes in sea-surface temperatures to predict cyclogenesis.

‘Monitoring pre-cyclonic eddies with atmospheric modelling techniques can help predict cyclones four days earlier than before,’ says Prasad K. Bhas-karan, IIT Kharagpur.

The IMD needs to test the value of the technique for forecasting and early warning of cyclones.

DOI: 10.1016/j.atmosres.2021.105670

Dams and Landslides

Tale of Teesta River

Before constructing dams, environmental impact assessment is done. But what are the ecological and morphological impacts on the river after a dam is constructed? This question intrigued researchers from India and the USA.

A team of researchers, led by Nirmalya Chatterjee from the Ashoka Trust for Research in Ecology and the Environment decided to document changes in two such reservoirs created by dams, in a section of the river Teesta in West Bengal.

They conducted sonar studies on a more than eight kilometre stretch upstream for both dams and found the original floodplain filled with sediments and fully grown trees submerged. The submergence of the original floodplains has lowered the chances of long-term ecological recovery in the area.

The researchers analysed land cover changes using satellite imagery of pre- and post-dam construction using image analysis software. They noticed considerable build up of sedimentation in post-dam images.

A major portion of the river appeared to be standing in a lake-like form rather than flowing perennially. The two dams, constructed just 12 kilometres apart, have affected the whole stretch, say the researchers.

There were no concrete reinforcements or embankments along vulnerable sections to prevent landslides and erosion of the banks. So Teesta valley is at risk of landslides years after dam construction.

‘According to public testimony in the Teesta valley, increased landslides are responsible for interrupting traffic on NH-10, the only major highway that connects Sikkim to the rest of India,’ says Nirmalya Chatterjee.

In order to document further changes in the river’s morphology, the researchers call upon concerned citizens to monitor changes in the depth and flow of the river, as well as the flora and fauna in the region.

DOI: 10.1007/s10661-021-09433-z

Hornbills

Gardeners of the forest

The Hornbill Plateau in the Namdapha Tiger Reserve, Arunachal Pradesh is so named due to the high abundance of hornbills there.



Image: Clement2012 via Wikimedia Commons

Interactions between such fruit-eating birds that help disperse seeds and their food plants determine tropical forest diversity. Fruit plants, in turn, are a necessary factor in the conservation of hornbills.

To study these interactions further, Rohit Naniwadekar, Nature Conservation Foundation, Mysuru collaborated with researchers from the Indian Institute of Science, Bengaluru.

They first examined whether hornbill encounter rates were positively associated with the abundance or presence of different fruit resources.

The team found hornbills the most reliable seed dispersers of the focal large-seeded plants. Patches with canopy food plants had a higher abundance of hornbills. These patches also had higher diversity of seedlings and saplings. This suggests their role in attracting frugivores year after year.

Canopy food plants like *Canarium strictum* are among the most preferred food plants for some hornbill species. Unfortunately, this tree, commercially called black dammar, is heavily logged and tapped for resin outside protected areas.

Widespread loss of hornbills or their food plants is likely to disrupt the seed dispersal mechanism that is critical for the regeneration of the tree species. The loss of black dammar trees can disrupt the intricate mutualisms that contribute to maintaining plant diversity in these forests.

Considering this important interaction, the conservation of the birds and fruit trees needs to be taken up together, say the researchers.

DOI: 10.1111/jav.02748

Meeting Fodder Needs

Clover in Himalayan fields

In Himalayan areas, fodder for livestock is limited due to shortage of grasslands. Most available cultivable land is used for agriculture. How can we bridge the demand and supply gap in fodder for the livestock in the region?

Researchers from four ICAR organizations and the Himachal Pradesh Agricultural University, Palampur collaborated to find a way.

They considered incorporating white clover in the existing wheat-maize cropping in the Himalayan areas. Clover is a nutritious fodder, palatable to cattle and it belongs to the legume family.



Image via Wikimedia Commons

'We thought that integrating fodder with a wheat-maize cropping system will reduce the demand-supply gap,' says Asha Ram, ICAR-Central Agroforestry Research Institute, U.P.

'And it will improve the productivity of associated crops through nitrogen fixation,' adds Sindhu Sareen, ICAR-Indian Institute of Wheat and Barley Research, Haryana.

The experiments on cereal-clover bi-cropping were carried out simultaneously at ICAR-Indian Grassland and Fodder Research Institute, Palampur and nearby fields for two years.

One treatment had wheat-maize with clover without any fertilizer. Another treatment had only clover in the fields. Other treatments included different combinations of nitrogen recommended for wheat-maize cultivation along with clover.

White clover showed higher leaf area and short height when grown alone in the fields. But when grown in bi-cropping, the height increased and leaf area reduced. This may be due to competition for space and sunlight, explain the researchers.

'Incorporating clover reduced weed growth and nutrient leaching by providing permanent soil cover,' explains Sindhu Sareen, ICAR-Indian Institute of Wheat and Barley Research, Haryana.

The best result was when 100% of the recommended dose of nitrogen for both wheat and maize was given along with clover.

'Nitrogen application in the wheat-maize sequence also had a positive impact on fodder quality,' says Inder Dev, ICAR-Indian Grassland and Fodder Research Institute, H.P.

Thus, incorporating legumes like clover can meet the fodder requirement for livestock and help farmers make a better livelihood. Seed industries may think of packaging clover seeds along with cereals for such farmers.

DOI: 10.1016/j.eja.2021.126354

Pine Needles for Packaging

Zeolite to absorb ethylene

Most fruits release ethylene, a plant hormone responsible for ripening. However, during storage and transport, ethylene causes over-ripening and spoilage.

Zeolites, microporous aluminosilicate minerals, can absorb ethylene. Commercially, zeolites are added to plastics for packaging. But active packaging using plastics raises environmental concerns.

Paper, on the other hand, is a biodegradable, lightweight and recyclable packing material. Can we impregnate zeolites in paper sheets to make an environment-friendly packaging that absorbs ethylene, wondered Avinash Kumar from IIT Roorkee. Roorkee is close to many chir pine forests that

shed huge amounts of pine needles containing cellulose and lignin, ideal for making paper.

Avinash and a team of researchers set out to prepare zeolite-impregnated paper from pine needles. They gathered and pulped pine needles, added varying concentrations of zeolite powders to the pulp to form sheets by applying hydraulic pressure.

Different concentrations of zeolite did not change the paper's weight and thickness significantly. But the paper's strength was influenced by zeolite content.

'Sheets with 10% zeolite concentration had the maximum strength,' says Kirtiraj K. Gaikwad, IIT Roorkee.

Porosity is the major factor when considering the ability to absorb. The paper's porosity increased significantly by increasing zeolite concentration from 0% to 30%.

Increasing zeolite concentrations makes the structure more porous, which, in turn, affects the strength, explain the researchers.

Since the internal moisture of fruits and vegetables is important to maintain freshness, the team investigated the sheets' water vapour transmission rates. The results suggest that adding zeolites reduced water transmission from the sheets.

'Zeolite binds water and retains it inside the sheet,' explains Vidhi Gupta, IIT Roorkee.

To check for ethylene gas scavenging, the team used gas chromatography. Sheets with 30% zeolite concentration could scavenge about 60% of ethylene.

Pine needles are biowaste, abundantly available in the fruit producing regions of the Himalayas.

'In fact, they pose the threat of forest fires. So using them to produce active packaging serves many purposes,' says Kirtiraj K. Gaikwad.

Now, entrepreneurs and start-ups in the region can make use of this opportunity to manufacture active packaging for fruits and vegetables.

DOI: 10.1016/j.indcrop.2021.113752

Rain Garden Infiltration

Computational modelling

Most cities have paved over most of their natural spaces. And, when it

rains, urban stormwater no longer seeps into soil to recharge groundwater. It rushes and gushes over impermeable paved surfaces, creating traffic chaos and environmental issues.

Rain gardens in cities are effective in reducing stormwater runoff. However, knowledge of appropriate design and infiltration models of rain gardens are still very rudimentary. So, Sandeep Kumar and K. K. Singh from NIT Kurukshetra experimented with the infiltration rate of rain gardens using different models.

They created four experimental rain gardens at NIT Kurukshetra. And measured the infiltration rate of rain gardens with different types of vegetation and flow conditions. They took into consideration the types, number and height of plants and measured air temperature, soil moisture, water depth and inflows into the rain garden.

For infiltration modelling, the researchers used the conventional Philip's model which is valid for natural ground surfaces. There are wide variations in infiltration rates obtained in Philip's model.

The team then tried soft computing tools such as the gradient boosting machine and deep learning techniques. From a total 216 observations, 75% of data were used for training and the remaining data for testing. The researchers compared the infiltration rates computed with observed experimental infiltration rates.

The models show good agreement between predicted and observed infiltration rate. The performance of the gradient boosting machine and deep learning is better than Philip's model, say the researchers.



Image: Harry Ross via Flickr

'The better performance of the gradient boosting machine and deep learning techniques may be because

they include a larger number of parameters,' says Sandeep Kumar.

The infiltration rate of rain gardens depends on time, water depth and the number of plants.

'Among the chosen plant types scutch grass, *Cynodon dactylon*, performed the best,' says K. K. Singh.

Municipal corporations can now select the plant type and density for rain gardens to reduce urban stormwater flows.

DOI: 10.2166/wst.2021.444

Mustard Oil and BMI

A must oil!

Most Indian diets are rich in omega 6 polyunsaturated fatty acids but relatively low in α -linolenic acid, or omega 3 fatty acid. High levels of omega 6 can be deleterious to health and can cause many metabolic disorders. Omega 3 fatty acid, on the other hand, is associated with lower risk of heart disease.

Mustard oil is richer in omega 3 fatty acid than sunflower oil. So, blending the oils can give an ideal omega 3/6 ratio.

Mustard oil is a favourite in the northern and eastern parts of India. However, many believe that consuming the oil leads to obesity.

Rutuja Chhajed and her team from St John's College, Bengaluru recently tested this belief in the relationship between mustard oil use and body mass index.

The researchers took data on Indian household nutrient and oil consumption from the National Sample Survey and the National Health Survey-4. They calculated the per capita intake of different oils and the percentage of fats and saturated fats in the oils.

They found that mustard oil was most popular in rural areas, whereas urban households preferred refined oils like sunflower, safflower and soybean.

The per-capita fat intake was high in the predominantly mustard oil using population. However, using mustard oil did not make these people overweight or obese.

'Our results question the notion that mustard oil increases obesity,' says Indu Mani, St John's College, Bengaluru.

There have been reports that caution against using mustard oil due to its erucic acid content.

'Erucic acid is monounsaturated omega 9 fatty acid. High quantities of erucic acid can cause cardiac ailments in animal models,' explains Rutuja Chhajed. 'But then many essential nutrients in high quantities can be harmful.'

'In fact, mustard oil has health benefits. It is a rich source of polyunsaturated fatty acids. Especially omega 3 fatty acids,' says Indu Mani.

DOI: 10.1017/S1368980020004632

Health Impact Assessment

Of atmospheric pollutants

Ahmedabad is one of the highest air-polluted cities in India according to SAFAR, India's System of Air Quality and Weather Forecasting and Research. Particulate matter suspended in the air we breathe affects our respiratory system.

To understand seasonal variation in pollution levels and to identify possible reasons and remedies, Utsav Gandhi and team from the Gujarat Environment Management Institute chose five areas of Ahmedabad – one industrial area, two with heavy traffic and two residential areas.

Every week, in winter and summer, they took air samples using a respirable dust sampler.

Using plasma emission spectroscopy, they found metal contents in the air samples. And they identified the proportion of finer particles among the samples. The higher the ratio, the more hazardous the air. This is an indicator of the level of air pollution.

'Among the five selected sites, the industrial area at Narol had the maximum amount of particulate matter smaller than 10 micron,' says Nitasha Khatri, Gujarat Environment Management Institute.

The researchers calculated the enrichment factor due to elemental abundance in the upper crust of the area. Thus they could infer that high amounts of cobalt, iron, strontium and manganese are mostly from natural sources. But excess lead, zinc, arsenic and cadmium is due to human made pollution, say the researchers.

The presence of carcinogenic metals such as chromium, cobalt and arsenic in the Narol Industrial Area is beyond safe limits and may make people there prone to cancer, warn the researchers.

A surprising finding was that there was high zinc and nickel in the residential area of Science City. Dust from the nearby desert regions is a major source of pollution in Ahmedabad, explain the researchers.

DOI: 10.1007/s10661-021-09452-w

Bioelectricity Production

Photosynthetic microbial-fuel cells

About 70% of India's electricity is derived from coal. Shortage of coal leads to power outages – a phenomenon that may become more prominent in the coming decades. There is a dire necessity to explore alternative renewable sources. Among alternatives for power production, microbial fuel cells are the least explored.

Recently, Arti Sharma and Meenu Chhabra from IIT Jodhpur used photosynthetic green algae, *Chlamydomonas reinhardtii*, to produce power. The researchers grew this alga in the cathode chamber of a microbial fuel cell which contained a bacterial inoculum at the anode.

In these cells, the photosynthetic organisms convert the chemical energy of organic or inorganic biomass to electricity by transferring electrons. Moreover, photosynthetic algae generate oxygen which serves as an electron acceptor and undergoes oxidation, leading to power generation.

'*Chlamydomonas reinhardtii* containing microbial fuel cells generated higher power than other microbial fuel cells. The power generated is sufficient to run small fans and LEDs,' says Meenu Chhabra, IIT Jodhpur.

Power generation using microbial fuel cells with photosynthetic algae

removes 73% of carbon dioxide greenhouse gas from the input carbon dioxide.

'Algae from this process can be used to produce biodiesel, bioethanol, and industrial value-added products,' says Arti Sharma.



Image: Arti Sharma

Interestingly, *Chlamydomonas* algae possess antibacterial activity. The algal extract inhibited the growth of multi-drug-resistant *Pseudomonas aeruginosa* and common bacterial pathogens such as *Bacillus licheniformis* and *Escherichia coli*.

Recently, *Chlamydomonas reinhardtii* was approved for human consumption as it has high antioxidant activity, carotenoids and nutritional value equivalent to spirulina. Therefore, *Chlamydomonas reinhardtii* offers multifaceted benefits including power generation, preventing bacterial contamination and acting as a food.

Currently, microbial fuel cells generate electricity to power small devices. The researchers are investigating ways to scale up the process to increase the amount of power generated, to meet the increasing demand for clean renewable energy.

DOI: 10.1016/j.biortech.2021.125499

Delivering Babies at Home

Prevalence and causes

The Government of India has initiated programmes to promote institutional

delivery by giving monetary rewards to pregnant women who deliver at government or private hospitals. Yet many continue to deliver at home. What are the factors influencing the choices of women?

Recently, researchers from the International Institute for Population Sciences, Mumbai investigated relationships between prevalence and socio-economic factors for women choosing to deliver at home.

From the National Family Health Survey 2005–06, they took data on 35,000 female respondents to compare with data from about 200,000 from 2015 to 2016.

The team found that the prevalence of home deliveries has reduced from about 60% in 2006 to nearly 20% in 2016.

They conducted statistical analysis to determine factors influencing the decision to deliver at home.

'Women who deliver at home are mostly poor, with higher parity, uneducated and rural,' says Ratna Patel, IIPS, Mumbai.

'If antenatal care and counselling are promoted among poor and rural populations, perhaps we can achieve 100% institutional delivery in India,' says Shekhar Chauhan, IIPS.

India has to focus on developing rural medical infrastructure and facilities to ensure safe deliveries.

DOI: 10.1186/s12889-021-11779-5

Reports by: M. S. Induja, Khuban Buch, Aradhana L. Hans, Ankita Saha, G. Sharath Chandra, K. V. Aneesh Kumar, D. C. Jhariya, Sileesh Mullasserri, Ravindra Jadav, and Shwetakshi Mishra

ACKNOWLEDGEMENT: NCPOR, Goa for access to scientific databases.

scienceandmediaworkshops@gmail.com