Current Science Reports

The Himalayan Summer Monsoon
Regional reanalysis data

The Himalayas act as a barrier to the south-west monsoon winds, causing them to shed most of their moisture as rain in the southern parts of the mountains. Variations in the magnitude of precipitation, especially extreme weather events, cause loss of life and property. But gathering high-quality precipitation data to investigate such phenomenon at spatial as well as temporal scales is challenging due to the rough terrain and the meager network of weather monitoring stations. This may cause misinterpretations of data.

Thankfully, the newly developed high-resolution reanalysis data, generated by merging observed and modelled data, is now available at a 12 kilometre resolution. Can we use this high-resolution regional reanalysis data to fill the data void?

Rohtash Saini and Raju Attada from IISER Mohali recently checked the reliability of the high resolution data for the purpose. There are various reanalysis and satellite-based precipitation datasets. ERA5, the European reanalysis weather forecast dataset, TRMM, the tropical rainfall measuring mission by NASA, IMERG, a microwave sensor-based satellite dataset and CHIRPS, climate hazards group infrared precipitation data combined with data from ground stations. Besides these data sources, India has the National Centre for Medium-Range Weather Forecasting, in collaboration with the Met Office of the United Kingdom and the data from the Indian Meteorological Department.

The researchers compared some of these datasets to analyse the variability of precipitation during the monsoon. To enable the comparison, all the data were gridded and brought down to a single resolution of 12 kilometres.

To analyse the trends in rainfall from 2000 to 2009, the researchers used the Mann–Kendall test. To highlight trends, this test measures the difference between the final and initial measured data in the time series of the data in each grid.

Precipitation during the monsoon correlated best with high-resolution reanalysis data from ERA5.

To study the variability of patterns and how they change over time, the researchers analysed the empirical orthogonal function which provides spatial variations. The results suggest that the reanalysis data is a reasonably good record of Indian summer monsoon precipitation, even in the inaccessible terrains such as the Himalayas.

Coral Reefs of Lakshadweep
Home to new shrimp species

The coral reefs around Lakshadweep Islands form a complex geological structure. They host thousands of marine organisms, from voluminous whales to tiny shrimps. However, the identities of many marine organisms there, especially shrimps, are still unknown. Researchers from the ICAR-National Bureau of Fish Genetic Resources, Lucknow identified a new species there recently.

During a routine survey in the shallow waters of Agatti Island, Lakshadweep, they collected some translucent shrimps with bluish spots. The second pair of legs of these shrimps were larger, suggesting that the specimens belonged to the family Palaemonidae. Morphology suggested that the shrimps were members of the genus *Cuapetes*. When these specimens were compared with the 29 species of the genus *Cuapetes* documented so far, the team found that they closely resembled *Cuapetes elegans* and *Cuapetes andamanensis*.

However, careful examination revealed differences in key morphological characters such as the presence of 7–8 dorsal teeth on the rostrum with a wide gap between the 5th and 6th teeth. So the researchers suspected it might be a new species. To confirm, they performed molecular phylogenetic analysis, using mitochondrial genes, cytochrome oxidase subunit I and nuclear 16S rRNA, as well as histone 3. In the phylogenetic tree, the shrimp formed a separate cluster, indicating

that the translucent shrimp belonged to a new species.

The researchers named the species *Cuapetes purushothamani* in honour of the late Purushothaman Paramasivam, a crustacean taxonomist who has made significant contributions to shrimp taxonomy.

The specimens of the new species were deposited at the National Fish Museum and Repository, ICAR-National Bureau of Fish Genetic Resources, Lucknow and at the National Museum of the Zoological Survey of India, Kolkata.

The researchers found that habitat and host association played important roles in the genetic diversity and evolution of these shrimps.

'Shrimps associated with corals were morphologically and genetically more similar to each other than to shrimps associated with seagrass and other invertebrates,' says T. T. Ajith Kumar, ICAR-National Bureau of Fish Genetic Resources, Lucknow.

Phyto-compounds against Cancer
A deep search

Enzymes regulating cell growth, differentiation, and survival have an important role in cancer progression. The enzyme coded by the *RAF1* gene, first discovered in a rapidly accelerated fibrosarcoma, is a serine/threonine-specific protein kinase, which plays an important role in the process. When the activity of this enzyme is increased, it can cause normal cells to become cancerous. So it is a therapeutic target for several diseases, including cancer.

Recently, researchers from Jamia Millia Islamia, Delhi collaborated with scientists from Saudi Arabia and South Africa to explore plant-derived compounds that can be used to target the enzyme. They downloaded the structure of *RAF1* from the Protein Data Bank and about 5000 phytocompounds from MPPAT, a database of the phytochemistry and therapeutics of Indian medicinal plants. Using InstaDock, docking software, they identified about 50 compounds which bind to the enzyme.

The team then used molecular visualisation tools such as PyMOL, a molecular graphic system, and Discovery Studio Visualizer to analyse the interaction of these compounds with the enzyme. The number of potential plant-based therapeutic agents was thus reduced to about 40.

To reduce the candidate compounds further, the researchers used Swiss-ADME, a web tool to evaluate the pharmacokinetics and drug-likeness of small molecules. This reduced the candidate phytocompounds further to about 15.

To investigate the biological potential of the compounds, the researchers used PASS, an online tool to predict biological activity. PASS looks into the pharmacological effects, the mechanisms of action, the interactions with metabolic enzymes and transporters, the influence on gene expression and the toxic and adverse effects of compounds. This reduced the candidate cancer therapeutics to just two: moracin C, a phenolic compound from jackfruit, and tectochrysin, a flavonoid from sour cherry. These two compounds should effectively target the RAF1 kinase.

These compounds will now be tested for anticancer activity using *in vitro* and *in vivo* studies.

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Diabetic Kidney Damage
Apelin as marker

Long term diabetes causes kidney damage. In diabetic nephropathy, the kidney starts leaking small amounts of albumin protein into urine. So, microalbuminuria is an important marker for diabetic nephropathy. Recent studies reveal that apelin 13, a peptide hormone made up of 13 amino acids, controls glucose levels and insulin secretion. Since, in type 2 diabetes, insulin is secreted and yet glucose levels are not controlled, does apelin 13 play a role in the development of microalbuminuria?

Johnbasha Shaik and team from Saveetha Deemed University, Thandalam investigated the link between apelin and diabetic nephropathy. They selected 60 people with type 2 diabetes and, based on albumin levels in urine, divided them into diabetic patients with normal albuminuria and diabetic patients with microalbuminuria. The res-

earchers also inducted thirty healthy volunteers as a control group.

As expected, patients with type 2 diabetes had a significantly higher body mass index than healthy individuals. Glycated haemoglobin levels, a proxy for three-month average blood sugar levels and insulin resistance, were higher in microalbuminuric patients than in normal albuminuric diabetic patients.

The researchers checked for any correlation between apelin levels and albuminuria. Apelin 13 levels were significantly higher in the plasma of patients with microalbuminuria than in normoalbuminuria diabetic patients. Apelin 13 plasma levels correlated positively with higher urine albumin levels. Thus, type 2 diabetes mellitus patients with higher levels of plasma apelin 13 have an increased risk of developing nephropathy at an early stage.

Though further research is needed to fully understand the relationship between apelin and nephropathy, in clinical practice, monitoring apelin 13 in people living with type 2 diabetes may be a useful strategy to initiate early treatment for nephropathy.

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Vitamin D Deficiency
Predisposes to preeclampsia?

Preeclampsia is a hypertensive disorder associated with abnormal placental placement. This disorder affects about 10% of pregnancies in India.

In women with preeclampsia, recent studies show low vitamin D concentrations at the time of delivery. It appears that vitamin D has an important role to play in changes in endometrial cells during pregnancy.

Sixty to ninety per cent of women in India are reported to be deficient in vitamin D. Yet not all develop preeclampsia. So what role does vitamin D play in preeclampsia?

To examine the association between the mother's vitamin D status and the risk of preeclampsia, Sadhana Joshi and others at Bharati Vidyapeeth, Pune monitored maternal vitamin D status from early pregnancy to delivery. They collaborated with researchers at the Sitaram Bhartia Institute of Science and Research, New Delhi and the Gupte Hospital and Research Centre, Pune.

The team selected 1154 women with early pregnancies from Bharati Hospital and Gupte Hospital, Pune. Around 1000 were singleton pregnancies and about 100 developed preeclampsia.

The data collected showed that the women with preeclampsia had higher weight and blood pressure. The urine of women who had preeclampsia showed higher protein content. The proteinuria indicated a condition related to the kidneys. In cases where proteinuria was absent, there were other features like pulmonary edema, renal insufficiency, impaired liver function, headaches and high blood pressure.

The gestational age at birth and baby's weight were lower than those of the women who did not have preeclampsia.

Checking the serum vitamin D concentration, the team observed that women who had preeclampsia during childbirth showed significantly low vitamin D concentrations earlier, at 18–22 weeks.

The researchers performed multiple regression analysis to check for any association between maternal vitamin D concentration and preeclampsia. Low vitamin D concentrations were associated with an increased risk of preeclampsia.

'Vitamin D deficiency exists before the clinical diagnosis of preeclampsia. So it is important to maintain adequate vitamin D levels during pregnancy to reduce the risk,' says Sadhana Joshi, Bharati Vidyapeeth, Pune.

Interestingly, the data also shows that some women who had vitamin rich nutrition or supplements also showed low vitamin D concentrations in serum.

Exposure to sunlight, the other factor that improves vitamin D levels could not be reliably assessed. Keeping pregnant women indoors all the time is perhaps a factor in the development of preeclampsia.

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Aquaglyceroporins in Mammals
Adaptive selection

Aquaglyceroporins are a subset of the aquaporin family of proteins that allow the permeation of glycerol through the plasma membrane. Found in the epidermis, aquaglyceroporins help circulate

glycerol for mammalian metabolism. Since aquaglyceroporin dysfunction is seen in conditions such as diabetes, obesity and cancer, a better understanding of these channels can help create new strategies for treating such conditions.

However, there is a diversity of aquaglyceroporins. What are the evolutionary changes and selective pressures that led to this diversity of aquaglyceroporins across mammals?

Researchers from the National Dairy Research Institute in Karnal collaborated with researchers at the University of Delhi to investigate the structural and functional motifs of aquaglyceroporin genes.

They collected 119 aquaglyceroporin coding sequences from 31 mammalian species and identified chromosomal locations that act as coordinates for the aquaglyceroporins in the genome. These locations produced a neighbouring genomic environment of aquaglyceroporin genes.

Some aquaporin genes have lost their protein-coding ability due to accumulated mutations that have occurred over the course of evolution. But the researchers observed that some of the aquaporin sequences were conserved. So they studied the motif distribution of the aquaporins. There were structural modifications in aquaporins 3, 7 and 9. Aquaporin 3 showed the highest affinity for glycerol permeability along with water transport.

The researchers now visualised the phylogenetic distance of the aquaglyceroporin genes. Based on the amino acid sequences, the sequencing trees formed four clusters of aquaporins. Some of the aquaporin genes of horses were closely related to those of cows. Similarly, the water channel genes of moles clustered with those of cats and dogs. These results closely mirrored the traditional taxonomic groups among mammals.

The researchers wondered whether the selection pressures on aquaglyceroporins were positive or negative. They created phylogenetic trees to analyse the site- and branch-site models of selection pressures. Branch-site models showed that the genes for aquaporins 7, 9, and 10 have undergone positive selection at key sites in carnivores, rodents, and primates, suggesting their involvement in adapting to diverse environmental conditions.

Variations in amino acid sequences change the pore formation and substrate specificity of aquaporins. An understanding of these variations can be useful in designing drugs that target these proteins.

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Thalassemia in Children
Risk for atherosclerosis

Thalassemia is a genetic disorder where the haemoglobin level is reduced. Patients suffering from its most severe form require regular blood transfusions for survival. Repeated blood transfusions, however, cause iron overload due to the accumulation of iron from transfused blood. This increases oxidative damage and metabolic dysregulation, altering the lipid profiles of the patients.

Adult transfusion-dependent thalassemia patients are known to be prone to increased cardiovascular disease and stroke. Can we detect such comorbidities associated with thalassemia, using a lipid profile alteration at a younger age?

Sanghamitra Ray and her team from Chacha Nehru Bal Chikitsalaya, Delhi collaborated with Rajesh Kumar Meena from the University College of Medical Sciences, Delhi, to predict the risk of atherosclerosis at an early stage. They conducted a one-year study with nearly eighty 3 to 14-year-old transfusion dependent thalassemia patients.

Children with transfusion-dependent thalassemia were underweight because of underlying anaemia. Repeated blood transfusions led to high serum ferritin levels and, due to excessive iron deposition, the children suffered from gradual liver damage, leading to hepatic fibrosis. The researchers found increased levels of aspartate transaminase and alanine transaminase in the serum, confirming liver damage in children with severe thalassemia.

The plasma lipids, atherogenic lipid indexes and other lipid profile parameters were then compared with those of the age- and sex-matched healthy controls. Lipid profiles were altered in children with thalassemia due to diminished hepatic biosynthesis and iron overload.

The lipid profile abnormality suggested that the cardiac risk ratio and atherogenic index of plasma were high in children with transfusion-dependent thalassemia.

'Despite regular blood transfusion and chelation, most children with severe thalassemia had dyslipidemia, making them prone to the development of early atherosclerosis,' says Sanghamitra, Chacha Nehru Bal Chikitsalaya, Delhi

Follow-up and long-term evaluation of children with thalassemia can help reduce the chances of complications due to transfusion.

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Diabetes Mellitus
In rural Tamil Nadu

During 2008–2010, the prevalence of diabetes was estimated to be around 5% in a rural area of Tamil Nadu. Has the prevalence of diabetes among the rural population changed now?

To find out, Pradeepa Rajendra and team from the Madras Diabetes Research Foundation surveyed people in rural areas of Tamil Nadu during 2018–2020. The researchers conducted a survey of fifteen thousand people in 30 villages of Kanchipuram district. Besides measuring basic parameters, such as height, weight and blood pressure, they assessed biochemical values such as lipids, urea and creatinine. The assessments matched those of the 2008–2010 study suggesting that the two studies were comparable.

The current prevalence of diabetes mellitus, however, was found to be around 13%, nearly three times higher than earlier estimates. Self-reported diabetes and newly-diagnosed diabetes are increasing, perhaps due to higher awareness levels. The prevalence of prediabetes has declined.

The abrupt increase in diabetes in a decade, even in rural areas, is a signal to initiate awareness campaigns on diabetes prevention, early detection and management. The public health system has to take steps to identify and monitor the cases so that complications from diabetes are reduced.

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Pyroelectric Nanocomposites
For self charging smart gadgets

Pyroelectric materials generate electricity from heat. In other words, using pyroelectric materials, heat energy dissipated from the human body can be converted to electrical energy.

One such pyroelectric material is polyvinylidene fluoride, a synthetic resin produced by the polymerization of vinylidene fluoride. This polymer exhibits pyroelectric properties when its structure is in an organised form known as the beta phase. But current procedures to form the beta phase of polyvinylidene fluoride are expensive and time consuming.

Recently researchers from Graphic Era University, Dehradun collaborated with colleagues from South Korea to fabricate a beta phase pyroelectric polymer by modifying the structure of polyvinylidene fluoride.

They prepared a nanocomposite of polyvinylidene fluoride with carbon nanofibres and beads of poly-acryl-amido-methyl-propane-sulfonic acid, or PAMPS, a water soluble organic polymer used for ion exchange in resins

The researchers analysed the properties of the composite at 20, 50, 120 and 150 degree Celsius. Initially, under a scanning electron microscope, they observed that the carbon nanofibres and PAMPS beads were not aligned to each other. But, as the temperature rose, the carbon nanofibres and PAMPS beads became more ordered, reaching a maximum order at 120 degree Celsius. X-ray diffraction analysis of the composite at this temperature suggested that the polyvinylidene fluoride was in the beta phase.

The researchers checked the open circuit voltage for the composite at the different temperatures. At 120 degree Celsius, the material provided an output of 4.8 Volts, the highest among the existing materials.

The researchers attribute the enhanced properties of the composite material at this temperature to the formation of the beta phase of polyvinylidene fluoride due to the alignment of the carbon nanofibres with the PAMPS beads.

They investigated the tensile properties of the composite and found moderate flexibility at lower temperatures. At higher temperatures, it progressively became stiffer and more brittle. But the material was stable till about 400 degree Celsius.

'These materials can be used for various purposes. For temperature sensing, energy harvesting, health monitoring…,' says Varij Panwar, Graphic Era University, Dehradun.

Smart gadget manufacturers can use the material to develop self charging wearable electronic devices.

Crowd Management in India
Follow what's in front

Managing crowds at large gatherings is no easy task, and the masses at religious events are no ordinary crowd. When people are tightly packed together, a small movement can ripple through the crowd and cause mishaps of large magnitude.

Crowd disasters and stampedes happen when there is a sudden surge of people through narrow passageways. But with insights from the behavioural science of queue theory, it's possible to keep crores of people safe and in order.

Researchers from IISc Bangalore developed a model to predict the behaviour of crowds. They based their crowd simulation from the flux of cars on highways and in traffic. The car flow model is based on leader dynamics, where the leading car sets the pace for other cars. A similar type of behaviour can be seen in queue formation.

The researchers collected CCTV data of pilgrim movement from the Mahakal Temple, Ujjain, during the Kumbh Mela, 2016. The narrow corridors in the temple act as a natural barricade for the crowd, which formed long unidirectional lanes for movement. In the CCTV data, the researchers manually marked the leading pedestrians in lanes. To extract parameters like speed and acceleration, they created trajectories of the marked pedestrians.

Individuals tend to react to visual input from the neighbourhood. This strategy, based on the visual fields of each person in the crowd, creates a collective motion pattern. This collective motion helped the researchers measure crowd speed at each instant. They found that information on the speed spread to the people behind in the form of waves measuring hundreds of metres. Any change to the crowd's movement trajectory, however, dissipated quickly, spreading just a few metres through the crowd. In short, speed information spreads easily through the crowd, while orientational information does not.

The microsimulation model developed by the researchers can be used to test various possible scenarios during the event-preparation phase of crowd management.

'If we know how the changes in the movement of individuals propagates in a crowd, there are ways to control it,' says Ashish Verma, IISc Bangalore.

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