

Current Science Reports

Palaeoclimate of the Kashmir Valley *From sediments in Wular Lake*

Mid-late Holocene, the past six thousand years, is considered a warm period punctuated by multiple dry phases. The transitions between warm-wet period to cold-dry are recorded by sediments in lakes. The Wular Lake in the Kashmir Valley thus holds clues to climatic changes in the region.

Sanjeev Kumar and team from the Physical Research Laboratory, Ahmedabad recently reconstructed past climatic changes in the Kashmir Valley by examining geochemical factors and stable isotopes in sediment samples from the Wular Lake.

They first established the chronology of the sediment strata by radiocarbon dating using accelerator mass spectrometry. The sediment samples contained clues covering the last five to six thousand years.

The researchers also analysed sediment texture and observed a vertical arrangement of various sediment types, with predominantly fine-grained sediments in the upper portion of the sequence.

During dry and cold climate the sedimentation rates were lower and emergent macrophytes were dominant. During dry climate phases, the lake geochemistry changed, as indicated by a decrease in various element concentrations in the lake sediments.

The sediment data suggests that the lake faced two extended dry climate phases. One, about four thousand two hundred years ago, coincided with the Meghalayan age and the collapse of major ancient civilizations. Another dry phase occurred between 3000 and 2500 years ago, coinciding with a cold and dry phase – similar to that reported in the North Atlantic by other researchers.

The team also examined the impact of anthropogenic activities on erosion in the catchment area of Wular Lake and concluded that anthropogenic activities significantly influenced erosion during the last two millennia.

'Climatic conditions and human activities play significant roles in regulat-

ing hydrological conditions in the region, driving the biogeochemical changes in the Wular Lake,' says Rayees Shah, Physical Research Laboratory, Ahmedabad.

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Rampur Watershed Hydrology *Impact of changing land use*

The Rampur watershed is a part of the Jonk river catchment of the Mahanadi river basin. The land use and, hence, the land cover there has been changing rapidly.

Research suggests that the changing climate and land-use land-cover impact the distribution of water. So what is the hydrological status of the Rampur watershed now?

Researchers from the Dayalbagh Educational Institute, Agra, IIT Roorkee, NIH, Roorkee and IGKV Raipur collaborated to analyse the impact of land system changes within the Rampur watershed.

They collected data on different land use for 1994, 2004 and 2014 from the National Remote Sensing Center, Hyderabad.

To assess the impact of land use on runoff, they used soil, elevation and rainfall data as input in the Soil and Water Assessment Tool model. To improve the accuracy of the model simulations, the researchers tried to define the hydrological response unit, an area that represents similar topographic characters. They found that the greater the number of hydrological response units, the more precise and accurate the simulation of runoff. The model simulations were in good agreement with the observation data.

The results indicated an increase in runoff from 27% in 1994 to about 30% in 2014. Due to the increase in runoff, the annual average contribution to groundwater decreased from 20% in 1994 to 15% in 2014.

Since the changes in land use and land cover have decreased groundwater recharge in the area, water management practices need to be taken up immediately.

'We have identified two sub watersheds in the Rampur watershed for

immediate conservation,' says Priyanka Gunjan, Dayalbagh Educational Institute, Agra.

With good water management practices, and by developing better strategies, the population in the area will be more resilient to drought years.

Are the authorities and people in Rampur listening?

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Camera Traps on Tree Tops *For elusive mammals*

Camera traps helped identify wild tigers, their habits and interactions in their natural habitats, which contributed to the successful conservation of the tiger population in India. A success story that is now being repeated with other terrestrial wild animals.

However, mammals living in tree canopies are still under-studied, partly because of their nocturnal and elusive nature. Can we not use arboreal camera trapping to study and conserve such elusive arboreal mammal species?

Orvill Nazareth, Vivek Ramachandran and Arjun Srivathsa from NCBS-TIFR, Bengaluru recently tackled the issue.

They used sixteen camera traps, both terrestrial and arboreal, to monitor the mammals in a regenerating forest within a tea estate, in the Western Ghats, for the month of April and May 2022. The camera traps recorded 28 species of mammals. Three were exclusively arboreal, 11 were semi-arboreal and 14 were terrestrial mammals.

To get an idea about the extent of vertical habitat used by each species, the team also generated an arboreality index, where zero indicated the species is terrestrial and one indicated tree crown as the main habitat. The results from the camera traps indicated that six of the eleven semi-arboreal species had an arboreality index greater than 0.6, indicating that they are rarely found on the ground.

The researchers also attempted to compare the efficacy of using different baits for capturing the images of the animals on camera. When shrimp-dry fish baits were used, they could capture more carnivores.

Based on video captures from terrestrial and arboreal cameras, the researchers analysed mammal species richness and extrapolated species detections to evaluate the adequacy of their effort. This revealed that 648 trap-nights were enough to document all the arboreal species whereas more than double the trap-nights would be required for the terrestrial species at the study site.

Integrating arboreal camera trapping with terrestrial sampling and using different types of baits are important factors for the successful monitoring of fauna in the rainforest ecosystem.

Conservationists and wildlife management agencies can now use this method to monitor arboreal species in the unexplored regions in other parts of the country.

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Triple Negative Breast Cancer Treating with myricetin rhamnoside

Myricetin 3-rhamnoside, a compound found in the roots of the medicinal plants, *Myrica cerifera* and *Myrica esculenta*, has been reported to have antiproliferative activity in several types of cancer cells. In breast cancer caused by hormone dysregulation, myricetin rhamnoside is found to be active. But does it work on breast cancers that are not due to hormone dysregulation, commonly known as triple negative breast cancer?

Researchers from the CSIR-Central Institute of Medicinal and Aromatic Plants, Lucknow, and the Indian Institute of Information Technology, Allahabad investigated the question.

They procured a hormone-dependent breast cancer cell line, a hormone independent cell line and a normal kidney cell line from the National Centre for Cell Sciences, Pune.

They treated some of the cells with myricetin 3-rhamnoside, and left a few cell samples untreated, as controls.

With cytotoxic assays, they assessed antiproliferative activity, and found that myricetin 3-rhamnoside slows the growth of both types of cancer cells. When treated with 100 micromolar of myricetin 3-rhamnoside, the reduction in proliferation was about 57% in the hormone-independent breast cancer cell line. In the hormone dependent

cancer cell line, it was only about 40%. In the normal kidney cell line too, there was a reduction, but only about 18%.

Using a flow cytometer, the researchers examined the cells and determined that the cells were arrested at the G0/G1 phase of the cell cycle.

Using computer simulation, the researchers found that myricetin 3-rhamnoside binds with cyclin D1, the protein that regulates the cell cycle as well as some cyclin-dependent kinases. They also found that myricetin 3-rhamnoside has a good binding interaction with and inhibits the activity of ornithine decarboxylase and hyaluronidase. These two enzymes are now considered biomarkers of breast cancer.

The researchers isolated RNA from both myricetin 3-rhamnoside treated and untreated cells to understand the differences in gene expression. Myricetin 3-rhamnoside, they found, reduces the transcription of hyaluronidase. Thus myricetin 3-rhamnoside inhibits hyaluronidase at both transcription as well as at enzyme activity levels.

The last problem that the researchers had to tackle was the issue of the toxicity of myricetin 3-rhamnoside. They examined the absorption, distribution, metabolism, excretion and toxicity of the molecule using pkCSM, a web server designed for the purpose. More than 40% of the compound is absorbed by the intestine, they found. The compound was a good substrate for *p*-glycoprotein, the transporter of drugs from the intestine. It was also slightly permeable through the skin and is not a skin irritant. It does not cross the blood brain barrier, and it is not mutagenic or hepatotoxic.

Hormone-independent breast cancer or triple negative breast cancer is the most aggressive of breast cancers and the prognosis for patients has not been good so far. The results of this research may change that.

Pharmaceutical companies and philanthropic organisations now need to step in to take the research to the next level.

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Repurposing Anthelmintics To treat lung cancer

Recent studies have reported that benzimidazole-based anthelmintics have

potential activity against lung cancer. However, we do not yet fully understand how they work on cancer cells. It is also not very clear which compounds, out of the many benzimidazole-based anthelmintics, are the most active.

Recently, researchers from the Jamia Hamdard University and DRDO, New Delhi investigated the problem.

They first identified drug targets for all the benzimidazole-based anthelmintics from web-based platforms. Most anthelmintics had more than a hundred targets and one had more than four hundred! The researchers took into consideration 290 most common targets.

They also mined for data on the potential therapeutic targets for lung cancer. Genes involved in lung cancer were extracted from various databases and discovery platforms. There were more than 5000 unique targets.

The researchers then identified targets that were common to the anthelmintic drugs and to lung cancer.

If a target is a part of a protein-protein interaction network, the entire network will be affected. So the researchers analysed the protein-protein network and gene enrichment pathways. They identified twenty potential targets with more than average chances of being affected. These targets have been associated with cancer cell proliferation, differentiation, metastasis, chemoresistance and cell cycle regulation.

The targets were then used for molecular docking and simulation with ten anthelmintics. The results corroborated earlier investigations on the anticancer activity of individual anthelmintics on cancer and revealed other potential sites on which the anthelmintics might act.

The researchers identified five lung cancer targets with the highest degree of action by benzimidazole-based anthelmintics. The most stable binding to the lung cancer targets was shown by ricobendazole, fenbendazole, flubendazole, mebendazole and triclabendazole.

Though the research has clarified the mode of action of benzimidazole-based anthelmintics on lung cancer and identified the most useful ones as adjuvants to cancer therapy, more studies and clinical trials are needed before

anthelmintics can be used for lung cancer treatment in clinical settings.

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Chronic Low Back Pain *Yoga as an adjunct treatment*

Chronic low back pain is a complex problem, affecting the biological, psychological, social, functional and financial aspects of life. Despite the various treatment options available for chronic low back pain, management is usually suboptimal or inadequate. Most treatments concentrate on the biomedical aspect of pain and overlook the lack of mental well-being. But chronic low back pain patients are also more prone to depression as they find day-to-day activities difficult.

Studies have shown that yoga is a potential intervention, not only in managing pain, but also in improving mental health and the quality of life. So, Babita Ghai and team at the Postgraduate Institute of Medical Education and Research, Chandigarh collaborated with doctors, academicians and yoga experts to recruit patients with chronic low back pain. The patients were randomly divided into two groups: a control group received the usual care treatment as per the institutional protocol: pregabalin, an analgesic and anxiolytic, either alone or with amitriptyline, an antidepressant.

The yoga group received the usual care along with yoga – bodily postures to stretch and strengthen the body, breathing practices to focus and relax the mind and meditation. Over a period of two weeks, the team conducted twelve one-hour sessions for training the patients in yoga. Participants were then encouraged to continue practising yoga at home for at least 45 minutes throughout the three-month intervention period.

The researchers recorded the baseline before starting the treatment for both groups and followed up after one month and at the end of three months. They used different validated questionnaires intended to identify neuropathic pain and its severity, to assess the extent to which a person exaggerates pain, and to assess the levels of anxiety and depression.

To reduce the chances of personal biases in the responses to the ques-

tionnaires, the researchers examined the efficacy at the molecular level. They also analysed associated bio-markers – beta endorphins, internal pain relievers, and tumour necrosis alpha, in blood samples, and calcitonin gene-related peptides, inflammatory mediators, in saliva.

From the data collected before, during and after the three months, the researchers found that the yoga therapy group had increased beta-endorphin levels although the change was not statistically significant. The tumour necrosis alpha levels had reduced significantly in the yoga group compared to baseline. The level of calcitonin gene-related peptide differed significantly at baseline and also at a one-month follow-up between the yoga and control groups.

The changes in the biomarkers may not be due to yoga alone, say the researchers. The differences could be due to the intake of amitriptyline, psychological state and other factors.

But from the questionnaires, it was evident the yoga group had better pain relief and could manage the trauma and psychological issues better than the control group.

At three months, 42% of patients stopped taking their painkillers while all patients in the control group continued to be on medication.

Since yoga is an effective low-cost self-management tool, clinicians should consider this an adjunct treatment for chronic low back pain patients.

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Sensing Sulfamethazine *Fluorescence quenching*

Sulfamethazine is widely used to treat acute and chronic bacterial infections. The antibiotic is effective against Gram positive and Gram negative bacteria as well as against some protozoans. Since it is cheap, it is used in animals and birds bred for their meat also.

But sulfamethazine is not completely metabolised and is excreted through urine and faeces. The contamination of the food chain leads to unintended exposure of human beings to sulfamethazine. In some, it causes allergic reactions. Constant exposure can even cause thyroid cancer. So there is a need to monitor the amount of the

compound. But detecting the compound is either time-consuming or requires costly equipment.

Researchers from IIT Palakkad recently tackled the problem. Detecting the compound using fluorescence is faster than chemical analysis and cheaper than detection using costly equipment, they reasoned. Luminescent covalent organic polymers are easy to synthesise and are quite stable. It is easy to attach fluorenone on the backbone of these polymers and the polymer will amplify the sensing response. The remaining problem was to identify a molecule that will selectively connect to sulfamethazine.

The researchers explored different possibilities and found an organic compound that has a concave shape in its structure with two nitrogen atoms at two ends, popularly known as Tröger's base. Would this work?

The researchers started synthesising a covalent organic polymer, with many fluorenone molecules and Tröger's base attached to it. The recipe was simple. Mix a fluorodaniline monomer with dimethoxymethane and trifluoroacetic acid in a nitrogen atmosphere and keep stirring for 16 hours. Mix the resulting brown-coloured liquid with ammonia solution and stir for two hours.

The researchers examined the white amorphous material that was formed using various techniques and found that at high resolution, the surface of the material contains non-homogeneous spherical particles, and that the surface had pores with large radius – properties that are useful for sensors. And what is more, it was stable up to 400°C.

Now the researchers tested the specific interactions of the material with seven antibiotics, including sulfamethazine. They measured the fluorescence efficiency of the compound before and after adding the antibiotics. Among the antibiotics, sulfamethazine showed a prominent reduction in the fluorescence signal. The sharp visual change in fluorescence when sulfamethazine was added to the compound was observable even without any instruments.

From time-dependent fluorescence lifetime measurements, the researchers found that the initial absorption of sulfamethazine increased with an

increase in concentration. The intensity of the fluorescence signal was reduced as the concentration of sulfamethazine kept increasing.

Then the researchers mixed sulfamethazine with other antibiotics and observed the fluorescence behaviour. This confirmed the significant reduction of the fluorescence signals by sulfamethazine in the presence of other antibiotics too.

To understand the exact mechanism of the selective sensing of sulfamethazine with the prepared polymer, the researchers conducted computational modelling. The simulations showed that the energy difference between the lowest occupied molecular orbitals of sulfamethazine and the polymer was low, which facilitates energy transfer between them.

They tested the reusability of the sensor and found that it was suitable after six cycles.

The researchers then extended their sensing studies to water samples collected from a pond near Ahalia Hospital in Palakkad. Even though the pond contains many contaminants and impurities, their sensor detected only sulfamethazine.

While earlier attempts to sense the antibiotic lacked specificity, the new polymer sensor is very specific. It is also very sensitive and responds to even 56 parts per billion of sulfamethazine.

Another important addition in the armamentarium of sensors that can prove to be useful.

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Social Work *Support and burnout*

Social workers address challenges faced by people and help improve their

well-being. Since their work profile may range from child care to criminal justice, social workers face varied situations and stresses. The stresses can often skew work-life balance and cause burnout. This impacts work performance and often leads to absenteeism and job turn-over in the social sector.

The chances of reduced motivation and withdrawal from work could decrease if there were social support for the field workers.

To understand the inter-relationships between work-life balance, social support and burnout, A. J. Sebastine, Periyar Maniammai Institute of Science and Technology, Thanjavur collaborated with Selwyn Stanley, who was teaching social work in Tiruchirappalli before he moved to a university in the UK.

From a list of voluntary organisations registered with the District Social Welfare Board, they identified organisations involved in social work in Tiruchirappalli and Thanjavur, Tamil Nadu. They contacted the organisations and administered questionnaires to more than a hundred social workers and received 73 responses.

The highest responses were from NGOs, followed by personnel in government programmes, hospitals and educational institutions. The respondents were involved in counselling, rehabilitation, child care protection, empowerment of women, community development or health services.

Using standard questionnaires, the duo collected information on work-life balance. While work interfering with personal life was high, there was a significant number of cases where personal life interfered with work. The cases of personal life being enhanced due to work were also not insignificant.

Age of respondent and years of work correlated positively with personal life enhancement due to work.

The questionnaire on social support revealed that support from family, friends and significant others were low for the social workers.

To analyse correlations between the variables, the researchers used statistical methods and found a negative correlation between burnout and overall social support. Where social support was high, the work life balance score increased.

Besides support from within the organisation, emotional support from partner, family or friends can reduce the chances of burnout and attrition from the social sector, say the researchers.

Linear multiple regression analysis showed that both skewed work-life balance and lack of social support are contributing factors for predicting burnout.

Social workers need to take care of themselves in order to be effective. This includes finding ways to manage stress, building social support systems, and achieving better work-life balance. People experiencing burnout may have difficulty separating their work from their personal life. So time management skills are also important for social workers, say the researchers.

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