Current Science Reports

Low-Latitude Ionosphere
Impact of solar flares

Solar radiation ionises atoms in the upper atmosphere of the earth creating the ionosphere. The total electron content of the ionosphere often changes abruptly due to solar flares. Solar flares deliver huge amounts of energy to the earth's atmosphere in the form of X-rays and extreme ultraviolet rays. This energy ionises more atoms, increasing the total electron content in the ionosphere. Though there is research on the effects of solar flares on the total electron content in high and mid-latitude ionospheres, studies on low-latitude regions are far too few.

So, Suniti Saharan and colleagues at Doon University, Dehradun decided to investigate the correlation between solar flares and total electron content in the lower ionosphere.

They collected GPS-based total electron content data for 2014, the peak of solar cycle 24, from the international global navigation satellite system station in Bengaluru. Using a data analysis software, they calculated the total electron content in a vertical column.

They also collected information about solar X-ray fluxes from the geostationary operational environmental satellite. Extreme ultraviolet flux data was gathered from the solar monitor in the SOHO spacecraft for the same period. The data included information about five X-class solar flares, nearly fifty M-class solar flares, and almost 400 C-class solar flares.

The researchers calculated the change in vertical total electron content during each flare using two different methods and compared these with X-ray and extreme ultraviolet ray flux enhancements to derive correlations.

Both methods showed a positive correlation between the change in total electron content and X-ray and extreme ultraviolet ray flux for X-class flares, but the correlation was lower for weaker flares. The baseline method gave better correlation for X-class and M-class flares, but not for C-class flares.

To check the effect of the position of the flare sites, the researchers modi-fied the flux data by including location effects. This resulted in an increased correlation coefficient of 0.82 between the X-ray flux and the change in vertical total electron content, but there was no correlation with the flux of extreme ultraviolet rays. The correlation factor was lower than in previous studies, which were mostly conducted during solar minima.

The new study reveals a significant connection between solar flares and fluctuations in ionospheric electron content in low latitudes even during high solar activity. The ionosphere reflects radio signals, and is therefore important for communication and navigation systems. An understanding of the dynamics of the ionosphere during solar flares can help us develop strategies to mitigate the problem.

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Indian Mangrove Forests
Home to diverse true crabs

Image: Amartybag via Wikimedia Commons

At the land–sea interface in tropical and subtropical latitudes, mangrove trees form a dense forest that supports rich biodiversity. There are 46 species of mangrove trees covering almost 5000 square kilometres across the coastal states and islands of India. This diversity is reflected in the diversity of the most abundant animals in mangroves: true crabs.

How many species of true crab are there in Indian mangrove forests?

Researchers from the ICAR-Central Institute of Fisheries Education, Mumbai collaborated with researchers from the Fisheries Research Station, Telangana to compile a checklist of the true crab diversity in Indian mangroves. As the team collected available literature, Chennuri Sathish, ICAR-CIFE collected crab samples from the mangrove region on the Maharashtra coast.

The researchers found that 184 true crab species belonging to 99 genera and 29 families were present in the mangrove forest. Of these, 127 species were reported from the east coast and 83 from the west coast of India. The Andaman and Nicobar group of Islands harboured 54 species.

The true crab species had limited distribution as most of the species were reported from one or two states. The most common crab species, *Scylla serrata*, often called mud or mangrove crab, were reported from 11 states and union territories.

West Bengal was the most species-rich state with 81 species, while Karnataka had only 14 species, the least among all the coastal states and union territories.

The highest species richness in a mangrove forest was reported from the Andaman and Nicobar Islands, followed by Odisha and West Bengal.

Using regression analysis between crab species richness and mangrove cover as well as crab species richness and mangrove species richness, the researchers found a positive correlation between crab diversity and mangrove cover, as well as between the species richness of crabs and mangroves.

The east coast hosts higher species diversity due to the vast mangrove cover. The Sundarbans, for instance, covering almost 40 per cent of total mangrove area in India, also accounts for 44 per cent of all reported mangrove crab species.

Image: Prabhisc via Wikimedia Commons

In the west coast, Gujarat has the highest mangrove cover, but it is

dominated by a single mangrove species, *Avicennia marina*, due to the high salinity there. Hydrological conditions, such as higher salinity, lower organic carbon availability, and habitat destruction are some of the reasons for decreasing crab diversity in the mangroves of Gujarat.

'True crabs play important ecological roles by processing algae and leaves in the ecosystem. So, true crab diversity can be used as a bioindicator of changes in mangroves,' says A. K. Jaiswar, ICAR-Central Institute of Fisheries Education, Mumbai.

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Fighting Cancer
Natural compounds and theranostics

Studies have shown that isoliensinine, an alkaloid found in the Indian lotus, *Nelumbo nucifera*, has antitumor activity. This natural compound effectively enhances the action of cisplatin, a cancer drug, especially in cisplatin-resistant colorectal cancers.

So, researchers from the Bharathiar University, Coimbatore wondered whether combining isoliensinine with paclitaxel, another chemotherapeutic agent, could help reduce the dosage of paclitaxel[1]. To test the idea, they investigated how different combinations of isoliensinine and paclitaxel affect a multidrug-resistant cancer cell line. The combination enhanced the cytotoxic effects of paclitaxel and induced apoptosis in a multidrug-resistant cancer cell line.

Lotus is a culturally and religiously important plant in Asia. Its rhizome, stem, leaves and seeds are consumed and are often recommended by traditional medicine for various diseases. As a potential source of an adjuvant in cancer therapeutics, lotus cultivation may find many takers.

Meanwhile, researchers from the Suresh Gyan Vihar University, Jaipur, the Saveetha University, Chennai and the Lovely Professional University, Jalandhar in collaboration with scientists from Australia, Malaysia, Chile and Ireland, reported a breakthrough in potential cancer therapy with zerumbone, a natural compound in bitter ginger[2].

The compound is known to have anti-cancer activity but is not very soluble and is poorly absorbed. To increase drug absorption, the researchers used liquid crystalline nanoparticles, a class of drug delivery systems, along with zerumbone.

They treated a human carcinoma cell culture with zerumbone-loaded liquid crystalline nanoparticles and performed cell proliferation, colony formation, and wound healing assays. The formulation effectively inhibited the growth and migration of non-small cell lung cancer cells.

The liquid crystalline nanoparticles have the potential to make chemotherapeutic drugs more effective and less toxic by reducing the dosage needed. Now, the formulation needs to be tested in animal models of cancer.

Yet another study by researchers from the ICMR-National Institute of Pathology, Jamia Millia Islamia, New Delhi, the Regional Centre for Biotechnology, Faridabad, and the Delhi Technological University has thrown up two more compounds with potential for treating cancer[3].

The researchers pursued a clue from a finding that cyclooxygenase 2, an enzyme involved in the inflammatory pathway, is increased during cancer. So they started looking for molecules to inhibit this enzyme to improve cancer prognosis using computer-aided drug design technology.

They screened about 12,000 compounds from different databases using molecular docking with the cyclooxygenase 2 enzyme, and found three new compounds with good binding affinity for the enzyme.

To verify the safety and efficacy of the three molecules, the team analysed the physical and chemical properties of the molecules and performed *in-silico* bioactivity assays. Two of the three compounds were safe and effective. These molecules can block the cell cycle and induce cancer-cell death.

So we now have two more candidate anticancer molecules for *in-vivo* and clinical trials.

A different approach to come up with another potential cancer therapy cum diagnostic was reported by research-

ers from the Jawaharlal Nehru University, New Delhi[4].

IriPlatins 1–3 is a combination of two iridiums and platinum, a new class of conjugates with potent anticancer properties. To make the bimetallic drug more water soluble and target it specifically to cancer cells, the researchers conjugated it with biotin, a water-soluble B vitamin. They tagged biotin with a radioactive atom to make it easier to visualize the location within the cells.

After incubating the conjugates with cancer cell lines, the researchers used organelle-specific staining dyes to identify the drug target and took fluorescence images after one hour. They found that IriPlatin conjugates preferentially accumulate within mitochondria and produce a high level of stress there, which leads to cell death.

A drug that can specifically bind cancer cells and deliver anticancer drugs as well as a dose of radiation locally can reduce the death of healthy cells. A useful candidate for cancer theranostics.

[1]**DOI:** 10.1002/jbt.23395
[2]**DOI:** 10.1007/s00210-023-02603-5
[3]**DOI:** 10.1148/rg.2020200021
[4]**DOI:** 10.1021/acs.jmedchem.3c00336

Blood Cell Image Recognition
Classification algorithm

The repetitive task of blood cell evaluation is still done manually by trained cytologists. The inspected cells in stained blood smears are classified into about 15 different categories. This process is not only tedious but is also prone to human errors.

Automating the process using machine learning to classify blood cells can reduce errors.

Recently, such a technique was reported by faculty members from the Noida Institute of Engineering and Technology, the Jain Deemed-to-be University, the Teerthanker Mahaveer University, and the Vivekananda Global University. The technique. they say, is nearly 100 per cent accurate.

Their first task was to identify cells in the digital images of stained blood smears. Image segmentation using the Naive Bayes classifier was adequate to achieve that. There are two features,

colours and shapes that are easily recognised, helping to classify the cells into distinct categories.

But that is not adequate. So the researchers used ant colony optimisation, an algorithm inspired by ants searching for food, to select the optimum number of other features.

The next step was to classify the blood cells based on the selected features. For this, they trained a support vector machine, a popular supervised learning algorithm.

Since more than 10000 digital microscopic images of stained blood cells are publicly accessible, training and validating was easy. The automated process achieved an accuracy of 99.7% on the test set – much higher than traditional methods.

The methods used are not computationally costly and classification is achieved in real time.

Clinics and hospitals can now start using the technique to improve accuracy in the diagnosis of diseases and to reduce the time taken to respond to the patient's treatment needs.

Improving Supercapacitors
Tinkering with the recipe

Unlike batteries, which use chemical transformations to store energy, capacitors store electrical energy between two metal plates. Supercapacitors can charge much faster than batteries, within seconds or fractions of a second, and store more energy than ordinary capacitors. The major chunk of research on supercapacitors goes into improving the metal electrode or other types of conductors, which store the electrical energy.

Polyaniline is a commonly used conducting polymer with high specific capacitance, excellent electrical characteristics, and it is comparatively cheap. Because of its porous structure, it has a higher surface area to accumulate more charge. But polyaniline deteriorates during charging and discharging cycles, reducing the polymer's life cycle stability and restricting applications.

Activated carbon is another commonly used material in electrochemical supercapacitors. But activated carbon too suffers from rapid degradation.

Researchers from NITK Surathkal thought of combining the materials to tinker with the capacity of the electrodes. The doping of transition metal oxides on the polymer chain can reduce the deficiencies of polyaniline and activated carbon. The researchers homed in on oxometalates, a class of metal-oxygen clusters used in energy storage devices.

They first dissolved polyaniline in an aqueous solution of citric acid and added a solution of polyoxometalate to the solution. Activated carbon powder was then added to the solution and the solution was stirred.

The researchers characterised the resulting material using Fourier transform infrared spectroscopy, X-ray diffraction and scanning electron microscopy and confirmed the presence of oxometalates over the aniline and activated carbon.

Then, they evaluated the electrochemical performance of the material using galvanostatic charge-discharge cycling and electrochemical impedance spectroscopy. The electrode made of polyoxometalate, polyaniline and activated carbon had high energy and power densities. The composite electrode could run 4500 cycles of charging and discharging and still retain more than ninety per cent of its full power capacity.

The researchers also demonstrated the practical application of the polyaniline composite by using it to light up yellow and red LEDs for more than a minute.

Electronic and digital industries may now evaluate this cost-effective material for their supercapacitor needs.

Urban Growth
Planning, managing, predicting

In the last few decades, the urban area in Kozhikode, Kerala has seen rapid and unplanned growth. Ashique Vadakkuveettil and Aakriti Grover, Centre for Development Studies, Thiruvananthapuram point out that this has led to the creation of urban heat islands in the city[1].

They used satellite remote sensing data to track land use and land cover changes over the urban area between 1993 and 2018. They found that the total vegetated areas decreased by more than 70 per cent from 1993 to 2018. The built-up area expanded from less than 20 square kilometres to more than 130 square kilometres in the same period.

The duo used the land surface temperature data derived from sensors in Landsat 8 to correlate changes in temperatures with changes in land use. Along with the increase in built up area in Kozhikode, the temperature in the city had gone up by 2.65 degrees Celsius. Spatial analysis using GIS showed that the increase in temperature was greater in built up areas.

'The loss of vegetation and the increase in impervious surfaces contributed to an increase in temperature in Kozhikode,' says Ashique Vadakkuveettil.

'Creating green spaces and other urban management strategies can help mitigate the effects of urban heat islands,' adds Aakriti Grover, his colleague.

Unplanned urban growth is not confined to Kozhikode. Planning and managing the growth of cities could be made easier if we could predict the growth beforehand. And that is what G. Krishnaraaju and K. Elangovan at the National Institute of Technology Karnataka set out to do. They chose Tiruppur in Coimbatore district, Tamil Nadu as their case study[2].

In a matter of a few decades, Tiruppur had established itself as a global hub in the knitwear industry. Rapid industrialisation led to demand for labour attracting migrant labour, increasing demand for housing and other amenities. The researchers used remote sensing data to show that the built-up area in the Tiruppur region increased from 100 square kilometres in 1987 to 250 square kilometres in 2015.

Statistical analysis showed that the most important factors that influenced urban growth in the Tiruppur region were population growth, economic development, and infrastructure development.

The researchers then used GIS to identify the hotspots for urban growth and their analysis showed that the areas with the highest potential for urban growth in the Tiruppur region were

those with good road connectivity and access to water resources.

'Combining data from remote sensing with geographic information systems and statistical analysis is useful for developing effective urban planning and management strategies,' says G. Krishnaraaju.

'We can use these strategies to help predict and mitigate the negative impacts of urban growth like traffic congestion, air pollution, and water scarcity', adds his colleague.

Are the city planners listening?

[1]**DOI:** 10.1016/j.landusepol.2023.106782
[2]**DOI:** 10.1007/s12524-023-01725-w

Investment Decisions
Multiple factors affect

One way to invest money is by buying the shares of a company on the stock market. People invest money based on information and advice from diverse sources. Many factors simultaneously act on the decisions which can impact investment returns.

To investigate the role of information from different sources in investment decision making, Garima Mathur, Navitha Nathani and Simran Rohira from the Prestige Institute of Management, Gwalior administered a questionnaire to 400 people in Delhi and Chandigarh[1]. They found that it was personal financial needs that drove people to invest in stocks.

Investors usually go through financial and accounting information about the firm in which they want to invest money. Such information might or might not impact the image that companies develop and maintain to attract investors. The psychological impact of the firm's image can greatly influence investment decisions.

However, before making the final decision, the investor may seek recommendations from friends or advisors. The researchers found that all sources from which information is obtained significantly impact investing decisions.

Since investment carries a potential for loss or gain, the decision to invest money depends on the financial knowledge of the investor.

Behavioural finance, an emerging field that studies the cognitive behaviour of investors, suggests that there are a few common cognitive biases involved in making financial decisions.

Stutee Mohanty, from the Kalinga Institute of Information Technology, Bhubaneswar hypothesised that recency, overconfidence, confirmation, and familiarity biases significantly impacted financial decisions taken by the surveyed investors[2].

To test her hypothesis, she surveyed 200 investors and collected data on their investment behaviour. She used Cronbach's Alpha test on the surveyed data, to assess the reliability of the variables used in the study. Discriminant function analysis helped her classify observations into different groups, based on their characteristics.

Stutee found that, except for overconfidence bias, all other psychological biases impacted investment decisions. She suggests that financial advisors, with their expertise and experience, can help people overcome cognitive errors and make better investment decisions.

Financial literacy is an aspect of life less-focused on in the educational system than language and digital literacy. Decisions taken by financially illiterate people might negatively influence their lives. What if this happens to socially deprived people?

Researchers from the Central University of Haryana and the Central University of Himachal Pradesh recently reported investigating the financial literacy of schedule tribes[3].

They collected data from 300 households of Scheduled Tribes in Himachal Pradesh. Only 27 per cent of the respondents had the minimum threshold level of financial literacy. The level of education and access to the internet were factors that were correlated with better financial literacy. Low income and living in joint families were factors that correlated with low financial literacy.

Governments must take initiatives to render even socially deprived classes financially healthier so that they can grow together with the nation. There are resources created by the National Centre for Financial Education that can be of use for the public to begin their financial journey. But outreach, especially among scheduled castes and other deprived social classes, may also be needed for national economic uplift.

[1]**DOI:** 10.1504/IJTGM.2023.130740
[2]**DOI:** 10.1108/AGJSR-12-2022-0296
[3]**DOI:** 10.1108/IJSE-01-2023-0008

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