Earth System Science Panorama
(The News, Events, Discoveries Awareness and Researches on Earth, Climate, Planetary and Environmental Sciences)

Prologue

The primary objective of this section is to compile and rejuvenate recent research findings, news, and advancements in Earth, climate, planetary, and environmental science. This initiative aims to disseminate advanced knowledge and insights for the benefit of students, educators, and the wider public who have an interest in these specialized fields. Aligning with the objectives outlined in the Patron's message, we seek to provide a comprehensive and engaging platform that encourages critical analysis and community-driven solutions on climate, earth and environmental sciences. Our global environment is under peril. The biggest question arises whether we shall survive or shall extinct by the fury of global warming and climate change. The inclusion of remedial measures reflects an intention to not only highlight problems but also offer potential solutions. The content is crafted to encourage readers to critically analyse all aspects. By encouraging critical analysis, providing potential solutions, and desiring an interactive platform for feedback, this section aims to foster a community-driven approach towards understanding and addressing issues related to Earth, climate, planetary, and environmental sciences. Few examples are mentioned on the above mentioned themes.

Brief Elucidation

Climate and Environmental Sciences

1. South and Southeast Asia Coastal Cities Sinking Fast

The rapid sinking of land in coastal cities, particularly in South and Southeast Asia, poses a significant threat to tens of millions of people due to rising sea levels. Factors such as melting ice sheets and expanding warm seawater contribute to global sea level rise, **but local land subsidence exacerbates the issue. Urbanization plays a key role in accelerating land subsidence, as cities draw groundwater to support their growing populations. Satellite data highlights Ho Chi Minh City in Vietnam as the fastest sinking city, followed by Chittagong in Bangladesh, Ahmedabad in India, Jakarta in Indonesia, and Yangon in Myanmar**. By 2050, over one billion people could be living in coastal cities vulnerable to sea level rise. Even with significant reductions in greenhouse gas emissions, global sea levels could still rise by up to 2 feet by the end of the century, as warned by the UN Intergovernmental Panel on Climate Change. The article "Sea-Level Rise from Land Subsidence in Major Coastal Cities," published in Nature Sustainability, provides further insights into this pressing issue. *This is a summary of the article "Sea-Level Rise from Land Subsidence in Major Coastal Cities," published in Nature Sustainability on September 12, 2022. The full article can be found on nature.com.* Courtesy: Medscape, December 14, 2022

2. Avalanche sets off glacial lake outburst in Nepal. Why GLOFs recur in Himalayas & how to prevent them

The recent event at Birendra Tal in Nepal highlights the growing concerns over glacial lake outburst floods (GLOFs) in the Himalayan region. Situated at a high altitude of 4,500 meters in the Manaslu region, Birendra Tal experienced a burst of its banks on April 21, 2024, triggered by an avalanche depositing ice into the lake. This resulted in a brief deluge downstream. Fortunately, the lake is reported to be "returning to normal" at present. This incident follows a similar event in October 2023 when the South Lhonak glacial lake in Sikkim suffered an outburst due to a cloudburst, leading to significant loss of lives. These occurrences serve as stark reminders of the increasing risks associated with GLOFs as temperatures rise in the region. Glaciologists have been sounding alarms over the heightened frequency of such events, driven by climate change-induced glacier melt and the instability of glacial lakes. The sudden release of water from

these lakes poses threats to downstream communities, infrastructure, and ecosystems. Efforts to monitor and mitigate the risks of GLOFs are crucial for safeguarding vulnerable populations in the Himalayan region. This includes implementing early warning systems, conducting risk assessments, and promoting sustainable adaptation measures. As climate change continues to impact the Himalayas, proactive measures are essential to reduce the potential for future disasters".
Courtesy: Sandhya Ramesh, The Print, 22 April 2024

3. Asia was the world's 'Disaster Capital' in 2023, with all climate change drivers upping the ante in region: WMO report

The State of the Climate in Asia 2023 report by the World Meteorological Organization (WMO) sheds light on the significant climate-related challenges facing the Asian continent. In 2023, Asia experienced a high frequency of disasters, with floods and storms causing the highest number of reported casualties and economic losses. Additionally, the impact of heatwaves intensified, particularly in eastern and northern India. One notable finding from the report is the considerable sea level rise observed in the Bay of Bengal off India's eastern coast. Satellite data indicates that the sea level rise in this region was nearly 30 percent higher than the global average. This rise poses risks to coastal communities, particularly in areas like the Sundarbans in West Bengal, which have experienced the highest sea level rise in India. The analysis also highlights the accelerating trend of long-term warming, with extreme heat becoming more severe and glaciers melting at an alarming rate. This poses threats to water security and exacerbates the risk of glacial lake outburst floods (GLOFs), as witnessed in Sikkim and northern West Bengal in 2023.Furthermore, the report underscores the link between rising sea surface temperatures and ocean heat with greenhouse gas emissions. The warming of the ocean contributes significantly to global mean sea-level rise and has far-reaching impacts on ocean currents, storm tracks, and marine ecosystems. While precipitation was below normal in several regions across Asia, floods and storms remained the leading causes of death and destruction. The intensity of flooding was exacerbated by record-breaking rainfall triggered by cyclones, resulting in significant impacts across multiple countries. Overall, the report underscores the urgent need for ro-

bust climate adaptation and mitigation measures in the Asian region. Addressing the impacts of climate change, including sea level rise, extreme heat, and increased frequency of extreme weather events, requires concerted efforts at both regional and global levels to safeguard vulnerable communities and ecosystems.
Courtesy: Down to Earth, Sanjeev Chopra - 22 April, 2024

4. Warming planet may transform Tundra ecosystems from carbon sinks to sources. Experiments show warming temperatures increased metabolic activity among plants and microbial soil

The study "Environmental drivers of increased ecosystem respiration in a warming tundra" underscores the significant impact of rising temperatures on arctic and alpine tundra biomes. Researchers found that increasing temperatures enhance both plant and microbial respiration, leading to the release of carbon into the atmosphere. This could potentially transform tundra environments from carbon sinks to carbon sources, exacerbating climate change. The study, conducted by over 70 scientists at 28 arctic and alpine tundra sites over 25 years, utilized open-top-chamber warming experiments to simulate global warming effects. Results showed that even a moderate increase in air and soil temperatures, coupled with a slight decrease in soil moisture, led to a substantial increase in ecosystem respiration during the growing season. Key findings include the influence of warming on nitrogen levels, pH, and plant and microbial turnover, all of which affect ecosystem respiration. Tundra regions with higher nitrogen limitations and those that stimulate plant and microbial turnover were found to be more sensitive to warming-induced respiration responses. Importantly, the study highlights the non-linear nature of ecosystem respiration increase, suggesting that microbial and plant processes respond to warming at different rates. Understanding these complex interactions is crucial for accurately predicting future warming impacts on tundra ecosystems. The research emphasizes the need to incorporate tundra carbon cycle dynamics into climate models to improve predictions of carbon emissions. By doing so, scientists can generate more accurate global and regional climate models, aiding in climate change mitigation and adaptation efforts. Overall, the study underscores the urgent need for comprehensive strategies to mitigate climate 3 change and protect vulner-

able ecosystems like arctic and alpine tundra from further degradation.
Courtesy: Earth.com ,Rodielon Putol

5.   Triple Junction Solar Cell Sets World Record Efficiency

The National University of Singapore (NUS) has achieved a significant breakthrough in solar cell technology with the development of a novel triple-junction perovskite/Si tandem solar cell. Led by Assistant Professor Hou Yi and his team from NUS College of Design and Engineering (CDE) and Solar Energy Research Institute of Singapore (SERIS), this pioneering research has resulted in a certified world-record power conversion efficiency of 27.1of a cyanate-based perovskite structure into the solar cell, whi ch enhances stability and reduces energy loss. Cyanate serves as a substitute for bromide, a common ion used in perovskite solar cells. By incorporating cyanate, the team achieved higher voltage and reduced energy loss compared to conventional perovskite solar cells. Building upon the success of cyanate-integrated perovskite solar cells, the researchers assembled a triple-junction perovskite/Si tandem solar cell. This structure involves stacking a perovskite solar cell and a silicon solar cell to create a dual-junction half-cell, which provided an ideal foundation for the attachment of the cyanate-integrated perovskite solar cell. Despite the complexity of the triple-junction structure, the resulting solar cell remained stable and achieved a certified world-record efficiency of 27.1advancement in perovskite-based solar technology, paving the way for further improvements in efficiency and stability. The research, published in Nature, represents a major milestone in the field of solar energy and demonstrates the potential of perovskite/Si tandem solar cells in meeting the growing demand for renewable energy sources. This breakthrough could have profound implications for the future of solar technology and its contribution to mitigating climate change.

6.   Exploring biodiversity, management plan: New study on Asola Bhatti sanctuary The Board of The Wildlife Institute of India (WII), Dehradun, while approving the proposal at its meeting in August 2023 , had asked that the project may be revised to include a comprehensive study of the biodiversity of the entire ridge in Delhi.

The initiative by the Wildlife Institute of India (WII) to conduct a comprehensive study on the biodiversity of the Asola Bhatti Wildlife Sanctuary in Delhi, along with the proposed management plan, marks a significant step towards conserving and utilizing the ecological resources of the area.The presence of eight leopards and two to four striped hyenas in the sanctuary, as revealed by a recent camera-trap study, underscores the importance of preserving the habitat and ensuring the coexistence of wildlife with human activities. The focus on evaluating potential socio-economic changes on nearby villages emphasizes the need for sustainable development strategies that maintain ecological integrity while benefiting local communities. The transformation of mined-out pits into attractions like the Neeli Jheel man-made lake showcases innovative approaches to repurpose industrial landscapes for eco-tourism. Efforts by the Delhi Forest Department to enhance visitor experiences through facilities like e-cycles, golf carts, nature trails, and cycle tracks demonstrate a commitment to promoting eco-friendly tourism practices.
Courtesy: Abhinaya Harigovind September 26, 2023

7.   Extreme weather events: Consequences and Remediation

The devastating events described in the Himalayan region underscore the urgent need to address the impacts of the climate crisis. Here's a summary of the key points highlighted in the editorial: **Monsoon Season in the Himalayan Region:** The monsoon season in the Himalayan region has been marked by intense rains, triggering floods and landslides in Himachal Pradesh, parts of Uttarakhand, and Sikkim. **Devastation and Loss:** These extreme weather events have resulted in large-scale destruction of lives, livelihoods, homes, and public infrastructure. The loss of lives, including Army personnel, and the widespread damage highlight the severity of the situation. **Glacier Lake Outburst Flood (GLOF):** The flash floods in the Teesta River, caused by a glacier lake outburst flood (GLOF) in upper Sikkim, have caused havoc in the state. The exact details of the weather event leading to the GLOF remain unclear. **Damages to Infrastructure:** The rampaging Teesta River destroyed the Teesta Urja dam, a 4 significant run-of-the-river hydroelectric project, causing extensive damage downstream. Several bridges and a section of the National Highway linking Gangtok to the rest of India were

also washed away. **Economic Loss:** The Teesta Urja dam, being the second-largest run-of-the-river hydro power project in India, suffered massive damage due to the flood, resulting in heavy economic losses for the region. In light of the recent extreme weather events, particularly the devastating floods and landslides in the Himalayan region, it's imperative to take proactive measures to prepare for and mitigate the impacts of such occurrences in the future. Here's a comprehensive guide on how to be ready for extreme weather events: **Stay Informed:** Keep abreast of weather forecasts and warnings issued by meteorological departments. Utilize various platforms such as weather apps, news channels, and official government websites to stay updated on changing weather patterns and potential hazards. **Develop Emergency Plans:** Create detailed emergency plans for your household or community, outlining procedures for evacuation, communication, and emergency supplies. Designate meeting points and establish communication channels to ensure everyone stays connected during crises. **Assess Vulnerabilities:** Identify vulnerable areas in your vicinity prone to flooding, landslides, or other weather-related risks. Conduct assessments to evaluate the structural integrity of buildings and infrastructure, and take necessary steps to reinforce or retrofit vulnerable structures. **Invest in Early Warning Systems:** Install early warning systems such as sirens or automated alerts that can quickly notify residents of impending disasters. Collaborate with local authorities to ensure timely dissemination of information and instructions to the public. **Implement Land Use Planning:** Enforce strict land use regulations to prevent construction in high-risk zones, such as floodplains or landslide-prone areas. Encourage sustainable development practices that prioritize resilience and minimize environmental impact. **Strengthen Infrastructure:** Upgrade critical infrastructure, including dams, bridges, and roads, to withstand extreme weather events. Incorporate climate-resilient design features and materials to enhance durability and minimize damage during disasters. **Promote Ecosystem Conservation:** Preserve natural ecosystems such as forests, wetlands, and mangroves, which act as natural buffers against extreme weather events. Support reforestation efforts and ecosystem restoration projects to enhance resilience and mitigate the impacts of climate change. **Invest in Disaster Response and Recovery:** Allocate resources for disaster response and recovery efforts, including emergency services, search and rescue operations, and humanitarian aid. Establish contingency funds and partnerships with humanitarian organizations to facilitate rapid response to emergencies. **Raise Public Awareness:** Conduct outreach campaigns to educate the public about the risks of extreme weather events and the importance of preparedness and resilience. Organize community workshops, training sessions, and simulation exercises to build capacity and foster a culture of disaster preparedness. **Advocate for Climate Action:** Advocate for policies and initiatives that address the root causes of climate change and promote sustainable development practices. Engage with policymakers, industry stakeholders, and civil society organizations to support climate mitigation and adaptation efforts at local, national, and global levels.By following these comprehensive guidelines, individuals, communities, and governments can better prepare for and mitigate the impacts of extreme weather events, ultimately enhancing resilience and safeguarding lives and livelihoods in the face of climate uncertainty.

Courtesy: Hindustan Times Editorial, Oct 05, 2023

8. China's sinking cities indicate global-scale problem, Virginia Tech researcher says

A third of China's urban population at risk of city sinking, new satellite data shows. The recognition of sinking land, or subsidence, as a hazard in urban areas globally is growing, thanks to recent research efforts by scientists from Virginia Tech and the University of East Anglia. Their perspective article in the journal Science sheds light on the causes and consequences of land sinking, particularly focusing on alarming findings related to Chinese cities. Satellite data indicates that 45 percent of the 82 Chinese cities studied are experiencing land sinking, with nearly 270 million urban residential areas in Beijing and Tianjin sinking at a rate exceeding 10 millimetres per year. This poses significant risks to crucial infrastructure like roads, buildings, railways, and pipelines. Moreover, similar issues have been observed along the U.S. East Coast.The utilization of advanced satellite imaging technology enables researchers to monitor millimetre-scale changes in land level over time. While groundwater withdrawal 5 stands out as a major driver of subsidence, geological factors and the weight of structures also play significant roles. Immediate measures, such as recharging aquifers and reducing groundwater extrac-

tion, are crucial for mitigating land sinking. Looking ahead, it's imperative for the research community to not only continue monitoring land sinking but also to comprehend its broader implications and facilitate effective responses. This entails developing comprehensive models that encompass all factors influencing subsidence, including human activities and climate change. Failing to incorporate these considerations into adaptation and resilience strategies could result in widespread infrastructure damage in the years to come.

Courtesy: Kelly Izlar, Prevention web ,18 April 2024

9. New unified theory shows how past landscapes drove the evolution of Earth's rich diversity of life

The recent research findings highlighted by Physio.org underscore the profound influence of landscapes on the variety of life forms thriving on our planet. These studies reveal that Earth's landscapes play a crucial role in determining the maximum diversity of species that continents and oceans can sustain at any given time. This suggests that it's not only the influence of factors like tectonics or climates but rather their complex interplay that significantly shapes the long-term development of biodiversity. **The research involved experimental alterations to land through sediment flows and extensive changes to landscapes, shedding light on the mechanisms by which landscapes influence biodiversity**. Importantly, these findings emphasize that the evolution of biodiversity has historically occurred at the gradual pace of plate tectonics—a rate much slower than the ongoing extinction events triggered by human activities. This highlights the urgent need for conservation efforts and sustainable practices to mitigate the rapid loss of biodiversity driven by human actions. Understanding the intricate relationship between landscapes and biodiversity can inform conservation strategies and help preserve the rich tapestry of life on Earth.

Courtesy: Physio.org, Dec 2, 2023, Editor's note

10. Climate change exacerbates nutrient disparities from seafood

The study highlighted in the **abstract from Nature Climate Change underscores the crucial role of seafood as a source of essential micronutrients for human health. By combining reconstructed fisheries data with predic-** **tive modelling**, the research aims to understand historical trends and future projections of nutrient availability from fisheries and mariculture, especially in the context of climate change.Key findings suggest that since the 1990s, availability of micronutrients such as iron, calcium, and omega-3 from seafood has increased, while protein availability has stagnated. However, the study warns of potential decreases in nutrient availability due to climate change, particularly in tropical low-income countries where reliance on seafood-derived nutrients is high. Under various climate scenarios, including 4°C of warming, significant declines in nutrient availability are projected, especially in low-income countries. For instance, at 4°C warming, nutrient availability may decline by approximately 30the century in these regions, compared to around 102.0°C).

Courtesy: William et al., Nature Climate Change volume 13, Abstract, CT., p.1242 (2023)

11. AI (Artificial Intelligence) may hold the key to the preservation of Amazon rain forest

The Amazon rainforest, the largest in the world, spans nine countries, including Colombia and Brazil, covering around 2.3 million square miles (6 million square kilometers) according to NASA's Earth Observatory. **Its significance in absorbing carbon dioxide, regulating weather patterns, and supporting diverse flora and fauna is immense**. However, deforestation poses a severe threat. Research from Amazon Conservation reveals that nearly 2 million hectares (almost 5 million acres) of the Amazon were deforested in 2022, a 21ranching, and illegal mining. In Colombia alone, nearly 1 million hectares were lost in 2022, especially in areas like Caqueta. If this continues unchecked, it could drastically alter the planet's ecosystem, as warned by international environmental experts. To address this daunting issue of the preservation of Amazon rain forest, AI technology is being harnessed. Through the efforts of the Department of Biological Sciences at Universidad de Los Andes, which provided 110,000 images collected over four 6 years, and collaborations with institutions like the Alexander von Humboldt Institute, CinfonIA Research Center, Instituto Sinchi, and Microsoft AI for Good Lab, Project Guacamaya (MACAW) was launched. **This initiative employs advanced AI models for satellite analysis and modifies existing AI models from Microsoft for camera trap analysis and bioacous-**

tics. **These databases are stored in the cloud, utilizing Microsoft Azure's virtual machines and computational power to design and train the models. Project Guacamaya's AI algorithms expedite data processing, significantly reducing analysis time. For example, hidden camera traps, which capture around 300,000 images each, are analysed more efficiently to monitor wildlife and detect invasive species. These AI tools, trained to quickly identify animals, save researchers valuable time for other essential tasks**. Diego Ochoa of the Humboldt Institute emphasizes the need for innovative technological solutions to address environmental problems, stating, "We need to be using technology and innovation to think outside of the box to face the problems that we have. "Juan Lavista Ferres from Microsoft's AI for Good Lab highlights the project's crucial role in measuring and understanding deforestation. He asserts that solving deforestation begins with accurate measurement, which Project Guacamaya aims to achieve, thus providing a foundation for effective intervention and policymaking. While not a panacea for all the Amazon's problems, this project represents a significant step toward mitigating one of the most pressing environmental challenges of our time.
Courtesy: Eliot Smith,6 Sept 2023

12.   Extreme Geomagnetic storm reaches Earth, NOAA says, following "unusual" solar event

An "extreme" G5(G5 is the strongest level of geomagnetic storm, on a scale from G1 to G) geomagnetic storm reached Earth on 10th May 2024 , NOAA's Space Weather Prediction Center said, after issuing a watch earlier in the day warning of the potential for a severe impact. The watch followed days of solar activity that sent several explosions of plasma and magnetic fields toward Earth. "Widespread voltage control problems and protective system problems can occur," NOAA warns. "Some grid systems may experience complete collapse or blackouts. Transformers may experience damage. "Radio transmissions and satellite navigation may also be disrupted. The last G5 geomagnetic storm, in October 2003, caused power outages in Sweden and damaged transformers in South Africa. A geomagnetic storm also means aurora borealis, otherwise known as the northern lights, could be seen as far south as Alabama and in Northern California. Earlier, NOAA had is-

sued its first watch for a potential G4-level geomagnetic storm in almost 20 years. "If geomagnetic storms were hurricanes, 'severe' would be category 4," SpaceWeather.com says. In a press release , NOAA said the most recent series of solar events started on May 8, when a large cluster of sunspots produced "several moderate to strong solar flares." Solar flares are bursts of radiation known to be the solar system's largest explosive events, according to NASA. The area where the flares are occurring is 16 times the diameter of Earth, the NOAA said, and more solar activity is expected.
Courtesy: Li Cohen, 11 May 2024, CBS News

Epilogue
Extreme weather events are increasingly frequent and intense due to climate change, affecting communities worldwide. Common extreme weather events are heat waves, floods, droughts, hurricane and typhoons, wild fire, tornados. An overview of common extreme weather events and potential remedial measures are: reduction of greenhouse gas emissions through renewable energy, energy efficiency, and sustainable transportation, development of infrastructure and policies that enhance resilience to extreme weather, education to the public about risks and preparedness actions, strengthening of disaster response systems and ensure quick, coordinated action during events. Sharing of knowledge, technology like use of advanced technology for better weather prediction and real-time alerts, implementation of policies and plannings like climate risks, support to resilience projects, incorporation of climate resilience into city planning and infrastructure development, encouragement to sustainable farming practices and crop diversification, energy storage solutions, and carbon capture technologies are some remedial measures and should be adopted strictly. to save human lives.We have observed and experienced breathtaking and amazing research and development in the field different branches of science and technology for the community and individual benefits. At the same time, we have to think and act seriously for the irreversible eco system to make it pollution and climate risk free environment for the sustainable existence of the human race.

Compilation and revamping

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