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TERRA YOUTH

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SPECIAL HIGHLIGHTS

Road Towards Carbon-Neutral Future
Glacial Lake Outburst Floods

IN CONVERSATION

Rajeev Kharyal

Head Customer Services, Key Consumer Group
and Government Affairs, TPDDL

Heat Waves and Action Plans

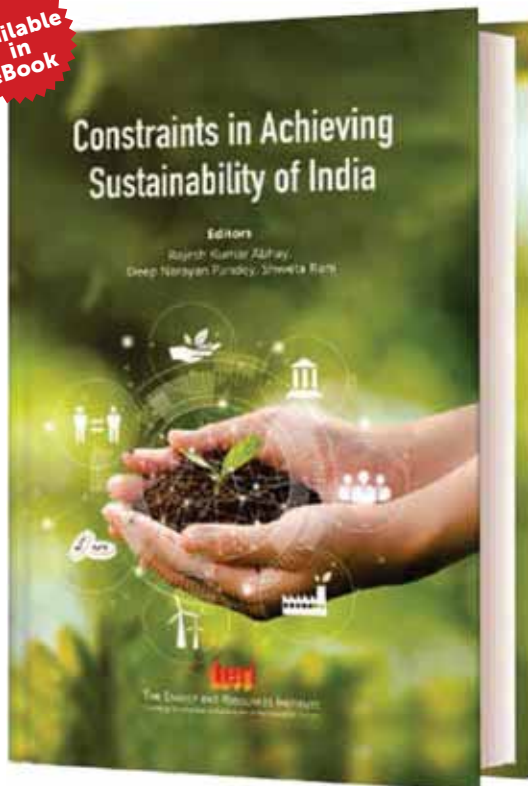
How Does India Fare?



teri

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Major topics covered

- Sustainable Development: concept, components and history
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- Sway of Indian Cinema in Diffusing Environmental Sentience
- Poverty Lines and Poor in India
- Sanitation Workers and Associated Problems for the Sustainability of Religious Events
- Assessment of Basic Infrastructure Development and Associated Issues in India

ISBN: 9789394657120 • Price: ₹550.00

Purpose of the book is to develop, contribute, and disseminate scientific knowledge pertaining to the issues related to sustainable development. The chapters are developed so that the contents can facilitate comprehension of the major constraints in achieving sustainability including but not limited to environmental, social, economic, and governance-related issues from local, regional, to national level. Resource management, climate change, agriculture, population, education, women, poverty, infrastructure, crime, corruption, governance, are the other relevant topics that have been both identified and suitably discussed. *Constraints in Achieving Sustainability of India* can be utilized as a guiding tool for realizing sustainability in development, especially, in the Indian context.

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EDITORIAL



“ Our unwavering commitment to research, innovation, and advocacy has not only influenced policies and thinking of the decision-makers within our nation but has also inspired change beyond our borders. ”

As TERI enters its 50th year, I take great pride in being part of this remarkable journey—a voyage characterized by unimaginable grit, unshakable resilience, and undeterred passion to support the nation and its stakeholders in their commitment to act for the planet and co-create sustainable solutions. Throughout our journey, we have fearlessly confronted complex challenges, ventured into uncharted territories, and yet could testify innovative ideas, resolved intricate issues and created pathways for a greener and more sustainable future. Our unwavering commitment to research, innovation, and advocacy has not only influenced policies and thinking of the decision-makers within our nation but has also inspired change beyond our borders.

One common challenge that we currently face pertains to global temperatures, which are likely to surge to record levels in the next five years, fuelled by heat-trapping greenhouse gases and a naturally occurring El Niño event, according to a new update issued by the World Meteorological Organization (WMO). This month our cover story on heat waves and action plans highlights that as heat waves impact people’s health and livelihood, and the nation’s economy adversely, there is a need to improve and better implement the heat action plans (HAPs). In 2013, Ahmedabad became the first city to create a heat action plan, following a heat wave that resulted in nearly 4500 fatalities in May 2010. Subsequently, state and city level HAPs have been created throughout the country. HAPs include sensitizing the public, putting up early warning systems, issuing colour-coded alerts and warnings, and advising the public on preventive measures. Other measures include urban greening, heat resilient infrastructure such as cool roofs, especially in low-income settlements.

Though HAPs have vastly improved health implications and reduced mortalities, as can be seen from the data, there is a lot of room for improvement. *Assessment of Climate Change over the Indian Region*, a Ministry of Earth Sciences report, suggests advanced research on how the intensity of a heatwave event has changed as a result of surge in atmospheric greenhouse gases from human activity. Since the temperature observation sites across India are not evenly distributed, it may lead to errors in the assessment of present-day temperature variations, particularly over the north that has a sparse network, and hence needs to be addressed, says the report. Experts emphasize that addressing the existing gaps, as indicated, and further improving our forecasting capabilities, alongside better implementation of HAPs, are imperative steps to overcome the challenges posed by climate-induced heat waves.

With this cover story and other articles of current interest, we hope that you enjoy reading this issue of *TerraGreen*, recognize the ecological crisis that calls for a concerted action and feel charged to make a difference. We eagerly look forward to receiving your feedback and reflections.

A handwritten signature in black ink that reads "Vibha Dhawan".

Vibha Dhawan
Director-General, TERI



I liked reading the June 2023 issue of *TerraGreen*. The cover article on circular plastics economy is a good one. Throughout the lifecycle of plastics, particularly when plastic waste is not managed through scientific means, harmful chemicals are released into the air, water, and soil. This poses significant risks to both the environment and human health. Plastics, especially single-use plastic (SUP) products, have become omnipresent, resulting in profound environmental, societal, economic, and health consequences.

As the world commemorated World Environment Day in 2023, with a focus on “solutions to plastic pollution” under the campaign #BeatPlasticPollution, it is imperative to recognize that each individual bears multiple responsibilities in addressing this global crisis. The present moment demands cooperation among governments, industries, packaged goods companies, waste

management personnel, consumers, innovators, and the general public—all along the plastic value chain—to collaboratively devise and implement solutions.

Abhay Sharma
Mumbai, Maharashtra

The June 2023 issue of *TerraGreen* offers entrancing reading material. The feature article on intersection of sustainability and technology is an apt one. To effectively and efficiently harness and expand technological interventions for the advancement of environmental sustainability, an ecosystem-based approach is essential. This approach should amalgamate networks, knowledge, capital, and innovation. Implementing such an ecosystem approach, involving critical stakeholders such as enterprises, policymakers, and both public and private investors, would expedite the implementation of climate technologies. This, in turn, would facilitate climate-resilient growth and the attainment of environmental sustainability. Such efforts are pivotal for realizing a worldwide net-zero economy by 2050 and making significant strides towards fulfilling the objectives outlined in the Paris Agreement.

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Melting of Ladakh Glacier Could Form Three Glacial Lakes

Accelerated melting of the Himalayan Parkachik Glacier in Ladakh could give rise to three glacial lakes with an average depth ranging between 34 and 84 metres, scientists have found. These lakes could be a potential source of glacial lake outburst floods in the Himalayas, the scientists from the Wadia Institute of Himalayan Geology, Dehradun, said.

Parkachik Glacier is one of the largest glacier in the Suru River valley, which is a part of the Southern Zaskar Ranges, western Himalaya. The Zaskar Range, part of the Himalayas, lies in the union territory of Ladakh. The glacier's yearly melting rate was 6 times faster between 1999 and 2021 (22 years) than that calculated from 1971 to 1999 (28 years), the scientists found using satellite data to determine its glacial retreat from 1971–2021. The findings are published in the journal *Annals of Glaciology*.

Source: <https://www.thehindu.com/>

India to Emerge as One of the World's Largest Solar Module Makers

India is set to emerge as one of the largest solar module manufacturers and has the fastest growing capacity in renewable energy, Union Power Minister Shri R K Singh said recently. Stating that India has a considerable existing solar manufacturing capacity, he pointed to "even larger capacities under construction, including polysilicon". India is poised to become a global powerhouse in renewable energy, including green hydrogen, fostering a robust ecosystem. "With one of the largest manufacturing ecosystems in wind energy and rapidly growing capacity in solar energy, India is the world leader in this regard," Singh said while speaking at an event in the national capital.

Source: <https://economictimes.indiatimes.com/>



Illegal Encroachments Devastate Bengaluru's Forests

While the total forest area in Bengaluru urban division is 6875.21 hectares, 924.4 hectares are illegally occupied. Bannerghatta National Park division alone recorded encroachment of 587.15 acres and witnessed 347 encroachment cases filed. The information was shared by Minister of Forest, Environment, and Ecology, Shri Eshwar Khandre in the state assembly session recently. Responding to a query, the Minister also informed that as many as 704 encroachment cases have been filed against these encroachments since 1978. Out of these, 65 encroachment cases were registered in the Bengaluru North sub-division, 20 cases were registered in the Yelahanka sub-division, 250 in Bengaluru East sub-division, 283 in Bangalore South, and 86 in Anekal sub-division.

Source: <https://bangaloremirror.indiatimes.com/>



Bihar on Top with Alarming Lead Level in Children's Blood

Bihar has the highest average blood lead level (BLL) at 10.42 microgram per decilitre (g/dL) among the 23 states. It is not only dangerous but much higher than the World Health Organization (WHO) intervention threshold of BLL 5µg/dL, as per a recent report by NITI Aayog. Field assessments conducted by Pure Earth and Vital Strategies, in collaboration with Mahavir Cancer Research Institute and Research Centre and Institute of Environment and Eco Development (IEED), Patna, also revealed the severity of the issue.

Source: <https://timesofindia.indiatimes.com/>

IIT-I Develops Process to Produce Green Hydrogen Gas from PET Waste in Water

Indian Institute of Technology Indore recently developed a process to produce green hydrogen gas, in large scale, from PET waste in water, an official release said. The research also addresses the global issue of the recycling of PET-based plastic waste by transforming 'waste to wealth'. The developed process will provide a simple yet effective way to transform PET waste to produce green hydrogen along with the formation of primary constituents of PET, which can further be used for the production of PET, the release said.

Source: <https://timesofindia.indiatimes.com/>



ICAR to Promote Technology to Address Challenges of Climate Change

Himanshu Pathak, the Director-General of the Indian Council of Agricultural Research (ICAR), announced that they have implemented a comprehensive approach to tackle the challenges posed by climate change. By leveraging technology, these measures aim to empower farmers and governments to enhance resilience in the agricultural sector. Dr Pathak discussed these initiatives during a press briefing in New Delhi on the occasion of ICAR's 95th Foundation and Technology Day. One of the key components of this approach is the establishment of 731 Krishi Vigyan Kendras, which serve as advisory centres, offering farmers technical expertise and guidance.

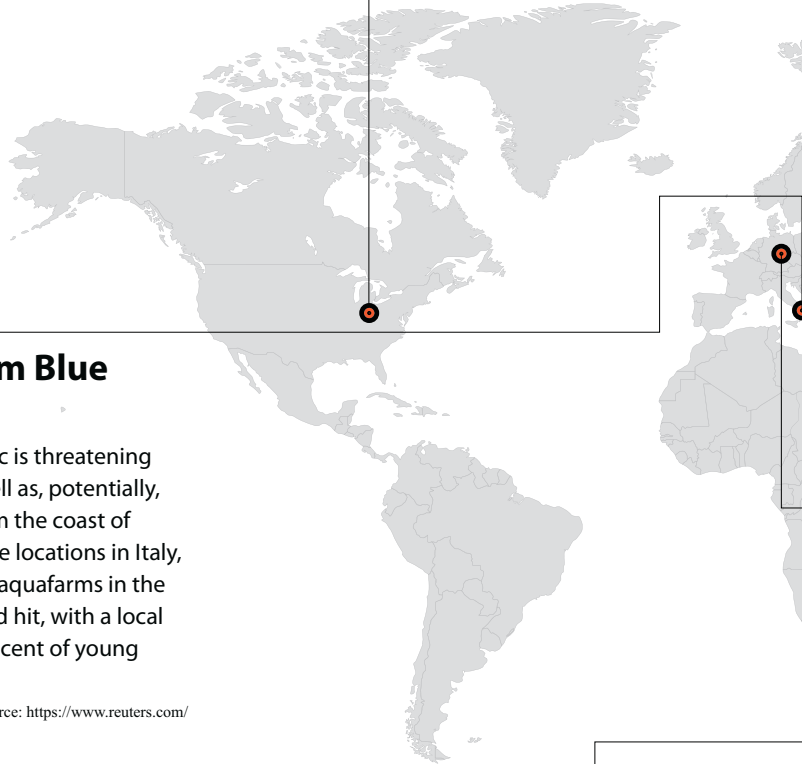
Source: <https://krishijagan.com/>



More Than 40 Million People in the US Live in Urban Heat Islands

About 41 million people in the US live in urban heat islands, where city topography elevates temperatures by at least 8 degrees Fahrenheit, according to an analysis published recently by Climate Central, a non-profit research group. Urban heat islands occur when cities replace land cover such as forest, open water and greenery with buildings, pavement and other materials that absorb and retain heat. While the heat effect is most noticeable during summertime, urban heat islands are warmer all year-round.

Source: <https://www.nbcnews.com/>



Italy's Clam Industry under Threat from Blue Crab 'Invasion'

A particularly aggressive crab species from the western Atlantic is threatening Italy's role as one of the world's top producers of clams—as well as, potentially, one of its signature pasta dishes. The “blue crab”, originally from the coast of North and South America, has spread across several lagoon-like locations in Italy, preying on local shellfish, fish roe, and other aquatic life. Clam aquafarms in the delta of the Po river valley in northern Italy are particularly hard hit, with a local marine biologist saying that the crabs have eaten up to 90 per cent of young clams, decimating future production.

Source: <https://www.reuters.com/>

Study Highlights Importance of Mineral Iron in Ocean Ecosystems

New research published today in *Nature* has revealed the importance of mineral forms of iron in regulating the cycling of this bio-essential nutrient in the ocean. The findings pave the way for new work on the relationship between the iron and carbon cycles and how changing ocean oxygen levels may interact. The study, led by the University of Liverpool and involving collaborators in the United States, Australia and France, addresses a knowledge gap in ocean research. Principal Investigator Professor Alessandro Tagliabue said: “To date we have not fully appreciated the role that mineral forms of iron have played in driving the distributions and temporal dynamics of iron in the ocean.”

Source: <https://www.sciencedaily.com/>





UAE Strives to Become a Pioneer in Climate-Smart Agriculture

The UAE, which has 0.7 per cent arable land and relies on imports to meet 90 per cent of its food requirements, has a new food security initiative aimed at making it the best in the Global Food Security index by 2051. Manbat, the Emirati farmers' market, is a joint initiative between real estate developer Arada and the Ministry of Climate Change and Environment of the UAE (MOCCA) to promote the UAE's homegrown produce in an enjoyable and family-friendly way. Manbat now has a permanent store in Aljada and pop-up markets in Dubai and Abu Dhabi on weekends, which have become popular.

Source: <https://www.thehindu.com/>



Beijing Records Heaviest Rainfall in 140 Years

China's capital Beijing has recorded its heaviest rainfall in at least 140 years recently. The city recorded 744.8 millimetres (29.3 inches) of rain between July 29 and August 2, the Beijing Meteorological Bureau said on August 2, 2023. The record rainfall comes as northern China has been deluged with heavy rains as the remnants of Typhoon Doksuri moved north after earlier hitting southern Chinese provinces. Beijing and the surrounding province of Hebei have been hit by severe flooding, with waters rising to dangerous levels. The rains destroyed roads and knocked out power and even pipes carrying drinking water.

Source: <https://www.thehindu.com/>

Europe's Most Vital Trade Route Rhine River at Risk Due to Climate Change

The Rhine River has been a reliable shipping lane for centuries, helping spawn industrial giants along its banks. Low waters are becoming more frequent and forcing costly and cumbersome workarounds to keep supply lines open. With water regularly receding to levels that impede shipping from late summer through the fall, companies up and down Europe's most important trade route are rushing to adapt, underscoring how the climate crisis is hitting even advanced industrial economies. BASF SE is re-routing logistics to trains and trucks.

Source: <https://www.hindustantimes.com/>



Technology and Cultural Showcase at CEM14-MI8 in Goa

On July 19, 2023

As leaders, eminent authorities, and dignitaries from the G20 and CEM nations gathered in Goa for the G20 Energy Transitions Ministerial Meeting (ETMM); key stakeholders, major OEMs (Original Equipment Manufacturers) and significant players from the space of clean and sustainability mobility assembled at the Dr Shyama Prasad Mukherjee Stadium—all under a single roof—to showcase technological innovations and advancements that can propel India's decarbonization efforts for

a sustainable future.

As part of the 14th Clean Energy Ministerial and the 8th Mission Innovation meeting being held alongside the G20 EETM, the Technology and Cultural Showcase—a carefully curated expo portraying the remarkable advancements made in the sustainable mobility domain was inaugurated by the Hon'ble Chief Minister of Goa, Dr Pramod Sawant. In addition, the Hon'ble Chief Minister also inaugurated the Zero Emission Truck and Bus

Showcase, highlighting the cutting-edge technology being employed to further India's sustainable mobility fleet through zero-emission heavy duty vehicles, hydrogen fuel cell and battery swapping infrastructure, electric tractors, and so on.

With the transport sector amounting for almost 14 per cent of India's GHG emissions, and road transport sector which is dominated by medium- and heavy-duty trucks being responsible for the lion's share in this, addressing the carbon emissions from transport is imperative to achieve India's net zero commitment and the EV30@30 vision.

Zero Emission Technology (ZET), especially in heavy duty vehicles (HDVs) and long duty vehicles (LDVs) segment, then opens myriad opportunities not only for the country to accelerate action towards decarbonization of the road transport sector and reduce the growing diesel consumption in the country but also unlock new markets for OEMs (vehicle, battery, and powertrain) and infrastructure providers.

Cognizant of the challenges and potential of zero-emission vehicles and technologies in accelerating India's efforts for a decarbonized future, The Energy and Resources Institute (TERI), with Shakti Sustainable Energy Foundation as a knowledge partner, curated the Zero-Emission Truck and Bus Showcase. ■

Source: <https://www.teriin.org/>



Chief Minister of Goa, Shri Pramod Sawant inaugurates the Technology and Cultural Showcase at CEM14-MI8

Report Launched by TERI and Shell

Outlining a Path towards Sustainable Development and Net-Zero Emissions

Energy lies at the heart of India's development aspirations, from ensuring a better life for its 1.4 billion people to realizing a USD 5-trillion climate economy. At the same time, India confronts an energy trilemma: Balancing energy security, energy equity, and environmental sustainability while pursuing decarbonization. To successfully navigate this trilemma, concerted efforts and partnerships are essential among the government, businesses, and civil society. Decisions made in this decisive decade will determine India's ability to decarbonize while ensuring continued economic growth and development.

The report launched on August 1, 2023 by TERI and Shell, 'India transforming to a net-zero emissions energy system: A Call to Action to 2030' outlines what India needs to do in this decade (from now until 2030) to help meet its net-zero emissions target while also delivering energy security and energy equity.

The report presents four potential scenarios, all aiming to achieve net-zero emissions within India's energy system by the latter half of this century. It highlights the need for: (i) Increasing electrification in energy end use sectors; (ii) Meeting electricity demand increasingly from non-fossil sources; (iii) Developing low-carbon alternatives such as hydrogen and biofuels for hard-to-electrify segments; (iv) Deploying digital solutions to enable low-carbon alternatives; (v) Supporting circular economy business models to drive resource efficiency; (vi) Creating an enabling environment for planning, establishing and scaling up carbon removals after 2030 to address the most expensive and hardest-to-abate residual emissions. It further emphasizes the need for policy interventions, technological advancements, and behavioural changes to facilitate the transition towards more sustainable energy practices. It also highlights the new economic and business opportunities for India to

position itself as a leader and to leapfrog to more energy and emissions-efficient technologies and solutions.

Speaking at the launch, Nitin Prasad, Chairman, Shell Group of Companies in India, said, "Shell has been a thought leader in India's energy transition journey jointly with TERI for over a decade. Building on this collaboration, the report explores pathways for India until 2030 to achieve its commitments, emphasizing the pivotal role of renewable energy, energy efficiency, and electrification in its decarbonization efforts."

Highlighting the need for conducive regulatory framework that will help India decarbonize, Dr Vibha Dhawan, Director General, TERI, said, "India possesses a remarkable prospect to establish itself as a prominent global front-runner in low-carbon technologies and solutions. To seize this opportunity, India must give paramount importance to establishing a conducive regulatory framework that promotes growth and encourages innovation. In addition, businesses and companies must play an active role in supporting India's ambition of achieving net-zero emissions. Significant contributions can be made by investing in renewable energy, hydrogen, and bioenergy sectors. By capitalizing on this potential, India can propel itself towards a future driven by low carbon and energy efficient technology, surpassing the greenhouse gas-intensive paths pursued by advanced economies at present." ■

Source: <https://www.teriin.org/>



The report was launched by Dr Vibha Dhawan (DG, TERI) and Mr Nitin Prasad (Chairman, Shell Group of Companies India) along with other dignitaries on August 1, 2023

Study of Earth's Stratosphere

Reduces Uncertainty in Future Climate Change

New research from the University of East Anglia (UEA) provides more certainty in predicting future climate change, by examining stratospheric water vapour amounts. The research effectively rules out the most extreme scenarios, which imply that water vapour concentrations could increase by more than 25 per cent per degree of global warming. The new approach represents a 50 per cent reduction in the 95th percentile of climate model responses.

New research led by the University of East Anglia (UEA) reduces uncertainty in future climate change linked to the stratosphere, with important implications for life on Earth. Man-made climate change is one of the greatest challenges facing us today, but uncertainty in the exact magnitude of global change hampers effective policy responses. A significant source of uncertainty relates to future changes to water vapour in the stratosphere, an

extremely dry region of the atmosphere 15–50 km above the Earth's surface.

Future increases in water vapour here risk amplifying climate change and slowing down the recovery of the ozone layer, which protects life on Earth from harmful solar ultraviolet radiation.

Now an international team led by Peer Nowack, until recently a member of the Climatic Research Unit at UEA, has developed a new statistical learning approach that combines information

from satellite observations with state-of-the-art climate model data to narrow the range of likely future stratospheric water vapour amounts.

One of the key results, published in June 2023 in the journal *Nature Geoscience*, effectively rules out the most extreme scenarios, which imply that water vapour concentrations could increase by more than 25 per cent per degree of global warming. The new approach represents a 50 per





cent reduction in the 95th percentile of climate model responses.

“Man-made climate change affects Earth’s atmosphere in many important and often surprising ways,” said Prof. Nowack, now at the Institute of Theoretical Informatics at the Karlsruhe Institute of Technology, Germany. “In our paper, we look at changes in stratospheric water vapour under global warming, an effect that is still poorly understood. Since water vapour is central to the physics and chemistry of the stratosphere, I felt that we crucially need a new approach to address this longstanding uncertainty factor.

“With our new data-driven approach, which exploits machine learning ideas, we were able to make highly effective use of Earth observations to reduce this uncertainty. This required us to develop a framework in which we could combine scientific understanding and mathematical relationships learned from satellite data in innovative ways.”

“With this approach, we were able to show that many climate model projections of very large stratospheric water vapour changes are now

inconsistent with observational evidence,” said co-author Dr Sean Davis, a Research Scientist at the National Oceanic and Atmospheric Administration in the US, specializing in satellite measurements of stratospheric water vapour.

Quantifying stratospheric water vapour trends under global warming is a longstanding research challenge. The complexity of the underlying processes that control stratospheric water vapour and the relatively short record of high-quality satellite observations has made this task difficult.

The presence of so-called climate feedbacks presents an additional challenge, as these can act to further amplify or dampen global warming, therefore leading to a wider range of possible future temperature increases. The amount of water vapour that the stratosphere holds is an example of one such feedback, which climate models have predicted to increase, but the range of modelled increases has remained very wide for decades.

This is important, because large climate-driven increases in stratospheric

water vapour, like those projected by many climate models, could delay the recovery of the ozone layer and of the Antarctic ozone hole over the course of this century.

However, Manoj Joshi, Professor of Climate Dynamics at UEA and a co-author on the paper, said “Our research implies that while stratospheric water vapour concentrations are still likely to increase with global warming, the large changes that could substantially delay ozone recovery are highly unlikely.”

The research was funded by the UK Natural Environment Research Council (NERC) through the ML4CLOUDS project. ■

‘Response of stratospheric water vapour to warming constrained by satellite observations’; Peer Nowack et al., was published in Nature Geoscience on June 26, 2023. The University of East Anglia (UEA) ranks in the UK Top 20 for research quality (Times Higher Education REF2021 Analysis) and the UK Top 10 for impact on Sustainable Development Goals. The University was awarded Gold in the Teaching Excellence Framework and is a leading member of Norwich Research Park, one of Europe’s biggest concentrations of researchers in the fields of environment, health, and plant science. Website: www.uea.ac.uk

Feature



A hand is visible on the left side of the image, holding a small green wind turbine and a green recycling symbol. The background is dark and textured, possibly a wall or a screen. The overall theme is environmental and sustainable energy.

Road towards Carbon-Neutral Future

In this article, **Dr Anil Pratap Singh** discusses the proverbial road towards carbon-neutral future by dwelling on the fact that the pressing priority of the time is to promote the use of clean energy solutions for affordable and reliable energy access, inclusive development, climate mitigation and adaptation, and greenhouse gas emission reduction. Concurrently, it is crucial to recognize the significance of enhanced climate finance as a central element in addressing the problem.

2023 marked the 50th anniversary of World Environment Day, with this year's theme centred around 'Solutions to Plastic Pollution.' Concurrently, World Ocean Day 2023 has adopted the theme 'Planet Ocean - Tides are Changing,' aiming to ignite a new wave of understanding regarding the crucial role of the ocean. The focus is on raising awareness for its protection and promotion. This is because the planet's greatest carbon sink, the ocean, absorbs excess heat and energy released from rising greenhouse gas (GHG) emissions trapped in the Earth's system. Hence, appropriate action is exceedingly desirable in order to take important step towards addressing issues of climate change. Ocean mitigates global-warming effects by absorbing about one-quarter of anthropogenic carbon dioxide emissions.

Reaching Climate Goal by the Midcentury

Though strategies to reduce emissions are imperative but are still insufficient in reaching out climate goals by the midcentury. Albeit, natural as well as technological strategies exist to



eliminate carbon dioxide (CO₂) from the atmosphere and stockpile the same in trees and plants, soils, underground reservoirs, rocks, the ocean, etc. Even so, world obligatorily requires large-scale investments in new technologies that can remove carbon from the atmosphere.

Strategies towards staying below 1.5°C of global temperature rise not only requires net-zero carbon emissions by 2050 as delineated in the Paris Agreement but also exigently

entails multifaceted and wide ranging approaches, e.g., increasing renewable energy, improving energy efficiency and avoiding deforestation, etc., as well as actively removing CO₂ from the atmosphere in order to secure a carbon-neutral future of the planet. Concurrently, enhanced climate finance should be considered as central in deciphering the problem. However, the pressing priority of the time is to promote the use of clean energy



solutions for affordable and reliable energy access, inclusive development, climate mitigation and adaptation, and GHG emission reduction. New technologies accompanied with large-scale investments are indispensably significant in stabilizing the global climate.

In 1992, the first-ever global treaty aimed at addressing climate change was endorsed at the UN Framework Convention on Climate Change (UNFCCC) with the consensus of 197 countries. This convention, now widely recognized as the Conference of the Parties (COP), is held annually with the goal of stabilizing the concentration of GHGs in the atmosphere. Among these COPs, the Kyoto Protocol and the Paris Agreement emerged as the most important negotiations and the recent COP, held in Sharm el-Sheikh (Egypt), reached a historic agreement on new "Loss and Damage" fund for vulnerable countries, which were hit hard by climate calamities.

Adopted in 1997, Kyoto Protocol entered into force in 2005, was the first legally binding climate treaty but agreed on reasonable ease to developing countries on their emissions. On the other hand, the Paris Agreement necessitated all countries to set emissions-reduction pledges as targets named as nationally determined contributions (NDCs), with the goals of preventing the global average temperature from rising 2°C above preindustrial levels and pursuing efforts to keep it below 1.5°C.

Despite this, scientists warn that the Paris Agreement is not enough to prevent the global average temperature from rising above 1.5°C. When that happens, the world, more likely, will suffer devastating consequences, such as intense heat waves, melting glaciers and ice sheets, polar sea ice loss, extreme weather and climate events including floods and droughts, adverse impacts on animal habitats and loss of biodiversity, etc. These circumstances



compel us in finding out innovative solutions, e.g., technological carbon removal. In the recent past, a significant milestone occurred when the US Government allocated USD 60 million as 'first-ever' funding to develop carbon removal technology. According to the Intergovernmental Panel on Climate Change (IPCC), up to 10 GtCO₂ will need to be removed annually from the atmosphere by 2050, with increased removal capacity up to 20 GtCO₂ per year by 2100.

Aiming to stabilize GHG levels, the IPCC receded mitigation as reducing climate change by reducing the flow of heat-trapping GHGs into the atmosphere, either by reducing sources of these gases or enhancing the sinks that accumulate and store these gases, e.g., oceans, forests, and soil. Ocean not only absorbs CO₂ emissions but also captures around

90 per cent of the heat generated from these emissions and defends the Earth against the brunt of climate change and supports in conciliating SDG13, as meant to limit and adapt to climate change. Hence, while taking urgent action to combat climate change and its impacts, oceans become more centric in dealing with climate-associated dilemma.

Avoiding carbon footprints and achieving Net Zero emissions, there also necessitate the adoption of the principles of a circular economy. For instance, globally around two billion mobile phones sold each year, have a substantial environmental footprint as these mostly end up as toxic e-waste. If properly incentivized with indulgent benefits, it could be promoted for reuse, repair and refurbishment in order to reduce the number of new devices being produced. And, as an estimate,



adding one year onto the lifetime of all smartphones in the world could save as much carbon emissions by 2030 as taking 4.7 million cars off the road.

Outlying Agonies of Climate Change

Recently, the National Aeronautics and Space Administration (NASA) and the National Oceanic and Atmospheric Administration (NOAA) of the US federal government, examined some of the lesser-known, and often astounding means of climate change distresses in aviation industry. For example, climate change makes it harder for an aircraft to take off because as temperatures rise, air becomes less dense, so planes have a harder time generating the lift they need to become airborne. Also, Professor of Atmospheric Science at the University of Reading in the UK led the weather research on clear-air turbulence, i.e., turbulence without cloudiness or thunderstorms. Among his noteworthy findings he concluded that by 2050, the frequency of reported clear-air turbulence is expected to double, and the average strength of turbulence is expected to increase by 10–40 per cent. Moreover, severe turbulence at typical airplane cruising altitudes could become 2–3 times more common and more likely

to impact airspace over huge areas of the Northern Hemisphere.

Eliminate Plastic: Take Initiative Instead of Waiting for a New Treaty

Worldwide, more than 400 million tonnes of plastic are produced every year, of which about 200 million tonnes are manufactured for single use. Only less than 10 per cent of the remaining plastic is recycled and an estimated 19–23 million tonnes of plastic end up in lakes, rivers, and oceans every year. In the second session of the Intergovernmental Negotiating Committee to develop an internationally legally binding instrument on plastic pollution, including in the marine environment (INC-2) that took place during May 29 to June 2, 2023 at the United Nations Educational, Scientific and Cultural Organization (UNESCO) headquarters in Paris, UN Under-Secretary-General and Executive Director, UN Environment Programme (UNEP), Inger Andersen called upon the private sector not to wait for a new treaty, but to take initiative on transforming production and manufacturing processes for eliminating unnecessary plastic. In its thoroughgoing session, via Video, President of France, Emmanuel Macron,

described plastic pollution as a “ticking time bomb.” He called for greater innovation in creating new value chains for sorting, reusing, and recycling plastic, and urged incentivizing the private sector to move from linearity to circularity. He grieved the current practice of extracting fossil fuels for producing plastic, which is then discarded.

Jean-Luc Assi, Minister for the Environment and Sustainable Development of West African country, Côte d'Ivoire said that the scourge of plastic pollution has become a visible threat that impacts every community. It worthwhile to mention that World Environment Day in 2023 was hosted by Côte d'Ivoire in partnership with the Netherlands.

Before now, there were mechanisms such as Global Plan of Action of the Marine Environment from Land-based Activities, the UN Convention on the Law of the Sea, and the UN Food and Agricultural Organization Action Plan for Fisheries that existed but not implemented enough. Additionally, the Global Partnership on Plastic Pollution and Marine Litter (GPML) was launched at the United Nations Conference on Sustainable Development (Rio 20) in June 2012. However, there is still a pressing need for the implementation of multi-sectoral policies aimed at ensuring the



sustainable use of coastal and marine resources, along with the provision of adequate financing and the adoption of relevant technologies.

On March 4 2023, the countries agreed on the High Seas Treaty, aimed at protecting the world's oceans and also establish global rules to limit environmental impacts and create protected marine areas beyond national jurisdiction, which make up 95 per cent of the volume of the world's oceans. Such UN conventions have substantial benefits for the conservation of biodiversity, ocean revitalization as well as guarding climate—since these are codependent on each other.

Halt the Cycle of 'Oil-economy'

Even though, during UN climate summits, countries across the continents agree to reduce their carbon footprint and their dependence on fossil fuels, the global subsidy bills for fossil fuels reached an all-time high of USD 1.1 trillion in 2022 due to global energy crisis. Furthermore, according to Bloomberg report, fossil fuel subsidy was more than double the total investment as was there in renewable energy sources. Avoiding of such attitude is a must to accelerate efforts to phase out fossil fuel subsidies and to create a better future for generations to come by prioritizing sustainable solutions that promote coherence and prosperity. It is the time to stop supporting an oil economy that threatens our very existence.

UN COP28 Climate Summit: UAE as a Debated Pick

The United Arab Emirates (UAE) is going to host the 28th Conference of the Parties to the UN Framework Convention on Climate Change, i.e., COP28 in November 2023 at Expo City Dubai in order to unite the world towards agreement on bold, practical and ambitious solutions to the



most pressing global challenge of our time. Flipside, the UAE is one of the 10 largest oil producers in the world and according to the Organization of the Petroleum Exporting Countries (OPEC), their state oil company pumped 2.7 million barrels of oil per day in 2021. The UAE is widely being criticized for leading the COP28 climate summit because of being an OPEC member and one of the major oil exporter and some countries wrote to the UN calling for its removal while others such as the UK defended it. However, Dr Sultan Al Jaber, COP28 President-Designate said recently that the UAE approached this role with humility, a deep sense of responsibility and a great sense of urgency. He acknowledged the common risks of rising temperatures for all countries and looked at transformational change process for better climate. The country has targeted net-zero domestic carbon emissions by 2050 and spending billions to develop ample renewable energy to meet its needs. Also, one of the world's biggest solar plants in the UAE is likely to become fully operational this year prior to UN climate talks and the country has further plans for decarbonization. Businesses in France and the UAE have also invested more than USD 6 billion in this effort, which will be able to displace

approximately 10 million tonnes of CO₂.

Back home, India has been advocating phasing out of oil, gas, and coal. Also, various government corporations of the country like Indian Oil Corporation, Gas Authority of India, Indian Railways, etc., have also prepared their respective action plans in a time-bound manner towards achieving net-zero carbon emissions. In addition, large-scale work is being done for offshore wind-power, off the coast of Tamil Nadu and Gujarat, and large projects for solar power have also been in the pipeline. According to the Optimal Generation Capacity Mix report, the Government of India considered even greater scale of electricity generation, including installation of 300 GW of solar capacity by 2030, as drafted in the 'National Electricity Plan'. Likewise, one of the India's leading Renewable Energy Solutions Company, Fourth Partner Energy (4PEL), recently announced several solar power projects that are not only cost-effective but would also cut carbon emissions by around 4500 tonnes annually. ■

Dr Anil Pratap Singh, General Secretary & Founder Director, Global Science Academy (GSA), Basti, Uttar Pradesh; Website: www.gsaIndia.org



Urja Arpan Initiative

Getting Customers Aboard on the Need to Commit to Energy Efficiency

The brain behind the Tata Power-Delhi Distribution Ltd's (TPDDL) Urja Arpan initiative in the National Capital Region (Delhi-NCR)—**Rajeev Kharyal**, Head Customer Services, Key Consumer Group and Government Affairs, TPDDL, is a leader with his eye on an ambitious goal. Understanding that for a power distribution unit like the TPDDL to be financially sustainable consumer behaviour is key, he has introduced several energy efficiency initiatives. Apart from Delhi, this energy efficiency model is being replicated in Odisha as well under Demand Side Management (DSM) initiatives. Speaking to **Sushmita Malaviya**, he details the challenges to bringing down carbon emission and the mission that TPDDL is on to double its efforts to reach 300 million units (MUs) in three years.

Tell us about energy efficiency being the first fuel.

While India contributes only 5 per cent in carbon emissions, we at TPDDL have been following the global data very closely. The evidence is present that carbon dioxide levels have increased by nearly 50 per cent above pre-industrial levels. More importantly, carbon dioxide has never increased more than 30 parts per million (ppm) during any previous 1000-year period and that has already risen by 30 ppm in the past two decades. We also know that electricity and heat contribute 43 per cent to carbon emission and transport contributes 22 per cent.

Energy efficiency is the first fuel—the fuel you do not have to use—and in terms of supply, it is abundantly available and cheap to extract. But demand for the first fuel needs to grow, and that's where policy action matters the most. As a power distribution unit, we had to initiate activities aimed at raising awareness and committing to action.

What was the thinking behind launching of Urja Arpan?

Following Prime Minister Shri Narendra Modi's commitment at COP26 Summit in Glasgow that India would reduce the total projected carbon emissions by one billion tonnes from now till 2030, in Delhi we at the TPDDL knew that as a power distribution company we had to be first mover.

With a 19-lakh customer base we recognized our role as a major stakeholder in taking measures to begin the process of setting goals, planning and most importantly getting Delhi citizens on board. At the Central level, we worked with all the important stakeholders.

Additionally, we already had six proven energy efficiency steps that customers could easily switch to. They have the option to move to solar power, use five star rated air conditioners, brush less direct current (BLDC) fans, tubelights, and LED bulbs.



Who are your key stakeholders?

The Urja Arpan connects individuals and organizations to saving the planet. The initiative underscores at its key platforms—schools, Resident Welfare Associations (RWAs), residents of vicinity and Industrial Welfare Association (IWA) members and respective industrial and commercial customers—that energy efficiency is critical to the health and welfare of the planet. Urja Arpan plays on the Indian beliefs and values towards devotional offering to Mother Earth, that by making small changes to daily habits and investing in energy-efficient products, all Indians can contribute to a healthier, more sustainable future.

How did you begin to convince a customer base to begin to think about reducing carbon dioxide emission?

At the customer lever, in 2021, the initiative in the NCR was launched as Energy Efficiency. However, we could see that we were failing to get an emotional connect and we were able to convince only 2000 families. Going back to the drawing table, we began looking for a connect with people. The Urja Arpan initiative 'offer to mother earth' was launched on April 22, 2023— World Earth Day and pledged to a target of 300 million unit earned units. The target was

set keeping the focus on reducing 2.70 lakh tonnes carbon dioxide, which is the equivalent of 110 million fully grown trees that would mitigate the current rate of carbon dioxide emission in Delhi.

It was important to underscore to customers who were not using energy efficient equipment would mean that they were polluting the air. This caught customer attention. The initiative encouraged responsible and optimal electricity consumption through the use of energy efficient products.

The other was to persuade citizens to practise sustainable lifestyle for a greener tomorrow. It may seem easy for families to do the following—sit in a single room and use only one air conditioner instead of multiple AC(s), set the AC temperature at optimum level (24 degree), shift the usage of non-essential equipment such as washing machines, water motors, and microwave ovens.

So, how is Delhi faring?

In essence, TPDDL's Urja Arpan is an initiative to encourage responsible and optimal electricity consumption through the use of energy efficient products and services among individuals and organizations and persuade citizens for practising sustainable lifestyle for a greener tomorrow.

Our goal is ambitious—300 MUs. We knew we had to move backwards so the target for the first year was 90 MU. We are currently in the awareness phase. From our initial lot of 2000 customers, we have moved to 20,000 customers. The task is to expand the customer base to 1 lakh and we have to double all our efforts to reach this goal. Therefore, the focus is to convert awareness into action. Every summer air conditioners and fans are being bought and the effort is to make customers buy energy efficient one. Unfortunately, the sale of BLDC fans is yet to pick up and that could help customers contribute to energy efficiency.

Designed to reach this target, the TPDDL has started awareness programmes with five schools in Delhi, roped in the Brahmakumari's Shivani Di—to speak about the importance of practicing energy efficiency—starting with the smallest steps. We are moving towards identifying more influencers.

Who do you think have been your greatest influencers?

School students in Classes 6 to 9 of five schools in Delhi have emerged as the 'energy efficiency' influencers who have been nudging important decisions at home. The first few schools to take up the 'energy efficiency' challenge were Rukmani Devi Jaipuria Public School, Civil Lines; Prabhu Dayal Public School, Shalimar Bagh; CRPF Public School, Prashant Vihar; Adarsh Public School, Bali Nagar; and GD Goenka Public School, Rohini. We have information that when



an electrical gadget has to be replaced in a household, children are helping parents make the decision to move to energy efficient ones!

How have NCR customers responded to the Urja Arpan initiative?

Initially customers would plea that when children come back from school, they (parents) like to have the air conditioners on. Also, air conditioners need to be functional in individual rooms. We addressed a host of such pleas through individual calls to the prospective customers. This was followed through more phone calls to individual customers through the Demand Response project. Customers were informed about energy efficiency and demand response and requested to reduce their consumption. When we called customers with an emotional appeal to save the environment by reducing electricity consumption, the customers responded positively.

Tell us more about how customers are rewarded for taking affirmative action.

TPDDL has also launched an array of digital initiatives for the safety and convenience of its customers. Through an awareness, engagement and reward cycle, customers who opt for solar panels expressing a commitment of 20 years are awarded platinum membership, customers moving to electrical vehicles which shows a 10–15 year commitment are awarded a diamond membership. Those moving to tubelights and LED bulbs are awarded gold membership. Anyone from the NCR who opts for energy efficiency can log into <https://urjaarpan.com/registration/> to commit their pledge.

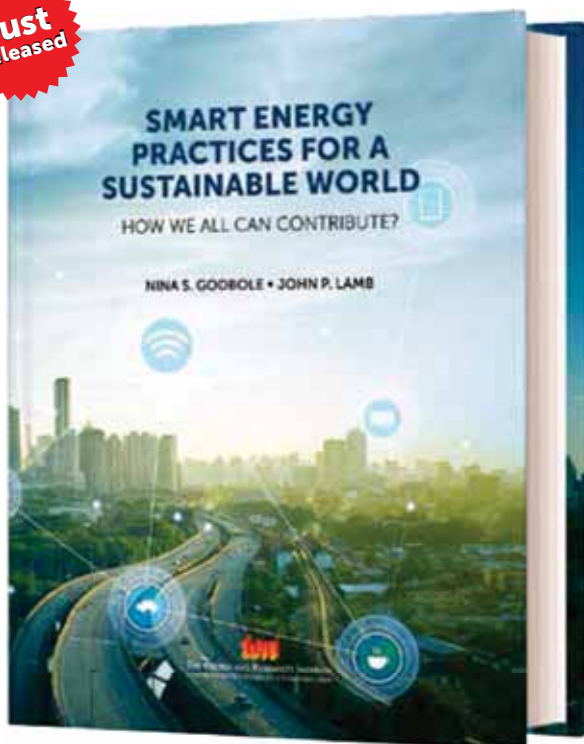
As a citizen, what did you learn from Urja Arpan?

At personal level, I am a Life skills coach and climate change catalyst and Urja Arpan aims to foster climate consciousness and awareness among citizens of all age groups, promoting a sustainable future through widespread outreach. Behaviour Demand Response, driven by Emotional Quotient (EQ), seeks to facilitate energy conservation. Additionally, the initiative advocates for the adoption of Energy Efficient Products as a smart choice and promotes solar and electric vehicles for a greener and sustainable tomorrow. Hence, this movement aims to bring the entire society for contributing in their own ways towards energy efficiency. ■



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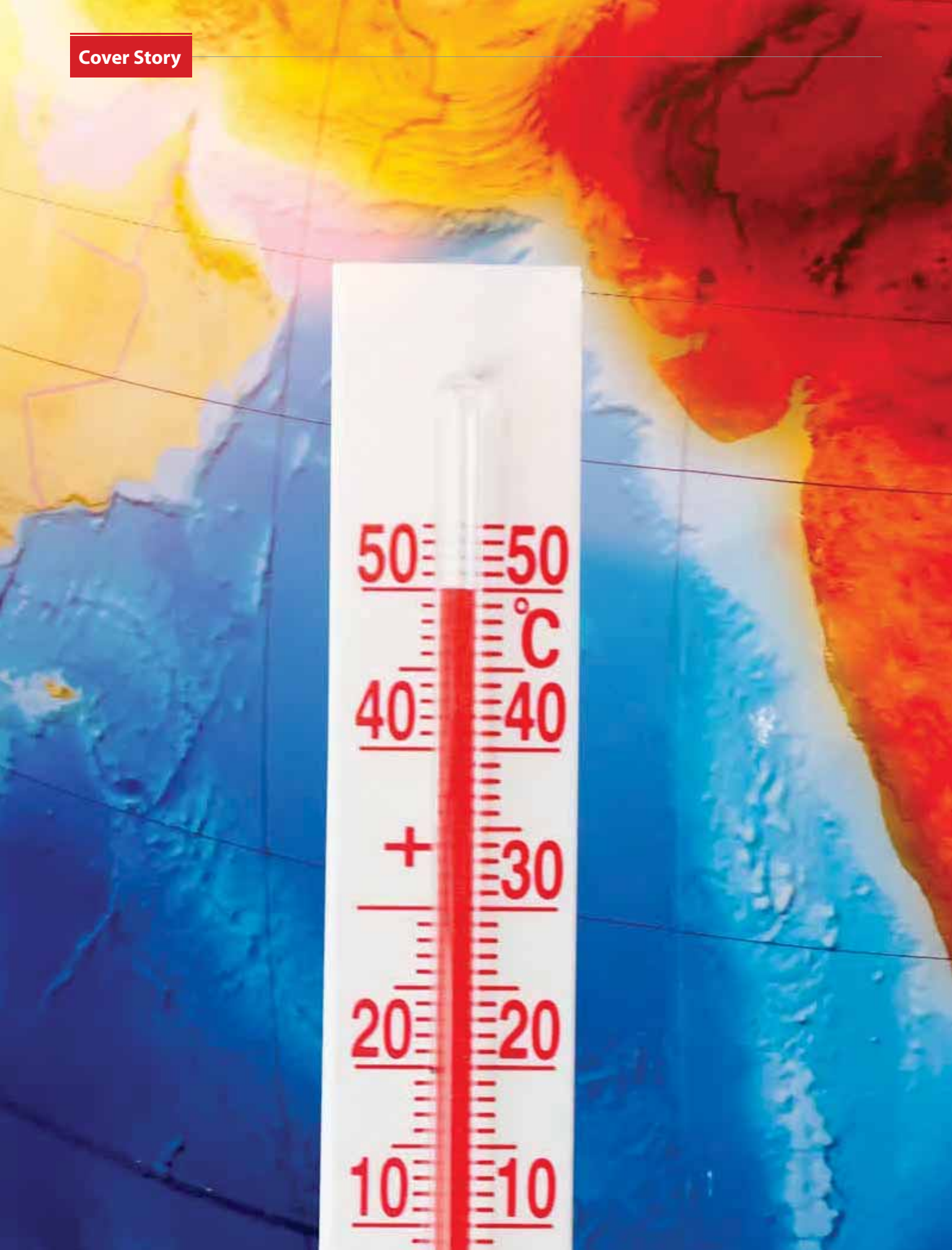
This book stresses the need for us to judiciously, sustainably, and smartly harness and use energy techniques in order to effectively combat climate change. The book also gives an in-depth discussion on utilization of artificial intelligence and information technology to realize energy efficiency in various sectors of economy including such as transportation, buildings, infrastructure, health care, and other services.

Text is supplemented by case studies that depict ground-level reality to facilitate comprehension of the subject matter. The appendices serve as an extended learning of the concepts discussed in the chapters. The publication would serve as a valuable reference for both scholars and researchers engaged in the domain, in addition to, being a guide to industry and the academic world.

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Heat Waves and Action Plans

How Does India Fare?

While preparedness, alerts and warnings, and other measures of heat action plans have vastly reduced the impact of heat waves, the duration and frequency of climate-induced heat waves are on the rise. **Jency Samuel** says that as heat waves impact people's health and livelihood, and the nation's economy adversely, there is a need to improve and better implement the heat action plans.



The World Meteorological Organization announced in mid-May this year that global temperatures would increase to record levels in the next five years, caused by greenhouse gases and El Nino. In April this year, the world has witnessed how lives were impacted in India and many South Asian and Southeast Asian countries owing to intense heat waves.

Consequently, the high temperatures continued in May and June, as recorded at some places in India. An update on this shows the temperature rise across few cities. On 23rd May, Delhi recorded 45°C. During May, temperature recorded in Chennai was around 40°C or more and the same condition lasted for more than two weeks; and incidentally the same weather condition continued till almost the middle of June 2023 as on June 20, 2023. In May, Jaipur recorded 40°C or more at a stretch for 11 days. In June, Lucknow recorded 40°C or more consecutively for 14 days as on June 20.

This would be exacerbated as a recent multi-country study has revealed that the likelihood of human-induced climate change causing such heat waves is 30 times higher.

What is a Heat Wave?

“Heat wave is a period of abnormally high temperatures, more than the normal maximum temperature of a place,” is how the National Disaster Management Authority defines it.

“Normal temperature refers to a 30-year average. Every day the temperature of a place is recorded. The normal temperature of a particular day, let’s say June 15, is calculated by taking the average of the temperatures recorded on June 15 over 30 years,” says Dr S Balachandran, the head of Regional Meteorological Centre, Chennai, one of the centres of the Indian Meteorological Department (IMD).

The entire discourse on heatwave happens on the basis of certain criteria comprising the temperature range. “If the maximum temperature of a place reaches at least 30°C for hilly regions, 37°C for coastal regions, and 40°C for interior plains, then it is considered as heat wave. That is the threshold value,” adds Dr Balachandran. “One of the criteria is, if the departure





from normal temperature is 4–6°C, it is considered a heatwave and when it exceeds 6°C, it is considered a severe heat wave.”

The other criterion is to consider the actual maximum temperature. If the temperature is 45°C or more, it is a heat wave condition, and if it is more than 47°C, it is a severe heat wave condition.

What Causes a Heat Wave?

Winds generally cause the circulation of air. But sometimes it gets trapped due to high pressure, which happens commonly in summer. “Depending on the direction in which air circulates, we call it cyclonic circulation (it is not a cyclone) and anticyclonic circulation. Anticyclonic circulation involves high pressure accumulating over an area and sinking of air towards the ground. When air comes down, it gets compressed,” says Dr Balachandran.

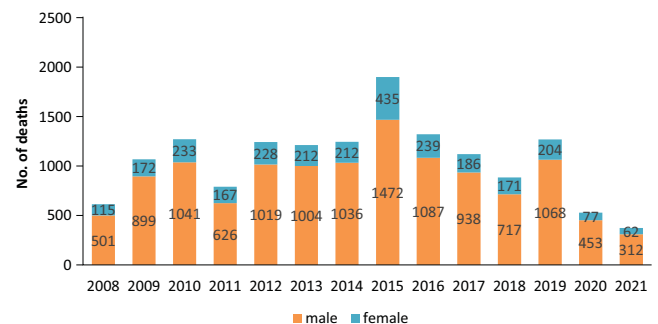
The air also heats up as it sinks. For every 100 metres the air sinks, the temperature increases by 1°C. “The sinking air acts like a dome and prevents vertical movement of air. The conditions lead to loss of moisture in the air and cloudless skies. Without the clouds, the sunlight hits the earth directly,” says Dr Balachandran. “In coastal regions, sea breeze and land breeze play a role. When land breeze, which blows from the land to the sea in the morning, is stronger, sea breeze cannot blow into the land in the evening. This results in prolonged heat over the land.”

Various factors combined together may result in heat waves. But qualitatively heat wave is a condition of air temperature which becomes fatal to human body when exposed (Source: IMD).

Impact on Health

Heat waves have been increasing across the globe, which has immensely impacted lives. Between 1998 and 2017 more than 166,000 people died due to heatwaves, according to the World Health Organization (WHO).

In 2021, in India, out of the 7000-odd accidental deaths caused due to forces of nature, 374 deaths happened due to heat/sunstroke, as per the report of the National Crime Records Bureau (NCRB). Between 2015 and 2019, 20 transgenders lost their lives, as per the NCRB data (which is not indicated in the chart below). Many argue that the NCRB data does not truly reflect the heat-related mortalities. This also raises the issue of unreported data, and therefore the data reported in NCRB may not reflect the real life scenario in its entirety.



“In India, normally heatwaves occur in the northwest—from Rajasthan to Uttar Pradesh and Madhya Pradesh—and in Odisha, Andhra Pradesh in the east. This is the core heat wave zone,” says Dr Balachandran.

Among the states heat/sunstroke was the dominant cause in Telangana, where 43 of the 112 accidental deaths occurred due to forces of nature—heat/sunstroke, as the state falls in the core heat wave zone. In 2020 also, Telangana had the most heat/sunstroke deaths among the states, with 98 deaths.

A team of researchers at Banaras Hindu University analysed monthly, seasonal and decadal variations along with long-term trends of heat waves and severe heat waves for pre-monsoon (March–May) and early summer monsoon (June–July) season during 1951–



2016 and found a southward expansion in heat wave events, explaining the mortality in Odisha and Andhra Pradesh as well.

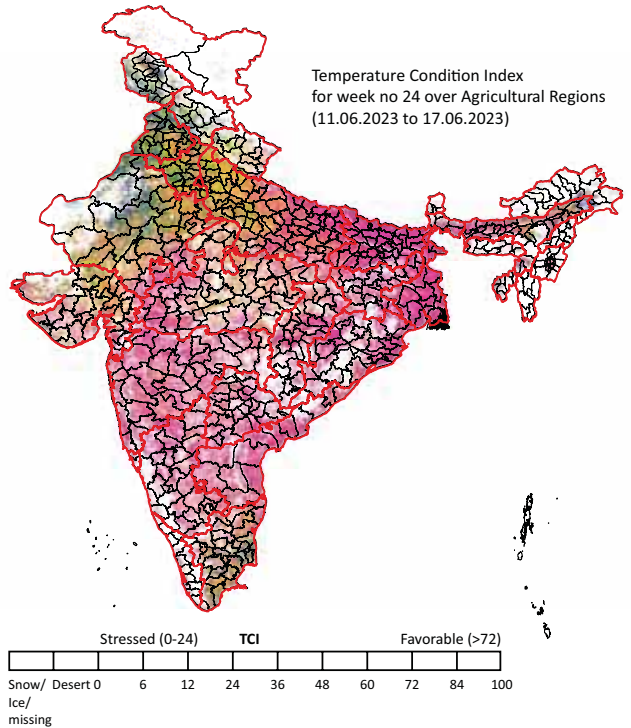
Heat waves result in many illnesses such as heat cramps and hyperthermia, besides making chronic illnesses worse, according to WHO. While such is the impact on human health, heat waves cause a host of other problems as well.

Impact on Agricultural Sector

The Agriculture Meteorology Division of IMD, Pune, offers regular weather reports for the benefit of the farm sector. The division calculates the Temperature Condition Index (TCI), which is used to indicate the stress on vegetation caused by temperature and extreme wetness. While the TCI remained favourable across most states in the first week of April, it had become stressed by the third week of June, as shown in the figure, indicating the likely adverse impact on crops.

According to *State of the Global Climate 2022* report, published by World Meteorological Organization, pre-monsoon period was exceptionally hot in India, and grain yields were reduced by the extreme heat. Not only were the maximum temperatures higher in many states in March and April last year, but the minimum temperatures were also higher. This led to reduced yields in many states.

In Punjab, the heat wave events led to yellowing and shrivelling of wheat grain, besides forced maturity,



resulting in up to 25 per cent reduction in yield, according to *Heat Wave 2022*, a report published by Indian Council of Agriculture – Central Research Institute for Dryland Agriculture (ICAR-CRIDA). The increased temperature also led to whitefly infestation,





reducing green gram yield by up to 20 per cent. Some districts in Punjab had an increase in fall army worm attack. This study also reports reduced yields in maize in Punjab, chickpea in Himachal Pradesh, besides wheat and chickpea in Haryana and Madhya Pradesh. In Uttar Pradesh, reduced yields were recorded in wheat, cow pea, and mustard. Horticultural crops including lemon, mango, onion and cauliflower were impacted in Punjab, Madhya Pradesh, Bihar, Marathwada, and Rajasthan.

Impacts on Economy

Such widespread impact on crops naturally impacts the economy. It is a vicious circle cycle of scarce water, increased electricity needs for cooling purposes, increased public health expenditure, and reduced labour productivity. Socioeconomic factors play a critical role in the extent of the impact.

“Heat waves affect the vulnerable citizens and people such as vendors, construction workers and farmers, who work outdoors,” said Dr Emmanuel Raju, Copenhagen Center for Disaster Research at the University of Copenhagen, and one of the authors of the World Weather Attribution study, during a media briefing.

Assuming a global temperature increase of 1.5°C by the end of the 21st century, the International Labour Organization (ILO) estimates that by 2030, 2.2 per cent of total working hours will be lost due to heat stress. Among the South Asian countries, India is affected the most by heat stress, which lost 4.3 per cent of working hours in 1995 and is projected to lose 5.8 per cent of working hours in 2030.

Given the region’s role as an economic hub for manufacturing, the impact of extreme heat events propelled by climate change will be highly disruptive to

the economies in the region, with global implications.

The Economic and Social Commission for Asia and the Pacific (ESCAP) Asia-Pacific Disaster Reports 2021 and 2022 estimate that in Asia, the annual investment in adaptation would need to be highest for China, at USD 188.8 billion, followed by India at USD 46.3 billion, and Japan at USD 26.5 billion. As a percentage of the country’s GDP, the highest cost is estimated for Nepal, at 1.9 per cent, followed by Cambodia at 1.8 per cent, and India at 1.3 per cent.

The Climate Change – Heat Wave Connection

Following the heat waves in India and South Asian countries, World Weather Attribution (WWA), which is an international group of climate scientists, analysed the event. The scientists analysed weather data and computer model simulations to understand the impact of climate change on the Asian heatwave. They analysed the average maximum temperature and maximum heat index for four consecutive days in April across south and east India and Bangladesh. The heat index is a measure that combines temperature and humidity and reflects more accurately the impacts of heatwaves on the human body. According to their study, human-induced climate change made April’s humid heatwave in India—besides in Bangladesh, Laos and Thailand—at least 30 times more likely.

Another analysis by Climate Central, an organization that simplifies and communicates climate science, after the three-day extreme heat event in Uttar Pradesh between June 14 and June 16, 2023, showed that the heat wave was made at least two times more likely by human-induced climate change. The Climate Central

analysis uses Climate Shift Index (CSI), which quantifies how climate change contributes to daily temperatures.

“CSI goes from -5 to +5. A score of 1 indicates that the temperatures are 1.5 times more likely because of climate change. We use level one as a threshold for detectability. Level 2 indicates conditions are two times more likely, and so on,” observes Dr Andrew Pershing, Director of Climate Science at Climate Central.

Besides Uttar Pradesh, most locations across India experienced significant CSI levels during the same period. “We usually use CSI 2 as the basis to indicate significant level. India has had strong CSI signals for more than a month. The western coast including Mumbai and Goa have had lots of days with CSI 5,” notes Dr Pershing.

“Weather observations and models showed an increasing likelihood in humid heat wave, such as the one that we witnessed in April,” said Dr Mariam Zachariah, researcher at Grantham Institute, Imperial College, London, and one of the authors of the WWA study, during a media briefing. The heat wave risks will increase because of the warming climate and El Nino, warn scientists. “When Pacific Ocean is warmer than normal, we call it El Nino. But El Nino characteristics will vary depending on how much the surface temperature is warmer than normal and also whether it starts in winter or in pre-monsoon season,” says Dr Balachandran. “Research shows that heat wave duration and frequency are more during El Nino.” Administrators come up with different measures to counter the situation.

Heat Action Plans

In 2013, Ahmedabad became the first city to create a heat action plan, following a heat wave that resulted in nearly 4500 fatalities in May 2010.

In 2016, the central government drew up guidelines—which were revised in 2017 and 2019—so that states could use them as a framework and develop



their own heat action plans (HAPs). Subsequently, state and city level HAPs have been created. HAPs are strategies that help state governments and city administrations to prepare for heat waves, based on forecasts, and take up mitigation measures. “IMD makes daily, weekly, and monthly forecasts. We share the same with administrators who disseminate through various means,” says Dr Balachandran.

HAPs include sensitizing the public, putting up early warning systems, issuing colour-coded alerts and warnings, and advising the public on preventive measures. Other measures include urban greening, heat resilient infrastructure such as cool roofs, especially in low-income settlements.

Though HAPs have vastly improved health implications and reduced mortalities, as can be seen from the data, there is a lot of room for improvement.

Overcoming the Lacunae

“Implementation of heat action plans is slow. It needs to be an absolute priority adaptation action,” says Dr Friederike Otto, a researcher at Imperial College, London and co-lead of World Weather Attribution.

Centre for Policy Research (CPR), a Delhi-based think tank, studied 15 state level, 13 district level and nine city level HAPs across 18 states, and released a report in March 2023. While the study finds HAPs having a balanced mix of short- and long-term actions, there is a lack of information on implementation.

CPR’s recommendations include tailoring heat wave threshold values for local conditions, shifting from vulnerability assessment to holistic risk assessment, responsibility in implementation, and conducting external evaluation and making the implementation data available to the public.

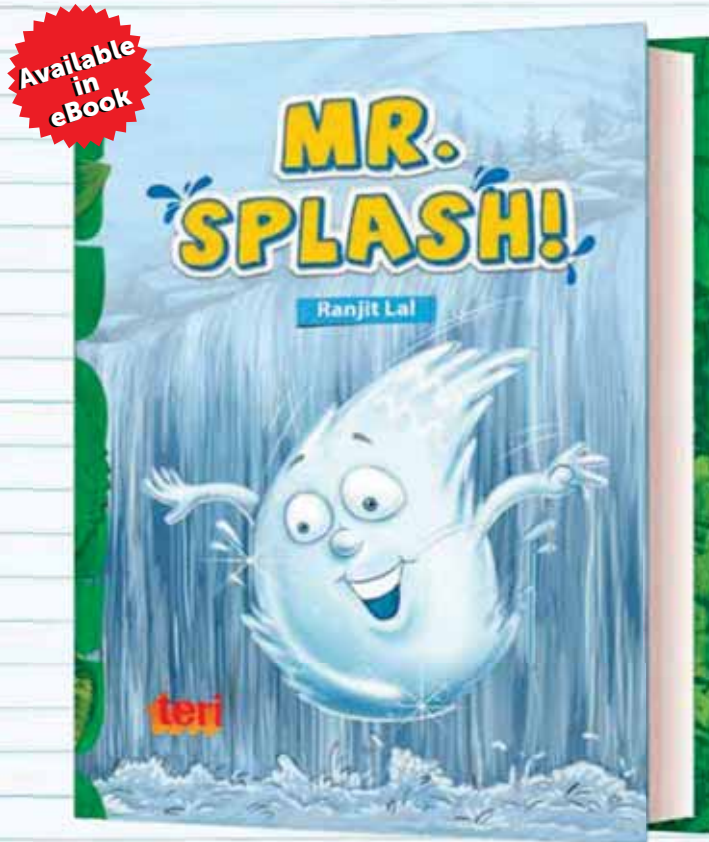
Assessment of Climate Change over the Indian Region, a Ministry of Earth Sciences report, suggests more research on how the intensity of a heatwave event has changed as a result of increase in atmospheric greenhouse gases from human activity. Since the temperature observation sites across India are not evenly distributed, it may lead to errors in the assessment of present-day temperature changes, particularly over the north that has a sparse network, and hence needs to be addressed, says the report.

Experts emphasize that addressing the existing lacunae such as the ones indicated, improving our forecasting further, in addition to bettering and better implementation of heat action plans, are imperative to tide through climate-induced heat waves. ■

Jency Samuel regularly contributes articles in TerraGreen.

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The Age of Drones

Powering India to a New Paradigm

In this article, **Anish Michael** and **Roshan Toshniwal** highlight how drones are poised to redefine the future of mobility and become integral components of the urban ecosystem. Commercial drones have the potential to revolutionize the aviation landscape by providing sustainable and innovative solutions, thereby reducing the need for more resource-intensive processes. The disruptive power of drones is expected to significantly reshape various sectors.

“Successful technologies always begin as hobbies...,” says renowned physicist Freeman Dyson in his book, *Imagined Worlds*. Pursuing interests beyond the mundane routine of repairing bicycles, led the Wright Brothers to invent motorized aeroplanes. Today, air travel has become an indispensable part of our

lives connecting the world and impacting global economies. Similarly, drones and related technologies that began as a hobby are at a cusp of disrupting the world order.

Drones are set to redefine the future of mobility and become an integral part of the urban ecosystem. The gradual

liberalization in commercial drone regulations is redefining the future of mobility in the urban ecosystem to efficiently enhance services for numerous applications spanning across agriculture, construction, logistics and delivery and emergency services, and even data collection to improve surveillance among





others. However, drone operations are complex and require advanced softwares and hardwares in addition to a good telecommunication network.

Since drones are customized based on different requirements ranging from payload, batteries, sensors and data storage among other things, Drones-as-a-Service (DRaaS) as a business model could thrive as a solution. This will appropriate customized service requirements based on the demands eliminating the need for an investment in drones, hardware or software, pilots and even training programmes to ensure time and cost efficiency for end users.

DRaaS can enable collaboration across multiple service providers in specific regions listed over limited platforms to deliver services. Proliferation of 5G services further generates new possibilities that will revolutionize the lower airspace. Superfast connectivity,

enhancing reliability and precision movement, will help assemble next-generation, high performance, and power-efficient drones. Hence, Information and Communication Technology are essential for growth and safety of the drone ecosystem.

In addition to defence, drones can potentially transform hyperlocal logistics and deliveries, especially for smaller and lighter packages such as medicines, food, and groceries. Drones can optimize the supply chain by reducing time taken to pick goods from local distribution centres to deliver at restaurants and other end points and the last mile to be made manually. Though the last mile will be done by delivery agents to limit handling of drones, it is a first step towards an automated delivery system for logistics in India, which will potentially save on transportation cost and time.

Contrary to popular belief, the use

of drones in logistics is expected to create more jobs as the urban built environment with multi-storey buildings and high density will continue to need delivery agents for delivering the package accurately. Skilled handling of drones will entice new skills among delivery agents and its end use will remain in the business-to-business segment until the ecosystem matures. Further, as drone usage increases, the demand for skilled pilots arises, which in turn impacts the entire value chain right from manufacturing to operations. The Government's Production-Linked Incentive (PLI) scheme for drone and drone component manufacturing, further augments the job prospects for the sector.

The introduction of the PLI scheme in October 2021, with an outlay of INR 120 crore for three financial years and until March 2023 INR 30 crore has

been disbursed to 23 beneficiaries under this scheme. This is a shot in the arm for indigenous drone and drone components. In addition, the government's decision to ban import of drones, except for the purpose of defence, security and R&D, gives a big boost to local manufacturers. While manufacturing and infrastructure is critical, emerging business models for diverse applications could mark the beginning of a future with drones. As drones are an evolving technology, the DRaaS model will enable end users to take advantage of its capabilities and latest technology without owning and taking necessary licenses to operate.

The use of drone technology as a service is still at a novel stage and there are several challenges to overcome before it becomes ubiquitous in our skies. While rapid technological advancement has provided cutting-edge services,

they however come at a premium. The Government, cognizant of the high costs, has initiated processes to aid and assist the uptake of drones. For instance, a funding guideline was provided for the agricultural sector to make drones affordable.

Similar initiatives in building the service capacity in other sectors will also help in bridging the overall social acceptance gap. Goa, for instance, has been the first mover in this space by drafting a Drone Policy with future roadmap and opportunities for taking leadership. The policy envisions to promote and facilitate design, manufacture, testing, maintenance and position itself as a skilling destination for drone-related use. The policy also envisions to encourage innovative delivery solutions apart from building institutional and academic capacity. Tamil Nadu too has taken lead in setting up

training centres for drone pilots in the backdrop of the utilization of drones, which was on the rise in various sectors including agriculture, law and order, surveillance among others. The state aims to produce 2500 pilots every year. As use cases expand, a consolidated approach by all stakeholders coupled with prioritizing privacy and insurance elements will be key to the wider proliferation of the sector.

Drones are set to dictate the coming decade as they trickle their way to a wide array of sectors—agriculture, transport, health, mining, construction, etc., that are discovering their value addition. Going forward, there is a need to build resilience to the drone sector. An appropriate financial structure, along with the requisite resources, needs to be established along with extensive support for research and development. A specific fund could also be created for the sector.

Photo courtesy: Miguel Angel Hernandez@httpsunsplash.com



Further, safety and quality standards along with appropriate knowledge transfer through upskilling needs to be prioritized and implemented through ITIs. Such a framework will help expand capabilities to several on-demand applications providing an inflexion point for creating more jobs from pilots, R&D, analyst, skilled technicians, etc., and building indigenous capacity for a global audience.

Drones operating seamlessly in safe airspaces face challenges and will find solutions as operations expand. Further, technical challenges are going to come to the forefront before drones become ubiquitous. Limited battery capacities, obstacle detection, and unpredictable events such as weather are a few challenges that will be overcome as the industry evolves. The current upbeat mood in the industry will only help in navigating through these challenges. Going forward, a consolidated approach by all units coupled with prioritizing privacy and insurance elements will be key to the growth of the sector. A push towards Atma Nirbhar Bharat will further boost the industry with less reliance on imports that in turn will help building resilience to the drone sector.

Given the nascent stage, insurance in the sector becomes vital. As the adoption of drones for commercial purposes grows, the risks involved are also set to increase. As per Rule 44 of Drone Rules, 2021, all drones larger than 250 grams are mandatorily required to have third-party insurance. In the recent past, there has been a flurry of activities in the insurance sectors specific to the drone segment. Drone insurance can also help farmers leverage the data collected and help to file a claim for crop insurance in case of damages. Currently, most drone operators in India have minimum levels of insurance like the third-party liability cover instead of a comprehensive coverage. However, comprehensive coverage covers risks like damage to hull cover, payload cover, equipment cover, personal accident

Photo Courtesy: Yuhan Chang@httpsunsplash.com



cover, medical insurance cover, and third-party liability. However, this is yet to pick up in India. What is essentially happening is that most of the drones till now are only being assembled in India and not manufactured. The parts that are manufactured outside are being brought to India and assembled in India. It is plug and play in India. And the parts tend to be very expensive.

Commercial drones can transform the aviation landscape, offering sustainable and innovative solutions, which would otherwise require a more intensive process. The disruptive power of drones is set to radically reshape several sectors. The favourable regulations, strong vision

for the sector and the growing value chain will unlock economic opportunities and innovative practices for drones. Drone Shakti could very well be the wormhole that catapults India to new heights. Drones are set to be a game-changer powering India's upward growth trajectory—giving rise to the Age of Drones! ■

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Glacial Lake Outburst Floods

Increasing Risks in the Himalayas

Glacial lake outburst floods (GLOFs) occur when water stored in a glacier-fed lake formed at the side, front, within, beneath, or on the surface of a glacier is suddenly released. In this article, **Mohammad Imroz** says that the retreat of mountain glaciers due to climate change is a visible indicator of global climate change. The risk of glacial-related hazards, including GLOFs, increases as glaciers melt in high mountainous regions. Climate change is a cause of concern in this aspect due to the potential increase in GLOFs. Keep reading to know more...

Climate change, also known as climate transformation, refers to changes in the planet's typical climate in terms of temperature, precipitation, and wind that are primarily caused by human activity. The global climate has always fluctuated. It is changing, however, much faster than in the past, and this time it is due to human activity. The use of fossil fuels such as coal, gas, and oil for transportation, energy production, and industry contributes significantly to climate

change. Climate change is not a new phenomenon, but little appears to have been done to address it on a global scale. The Himalayan region is grappling with serious consequences of climate change, which are posing a threat to water, food, and energy security. Despite efforts to limit global warming, alarming projections of significant glacier loss by 2100 suggest that water scarcity, food shortages, increased disasters, biodiversity decline, pandemics, and poverty will result. Meeting the 1.5°C

target appears unlikely, given the region's current warming rate of 0.2°C per decade, which is expected to exceed the global average by 0.3–0.7°C in the future.

Climate change has far-reaching repercussions for natural systems and particular regions, including the Hindu Kush-Himalayan region. Mountains around the world are particularly vulnerable to the effects of rapid climate change. Because of global warming, the region's sensitive glaciers are melting at a faster rate, resulting in rising sea levels, altered river flows, and threats to downstream water resources and ecosystems. Furthermore, the region is vulnerable to natural hazards such as landslides, avalanches, and glacial lake outburst floods (GLOFs). These occurrences pose significant risks to human settlements, infrastructure, and regional ecosystems.

According to a recent global assessment, approximately three million people in India live in areas where a GLOF is imminent. Furthermore, two million people in Pakistan are at risk, accounting for one-third of the global population exposed to such hazards. The study, which was published in *Nature Communications* on February 7, 2023, claims that 90 million people live in 1089





basins with glacial lakes around the world. Among them, 15 million people (16.6 per cent) live within 50 kilometers of a glacial lake.

Glacial Lake Outburst Floods

GLOFs occur when water stored in a glacier-fed lake formed at the side, front, within, beneath, or on the surface of a glacier is suddenly released. The retreat of mountain glaciers due to climate change is a visible indicator of global climate change. The risk of glacial-related hazards, including GLOFs, increases as glaciers melt in high mountainous regions. As glaciers recede, glacial lakes form behind moraine or ice “dams,” but these dams are relatively unstable and can fail unexpectedly. This failure can result in the rapid discharge of millions of

cubic metres of water and debris, causing devastating floods downstream, severe property damage, and life-threatening situations. In the Himalayas, GLOFs exhibit various types discussed here.

Supra-glacial GLOFs

These occur when water accumulates on the glacier’s surface from melting or precipitation, forming a lake. Sudden water release happens when the ice or debris dam gives way.

Ice-dammed GLOFs

Ice-dammed GLOFs refer to the phenomenon where glacial lakes are obstructed by ice, typically caused by a glacier or an ice avalanche. These GLOFs occur when the ice dam holding back the water in the lake collapses or weakens, leading to the sudden release of a significant volume of water downstream.

Moraine-dammed GLOFs

Glacial debris forms moraine dams, and lakes accumulate behind them. Overtopping, erosion, or seismic activity can lead to the rupture of the moraine dam, causing a rapid release of water.

Rock/landslide-dammed GLOFs

Glacial lakes can also be dammed by rock or landslide deposits. Failure of these natural dams can result in significant floods downstream.

Combination GLOFs

In some cases, multiple factors contribute to the formation and subsequent outburst of glacial lakes. A supra-glacial lake, for example, can form on a glacier, and later, a landslide or rockfall event can further impound the lake.

A combination of GLOF can be

triggered by the failure of either the ice dam or the debris dam. It is critical to recognize that these categories are only broad classifications and that the specific processes and dynamics of GLOFs may differ across the Himalayan region. Glacial morphology, climate conditions, topography, and local geology all have an impact on the unique characteristics of each GLOF event.

Climate change is a cause of concern in this aspect due to the potential increase in GLOFs. Rising temperatures cause new lakes to form, existing lakes to expand, and existing lakes to merge, increasing the risk of high-volume floods in mountainous areas. There are 9575 glaciers in the Himalayan region adjacent to India, making several Indian states vulnerable to GLOFs. It is estimated that 200 glaciers are vulnerable to outbursts. According to recent research, the eastern Himalayan region has the highest GLOF risk, with a risk level at least twice that of adjacent regions. These scientists also predicted that increased lake formations would nearly triple the hazard potential in this zone. The first reported GLOF in the Indian Himalayan region was in Jammu & Kashmir in 1926. Two instances of sudden emptying of moraine-dammed lakes were observed in Himachal Pradesh in the 1980s. When the Chakrabarti glacier melted in 2013, Uttarakhand experienced an unprecedented flood,

resulting in the tragic loss of over 5000 lives.

Researcher Dr Shakeel Ahmed Romshoo has done an extensive research on Himalayan glaciers and found that out of 2000 glacial lakes, more than 200 are at risk of bursting. Furthermore, catastrophic glacial floods threaten approximately 30 per cent of Uttarakhand. In the Hunza Valley, which is situated within the Hassanabad glacier system, a series of glacial lake outbursts has been recorded in recent years. These incidents occurred specifically in 2019, 2020, and 2022. And one of the most notable incidents was the 2013 GLOF event in Uttarakhand, which caused widespread devastation and the loss of thousands of lives. This event highlighted the region's vulnerability to GLOFs and the importance of effective monitoring and early warning systems to mitigate the risks associated with glacial melt and potential outburst floods. A significant glacier detachment occurred in Chamoli district, Uttarakhand, in 2021, resulting in a devastating flood that caused extensive damage. There have been numerous reports of people going missing near the Alaknanda and Dhauliganga rivers. According to subsequent reports, the event was a GLOF.

GLOFs and associated impacts are becoming a common occurrence in Himalayan region. The subsequent

section presents some strategies that can be adopted to minimize the impacts.

Strategies that can be Implemented to Minimize the Impacts of GLOFs

Identification of potentially hazardous lakes: Potentially hazardous lakes, as well as any other underlying physical issues, can be identified through field observations, historical records, and analysis of the lake or dam's geotechnical and geomorphological features, as well as its surroundings.

Improvement of early warning systems: Glacial Lake Outburst Flood Early Warning System (GLOF EWS) implementation and operation are limited globally. However, two documented cases of sensor and monitoring-based technical systems being used for GLOF early warning in the Himalayan region, one in Nepal and one in China, have been documented. Emergency response team: In remote areas where road access is limited, it is essential to establish Quick Reaction Medical Teams, mobile field hospitals, Accident Relief Medical Vans, and Heli-ambulances to provide medical assistance.

Empowered local manpower: In addition to specialized forces such as the NDRF, ITBP, and the military, there is a need for trained local personnel who can help with tasks like planning and setting up emergency shelters, distributing relief supplies, locating missing people, and addressing food, healthcare, water, sanitation, and other necessities.

Land use planning: There is a need to establish regulations for land use planning, ensuring careful monitoring of infrastructure development in downstream areas throughout the entire construction process. ■

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Terra Youth

Joining Hands
for a Greener
Tomorrow

Green Autorickshaws

An Urgent Need

In this article, **Ram Ramprasad** says that India can convert its 8 million autorickshaws to solar power with organic batteries by 2025 with zero reliance on the grid. This will be revolutionary.

In 2016, Naveen Rabelli, a young automotive engineer had a big dream. After experimenting with three prototypes, and a lot of his own money, he finally built himself a solar-operated autorickshaw (tuk-tuk) and drove 14,000 kilometres from Bengaluru to London to create awareness on a pollution-free vehicle as well as show case his invention at a carbon free expo. At a young age, he was inspired towards a zero-emission 3-wheeler since it transported millions of people to the destinations of their choice within urban and rural India. Plus, it provided millions of jobs to drivers. Seven years have passed since Naveen's first invention of a zero-emission 3-wheeler—his dream of India having emission-free autorickshaws that did not depend on the electric grid is yet to materialize. There are a few small

developments happening such as the Mahindra Electric Mobility that recently launched its 3-wheeler, L3, that has a load capacity of 310 kg, costs USD 1920 and has a speed of 25 kph. It is useful for light cargo, but not practical for a person who drives an autorickshaw for a living. Honda Motors recently started an outfit in Bengaluru where autorickshaws could rent a lithium-ion battery. Reliance on our electric grid has still not gone away.

India currently has about 8 million autorickshaws on its roads; they are quite ubiquitous in the urban cities of India—often noisy and polluting. About, 1.5 million of these are battery operated. The combined number of two- and three-wheelers in India is about 210 million—a golden opportunity to make them one hundred per cent “green”.

Strategy for Developing Green Autorickshaws

Rapid advancements in solar-powered vehicles and the development of organic radical batteries (ORBs), offers India a plethora of opportunities to capitalize on. For example, Squad, the world's first solar city car is used for daily urban mobility in the Netherlands for short errands. It charges itself by using the solar panels on its roof. If Squad has been a success in the Netherlands, it certainly has great promise in India with sunshine all year round. Plus, flexible organic photovoltaics (OPVs) offer the advantage to cover even the sides of an autorickshaw. These OPVs can then charge the organic radical batteries (ORBs)—practically zero reliance on our coal dominant grid.

Today, most electric vehicle (EV) batteries rely on lithium-ion that also uses cobalt, nickel, and other heavy metals—supplies of these precious minerals are limited; mining them is often hazardous, relies on child labour, and regions from where they are sourced are subject to geopolitical volatility. Aware of these issues, start-ups are armed to mine our ocean floors and the moon for these minerals. Deep sea scientists have warned about the dangers of deep sea mining. Some organizations and individuals have also expressed serious concerns on mining the moon



Several advances in non-lithium ion batteries are emerging. For example, Texas A & M University, USA, has made a breakthrough in polypeptide organic metal free biodegradable batteries. Researchers at the same University have also discovered a 1000 per cent difference in the storage capacity of metal-free, water-based battery electrodes. Their findings were published in *Nature Materials*, March 27, 2023. Ligna Energy AB, a spin-off of the Organic Electronics Laboratory of Linköping University, Sweden, has developed a “wood battery”—the battery technology is based on lignin—an abundant biopolymer that comes from trees and is a waste product by the paper mill industry when converting pulp to paper. Lignin has been explored as an electro active material in battery applications. In 2022, MIT Scientists published a paper in *Materials Today* that they created customizable wood in their lab from the cells of the common zinnia plant (*Zinnia elegans*). Perhaps one could explore producing more potent electro active lignin in the lab to make a wood battery that is highly cost competitive. China has made a lot of progress in environment-friendly sodium-ion batteries. Advances in battery technology are happening at a tremendous speed.

Government, industry, and media should give more attention to nature-based solutions (NBS) rather than pursuing new explorations of lithium-ion.

Research in non-lithium-ion and organic batteries is exploding. Universities must create centres of excellence to develop novel organic electronics applications that create a circular economy such as the polypeptide, wood or water-based batteries. Allocation of resources and subsidies should be directed prudently to NBS.

Overcoming Obstacles to Developing a Green Autorickshaw

Most often, the problem with commercialization is that we want to go big rather than going small. We also tend to focus our research on the obscure rather than on the obvious problems that confront our society. India has to leverage the new research occurring all over the world in a small way—experiment creating a new green autorickshaw. Universities should be encouraged to do real world experiments. The learnings will be important before we embark on big projects. Integrating OPVs with ORBs will propel further innovation and will create a new ecosystem for clean and organic mobility technologies.

India has to address both the technical and financial obstacles at the ground level. Financial challenges come down to upfront investment cost by the owner of the autorickshaw, inertia by local, State, and Central Government to

develop supportive policies. Recently, Terra Motors, a Japanese electric 3-wheeler set up a financial services unit to offer small loans to people who want to drive for a living. While these efforts are laudable, we need to figure out a way to transform all the existing autorickshaws to run on solar cum organic batteries so that they don't depend on our coal-dominated electric grid.

Research by various organizations has shown that a switch from fossil-fuel-based vehicles to electric vehicles will save operating costs in the long run. However, such data for the owner of an autorickshaw will be meaningless. The government, philanthropists, and local leaders will have to step in to develop creative financing schemes. In the meantime, tech entrepreneurs, research institutions, and technological universities need to leverage some of the ideas mentioned here to develop prototypes that will succeed without taxing our electric grid.

Conclusion

Finally, let us listen to the wise words of Naveen Rabelli, inventor of the first solar autorickshaw in 2016. His message to the world, “Big ideas start small, little by little, and step by step – I created my dream”. Profound wisdom in simple words. Companies, Universities, and Government leaders need to listen to Naveen's message. With a few meagre resources he could make it happen in 2016. Certainly India can convert its 8 million autorickshaws to solar power with organic batteries by 2025 with zero reliance on the grid. This will be revolutionary. We don't need grand promises, just a few small wins one at a time. Our actions should speak louder than our words if we truly want to build a net zero economy. ■

Ram Ramprasad has contributed articles on Sustainability to various magazines in India. He worked as Marketing Director for a Fortune 100 company in the USA. He graduated from Yale University, USA, and Madras University, India.



Bizarre Facts



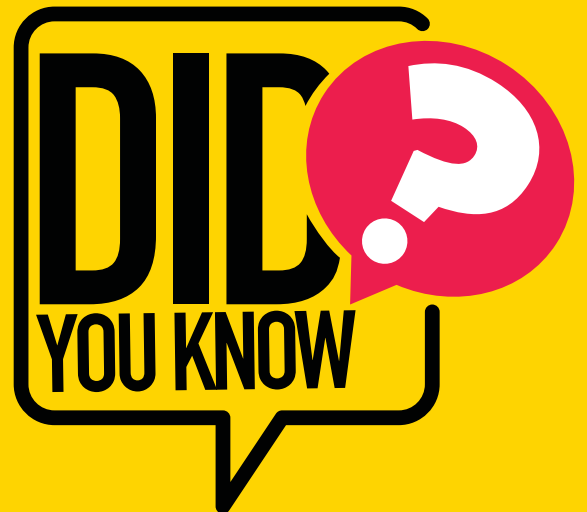
1. Australia is wider than the moon. The moon sits at 3400 km in diameter, while Australia's diameter from east to west is over 4000 km.
2. A single lightning bolt has enough energy to toast 100,000 slices of bread.
3. The average person produces about 1.5 litres of saliva per day.
4. The world's oldest piece of chewing gum is over 9000 years old!
5. The heart of a shrimp is located in its head.
6. Bananas are berries while strawberries are not.
7. Penguins can drink seawater. They have a gland in their bodies that filters out salt.
8. Shakespeare created about 1700 common words in the English language.
9. The average person walks the equivalent of five times around the world in a lifetime.
10. There are more lifeforms living on your skin than there are people on the planet.



Did You Know?

- Humans and giraffes both have seven neck vertebrae.
- Sharks have been around longer than trees.
- Your taste buds are replaced every 10 to 14 days.
- More people speak Mandarin, a Chinese dialect, as their first language than any other language in the world.
- A single cloud can weigh more than 1 million pounds.
- The smallest bone in the human body is the stapes bone in the ear, which is less than an inch long.
- The first email was sent by Ray Tomlinson in 1971.
- An individual blood cell takes about 60 seconds to make a complete circuit of the body.
- Cows have a magnetic sense and align themselves with the Earth's magnetic field when grazing or resting.

Source: newsgpt



CGAPP Launches Ganga Anti-Plastic Expedition

in India and Bangladesh

On April 25, 2023, The Centre for Global Affairs & Public Policy (CGAPP) spearheaded a comprehensive project aimed at addressing the issues of plastic waste in the Ganga Basin. The project, "Tackling Plastic Pollution in the Ganga Basin", comprises a research component, a solution component, and an outreach component. The research will be conducted by an all women team in over 12 locations spread across India and Bangladesh. The solution component includes anti-plastic expos in Rishikesh and Varanasi and outreach will involve local communities and civil society organizations. The project will also

feature a river expedition from Prayagraj to Varanasi by women researchers and a culminating summit in Dhaka at the end of the year. The aim is to initiate measures for effectively countering the danger posed by effluents and microplastics currently choking the Ganga basin, and threatening the aquatic ecosystem and the environment at large.

Research for this ambitious action plan will be held over 12 locations in India, including vital points in the Ganga Basin such as Rishikesh, Prayagraj, Varanasi, and other locations such as the Sunderbans. Two locations have been earmarked in Bangladesh, including Chandpur and the Sundarbans region in

Bangladesh. A 220-km river expedition, from Prayagraj to Varanasi, using solar-powered boats will be held in collaboration with youth organizations, NGOs, and urban local bodies to collect detailed data on plastic pollution.

The first leg of the research kickstarted in Rishikesh on April 24, 2023 and culminated in a two-day expo, beginning April 29, 2023. The "Rishikesh Ganga Anti Plastic Expo" will bring together start-ups, urban local bodies, domain experts, students, local personalities and community representatives as audience and panelists. It will feature roundtable discussion to explore solutions that can be deployed to address the problem of plastic pollution in the Ganga.

A highlight of the project will be its all-women team, comprising 15 members, including 12 permanent team members and 3–4 local representatives from academic institutions. The group comprises women PhD scholars and graduate students specializing in various disciplines, ranging from urban planning, science and engineering, governance and architecture, among others. The project research will be led by Dr Mansee Bal Bhargava, National President of Water Resources Council. The research component seeks to build upon the methodology used in the National Geographic Sea-to-Source Expedition held in 2019, while the solution and outreach component will add to this aspect to look at scalable solutions, including plastic alternatives and waste management, to address the issue of plastic pollution in the Ganga. ■



Impacts of Climate Change on Children

Role of Youth in Averting the Climate Crisis

In this article, **Sarah Berry** says awareness has played an important role in serving the cause of climate change, especially media and social media in today's time and age. However, engagement at the grassroots level and involvement of children and youth has been extremely crucial in accelerating the cause. India boasts of a rich demographic dividend, especially since approximately 65 per cent of its population is below 35 years of age.

Chikku plays happily in the service lane hopping from one puddle of water to the other. He delightfully remarks to his mother: "This year has been fantastic; good rain and less heat." His mother, who has been taking a well-deserved break from carrying bricks on her head, right from the ground up

to the third floor of a building under construction, manages a weak smile. "It's rather unusual; normally, May is slithering hot in Delhi," says she. Her husband adds that though this is a welcome break, work is slow due to spells of rain. "We came from our village in Odisha to Delhi many years back, because natural disasters had

played havoc with our lives, leaving us with no choice but to migrate. It has been a tough journey, with hard work, and income not being enough to secure even two meals a day." Chikku, age 6, has never been to school, and, perhaps, may not any time soon.

According to UNICEF, approximately 1 billion children are at an 'extremely high risk' of the impacts of the climate crisis. These children experience multiple climate shocks combined with poor essential services such as water, sanitation, and healthcare. As climate change disrupts the environment, children are being forced to grow up in an increasingly dangerous world. This is a crisis that threatens their health, nutrition, education, development, survival, and future.

In the words of Greta Thunberg: "The climate crisis has already been solved. We already have the facts and the solutions. All we have to do is wake up and change." Nothing can hold truer than this statement. With growing awareness, the challenge of climate change has gained





the required impetus, and solutions are consistently evolving. The need stands with each individual to his or her own bit. As they say, change begins with the self.

“During my last summer vacation, I spent a lot of time at the shop my father owns, as it was really interesting for me to see people come and go, and interact with my father. Of course, I also learnt a lot during that period. However, one thing caught my eye: the heavy use of plastic, especially plastic bags. Almost every person, at that time, wanted a plastic bag to carry the stuff bought. Of course, now plastic bags less than a certain number of microns are banned in Delhi, but then plastic is non-biodegradable and its use should be limited as much as possible, if not completely stopped. I remembered the posters we had created in school on the reduction of the use of plastics. I modelled these and placed them at strategic places within and outside the shop. In fact, I also coaxed my father to introduce a ‘scheme’: everyone who would come to the shop would get a special discount if he or she carried their own bag. Though this is so simple, it worked really well. It made me believe in the power of change that even one person can bring about,” says Nikki, who is 15 years old.

Everything said and done, behavioural change is one of the most important aspects of any long-term, sustainable change. It is hardly any wonder then that educational institutions begin early with the generation of awareness about pressing challenges society faces at large. PRATYeK, an NGO that serves child advocacy at its core, began the famous child-led NINEISMINE campaign way back in 2006, for which it won the Special Recognition Award from the UN and the Harvard US-India Initiative NGO Excellence Award. Says Steve Rocha, the Vision and Identity Leader at PRATYeK and the national convener of the NINEISMINE: “Climate change is not just a challenge that remains in the future; it is very much right here, right now, and needs urgent addressal. It is also a fact that child-citizens are most vulnerable to the impact of climate change. Child-led advocacy is, hence, extremely important, impactful, and non-negotiable. When children empower children to work towards achieving the greater good, people sit up and take notice, including those in positions of authority and power. Today, around a million children have been engaged for a better present and brighter future through child-led advocacy, via the NINEISMINE campaign.” The NINEISMINE campaign recognizes

children as primary stakeholders of society and provides them with local, national and international fora to engage with policymakers, while ensuring effective implementation of the policies that serve the greater good. It also believes that while children set out to learn the principles and entitlements embedded in the Convention on the Rights of the Child (CRC), they should also be engaged in affecting local, national and international level changes as equal and active citizens.

The concept of Bal Sansads or Children’s Parliaments has also gained a lot of impetus over the past years. Young advocates from vulnerable communities advocate for their rights as well as the rights of their peers. Children are imparted with the necessary know-how, knowledge, skill sets and training to empower them for the same. Ram is 17 years old and has been engaged with what he calls ‘climategiri’ since almost a decade. “I understand the impact of climate change first hand. I live in a re-settlement colony, and unexpected changes in weather affect us a lot, especially since we don’t have the necessary infrastructure, and almost everything is makeshift. I knew early on that it was up to me and my peers to do something about this challenge that was

affecting us not only at a local but also on a global level.” Ram, and his friends, were a part of the climate strikes held at Jantar Mantar in Delhi, which saw children from across India take part, urging for changes in lifestyle: vegetarianism, reduction in vehicular usage, recycling, ban on plastics, segregation of waste, involvement of children in policy making, and many other such aspects.

“I am a part of YASH, which stands for Young Advocates for Social Harmony,” says Sheetal (16) a Climate Action Minister of her neighbourhood YASH children’s parliament. “Just a few months ago, more than 4000 children gave their recommendations to the Draft General Comment 26, which were then compiled into our ADvocal Charter. Currently, we are in the process of meeting foreign missions, policy and decision makers in India and presenting the recommendations to them. The objective of these interactions is urging the unanimous adoption of the General Comment 26, due to release in September, and also press for this charter to be used in the ongoing and future discussions and dialogues on climate change, child rights and, specifically the ecological rights of the child.”

Mass engagement campaigns result in not only generation of awareness, but also a resolve to collectively do something for the cause. Climategiri was



one such initiative, which was organized to draw attention to the cause of climate change via a unique form of child-friendly mediums and performing arts such as circus art, chalk art street plays, and flash mobs. “I recall this campaign so clearly though it took place a few years ago. The ninth edition was in Chandigarh, and more than 3000 children got together to create this huge buzz around climate change. So, we performed circus art, which requires training and finesse. It was a unique performance, and we received accolades for the same, but the most important part is that this was associated with an important cause—drawing attention of everyone to the

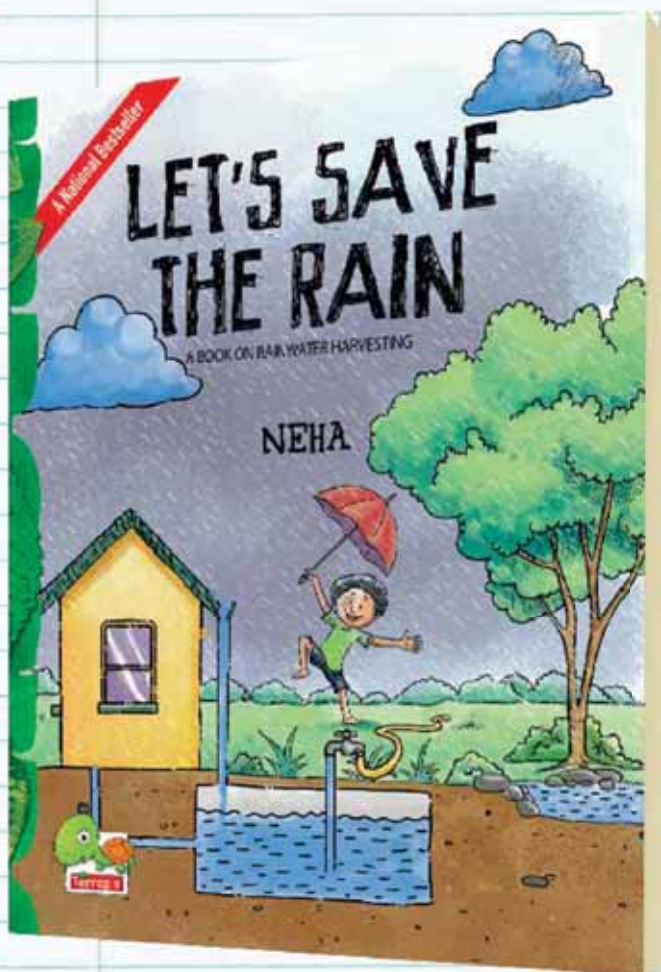
cause of climate change, and how each individual is part of the movement. It doesn’t matter how much you do, as long as you do. Change will happen, says Ruksar Rehman (16) the child President of the National Inclusive Children’s Parliament.

Awareness has played an important role in serving the cause of climate change, especially media and social media in today’s time and age. However, engagement at the grassroots level and involvement of children and youth has been extremely crucial in accelerating the cause. India boasts of a rich demographic dividend, especially since approximately 65 per cent of its population is below 35 years of age. Imagine, what this segment can achieve, if it really gets down to doing this with dedication and sincerity, long-term! It may not be possible to reverse the damage done, but it can definitely prevent us from losing the only home we know we have, forever. As Jane Goodall says: “I think we are smart enough to not destroy planet Earth, our only home.” In the coming years, we can only hope that this quote holds true. ■

With almost three decades of professional experience, Sarah Berry serves as a consultant for a number of organizations in the social impact space. Her areas of expertise lie in the fields of communication, outreach, partnerships, and advocacy.



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Rejuvenation of Neem River Origin

The Ongoing Journey

In this article, **Raman Kant** talks elaborately about rejuvenation work of Neem River origin, which is a unique example of coordination between society and government.

Origin Discovery Tour

On December 5, 2019, when I and my team were studying the eastern Kali River, the main tributary of the Ganga River, it was found in Kasganj that another river named Neem also joins it. After this we started the reverse journey of Neem River, i.e., from Kasganj to Hapur. In this, we started collecting information and remains of the Neem River, but no accurate information was found about the origin of the river, or rather, there were many misconceptions about the

origin of the river. Some people used to claim that this river originates from Parikshitgarh town in Meerut district, while other sources state that its starting point is in Hapur district itself.

After this, we presented the authenticity of the origin of the river in Hapur district before the society with the help of the *British Gazetteer*, the documents of the Irrigation Department, and the history of the local administration. Neem River and its information were mentioned in all the

documents, but the Neem drain was shown in the documents of the Irrigation Department. In this, we also took support of satellite mapping and GPS technology. The mention of Neem River is also found in mythological tales and stories. According to legends, the origin of the river is said to be from Parikshitgarh town in Meerut district. However, according to present-day government documents, these legends are correct, as they provide information about the extinct Koshiki River, which used to originate from Parikshitgarh town in Meerut district. Additionally, there are accounts of neem tree properties mixing in the river itself in the past. The work of authenticating the ascension went on for about a month as we wanted to get to the facts.

A Rajwaha flows near the river source, which divides the river into two parts. This is because the Rajwaha is a man-made dam built by the Irrigation Department to deliver canal water to the farmers' fields. The bed of the Rajwaha is still higher than the river bed. It is obvious that Rajwaha must have been built from the middle of the origin of the river. There is about 80 bighas of land on the right side of the river. There is a huge pond on the left side of the Rajwaha, which was once a part of the river's catchment area. Water gets filled here even today in the rainy season, while according to the villagers till about



three decades ago due to excessive water logging it was not possible to do farming here and the water used to flow in the river throughout the year. As the groundwater level went down and the average rainfall also started getting less every year, gradually the river stopped flowing.

Origin Resuscitation Process

When we were completely sure that the origin of the river is in Datyana village itself, we requested the then District Magistrate of Hapur Ms Aditi Singh to mark the land of this river. For this Ms Aditi Singh engaged the then Chief Development Officer Mr Uday Singh with us. Mr Uday Singh formed a team and the work of land measurement started. About 80 bighas of land has been identified. Following this, the major challenge was to reclaim the land along the river from those farmers.

A meeting was convened with the encroaching farmers to address the issue of river land encroachment, during which they were informed about the significance and pride associated with this river. An appealing letter was written to the village to convey the pride of Neem River to the residents of Datyana. After about 6 months of mentally exhausting hard work, all the farmers got ready to give up their possession from the river origin land and gradually all the farmers gave up their possession from the river land. During this, Mr Anuj Jha had taken charge as the new District Magistrate of Hapur, but the good thing was that the Chief Development Officer was Mr Uday Singh, who was a part of the whole process. After the farmers vacated the land, a new challenge emerged before us—to construct a lake at the source of the river in that area. The whole issue of river origin was brought to the notice of the new District Magistrate. While on the one hand we started the work of reviving the river source, on the other hand we also travelled about 14.2



kilometres of the total length of the river flowing in Hapur district and prepared a map of it. To create a comprehensive map of the entire Neem River, we have sought the cooperation of the Namami Gange programme, Government of India. A technical team from Namami Gange also came here and prepared a map.

During this, we presented our draft of river revival in front of the society and the administration and decided to do it with the help of *Shramdaan* and the administration.

During this period, Mr Surendra Singh took over as the new Divisional Commissioner of Meerut. He is known



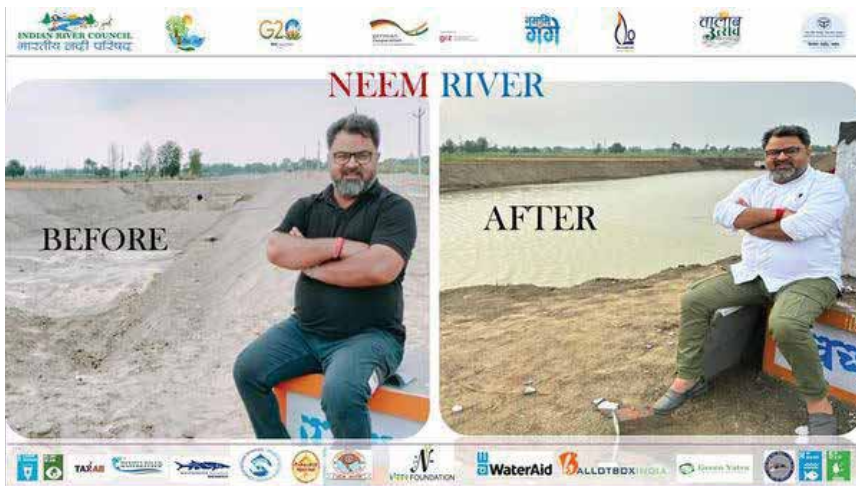


to be a river-loving officer, which further added to the enthusiasm for the project. On June 7, 2021, the work of reviving the river origin was started with the cooperation of the society and the government by worshiping the land at the river origin. The then Divisional Commissioner – Meerut, Surendra Singh; District Magistrate – Hapur, Mr Anuj Jha; and Chief Development Officer – Hapur, Uday Singh from the administration participated in this work along with their subordinates, farmers, students,

representatives of social organizations, etc. Social worker Karmaveer Singh contributed INR 10,000 on this occasion, so that the machine could be used for a few days. Some work was also done under CSR. This work of cooperation and labour of the society went on continuously for about 6 months. During this time, children of many schools and social workers also kept coming here for *shramdaan*. Due to the sound of river revival, many like-minded organizations, including Lok Bharti, have also started

getting involved in this work. Public awareness programmes were started daily in the villages on the banks of the river.

In Bulandshahar, ahead of Hapur district, the then District Magistrate Ravindra Kumar marked about 40 kilometres of the river stream and started work on that too. During this time, the work continued to progress, despite facing challenges such as the rainy season, the COVID-19 pandemic, and village panchayat elections. Because it was a major work, the need for meaning was felt for it. In such a situation, the Minor Irrigation Department, Hapur sent a proposal to the government through Mr Surendra Singh. During this time, Ms Megha Rupam had become the District Magistrate in Hapur district and Ms Prerna Singh had become the Chief Development Officer in place of Mr Uday Singh. It took about a year to get the money sanctioned from the government level. When the money was received from the government, the work of construction of the lake here was finalized by the Minor Irrigation Department under its tender process.





Our coordination with the Minor Irrigation Department and the Irrigation Department continued. The construction work of this lake was completed in the first week of May 2023. During this, Ms Prerna Sharma took charge as the new District Magistrate in Hapur, while Divisional Commissioner - Meerut Mr Surendra Singh was transferred to Delhi.

About Neem River

Basrati River has been flowing through the forest present in the lower part of Datyana village. It is a river as good as its name. It originates from Datyana village of Hapur district, passing through Bulandshahr and Aligarh districts, covering a distance of about 180.2 kilometres near Shyam Baba's temple in Kasganj, joins the eastern Kali River, the main tributary of the Ganga River. Neem River flows only for 14.2 km in Hapur district, while about 166 km of its flow area is in Bulandshahr, Aligarh, and Kasganj districts. The maximum flow of the river is about 94 km in Bulandshahr district while the remaining 72 km is in Aligarh district. There are about 200 villages situated near the total flow area of the river, which have been affected by the river in one way or the other.

How did the Neem River get its name? No one has a direct and authentic

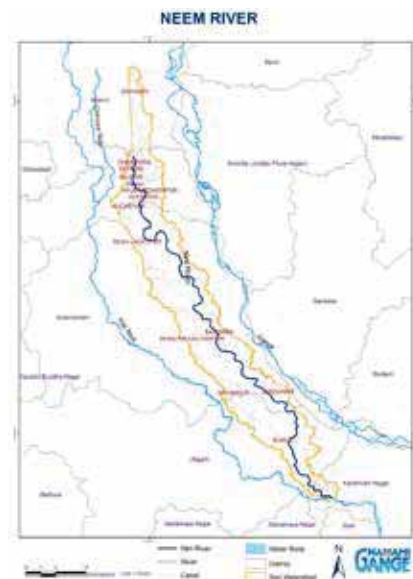
answer to this, but the elders of the village tell the reason that neem trees were in abundance on the banks of the river, due to which the water of the river had medicinal properties. Neem River is a unique, pure village river. Out of all the villages situated on the banks of the river, this river is connected to the ponds. In Muradpur and Saina villages of Hapur district, this river falls at one end of the pond and starts again from the other end, whereas in villages such as Datyana and Khurana, it has been flowing adjacent to the ponds. This is its specialty. During the rainy season, the water logging in the villages could not last for long as the Neem River used to carry it away. Although every rainy river has a close relation with villages and ponds, but Neem River has a very deep connection with villages and ponds.

River Festival

When the work of construction of the lake at the origin of the river was completed, on May 18, 2023, 'NEEM River Festival' was celebrated on the banks of the origin of the Neem River, in which thousands of farmers, social organizations, children and women from nearby villages participated.

Future Planning

After completing approximately 80 per cent of the Neem River Origin Rejuvenation project, the Hon'ble Prime Minister of India, Shri Narendra Modi, introduced this significant topic to the entire nation in the 102nd episode of his programme 'Mann Ki Baat'. While our spirits have been boosted, we have also received a message to approach the upcoming work with even greater hard work, dedication, and vigilance. In such a situation, we will proceed with the work with more discipline. The Raman River Rejuvenation Model is being implemented for the complete revival of the Neem River through the River Council of India. Through this model, the society established on the banks of the river



is being connected with the works of the river, which will give stability to this work. River Rejuvenation Committees are being formed in the villages on the banks of the river flowing ahead of the origin of the river, with the aim of keeping the river clean and continuous. Through these committees, 'Neem River Council' will be formed. GIZ, a German organization is giving full cooperation in this entire work of river rejuvenation along with the Indian River Council and Minor Irrigation Department. Neem River Council will have all the rights of its river. This Council will take all the decisions of the river. We are striving to transform the society living on the banks of the river into genuine and responsible well-wishers of the river. Various social organizations, social workers and people associated with different professions of Hapur, Bulandshahr and Aligarh are also joining in the work of Neem River revival to sacrifice their own deeds. We are hoping that in the coming few years, we will be able to present a model before the country by reviving the Neem River and will be able to live up to the trust of the Hon'ble Prime Minister. ■

Raman Kant, Riverman of India, CEO-Indian River Council; www.theneerfoundation.org

A Whiff of Fresh Air

Active Buildings' Pioneering Initiative

In this article, **Dr Rina Mukherji** highlights that Active Buildings' community initiative—Sarva, looks after the air quality concerns of the economically weaker sections of the society. Sarva wants to break the socio-economic barrier between healthy air and people in need. They aim to introduce technology-driven affordable innovations to the communities in need, with the help of more like-minded people who believe in community welfare and want to facilitate better lives with better air quality. The organization, which has been manufacturing and selling sophisticated sensors and air purifiers to commercial and individual consumers since 2017, ventured to work on eradicating exposure to indoor air pollution among the poorest communities in the post-pandemic period.

On a normal day at Uthalsar Clinic in Thane, Maharashtra, run under the auspices of the Thane Municipal Corporation, General Nurse and Midwife (GNM) Sarika Latpate, and Auxiliary Nurse and Midwife (ANM) Purnima Dake would end up feeling

suffocated, owing to the onslaught of patients and the pressure of attending to their work. The huge number of persons packed in a moderately-sized outpatient department in the tropical summer did little to ameliorate their discomfort. The situation was even worse for GNM Sunita

Salve at the C R Wadia Health Centre in Thane, since she is diabetic and suffers from an allergy. "I would frequently suffer from cough and cold, and often fell sick." The crowds of patients at the Health Centre, the first such to operate from Thane, were probably to blame.





But, ever since sensors and air purifiers were installed in late 2022 in these clinics, courtesy the Sarva programme run by *Active Buildings*, there is a marked change. Salwe no longer falls sick, “Coughs and colds no longer torment me. What’s more, we do not need to fumigate our premises for mosquitoes and pests either,” she says. Nurses Latpate and Dake find the air “fresh” and “invigorating”, too. “We can work much better.” This, the healthcare staffers of the Valmiki Arogya Kendra in the same city, feel, is also due to the removal of humidity, which adds to the discomfort caused by the summer heat in coastal Thane. It also helps clean up dust particles which are a common feature of the city’s thoroughfares, along which each of these clinics are located. s.

The biggest advantage, however, is felt by medical practitioners such as Dr Atul Mundra. “Patients with respiratory ailments such as bronchospasm and pneumonia can breathe much easier

now. It is definitely a great relief for them.”

Indoor air pollution has garnered attention in recent times, with high degrees of exposure to polluted air indoors found to cause severe damage to the lungs, besides respiratory ailments such as asthma, allergies, and the like. Yet, the issue received scant attention until the COVID-19 pandemic.

Many corporate houses have now installed sensors and air purifiers in place, besides lining their corridors with plants that naturally purify the air. However, such facilities are never available to the people from lower classes who live in overcrowded slums, visit government hospitals, and attend schools run by zila parishads, municipal bodies, or the government.

Hospitals are particularly a minefield of infectious ailments, especially if they happen to be government hospitals, where those from the lowest economic classes frequent. Hitherto, the issue

received slight attention until the COVID-19 pandemic, when it was realized that airborne viruses can wreak havoc and unleash an epidemic. But thankfully, the scenario is slowly changing.

Active Buildings, which pioneered the Bubble PAPR under their CAWACH Initiative in 2020 and installed low-cost



Air Purifier with sensor placed above it at a primary health centre



Air Purifier at Udalsar PHC OPD

air cleaners in schools and hospitals to help COVID warriors battle the pandemic, realized how dire the battle for clean air was.

Thus, the organization, which has been manufacturing and selling sophisticated sensors and air purifiers to commercial and individual consumers since 2017, ventured to work on eradicating exposure to indoor air pollution among the poorest communities in the post-pandemic period. In 2022, propped up by the Balvi Fund set up by Vitalki Buterin's *Ethereum*,

it has been providing clean air to primary health centres, anganwadis, government schools, and slum communities under its Sarva programme.

The air purifiers and sensors use a very basic, open-source design, which makes them easy to clean and maintain, unlike any sophisticated devices. *Active Buildings* has developed RESET (15) certified Indoor Environment Quality (IEQ) monitoring sensors and low-cost affordable air filtration devices inspired by Corsi-Rosenthal boxes. These air sensors can detect PM_{2.5}, PM₁₀, CO₂, VOCs,

humidity, temperature, and several other parameters that determine air quality.

These sensors are plug-n-play in nature and they contain a 4G-enabled sim card that sends the data out in real time. The sensors are globally accredited, and adhere to RESET standards certified worldwide. The air purifiers are inspired by the Corsi-Rosenthal box design and have HEPA filters to get rid of PM_{2.5}, PM₁₀, and aerosol particles to reduce the risk of air-borne viruses.

So far, 10,000 air purifiers and 5000 sensors worth USD 1 million have been distributed to low-income communities, besides government-run primary health centres and anganwadis in Mumbai, Ulhasnagar, Thane, and Kalyan.

The organization has also set up several low-cost air purifiers and sensors in a government school in Gurugram in Delhi-NCR under Project Sameer, in collaboration with the DRIIV Foundation and the Principal Scientific Advisor of the Government of India. ■



Patient at a Primary Health Centre being checked by a nurse

Article by Dr Rina Mukherji. Sarva moves forward with one community at a time with the help of contributions from philanthropic individuals and organizations that support the "Clean Air for All" mission to help those who face deadly health hazards from air pollution every day with a simple act of breathing and have no means to improve their living conditions.

Rare Coffee Species from Sierra Leone's Rainforest

On Course to Save Climate-Vulnerable Coffee Industry

Great news for the world's coffee drinkers: there has been significant progress in a Sierra Leonean project to recultivate a historic local coffee species, which is better adapted to higher temperatures than the climate-vulnerable Arabica, currently the main source for commercial coffee.

There is great news for the world's coffee drinkers with significant progress achieved in a Sierra Leonean project to recultivate a historic local species better adapted to higher temperatures than climate-vulnerable Arabica, the main source for commercial coffee. Lost from cultivation for more than half a century, stenophylla coffee, or *Coffea stenophylla* to give it its scientific name has been grown successfully at a pilot project in the east of the country following its rediscovery in the wild.

It took a five-year-long search by a Sierra Leonean forestry expert, a sort of botanical Indiana Jones, slogging mile after mile through dense West African bush armed with little more than a

pressing of a dried stenophylla leaf dating from the 1950s, before the first wild examples were found.

With rising temperatures and changes in rainfall threatening to wipe out more than half current coffee production, developments in Sierra Leone offer hope for climate-resilient solutions for the world's coffee drinkers. The pilot project is driving ambitious plans to establish stenophylla as the flagship product of Sierra Leone's agricultural sector, a remarkable turnaround for a species once sold as Sierra Leone highland coffee but which had been quietly forgotten through history.

Much more work needs to be done to establish the commercial viability

of stenophylla but progress of the preliminary project, funded by the Switzerland-based coffee trader Sucafina, has been encouraging.

"The results are so positive that we believe everything is in place to potentially rejuvenate stenophylla, a coffee that was once drunk in Paris and London but has not been sold commercially for decades," said Daniel Sarmu, the forestry expert who found the lost plant and is running the pilot.

The Sierra Leonean project has implications for the world's coffee market as it offers hope in the face of the dire threat that climate change poses to the two species—Arabica and robusta—which produce the beans that go into almost all of the 400 billion cups of coffee drunk each year. Grown commercially in more than 50 nations in an industry that generates more than 25 million jobs, these two species have a weak spot: vulnerability to climate change.

What stenophylla offers, which makes it stand out from the 129 other known species of coffee, is a double whammy of great taste and heat tolerance. In blind tastings held since the rediscovery, experts scored stenophylla as highly for taste as some high-grade Arabicas, as well as offering distinctly novel flavours. Many other wild species of coffee have been tasted over the decades but with disappointing results.



Naturally occurring in the eastern highlands of Sierra Leone, a vestigial stenophylla farming sector flourished briefly during British colonial rule until the turn of the twentieth century when it dwindled and was forgotten as mass production of Arabica and robusta came to dominate the global market.

There are even early colonial records of it being grown commercially on hilly farm-holdings close to the centre of what is now Freetown, the coastal capital of Sierra Leone. It is its adaptation to the environment of lowland, tropical Upper West Africa that makes stenophylla so unique. With old records of it occurring naturally in Guinea-Conakry, Sierra Leone and Ivory Coast, on slopes of hills ranging from 200–700 metres above sea level, stenophylla has a tolerance for high temperatures, and perhaps even some drought tolerance.

Mr Sarmu and his two British collaborators, Aaron Davis from The Royal Botanic Gardens at Kew and Jeremy Haggard from the University of Greenwich, point out that more research needs to be done on the unique characteristics of stenophylla. This includes analysis of the climate, terrain, soils and topography that favour its growth and, importantly, its yield in terms of amount of berries and the time taken for the plant to grow from a seed to productivity.

The lifecycle of Arabica and robusta is three or four years from planting a seed to harvesting fruit mature enough

to produce commercial coffee. Working with his British colleagues who found references to stenophylla in old books and journals, Mr Sarmu led the field work. A forestry graduate with a degree from Sierra Leone's Njala University, to begin with all he had to guide him were a few old photographs and a dried sample of a stenophylla leaf that had been archived at the National Herbarium which is located at his alma mater.

Mr Sarmu led search parties with his colleagues in the forested hills around Freetown but found no remnants of the historic farms where stenophylla bloomed more than a century ago. The city is located on a mountainous peninsula and although the slopes used to be heavily forested urbanization has led to a significant amount of deforestation.

After cross referencing maps with old records his search focused far from the city in areas that included the Kambui Hills in the Eastern Province of Sierra Leone, densely forested areas which meant locating the remnant stenophylla plants was like hunting a needle in a sweaty, humid haystack.

While experts have other ways to identify stenophylla, the layman might look for their long, thin, spear-tip shaped leaves and their distinctive black berries, different from the deep red berries of commercial coffee plants.

After a search that lasted five years and working with local villagers and

foresters, Mr Sarmu eventually found 15 stenophylla trees and was able to gather fruits and so-called 'wildlings', young stenophylla plants propagated naturally in the wild.

His work led to growing sense of 'stenophylla fever' as word spread among rural communities with foresters, farmers and hunters all searching for areas where the plant might grow. Stands of mature stenophylla have now been found in three areas in the east and south of Sierra Leone with more discoveries expected in other hilly regions.

A five-acre plot was offered up by one community for a nursery, where seeds were successfully planted and germinated, appearing as seedlings under the cover of thatched sunshades made from palm fronds.

More than 1400 seedlings cultivated in the nursery have been planted out in the areas where the project managers hope they will be able to mature and grow a first crop of fruit. Another 6000 seedlings from the nursery are due to be planted out in the rainy season, which has just begun in Sierra Leone and will last until early September. The community is fully committed to the project and has made available 50 acres of additional land to be used as potential hub plantations for a more ambitious plan to grow stenophylla on a commercial scale.

Potential stenophylla farming is the sort of commercial enterprise welcomed by the government of Sierra Leone, which has just opened a new 'one stop shop' for foreign investors seeking opportunities in the country. The newly-created National Investment Board, which streamlines a notoriously clumsy current process for business licensing and regulation in Sierra Leone, is putting a strong emphasis on agriculture, the country's single largest employer, and the environment. Stenophylla fits well with both categories of priority. ■

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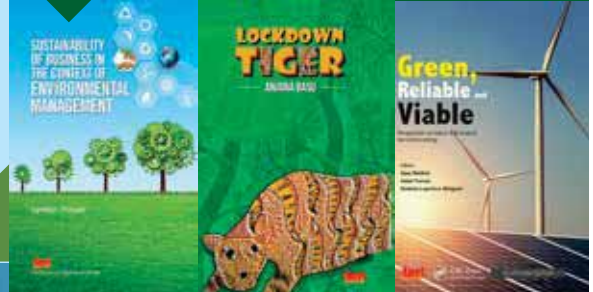
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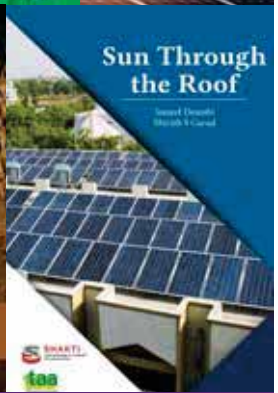
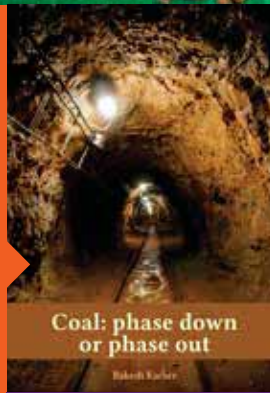
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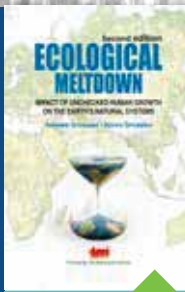
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