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EDITORIAL

> "This special edition of *TerraGreen* has covered a wide range of contributions on India's leadership at G20, mainstreaming sustainable development, climate change, migration, Prime Minister's LiFE Movement, and climate smart agriculture."

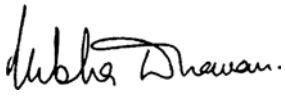
The Energy and Resources Institute (TERI) has successfully concluded the 22nd edition of the World Sustainable Development Summit (WSDS). It is with immense pleasure that I note that TERI brought together leading representatives from international organizations, government, business and industries, research and academia, civil society, and youth to deliberate on the modus operandi required for mainstreaming sustainable development and climate resilience for collective action. The Summit deliberations examined topics such as finance, science, technology and innovation, sustainable consumption, inclusive energy transitions, climate action, and the global commons. Special features at the Summit included Ministerial Sessions, Youth Plenary, Women Leadership Plenary, CEO Forum, Media Colloquium and Thematic Tracks.

We were honoured to receive a message from Honourable Prime Minister Mr Narendra Modi. The keynote address was given by the Union Minister for Environment, Forest and Climate Change, Mr Bhupender Yadav, on Visionary Leadership for Mainstreaming Sustainable Development and Climate Resilience at the inaugural session of the WSDS 2023. Mr Yadav rightly emphasized that with India taking over the G20 presidency, the discourse around sustainable development especially in the UN Critical Decade of Action has caught global attention. His Excellency, Dr Bharrat Jagdeo, Vice President, Republic of Guyana; and His Excellency, Dr Sultan Al Jaber, Special Envoy on Climate Change and COP28 President Designate were also present on this memorable occasion.

The participation of stakeholders of sustainable development and climate action truly enriched the dialogue and provided a broader perspective to all our participants. Over the years, the Summit platform has brought together thought leaders, heads of state and government, scholars, corporates, youth groups, and civil society representatives from across the world. The Summit series has established itself as a responsible and an effective platform for mobilizing opinion-makers to identify and advance pioneering actions to address some of the most relevant issues concerning sustainable development.

The Valedictory Session of WSDS 2023 summarized the key messages emanating from various sessions that were part of the Summit deliberations. During the valedictory, the Act4Earth Manifesto was released, which included messages for the G20 presidency as well as COP28, followed by the launch of Vasundhara Magazine by TERI School of Advanced Studies (TERI-SAS). The session also served as a platform to showcase the curtain-raiser for the 23rd edition of WSDS, where the theme of the next edition of the Summit was announced.

This special edition of *TerraGreen* has covered a wide range of contributions on India's leadership at G20, mainstreaming sustainable development, climate change, migration, Prime Minister's LiFE Movement, and climate smart agriculture. These contributions make strong, informative, and well-analysed suggestions for mainstreaming sustainable development and climate resilience for collective action.



Vibha Dhawan
Director-General, TERI

I liked reading the online issue of the February 2023 issue of *TerraGreen*, particularly the cover story on mainstreaming climate-resilient water and sanitation infrastructure. The authors succinctly say that with 50 per cent of the urban environment required by 2050 not having been built yet, there is huge potential and responsibility of global governments and urban planners to plan and execute for climate change resilient infrastructure. The National Commission on Population in India has predicted that 38.6 per cent of Indians will be residing in urban areas by 2036, and some of India's largest cities are low-lying coastal cities (such as Mumbai, Kolkata, and Chennai). Thus, future planning should focus on developing urban cities away from low-lying coastal areas. This can be easily taken care of by developing a climate-proof infrastructure index (CPII) that would identify chronic and acute risks, map critical vulnerabilities, and enumerate strategies to protect the built-in and planned infrastructure. It is necessary to support long-term thinking, transformation, flexibility and innovation while taking the associated climate risks into consideration to attain climate resilience.

Nalini Sharma
Mumbai, Maharashtra

The Green Challenges article published in the February 2023 issue of *TerraGreen* is quite engaging. I agree with the esteemed authors that ponds play a key role in contributing towards SDGs ultimately by balancing the global climate change to some extent. Therefore, the concept of pond rejuvenation in rural India can be a part of CSR projects in order to address the various environmental concerns. This concept will tap multiple SDGs such as SDG6 (Clean Water and Sanitation), SDG12 (Responsible Consumption and Production), SDG13 (Climate Action), and SDG15 (Life on Land). Rejuvenation of ponds as a part of a CSR initiative ensures the awareness generation among the communities or beneficiaries along with the availability of water for various purposes. On the other hand, it will ensure sustainable consumption and production patterns by providing water to the agricultural fields to meet the growing demand for limited resources without threatening the sustainability of natural resources. The current practice of drawing groundwater for irrigation results in the decline of water table of the region, which ultimately brings an alarming situation of depleting groundwater.

Harsha Gupta
New Delhi

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ACT4EARTH MANIFESTO

Presented at WSDS 2023 Valedictory Session

As global leaders and stakeholders assembled for the 22nd edition of the World Sustainable Development Summit (WSDS), it was the planet that took the much-needed centre stage. As we begin heading towards the deep end of the 2030 Agenda, it is now more than ever that the world needs collective visionary leaderships that put forth a collaborative front to act for planet Earth.

In an unwelcome transition from the triple planetary crisis of climate change, biodiversity loss, and pollution, the post-COVID world has seen itself undergo a poly-crisis, warranting the need to reimagine structures of governance at the international, national, and sub-national levels. The problems that we

face today cannot be solved by structures of yesterday. Just like the scale and impacts of the climate crisis are based on geographical and socio-economic contexts, addressing today's challenges merits looking beyond the conventional approaches towards a regime that encourages polylateralism and poly-centric approaches.

Our window to act is shrinking, and it is shrinking fast. As we stand here today on a platform with a legacy of over two decades having served as a means to mobilize opinion-makers for driving ambition and advancing pioneering actions to address vital issues concerning sustainable development and climate change, the following is our message to the world supported by the youth in their Youth Climate Conclave 2023 Pledge:

Incremental pledges need to transform into meteoric climate action

We believe that if enough individuals can be mobilized, the opportunity for change is exponential. It is to this end, to nudge action, raise ambition, encourage dialogue, and bring like-minded people together that we have come out with a 10-point Act4Earth Manifesto.

We pledge to Act for Earth by:

1. Bringing together stakeholders including governments, businesses, civil society, women, and youth for creating a paradigm shift in the process of policymaking and visioning for much-needed climate action.
2. Reorienting anthropocentric worldviews to nature-centric approaches in policy and governance for intergenerational and intergenerational equity for all life on planet Earth.
3. Identifying linkages and good practices within and across Sustainable Development Goals.
4. Amplifying global south perspectives on important focus areas on global norms around Global Goal on Adaptation, Financing Loss and Damage, Climate Finance, Global Stocktake, and Transparency.
5. Developing actionable frameworks on sustainable consumption and lifestyles by promoting science-based actions, deriving inspiration from indigenous communities, driving policy change, reorienting markets, and enabling social innovations.
6. Informing and steering deliberations on key areas aimed towards fostering green growth and development to achieve meaningful outcomes in the G20 fora.
7. Realizing the criticality of the energy trilemma and develop supply and demand solutions using a systems approach.
8. Advocating for nature-based solutions through means such as sustainable agricultural practices to ensure food security while simultaneously ensuring climate resilience and ecosystem integrity.
9. Fostering integration and mainstreaming of sustainable development through policy innovations such as green budgeting.
10. Addressing global commons' governance gaps by strengthening the climate–ocean interface. ■

India's Leadership at the G20

All Nations to Benefit from India's Stewardship

In this stimulating article, **Aarti Khosla** highlights that the G20 mantle allows India the opportunity to influence the energy track discussions, while emphasizing the need for energy security and demonstrating rapid investment in clean energy goals.

India's leadership of the G20 or Group of Twenty in 2023 pulls into focus its singularly unique position: that of a host of a group of economies that together accounts for 81 per cent of the world's GDP, but also that of a primarily market-driven test-bed, and promoter of solutions that are critical to mitigating against climate change. It is a prominent member of the Global South and is proactive on expanding clean energy, but is also pragmatic on the balance needed for a *Just Transition* away from fossil fuels. India understands and is living the principle that even though the climate crisis necessitates a rapid retreat from coal, oil and natural gas, the transition to clean alternatives need not foment economic uncertainty.

Energy Self-sufficiency

The G20 mantle allows India the opportunity to influence the energy track discussions, while emphasizing the need for energy security and demonstrating rapid investment in clean energy goals. As the European Union and the UK are forced to tackle rising energy costs and buy expensive gas supplies after Russia's invasion of Ukraine, the rest of the developing countries have also been scrambling for expensive gas, leaving countries like Bangladesh with high gas prices, high inflation and domestic turmoil. The shock to the global energy system last year has shown that large-scale energy imports and carbon-intensive systems are not conducive to nimble, future-ready economies. Even if India remains wary of any commitment to shun its coal dependency, the G20 will certainly provide an opportunity to emphasize the diversification of energy systems, as well as lowering emissions from all energy sources—coal, oil and gas—a viewpoint that the country also put forth at the UNFCCC negotiations in Egypt in late 2022.

What India has to Offer

Firstly, India's central tenet of *Vasudhaiva Kutumbakam* (the world is one family) recognizes the need for all nations to work together. It does not segregate countries into factions based on political ideologies or social dynamics but offers solutions that are relevant and replicable regardless of geography. In a year when monetary conditions are constricted, and the need for financing climate-smart development comes home to roost, India can become the ground where a sustainable finance agenda is discussed with greater sincerity, and the stalemate on the reform of the multilateral banks gets broken.

Its stated ambitions on renewable energy also present an opportunity to focus on accelerating clean energy, especially in parts of the world where it is most needed, such as Island Nations and Africa. The latter leads the world in solar potential at 4.51 kWh/kWp/day, which is 30 per cent greater than Europe and Russia (3.44 kWh/kWp/day), but still lacks access to either the equipment or the financial aid to capitalize on its resource. The International Solar Alliance (ISA) and the One Sun One World One Grid (OSOWOG) initiative are prime examples of initiatives that could be helpful here as they intend to make solar power accessible to the very countries that are blessed with the strongest solar insolation and need the energy security that localized solar capacity would unlock.

Also, the country's commitment to 500 GW of installed non-fossil power capacity by 2030 has seen public and private financing into its solar and wind power industry rise by 70 per cent compared to 2019 and pre-pandemic levels. However, coal has not been abandoned as India's emissions are only expected to peak in the next decade or so. This implies that the economy must have stable energy supplies and employment till non-fossil power can play the same role as coal does today. Twenty-six of its 29 states have also enacted impressive policies on e-mobility in recognition of the zero-emissions future of transport, but crude oil still plays a major role to prevent a sudden contraction in tax revenues, employment, and energy supplies.

India is thus a de-facto test-bed for the Global South—and for any other country that needs proof-of-concept. The

country's 1.3 billion-strong population, its incredible diversity and the challenges that come with it, combined with the Centre and state governments' embracing of free-market dynamics despite systemic inefficiencies will prove that if India can reconfigure its energy market while not decimating jobs and its GDP, others can too. At present it is stepping away from its massive, USD 12 billion-a-year subsidy on grey hydrogen to invest in green hydrogen, which would lower its carbon emissions by 3.6 Gigatonnes by 2050. The move will help migrate skilled personnel from coal and oil jobs and make available an energy-dense but carbon-free fuel for heavy industry and transport. The two have traditionally been the largest polluters in most countries. Secondly, India is a treasure trove of nature-based solutions that are inherently climate-resilient. Successful community-led campaigns in Rajasthan, Tamil Nadu and Uttar Pradesh have regenerated degraded lands, dried-up streams and rivers and brought back the use of tanks for (rain)water conservation.

Additionally, the state of Sikkim is certified as the "world's first organic state" by the UN Food and Agriculture Organisation (FAO) for its produce. All of this shows that the prime minister's LiFE (Lifestyle for Environment) and Pro-Planet People (P3) principles are grounded in real-world solutions that could be replicated by other countries. Indeed, the lesson from India here is that there are handy solutions embedded into our societies that obviate the need for desperate new policies.

Over 1000 women in Tamil Nadu restored the dried up Naganadhi River by digging groundwater recharge wells and installing check dams in its catchment area | Photo: Santha Ashokan

What India Should Demand

The ongoing G20 Summit should therefore be used by India to not just offer solutions in sustainability, but also to demand stronger commitments. For example, it should demand that the countries that benefit from the equipment transfer and capacity building under ISA and OSOWOG must reciprocate by adopting bolder targets for solar and wind capacity.

It should also demand that the developing world, particularly the coal-heavy economies such as Indonesia, South Africa and sub-Saharan African nations, match its efforts on a Just Transition away from coal. Every country's power sector has its own constraints, but India faces the gargantuan task of migrating at least 725,000 direct jobs and an estimated 13 million indirect jobs that Coal India alone accounts for. The matter is highly political and yet calls for a resolution within what little time and carbon budget the world is left to work with. A pathway for India would be for the policymakers to mandate that academia and the private sector launch re-skilling programmes under the umbrella of Corporate Social Responsibility (CSR). They could be required to train the workers to work in agro-forestry and locally-relevant nature-based solutions in return for results-based tax reliefs. Not only does this approach offer an incentive to all parties but should also be replicable outside India's borders.

Thus, even though geopolitical turmoil may be a major strain on many governments this year, India's energy initiatives and traditional knowledge systems must be studied by all. The climate crisis will be harsh and unforgiving, so it is prudent for all nations to benefit from India's stewardship and to start collaborating, wherever possible.■

Aarti Khosla, Founder & Director – Climate Trends, New Delhi.

India's G20 Presidency

Delineating Economic and Emissions Growth and Promoting Energy Transition

G20 presidency serves as a big opportunity for India, to raise this challenge that emerging markets face, around delinking economic and emissions growth and promoting energy transition, and garnering suitable solutions from the global community in terms of finance and technology. Towards this, it may focus on scaling up risk mitigation mechanisms, financing mechanisms, Just Transition, integrating a risk-return-impact lens, and creating an enabling ecosystem. This insightful article by **Namita Vikas** looks further into each of these areas.

India has taken over the presidency of the G20, the world's most influential multilateral forum, at a time the global economy is undergoing VUCA (short for volatility, uncertainty, complexity, and ambiguity) with multiple headwinds. To mitigate these times, governments, corporates and financiers globally are driving post-pandemic recovery, stabilizing disruptions to global supply chain which have occurred due to conflicts, adapting to the climate crises, ensuring a just energy transition and avoiding social unrests due to income inequality.

At the same time, India faces a paradox. Its latest data shows that while it contributed little to greenhouse gas (GHG) emissions historically, this grew three-times from 1991 to 2019, double the global average. Moreover, amongst the G20 nations, it ranked 3rd in emissions/GDP intensity (Figure 1). Given the investible life left in its coal power assets, complex production processes in hard-to-abate sectors that are tough to alter with current technologies, and new technologies yet to be fully tested and commercialized, its emissions are expected to continue rising until they peak around 2040–2045. This is in line with the expected trajectory of emissions reduction highlighted by India during COP26. Until then, it does need to drive its economic growth to improve per capita income and quality of life of millions, not to mention drive energy access to a scale that leads to productive economic activities, while at the same time balance this with development that is sustainable and environmentally prudent. For this, delinking its economic growth from emissions growth and arriving at a climate-smart economic growth model is imperative, thus acting as a precedent for other emerging markets globally on similar trajectories.

G20 presidency serves as a big opportunity for India, to raise this challenge that emerging markets face, around delinking economic and

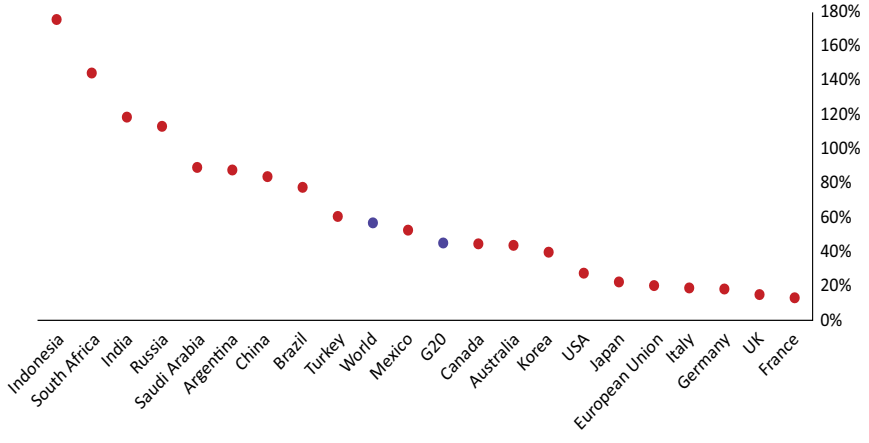

Figure 1: G20 countries: GHG emissions to GDP intensity (%) (As of 2019)
Source: IMF and ClimateWatch

emissions growth and promoting energy transition, and garnering suitable solutions from the global community in terms of finance and technology. Towards this, it may focus on scaling up risk mitigation mechanisms, financing mechanisms, Just Transition, integrating a risk-return-impact lens, and creating an enabling ecosystem.

With a hard focus on the climate finance agenda specifically, scaling up risk mitigation mechanisms using its domestic capital as well as support from the governments of industrialized countries and multilateral institutions, such that it incentivizes private sector capital to enter and create scalability in finance, would lead to substantial climate action. That includes not just green energy, but also investing in the transition of hard-to-abate sectors like steel, cement or chemicals into low-carbon models, or investing in R&D of new technologies to make these affordable and accessible for developing countries. Sectors like solar battery and storage, green hydrogen, green ammonia, carbon capture and storage, direct carbon capture, etc., serve as a significant green potential waiting to be exploited.

An example is demonstrated by the International Solar Alliance (ISA), where India plays a leadership role. It has recently released a Request for Proposal, to create a risk guarantee, insurance and investment mechanism to promote clean energy adoption in Africa. Once this mechanism is created and rolled out, it would be interesting to assess the risk mitigants and covenants it has used. Such a facility could even be considered for replication with the G20, given that as part of its G20 presidency, India has invited nine countries to partner bilaterally.

Scaling up potential financing mechanisms would lead to enhancing capital flows to energy security projects. For example, on the back of the success of India's maiden sovereign green bond issuance that saw a greenium, is there a scope to raise a first-of-its-kind sovereign transition bond that particularly focuses on financing energy transition programmes? In this context, the planned second sovereign green bond, expected to be issued in the second-half of the next fiscal, could look at funding projects within the public sector that promote low carbon transition and emissions reduction. Further, Indore Municipal Corporation's issuance to raise INR 2.44 billion through the first-ever public green bond issuance, and the plans of the country's largest agriculture DFI to issue its first-ever green bond, would unlock domestic green capital and accelerate sustainable finance and climate action across India. With this surge, India is bound to move steadfastly to meet its Net Zero plans.

The other larger challenge looming ahead of India is to ensure a Just Transition, which remains an unsolved social issue. However, without frameworks and standards to classify what activities are covered under transition finance, it is still a far cry. Clear guidance and direction to commercial financial institutions to initiate transition, would channelize capital to the right projects and to fund the transition to decarbonization. Further, in the absence of reported data, estimates suggest India has seen sustainability-linked loans (SLL) issuances of USD 2.6 billion (approx.) across sectors, unlike green bonds that have seen a cumulative USD 18 billion (approx.) raised predominantly for solar. Thus, even the emerging SLL segment can benefit from such a transition finance framework, resulting in flow of dedicated

capital at scale towards a just energy transition agenda.

There is a scope to use the G20 presidency to drive changes in how the financial community looks at the risk-return lens. For example, is there a way to mainstream an alternate lens of risk-return-impact? Moreover, the opportunity to drive the acceptability of the financial community towards a concept of integrating climate risks into loan pricing or calculating climate-adjusted returns is emerging with the RBI announcing its intent of issuing guidelines. Climate risks are currently not part of loan pricing decisions in many institutions, even if they may be part of checks and balances in some form or shape. Climate-adjusted returns of projects, or ESG-adjusted returns, looks at integrating the impacts of sustainability and climate risks into the business-value drivers, and according to a probability-based quantifiable scoring to discount elements of financial analysis like cost of capital, cash flows, revenue growth, cost base, margin growth, cost of borrowing, etc., either with a negative or a positive impact. There is a need to leverage this opportunity to push the climate finance and energy transition agenda by creating an enabling ecosystem, not just limited to risk mitigation, financing flows and analysis of projects. An enabling ecosystem may involve creating an open-source database on climate risks that corporates and financial institutions can access to take informed decisions, or even compiling estimating data on how much clean energy and resources would be required for green hydrogen capacity. Channelizing low-carbon financing by banks using priority lending programmes, integrating climate change risks into capex plans, feasibility analysis and detailed project reports for new projects awaiting commissioning, and promoting cleantech/climate-tech in the venture capital and private equity space, such that those businesses scale up and become bankable for commercial banks may be suitable finance initiatives to create an enabling ecosystem.

Further, mandatory adoption of solar rooftops for buildings over a certain floor-plan area, allowing carbon offsets in voluntary markets to enhance carbon trading if net zero technologies are not yet commercially available, extending the PLI scheme to encourage domestic manufacturing of clean energy technologies and mainstreaming its PAT scheme in energy efficiency across peer markets, may be suitable policy initiatives towards creating such an ecosystem. Lastly, in emerging markets like India where industrial clusters abound, piloting energy transition to create 'green industrial clusters' may enable SMEs to look at sustainable finance and contribute towards energy transition.

Conclusion

In conclusion, the G20 presidency offers a unique opportunity to solve a challenge for emerging markets globally. This is the paradox of delineating economic and emission growth and scaling up the energy transition. If done right, it may create scope to use India as a global case-study, thus strengthening the country's global standing further! ■

Namita Vikas, Founder and Managing Director, auctusESG LLP

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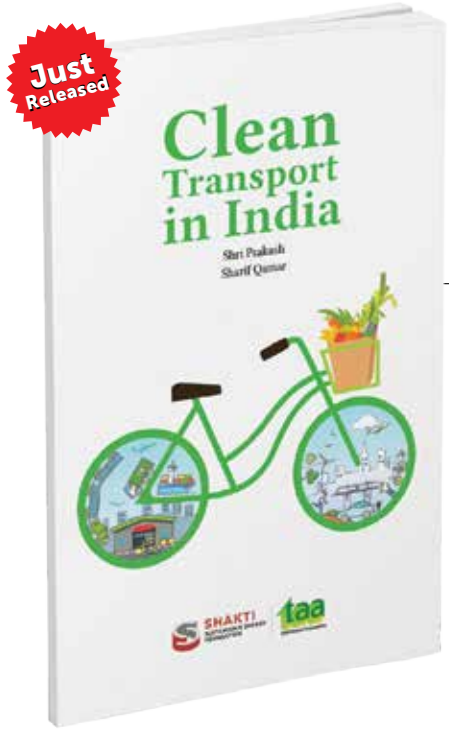
THE PATHWAY TO SUSTAINABLE TRANSPORT



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This book not only presents all the relevant statistics but, more important, explains the implications of those numbers and the interconnections between different facets of transport: for example, the greater number of vehicles on roads may seem to favour mobility but in fact makes roads more congested—and the congestion makes air pollution more severe, thereby aggravating its impact on health. At the same time, the book is not a prophet of doom but also touches upon electric vehicles, hydrogen fuel cells, drones, and even flying cars.

Instead of fretting and fuming when you are caught in a traffic jam, read this book: it will not only calm you but, who knows, may inspire you to be a 'green' commuter.

This book is useful for adults who are concerned about topical issues but lack the understanding to make sense of what they read or watch in the mass media.

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Five Ways India Can Ensure the G20 Supports Business

To Deliver a Cleaner and Sustainable Future

In this thoughtful article, **Rasmus Valanko and Gitika Mohta** say that we are in the decisive decade for climate action. Global emissions must be cut in half by 2030, to avoid the worst impacts of climate change. With India's presidency of the G20, India has a unique opportunity to chart a healthier, safer, more sustainable future not just for its own citizens but also for others on our shared planet.

India's presidency of the G20 comes at a point when the world faces multiple, interconnected crises: energy, climate, nature, health. To tackle the climate crisis, the science is clear. We must phase out all fossil fuels in order to limit global temperature rise to 1.5°C.

As a leading voice of the global south, India can change the course of history by continuing to take bold action on climate change.

India has already shown leadership with strong national commitments on renewable energy as well as hydrogen through its National Green Hydrogen Mission. India's annual budget for 2023 focuses on green growth with major investments allocated towards a cleaner energy transition. At COP27, business was strongly encouraged by India's international leadership in calling for a phase down of all fossil fuels.

At We Mean Business Coalition, we work with thousands of companies across the world and stand ready to support India's leadership to drive meaningful progress on this vital topic throughout its G20 presidency. With the right policies and incentives, all G20 nations can stimulate business to scale up investments and innovations for clean solutions within energy systems as well as in diverse sectors such as heavy industry and transportation. With the right policies that accelerate a shift away from fossil fuels, countries can reliably attract private investment into the growth industries of tomorrow.

Throughout its G20 Presidency, India has a unique opportunity to lead the world's largest and fastest growing economies in this transformation. Specific language in the G20 communiqué on how countries can accelerate the transition to clean energy will have huge repercussions globally. Clear language will bring certainty for CEOs across the world and confidence for them to invest now in the future of these countries.

The business case for accelerated action on climate is clear. That's why thousands of companies are working to reduce their emissions in line with climate science. In India alone, 116 companies including Infosys, Dalmia Cement and the entire Mahindra

Group, are committed to cutting their greenhouse gas emissions across their value chains by setting credible science-based emission reduction targets. Also, 75 companies with operations in India, including Tata Motors and Ultratech Cement have committed to procuring 100 per cent renewable energy. In addition, 13 Indian companies including WIPRO and Flipkart were committed to electrifying 100 per cent of their corporate fleets, which means procuring over 200,000 electric vehicles locally and setting up 2850 charging stations in India. To achieve their targets, these companies need more widespread access to clean energy, fast.

What's more, We Mean Business Coalition research found that if India rapidly accelerated its transition to clean energy, it would create 15.4 million additional jobs by 2025, and grow the economy by almost 10 per cent compared to business-as-usual.

Strong outcomes from the G20 on the following five areas will enable companies in India and globally to seize opportunities and help drive a just transition to a global clean energy system while avoiding the growing risk of stranded assets. It will drive finance into areas that will help deliver the transition away from fossil fuels and into new technologies.

1. Energy Security

Amid a global energy crisis, accelerating the transition to a diversified, reliable clean energy system is the most cost-effective way to increase energy security, cut emissions, and increase jobs and growth.

2. Finance

Redirecting fossil fuel subsidies—which in 2021 represented almost USD 700 billion across G20 nations and in India alone in 2019, over USD 10 billion—would generate a huge wave of private investment into the clean energy transition. It would give companies

a clear signal that it's time to invest in renewable energy infrastructure, electrification, energy efficiency measures and R&D and innovation in the breakthrough technologies needed to decarbonize sectors such as industry and transport.

3. Renewables

Scaling up renewables at speed, streamlining permitting processes, rolling out grid infrastructure and ensuring that the negative impacts of energy transition on communities are reduced across the G20 would be transformative. Some G20 countries are already further along on this journey than others, so sharing learnings will be enormously valuable. G20 countries need to go all in so that businesses can invest, build, and reinvest at scale.

4. Energy Efficiency

Energy efficiency drives down demand for energy, allowing a faster shift away from fossil fuels. According to International Energy Agency's latest analysis, energy efficiency actions taken since 2000 have led to over USD 680 billion cost savings globally. Through Climate Group's EP100 campaign, 126 companies have committed to enhancing energy efficiency measures and through actions taken in the past few years, have already saved over USD 128 million annually from their efforts.

5. Jobs and Communities

The G20 must agree to implement people and community-centric policies to support those that rely directly as well as indirectly on fossil fuel industries for their livelihoods. Ensuring a just energy transition is particularly relevant for India given the size of its population dependent on fossil fuels as well as the need to re-skill and upskill a large number of people joining the clean energy economy.

We are in the decisive decade for climate action. Global emissions must be cut in half by 2030, to avoid the worst impacts of climate change. India has a unique opportunity to chart a healthier, safer, more sustainable future not just for its own citizens but also for others on our shared planet. The eyes of the world are watching, and we are confident that the Indian government and Indian business will rise to the challenge. ■

Rasmus Valanko, Managing Director, Systems Transformation, and Gitika Mohta, Industry Manager, Systems Transformation, We Mean Business Coalition.

Pioneering Climate Finance in India

TCCL Helping India to Realize its Climate Goals

Climate Finance has always been viewed as a public sector initiative. India's ambitious plans were constrained by the inadequate capacity of such institutions to meet the agility, innovation, and deep understanding required to finance dynamic cleantech sector. TCCL has played an important role in mainstreaming of emerging sectors such as solar rooftop, energy efficiency, electric mobility, and water treatment. TCCL has been able to do this by developing a profound understanding of the rapidly evolving sector including technical, commercial, regulatory, contractual, and E&S expertise. In this succinct article, **Manish Chourasia** says about challenges to crowd-in capital from global north and role of TCCL in channelizing these funds.

Global warming is posing a real threat to the human life. According to the Intergovernmental Panel on Climate Change (IPCC), 1.5^{0}C temperature rise would be the tipping point. Human activity-induced climate change has their origin in the industrialization era that started from the 1800s. But, the heightened spate of economic activity across advanced as well as newly emerged developing economies since the last three decades has accelerated emissions. To illustrate this with data, the planet had used only 32 per cent of the carbon budget until 1990. However, this doubled to 60 per cent within the last 30 years alone, leaving us with only 8 per cent of the carbon budget before circumstances become irreversible. Apart from emissions, land degradation, deforestation, waste discharges, extreme heat incidents and sea water rise have intensified in recent years.

In terms of absolute value, emissions were led by the advanced economies. But, the battle to combat global climate change will have to be fought in developing countries. While India may have ranked lower in absolute terms, the outlook looks worrying. This is because in growth terms, India's emissions are estimated to rise by 25 per cent between 2020 and 2030, as per Global Carbon Atlas data. India has the unique opportunity to create growth, new infrastructure and meet the aspirations of its young citizens in a green, sustainable way.

The challenge is not macroeconomic in nature considering the fact that the global annual savings are about USD 20 trillion, which is about 4–5 times higher than the funds required to fight climate change. In fact, globally, annual defence spending far exceeds investments required towards climate action. The crux of the issue is that most of these savings are in the global north, but the requirement is in global south because they are the ones who will grow at a much higher rate and their carbon intensity of the GDP will be higher, going forward.

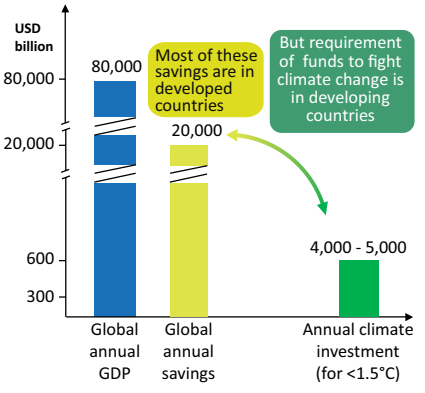


Figure 1: Fund required for Climate Finance vs global savings
Source: World Bank, Energy Transitions Commission (ETC)

Globally, diverse class of investors are eager to contribute towards the war against global warming, but they require credible local platform to effectively channelize funds. TCCL has established itself as that ideal platform to intermediate global climate funds to Indian climate projects and companies.

World over, Climate Finance has always been viewed as a public sector initiative. India's ambitious plans were constrained by the inadequate capacity of such institutions to meet the agility, innovation, and deep understanding. There was a huge gap in sector understanding prohibiting channelized capital to come in the sector.

Tata Cleantech Capital Limited (TCCL) addressed this by developing a profound understanding of the rapidly evolving sector including technical, commercial, regulatory, contractual, and E&S expertise. TCCL has built a robust risk diligence and comprehensive monitoring framework to underwrite complex transactions and effective asset management. Further, TCCL has institutionalized E&S assessment for every project appraisal. TCCL is progressively vying to adopt cutting-edge technologies for making its business digital- friendly and competitive. TCCL hired people not just from financial services but also from renewable industry to build a dedicated research team and unparalleled expertise of the segment. TCCL is also disseminating knowledge through its publications. TCCL has published White Papers in Cleantech segment, "Renewable Integration & Curtailment: Causes, Solutions and Impact on Project Bankability", "Indian Renewable Sector Status – Impact of COVID-19" and "Indian Renewable Open Access Landscape: Market Trend and State Comparatives". TCCL has also collaborated with a working group led by FICCI to publish a report on "India Roadmap on Low Carbon and Sustainable Mobility". All the publications are available on the Company's website.

TCCL's instrumental efforts have been recognized globally and have won several accolades. TCCL has received "Enterprises in the renewable energy space, 2021" awarded with prestigious Earth Care Award (sponsored by JSW and The Times of India). The Award is an initiative that rewards corporations for their efforts to mitigate climate change. TCCL has also been awarded with Green Urja Award in both 2020 and 2021 as a recognition of the efforts in financing of

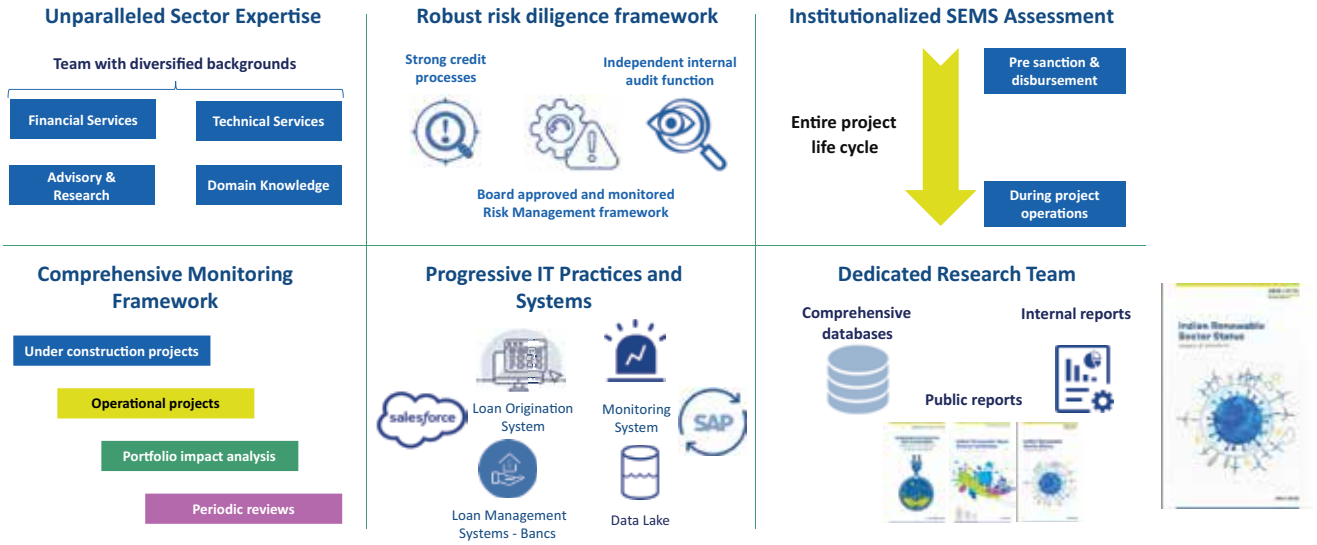


Figure 2: Key differentiators of TCCL

renewable energy and energy efficiency projects. TCCL has also been awarded by World BFSI Congress and Solar Quarter.

Furthering the efforts, TCCL's MD has become a part of marquee committees for promotion and support of climate finance. The key committees are:

- NITI Aayog led Policy Framework for Electric Vehicles
- India–EU Collaboration to Fight Global Warming
- Co-chair in International Solar Alliance led committee to raise USD 1 trillion
- CII Net Zero Council to Develop Climate Action Plan
- Chair – Working Committee on Climate Finance led by Gateway House
- Part of Climate Finance Leadership Initiative (CFLI) convened by Michael Bloomberg

TCCL started its journey as a novel experiment in 2013 as a Joint Venture between Tata Capital Limited and International Finance Corporation (IFC). Since then, TCCL has come a long way having financed over 310 projects and 12.4 GW of renewable capacity and abatement of more than 19.1 million tonnes of carbon emissions as of June 2022. Further, TCCL prides itself by endeavouring to mainstream such sectors of Climate Finance, which are yet not attractive for traditional banks and finance institutions. It is working aggressively to develop markets for emerging sectors such as solar rooftop, energy efficiency, electric mobility, and water treatment. Even while TCCL is contributing to the green developmental agenda of the nation and the globe, it has made handsome returns for its investors. Over the past five years, the Company has exhibited strong growth

TCCL Achievement

~ 12.4 GW	310	19.1 million tons
Renewable capacity financed	Projects financed	Annual carbon emission averted

TCCL Cleantech Sanctions

> 500	187 MLD	12.5 MLD	5
Rooftop Solar Sites	Sewage Water Treatment	Water Desalination	Small Hydro Plants
> 250,000	**20**	**40,000**	**240**
Street Lights	EE ESCO sites	Smart Meters	Electric Buses

Figure 3: TCCL achievement and mainstreaming activities

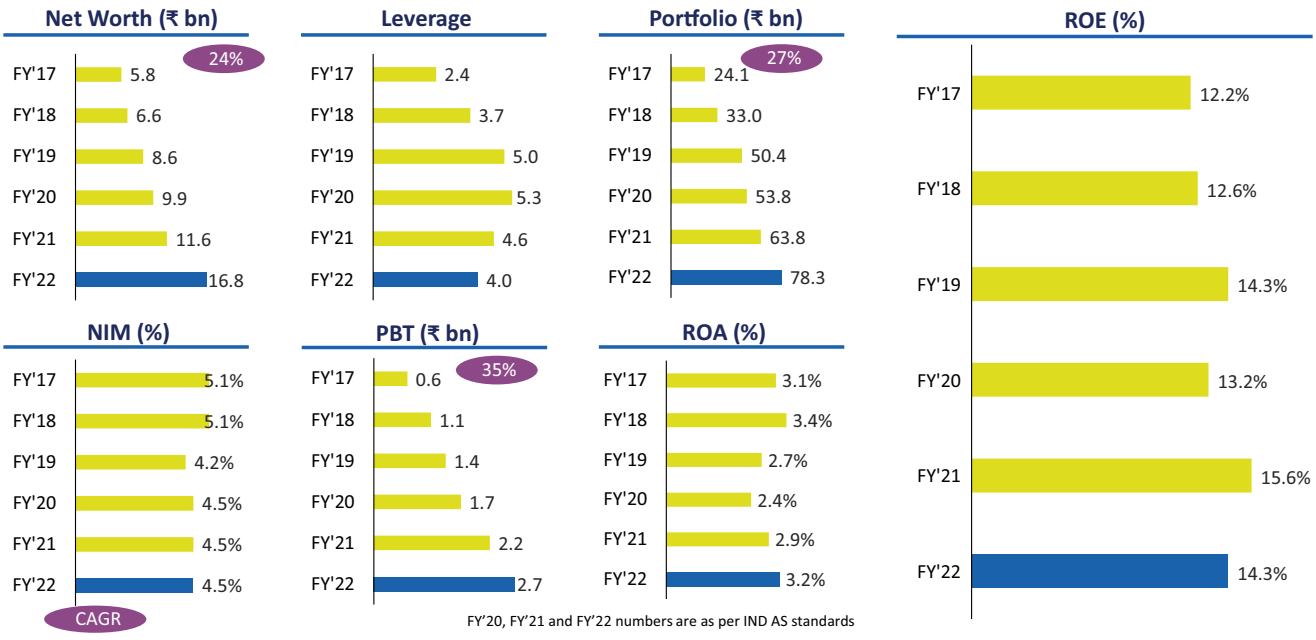


Figure 4: TCCL's financials

on all parameters, with the total loan portfolio growing from ₹24.1 billion to ₹78.3 billion over the period FY 2016–17 to FY 2021–22. TCCL has delivered significantly higher ROE than industry while maintaining the best-in-class asset portfolio and is rated AAA by CRISIL.

TCCL charted the strategy of collaboration with investors, clients and regulators from the very beginning. It has entered into partnerships with reputed Indian Institutions such as IREDA (Government-owned Leading Renewable Energy Financier), EESL (Government- owned Super Energy Services Company), and Bureau of Energy Efficiency (Govt. body mandated to set Energy Conservation Standards). In addition, TCCL is the only private sector Institution in India to have received a line of Credit from the Green Climate Fund (GCF, the largest global fund dedicated to help fight climate change). This USD 100 million facility is being used to develop and mainstream the rooftop solar financing in India.

TCCL has been able to further strengthen its global footprint by being inducted into the Green Bank Network. TCCL is the first Private Sector Climate Finance Institution in the Green Bank Network and the first Indian financial institution to enter the coveted network.

In addition to its lending business, TCCL has also expanded its offering in financial and cleantech advisory services. Over the years, TCCL has been proud to work not only with leading multilaterals such as the World Bank, IFC, ADB, GIZ and DFID, large Asian multilaterals but also with leading corporate institutions.

With such abundance of sunshine and wind, India has large untapped potential. India is set to reach 165 GW to 180 GW in the next 4 years from 103 GW as of October 2022 of solar and wind capacity. Further, Indian government is targeting capacity of 450 GW from solar

and wind by 2030. Similar opportunities await in the Energy Efficiency space (through programmes such as Smart Meters, Industrial Energy Efficiency), Water, and the E-mobility space. In all, investment required in the next 8 years in Sustainable Infrastructure could well exceed USD 1 trillion as per estimation of TCCL. This would represent over 15 times jump over the actual investments of around USD 66 billion in the last 8 years.

The key ingredient to provide a bridge between potential and implementation is finance. To put this into context, the investment required makes up ~40 per cent of the current total assets of all commercial banks in India. The public sector will be unable to meet the sheer size of this investment, which implies crowding in of investment from the private sector. In this regard, TCCL has so far played a pivotal role. TCCL has disbursed more than double of its total portfolio (disbursed ₹213.2 billion and portfolio of ₹92.9 billion as of September 2022) and created the framework for other players to enter in the segment.

Developing countries face another fundamental challenge. First, green technologies have higher capital requirement in comparison to conventional technologies, which often makes it prohibitive to invest in these. Secondly, developing countries have higher cost of capital making green investments costlier. Even if India can raise low-cost international capital, all savings get neutralized by the high cost of hedging. Moreover, for tenure larger than the average maturity of over 10 years, hedging market itself is

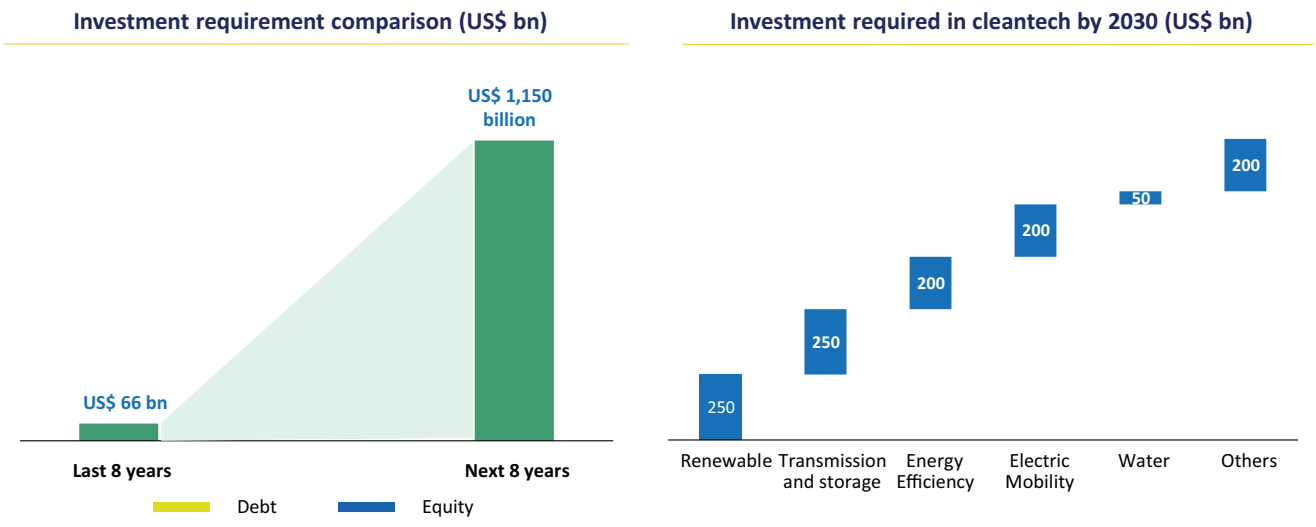


Figure 5: Investment required in cleantech by 2030 (USD bn)
Source: TCCL Research

non-existent leaving projects exposed to currency risk in medium to long term. A de-risking mechanism is another imperative to finance energy transition in India. Given the scale of requirement of climate finance, the collaboration of the developed world is essential.

India will also need to strengthen the domestic bond market to facilitate more green bond issuances, a product largely dependent on global pools of green capital as of now. Further, capital flow from Indian insurance and pension funds needs to be promoted. India would also need to create right processes to enable the channelization of funds from developed countries. Though investment required is huge, business models and payment security mechanisms are yet evolving. In addition, industry will need to be vigilant of continually evolving policy environment and incongruous liability profile. Over the past few years, industry has the following long-term sustained reforms in target sectors:

- **Renewable energy**: Feed-in Tariff regime to auctions, solar parks and increase in scale of operations
- **Water:** Emergence of HAM, higher upfront clearance, and industrial projects
- **Transmission**: PPP model and faster clearances

Similarly, there have been reforms in financial markets and legal frameworks. New class of platforms such as IDF, AIF and Infrastructure Investment Trust (InVit) have emerged attracting capital from domestic and offshore players. But for really scaling up, strengthening of public institutions such as DISCOMs, municipalities and urban local bodies is required. Weak financials and rising liabilities of these institutions creates threat of non-payment. Cleantech projects have higher upfront costs and require longer contracts for viability. However, nature of technology is such that, future prices could be much more attractive than that of today. In the absence of contract enforcement framework, viability of cleantech projects could be jeopardized.

Another missing framework to attract green investment is the harmonization of taxonomies or comprehensive classification systems with relatively precise and consistent definitions to rate an investment as 'Green'. All of this presents an unprecedented opportunity in terms of scale and longevity, but TCCL needs to stay focused in its carefully chosen current and future sectors and markets. Further, TCCL would continue to work along with partners to channelize requisite capital and realizing the climate goals of India. ■

Manish Chourasia, Managing Director, TATA Cleantech Capital.

Hariyali Gram

Empowering Rural India to Lead the LiFE Movement

In this succinct article, **Charu Lata** and **Akanksha Golchha** highlight the transformative Hariyali Gram initiative in Gujarat, Rajasthan, and Maharashtra states in India. Hariyali Gram is a women-led initiative with an emphasis on policy implementation and scalable business solutions for the adoption of climate-friendly solutions at the village level.

India's 'Lifestyle for the Environment (LiFE) Movement,' announced at COP26 in Glasgow, aims to propagate sustainable lifestyles based on traditions and values of conservation and moderation. Rural women-led programmes in implementing renewable energy and climate- friendly solutions can support the LiFE movement and India's pledge towards a net zero carbon economy by 2070. Both initiatives are closely interlinked with empowerment of women and communities, focusing on energy security and sustainable consumption and use of resources. As India transitions to fossil-fuel-free sources of energy, distributed renewable energy (DRE)—when energy is generated from renewable energy sources near the point of use, and climate-friendly solutions are vital and can also help support both the LiFE movement and the net zero initiative.

Close to two-thirds of India's population lives in villages, with uncertain and irregular power grid availability. Distributed renewables can supplement the emerging demand of newly electrified households under the flagship 'SAUBHAGYA' scheme and increase reliability of power supply. Distributed renewables can also help these villages electrify, improve livelihoods, and reduce drudgery for women through mechanizing activities or reducing time spent collecting and processing traditional fuels such as wood.

Biogas plant installed in a rural household in Anand district, Gujarat. Picture source: NRDC

Households without access to clean energy technologies and climate-friendly solutions spend a substantial portion of their monthly budgets on the procurement of fossil fuels, primarily for cooking and water pumping. Thus, the adoption of clean energy technologies makes both environmental and economic sense, and creates a strong linkage with the LiFE mission. In addition, decentralized renewables have immense potential to create jobs, empower entrepreneurship, and enhance livelihood opportunities for rural communities. With increased electrification levels, the narratives on energy access need to evolve with a focus on tangible solutions for unserved and underserved communities. Natural Resources Defense Council (NRDC) along with Self-Employed Women's Association (SEWA), and Association of Renewable Energy Agencies of the States (AREAS) have been implementing the transformative Hariyali Gram initiative in Gujarat, Rajasthan, and Maharashtra. Hariyali Gram is a women-led initiative with an emphasis on policy implementation and scalable business solutions for the adoption of climate-friendly solutions at the village level. The Hariyali Gram initiative covers a host of climate-friendly solutions such as solar pumps, biogas plants, precision irrigation, cool roofs, solar fodder systems, etc., implemented in villages

with women in the forefront of leading this change. The initiative is designed with an objective to elevate living conditions, reduce expenses on fossil fuels, increase livelihood opportunities, and improve mindful and deliberate utilization in rural India.

Improving women's productivity and incomes through reliable and affordable access to energy for economic activities could help in accomplishing Sustainable Development Goals 5 (gender equity), 7 (affordable and clean energy), and 8 (decent work and economic growth). Critical inferences can be drawn from the ground-level experiences of the Hariyali Gram initiative to develop better policies and interventions to scale up adoption of these climate-friendly solutions. In addition to cutting down carbon emissions, and enhancing energy security, implementation of these solutions led by and targeted at women can accelerate economic and social empowerment—a clear goal highlighted in the Union Budget 2023 with strong interlinkages to Mission LiFE.

To scale up the adoption of these climate-friendly solutions, implementing the following key recommendations is vital:

Women-Centric Policies

Access to climate-friendly solutions can enhance productivity and raise incomes. As an enabler of economic growth and poverty reduction, green energy access could be the lever for women's economic empowerment. However, our interactions on the ground have highlighted the limited participation of women in policy design as a recurring issue.

Women have limited decision-making authority, especially in rural communities. Thus, it is important to develop women-centric policies, where women are the main stakeholders and beneficiaries of the policies and interventions. In addition, renewable energy and women empowerment is multi-dimensional and has critical connections with other sectors, including tribal and rural development, climate change, irrigation, industry, women and children's welfare, etc. Thus, identifying convergence between policies and schemes being implemented by various union ministries is key for better synergies.

SEWA Sisters in Fangini Village, Gujarat. Picture source: NRDC

Access to Finance

Financing remains one of the most significant barriers to scaling the adoption of clean energy solutions. Social, structural, and institutional challenges exist for both borrowers and lenders. Households can leverage a host of financing mechanisms offered by many financing institutions, including banks and microfinance institutions, to finance the procurement of clean energy solutions. However, it is important to identify the right financing instrument that matches a borrower's risk-return profile and provides flexible repayment options to households to avoid unwarranted financial burden. Access to government subsidies should also be simplified so that the most vulnerable communities are able to access the financial support offered under various central and state government policies and programmes.

Awareness Generation

Many policies, technologies, and financing schemes have been rendered unsuccessful due to limited awareness amongst the target stakeholders, especially in rural areas. To address this, NRDC and SEWA are working in the states of Gujarat, Rajasthan, and Maharashtra to generate awareness by leveraging the substantial network of SEWA sisters, an interconnected group of rural women entrepreneurs, to build capacities and share knowledge about relevant policies, clean technologies, and financing schemes.

Capacity Building

DRE can not only help bridge the energy access gap, but can be a powerful tool for creating jobs. Analysis by NRDC, CEEW, and SCGJ shows that 3.4 million (34 lakh) jobs, many of which would be in the DRE sector, can be created through widescale deployment of India's clean energy goals. Expanding DRE has the potential to uplift the rural economy and generate livelihood opportunities, but only if we make sure to invest not only in the technology but in the people by creating appropriate skilling ecosystems. This can provide people with the skills and power to ensure DRE deployment is successful

in their communities.

Appropriate Technology Selection

Identifying the right technology that suits the needs of households is important as poor-quality solutions can have long-lasting consequences. Reliable and tested technologies should be made available to rural households due to their restricted purchasing power capacity. As a result, rural households have limited chances of experimenting with technologies. Also, if a given technology fails, it can hamper the scaling of clean energy technologies because of the trust factor associated with it.

Under the Hariyali Gram initiative, households are empowered with knowledge about various facets of technology, including use, operations & maintenance, and basic repairs, through pilot demonstrations and capacity building workshops. The women in villages are empowered to select climate solutions for implementation based on the requirements of the households and resources available with them.

Large-scale deployment of climate-friendly solutions is critical to providing energy security to vulnerable communities and households. Deployment of these solutions can help build resilience while ensuring that the financial burden of energy use is reduced. Addressing both supply-side and demand-side challenges are key. The supply-side concerns require streamlined technology and policy pushes while the demand-side concerns can be addressed through targeted interventions such as capacity building and enabling access to finance. NRDC and SEWA along with AREAS are working with communities to enhance availability of clean and quality assured technologies at affordable prices.

Inclusive development and green growth are essential for an economy like India to deliver on its climate goals. Capacity building and access to resources are critical tools to ensure equitable gender development. Actions that enable women to both adapt to climate change and access resources to improve their livelihoods will provide major gains not just for women entrepreneurs but for entire communities. By empowering women, we can help build stronger communities as well as align with the LiFE movement to adopt and promote environmentally friendly lifestyles across India. ■

Charu Lata and Akanksha Golchha, NRDC India.

Indo-German Climate and Environment Cooperation

Adds a New Highlight on Forests

Preserving India's precious wetlands and fighting the global threat of marine litter, protecting the beauty and importance of the Himalayan regions, ending landfills of waste and creating green jobs—Indo-German Climate and Environment Cooperation addresses a wide range of topics. Both countries have been working together since more than 60 years bilaterally as well as internationally. Further, India has been a priority country in particular for the International Climate Initiative (IKI) of the German Government from its start in 2008 to support climate action and biodiversity conservation. Read on to know more…

Strong Cooperation between the Two Countries

In 2023, 46 bilateral, regional and global International Climate Initiative (IKI) projects are being funded by Germany and implemented in cooperation with the Indian government, in particular supporting priority actions of partners such as the Ministry of Environment, Forest and Climate Change (MoEFCC), the Ministry of Housing and Urban Affairs (MoHUA) as well as the Ministry of New and Renewable Energy (MNRE). IKI projects in India address a wide range of climate actions for mitigation measures assisting the implementation of the Nationally Determined Contributions (NDCs) that lie at the heart of the Paris Agreement as well as adaptation measures on the impacts of climate change and for improving resilience to the unavoidable consequences. The IKI also aims to conserve and rebuild natural carbon sinks, taking into account environmental, economic and social concerns and aims to work towards achieving the goals of the Convention on Biological Diversity (CBD). To accelerate action, IKI projects include trainings and support for access to climate finance. Not least, many IKI India projects include engagement with the private sector as well as cooperation with civil society. And the cooperation is deepening due to

IKI
INTERNATIONAL CLIMATE INITIATIVE

intergovernmental exchange.

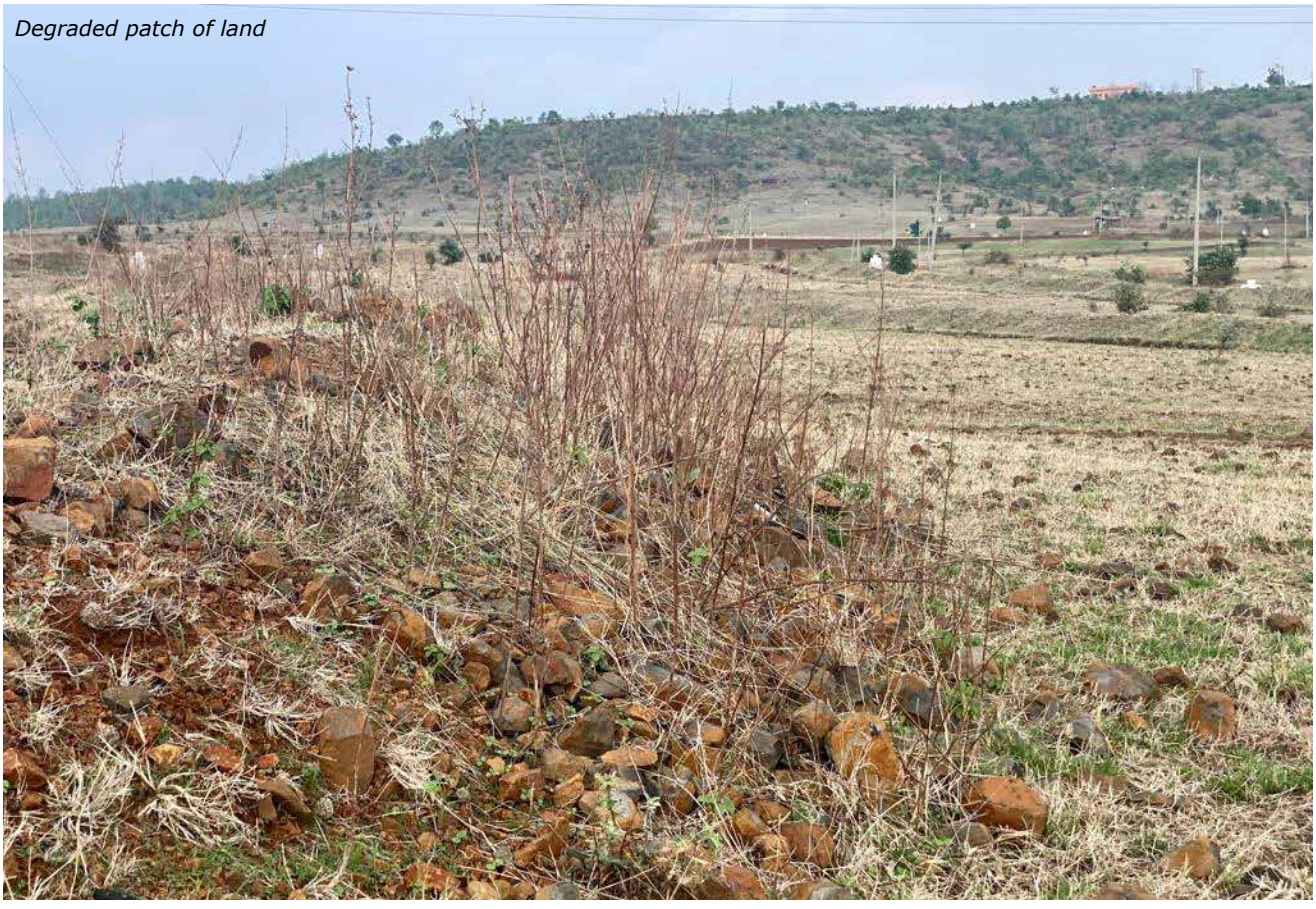
India's Prime Minister Shri Narendra Modi and the German Chancellor Mr Olaf Scholz sealed a bilateral Partnership on Green and Sustainable Development, in May 2022 in Berlin. With the new partnership, Germany and India aim to make joint progress on achieving the Paris climate targets and the Sustainable Development Goals (SDGs). As part of the Partnership, both Environment Ministers, Shri Bhupender Yadav and Ms Steffi Lemke, signed a Joint Declaration (JDI) on Forest Landscape Restoration (FLR). The JDI focuses on cooperation on forest landscape restoration and piloting new models in sustainable forest management and trees outside forests, including in urban areas, as well as restoration of degraded land and wasteland and conservation of wetlands.

International Politics Made a Major Change

Forest landscapes have been receiving special attention as they are unique in addressing the 'triple crisis' which the natural environment is facing today: the climate crisis, environmental pollution, and biodiversity loss. With this decade being declared as the UN Decade on Ecosystem Restoration, the world is in the midst of a new era that focuses on giving nature more space and integrating nature/biodiversity in land use and economic practices. The UN Biodiversity Conference Meeting that concluded in December 2022 in Montreal, Canada, committed to putting 30 per cent of land, water, and marine areas under protection by 2030. Growing interest in nature-based solutions, REDD+ and carbon credits in carbon markets, new financing initiatives are accelerating implementation of such measures on ground. Examples are the Lowering Emissions by Accelerating Forest Finance (LEAF) Coalition as well as the political initiative Forest and Climate Leaders' Partnership as well as bilateral partnerships between two countries, like the Indo-German Joint Declaration of Intent on FLR.

A New Lighthouse Project for Indo-German Forest Landscape Restoration

Germany aims at supporting Indian efforts in achieving its long-term goal of 33 per cent forest cover and its ambitious commitment under the Bonn Challenge goal to restore 26 million



Degraded patch of land

hectares of degraded and deforested land by 2030. For strong action in this regard, the newest kid on the IKI India block is the "Restore, Conserve and Protect Forest and Tree Cover for NDC Implementation in India" (RECAP4NDC) project. This project is currently being designed together with BMUV, the MOEFCC and other stakeholders and will begin implementation by the end of the first quarter of 2023. With the MoEFCC, the project has a strong partner and it aligns well with India's national and international goals and targets.

India is among the few countries worldwide to have achieved a positive trend in forest and tree cover which currently stands at 24.6 per cent against the 33 per cent target of the National Forest Policy, 1988. India's trees in and outside forests provide ecosystem services of local and global significance. At the same time, the livelihoods of about 300 million Indians depend on forests. However, areas with serious forest and land degradation stress exist and 43 per cent of India's forests can be considered degraded due to increasing urbanization, overgrazing, fuelwood extraction, extended droughts, and uncertain rainfall. Hence, the restoration potential is large, which is reiterated by the Forest Survey of India, the national agency that reports on forest and tree cover in India. In four states, the RECAP4NDC project aims to enable actors to effectively plan, finance, implement and monitor FLR and Trees Outside Forests (TOF) measures. Thereby, it aims to contribute to the achievement of India's NDC forestry target, enhance biodiversity conservation and sustainably improve rural livelihoods through increased forest and tree cover. FLR and TOF measures will be planned in four states and implemented as pilot projects on 150,000 hectares, showcasing best practices. The establishment of monitoring, reporting and verification (MRV) systems will facilitate investments and business development. Financing from private and public sources will be mobilized and leveraged through favourable regulation and standards, Corporate Social Responsibility (CSR) as well as market business models and increased capacity to use public funds. All outputs will be supported through capacity development measures. Around Euro 50 million in public and Euro 2 million in private funding shall be leveraged and channelled into these pilots. State partners will be supported with a decision support system (DSS), frameworks and tools for monitoring/verification and extensive capacity building. Policy advice will promote the upscaling of pilot projects and help smoothen regulations for trees outside forest. Knowledge sharing among Indian states and with countries in the global South, through a South–South exchange platform, will strengthen the dissemination of best practices. By 2029, RECAP4NDC project aims at achieving ecological, socio-economic, governance and climate change benefits in 400,000 hectares of landscapes, capturing 10 million tCO_2eq in 10 years. Upscaling measures aim to lead to restoration of 1.1 million hectares and sequester 110 million tCO_2eq in 10 years after the project.


Urban forest

The project will be implemented by a consortium of renowned partner institutions with strong involvement of national actors, including two government-backed apex institutions in the forestry sector, ensuring effectiveness and sustainability. The consortium partners include the Indian Council of Forestry Research and Education (ICFRE), Forest Survey of India (FSI), The Energy and Resources Institute (TERI), International Union for Conservation of Nature (IUCN) India, International Centre for Integrated Mountain Development (ICIMOD) with GIZ in the lead. The four states where the project will be implemented are Maharashtra, Gujarat, Uttarakhand, Delhi and NCR (National Capital Region). Beyond environmental benefits, the project is expected to generate substantial socio-economic benefits for forest-dependent communities and to Indian society at large. The project aims to reach a minimum of 10 million people. Not least, the project will also significantly contribute to multiple SDGs, in particular SDG 5, SDG 13 and SDG 15 by increasing access of forest benefits to women, contributing to climate action with mitigation and adaptation benefits and protecting, restoring and promoting sustainable use of terrestrial ecosystems by sustainably managing forests and reversing land degradation. ■


Agroforestry plantation

For more information contact: Kundan.burnwal@giz.de

Ensuring Reservoir Sustainability under Changing Climate

A Case Study on the Salaulim Reservoir, Goa

In this succinct article, **Dr Ashwini Pai Panandiker** says that very few studies have addressed the climate change impact on multi-purpose reservoir performance and deriving adaptive policies for possible future scenarios. Considering that the political and technical measures to adapt to climate change take place at a local level, site-specific studies are urgently needed. To address this, a case study on the Salaulim reservoir in Goa was undertaken. Read on to know more…

Climate change studies predict intense impacts on water resources in India. These impacts include higher annual average rainfall as well as increased drought. This can have negative impacts on the water supply. Here, reservoirs may play a vital role to alleviate these impacts. However, the repercussions of climate change are not always considered in reservoir planning and management. Relatively very few studies have addressed the climate change impact on multi-purpose reservoir performance and deriving adaptive policies for possible future scenarios. Considering that the political and technical measures to adapt to climate change take place at a local level, site-specific studies are urgently needed. To address this, a case study on the Salaulim reservoir in Goa, India was undertaken.

The small state of Goa in India is a popular international tourist destination. Along with its resident population of around 15 lakh, it caters to almost twice the number of tourists or floating population (28–30 lakh) annually. Over the years, Western India (Goa) has been witnessing a change in the rainfall pattern and the number of rainy days. The effect of this changing climate on the reservoir inflows was not examined. Salaulim reservoir is the biggest in the state and supplies potable water to around 70 per cent of the population. Further, water is also supplied for irrigation and industrial purposes. It has a catchment area of 200 sq. km and a gross storage capacity of 234.36 m^3. The construction of the dam started in the year 1976 and was commissioned around 1980. The one-of-its-kind duckbill spillway of the Salaulim Dam makes it resemble the famous Niagara Falls and adds to its beauty.

Climate change science and modelling capabilities were not developed in those times. Hence, climate variability was not factored into the design. This study investigated the original design metrics of the dam that are sensitive to the changing climate. It involved using an ensemble of numerical models where simulations from six different climate models were used as input into a hydrological model. The projections based on this study predict future rainfall patterns, the possibility of floods under maximum precipitation conditions, the

future quantum of rainfall or in-flow into the reservoir, and, the effect on the capacity of the reservoir. It attempted to answer three research questions: (i) What rainfall pattern can we expect in the future and how is the probable maximum precipitation (PMP) likely to change? (ii) What amount of water or inflow to the reservoir can we expect? (iii) How is the capacity of the reservoir likely to be affected with and without sedimentation? An ensemble of five downscaled models from the NASA NEX-GDDP dataset (MPI-ESM-LR, INM-CM4, MRI-CGCM3, MIROC-ESM-CHEM, MIROC-ESM) and one RCM (PRECIS) under two RCP scenarios (4.5 and 8.5) were used as input into a calibrated and validated hydrological model SWAT to simulate flow.

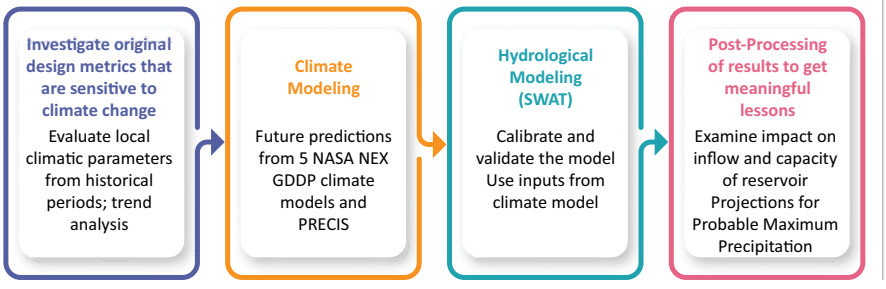
The study indicated the possibility of higher rainfall and inflows into the reservoir. When the scenario of sedimentation coupled with changing climate under both RCP scenarios indicates that the capacity of the reservoir to store water is likely to decrease; the reservoir is also likely to overflow 30 to 43 per cent more often when sedimentation is considered. The opportunity to store water for the lean period is likely to be lost. These results highlight the need for revising the reservoir operation policies for sustainable basin management.

The climate information generated by this project was valuable for the State government departments involved in water resources management and water supply. Continuous interactions with the key ministries and departments were done to study their requirements towards climate data utilization in terms of water resources management and tailoring the same for their beneficial use. The local situation was analysed based on field visits, primary/secondary data, past trends, future predictions, and stakeholder consultation. Due care was taken to provide policy inputs at different levels to encourage and facilitate implementation. The stakeholder workshops conducted under this project were targeted towards the relevant (from the climate-sensitive sectors) focused groups and users of the proposed climate products. Also, the deliverables under the climate services were focused on the user needs and their uptake. The primary aim of this research study was to provide insights to decision-makers and practitioners and steer them towards climate resilience and collective action.

In every meeting, the objective was to build the capacities of the lower-level staff that is responsible for data collection. The intention was to emphasize on the importance of the data, improve data collection methodology, and also inculcate a sense of ownership so that it is done more willingly and meticulously. It was very well taken. It was also observed that a lot of old data (rainfall and discharge from 1974–2019) was hand-written in old notebooks. This data was keyed in and a soft copy of the data was shared with the department as a backup for their future use. This gesture was greatly appreciated by WRD officials.

The key outcomes of this study are that the project report could be used by the Water Resources Department (WRD), Government of Goa as a scientific supporting document to prove its case and seek further funding from the World Bank under its Dam Rehabilitation and Improvement Program and the insights from this study may also prove useful while exploring the hydropower generation potential of the dam.

Acknowledgement: This study was funded by the Norwegian Ministry of Foreign Affairs. ■



Dr Ashwini Pai Panandiker, Fellow, Earth Science and Climate Change Division, TERI, Goa.

Climate Change, Migration and Vulnerability to Trafficking

Exploring the Extent and Impact

In this incisive article, **Daljeet Kaur** and **Ritu Bharadwaj** present empirical evidence on the links between climate change, migration, and trafficking and explore the extent and impact of climate change on distress migration and human trafficking in two diverse areas affected by slow-onset and rapid-onset climatic events. The research conducted by International Institute for Environment and Development (IIED) and supported by Foreign Commonwealth and Development Office (FCDO) unpacks the underlying drivers that policymakers should target to deal with this nexus.

Climate-related hazards affected close to 20 million people in India in 2020. Climate disasters add to the stress of socioeconomic factors like population density, income inequality, and degrading environment. Together, they increase the risk of loss of life, food insecurity and loss of livelihoods, compelling vulnerable communities to adopt migration as a coping strategy. Although a coping mechanism, migration can put the most vulnerable migrants at risk of modern slavery and trafficking.

Climate change and/or climate-induced migration intersects with severe forms of exploitation along at least three pathways: slow-onset disasters (droughts, crop failures), rapid-onset disasters (floods, cyclones) and an amalgamation of conflicts and climate change events. Yet policymakers have rarely considered climate change as a driver of human trafficking. This article builds on the limited evidence with respect to the links between climate change, migration, and trafficking.

Methodology

IIED FCDO's research partner on Technical Assistance Programme Infrastructure for Climate Resilient Growth partnered with two grassroots organizations in Jharkhand and Odisha. Through both qualitative and quantitative tools, including a household survey, the research covered two contrasting geographies: rapid-onset events in Kendrapara district in Odisha and slow-onset events in Palamu district in Jharkhand. In all, 420 households were covered, 210 in each location. The sample was distributed evenly across 14 villages (7 in each location). The sample comprised households with migrants and without migrants. The research captured

responses related to employment and working conditions questions from the sampled households that conformed to the definition of trafficking to identify trafficked households.

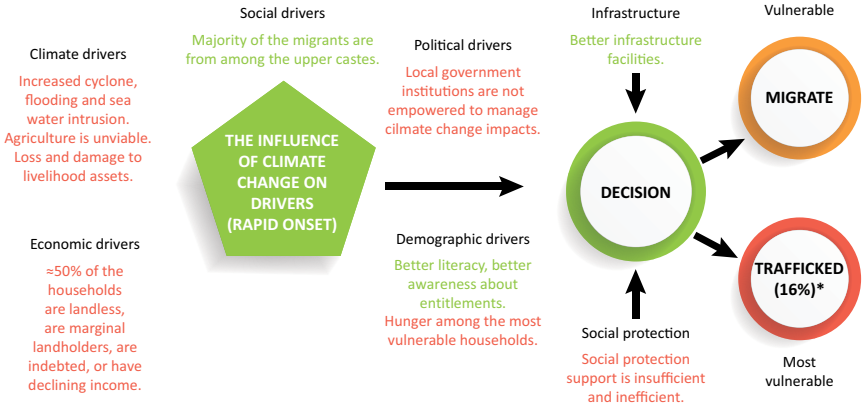
Findings of the Research

- **Climate change vulnerability:** Climate change multiplies vulnerabilities. More than 50 per cent of respondents said that environmental stressors (flood, cyclone, erosion, etc.) were more hazardous and frequent in the last ten years. In Kendrapara, more than 60 per cent said floods were a major climate stressor, while 87 per cent in Palamu reported that they were vulnerable to droughts. Extreme events were reported to result in loss and damage to crops, livestock, and equipment.
- **Migration trends:** In both study areas, the dominant form of migration was seasonal. Around 85 per cent of migrants in both Kendrapara and Palamu migrated once or twice a year for less than 6 months. Most migrated for work (80 per cent in Kendrapara; 51 per cent in Palamu). In Palamu, people also migrated for reasons related to healthcare and debt. In Kendrapara, people migrated for housing (possibly due to destruction of houses from cyclones and floods) and education. Most migrants from both study locations were engaged as wage labourers in construction (25 per cent in Kendrapara; 32 per cent in Palamu). Those from Kendrapara also worked in factories (24 per cent); 65 per cent of Palamu migrants worked as wage labourers in road laying, brick kilns, restaurants, hotels, supermarkets, farms, and factories.
- **Nature and trends of human trafficking:** Distress migrants become vulnerable to trafficking and suffer human rights violations. Slavery-like situations include forced labour, bonded labour, debt bondage, wage withholding and exploitative working conditions. The percentage of trafficked migrant households in Palamu was 42 per cent compared to 16 per cent in Kendrapara. The dramatic difference between the two locations could be due to the nature of climate events. Palamu suffers from slow-onset events, which often do not get the same attention as rapid-onset events in areas like Kendrapara. For moderate droughts, states must respond out of their own budgets. Thus, many states wait for droughts to become severe so that they can access federal funds. As a result, many droughts either go unreported or declared so late that communities are forced into distress migration to survive and feed their families.

- **Remittances:** In both locations, a high percentage of respondents sent remittances home. But Kendrapara migrants sent more than twice as much every month as Palamu migrants (₹11,032 vs ₹5160). In both locations, remittances were used to meet consumption needs, day-to-day household needs and healthcare. We found no evidence of remittances invested in economic activities or assets.
- **Coverage of social protection schemes:** Social protection schemes are expected to provide a safety net to vulnerable families during a crisis, including climate stress. But the coverage of most schemes among respondents was low in both study areas. There was high ownership of cards that ensures access to entitlements under such schemes, institutions and services (e.g., Aadhaar card, ration card, and voter card). However, in both the areas, MGNREGS job card coverage was low (33 per cent in Kendrapara; 42 per cent in Palamu).
- **Drivers of migration and trafficking:** The research analysed climate change impact on migration and resulting trafficking through five broadly recognized drivers of migration: economic, political, demographic, social, and environmental.

Kendrapara: Kendrapara had been one of the most fertile and prosperous regions of Odisha. But climate extremes, in the form of rapid onset events, have proven that even stable ecosystems and prosperous economies can erode. People in Kendrapara have better literacy and awareness levels, food

security and average landholding, higher average household income and better infrastructure than people in Palamu. Most migrants from Palamu belonged to Scheduled Tribes and Scheduled Caste, whereas Kendrapara migrants were predominantly from forward caste and other backward class communities. They did not face social discrimination in their villages. The area, unlike Palamu, is free of left wing extremism. Despite these positive aspects, people in Kendrapara are vulnerable, primarily due to climate change. Higher frequency of cyclones and flooding coupled with sea-level rise and sea water intrusion have caused loss and damage of livelihood assets, soil erosion and land degradation. Consequently, socioeconomic problems such as decline in income, unemployment and indebtedness have cropped up in the last few decades. An efficient social protection cover might potentially enhance people's absorptive and adaptive capacity. But the coverage of social protection programmes is inadequate. As a result, the vulnerable sections of the area are forced to migrate and the most vulnerable households are prone to trafficking. Figure 1 shows

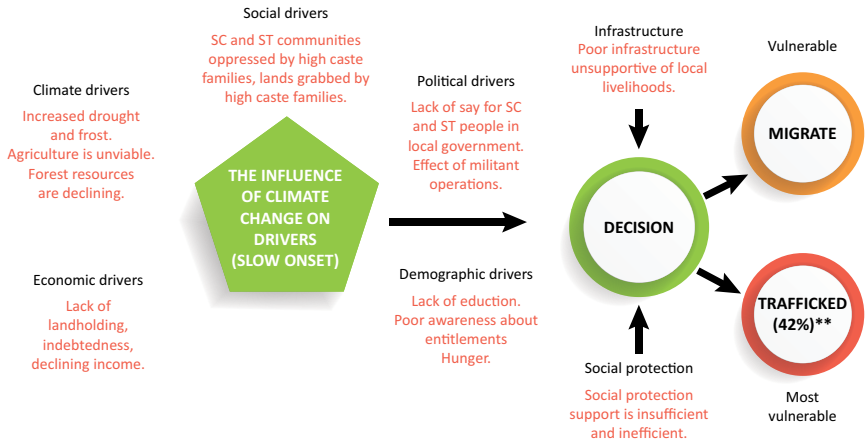


Note: drivers in red contribute negatively to migration and trafficking, while those in green are positive
*The figure inside the parenthesis indicates the percentage of sample respondents trafficked.

Figure 1: Drivers of migration and trafficking—Kendrapara of coastal Odisha

drivers of migration and trafficking in Kendrapara.

Palamu: Palamu is chronically underdeveloped in terms of socioeconomic–political factors. Over time, its climate has shifted from sub-humid to semi-arid, causing frequent and prolonged drought and frost. This has severely affected livelihoods, leading to lower agricultural yields and fewer non-timber forest products. Food insecurity and starvation have increased among the weaker sections of the community, while water for drinking and domestic needs is growing scarcer. Unfavourable and chronic socioeconomic–political–demographic pressures have further weakened the most vulnerable of the two communities. These factors have



Note: drivers presented in red factors that contribute negatively towards migration and trafficking.
**The figure inside the parenthesis indicates the percentage of sample respondents trafficked.

Figure 2: Drivers of migration and trafficking—Palamu of Jharkhand

forced vulnerable people to voluntarily migrate or become exposed to the threat of human trafficking. Our study shows how climate change has become the new driver of migration and trafficking, dwarfing all others in its impact. Figure 2 shows drivers of migration and trafficking in Palamu.

Key Recommendations

State level

- *Improve outreach of social protection programmes in climate-induced migration and human trafficking hotspots:* Coverage of social protection programmes needs to be targeted towards the most vulnerable households and individuals in areas prone to high climate impacts that are driving distress migration and displacement.
- *Promote registration of migrants using digital interfaces:* State governments need to ensure that all migrant workers are registered with labour welfare boards and use digital interfaces to track the flow and status of migrants and where they are employed, to ensure compliance to worker rights and entitlements. Also, ensure proper registration of workers at destination site.

National level

- *Mainstream climate-induced migration and human trafficking into climate and development planning:* Development and climate policy discourse needs to consider climate-induced migration and human trafficking by developing policy responses and integrating adaptive actions into urban and rural climate resilience plans, migration response plans, and state and national development plans.
- *Promote climate-smart solutions among farmers:* Agriculture is the primary occupation for most migrants. The vulnerability of farming communities can be addressed through adoption of climate-smart solutions in the agriculture sector developed through scientific research. Extension outreach can be improved by designing programmes in collaboration with extension departments of agricultural research agencies and universities.

- *Integrate trafficking issues into Nationally Determined Contributions (NDCs) and ensure climate finance commitments:* NDCs need to identify policies and actions for providing safe migration pathways and addressing human trafficking. This can help in creating the demand for climate finance (Green Climate Fund, Adaptation Fund).
- *Extend portability of entitlements to migrant workers:* The Indian government has already piloted portability of entitlements for subsidized food grain through the One Nation One Ration Card scheme. This 'Aadhaar'-based portability needs to extend to other social protection schemes such as employment, healthcare and integrated child development services. This would make basic services and entitlements available to migrants at the destination.■

Daljeet Kaur, Climate and Environment Advisor, Foreign Commonwealth and Development Office (FCDO) and Ritu Bharadwaj, Principal Researcher, International Institute for Environment and Development (IIED. This article is based on the project led by IIED; report available at—Climate change, migration and vulnerability to trafficking, Publications Library (iied.org)

Mainstreaming Sustainable Development through Climate-Smart Agriculture

By Promoting Evidence-Based Research

The Resilience project supported by the Ministry of Foreign Affairs (Norway) has tested and validated selected integrated climate smart agriculture (CSA) technologies in Odisha and Assam states in India over the last four years. Farmer-led demonstration trials were conducted with the active support of project partners and multi-stakeholders. In this article, **Udaya Sekhar Nagothu, Mehreteab Tesfai,** and **Amaresh Kumar Nayak** present two good practices of CSA and their key research results.

At a United Nations (UN) summit in New York (UN, 2019), one of the world leaders asserted that "For us, sustainability is the navigation instrument, the compass into the future". Unless sustainable development becomes a fundamental criterion in policy and practice in the future, protecting earth's resources for future generations will not be possible. Thus, mainstreaming sustainable development in the policy agenda both at the international and national levels is vital. It is necessary to promote collective action/cooperation and sharing of knowledge between countries, provinces, sectors, and stakeholders. Indeed, such emphasis is necessary to strengthen linkages and nexuses, moving from silos to integration and synergies, and the spirit of partnerships. Mainstreaming the three dimensions of sustainable development (i.e., environmental, economic, and social including gender integration) should be an integral part of national policies, plans, and strategies of countries.

Integrating Sustainable Development/Climate Resilience in Action/Work/Decision-Making

The Resilience project (www.resilienceindia.org) supported by the

Ministry of Foreign Affairs (Norway) has tested and validated selected integrated climate smart agriculture (CSA) technologies in Odisha and Assam states in India over the last four years. Farmer-led demonstration trials were conducted with the active support of project partners and multi-stakeholders. In this article, two good practices of CSA and their key research results have been presented.

Direct seeded rice

Direct seeded rice or DSR is a crop establishment technique in which seeds are sown directly in the main field rather than by transplanting seedlings from the nursery. Pilot demonstrations conducted in Cuttack, Odisha, showed that grain yields of wet-DSR and dry-DSR were significantly higher than the traditional transplanted rice (TPR). The rice yield in DSR increased by 6.7–13.3% in the wet season and by 6.4–11.5% in the dry season compared to TPR. Water saving was higher by 18–19.5% in wet-DSR and by 43–45% in dry-DSR over TPR. In addition to yield benefit and water savings, DSR addresses the problem of labour and water scarcity. In other words, it reduces agricultural workload and provides women and youth the opportunity to move into more remunerative on-farm and off-farm employment. DSR has the potential to curtail methane emissions by 44%, and the cumulative GWP by 25% compared to TPR.

Precision-based soil and nutrient management

Conventional blanket uniform rate of nutrient application does not cater to the specific needs of a crop, hinders realization of full yield potential as well as causes loss of nutrients leading to soil and environmental pollution and economic crises. Thus, precision Nitrogen (N) management based on spatial and temporal variability of soil N and crop status, is needed. The aim in the project was to guide farmers to decide field-specific rate and time of N application both for enhancing yield and minimizing environmental damage.

A range of tools and techniques from simple, easy-to-use leaf colour chart to highly sophisticated optical sensors, were tested in the Resilience project to improve precision in soil and nutrient management. The customized leaf colour chart (CLCC) developed by ICAR-NRRI based on leaf colour analysis of several rice varieties is one simple tool that helps farmers in precision N management. Field trials in the Resilience project indicated yield advantages of 0.5–0.7 t/ha with CLCC based N application over recommended practice. Rice grain yield with 75% recommended dose of N applied based on CLCC was at par with that of 100% recommended dose of N which implies a saving of 25% of fertilizer-N. When neem coated urea was applied using CLCC, the yield advantage enhanced to 21–23% for DSR and 15–16% for TPR.

An android-based real time N application app "riceNxpert" was developed in Resilience project that can give recommendations for in-season N application based on leaf colour analysis. The riceNxpert was equally effective as CLCC in terms of yield and N use efficiency. Results showed that the riceNxpert-based N application enhanced yield by about 7–24% over recommended dose of N application and 38% over farmers' practice. With the yield advantage of 0.5–1.1 t/ha, riceNxpert-based N application can give monetary benefit ranging from INR 9000–20,000/ha over recommended dose of N application. The riceNxpert has potential to cut down N use by 15–25% in rice production and hence bring about significant reduction in the country's urea subsidy bill. Upscaling precision N management in crops such as rice should be upscaled systematically. This is already being attempted in the project in the coming years, with the help of local stakeholders.


Direct seeded rice


RiceNxpert mobile app

Integrating and Mainstreaming Sustainable Development across Agencies at Various Levels

Policy/decision makers

In the Resilience project, a systemic upscaling framework/plan was developed in consultation with the stakeholders in Assam and Odisha states in India. The upscaling framework for good practices of CSA (e.g., DSR in Odisha) and seed production systems

(e.g., public private partnerships or PPP in Assam) ensures that the environmental considerations are met while upscaling. Government investment and policy support is needed to promote any successful implementation of good CSA practices (e.g., DSR and precision soil and nutrient management practices) in agriculture. DSR has now been considered as one of the best practices for climate adaptation and mitigation in agriculture both globally and within India.

Several efforts have been made by the Resilience project to integrate stakeholders at various levels:

- Through project stakeholder advisory committees, which help in the dissemination and policy uptake of research results from the project.
- Policy dialogue forum meetings to discuss key project results with state level policymakers to integrate project results/recommendations into state climate action plans.

Business and industry/NGOs, civil society

- Established public private partnerships and promoted climate resilient rice seed production in Assam to enable farmers get access to quality and improved seeds that are tolerant to flooding and drought risks
- Improved rice value chain (VC) and value added products to help farmers to get better income
- Provided customized trainings to VC actors and other stakeholders in value additions and marketing.

Research community

- Provided customized trainings and capacity building to researchers including women and youth in precision farming and ICT-based knowledge dissemination
- Conducted farmer-led demo trials that are demand based and directly relevant to the challenges faced by farmers and other stakeholders.

Farmers and practitioners

- Established customizing hiring centres that are managed by farmers' producer organizations (FPOs) where smallholder farmers can hire farm machineries at a nominal cost
- Engaged farmers collectively in planning and upscaling best practices, e.g., FPOs, practitioners, and other key stakeholders
- Enhanced capacity building/skills training of farmers, women, youth to mainstream the use of digital tools and CSA practices.

Key messages for the G20

- Review existing national strategies and plans and identify areas for change, set priority on the nationally relevant SDGs targets and reformulate strategy and plans using integrated systems thinking.
- Mainstream SD as the central focus to improve future agricultural productivity by combining nature-based- and technology-based solutions, addressing both climate adaptation and mitigation simultaneously.
- Consider addressing the SDGs as an opportunity where new development paradigms (such as circular bioeconomy) can be introduced for promoting economic growth and employment generation.
- Prepare a clear climate strategy and well-developed evidence-based Nationally Determined Contributions (NDCs) by highlighting climate actions, and supported by detailed plans and investments for implementation.
- Invest to support the climate action effectively by pooling resources, bringing different agencies (agriculture, forestry, energy) and sectors (public and private) together to cooperate, creating common infrastructure and working under one umbrella.
- Share knowledge and data through a common database developed by countries/states and sectors together.
- Promote awareness among the society about the importance of sustainable use of resources in daily life.■

Udaya Sekhar Nagothu and Mehreteab Tesfai are associated with Norwegian Institute of Bioeconomy Research and Amaresh Kumar Nayak is associated with ICAR – National Rice Research Institute, India.

Sustainable and Regenerative Agriculture Implementation

Kartikey Sharma tells us about the Sustainable and Regenerative Agriculture Implementation project in Vikarabad, Telangana, funded by IKEA Foundation.

As part of the Food and Land Use Coalition (FOLU), The Sustainable and Regenerative Agriculture Implementation project has been launched to understand and establish the feasibility of sustainable agricultural practices and interventions in the rainfed region through adopting an integrated landscape approach with an objective of enabling sustainability, profitability and inclusiveness of the farming system. Such an approach entails consideration of crop choices and crop cycles and farming practices, horticulture and livestock-related interventions, building backward and forward linkages and assessing the impacts of farm management and landscape management on the flow of ecosystem services and disservices to and from agroecosystems.

The project is being implemented within the Vikarabad district of the state of Telangana across three Gram Panchayats, namely Daulatabad, Erlapally, and Gokafasalwad. The team at TERI alongside its on-ground partner RRAN Network has successfully undertaken critical information collection activities to gauge an intricate understanding of the agricultural practices that the farmers undertake, and the existing socio-economic landscape of the region. This was effectively carried with the assistance of Household survey, Participatory Rural Appraisal (PRA) exercise and, District Consultation Exercise.

Household Survey

The intention behind collecting the primary data via the survey method was to augment our perception of the inter-relations that exist between the farming practices on field and the ecosystem services and disservices prevailing in the survey sites. Apart from this, the objective was to also understand the implementation of national and subnational policies, and if there exists enough support from both central and state governments for farmers to carry out sustainable agricultural practices. Given the longevity of the research project at hand, the data collection process will be continually repeated which will aid us in monitoring the progress and evaluating the effectiveness of the programme implementation on a y-o-y basis.

Participatory Rural Appraisal

The Participatory Rural Appraisal (PRA) exercise refers to an approach that allows participants to build an information base required for participatory action and planning. The exercise allowed us to gather anecdotal evidence of problems that preside within the three villages of the block, qualitatively compliment the findings from the survey data, and forge crucial inroads within the community by building relationships based on the mutual principle of reciprocity.

District Consultation Exercise

The rationale behind undertaking the district consultation exercise was to understand the enabling environmental factors such as willingness, policy landscape, and opportunities within the district. The exercise also allowed us to validate our PRA learnings and further co-create potential solutions at the landscape level through the assistance and inputs of farmers and government stakeholders alike.

Based on the information collected, the team developed an implementation plan with the objective of increasing production with input resource management especially in relation to water conservation, harvesting and its use, bringing higher economic benefits to the farming community through holistic and integrated approach for marketing and value chain development. A total of three core activities have been mapped out to enable the adoption of sustainable agricultural practices in the region, namely:

- Indigenous paddy cultivation using natural farming
- Polycropping of vegetables integrated with micro irrigation
- Improve production and productivity of livestock and sustainable livelihoods of farmers

As of January 2023, the project is in its implementation stage. The next steps will involve the on-field implementation of these activities within the farmlands of 300 farmers across the three Gram Panchayats. ■

Kartikey Sharma, Research Associate, TERI, New Delhi.

Enhancing Livelihood of Farmers and Forest-dependent Communities

Through Carbon Financing Mechanism in India

Carbon financing is a result-based mechanism that allows companies wishing to offset their GHG emissions to buy carbon credits generated from their projects. In this crisp article, **Aniruddh Soni** tells us that TERI is developing several Carbon Finance projects via Voluntary Carbon Markets in the AFOLU sector. The beneficiaries involved in the carbon finance project developed under ARR are small-scale farmers, who are practising sustainable agroforestry practices within their private farmlands. On the other hand, REDD+ projects aim at benefiting the forest-dependent communities along with the forest department.

Climate change has emerged as one of the prominent environmental issues in the recent past. Despite the burgeoning pressure of curbing emissions and achieving net zero targets, for developing nations like India, development activities are imperative to meet the necessities of its population. A majority of the rural population in India is primarily dependent on agriculture and forest resources for their day-to-day livelihood. However, the erratic rainfall patterns and extreme events are having an unfavourable impact on agricultural production, risking their sustenance. For forest-dwelling communities, this dependence is in the form of the collection of a variety of non-timber forest produce (NTFP) and the collection of fuelwood and fodder for subsistence and livelihood purposes. Due to this dependence, and lack of sufficient infrastructure, the local communities venture into the forest areas resulting in human–wildlife conflict that further results in the loss of human lives and wild animals in the retaliatory process.

This demands establishing an efficient mechanism in place, which not only reduces the dependency of these communities but also diversifies their livelihood alternatives for enhancing their resilience against the negative impacts of climate change.

A key to solving this lies in nature-based solutions (NbS) that include conservation, restoration, and land management projects that avoid, reduce or sequester greenhouse gas (GHG) emissions. Such NbS projects absorb CO_2 from the atmosphere or prevent the release of GHGs, while also delivering benefits to local communities and the area's biodiversity. The amount of CO_2 sequestered or the GHG emissions a project avoids generate carbon credits, which can be traded in the international market via compliance or voluntary carbon platforms. Carbon financing is

a result-based mechanism that allows companies wishing to offset their GHG emissions to buy carbon credits generated from these projects.

In this context, The Energy and Resources Institute (TERI) in India is developing several Carbon Finance projects via Voluntary Carbon Markets in the Agriculture, Forestry and Other Land Use (AFOLU) sector, which are majorly under two broad heads:

- Afforestation, Reforestation and Revegetation (ARR) and;
- Reducing Emissions from Deforestation and/or Forest Degradation (REDD+)

The beneficiaries involved in the carbon finance project developed under ARR are small-scale farmers, who are practising sustainable agroforestry practices within their private farmlands. On the other hand, REDD+ projects aim at benefiting the forest-dependent communities along with the forest department, which plays a crucial role in the conservation of forest ecosystems in tiger reserves as well as community-managed forests.

With a total of 18 projects in ARR, our carbon finance projects will benefit over 35,000 farmers across five states in India, by generating an additional income of approximately INR 115 crore. Similarly, the REDD+ projects will benefit around 700 EDCs/forest-dependent villages, generating an incentive of around INR 29.5 crore that will help in reducing pressures on forests and continue with sustainable practices.

The funds generated are channeled back to foster the protection and restoration of natural ecosystems and secure the rights and livelihoods of local communities. The benefits of the carbon offset projects can be broadly divided into three major categories, i.e., environmental, economic, and social. Environmental benefits involve the reduction and/or removal of excess CO_2 emissions from the atmosphere and conserving the natural ecosystems thereby altering the adverse effects of climate change. The incentive generated from the sale of the carbon credits is perceived as an economic co-benefit required to continue sustainable management practices while enhancing the lives and livelihood of the communities in the social benefit. It can also help in generating an added revenue stream and allowing for the effective transfer of technologies, knowledge, and expertise while simultaneously reducing and/or removing GHG emissions globally. The carbon finance projects help in achieving various Sustainable Developmental Goals (Social benefit) including SDG1 (No Poverty), SDG2 (Zero Hunger), SDG13 (Climate Action), and SDG15 (Life on Land). ■

Aniruddh Soni, Area Convener and Associate Fellow, CBES (Centre for Biodiversity and Ecosystem Services), Land Resources Division, TERI, New Delhi.

Plastic Waste Management in India

Importance of Data

In India, plastic waste management has long been a challenge and is considered an issue mainly due to the lack of infrastructure, efficient systems for collecting and processing plastic. In this analytical article, **Mandavi Singh** has considered estimates of all plastics for the reporting year 2018–19 to understand the plastic production, consumption and end-of-life data along with the recycling from available data sources. This is to develop a clear comprehension about the plastic scenario in India and to develop a quantitative understanding of the size and nature of major commodity plastic production, consumption, and waste flows in India.

India's economic growth has been concomitant with increased production and consumption of plastic products. The consequence of the increase in Indian plastic production and consumption means an increase in plastic waste, which contributes to the problem of waste management. India does have one of the highest recycling rates of 50 per cent to 60 per cent in comparison to the global average plastic recycling rate of 17 per cent. Contrary to this, India still deals with a substantial quantity of non-recovered or mismanaged plastic waste. Problems of ecological impact arise in the deposition of plastics at end-of-life.

In India, plastic waste management has long been a challenge and is considered an issue mainly due to the lack of infrastructure, efficient systems for collecting and processing plastic. As a result, a significant amount of plastic ends up in the environment. But in setting the scope for how and what lacks in tackling the plastic waste we often consider the above-mentioned lacunas and neglect 'how much', i.e., the 'data', to deal with. There are only rough estimates about the plastic waste generation in India and there is no single source stating the estimates. Instead, there are various sources listing different values/estimates. This leads to ambiguity in our understanding to know how much plastic do we consume, waste and recycle in India.

Plastic Consumption

Data point 1:

Table1: Sector-wise share of polymers in absolute values (2019)

Sectors /Key Polymers	Flexible Packaging	Rigid Packaging	Household	Building and Construction	Agriculture	Electrical and Electronics	Automotive	Others (Medical)	Total
Total	6549 KT (42%)	2546 KT (17%)	1015 KT (7%)	2096 KT (13%)	1415 KT (9%)	358.4 KT (2%)	1073 KT (7%)	412 KT (3%)	18.5 MT

Source: Plastic Industry Status Report 2018–19 statistics and calculations based on assumptions

Data point 2:

Table 2: Plastic use in India (2019)

Sectors	Packaging	Consumer and Institutional Products	Building Construction	Electricals and Electronics	Textiles	Transportation	Material Coatings	Industrial	Personal Care Products	Road Marking	Others	Total (MT)
KT	7.4	2.8	4.0	1.17	5.8	4.5	0.05	0.001	0.005	0.045	3.3	29.3 MT

Data point 3: As per the Organization for Economic Cooperation and Development (OECD), the total plastic used is 29.3 MT, which is almost double the number calculated by Plastindia report.

We are considering estimates of all plastics for the reporting year 2018–19 to understand the plastic production, consumption and end-of-life data along with the recycling from available data sources. This is just to develop a clear comprehension about the plastic scenario in India and to develop a quantitative understanding of the size and nature of major commodity plastic production, consumption, and waste flows in India, in order to gauge the magnitude of the challenges and opportunities of a circular economy for plastic. The plastics production in India for 2018–2019 was 17 million tonnes and there is not much dispute on this value but when it comes to consumption and end-of-life data, there are several inconsistencies among various sources. Major polymers commonly used in industry and consumer products: PET, HDPE/LDPE, PVC, LLDPE, PP, PS have been considered.

Given below are the data points for the plastic consumption and end of life.

End of Life

Data point 1: According to *Plastindia Foundation Annual Report 2019*, plastic waste generated in India is 9.45 MT.

Table 3: Plastic waste generated in India 2019

Polymer type	Waste (MT)
PP	3.2
HDPE	1.54
LDPE	2.40
PET	1.66
Other	0.65
Total	**9.45**

Source: Plastindia report 2019

Data point 2:

Table 4: End-of-life stream of plastic waste in India (2019)

End-of-Life stream	Waste (MT)	Percentage
Recycled	2.46	13.2%
Mismanaged	8.45	45.6%
Incinerated	0.77	0.04%
Landfilled	6.7	36.2%
Littered	0.1	0.005%
Total	**18.5**	**100%**

Source: OECD stat

Please note that amount of waste generated according to OECD Stat. is also double the amount of waste generated given by Plastindia report. In fact, the amount of waste generated as quoted by OECD is equivalent to the amount of plastic consumption according to Plastindia report.

Data point 3: As per the report by the Central Pollution Control Board (CPCB), total plastic waste generated in India in 2019 was 3.4 MT. However, there is no methodology stated to explain this number. There are significant and inherent data gaps and inconsistencies, notably around the collection and treatment of post-consumption plastic flows and their ultimate fate. This presents both a socio-environmental challenge and simultaneously, it suggests there are large flows of material that are not being recovered. This creates business opportunities not just for collection and recovery of waste, but also those related to recycling and reutilization. This can help reduce leakages of waste into the environment and the associated economic costs of managing the mismanaged (including leaked) waste.

It is a capital mistake to theorize before one has accurate data, which

allows us to see the bigger picture and make informed decisions that are based on all the available information. It helps us to identify trends, patterns, and relationships that might not be obvious otherwise. For setting targets and for setting efficient means for ensuring progress, data-centric approach is often considered reliable. This is majorly due to the fact that it facilitates periodic monitoring and evaluation of various policies and programmes while making necessary amendments in them so that the desired goals are achieved timely. Hence, to gain an understanding of the main supply chains for the major commodity polymers commonly used; the associated waste flow and end state destinations; and the subsequent leakages to the environment; data collection and transparency should be captured to provide necessary inputs to decision makers. The mass-balance approach can identify ways to improve raw materials' efficiency, contribute to saving natural resources, minimize environmental impacts, and consequently help to accomplish sustainable development goals

Acknowledgements

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Mandavi Singh, Project Associate, TERI.

Tourism in India through the Lens of Sustainability

In this thought-provoking article, **Swati Sharma** and **Palak Khanna** say that tourism in India contributes significantly to the economic sector and it has high growth potential as well. Therefore, sustainability in tourism has become imperative in today's scenario. Promotion of sustainable tourism can enable mindful utilization of existing resources and sensitization of tourists with behavioural nudges.

The Brundtland Commission report "Our Common Future" on Environment and Development defines sustainability as meeting "the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development 1987, 16). The report signified the three pillars to ensure sustainability—economic viability, social equity, and environmental stability. However, ensuring the balance between these pillars becomes difficult. The developed world has ensured enormous economic and social stability at the cost of environmental degradation. With the concept of sustainability, if conscious efforts are put towards collective action in ensuring the inclusion of all three aspects, it is possible to achieve sustainability in all sectors. Similarly, with the increased number of climate-induced disasters, promoting sustainability in tourism becomes imperative.

Tourism is one of the businesses with the fastest growth rates worldwide, which also ensures the livelihoods of many stakeholders and is a source of income overseas. According to the Indian Brand Equity Foundation (IBEF), "FDI inflows into the tourism and hospitality sector reached USD 16.48 billion between April and June 2022." According to the World Travel and Tourism Council (WTTC), India ranks 10th among 185 countries in total travel and tourism GDP contribution in 2019. Travel and tourism GDP contribution in 2019 was 6.8 per cent of the economy as a whole INR 1,368,100 billion (USD 194.3 billion). In 2020, India's tourism sector accounted for 39 million jobs, accounting for 8 per cent of the country's total employment. Since tourism in India contributes significantly to the economic sector with high growth potential, sustainability in tourism has become imperative in today's scenario.

The World Tourism Organization (WTRO) defines sustainable tourism as "Tourism that fully considers current and future economic, social and environmental impacts and addresses the needs of visitors, industries, the environment, and host communities." The 2005 report of the United Nations Environment Programme and United Nations World Tourism Organization titled "Making Tourism More Sustainable – A Guide for Policy Makers" identifies 12 aspects as the core to sustainable tourism agenda. These 12 aspects are—"a. Economic Viability; b. Local Prosperity; c. Employment Quality; d. Social Equity; e. Visitor Fulfillment; f. Local Control; g. Community Well-being; h. Cultural Richness; i. Physical Integrity; j. Biological Diversity; k. Resource Efficiency; and l. Environmental Purity". The Government of India has come out with the Sustainable Tourism Criteria for India (STCI) and indicators for hotels, and tour operators. The United Nations declared the year 2017 as the International Year of Sustainable Tourism for Development. Moreover, United Nations SDG8, target 8.9 covers sustainable tourism as a crucial indicator

to reflect economic growth and promote sustainable tourism that creates jobs and promotes local culture and products. The importance of sustainable tourism is also highlighted in SDG target 12.b., which aims to "develop and implement tools to monitor sustainable development impacts for sustainable tourism that creates jobs and promotes local culture and products." Tourism is also identified as one of the tools to "by 2030, increase the economic benefits to Small Island developing States and least developed countries" as comprised in SDG target 14.7.

Let's see through the recent incidents, how unplanned tourism has questioned the sustainability of the entire tourism development in India.

Case Studies

Recent climate-induced disasters in tourist destinations in India alarm the nation to promote sustainable tourism ensuring sustainable development. These incidents not only exacerbate prevailing vulnerabilities but also lead to social and economic losses. With the recent cracks widening in the Joshimath town of Uttarakhand, satellite images released by the ISRO show that Joshimath sank at a rapid pace of 5.4 cm in just 12 days, triggered by a possible subsidence event on January 2, 2023. It is the gateway to famous pilgrimage sites such as Badrinath and Hemkund Sahib, and the international skiing destination Auli, is facing a significant challenge due to land subsidence. Similarly, Assam went underwater twice in 2022 due to extreme rainfall. According to the coverage by *Hindustan Times*, the flooding affected 5.4 million people across 32 districts and caused the deaths of over 200 people. As many as 2675 villages in 79 revenue circles have been affected across the state, with 312,085 people taking shelter in 569 relief camps. With the heavy economic and resource loss, forced displacement, loss of livelihoods, and emotional turmoil become overwhelming to the community members with such disasters. Climate change is a global phenomenon as repercussions are fatal everywhere. Likewise, in June 2022 Noney district in Manipur dwelled away by a massive landslide due to a combination of factors including excessive rainfall and long-term exposure to cut hill slopes for infrastructure expansion, debris blocking the flow of a river, and changing land-use patterns such as deforestation. Some of the major factors are attributed to anthropogenic pressures for this tragedy. Again, in June 2022, one of the famous tourist spots— Amarnath—witnessed heavy rains in the high mountains around the Holy Cave that triggered floods in

the water body and surrounding springs which swept away several pilgrims. These tourist spots face a decline in footfall due to increased disasters and affect the livelihood of people living in those areas; however, tourist intervention often pulls up the resource demands leading to over-dependence on resources and forced developments and interventions to serve the growing demands. A lot of unplanned development harms the ecosystem and biodiversity. With profound disasters, tourist places face economic imbalance, loss of opportunities, and cultural, environmental and aesthetic loss. The tourism industry and infrastructure are ill-equipped to manage the growing stress of footfall. Promotion of sustainable tourism can enable mindful utilization of existing resources and sensitization of tourists with behavioural nudges.

In a Nutshell

Several initiatives have been taken to uplift sustainable tourism practices such as the World Travel and Tourism Council India Initiative (WTTCII), which was launched in February 2000 to raise awareness of the vital role travel and tourism play in the development and growth of the Indian economy. The mapping of roles and responsibilities of key stakeholders in sustainable tourism development, that is, the public sector (government departments and agencies) can facilitate participatory planning and monitoring to promote community empowerment. The tourism industry and businesses can practise and promote responsible advertising and marketing by other tourism businesses, tour companies, tourism agencies, among others, promote sustainable and culturally respectful images of destinations and communities. They can also set guests' expectations built on equality, respect, and partnership. The core business model can be positioned to link with social and environmental issues; voluntary organizations (NGOs, CBOs, etc.); host communities; media and tourists. In terms of regulation and management, they can demand specific policies to be in place to lobby, to raise awareness about issues and proper ways to address them.

Hence, sensitization and capacity building of each stakeholder group is essential. The EIA concerning air quality and traffic management, surface and groundwater quality, solid waste management, noise pollution, biodiversity in terms of natural vegetation and wildlife, archaeological and historical sites, visual amenities, cultural and social norms, livelihood generation, social inclusion and assessment of possible disasters and required preparedness plan must be carefully and effectively carried out. The policy shall promote intergenerational balance between the tourist as well as the local people in terms of access to the resources such as water, land, etc. Further, training and in-house capacity building of the small and medium enterprises in the tourism sector must be organized. Resource planning, utilization, and developments must be based on geo-settings like coastal environment and sea, rural area, towns and cities, mountainous areas, islands, deserts, etc., with diligent research. ■

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Need for Nations to 'Mainstream' Sustainable Development

With Inclusive Policymaking, Societal Participation, Innovation

Dr Rajiv Chhibber is Vice President, External Affairs at Sahajanand Medical Technologies, a leading developer and manufacturer of minimally invasive coronary stent and vascular systems. In this interview, he reminisces launching the first-of-its-kind *Heat Action Plan* for the city of Ahmedabad, which is now a role model for many states who have embarked upon the same. It was also the first city in South Asia to create a comprehensive early warning system and preparedness plan for extreme heat events fuelled by climate change. Keep reading to know more…

What to you is 'mainstreaming sustainable development'?

As a Public Health and Environmental Communications professional, 'mainstreaming sustainable development' to me is the ability to propel, propagate and ensure necessary decisions towards the 'refreshed vision and commitments' of India to stimulate economic growth, maximizing well-being and protect our environment, without negatively impacting on the ability of future generations to do the same.

According to you, what is the role of mainstreaming sustainable development in promoting collective actions?

The term 'mainstreaming sustainable development' itself connotes to action. No one country can solve the climate crisis alone or bear the brunt of environmental catastrophe alone. Nations need to 'mainstream' sustainable development with inclusive policymaking, societal participation, innovation, greater financial support, and

also advocate via as many channels to expand positive impact and contribute to meaningful change. Each entity has its role and strengths to bring to the table solutions that will ensure greater accountability and urgency, to drive a sustainable future for all.

Give an example of how you have integrated sustainable development/ climate resilience in your sphere of action/work/decision-making.

As a Public Policy and Communications professional, my work has always been at the crossroads of promoting sustainability and environmental health throughout my career. However, looking back, a major project on outreach that I spearheaded was launching the first-of-its-kind *Heat Action Plan* for the city of Ahmedabad, which today is a role model for many states who have embarked upon the same. Proudly, this was also the first city in South Asia to create a comprehensive early warning system and preparedness plan for extreme heat events fuelled by climate change. This groundbreaking project, which was a coalition of environmental health and academic groups, has over the years reduced the deadly impact of extreme heat deaths by initiating an early warning system for residents, providing preparation training to medical and community workers, building public awareness of the heat-related risks, and coordinating an inter-agency emergency response effort when heat waves hit. Over the years, news of extreme heat leading to health consequences, including heat stress and heatstroke reached dangerous levels, and was proclaimed as deadly waves by many. Hence, a joint action programme was derived where the priority was to ensure that people, through localized information and communication tools, were protected from the impacts of climate change and severe heat waves. Today, by building awareness through localized communication tools, training health professionals, and implementing

a coordinated heat plan inter-departmentally, Ahmedabad is showing other at-risk regions the way forward.

Ahmedabad's *Heat Action Plan* describes both immediate and longer-term actions to increase preparedness, information-sharing, and response coordination to reduce the health effects of heat on vulnerable populations. It includes:

- Preventative training and awareness building for medical professionals and slum community outreach workers
- Heat-health protection trainings for school children, outdoor workers, and other vulnerable groups
- Communications outreach, such as an early warning system that will immediately alert the public of impending heat waves, the distribution of multilingual pamphlets, and long-term awareness-building ad campaigns
- Coordinated action by government agencies at the municipal, state, and national levels to ensure successful implementation of the preparedness plan and warning system.

In support of the *Heat Action Plan*, four related policy briefs entitled *Rising Temperatures, Deadly Threat*, have also been released by the collaboration of partners. These briefs outline key strategies in the *Heat Action Plan* that cities across the world can adopt to protect against heat wave impacts.

What more can be done by policymakers for integrating and mainstreaming sustainable development across agencies and across levels?

The world has already spoken about the five 'P' theory that can integrate and mainstream sustainable development. While these five 'P's namely—Planet, People, Prosperity, Peace, and Partnerships have over the years worked together to make another "P", i.e., Progress, however, it failed to foresee some of the key challenges of our time—outbreaks of epidemics, climate change, and environmental pollution. This was because most of these were addressed on a regional basis and not global action. Unfortunately, the spirit of international cooperation and coordination seems in regrettably short supply. For mainstreaming collective action towards sustainable development, all the six 'P's have a role to play, not least in encouraging (quietly or noisily) governments to put their weight behind the SDGs by demonstrating the seventh 'P', without which none of this will happen—Political Will. Without that, and without governments, the private sector, civil society, foundations and

philanthropists finding ways of working more closely together to make progress towards the SDGs, our future—and conceivably our very survival—is much less certain.

What more can be done by business and industry in terms of integrating and mainstreaming sustainable development?

Industry is viewed as leading sector to economic development. The United Nations has clearly recognized that industry increases productivity, job creation and generates income, thereby contributing to poverty eradication and addressing other development goals, as well as providing opportunities for social inclusion, including gender equality, empowering women, and creating employment for the youth. While industry does tick most of the SDGs, however, to achieve Sustainable Industrial Development there is a need for an integrated approach, which will define an increased interrelation between environment and industrial policies. The achievement of sustainable development requires a balanced integration of environment, economic and social objectives, taking into account the needs and concerns of both present and future generations. While the role of business and industry to achieve SDGs has been largely defined based upon the environmental challenges, the new need is to inculcate responsible entrepreneurship, the concept of eco-efficiency and manufacturing, the new challenges of globalization, information society and the change of production and consumption patterns. For this constant innovation and approaches need to be developed in the basics that governed the sustainable industrial policies in the areas of preventive approach (support investments characterized by a preventive approach, including priorities such as the efficient and sustainable use of natural resources, waste minimization and reuse, reduction of air pollution); clean technologies (favour measures to accelerate the shift from old, polluting technologies and end-of-pipe measures to new clean technologies); environmental management (financial support provided to WTO, FTA and governments, in particular to SMEs, to make use of environmental services such as eco-audits); industrial sites (priority to the rehabilitation of derelict industrial sites (brownfields) over the development of greenfield sites) and; training, which includes improving skills in environment-related issues within the business sector.

What is your message for the G20 for which India is presently holding the Presidency?

The G20 Presidency for India came at a time of geopolitical tumult, uncertainty over post- pandemic economic recovery, the Russia–Ukraine war, and a looming crisis of climate change. While holding the Presidency of the G20, the Hon'ble Prime Minister of India clearly stated that India will discernibly push for the provision of finance and technology as critical enablers for achieving the climate goals set by the Paris Accord, which was a bold statement.

In my view, India which is slated to be the fastest growing economy, should garner not only G20, but global support for this approach to propel an ambitious greener government target that will ensure sustainability is at the heart of each government. For example, post the COVID pandemic the approach should demonstrate the synergies between enhancing and protecting our environment and improving the quality of life and health of our communities, while contributing to sustainable growth. The need to account for the social aspects of policies when assessing sustainable development needs to be recognized more strongly and this should lead to wider cross-government work to ensure we identify and measure social impacts as systematically and consistently as possible by further jointly developing our ability within the G20 to assess and value social, economic and environmental impacts when making policy decisions. ■

Dr Rajiv Chhibber is a Senior Corporate Affairs, Policy, Communications & Media Strategist with experience across several industries including Pharmaceuticals/Medical Devices and has worked in the past in the Development Sector in the key areas of Healthcare, Climate Change, Energy and Sustainable Development. He is a member of various government/industry associations and committees in areas of public health advocacy, pharma, medical devices, environmental health and climate change, where he plays a stewardship role in assisting the government's vision to achieve the SDGs and advancing health systems.

Enhancement of Conscious Consumerism

By Integration of Sustainable Natural Pigments in Textiles

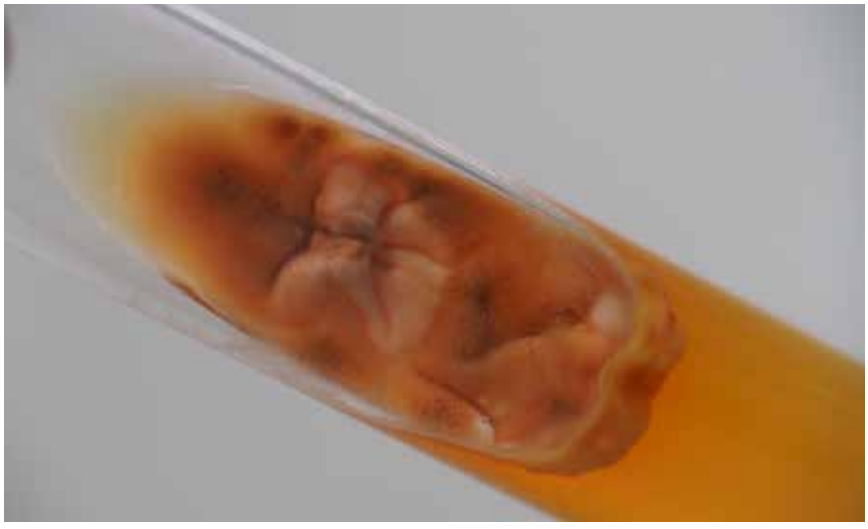
In this article, **Mehak Kaur** and **Dr Mayurika Goel** highlight that the Natural Products Group at the Sustainable Agriculture Programme of TERI is working on red pigment production by naturally occurring coloured microbes for application in the textile industry. Creation of colours through fermentation of non-pathogenic fungi on agricultural waste-based media can be used to produce pigments with bioactivities such as antimicrobial, antioxidant, anticancer and others in a sustainable way.

Trillions of litres of water is consumed annually during colouration and other processes of textile manufacturing that includes 10–50 per cent toxic non-biodegradable petrochemical-based synthetic dyes being washed out in natural water bodies. The fashion industry also contributes 4 per cent of global greenhouse gas emissions. While modern synthetic dyes are highly efficient owing to their non-biodegradable nature, their accumulation in the environment is causing depletion of safe water and soil. Further, antimicrobial finishing of fabrics involves heavy metals such as copper, silver, and zinc that leach into the environment. Naturally occurring pigments from microbial sources have been used traditionally but were ignored by the fashion industry because of their

inferior performance, restricted colour palette, and higher cost as compared to the synthetic dyes. However, with advances in regenerative agriculture, innovative extraction and cultivation techniques can be utilized to overcome these obstacles.

The Natural Products Group at the Sustainable Agriculture Programme of TERI is working on red pigment production by naturally occurring coloured microbes for application in the textile industry. Creation of colours through fermentation of non-pathogenic fungi on agricultural waste-based media can be used to produce pigments with bioactivities such as antimicrobial, antioxidant, anticancer and others in a sustainable way. The desired pigment is extracted from the broth via solvents that can be recovered and reused for the next cycles. At the laboratory scale, we have utilized two non-pathogenic strains of endophytic fungi (fungi that grows inside the plants without causing any visible harm to it) isolated from the biodiversity hotspots of India to obtain red pigments. These pigments were found to exhibit good antimicrobial activities against the tested pathogens and high antioxidant activities against free radicals. Furthermore, they were successfully tested on cotton cloth patches and are currently being upscaled at TERI's fermentation facility.

Dried red pigment from Talaromyces spp.



Evaluation of pigment adherence on cotton cloth

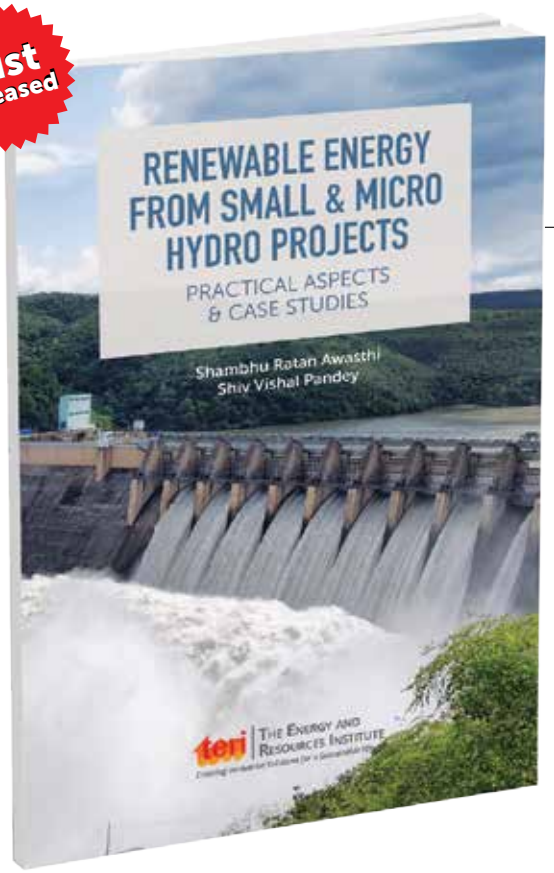
Currently, selecting natural pigments is a conscious choice. We tend to change it to default decisions and incorporate the choice of sustainable pigments sub-consciously for various religious and cultural practices. Our approach supports the innovative zero-waste manufacturing technology, industrial ecology and bio-based economy while bio-mimicking the designing processes. The contribution of textile sector to India's socioeconomic development is immensely evident as they support over 45 million jobs. Inclusion of natural pigments in the default choices of people would make impact of sustainable lifestyle evident on the community associated with their production, manufacturing, supply chain, and waste management. With agri-waste as raw material, creation of a formal supply chain, increased involvement of farmers, improved waste management and decreased stubble burning can be targeted. Local supply chains for large-scale production of microbial pigments can be developed by public, private, state and central engagements leading to more employment and skill enhancement in rural areas.

Sustainable Development Goals (SDGs) targeted by this approach are good health and well-being (SDG3), clean water and sanitation (SDG6), industry, innovation and infrastructure (SDG9), sustainable cities and communities (SDG11), responsible consumption and production (SDG12), climate action (SDG13), life on land and water (SDG14 and 15). Sustainability assessment and evaluation of the net energy requirements of our process is ongoing. Further, the aim is to involve researchers, academicians, designers, textile industries and distributors for adoption of sustainable practices to bring a visible change in the outlook of the community. ■

Mehak Kaur, Research student, Sustainable Agriculture Division, TERI, New Delhi and Dr Mayurika Goel, Associate Fellow, Sustainable Agriculture Division, TERI, New Delhi.

PRACTICAL ASPECTS OF HARNESSING RENEWABLE ENERGY

Just Released



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Energy production and utilization are directly associated with climate change. Harnessing energy from renewables can provide a viable path towards achieving sustainability and reducing carbon footprints, which can help mitigate the harmful effects of climate change. India is endowed with substantial hydropower potential. Under this light, *Renewable Energy from Small & Micro Hydro Projects: practical aspects & case studies* introduces the process of developing hydropower projects, especially in Indian context. The role of hydroelectric power, as part of water management, in combating climate change also forms the subject matter of this book.

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The Climate Discussion that Cannot Wait

Janos Pasztor says, "In the past three months, my colleagues and I at the Carnegie Climate Governance Initiative – C2G have met privately with senior government officials worldwide to discuss a topic that they—we have found—are reluctant to address publicly, at least for now." Keep reading this insightful article to know more…

The issue is as timely as it is consequential: if the world exceeds 1.5°C, which, as the IPCC has indicated is more likely than not under even the most ambitious emission pathways, how might the world respond to impacts resulting from that overshoot? What might be needed to inform policymakers as they grapple with options to reduce risks from an overheated planet? New options include the possible use of emerging climate techniques that could prevent temporarily further global heating by reflecting sunlight away from the Earth, but that also pose risks of their own.

One significant risk of these techniques, collectively known as solar radiation modification (SRM),[1] is the absence of comprehensive multilateral governance for a technique, which, if ever deployed, would affect all countries, though not necessarily equally. The lack of governance can lead to unilateral action or incoherent policies vis-à-vis

societal objectives like the Sustainable Development Goals (SDGs). Furthermore, to reach and implement decisions on use or non-use, governance is needed not just for government action to guide and regulate developments in this area, but also to enable transparent access to information for different stakeholders to be able to engage in the necessary societal conversations and activities.

In the last 6 years, C2G has spoken with representatives of over 45 governments and non-state actors, including most G20 members and many key climate vulnerable countries. We have encouraged them to seriously grapple with the fact that our planet will get warmer in our lifetime, jeopardizing the SDGs, and having serious impacts on global security, and that an emerging technique such as SRM may need their attention. The onus of responsibility is

[1] Also known as solar geoengineering or climate intervention. There are different SRM techniques, including surface albedo modification, marine cloud brightening or the use of space mirrors. This article, however, focuses on the most researched SRM technique: stratospheric aerosol injection.

now on policymakers to take the next steps to reduce the risks of overshoot and minimize climate risks resulting from overshoot.

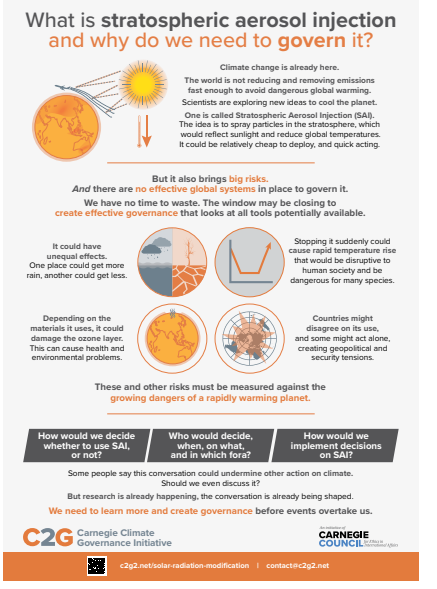
New Developments Strengthening the Urgent Need for Governance

Three recent developments have made a discussion of the need for comprehensive climate governance in the context of a temperature overshoot scenario more urgent.

First, climate impacts in 2022 continued to accelerate across the globe, from floods that left one-third of Pakistan under water, to worsening drought conditions in Europe and the western US to an epic heat wave in China, to highlight a few. Governments are finding it impossible to ignore the damages wrought by a global average 1.2°C temperature rise, and are increasingly worried about what 1.5°C or higher might bring.

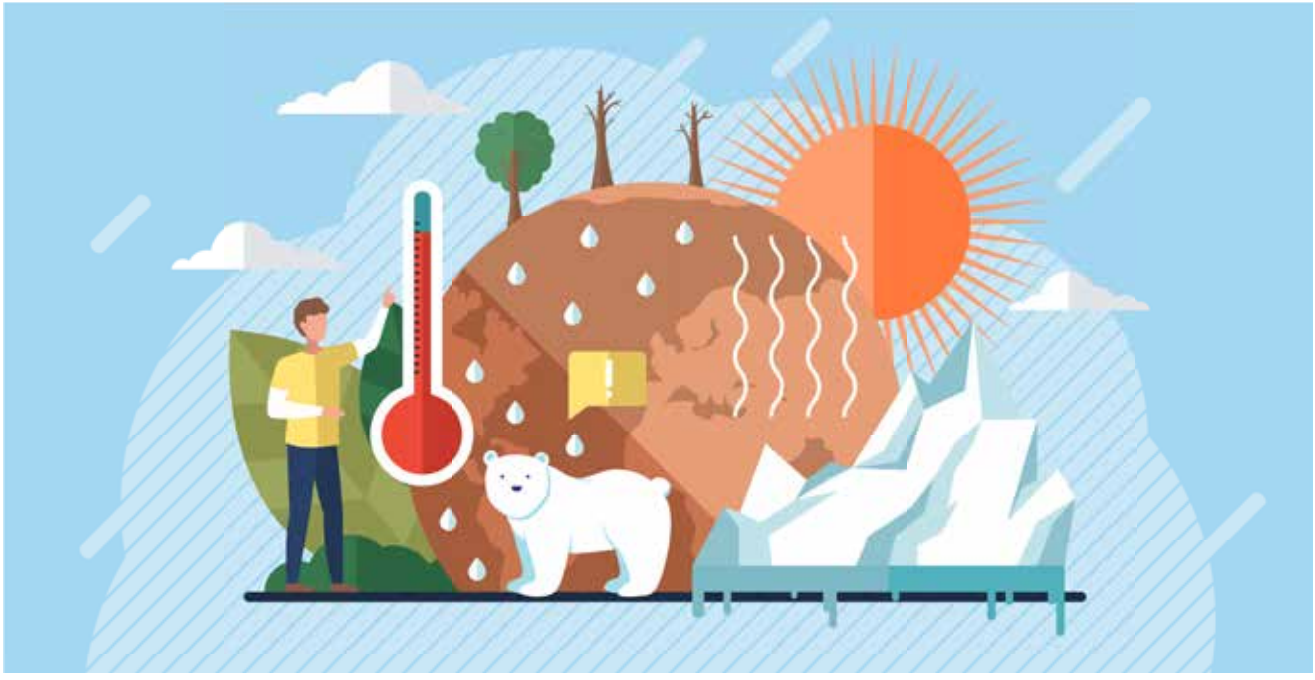
Second, late last year, the prestigious international affairs journal in the US, *Foreign Affairs*, published an article[2] calling for the imminent deployment of SRM given the increasing crescendo of climate impacts. Significantly, the author of this article called for unilateral action by the US if other governments were not willing/able to collaborate.

Third, a small start-up from Silicon Valley, Make Sunsets, announced in January 2023 that it has launched in Mexico, initially on a very small scale, stratospheric aerosol injection, and selling 'cooling credits' to the public. The company was widely criticized by scientists for lack of scientific rigour and



false claims. This is a private company, which has unilaterally embarked on a project that, at the greater scale they are aiming for, affects a 'global good'—the atmosphere. Selling 'cooling credits',

[2] The Time for Geoengineering Is Now - Drastic Climate Change Calls for Drastic Measures. By Robert Litan, Nonresident Senior Fellow in the Economic Studies Program at the Brookings Institution. Foreign Affairs, 26 October 2022.



inevitably leads to the 'moral hazard' of addressing impacts (symptoms), instead of reducing emissions (the cause).

In the developments cited above, we see an actor either calling for—or indeed, taking— unilateral action without a globally inclusive, transparent deliberation and decision-making.

At the time of writing this article, the Mexican Government has reacted, and stated that it would close down such activities.

The Current State of the Climate Crisis – And Responses to It

In the meantime, serious progress in reducing and removing emissions remains elusive. UNEP's *Emissions Gap Report (EGR) 2022* starkly noted that there is no credible plan for 1.5°C in place, and that the world is on track for 2.4–2.8°C of warming by the end of this century. Each additional tenth of a degree matters in terms of increasing the severity of impacts.

C2G's discussions with policymakers were framed by this reality. Governments are frightened— justifiably so—that the continued acceleration of climate impacts could undermine gains made through the SDGs.

How will the world proceed? What will sustainable development look like in a world that overshoots the Paris temperature goals? This is the question all countries need to be asking themselves now as the possibility of exceeding 1.5°C of warming above pre-industrial levels within the next two decades grows ever stronger.

First and foremost, governments can and must reduce the extent and duration of a temperature overshoot by continuing to prioritize and deliver deep and rapid emissions reductions, combined increasingly with large-scale removals. Governments will also need to increase adaptation efforts, including funding for developing countries. Not only is funding for mitigation competing with that for adaptation but adaptation has its limits.

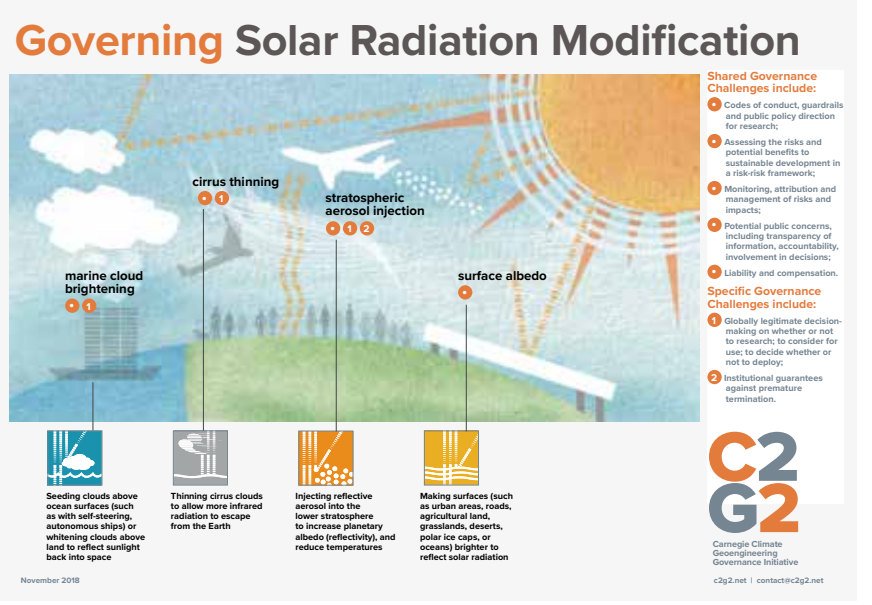
At COP27, governments agreed to create a loss and damage facility—a historic, welcome step forward for countries already suffering grievously from the impacts of climate change. But its focus is on addressing climate impacts after they have occurred, not on avoiding them in the first place. It remains to be seen how this facility will operate, and how much funding will be provided, in addition to the resources needed—and not yet delivered—for massive adaptation and mitigation needs.

SRM as a Potential Response Tool—Risks, Benefits, Governance Needs

Given the gravity of the climate crisis, it is not surprising there is growing interest in SRM. This technique would spray aerosols in the stratosphere to reflect sunlight back into space and thus temporarily cool the Earth. SRM would not address the cause of climate change—and therefore could never be a substitute for transformative emission cuts and removals. Instead, SRM would temporarily mask one of its symptoms (temperature rise) and, in theory, give the world more time for mitigation efforts to pick-up speed.

Researchers are confident that SRM could lower global temperatures quickly and inexpensively, on the order of USD 10 billion per year. It is important to remember, however, that since SRM is not a substitute for mitigation, there will still be a hefty price tag to pay for those efforts as well. Those countries and communities that have contributed least to the climate crisis are among those most affected by its impacts. This will surely be the case in an overshoot scenario as well. By the same logic, these countries, overwhelmingly in the Global South, could also be the ones that are most affected—for good or for ill—from SRM.

SRM would affect all countries, but not necessarily equally. Models show that the monsoon cycle in South Asia might be affected, which would have major implications for over a billion people. Depending on the type of aerosol used, SRM could potentially damage the ozone layer, increase acid rain and respiratory illnesses, exacerbate, or trigger conflicts and undermine biodiversity. Of course, current fossil fuel-related emissions are also having negative impacts on the risks listed here. Are the consequences of a world with a 1.6°C or more temperature rise better or worse than using a new technique that could lower temperatures but also has unknown risks? Better for whom? Who decides?



Should humanity try to deliberately alter the climate to protect loss of biodiversity and potentially avoid climate tipping points from being triggered? Do we even have the right to do this, or conversely, the right not to do this? How might the world make such a decision? Based on whose authority? Using what—or whose—criteria?

Currently there is no dedicated process where these questions can be raised, discussed, and eventually decided upon. Decision-makers are only beginning to learn about the risks and benefits of SRM, and how these relate to the risks of overshooting 1.5°C. There are far more questions than answers. But policymakers need to start discussing and asking those questions; initiating and strengthening fora where such discussions can take place, and thereby preparing themselves for what could be difficult decisions to be made.

Now is the time for these policymakers to form their views, and decide next steps.

To this end, C2G is seeking to catalyse an initial consideration of SRM in the UN General Assembly (UNGA) in 2023, framed in the context of managing the risks from temperature overshoot in ways that support better sustainable development outcomes. Given its universal representation, as well as its ability to consider issues going beyond individual sectors, UNGA is well-placed to deliberate transparently on this issue and encourage and guide further responses by the UN system and by other partners. Doing so, would be an important first step towards creating effective multilateral governance that can help the world navigate uncharted territory ahead. ■

Janos Pasztor, Executive Director, Carnegie Climate Governance Initiative (C2G).

Achieving Sustainable Development through a Cohesive Response

In 2016, **Dr Ash Pachauri** founded the POP (Protect Our Planet) Movement alongside Dr R K Pachauri. With a key focus on climate action and sustainable development, the POP Movement mobilizes and mentors young people around the world, inspiring them with knowledge to undertake projects and implement actions in their schools, colleges, communities, and homes.
In this interview, Dr Ash Pachauri reflects on the foundational idea behind the Sustainable Development Goals (SDGs), the need to move away from silo-ed approaches towards collaborative and coordinated action, especially with the active leadership of business and industry among other stakeholders, promoting community engagement, and the unique opportunity for India to represent the Global South in the G20.

What to you is 'mainstreaming sustainable development'?
It was the unique vision, experience, and wisdom of the great leader, H.E. SG Ban Ki-moon which inspired the formulation of the Sustainable Development Goals (SDGs). The fundamental goal behind the SDGs is the need to further mainstream sustainable development at all levels, integrating economic, social, and environmental aspects and recognizing their interlinkages, so as to achieve sustainable development in all its dimensions.

As the first step towards achieving the mainstreaming of the SDGs, I believe that we need to create awareness about sustainable development and build a foundation for deeper understanding and informed action. The 2030 agenda for mainstreaming the SDGs demands

reaffirmed commitment led by communities, globally.

Achieving the SDGs requires mainstream planning and action as a necessary prerequisite to a sustainable future for all. We have less than a decade to achieve the SDGs. Yet we do have the wherewithal and capacity to achieve what we have set out to achieve on a sustainable pathway. It will take urgent, collaborative action of all stakeholders. This, I believe, was the vision SG Ban Ki-moon had at the time he envisioned the SDGs. While achieving the SDGs will be the greatest tribute to H.E. SG Ban Ki-moon, what is important to remember is that it is our success in their attainment that is essential to keep the legacy of humanity alive.

According to you, what is the role of mainstreaming sustainable development in promoting collective action?

As described above, by mere definition, I believe mainstreaming signifies moving away from the silo-ed approach to coming together, taking action collectively, joining the dots for a common agenda.

Give an example of how you have integrated sustainable development/ climate resilience in your sphere of action/work/decision-making.

My work over the last several years has been about creating structural interventions founded on participatory, dialogue-based approaches, whereby communities are empowered to critically analyse barriers to progress and devise solutions based on local, community knowledge, customs, and practices to overcome challenges, and do so, sustainably. In such a manner, communities are encouraged to identify problems and possible solutions based on indigenous wisdom. Programmes are devised by and for communities, and are, by definition, owned by communities and are, therefore, sustainable.

These, community-led, structural interventions, are those that I have been trained in and have trained many others to work with. The goal of such interventions is to identify local representatives and leaders from within communities (with community engagement). Communities implement programmes (by and for communities) that they devise as peer-leaders. Local partnership and peer-to-peer approaches are lasting, faithful to communities, and impactful. They are also sustainable and founded on structural change.

What more can be done by policymakers for integrating and mainstreaming sustainable development across agencies and levels?

I believe we need to be more equitable in the manner in which we address the issue of mainstreaming our efforts for

sustainable development. This means that donors and policymakers need to be on the same page as decisions are made about funding and financing action. Mainstreaming by mere definition implies breaking away from silos/parallel and fragmented approaches often created by funding agencies, which leave out cohesive responses to achieving human progress and sustainable development. Therefore, policymakers, governments, and government departments need to talk to each other in order to achieve common goals. This means breaking down silos and moving away from traditionally competitive models to fostering collaboration and cooperation.

What more can be done by business and industry in terms of integrating and mainstreaming sustainable development?

We need to develop a concerted and coordinated approach towards achieving the SDGs, which demand action by business and industry leaders. The pandemic has derailed our efforts towards attaining the SDGs and put us off by over a decade. The war in Ukraine and the global climate, economic, and political crisis will further push us off track. A 2019 Oxfam Report revealed that the world's 2153 billionaires have more wealth than the 4.6 billion people who make up 60 per cent of the planet's population. In addition, in 2022, Oxfam reported that the world's ten richest men more than doubled their fortunes from $700 billion to $1.5 trillion during the first two years of a pandemic that has seen the incomes of 99 per cent of humanity fall and over 160 million more people forced into poverty. "If these ten men were to lose 99.999 per cent of their wealth tomorrow, they would still be richer than 99 per cent of all the people on this planet," said Oxfam International's Executive Director Gabriela Bucher. It is unfathomable that we can attain what has been set out for the SDGs without active leadership of businesses and industry.

What are your expectations from India's G20 Presidency?

At the POP Movement, we don't just state but rather practice the principle of "Vasudhaiva Kutumbakam" ("The Universe is One Family"), which is also the theme set out by India for its G20 Presidency. India's G20 presidency comes at a difficult time when the global economic outlook for 2023 remains uncertain. The International Monetary Fund and other international agencies have scaled back a number of G-20 country forecasts. Nevertheless, this is an important time for India to take leadership and be decisive. Being decisive will be key. The outcomes of India's G20 Presidency will rely heavily on India's leadership by example. In the context of increasing financial vulnerabilities and heightening geopolitical stress, India will have to steer discussions and inspire collective action at the G20 to advance global economic stability and peace. This will not be an easy task especially in light of increasingly fragmented and divisive global factions and leadership worldwide. Historically, in its Presidency role for India, the G20 brings additional responsibilities for India as many non-G20 countries (e.g., from the global South) will look to India to table their concerns at the G20. Therefore, it is a great opportunity for India to take lead by representing many countries especially from the Global South, including Africa that would otherwise go unrepresented. India has a chance to pave the way to the global collaboration we are all, as a global family, so in need of. ■

Dr Ash Pachauri, Director, Center for Human Progress, New Delhi, India, and Senior Mentor, the POP (Protect Our Planet) Movement, New York, USA. Dr Ash Pachauri has a PhD in Decision Behavior and a Master's Degree in International Management. He worked with McKinsey and Company before pursuing a career in the social development arena. Dr Pachauri's experience in the fields of public health and management emerges from a range of initiatives including those of The Bill and Melinda Gates Foundation, Program for Appropriate Technology in Health (PATH), United Nations Development Programme (UNDP), International Planned Parenthood Federation (IPPF), and Centers for Disease Control (CDC) in the US.

“We Need to Make the SDGs a Part of People’s Lives by Including Them in Policies, Plans, and Budgets”

Deepali Khanna is Vice President, Asia Regional Office, The Rockefeller Foundation. She says mainstreaming sustainable development is paramount to universalizing opportunities—embedding ethos of inclusion and diversity into programmes and policies that concern people. At The Rockefeller Foundation, they are dedicated to the principle that all humans have the right to quality health care, nutritious food, affordable and reliable energy, and economic mobility. Read this interview to know more…

What to you is ‘mainstreaming sustainable development’?

Sustainable development has three components: economic development, social development, and environmental protection. Mainstreaming sustainable development means universalizing the very idea of development—ensuring that these components are considered, individually and collectively, in decision making by people, governments, organizations, and businesses. We need to make the 17 Sustainable Development Goals (SDGs) a part of people’s lives by including them in policies, plans, and budgets.

Environmental, climate, and socioeconomic challenges are interlinked and cannot be solved in silos. Everybody must come together and play an active role in internalizing and integrating the objectives of sustainable development into practice and decisions. To mainstream the SDGs, countries need

to consider national and subnational contexts. This involves a wide range of issues—from the environmental and socioeconomic setting to government policies and management strategies. Key tasks include setting goals and targets, determining the means of implementation, and using indicators to measure and monitor progress.

According to you, what is the role of mainstreaming sustainable development in promoting collective actions?

Mainstreaming sustainable development is paramount to universalizing opportunities— embedding ethos of inclusion and diversity into programmes and policies that concern people. At The Rockefeller Foundation, we are dedicated to the principle that all humans have the right to quality health care, nutritious food, affordable and reliable energy, and economic mobility.

Today, the way the world produces and consumes food is failing both people and the planet. Smallholder farmers throughout the world continue to struggle financially, unhealthy diets account for one in five deaths worldwide, and over a quarter of all greenhouse gas emissions come from food systems. Our Good Food Strategy recognizes the systemic interconnectedness of public health, biodiversity, nutrition, environment, and livelihoods, and puts the onus of a positive food systems transformation on collective action: no single entity can alone bring about a mammoth change. During COP27, The Rockefeller Foundation announced a first step towards such a transformation: USD 11 million in grants to ten organizations scaling indigenous and regenerative agriculture practices worldwide.

Mainstreaming is therefore an act of democratizing action—enabling stakeholders to look beyond their differences and work together towards common goals. Therefore, we need more multi-stakeholder partnerships driven by data and evidence rooted to drive meaningful collective action that improves people's lives and livelihoods.

Give an example of how you have integrated sustainable development/ climate resilience in your sphere of action/work/decision-making.

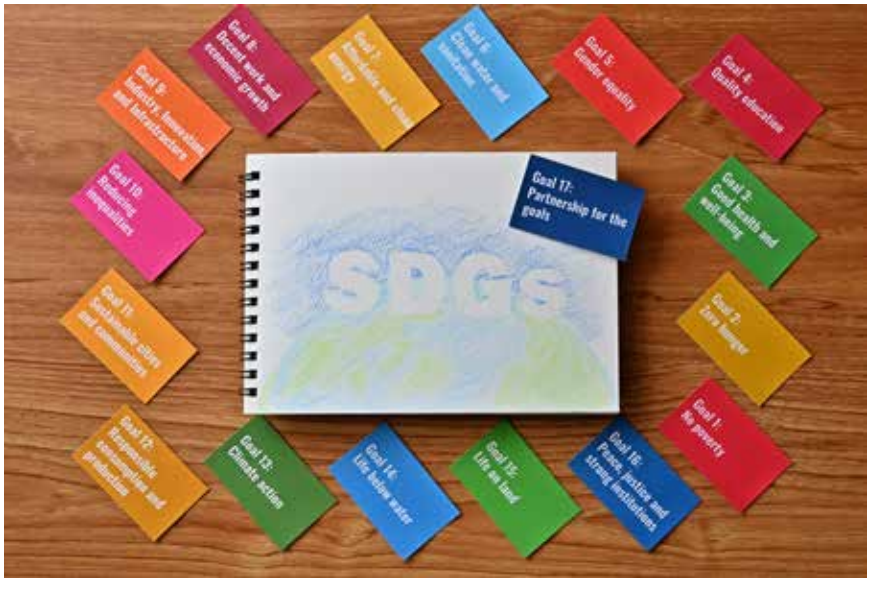
Approximately 3.6 billion people, or nearly half of the global population, do not have access to stable and sufficient electricity. This lack of access hinders the development of communities by limiting their ability to communicate, learn, farm, store food, and operate factories, ultimately limiting their opportunities. Simultaneously, the world is facing an urgent climate crisis.

Recognizing the complexity of this challenge, The Rockefeller Foundation, along with the Bezos Earth Fund, the IKEA Foundation, and other partners, invested USD 10 billion to launch the Global Energy Alliance for People and Planet (GEAPP) at COP26 in November 2021. This innovative partnership takes into account that building climate resilience cannot be an afterthought to development and must be integrated into programming from the onset. Through its multi-stakeholder and multi-dimensional approach, GEAPP has partnered with governments in 12 countries, advancing their national agendas for better energy access, faster decarbonization, and economic development.

Another example of the action undertaken by The Rockefeller Foundation in this direction is supporting The Urban Climate Change Resilience Trust Fund administered by the Asia Development Bank (ADB), which aims to assist cities through the enhancement of urban planning, the creation of infrastructure that is able to withstand the effects of climate change, and by investing in both projects and individuals. It aims to increase investments in urban climate change resilience (UCCR) in 25 cities in Asia, particularly for those living in poverty. The fund focuses on developing member countries of the ADB, including Bangladesh, India, Indonesia, Myanmar, Nepal, Pakistan, the Philippines, and Vietnam.

What more can be done by policymakers to integrate and mainstream sustainable development across agencies and across levels?

Before implementing any policy across agencies and levels, policymakers should make use of the United Nations' localized Rapid Integrated Policy Assessment, which will help them design policies that address existing gaps.



Furthermore, policymakers must also ensure that any new policy serves to solve more than one development challenge. For example, a policy for empowering women could encompass education, health, nutrition, and/or economic stability. Policies and their resulting programmes should be at the intersection of sustainable goals.

Another important policy metric revolves around the involvement of multiple stakeholders and institutions. Any integrated policy must be planned with a long-term perspective that accounts for budgetary needs and stakeholder risks. It is also essential that policy indicators be measured locally, nationally, and compared with global estimates.

What more can be done by business and industry in terms of integrating and mainstreaming sustainable development?

As corporate social responsibility grows more prominent, the private sector has been searching for ways to help countries achieve their SDGs. With market investors focusing on a business's environmental and social processes, the private sector is also adopting sustainable practices in their day-to-day operations.

Corporations can and should do more. Companies should make good on their pledges to reduce emissions, recycle their raw materials, build sustainable products, and support technological innovations to build resilient livelihoods. They should also be willing to work with stakeholders including governments to establish fair regulations and standards.

As companies modify their operations, they encourage their peers to do the same; these chain reactions can lead to a rise in awareness and accountability. They can also inspire small-scale changes among their workforces. Every individual can contribute to reducing carbon emissions by changing their lifestyles, such as adopting public transport or choosing an electric vehicle.

What is your message for the G20, for which presently India is holding the Presidency?

The Indian G20 Presidency is a hallmark moment for the Global South. Following the Indonesian Presidency and preceding the Brazil Presidency, India finds itself not only expanding the calls to action from Indonesia but also setting the stage for the Global South to further raise its voice and expand its collective action in Brazil.

India's digital-first approach in energy, health, and agriculture—and the government's commitment to involve the private sector in SDG policymaking and implementation—will set examples for other Global South countries to follow. The country has also stated that collective action is one of their foremost priorities.

With an aim to depoliticize the global supply chain of food, fertilizers, and medical products, the Indian Presidency will also create new avenues for philanthropies like ours, along with the private sector, to finance endeavours to reduce the chasm between the Global North and South. These Presidencies help the Global South move beyond just finding a seat at the table to play a leading role in decision-making. ■

TERI's TADOX® Technology for Wastewater Treatment

Promising Approach to Achieve Water Vision@2047

In this insightful article, **Dr Nupur Bahadur** highlights that a technological intervention like TADOX® is a novel and innovative step towards adequate treatment of industrial and municipal wastewater. This novel technology holds great potential to achieve water security, 'monetize' wastewater treatment and management, support circular economy, and contribute towards achieving the WaterVision@2047.

"When treated water is reused, fresh water is conserved, it benefits the entire ecosystem. That's why water treatment, water recycling is essential".

Shri Narendra Modi
Hon'ble Prime Minister of India

The current wastewater treatment faces various issues and challenges, which majorly involve use of a large amount and large number of chemicals, which leads to secondary problems associated with toxic sludge generation, disposal and management; high dependence on biological treatment systems, which involves large footprint, prone to shock loads and inadequate treatment, especially in case of industrial effluent treatment. More importantly, the inadequately treated coloured water that goes as the feed to tertiary treatment systems, involving RO/MEE/MVR, etc., leads to chocking and biofouling of membranes. Moreover, it also creates associated problems leading to higher capital expenditure (CAPEX) and operational expenditure (OPEX) and makes the overall wastewater treatment and management highly unsustainable, unacceptable, unaffordable and non-compliant.

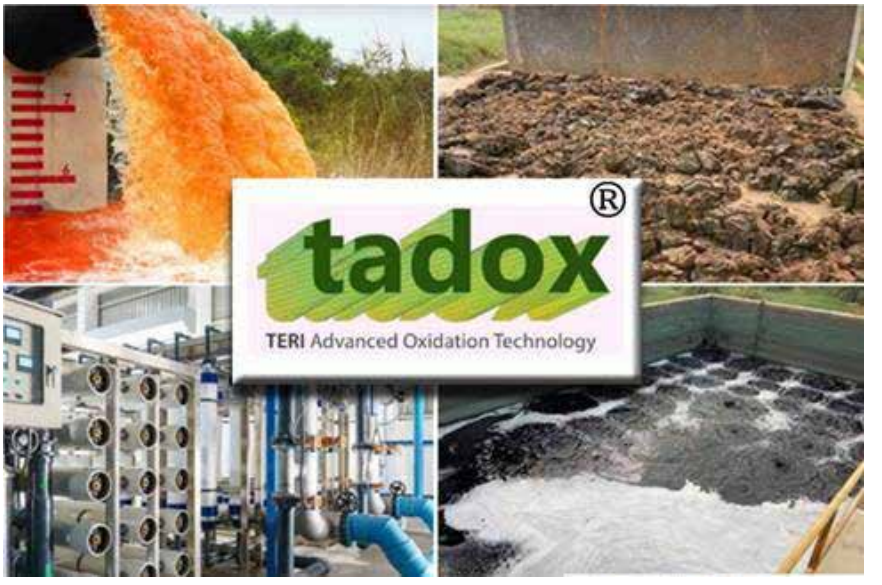
Dr Nupur Bahadur, Head, NMCG-TERI Centre of Excellence on Water Reuse at TERI.

Further, with many National Missions centred around the theme 'Water' like the Namami Gange Programme or the National Mission for Clean Ganga, Jal Jeevan Mission, Swachh Bharat Mission (SBM), Atal Mission for Rejuvenation and Urban Transformation (AMRUT), etc., and the latest release of the 'National Framework for Safe Reuse of Treated Water', and having Water Vision@2047, laid down by the Hon'ble Prime Minister of India, Shri Narendra Modi, it becomes imperative for us to enhance the quality and quantity of treated wastewater, such that it becomes available to various stakeholders for high end non-potable reuse and the freshwater sources are available for potable use.

Thus, in order to support and make

these National Missions truly successful, prevent water depletion and high dependence on groundwater, help all sectors of industries to become truly water secure and compliant, and provide safe and secure water and sanitation to rural and urban areas, we have to make wastewater treatment and management highly resource and energy efficient, much more sustainable, affordable, robust and future ready with augmentation of capacities within existing infrastructure. Thus, it is required to integrate in current systems, novel approaches and advanced technologies which could help in addressing these gaps and challenges.

It is in this pursuit, The Energy and Resources Institute (TERI), New Delhi, has developed a novel technology called TERI Advanced Oxidation Technology (TADOX®), which provides treatment of wastewater stream containing high colour, chemical oxygen demand (COD), biochemical oxygen demand (BOD), total oxygen demand (TOC), dissolved organics, micropollutants, non-biodegradable and persistent organic pollutants (POPs) in effluents



from grossly polluting industries and municipal wastewater. TADOX® is under TERI's Patent and a registered Trademark and involves UV-Photocatalysis as an Advanced Oxidation Nanotechnology (AON), leading to oxidative degradation and mineralization of targeted pollutants. Also, it involves novel approaches which make very less use of chemicals in the overall treatment leading to much reduced quantum of sludge, preventing secondary pollution and provide highly resource- and energy-efficient treatment [https://youtu.be/prHy2Gu13Mk]. This technology has been developed under DST Water Mission, Water Technology Initiative (WTI) Programme of the Ministry of Science & Technology, Govt. of India during 2017–2020 and the outcomes were announced through

its Press Release on August 25, 2021 [https://pib.gov.in/PressReleasePage.aspx?PRID=1748888]. Also, the Department of Science & Technology, Govt. of India published the successful outcome on its website at https://dst.gov.in/new-advanced-oxidation-technology-can-enhance-waste-water-reuse-lower-cost

This technology has received various prestigious Awards including 2022 FICCI Water Award, for the 'Innovation in Water Technology' category.

TADOX® as Decentralized Wastewater Technology for Industrial Effluent Streams

TADOX® has been tested for diverse effluent streams such as textile, tanneries, pharmaceutical, petrochemical, chemical & pesticide manufactures, oil & gas, etc., across the country. Figure 1 depicts TADOX® treatment in industrial wastewater in Textile ETP, Sonipat TADOX® could be a retrofittable and integrated solution at either pre- or post-biological treatment stages of the existing wastewater treatment plants (WWTPs), depending upon the effluent matrix and requirement of treatment or even at the end of treatment trail to polish any stream like the MEE condensates, etc. It could be noted that along with improving the water quality, the technology has very less treatment time, small footprint and together with resource and energy efficiency, TADOX® integration is expected to bring down ZLD CAPEX by 20–25 per cent and OPEX by 30–40 per cent than current values.

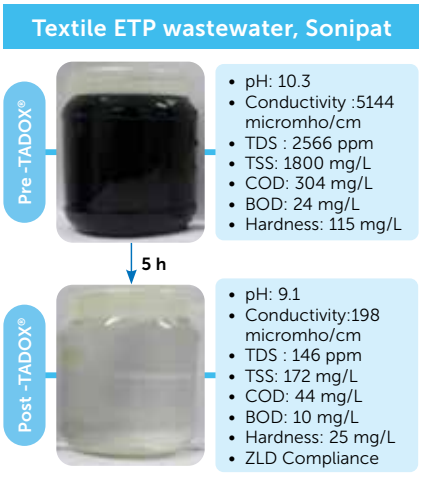


Figure 1: *TADOX® treatment in industrial wastewater*

TADOX® Technology for Municipal Sewerage Treatment

In case of municipal sewage treatment, TADOX® requires no stream segregation of black and grey water and also could be directly used for inlet stream or could treat the outlet, i.e., polishing of the treated wastewater. Also, no biological treatment of any kind is required at any stage. Thus, implementation of TADOX helps in reducing overall footprint of municipal sewage treatment and makes it more resource and energy efficient.

Figure 2 depicts treatment of mixed sewerage at 10 KLD TADOX® WWT plant at TERI, Gurugram campus, where it is treating without any stream segregation, the mixed effluent from research labs, hostels, canteen, and toilets. This TADOX WWTP is successfully running since 2.5 years.

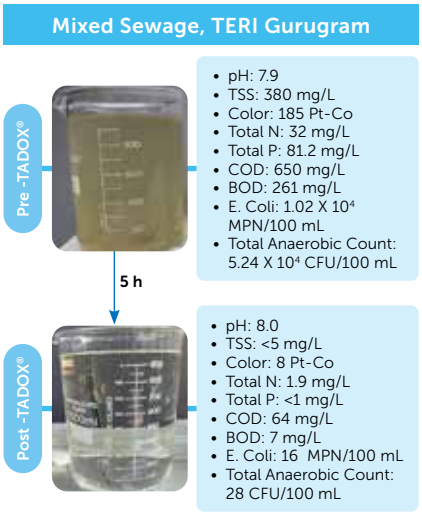


Figure 2: *TADOX® treatment for mixed sewage at 10 KLD WWTP at TERI Gurugram*

The results clearly indicate reduced biological parameters like *E.coli* and total coliform along with substantial reduction of recalcitrant organics, colour, 97 per cent reduction in BOD and 98 per cent reduction in COD, together with treatment times to few hours as compared to 12–24 hours

in conventional biological treatment. TADOX® makes it an excellent choice in augmenting capacities and improving efficiencies of current sewage treatment plants. TADOX® treated municipal sewage wastewater is aesthetically pleasant and certified by NABL accredited Labs for high end reuse for land irrigation, cooling tower make-up water as well as green building wastewater management plan.

Thus, a technological intervention like TADOX® is a novel and innovative step towards adequate treatment of industrial and municipal wastewater together with ensuring high water reusability, help in achieving decarbonization in wastewater treatment, meeting various regulatory norms and help in meeting the objectives of various National Missions together with meeting United Nation's Sustainable Development Goal 6, and in particular SDG 6.3, 6.4 and 6a. This novel technology holds great potential to achieve water security, 'monetize' wastewater treatment and management, support circular economy and contribute towards achieving the WaterVision@2047.

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Dr Nupur Bahadur is Senior Fellow & Associate Director, Environment & Waste Management Division, TERI, New Delhi and Head, NMCG-TERI Centre of Excellence on Water Reuse at TERI.

“Mainstreaming Sustainability Practices and Culture is Key to Realizing Sustainable Development in the Real Sense”

Dr Pranab J Patar is an award-winning environment and sustainability professional with close to 25 years of association with the non-profit environment sector. He is currently the Chief Executive of Delhi-based environmental and social impact organization—Global Foundation for Advancement of Environment and Human Wellness. An advocate of Nature-based Solutions, Decentralized approach to Conservation and Eco-technology for Environmental Sustainability, Dr Pranab speaks and writes regularly at various forums globally. A member of the Climate Reality Leadership Corp - USA, Dr Pranab sits on a number of national and international bodies including government-appointed committees, IUCN Commissions and Specialist Groups. Early last year, he took charge as the maiden President of the Assam Science Society Delhi & NCR branch and subsequently as the Secretary of TERI Alumni Association, New Delhi. In this interview, he talks about the role of mainstreaming sustainable development in promoting collective action and also tells us about his expectations from India's G20 Presidency.

What to you is 'mainstreaming sustainable development'?

For me, it is about internalizing the practice of doing things in a sustainable way in our day-to-day lives both in the professional and personal spaces. It is even better if we are able to develop a habit of shaping our actions that can lead to Sustainable Development Goals regularly.

Our individual action has the ability to influence the larger scheme of things in every aspect of our environment either in a constructive way or negatively. At the organizational level, our Foundation's work culture is ingrained with the ethos of sustainable development, so it is able to yield positive action on the ground, influence its stakeholders and generate awareness among its beneficiaries and most importantly inspire others through realistic outcomes.

According to you, what is the role of mainstreaming sustainable development in promoting collective action?

Mainstreaming sustainability practices and culture is key to realizing sustainable development in the real sense.

While sustainable development may appear as a logical solution to end our environmental, social and economic woes, the path is never easy, which makes us often believe that sustainable development is just a utopia! However, that's not the case, sustainable development is real and achievable in a given time frame.

Despite its critical importance, environmental concerns as well as sustainability practices, at times, fail to make it to the centrestage of the decision-making process or to the boardroom discussions. Not that we are unaware of the increasing environmental challenges or the likely consequences these issues will invite, but we are too lazy to mend our ways and amend necessary changes.

The reality is, mainstreaming helps achieve a sustained development and to sustain this, we need collective action—people-led and people-centric efforts to secure our future progenies.

Give an example of how you have integrated sustainable development/ climate resilience in your sphere of action/work/decision-making.

At the Foundation, it has been a conscious decision to narrow down our focus around climate action in order to build resilience at the ground level for communities to overcome the impacts of climate change in the most logical and sustainable way. It's been over 35 years since the concept of Sustainable Development emerged but the transformation is far from over. To create a long-lasting impact in an inclusive way, we have been practising a multi-stakeholder and participatory approach.

Our Foundation has been promoting and propagating low-carbon energy solutions for cooking and heating aimed at delivering multi-pronged benefits in an inclusive way. This collaborative programme offers skilling opportunities to marginalized youths/women to build local capacity on the development and deployment of local-carbon devices that allows carbon emission reduction by reduced transportation, enhanced fuel efficiency, and minimal consumption of fuelwood and other fossil fuels for cooking. This programme is able to open-up alternative and sustainable livelihood options, improve ambient air quality, ensure better health and generate carbon credit, while building climate resilience at the community level. This was possible by integrating an approach to sustainable development in the organizational policies and work by consciously focusing on local production of low-carbon devices instead of procuring readymade instruments manufactured in a far-away place.

What more can be done by policymakers for integrating and mainstreaming sustainable development across agencies and levels?

Despite being plagued by the prevailing challenges across social, economic and environmental fronts, India has demonstrated remarkable commitment towards the Sustainable Development Goals by steering transformation from within.

A complete transformation is only possible through integration and strict enforcement. The United Nations recognizes that policy integration in government is central to the sustainable development paradigm; bringing about the delivery of integrated policies is a daunting challenge, especially in developing countries where, for example, administrative silos are prevalent.

This is very much the case of India too, thus given the complexities of our problems and in absence of an ideal delivery mechanism, it is, therefore, vital to collaborate and engage with multiple stakeholders including the Civil Society sector to catalyse the appropriate transformation and ensure the last-mile delivery of benefits particularly to the unreached. An inclusive and sustainable approach to growth is an age-old practice in India, which has been able to make all the difference, however, the road to complete sustainable development is long and curvy, we still

have much to do and many more goals to achieve.

What more can be done by business and industry in terms of integrating and mainstreaming sustainable development?

Inclusivity is a key ingredient in ensuring effective environmental action. We must welcome and encourage the participation and active engagement of businesses in every step of the sustainable development narrative.

In the environment conservation sphere, for long, a divide has existed between polluters and non-polluters creating an exclusion. However, time demands that we break this shackle and encourage everyone to participate and contribute towards sustainable development and make them part of key environment and sustainability deliberations.

Corporate leaders have a huge influence within and outside their companies to inculcate fair business practice as well as environmental policies that are conducive for a sustainable future. They can achieve environmentally more by promoting integration and showing the way to the rest of the world while they hold their positions of authority in business rather than seating outside with no portfolio.

On the wake of a potential global slowdown, it is time for the industry world to tread its path carefully, else a recession paired with any environmental meltdown could be more disastrous than we have ever imagined. A class of environmentally conscious businesses is already emerging and is likely to be the torchbearer of industrial sustainable development that is thoughtful of the environmental and social needs.

What are your expectations from India's G20 Presidency?

Riding on the goodwill India has accrued in the recent past plus India's competency and youthful potential to deliver big results in the international arena, makes it all the more special for us as a country that took over the Presidency of G20 this year. Obviously, our expectations as well as the expectations of the rest of the world have only grown manifold and I am confident, India will be able to make a dent economically, environmentally as well intellectually as a moment of unprecedented opportunity has knocked on our door. India can now take lead on a number of policy discourse which will not only impact the G20 countries, perhaps the entire globe shattering the North–South Divide.

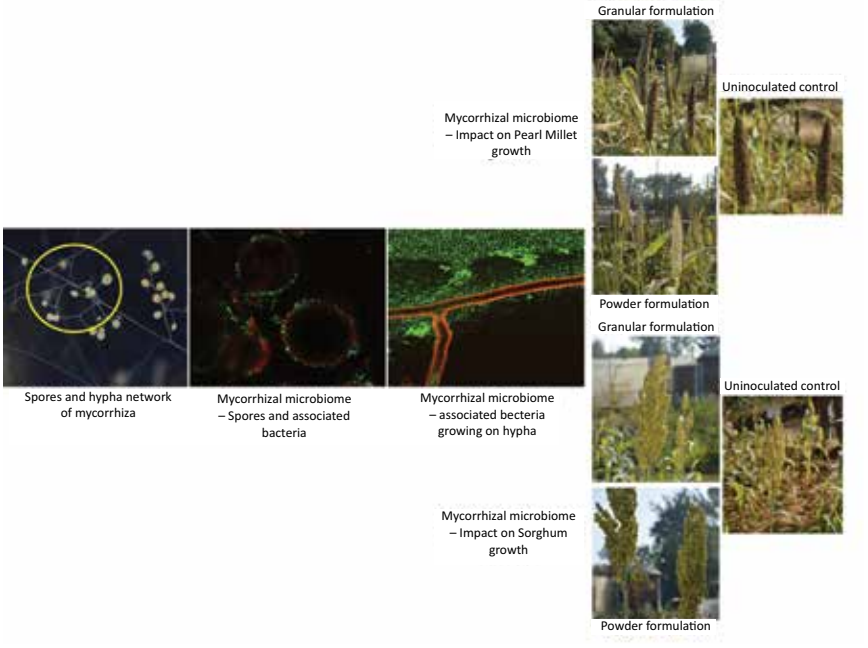
I have reasons to believe, as the new president of G20, India is better placed to negotiate and even influence the world order towards securing investments for the green shift, the world is craving for. By the precedence of India's fight against COVID-19 nationally as well as how it aided other vulnerable nations to face the pandemic through Vaccine Diplomacy, I am certain, it will work out an innovative mechanism to support countries outside the G20 network in areas of climate action and economic growth.■

Mycorrhiza and Bacteria-Enriched Microbiomes

For Invigorating Soil and Plant Health

In this article, **Dr Mandira Kochar** tells us about TERI's *in vitro* Mycorrhiza technology that has shown 30–50 per cent reduction in usage of chemical fertilizers in crops such as wheat and maize.

Mycorrhizae are beneficial soil fungi that establish a symbiotic association with host plant roots. In nature, they also associate with bacteria during different stages of their life cycle. Cross-kingdom associations formed between plant roots and mycorrhizae have been proficient in positively influencing plant growth as these associations are evolutionarily selected and maintained in nature, and are hence more powerful than introduced, non-native, combinations of biofertilizer bacterial strains. The Energy and Resources Institute's (TERI) *in vitro* Mycorrhiza technology has shown 30–50 per cent reduction in usage of chemical fertilizers in crops such as wheat and maize. The tiny mycorrhizae spores do not simply exist in soil, but they tirelessly work even in adverse environmental conditions to support plant growth and provide protection to their hosts from pathogens and parasites. Mycorrhizal microbiome contributes significantly to plant nutrition, particularly to the macronutrient, phosphorus uptake. They contribute to the selective absorption of immobile (P, Zn, and Cu) and mobile (S, Ca, K, Fe, Mn, Cl, Br, and N) elements to plants and water uptake through the network between mycorrhiza and its associated bacteria.



The impact of mycorrhizal microbiome on the growth of pearl millet and sorghum

The Mycorrhiza-based Biofertilizer Market is segmented by geography into North America, Europe, Asia-Pacific, South America, Middle East, and Africa. Each region is further sub-segmented into different countries. In India, commercial mycorrhiza-based biofertilizers are used in large-scale crop production where they have been shown to result in around 10–20 per cent yield increases with a 25–50 per cent reduction of fertilizer, considering India's low phosphorus soils. With the rising price of phosphate fertilizers and almost 50 per cent of Indian soils being phosphorous deficient, mycorrhiza can play a major role in sustainable farm

fertilization. Given the rising global demand for food and the current rate of soil nutrient extraction brought by increasing use and decreasing worldwide supply, there is a dire need for a sustainable alternative. Mycorrhizal microbiome that can greatly enhance nutrient uptake could thus be a very effective approach to overcome soil degradation and nutrient deficiency crisis. Governments are offering various schemes for encouraging the manufacturers of biofertilizers, besides several initiatives to include biofertilizers in farming practices and bring about a shift from conventional to organic farming practices. These are driving the usage of mycorrhiza-based biofertilizers. Increased food demand and the need for sustainable agricultural development, impressive efficacy in the growth of important crops are the factors driving the market. This, in turn, has led the mycorrhiza manufacturers to meet the demand-supply gap for these biofertilizers and related innovations.

The TERI Mycorrhiza Mass Production facility complies with the legal and regulatory requirements of FCO and has a production capacity of over 600 billion propagules/annum, expandable to 1000 billion propagules/annum. This can be translated to 16,000 tonnes/annum of the biofertilizer with a minimum capacity of 60 tonnes/day. The products developed at TERI are being commercialized through joint co-marketing agreements with leading Indian fertilizer companies. Apart from standard product supply, TERI is also actively engaged in developing new product formulation including the soil microbiome components and crop-specific mycorrhizal formulations for the Indian and foreign markets. Many of these formulations are also being tested in several countries which is likely to expand the Mycorrhiza Product Portfolio of TERI and contribute significantly to increasing agricultural productivity while rejuvenating our soils, thereby, achieving sustainability in agriculture. ■

Dr Mandira Kochar, Fellow and AC, Sustainable Agriculture Division, TERI, New Delhi.

"NRDC India Works at the Intersection of Public Health, Equity and Livelihoods to Address Climate Action"

Dipa Bagai is Country Head, NRDC India. In this interview, she says initiatives such as the Lifestyle for the Environment (LiFE) Campaign, launched by the Government of India is an excellent example of sustainable development making headway into the public conscience with the aim of promoting collective action. She also talks about Hariyali Gram, which is a women-led initiative with an emphasis on policy implementation and scalable business solutions for the adoption of climate and clean energy solutions at the village level. Keep reading to know more…

What to you is 'mainstreaming sustainable development'?

Mainstreaming sustainable development is a term that is more relevant than ever, with climate action solutions available and the need of the hour being investment for scaling. While the ecosystem to take forward sustainable development is in place, organizations need to be impact-driven and focus on making changes on the ground. We also need to see a more collaborative effort across the board to address and resolve the crucial issues around climate change. With India voicing concerns over the loss and damage being suffered inequitably by the poor and vulnerable nations, true sustainable development will be seen when we reach the most vulnerable and marginalized and make them central to climate investments.

According to you, what is the role of mainstreaming sustainable development in promoting collective actions?

Initiatives such as the Lifestyle for the Environment (LiFE) Campaign, launched by the Government of India is an excellent example of sustainable development making headway into the public conscience with the aim of promoting collective action. But as organizations, both in the public and private domain, work on the larger goals to combat climate change, we need to have the right conditions to make things sustainable. For instance, policy frameworks need to come into play at the State and National level where civil society organizations and state regulatory bodies have the autonomy they need to make the changes at the

ground level and create the impact we're all working towards.

Give an example of how you have integrated sustainable development/ climate resilience in your sphere of action/work/decision-making.
NRDC India works at the intersection of public health, equity and livelihoods when addressing climate action. This has played into the design of our work, an example being the 'Hariyali Gram' Initiative that we are implementing in partnership with the Self-Employed Women's Association (SEWA). Present in Gujarat, Rajasthan, and Maharashtra, Hariyali Gram is a women-led initiative with an emphasis on policy implementation and scalable business solutions for the adoption of climate and clean energy solutions at the village level.

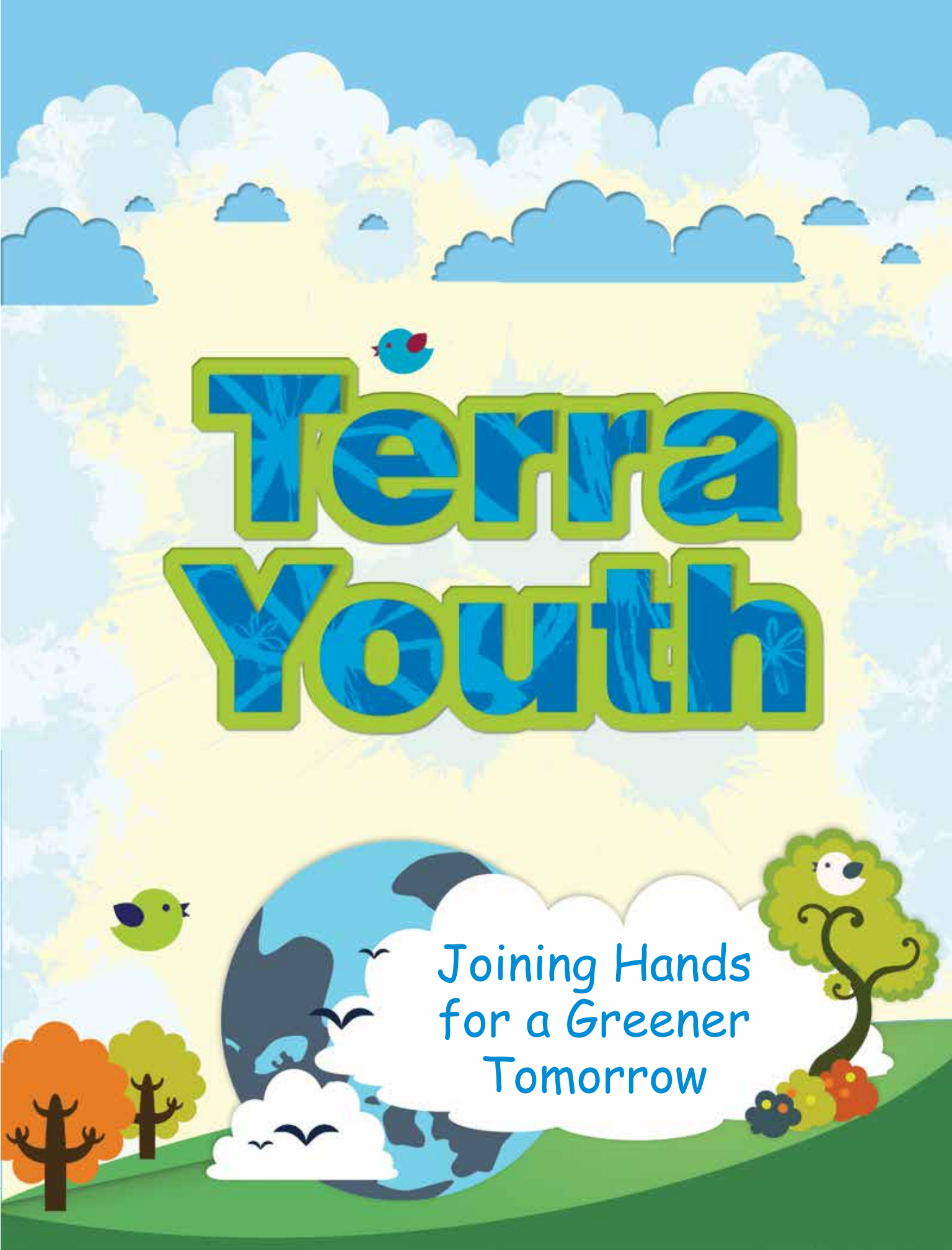
The initiative is proving to be transformative in improving livelihoods as it makes the adoption of clean energy an economic decision, giving longevity to sustainable development and climate resilience.

What more can be done by policymakers to integrate and mainstream sustainable development across agencies and across levels?
India has seen an increase in proposals by policymakers focusing on addressing mainstream sustainable development, be it the recent Energy Conservation (Amendment) Act of 2022, the India Cooling Action Plan, the National Clean Air Program, and the state-level Heat Action Plans. With the national initiatives in place, I see an opportunity for policymakers to integrate the findings of credible independent research being done by organizations working on climate solutions to ensure effective implementation.

For instance, NRDC worked on a multi-sector project that sought to estimate the air quality and health co-benefits of climate change mitigation and adaption in Ahmedabad by the year 2030. The study, done in collaboration with the Indian Institute of Public Health – Gandhinagar, Gujarat Energy Research and Management Institute and the Indian Institute of Tropical Meteorology, strengthens the understanding of health implications of policies in India that affect energy use and air quality. This report's findings on avoidable premature deaths from air quality improvements in Ahmedabad strengthens the health argument for scaling up local climate solutions across the country.

What more can be done by business & industry in terms of integrating and mainstreaming sustainable development?
Business and industry have a significant role to play in mainstreaming sustainable development. Take cooling for instance, where India's needs will be multifold in the coming decades. That, in turn, means increased energy requirements. To optimize energy use for India's cooling requirements, industry and businesses will play a key role vis-à-vis the adoption and advocacy for energy efficient and climate-friendly technologies that can be scaled for mass usage. To this effect, NRDC India is working on Cool Roofs, building energy codes, and developing a technology roadmap for efficient appliances to assess the future of cooling. The readiness of businesses and industry to adapt to these changes is the need of the hour. This will also undoubtedly contribute to India's net zero carbon emissions goals by 2070.

What is your message for the G20, for which presently India is holding the Presidency?
India seems to be on track to meet its revised climate commitments but getting to India's 2030 goals will not be easy and will require significant international collaboration and investment. India has voiced strong concerns over the loss and damage being suffered inequitably by the poor and vulnerable nations and has called for developed countries to provide financial assistance to address these. Resilience-building initiatives such as the city-wide Heat Action Plans to reduce heat stress, cool roofs to provide affordable thermal comfort, and women-led clean energy initiatives, such as the Hariyali Gram initiative, can make an impact. However, more investment is needed to implement these at scale. The G20 countries also need to look towards and possibly consider global adoption of the LiFE Campaign launched by the Indian government that calls for a sustainable, citizen-led, low-carbon approach.■


Terra Youth
Joining Hands for a Greener Tomorrow

Backing the Almost-Last Generation

Integrating Youth Engagement and Participation across the Developmental Agenda

In this insightful article, **Karishma Kaydan** and **Marije Broekhuijsen** say that India is the leader the world requires in positioning the youth as meaningful partners in future policies and programmes.

"With the global population now at eight billion and growing, action or inaction by the world's largest economies—the G20—will be critical to determine if everyone gets to live on a peaceful and healthy planet."

- UN Secretary-General António Guterres, Bali, Indonesia, November 2022

At the close of the G20 Summit in Indonesia last year, the group of 20 (G20) leaders issued a declaration in which they reaffirmed their commitment to cooperate in addressing serious global and economic challenges, including those related to food and energy security, climate change, biodiversity loss, the COVID-19 pandemic, and the digital transformation. The Summit was convened under the theme, 'Recover Together, Recover Stronger'.

In December 2022, India assumed the G20 presidency for the very first time, under the theme 'one earth, one family, one future'. India is a country that not only encapsulates 17.7 per cent of the world's population,[1] but has over 50 per cent of its population below the age of 25 and over 65 per cent below the age of 35.[2] As of 2020, with an average age of an Indian at 29 years,[3] India is the poster child for the last generation that will use fossil fuels—whether willingly or not.

With the enduring COVID-19 pandemic and the global slowdown in economic growth, the world has recently seen consecutive crises. In this context, youth—especially those most deprived—risk becoming the world's worst affected, with their futures most uncertain. UNICEF reports that, globally, approximately 1 billion children are at an 'extremely high risk' of the impacts of the climate crisis.[4] Some of these impacts include health crisis, displacement, migration, loss of education, psycho-social trauma, among others. In India itself, an estimated 24.1 million children are impacted by floods, cyclones, heat waves, and other emergencies every year.[5]

In a survey carried out by UNICEF across eight South Asian countries,[6] 69 per cent respondents reported being worried (either little or very) about the future effects of climate change. Seventy-eight per cent believed that climate change has had an effect on their studies. The impact of climate change on children and youth across the globe has made them more than willing to play an active role in tackling these interconnected challenges. In fact, with 42 per cent of the world's population under the age of 25,[7] youth are seeking equal stakeholdership and institutional avenues to forge inter-

[1] Details available at https://www.worldometers.info/world-population/india-population/#:~:text=India%202020%20population%20is%20estimated,of%20the%20total%20world%20population

[2] Details available at https://www.livemint.com/news/india/more-than-50-of-india-s-population-25-yrs-or-older-survey-11593793054491.html

[3] Details available at https://www.financialexpress.com/india-news/with-an-average-age-of-29-india-will-be-the-worlds-youngest-country-by-2020/603435/

[4] Details available at https://www.unicef.org/stories/impacts-climate-change-put-almost-every-child-risk

[5] Details available at https://www.unicef.org/media/131516/file/2023-HAC-India.pdf https:/www.un.org/en/climatechange/youth-in-action

[6] Details available at https://www.un.org/en/climatechange/youth-in-action

[7] Details available at https://blogs.worldbank.org/opendata/chart-how-worlds-youth-population-changing

Youth4Water youths voluntarily remove the plastic bottles, cans and solid waste from Chilka wetland while collecting them in a dry waste dustbin at Mangalajodi village at Khurdha district in Odisha, India, on May 16, 2022.
© UNICEF/UN0643376/Singh

generational solidarity and partnership in governance and decision making around issues that wield significant influence on their lives.

The G20 too takes cognizance of this. The Y20 is the official youth engagement group of the G20. Y20 encourages youth as future leaders to raise awareness of global issues, exchange ideas, argue, negotiate, and reach consensus, and is a mechanism that facilitates a set of consultative dialogues among youth representatives and leaders across G20 countries on key youth issues. These series of deliberations lead up to an international youth-led summit where consensus is built on a charter of policy recommendations, also known as the communiqué. This is released at the conclusion of the Y20 Summit and presented to world leaders as part of the official G20 summit.

An important theme of the Y20 engagement group this year pertains to climate change, environmental sustainability, and disaster risk reduction. Not only is the theme of critical importance to the youth and the entire planet, India's G20 presidency is the perfect time to integrate youth engagement and participation across the developmental agenda. India is emerging as the global leader in climate change and has been ranked amongst the top five best performing countries globally on climate change.[8] In the last decade, the role of the youth as change leaders in India has only accelerated.

From the Skill India Mission to the Fit India Movement to the Make in India campaign, India's flagship programmes are increasingly being formulated around youth participation and leadership. Programmes such as the Swachh Bharat Mission and the Jal Jeevan Mission—two of the world's largest WASH programmes—not only promote the youth but are actively aided by youth participation and volunteer activities. Youth groups from Nehru Yuva Kendras, volunteers from the National Service Scheme (NSS), and cadets from the National Cadet Corps (NCC) have been instrumental in generating unprecedented momentum in villages, undertaking tree plantation activities, spot cleanliness drives, cleanup of water bodies, and awareness generation around sanitation and hygiene.

Local youth groups such as Youth4Water in Odisha are taking collective action to help revive coastal

[8] Details available at PIB, 2022. https://www.pib.gov.in/PressReleasePage.aspx?PRID=1878023

towns reeling from climate change.[9] An exciting and ambitious campaign—Youth4Water—has led outreach to over 435,000 youths in awareness and action programmes around water, sanitation, hygiene and climate change, to enable youth action to contribute towards achieving water security and environmental sustainability. In Maharashtra, Maha Youth for Climate Action (MYCA) is a partnership between UNICEF, the Government and development partners to train youth advocates in planning, reporting and advocating for climate action. As part of the Local Conference of Youth (LCOY) India 2022, along with 110 national youth, 10 representatives from MYCA shared a statement to the COY17—the biggest and most substantial youth conference related to the multilateral UN climate processes—and later to the COP Presidency at COP27 in the form of a Global Youth Statement.

Recognizing that lifestyle has a big role in climate change, the 'LiFE' mission, i.e., Lifestyle for Environment Mission was recently launched by the Prime Minister of India. The Mission aims to influence and persuade individuals, communities, and organizations across the world to adopt an environment-conscious lifestyle. The vision of LiFE is a lifestyle that is in tune with our planet and does not harm it. As the leaders of tomorrow, the G20 nations' youth are best suited to lead the LiFE campaign and steer a global shift towards more sustainable lifestyles.

It is abundantly clear that the youth are not only victims of climate change, but they are valuable contributors to climate action. They are agents of change, entrepreneurs, innovators, and very clearly, leaders. With the G20 presidency, India is perfectly positioned to strengthen the cause for greater institutionalization of youth participation to enable collective action by the very generation who will reap the benefits. With greater commitments being made by India to realize a sustainable world and global economy,[10] it will be interesting to see how this significant opportunity for youth to become professionalized contributors to the ongoing 'green' recovery, plays out. ■

Karishma Kaydan, WASH Knowledge Management Consultant, UNICEF India and Marije Broekhuijsen, WASH, Climate and Environment Specialist, UNICEF India.

[9] Details available at https://www.rfi.fr/en/international/20221127-oung-indians-help-revive-coastal-towns-reeling-from-climate-change

[10] Details available at https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1847812

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Mycorrhiza News provides a forum for the dissemination of scientific information on mycorrhiza research and activities; publishes state-of-the-art papers from eminent scientists; notes on important breakthroughs; provides brief accounts of new approaches and techniques; publishes papers compiled from its RIZA database; provides information on forthcoming events on mycorrhiza and related subjects; lists important research references published during the quarter; and highlights the activities of the Centre for Mycorrhizal Culture Collection.

Editor: Dr. Mandira Kochar, TERI, New Delhi.
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TerraGreen

TerraGreen is India's most respected monthly magazine dedicated to informing and enlightening its readers on issues of environment, energy, and sustainable development. Launched in 2004, *TerraGreen* has made an indelible impression on the minds of readers, both in India and across the world. Today, it enjoys a readership of over 40,000 and a subscriber base of close to 10,000.

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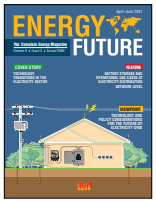

Energy Future

Energy Future draws from a deep well of expertise at TERI, India's leading research institute on energy and green growth. Knowledge of energy security and development is a critical requirement in the modern global economy, and Energy Future aims to educate and inform you about the wide world of energy; its history, its future, how the energy industry works, how it has affected the world, and how it continues to affect you and me.

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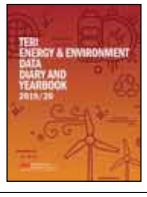

TERI Energy & Environment Data Diary and Yearbook

A TERI Publication

TERI Energy & Environment Data Diary and Yearbook, or *TEDDY*, is an annual publication brought out by TERI since 1986. *TEDDY* is often used as a reference in other peer-reviewed books and journals for energy and environment-related data. It gives an annual overview of the developments in the energy supplying and consuming sectors as well as the environment sector. It also provides a review of the government policies that have implications for these sectors of the Indian economy.

402 pages • Hardback • 220mm × 280mm • ₹1995/$129 (Online only)

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Human-Centred, Inclusive Digital Infrastructure

For Sustainable Entrepreneurship

In this incisive article, **Ashraf Nehal** highlights that at a pace and scale never before seen, data and digital technologies are revolutionizing our economies and societies. They could help accomplish the Sustainable Development Goals and the 2030 Agenda by fostering inclusive growth, addressing disparities, and modernizing the delivery of public services.

Digital technologies bring substantial productivity increases and boost access to essential services, potentially raising living standards as they widen access to global markets, foster network economies, and shorten distances at a reasonable cost. The development of digital technology presents the potential to open up fresh avenues for swift economic expansion, encourage economic mobility, foster innovation, generate jobs, and quicken equal access to high-quality public services. The current socioeconomic models are being disrupted by this, along with the convergence of various technologies and the emergence of global platforms. In the increasingly digital and data-driven economy, new rules are needed to foster trust, protect data and Intellectual Property Rights (IPRs), and ensure security along the entire value chain.

The global digital economy is anticipated to reach 25 per cent in less than ten years, exceeding the rise of the analogue economy, and was already worth USD 11.5 trillion in 2016—or 15.5 per cent of the world's GDP.[1] However, there is also a chance that digitalization

[1] Huawei and Oxford Economics (2017) Digital Spillover: Measuring the true impact of the Digital Economy. Website.

may exacerbate already-existing disparities, be abused to weaken social cohesiveness and democracy, and violate people's rights.

The Digital Economic Era has Begun

The technical landscape has dramatically changed over our lifetime. Faster, more potent, and more affordable digital technologies are combining in ever-innovative ways to maximize their potential. The virtuous loop of technological advancements has been a major driver of global economic growth during the last three decades, and its significance is increasing. The way we think, work, play, and communicate has all altered as a result. All facets of the economy are becoming more and more affected by digital technologies. Beyond the technology manufacturing industries, which were at the forefront of the initial wave of digital expansion, the digitization of business processes now affects a far broader portion of economic activity. The economic sectors that are typically regarded as being "least digital," such as mining, agriculture, construction, and utilities, are really among those where technology investment is rising at the quickest rate. The character of the digital economy is shifting as a result. A new era has begun, one in which firms operating in all economic sectors are increasingly reliant on digital technologies to fundamentally alter the way value is produced.

The landscape of the economy has changed due to digital technologies. Since IBM revealed the first random access computer storage system in the world in 1956, the business world has been pursuing digitalization with an irrepressible zeal. Information and communication technology (ICT) has developed over the past 60 years from processing information in a highly specialized and constrained way to becoming a multipurpose instrument that can be used for nearly any task.

Challenges

As a key engine of global growth, the digital economy is now firmly established. Digital investments are being pushed across established and developing countries and are generating returns. They are no longer limited to a select group of "high-tech" economies. Leaders and decision-makers are working to figure out how to effectively make use of the digital opportunity for the good of their citizens. They work to transform established economic systems and analogue firms into cogent, vibrant, and cutting-edge digital engines of future global growth.

Understanding what it is to live in a digital economy is a challenge. Although there are many official statistics and benchmark indicators, none of them fully reflect the influence of digital assets on enterprises. National statistics emphasize the size of a nation's technology manufacturing industry, but this says nothing about how the rest of the economy is being digitized. According

to surveys, consumers own the newest technology to a greater or lesser extent, but this may just be a thin digital facade over a mainly analogue economy.

All economic sectors, from agriculture to pharmaceuticals, must fully embrace digital manufacturing technology in order to increase economic performance. This digital economy's difficulties in being quantified needs to be reconsidered in order to show how the benefits of digital investments can extend from one business to the next, increasing their overall impact. By looking beyond the conventional metrics and offering new light on how to create future plans, it can do this by proving that the digital economy is wider and more pervasive than previously thought.

Eliminating the Digital Gap

When companies from all sectors of the economy invest in digital and utilize it to its fullest potential, the economy is said to be genuinely digital. The processes by which this occurs are intricate and dynamic. Beyond the immediate increase in productivity that digital technologies bring to businesses, a more extensive chain of indirect advantages also arises as a result of the impact on a company's internal operations, competitors, and supply chain. These "digital spillover" effects manifest through a variety of routes and are crucial to comprehending the economic role that digital technologies play.

Even while digitalization is spreading to every aspect of our economies and communities, not everyone in the globe has equal access to or usage of digital technologies. With a large majority residing in Least Developed nations, around 40 per cent of the global population is still unconnected. Along with those with disabilities, the elderly, the economically challenged, and immigrants, women and girls are among those most at the peril of exclusion.

Building links across science, technology, and innovation is made easier with the installation of critical supporting infrastructure. In Southern and Eastern Africa, the AfricaConnect project[2] has built a high-capacity internet infrastructure for research and education, opening up the area to international research collaboration.

Comparing digital economic measurements to traditional ones indicates a surprising disparity. The global digital economy is far greater than previously thought, with a value of USD 11.5 trillion. The countries that have made the most significant and prudent investments in digital assets, adopted digital services, and are now at the forefront of the global digital economy are those that are benefiting from the digital spillover effect. But there is still plenty at stake for the future of the global digital economy. In order to benefit from emerging digital technologies, nations will need to comprehend their potential during the coming ten years. The nations that are most adept at removing barriers to technology adoption, fostering an atmosphere that encourages investment, and welcoming participation and innovation will be those that set the global digital economy.■

[2] The AfricaConnect project intends to create high-capacity regional data networks for research and education across the entire continent of Africa as well as to increase the quantity and dependability of connectivity to the international research and education community.

Ashraf Nehal is a South Asia analyst and is currently pursuing his Master's from School of Oriental and African Studies (SOAS) University of London. He has been associated with TERI's youth initiatives for over four years now and has been recognized as a Youth Climate Leader by the Delegation of the European Union to India. Currently, he is working on the Climate footprints in the South Asia region and also tracking the geopolitical assessment of the same.

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POP Global Climate Crusade

Promoting Youth Leadership to Tackle Climate Change

"Given the slow pace of international negotiations and inadequate implementation of the Paris Agreement on climate change, it is essential that grassroots actions are stepped up to ensure timely and adequate action by society. In this regard, the youth of the world must take the lead, because it is their future which is at stake and more importantly their minds do not carry the inertia of adults."

- Dr Rajendra Kumar Pachauri, Founder and Chief Mentor, POP Movement

The POP (Protect Our Planet) Movement was founded on Earth Day in 2016, by Late Dr R K Pachauri, who believed that dealing with climate change requires youth-led actions, inspired by knowledge about the problem and its solutions. Over the last six years, the POP Movement has reached over 2.3 million youth in 127 countries, facilitated over 1000 capacity building and advocacy activities, showcased more than 200 youth-led projects and 10 country-based initiatives, and works with about 424 partners across the globe. With a mission to ultimately reach the

size, scale, and momentum to become a global movement, the POP Movement seeks to promote youth leadership to tackle climate change through unique and innovative technology-based solutions, community-driven regional projects, and advocacy.

Partnerships and meaningful collaborations—with world leaders, thought leaders, decision-makers, stakeholders, institutions, and organizations—have remained POP's cornerstone in its mission to promote youth-led climate action. In this regard, the POP Global Climate Crusade, launched in 2022, has been a global transgenerational effort to gather all actors, especially youth, to fight climate change through a series of joint strategies directed to create effective and self-sustaining initiatives that deliver positive social and environmental impacts.

On June 5, 2022, the POP Global Climate Crusade was kickstarted through the POP Africa Festival, a one-of-a-kind event that moved beyond traditional conference formats and focused on building ground-up action. Youth leaders from 22 African countries organized more than 100 activities related to climate change adaptation including 65 awareness/education campaigns, 20 tree plantation drives, 21 sanitation drives in garbage dump sites, waterways, streets, and educational institutions, 25 community dialogues, and more. Some examples include Aristide On-keba Yago Dering's football match with 30 men in his neighbourhood in Chad, Ngozi Osadebe's awareness sessions with children from a slum neighbourhood in Nigeria and sessions with librarians on making climate information available to the public, and Happy Mwebe's interactive sessions on agricultural knowledge and practices with traditional chiefs, faith leaders, and women farmers in Malawi, Kenya. Mobilizing such microcosmic grassroots interventions to create a groundswell movement of over 1000 people has been a success of the POP Africa Festival, with lessons that could be replicated in other regions through the POP Climate Crusade.

The POP Africa Fest ended with youth leaders presenting their work at the global level, receiving networking opportunities, and being considered for prestigious awards like the R K Pachauri Award for Youth-led Climate Action and the John "Mac" McQuown Award for Youth-led Climate Technology and Innovation.

The POP Africa Fest is the first evidential example of the impact of POP Climate Crusade. With lessons from this event, the POP Climate Crusade aims to undertake a tour of the world mobilizing and mentoring youth, promoting knowledge sharing, capacity building, networking, and stakeholder engagement, implementing a range of on-ground and multi-level activities—all through close and vital collaborations with local and international partners who share the common agenda. For a long-term and sustained impact, the POP Movement will collaborate with some identified projects, and will work to mentor and amplify them as POP initiatives with seed grants.

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The Greatest Teaching from the Pandemic

Hopeful Pessimism

In this thought-provoking article, **Ryan Pathak** says COVID-19 was an early indicator to a late problem that we had yet to fix. Hence, it is time for us to now devise and work harder to make sure we can counteract the current ecological crises.

Optimism is an important virtue of mankind. The quality to see the good in everything is one that inherently allows man to continue his goals despite the hurdles and turmoil in his path. However, it can sometimes be his greatest weakness as well.

Optimism limits us as individuals to only do what is satisfactory. It causes us to declare victory too early when work is yet to be complete and more importantly, it makes us indolent. Hence, the British Historian, David Olusoga once aptly noted "Whether we like it or not, there are moments in history when pessimism is the appropriate response." Pessimism in controlled amounts is a required strength to succeed. Pessimism can motivate us to actually go above and beyond what is necessary and with us inheriting the climate crisis of our forefathers; it is one we require appropriately.

The recent past years, had brought forth a time of sadness, misery and death to many lives. All brought forth by a single killer, that is, COVID-19. At the time of the pandemic and lockdown, life had been difficult, both livelihood and lives had been lost, and so had freedom. During this miserable time, the one piece of advice that had been given to us, from doctors to our designated representatives, remained: stay positive.

It was one, that was quite ordinary, but it gave great hope to the people. Our nation eventually adopted this maxim, and now we have returned from the brink, back into normalcy, maybe even stronger than before.

But now that the pandemic period, lies behind us, it is our duty with fresh eyes and proper analysis to actually look back and see the truths that may have been overlooked during this time. COVID-19, despite its disastrous wake, has often been cited to be a major benefactor to reducing environmental pollution. However, while, this proposition is indeed true is case of air and water pollution, the truth is however, more complicated.

COVID-19 and the subsequent lockdown on activities had several pronounced effects on our environment. The restrictions led to effects such as a decline in fossil fuel consumption due to confinement, reduction in industrial activities and localized disposal of waste. These effects consequently led to domino impacts. This included increased air quality due to reduction in emission of substances including greenhouse gases (GHGs). Our national capital, Delhi, which often struggles with air pollution, recorded a reduction of around 70 per cent in NO_2 and $PM_{2.5}$ (fine particulate matter).

The Yamuna and Ganga rivers both experienced an improvement in water quality as a result of a decrease

in industrial waste, with the Ganga River demonstrating physicochemical characteristics that are within India's water standard quality range. There were also several nuanced impacts such as increase in vegetation as well as wildlife reaching a flourishing standpoint due to the lack of human interactions such as in the case of the endangered Olive Ridley sea turtle found in Odisha displaying increased eggs being laid.

But, the overlooked reality is that the domino effect had not been truly seen to the end and in the process, the negatives have been unintentionally discounted.

Firstly, there was an increased non-recyclable waste generation especially single-use plastics and equipment like needles and syringes, which due to restrictions were often improperly disposed. In Ahmedabad, there was found to be an increase in plastic waste from 550 kg/day to 1000 kg/day, around an 82 per cent increase.

There had also been amplified biomedical waste generation, which was further aggravated due to the conditions. These included waste such as polypropylene and Tyvek, which were used to make protective equipment during the pandemic. These chemicals often decompose to give dioxins, which are environmental pollutants.

Next, an increase in organic waste which could be attributed to the hoarding done by individuals and also due to the lack of transport networks during lockdown, leading to mass wastage of perishables was observed. Also, significantly, domestic wastewater production increased significantly. Moreover, the treatment of this wastewater was often incomplete before being released back into the water bodies for disposal. As a result, while the pandemic did have a notable short-term favourable influence on the environment, such as on air and water bodies, the truth is that there was also a negative impact, especially on the state of soil and wastewater generation.

This is a fact we must accept, so as to understand further on what needs to be done. A wise man once said that one should not count their chickens before they hatch and it is the same for our case. We must avoid becoming complacent and continue working on sustainability-based strategies to maintain the positive impacts and eliminate the negative impacts on the environment caused by the pandemic.

Some possible moves could include higher taxation and monitoring of GHG production by the government, increased treatment and reduction of industrial waste as well as proper

domestic waste disposal outlets for both solid waste and wastewater. There could also be strategies such as use of alternative cleaner energy sources to reduce emissions and also use of possible alternative cleaner materials in both biomedical and public field such as the usage of reusable masks.

The pandemic may have led us to make significant strides in reducing pollution, something that once would have seemed like an impossibility, but the downsides, remind us not to celebrate too early and pat ourselves behind our back. COVID-19 was an early indicator to a late problem that we had yet to fix. Hence, it is time for us to now devise and work harder especially those of us who are in the roles of researchers, policymakers or work in different scientific organizations to make sure we can counteract the ecological crises. We must look at the future as an uncertain domain with a sort of "hopeful pessimism" which sees the situation as problematic but also as one that could be fixed if each one of us decides to pitch in and work together. ■

Ryan Pathak is a student of St. Joseph's College (Autonomous), Bengaluru. He is currently in 3rd year and pursuing a BSc degree in CBBT (Chemistry, Botany, Biotechnology).

Cool The Globe

An App for Climate Action

In this awe-inspiring article, **Prachi Shevgaonkar** tells us about her inspirational story on what prompted her to build Cool The Globe app for climate action. She built this app to help citizens and organizations reduce their personal carbon footprint to a target. Using the app, she and her team are gamifying sustainability for individuals and communities.

When I was a young student, I learned about climate change and the role I was playing in it.

One day, I went to my father and asked him—*"What can an ordinary girl like me do about a big problem like climate change?"*

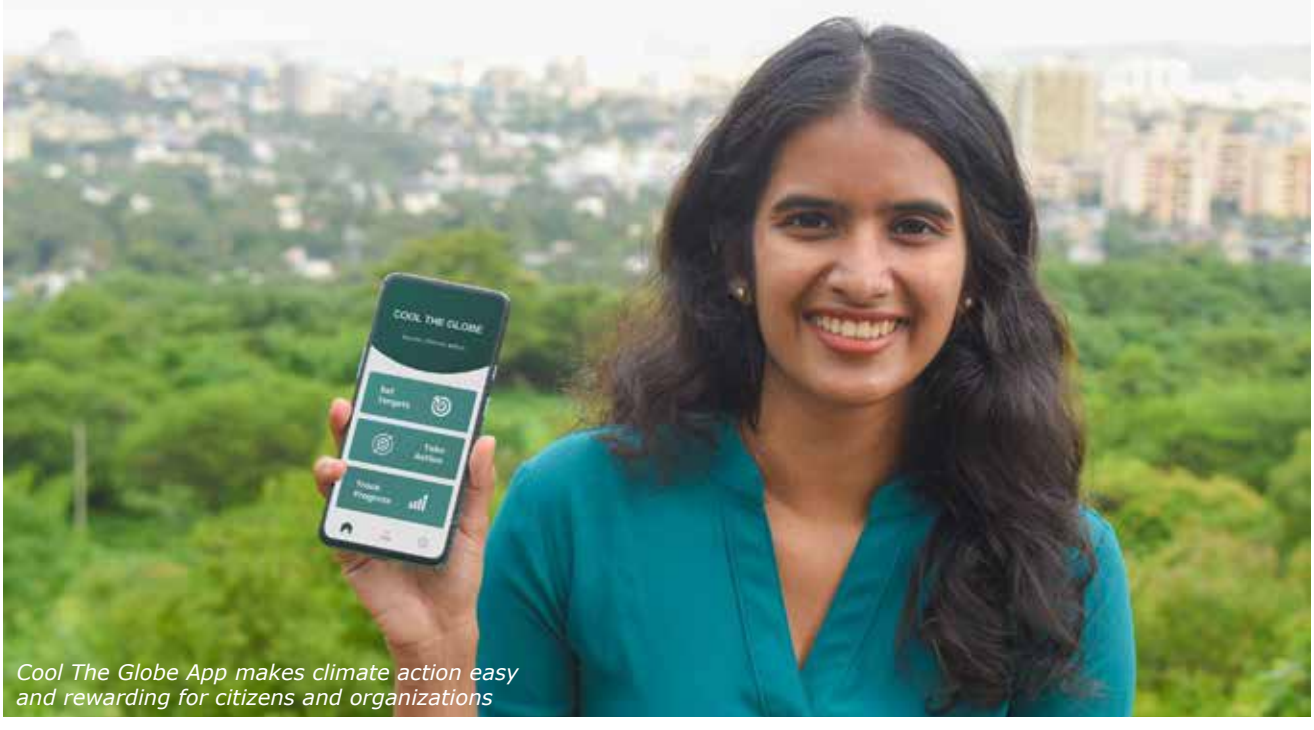
We decided to start from our own home.

We took up a simple quest, to start making small lifestyle changes to reduce our personal greenhouse gas (GHG) emissions by 10 per cent every year. As we started doing that, something surprising happened.

I began to enjoy it. It almost became like a fun activity that I was doing with my family. It felt good, that at least at my own level I was doing something. My friends, neighbours, and people around me started to take notice. They would come to me and say,

"You are doing something interesting, and we would like to join you in this quest."

So we began thinking—*"How can we take global citizens to start making these sustainable lifestyle changes with us?"*



Cool The Globe App makes climate action easy and rewarding for citizens and organizations

Prachi receiving Changemaker of the year award for Cool The Globe App

From this was born an app for climate action—Cool The Globe. We built this app to help citizens and organizations reduce their personal carbon footprint to a target. Using the app, we are gamifying sustainability for individuals and communities.

In the App, users can record from 100+ simple day-to-day climate actions, and track the emissions they saved with each action.

When Global Citizens come together, miracles can happen! To show this power of collective action, Cool The Globe app shows in real time, the emissions avoided by all users combined. I began this journey with a simple question—What can I do about climate change?

Today, Cool The Globe campaigns have reached over 4 million citizens from around the world. 35,000 users from 110 countries came together on Cool The Globe App to save 2.5 million kg GHG emissions. This year, Google India made a campaign inspired by Cool The Globe App that ran on nationwide television.

Cool The Globe is growing into a global movement as well as an enterprise with a vision to help organizations integrate sustainability and create real time meters to measure their avoided GHG emissions.

Advisors, organizational partners, citizens, and youth advocates from around the world have joined our mission. But, this is only the beginning. We invite you to become a part of Cool The Globe by signing up as app users, organizations, mentors, advisors, and citizen advocates. Together, we can make a difference! ■

Get in Touch: Prachi Shevgaonkar, Founder, Cool The Globe: prachi@cooltheglobe.org, Website: cooltheglobe.org

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TerraGreen (WSDS 2023 Special Issue)

The Twenty Second Edition of the annual flagship event of The Energy and Resources Institute (TERI), the World Sustainable Development Summit (WSDS), was held from 22-24 February 2023 in New Delhi. The Summit deliberations focused on the umbrella theme: Mainstreaming Sustainable Development and Climate Resilience for Collective Action.

The world is approaching the crucial midpoint of the 2030 Agenda and the sustainable development goals. It has been more than 50 years since the 1972 Stockholm Conference. Since then, the world has made many strides in bringing to the forefront the issues related to the environment, biodiversity loss, climate change, and has achieved many milestones in integrating sustainable development into the public, private and societal discourses. But we still have a long way to go especially in terms of horizontal and vertical integration of sustainable development in spheres of policy and practice. This WSDS special edition of TerraGreen covers a wide range of contributions on adaptation, livelihood, finance, India's G20 presidency, climate change, innovation, and technology.

WSDS 2023 was supported by the Ministry of Environment, Forest and Climate Change [Nodal Ministry] in partnership with the Royal Norwegian Embassy [Country Partner], Bloomberg Philanthropies [Star Partner], Bill and Melinda Gates Foundation [Star Partner], Rockefeller Foundation [Premier Partner], German Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection and the International Climate Initiative [Senior Partner], European Union [Senior Partner],World Bank [Senior Partner], Tata Capital [Associate Partner], TERI School of Advanced Studies [Associate Partner], International Energy Agency [Associate Partner], Carnegie Climate Governance Initiative [Co-associate Partner], Johnson Controls International [Co-associate Partner], Capgemini [Co-associate Partner], and McKinsey [Co-associate Partner].

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