Current Science Reports

Holocene Geomagnetic Intensity

Beryllium-10 in ocean sediment

Beryllium-10, a radioactive isotope, is produced by cosmic-rays. In the atmosphere, cosmic rays and the shower of secondary particles produced by them interact with oxygen and nitrogen nuclei, ejecting nuclear particles to form beryllium-10. Extremely high energy cosmic rays can reach the earth's surface. They then interact with silicon and oxygen nuclei in rocks to produce beryllium-10.

Rain washes beryllium-10 from the atmosphere and rocks to deposit it in the ocean, layer by layer as sediments. An examination of the sediments will, therefore, tell us about the production of the isotope which depends on the influx of galactic cosmic rays which, in turn, are influenced by the interplanetary magnetic field and the earth's magnetic field, providing clues about past conditions on earth.

Recently, Ravi Bhushan and team, from the Physical Research Laboratory, Ahmedabad collected a sediment core – more than five and a half metres – from the equatorial Indian Ocean, to measure beryllium isotopes.

'Beryllium-10 decays by emitting beta particles. It has a half-life of about 1.39 million years, the time required to reduce to half its quantity. So, it's a potential proxy to understand the distant past of the earth,' explains Ravi.

At the Accelerator Mass Spectrometry Laboratory, Ahmedabad, the team analysed carbon and beryllium isotopes in the top 94 centimetres of the core. To understand the time of sediment depositions, they did radiocarbon dating. After calibration, samples from different depths revealed that the top 94 centimetres corresponds to the Holocene – from about 3000 years to about 43,000 years ago.

Using inductively coupled plasma-optical emission spectrometry, the researchers measured beryllium-9, the stable isotope of beryllium.

'We used the data of beryllium-9 to normalise and correct for beryllium-10 in the sedimentary column,' says Partha Sarathi Jena.

The team observed an increase in beryllium-10 flux and beryllium-10/beryllium-9 ratio, about 27,700–43,400 years ago. This is due to the lower geomagnetic field intensity during that time.

For finer time resolution, the team examined every centimetre between 84 and 94 centimetres of the column of deposits. There was a high peak 41,200 years ago. This is associated with the Laschamp event, when the geomagnetic dipole moment was greatly reduced.

Increased cosmic radiation during the event could have affected the evolution of mammals including humans, say the researchers.

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Arsenic Contamination

A burden for rural Bihar

About half of the districts in Bihar are affected by high arsenic levels. Groundwater arsenic contamination is especially high in Chapar village, Samastipur district. How is arsenic in groundwater impacting the population there? What is the level of cancer risk?

Researchers from the Mahavir Cancer Sansthan and Research Centre, teamed up with the Central Ground Water Board, Patna, and the Geological Survey of India, as well as with researchers from UK and Japan to survey the village.

They analysed the arsenic content, in about a 100 samples of groundwater from hand pump wells as well as hair and urine samples from the households.

About half of the groundwater samples had a high concentration of arsenic – above the permissible levels suggested by the WHO. And about one-third of the hair samples had arsenic concentrations above permissible limits. Moreover, 20% of the villagers had high arsenic concentrations in their urine. Thus, one-fifth of the villagers may be at risk of getting cancer.

The researchers surveyed about 3000 people using a health assessment questionnaire. Nearly half of the respondents had skin problems and general body weakness. Besides, about 50% of them had high blood pressure, diabetes and mental disabilities. About 10% of the villagers reported hyperkeratosis, melanosis, anaemia, diarrhoea and breathlessness. However, cancer incidence was less than 1%.

'Most villagers are poor and may not have access to early diagnosis of the disease,' says Ashok Kumar Ghosh, Mahavir Cancer Sansthan and Research Centre, Patna.

The researchers also studied arsenic content and its relationship with hand pump depth. Shallow aquifers had higher arsenic levels.

'Tapping deep aquifers may be an interim measure to reduce arsenic exposure,' says Arun Kumar, Mahavir Cancer Sansthan and Research Centre.

But, for this, the villagers may need financial support.

The local health department may also need to focus on the early diagnosis of diseases caused by arsenic toxicity.

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Exotic Fish Trade

Threat to Asian snakeheads

Asian snakeheads are becoming popular exotic pets. The freshwater fish in the genus Channa has about fifty known species. The genus is not listed under the Convention on International Trade in Endangered Species and there are no national laws governing its trade. Can the trade in exotic fish have repercussions on the species?

Wildlife consultant, Aniruddha Mookerjee, along with Minakshi Kalita and Anu Saikia from Gauhati University, investigated the snakehead fish trade in India.

From the website of the Ministry of Commerce and Industry, they collected and analysed commercial data – date of export, quantity, price, source and destination for all live snakeheads, from 2014 to 2019.

Approximately 15,000 fishes were exported per year, mainly from West Bengal, the export hub of the east.

Among the 19 species of snakeheads exported, four species endemic to the eastern Himalayan region were dominant. And among them was *Channa bleheri*, recorded only in the Brahmaputra basin. *Channa bleheri* is listed as Near Threatened in the IUCN Red List.

Image: Mirko Hartig via Wikimedia Commons

None of the registered captive centres breed snakeheads. So the researchers infer that the exported fish are sourced from the wild. This, in turn, points to overexploitation.

The researchers suggest policy measures such as surveying wild populations, limiting harvest size and suspending or regulating snakehead trade.

'Freshwater fish are a legislative anomaly. Lack of baseline data and incomplete taxonomy puts several species at risk,' cautions Minakshi Kalita, Gauhati University.

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Automatic Counting of Palm Trees

From drone images

Oil palm cultivation is catching up in India. The crop now covers more than three lakh hectares over 12 states. So it is increasingly difficult for the National Mission on Oilseeds and Oil Palm to update the data.

Satellite images could be used to identify the locations of the plantations but do not have the resolution to provide data on the number of palm trees. To overcome the problem, aerial images from drones can be used. But manual detection and counting is time consuming.

Researchers from the Indian Statistical Institute, Kolkata recently collaborated with researchers from Malaysia and China to create a method for the automatic detection and counting of oil palm trees.

Palm trees have leaves that spread from the stem in a pattern – a pattern that can be depicted as gradient vectors that point to the crown. So the generalised gradient vector flow algorithm which considers the edge pixel symmetry as a dominant point might help identify the crowns of individual palm trees.

So the researchers used the generalised gradient vector flow algorithm. Oil palm trees could be successfully identified by the algorithm even from images taken from different directions and oblique angles.

'The generalised gradient vector flow algorithm does not have degradation and distortion of drone images due to oblique angles,' says Umapada Pal, ISI, Kolkata.

Now the problem was to automatically count oil palm trees from the images. The team used the deep learning model, YOLOv5, for the purpose. YOLO (you only look once) models are mostly used for object detection. YOLO is fast and reduces computation requirements. It is also easily deployable in drones.

The researchers selected more than 1500 drone images and used 70% for training and 30% for testing. The oil palm trees were annotated manually using a labelling tool available on Github. This made the system ready to identify oil palm trees from similar structures such as banana and coconut trees.

To count the oil palm trees, the team took images with regions selected using dominant edge components and fed them into the YOLOv5 network.

'YOLOv5 architecture is quite consistent in oil palm tree detection,' says Pinaki Nath Chowdhury, ISI, Kolkata.

The team evaluated the method's accuracy using the F1 score, an indicator of classification accuracy. The score is 81% for oil palm tree detection and 71% for coconut trees. The researchers compared other models for tree detection with their model. It was approximately 10% more accurate than other methods.

'The method can be used to detect any palm type family irrespective of shape, size and image quality. But it degrades when images are captured at high altitudes and in cloudy environments,' says Umapada Pal.

The method can be used for counting other palms including coconut trees. Since the Drone Policy 2021 allows image acquisition without permission, automatic palm tree counting can revolutionise inventory management in large plantations.

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Alleviating Aluminium Toxicity

Using gotu kola extracts

Aluminium, a neurotoxin, accumulates in the brain, and causes neurological disorders and cognitive deficits. Exposure to aluminium has increased via food wraps, cookware and medicines.

Gotu kola, *Centella asiatica*, is used in Ayurveda as a memory enhancer. Can it treat cognitive deficits caused by aluminium toxicity, wondered Tryambak Deo Singh and team from the Banaras Hindu University.

Image: Vengolis via Wikimedia Commons

To find out, they induced cognitive defects and memory loss in rats by feeding them aluminium chloride.

To verify the neuroprotective effects of gotu kola against aluminium toxicity, the team prepared ethanolic extracts of the plants and fed rats with the extracts in varying concentrations. For comparison, one group of rats only received aluminium chloride. And a control group got neither extract nor aluminium.

After 60 days of these treatments, the researchers examined the performance of the rats in Y-maze and open field tests.

'Memory loss was greater in rats injected with aluminium,' says Devendra Kumar, IIT, BHU.

'The extract reduced memory loss. Rats fed with the extract performed better in many behavioural tasks,' adds Sushil Kumar Singh, IIT, BHU.

The researchers checked the rat brains for oxidative damage caused by aluminium.

'Aluminium had increased the levels of lipid peroxidase, superoxide dismutase and catalase,' says Zeba Firdaus, BHU.

Acetylcholinesterase, an enzyme that breaks acetylcholine, a neurotransmitter, is implicated in memory defects. So the team examined acetylcholinesterase activity in the rats. Aluminium increased acetylcholinesterase activity in the rat brains. The extract lowered levels significantly, comparable with control.

Rat brain structure images from fine brain sections suggested that aluminium intake leads to cell abnormalities and to the degeneration of neurons.

'The extracts reduced cognitive defects and neurodegeneration,' says Tryambak Deo Singh, BHU.

All that now remains is for research to identify the active components in gotu kola.

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Black, Blue and Purple Wheat

Fulfilling protein requirements

Chapattis, made with wheat flour, consist of many nutrients including amino acids, the building blocks of proteins. However, heat applied while cooking causes the degeneration of amino acids and proteins. How can we stabilise the proteins and amino acids against heat?

Monika Garg and her team at the National Agri-Food Biotechnology Institute, Mohali, thought of anthocyanins. These coloured pigments are known to protect plants from temperature variations. So they collaborated with researchers from Chitkara University, Himachal Pradesh and Water India Pvt Ltd, Bengaluru to do a series of experiments with wheat containing anthocyanins.

They developed, cultivated and harvested these wheat varieties. The coloured grains, they found, weighed more than white grains. However, there was no significant difference in the grain hardness.

The researchers ground the grains and prepared whole wheat flours. To check the strength of gluten, a network protein consisting of various amino acids, they did a sedimentation test, mixing the flour with sodium dodecyl sulphate, an anionic surfactant which hydrates gluten. Gluten from black flour settled slowly, indicating strong bonds and more protein content.

The team quantitatively analysed the different amino acids in the flour using ultra-high performance liquid chromatography.

'We identified 17 amino acids. Glutamic acid was most abundant in all,' says Natasha Sharma, National Agri-Food Biotechnology Institute, Mohali.

'Black flour had the highest protein content, followed by blue, purple and white flours,' adds Ajay Goyal, Chitkara University, Himachal Pradesh.

The team then made chapattis from the flour and analysed them using ultra-high-performance liquid chromatography.

The heat during cooking caused significant amino acid loss. However, coloured chapattis showed reduced loss. While white flour lost 24%, black flour lost only around 11% of amino acids due to cooking. Blue and purple chapattis also exhibited lower losses than the conventional white chapatti.

Image: Anita Kumari, NABI

'It appears that the anthocyanin content in coloured wheat helps reduce the loss of nutrition due to cooking,' says Monika Garg, National Agri-Food Biotechnology Institute, Mohali.

In recent decades, the cultivation of black, blue and purple varieties of wheat has reduced. The resurgence of these varieties depends on the answer to the question: how would you react to black, blue or purple chapattis?

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Solar Desalination

Enhancing output

Solar stills distil water using the sun's heat. But they only work during peak sunlight hours. So, the daily yield remains low.

One solution is to use composite materials for thermal energy storage. Such materials absorb heat to become liquid and release the latent heat when turning back to solid form, when the sun goes down.

Another trick is to use magnetic or electric fields to weaken the bonds between salt ions and water, increasing the freedom of movement of water molecules and allowing them to escape as water vapour. Using graphite plates to increase evaporation is yet another possibility.

Recently, researchers from the Vellore Institute of Technology and the KPR Institute of Engineering and Technology, Tamil Nadu collaborated with scientists from the UK, China and Egypt to improve solar stills with such methods.

They fabricated a solar still using aluminium sheets covered with transparent glass. To enhance the absorption of solar radiation, they coated the inner walls with aluminium enamel and the base with black synthetic enamel paint.

The team used graphite plates on the solar still basin. A small reservoir below the basin contained 10 kilograms of paraffin to absorb heat during peak heat hours and to release heat in the evening. A ring-shaped hollow ferrite magnet, arranged geometrically, provided a uniform distribution of magnetic field strength across the basin.

The magnetic field also helps increase the partial pressure difference between the water and the glass cover and helps increase evaporation.

'The cumulative yield of the still increased by about 60%,' says D'silva Winfred Rufuss, VIT University.

Safe and potable water from salty water using solar energy will be a boon for people living in areas with brackish water.

DOI: 10.1016/j.renene.2021.07.124

Turbine Blade Shape

Improving performance

Conventional horizontal axis wind turbines are difficult to install. And, after installation, they make a racket. Vertical axis wind turbines, or Savonius

turbines, are less expensive to install and produce less noise. And they operate even at low wind speeds. But they have lower power efficiency.

To improve the performance of Savonius turbines, J. Ramarajan and Jayavel from IITDM Kancheepuram optimised the curvature of the blades of two-blade Savonius turbines.

In a two-blade rotor, for one half of the rotation, one blade acts as a driver, advancing action.

For the next half, the blade moves against the wind. The duo tried to increase the drag on the advancing blade and reduce the drag on the returning blade by modifying the shape of the blades.

They modified the conventional semi-circular shape by skewing its concavity to various extents. Using simulations, they compared the performance of the modified blades with conventional semi-circular blades

The modified blades with concavity skewed away from the axis showed the best performance. While the blade's increased concavity enhanced the advancing action, convexity skewed away from the axis on the other blade reduced the drag during the return by directing the wind stream towards the concave side of the other blade. This increased the power coefficient by 20%.

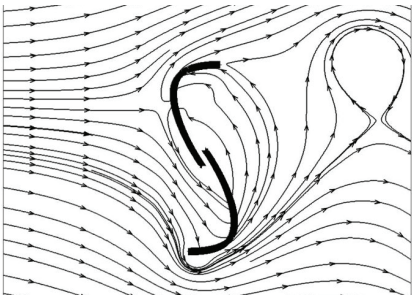

Image: S. Jayvel

Wind turbine manufacturers and designers can thus improve turbine performance by using a modified blade shape.

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Artificial Intelligence Chatbot

For sexual and reproductive health

Unwanted pregnancies and sexually transmitted infections are major health risks for the younger sections of society. Taboos inhibit discussing sex-related issues and lack of formal sex education prevents young people from making informed decisions about sexual and reproductive health. So, where can young people find answers to questions about sex and reproduction?

Though the internet can help find answers, there is also the risk of getting false or incorrect information. Could a chatbot help youngsters overcome their shyness? A database containing culturally appropriate answers to commonly asked questions can perhaps address the problem.

Poonam Muttreja and team from the Population Foundation of India, Delhi created such a database with video and audio clips from a TV and a radio series in which Dr Sheha, a fictional character, tackles issues of sexual and reproductive health in a typical village. The team added fields of text as well as games that young people might like.

With help from technical experts and researchers from the UK and the US, they created an artificial intelligence-powered chatbot that interprets questions entered as text and displays appropriate answers, available in the database.

The chatbot, SnehAI, a natural language processing communication tool in *Hinglish*, a combination of English and Hindi, is suitable for the most populous region in India. SnehAI was made available on the Facebook Messenger app in April 2019. Learning from the field was used to create an improved version in April 2020 which also contained helplines – one for sexual and reproductive health and the other for gender-based violence.

However, the assumption is that young people can afford broadband internet on their mobile and can interact comfortably. So there was a need to analyse the issues from the point of view of the theory of affordances. And there was a need to understand user behaviour.

'Within five months of the launch of SnehAI's second version, the chatbot received more than 8 million messages from more than 135,000 unique chatbot users,' exclaims Sanghamitra Singh, Population Foundation of India.

And, to their surprise, 93% of the users were male. Though gender disparity is recognised in access to the net, and more so among Facebook users, the magnitude of the problem needed to be addressed.

The team randomly selected 15,000 free text messages with over 20 characters and used machine learning techniques to detect user behaviour patterns. And they found that among the few who were female, confidence in interactions was low. On the other hand, male users tended to look for sexual favours and were often indecent.

An average user came twice to the chatbot and spent less than 8 minutes each time. But there were also cases of up to 14 hours, distributed over more than 40 sessions in a month.

Based on the insights gained from the analysis, the team can upgrade the chatbot, make it more female-friendly and create an independent application for social and behaviour change communication. Chatbots in other regional languages of India would also need to be developed, leveraging on this experience.

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