

Current Science Reports

Wainganga Basin Development *Evaluating watershed parameters*

The Wainganga River receives moderate rainfall – an average of 1400 millimetres per year. The basin has valleys and ridges. These tend to concentrate rainwater, causing frequent floods. Yet groundwater is seen to be depleting in the region – 60% in the past five decades, due to high demand for irrigation.

There was a need to critically evaluate various hydrological parameters for an integrated watershed management plan. So Ashwini Baswaraj Mirajkar and Saranya C. Nair from the Visvesvaraya National Institute of Technology, Nagpur set about doing it.

They first delineated the watershed and stream network from a digital elevation model. A soil and water assessment tool, the SWAT model, was used to simulate the runoff for small watersheds and for the whole river basin.

An analysis of 101 years of gridded rainfall data, from 1913 to 2013, showed decreasing trends of average annual rainfall and an increasing trend of peak rainfall. Every two years, there is about 1200 mm of rainfall and 1500 mm every five years, making the basin flood-prone.

'The increasing trend in peak rainfall indicates storm events of high intensity – the main reason for flash floods in the area,' says Ashwini Baswaraj Mirajkar.

SWAT simulation data based on various topographical and weather parameters for the last two decades indicate that about 25 million cubic metres of water run off every year – more than adequate to replenish groundwater in the region, if allowed to percolate.

The overall soil type has a low infiltration rate, favourable for runoff. Agriculture and forests cover most of the land area in the basin. But the study shows a decadal depletion of about one thousand square kilometres in water bodies and forest land from 1985 to 2005. Urbanisation in the area due to population growth has increased built-up land.

'There is more than a thousand square kilometres of fallow land now

which increases runoff volume and top-soil erosion, posing a major threat to the ecosystem,' says Saranya C. Nair.

To understand the groundwater status in the region, the team collected and analysed data from about 450 wells. In most of the area, groundwater availability is within 10 m, except in the south-western districts of the Wainganga basin where groundwater availability is at 31 m.

A floodwater spreading system can help flood water percolate to the aquifers below. It can tackle the problem of frequent flooding as well as the depleting groundwater resources, say the researchers.

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Upper Jhelum Basin *Tracing sources of groundwater*

The upper Jhelum basin is an oval-shaped depression bound by Pir Pinjal to the south-west. And the Greater Himalayas cradle the Jhelum River, feeding it with 24 tributaries. The region gets the southwest monsoon, carrying moisture from the Indian Ocean, the Arabian Sea, and the Bay of Bengal. It also receives rain due to the western disturbance that brings moisture from the Atlantic Ocean, the Mediterranean Sea, the Black Sea and the Caspian Sea.

The two sources of rain, snowmelt and glacial melt can all, in principle, contribute to recharging groundwater. But what are the actual sources of groundwater in the basin? What are the contributions by rain, rivers, snow melt and glacial melt? Will the reduction of glaciers due to climate change impact groundwater availability in the region?

Ghulam Jeelani and a team from the University of Kashmir were concerned. They investigated the issue using stable isotope values of oxygen-18 and deuterium. Heavier isotopes in water are enriched due to evaporation when water molecules with lighter weight escape first. And each source of water has its own isotopic signature.

The researchers took water samples every month from groundwater, melted

snow and glaciers from various places in the region. They analysed the samples in an isotope-ratio mass spectrometer and compared the result with the Vienna Standard Mean Ocean Water. IMD and irrigation department datasets helped them infer water sources.

The result of the analysis indicates that temperature and altitude are factors that modulate the isotopic composition of precipitation. Moreover, rainfall due to the western disturbance has an isotopic profile distinct from that due to summer rainfall.

'We have identified snow melting as the main source of groundwater recharge in the Upper Jhelum. It sustains water flow in the region,' explains Jeelani.

The study pointed to the severe consequences of retreating glaciers due to climate change on agriculture and on horticulture in particular and to the economy in general.

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Using Wild Bioresources *How sustainable is it?*

We exploit bioresources for food, medicine, and cultural uses. Using them for display or as pets is also quite prevalent – a pet red panda, exotic corals in the aquarium, or rare orchids in the home garden ...

Can the current levels of use place a species at risk? Are there action plans in place to tackle the unsustainable use of bioresources?

Researchers from the French Institute of Pondicherry and other parts of the world investigated patterns of wild bioresource use to answer these queries.

They analysed patterns of usage and trade for over 31,000 aquatic and terrestrial species listed under the IUCN Red List.

From available data, they find that aquatic species are mostly used for food. Use as pets or for displays and for specimen collection is also common.

On the other hand, terrestrial species are mostly used as pets or for display, and for food, hunting sports and collection.

Plants are mostly collected for building materials and for gardening, and for food, medicine, household goods and handicrafts.

The researchers found that corals, followed by fishes, are the most used aquatic species.

Among terrestrial species, cycads and birds are the most exploited. Overall, aquatic species are more exploited than terrestrial ones.

There are no management action plans to address threats to species used as bioresources.

In light of the observations, the researchers recommend modifying the threat classification scheme and document the timing, scope and severity of threats posed by the various uses. They also recommend species-specific harvest management plans along with trade restrictions.

The study brought out the lacunae in available data and the need to improve species information services. The researchers advise combining the results from this study with national or regional data sets to provide a better picture of the impacts on the use of wild species.

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Aeromonas Infection in Fish *Global research output*

Aeromonas species are the most common bacterial pathogens of fish. They infect a wide range of cultured freshwater fish, causing mass mortality and loss of income for fish farmers.

This is a global problem. Yet only some countries seem to research the issue. Which countries and which institutions put in greater efforts? Who are the leading authors of publications on the topic?

Researchers from the ICAR-Central Institute of Fisheries Education, Mumbai and the ICAR-Central Agroforestry Research Institute, Uttar Pradesh analysed bibliographic information about research on *Aeromonas* spp. infection in fishes. They retrieved bibliographic data on *Aeromonas* Infection from the Web of Science from 1998 to 2020.

They analysed the data using the bibliometrix R-package, a programming package for comprehensive science mapping analysis.

There were a total of about 2000 research papers on different aspects of the *Aeromonas* species in fish diseases contributed by about 6000 authors worldwide.

China contributed more than a quarter of the publications, India less than one-seventh and the US about one-tenth. In publication output, India, Iran, Egypt, Brazil, and Thailand showed a significant increase in publications in this field.

To assess the productivity of institutions and authors, the researchers used scientometrics indicators of publications such as total citation counts, average citation per paper and *h*-index, a measure of scientific contribution. India ranked first among top publishers on *Aeromonas* research in terms of the *h*-index and second among the most productive countries.

Using free software, the VOSviewer, the researchers characterised the most productive institutions and authors as well as the most highly-cited papers in the field. Two ICAR institutions, the Central Institute of Freshwater Aquaculture, Bhubaneswar and the Central Institute of Fisheries Education, Mumbai together contributed about 11% of the publications.

The Chinese Academy of Sciences, the Chinese Academy of Fishery Sciences, Nanjing Agricultural University, Huazhong Agricultural University and Shanghai Ocean University together contributed about 15% of the publications.

Among the most prolific authors, P. K. Sahoo from India and Baldisserotto from Brazil contributed about 30 papers.

The National Natural Science Foundation of China and the National Council for Scientific and Technological Development, Brazil were identified as major funding agencies for research on the topic.

'The data on the 2000 papers identified can now be used for writing focused review articles on the subject,' says Suresh Ramanan, ICAR-CARI, Jhansi.

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Helminth Infection *After mass drug administration*

The WHO estimates that, in India, there are more than 240 million chil-

dren under five infected by soil-transmitted helminths. The prevalence of the problem can be reduced with mass administration of anthelmintic drugs like mebendazole and albendazole.

Similarly, the prevalence of filariasis, another helminthic infection transmitted by mosquitoes is reduced by mass administration of diethylcarbamazine.

If these two preventive strategies can be combined, a lot of effort can be saved. So when a mass drug administration to prevent lymphatic filariasis was carried out in 250 endemic districts in 2000–2005, albendazole was co-administered in a government pilot programme.

How effective was it in reducing soil-transmitted helminth infections?

In 2017, researchers from the Christian Medical College Vellore, Tamil Nadu along with a collaborator from the University of Washington, US carried out a survey to identify soil-transmitted helminth infections in the Kaveripakkam block of Tamil Nadu.

The block has 54 villages and 1 semi-urban village with a total population of around 1.6 lakh and equal proportion of males and females.

A total of 862 people provided stool samples for the study. About half were children aged above two and the other half were adults. Though other intestinal worms are more common among children, hookworm infestation is common among adults too.

The team analysed the stool samples using the Kato Katz method, sieving the samples through a mesh to remove large particles and using glycerol to clear faecal matter around helminth eggs so that they become easily visible under a microscope.

The researchers identified only 60 positive infections. A relatively low percentage of about 7%.

The majority of the cases were adults. The infections were usually light in intensity. Infection was significantly associated with increasing age and negatively correlated to regular toilet use.

The researchers say that the infections may be underestimated because the participants of the study were largely female as males go out to work during the daytime.

Apart from skewed male–female ratio, unavailability of socio-economic status information emerged as a limitation while interpreting the results.

However, it appears that co-administration of drugs for soil transmitted and mosquito transmitted helminth infections is a good strategy but needs to be reinforced with better sanitation.

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Low Birth Weight *Prevalence and reasons*

Weight at birth influences the development, health and well-being of future citizens. Low birth weight is a prime indicator of low socio-economic development.



Image: K. Vardeman via Wikimedia Commons

Recently, researchers from the International Institute for Population Sciences, Mumbai and the Institute for Social and Economic Change, Bengaluru assessed the prevalence of low birth weight and its relationship with socio-economic inequality in India.

They used data from the fourth round of the National Family Health Survey conducted in 2015–16. The researchers took about 250,000 of the most recent births in the 5 years before the survey. They considered below 2.5 kilograms as low birth weight.

The researchers used predictor variables such as age of woman, body mass index and antenatal care. They identified factors linked with low birth weight using bivariate and multivariate logistic regression analyses.

The team found that children born to women aged nineteen or less, underweight women, women with no antenatal care and mothers with no primary education have a higher risk of delivering low birth weight babies.

Being born as the fourth child or later and a birth interval of less than 24 months put babies at risk of being low weight.

The team also found that the prevalence of low birth weight is higher in rural than in urban areas and there is a higher prevalence of low birth weight in female children.

Where households lack adequate toilet facilities, there is a risk of helminths and other infections, which increases the chances of low birth weight babies. Unclean cooking fuel was another factor. In other words, low birth weight is associated with the socio-economic background of the family.

‘India had the highest low birth weight in South Asia. Adequate attention should be given to the mother’s nutritional status,’ says Pradeep Kumar, IIPS, Mumbai.

The government has to implement adequate policy interventions to curb low birth weight prevalence in Indian rural populations.

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Airborne Viral Transmission *Role of short range conversations*

Long range transmission of COVID-19 is dependent on air flow and ventilation, while short range transmission depends on the dynamics of fluid jets emitted by speakers. Conversing without a mask can spread the COVID-19 virus through air.

Recently, Arghyanir Giri and colleagues from IIT Kharagpur collaborated with researchers from the USA and France to explore jet collision dynamics during face-to-face conversation.

The jet-like flow produced by one speaker is modulated by the flow exhaled by the second speaker. The team characterised the interaction between these two colliding jets, using numerical simulations. They assumed a separation of one to one and a half metres, commonly found in conversations. The simulations were modified for different heights of speakers, speaking or breathing time and the phase difference of the conversation.

They also conducted experiments to visualise the flow using a set up scaled according to the simulations. The experimental set up consisted of two reservoirs which supply pressurised air. One of the reservoirs was seeded with fog and laser sheets were used to visualise the flow pattern.

The simulations and the experiments led to similar conclusions. If the second person is not talking, the flow jet from the first speaker reaches the second in a few seconds. But, during conversation, collision splits the jets into a two-lobe structure, which reduces the streamwise spread – a blocking effect which enhances lateral spread. This causes the transmission of pathogens to bystanders, but not to the second speaker.

The blocking effect is highest when the difference in height between the mouths of the speakers is small and decreases with increasing offset heights. For intermediate height differences of 8–10 cm for 1 m separation distance, the blocking effect is reduced and the respired air jet can reach the other speaker.

‘However, a real conversation has additional complexities that need to be understood to assess the risk of direct airborne transmission,’ says Sandeep Saha, IIT Kharagpur.

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Inhibiting Mayonnaise Oxidation *By finger millet polyphenols*

Consuming creamy mayonnaise with foodstuffs is trending among Indian consumers. But auto-oxidation of unsaturated fats in mayonnaise on storage changes the smell and flavour, making it unpalatable.

Industries commercially producing mayonnaise add synthetic antioxidants to efficiently and cost-effectively inhibit oxidation. However, synthetic antioxidants like butylated hydroxytoluene possess several side effects including liver damage and cancers.

Natural antioxidants are safer. For example, the seed coat of finger millet has a lot of polyphenols, a type of natural antioxidant. However, during processing, seed coats are removed as red colour and chewy texture are not preferred by consumers. Can we use the natural antioxidants from finger millet seed coats to make mayonnaise last longer, wondered researchers from the Anna University, and the National Institute of Ocean Technology, Chennai.

The team extracted polyphenols from seed coats by breaking open the millet cells using sound energy.

The polyphenols were separated by centrifugation. The researchers analysed compounds in the supernatant using high-performance liquid chromatography. There were 13 polyphenols with antioxidant activity.

The researchers prepared mayonnaise by blending egg and vegetable oil, with a dash of vinegar and lemon juice. To the mayonnaise, they added varying concentrations of the supernatant containing polyphenols. For comparison, a synthetic antioxidant was added to one set of mayonnaise. And all mayonnaise samples were placed under refrigeration.

After seven weeks, the researchers checked the samples for acids and peroxides that oxidise lipids. One milligram of polyphenol solution per gram of mayonnaise effectively reduced lipid oxidation by 80% whereas synthetic antioxidants reduced it to only 75%.

Using a texture analyser, the team checked for spreading and other texture properties of stored mayonnaise.

They found that the mayonnaise thickened during storage, which reduced overall textural properties.

'Mayonnaise with natural antioxidants managed to maintain softer and better texture,' says Leema Mary Roy, National Institute of Ocean Technology, Chennai.

The researchers then evaluated the colour of the stored mayonnaise by spectrometric techniques. Colour was reduced in mayonnaise with synthetic antioxidants. But mayonnaise with polyphenols retained its original shiny yellow-white colour.

A group of 30 semi-trained panellists evaluated the stored mayonnaise samples.

'Mayonnaise with polyphenols got better scores,' says Ayyappan Palaniappan, Anna University, Chennai.

Seed coats thrown away as waste after finger millet processing can become a means of extra income for

farmers. And mayonnaise lovers can use this cheap and efficient way to improve the spread's shelf life.

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Automated Garbage Segregation *Design and execution of SmartBin*

Around two billion tonnes of waste is generated every year. If this waste could be segregated, it can be recycled and a lot of resources can be conserved. However, manual separation of heaps of waste is tedious and involves huge amounts of manual labour and hence money.

To solve the problem, there are now deep learning algorithms that can help sort garbage automatically. But which algorithm works best and how can it be put to practical use?

To investigate, researchers from the Bharati Vidyapeeth's College of Engineering, New Delhi, and the Vivekananda Institute of Professional Studies – Technical Campus, College of Engineering New Delhi, collaborated with researchers from Spain.

The team collected images of different types of garbage items from TreshNet, waste classification data and drink packaging waste classification data sets.

Using these data sets, they trained four models based on the convolutional neural network to classify materials normally found in garbage.

'The Inspection Net algorithm model worked best in segregating garbage with 98 per cent accuracy – better than AlexNet, ResNet and VGG-16,' says Deepali Virmani, Vivekananda Institute of Professional Studies – Technical Campus, New Delhi.

Inspection Net is a 27-layer deep machine learning algorithm with superior identification and classification features.

The researchers then designed and developed a smart bin with two cate-

gories: biodegradable and non-biodegradable. When the waste falls on a platform, an infrared signal switches on a LED light and an attached low light sensitivity camera clicks a picture. The image is passed on to the trained Inspection Net. If the Inspection Net predicts that the waste is non-biodegradable, the platform swivels to one side of the smart bin, and, if the waste is biodegradable, it moves to the other side, to dump the material.

'The infrared camera worked better than the 5 MP standard pi-camera. It has higher resolution and works even in the dark, without human intervention,' says Tanya Gupta, Bharati Vidyapeeth's College of Engineering, New Delhi.

The team calculated the cost of their lab-scale model for the system and found that the costs go up a little with an infrared camera and the related circuit chip. But, even with the standard pi-camera, they could achieve 96% accurate sorting of the materials into biodegradable and non-biodegradable bins.

Presently, the lab-scale model works with one piece of material at a time. But, with the given results, the team is confident that they can tackle the sorting of multiple objects at a time. Moreover, to enable easy recycling, instead of sorting into binary categories, sorting the non-biodegradable materials into different categories is also possible with further development of the system.

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