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IIC WINTER 2019 SPRING 2020
Quarterly

India International Centre

REGISTERED WITH THE REGISTRAR OF NEWSPAPERS OF INDIA UNDER R N 26757/74

Weather Report
THE CRISIS OF CLIMATE CHANGE

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ISSN NO. 0376-9771

Winter 2019–Spring 2020
Volume 46, Numbers 3 & 4

India International Centre Quarterly is printed and published by Kanwal Wali for India International Centre, 40, Max Mueller Marg, New Delhi 110 003

Price: ₹ 250

Annual Rate
IIC MEMBERS
India: ₹ 350; Abroad: $ 35 (by airmail)
NON-MEMBERS
India: ₹ 500; Abroad: $ 45 (by airmail)
INSTITUTIONS
India: ₹ 750; Abroad: $ 55 (by airmail)

BANK CHARGES for Outstation Cheques: ₹ 50 / $ 15

Payments should be made by money order or bank draft or cheque payable to **INDIA INTERNATIONAL CENTRE** at New Delhi

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WeatherReport

THE CRISIS OF CLIMATE CHANGE

EDITED BY

RAVI AGARWAL
OMITA GOYAL

India International Centre
IIC WINTER 2019 SPRING 2020
Quarterly
ISSN NO. 0376-9771

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VOLUME 46 NUMBERS 3 & 4
WINTER 2019–SPRING 2020

EDITORIAL

Climate change is a natural phenomenon and would probably have progressed at a gentle, safe pace had it not been for the intervention of humankind. Humans accelerated the pace of climate change over the past few centuries as a result of industrialistion, new forms of agriculture, the pursuit of wealth and leisure—'development', in other words.

The phenomenon of climate change has been studied for a long time. In fact the term 'greenhouse effect' was coined in the early 1800s. From the mid-1950s when detrimental effects of human activity on climate and the increased pace of climate change became obvious, there have been countless global conventions, protocols, and environment conferences to discuss and arrive at policies to check climate change and mitigate the damage already done. Scientific and social research provide clear proof of the deleterious effects of accelerating climate change on life as we know it today. Increasing temperatures, environmental pollution, vast swathes of agricultural land turning into desert, rapidly disappearing glaciers and Arctic ice, declining populations of wildlife from large animals to insects to name a few. Some argue that a new geological epoch—the Anthropocene—has already commenced.

Yet we continue to debate and argue and allow political and policy considerations to win the discussion and ensure there is no decisive progress on halting, or at least mitigating, human-driven climate change. The most recent talks on climate change (COP–25) in Madrid in December 2019 ended after two weeks of deliberations with no outcome. COP–26, when the COVID–19 pandemic permits it to be held, is not likely to be much different.

The past few weeks have turned the world on its head. As I write this editorial about five weeks into the 'lockdown' in India—an attempt to manage the COVID–19 pandemic, the world has changed dramatically. The tremendous economic fallout of the world's efforts to contain the pandemic and reduce its toll on human life and health may well cause a global recession and have long lasting effects on

jobs and livelihood. Industries, agriculture, trade, social interaction, travel and tourism to name a few are in free-fall.

It is, however, ironic that these restrictions on human activity have drastically reduced carbon emissions, industrial pollutants, waste, vehicular traffic and so much more we have believed integral to our lives and lifestyles. As a result, the skies are blue, lakes, rivers and other water bodies are clear, one can hear the sound of birds even in urban areas, roadside trees are green and not covered in a layer of grime. It cannot continue for long because the economy has to be revived, joblessness needs urgent attention, salaries for those fortunate to be employed must be assured, peoples' savings protected, production restarted and so much more. We have had a brief glimpse of what we have done to our environment and climate. Can we learn long-term lessons and work towards a more sustainable, equitable and responsible lifestyle? Is there a possibility that there will be some positive outcomes? Will we pause and consider the state of the world we inhabit and take steps to secure it for further generations?

This special issue draws attention to and discusses many of the debates on environmental and climate change—several that been brought into focus by recent events. Large scale, input heavy, single-species agriculture versus smaller, species-diverse agriculture that is less dependent on fertilisers and pesticides; environmental regulations for industry; the state of our rivers; plant and animal habitats; encroachment of coastlines; energy efficiency. These and many more debates are covered in this issue. I hope you enjoy reading it and if it sparks some debate, that much better.

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OMITA GOYAL

FOREWORD

I had the privilege of attending the first United Nations Conference on the Human Environment held in Stockholm in 1972, which is from where the world started focusing on the crucial relationship between humanity and the planet that we inhabit. I was a member of the Indian delegation led by Prime Minister Indira Gandhi, while the Swedish delegation was led by its Prime Minister, Olaf Palme. Tragically enough, both were assassinated some years later. The Stockholm Conference was in fact the first organised attempt by the UN to promote the study of the human environment. Indira Gandhi made a significant speech which was widely appreciated. In fact, behind the scenes I was urging that the proposed United Nations Environmental Programme (UNEP) should be located in India in view of our unique human environment, stretching thousands of kilometres from the great Himalayas in the north right down to Kanyakumari where three great oceans meet and mingle. As it turned out, the move was not successful and UNEP was located in Nairobi. Kenya is indeed a beautiful country that I have visited more than once, but I do not think it had the necessary infrastructure to really do justice to this new initiative.

At the Stockholm meeting only two heads of government were present, but over the decades in subsequent meetings such as the one in Rio 20 years later, over a hundred heads of states and government attended. This shows the manner in which environmental factors have moved from the periphery to the centre of the world's attention. This also highlights the horrific devastation that our race has inflicted upon the planet. After numerous conferences and consultations, the Paris Agreement was finally signed in 2016. It is indeed a tragedy that the world's most populous and most polluting nation decided to pull out of this Agreement.

Over the last century millions of insect, plant and animal species have become extinct, huge areas have been deforested, thus losing the true cover so essential for the health of the planet. We

have even succeeded in polluting the oceans that are steadily rising as a result of enhanced glacial melting due to global warming which will wipe out several coastal habitations quite soon. The air that we breathe has been polluted by our unsustainable lifestyle. In Delhi, for example, it was difficult to breathe at the height of the pollution earlier this year. It is indeed ironic that it has required a global pandemic for us to see blue skies again in our great capital, and even some stars at night, and lots of lovely butterflies.

Every religious and cultural tradition in the world contains significant environmental values. In Hinduism, for example, we have the magnificent *Bhumi Suktam* 'Hymn to the Earth', whose 63 verses contain the most holistic statement of environmental values to be found anywhere in the world. This is based on the realisation that human beings themselves are a product of the earth and it is their duty to protect and cherish it. We have done precisely the reverse, as a result of which environmental disasters, including climate change, are upon us and will soon engulf several island nations. It is now quite clear that unless we substantially modify our lifestyles, our production mechanisms and our consumption patterns, we are hurtling towards a major disaster in the next few decades. This process has to involve not only state governments but the intellectual and academic communities around the world, particularly the young who have the greatest stake in the future.

Climate change is adversely affecting all aspects of our life including our health, our livelihoods and our very existence. The terrible global pandemic which has encircled the world in a way flows from the consistent aberration in our unsustainably high protein diet, which leads to the consumption of lethal animals and reptiles, and cannot be de-linked from our general distortion of environmental values. This is a grim warning, and if we do not take heed there may be even worse to come.

This special and very timely issue of the *IIC Quarterly* deals with the crisis of climate change from several different perspectives. A spectrum of distinguished intellectuals and experts have presented various aspects of climate change and have explored what can be done to halt or even reverse the process. This issue will thus be of considerable value not only to members of the IIC but to the broader interested public in India and around the world.

KARAN SINGH

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INTRODUCTION

RAVI AGARWAL

During my many visits (2013–2017) to a fishing village in Tamil Nadu off the Bay of Bengal, I witnessed the coast change. Each year the tide became more unpredictable, coming in further till it lapped at the edges of fishing huts, carrying away more of the sandy beach with it, even as storms became more frequent and intense. The landing beach was the fishers' lifeline, a place to launch and park their boats—without it fishing was not possible. The fish catch near the coastline was dropping, and the smaller fishermen who went out in their paddle-driven boats came back with increasingly meagre catches. The young did not want to fish anymore, instead opting to learn other vocations, while those who were too old to fish spent their time reminiscing about their forefathers who had seen different times. The sea gods they prayed to every morning had evidently turned their backs on them.

The term climate change was unknown, or not understood, or that the changes being seen could be caused by conditions far beyond their control. It was as if everything was slowly, but surely, changing. Not only this community, but those like them around the globe would be the first victims of sea level rise. Their lives were so entangled with the sea that the impact would be catastrophic to their very way of life. On the other hand, perhaps in such entanglements could lie hidden secrets of other ways of being and re-learning how to coexist with the planet.

The uncertainty of knowing the manner in which the impacts of climate change would be visible, or even their unpredictability, has left a large gap in our comprehension of the crisis. Even so, the term 'Climate Change' has acquired widespread global urgency.

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It has become a marker of the planetary crisis caused by greenhouse gases (GHG), resulting in global warming. The change in climatic systems has been induced by anthropogenic emissions in the atmosphere, largely owing to fossil fuel-based energy use. It has led to severe environmental decline, raising fears of catastrophic consequences, and calls into question the fossil fuel-based economic growth model.

Initial efforts to comprehend the effects of climate change focused on determining the extent to which human activities have triggered this crisis. Future climatic scenarios were modelled to suggest mitigation and adaptation measures, and hold responsible the largest emitters of such gases through global UN-based mechanisms. However, despite unfavourable scenarios predicted by the Intergovernmental Panel on Climate Change (IPCC), countries expressed unwillingness or an inability to bear the cost of achieving mandated GHG emission targets. The issue of bearing the cost and responsibility for legacy emissions by developed nations proved sticky. The Paris Conference of Parties (COP–21) of the United Nations Framework Convention on Climate Change (UNFCCC) attempted to overcome the impasse by changing the approach to one that was more ground-up inclusive and state-centric, through instruments such as nationally determined emission contributions (NDCs). Yet those efforts have not been very successful thus far, as greenhouse gases continue to rise. Some say it may already be too late. Alongside, the idea of the Anthropocene has come into play.

'Anthropocene' is a term for this era, where human activity will determine the future of the planet. It calls for an urgent response as well, but also shows a deeper malaise. Other terms have been coined to capture this era, such as the Capitalocene, or the Chthulucene, etc., depending on the perspectives through which the evidence is viewed. They all point to a much broader condition in which climate change occurs. The 'crisis' is multi-dimensional and questions the very foundations of modern life, which has been based on using nature as a 'resource', instead of an ecosystem in which human life exists.

The recognition that man has been able to modify climate systems (and, as a consequence, ecosystems) opens up such broader questions as: What are the barriers to adopting other trajectories; or, are we able to fully comprehend or deal with the problem from

within our current social and political paradigms, or are larger shifts called for? For example, although we have recognised that the effects of climate change are not the same in different parts of the world, we are not able to fully predict them. In particular, we do not know the impacts on the most vulnerable populations on the planet.

Political, economic and social factors determine the magnitude of the impacts. There is a palpable difference between rich and poor countries in their ability to cope with the impacts of climate change. While rich countries have more financial and organisational capabilities for mitigation, poorer countries face serious difficulties in containing the negative effects. Such effects also generate social problems as they impose changes in modes of life at a greater speed than the current capacity to react to them. The more distant populations are from the centres of economic and political activities (thus closer to rural risk areas), the greater is their risk for survival. Climate change could be gradual and appear counterintuitive, yet visible in diverse ways if one knows how to look. The larger, looming questions of a greater ecological crisis rooted in inequities of social and political power structures ought to be reflected upon, besides deeper issues relating to science and society.

The otherness of vulnerable populations should be particularly considered in India. Indeed, India's vast geographical size, huge population and cultural diversity require a differentiated response to climate change impacts. As a consequence of rapid economic development, India is rising on the list of future contributors to GHG emissions. In fact, the country's economic and political security is dependent on factors which global warming will impact. These include vulnerabilities owing to the dependence on the monsoon for agriculture, rapid urbanisation, severe demands on water, contestations of forest areas and wildlife with human habitation, changing river flows, large coastal populations and susceptibilities to new vector diseases, etc. In addition, India is also home to deep cultural and philosophical values of living with nature, and conservation-oriented thinking and practices which can help lead towards different kinds of futures.

Another aspect of these vulnerabilities is through the widespread environmental changes predicted by the Anthropocene that are all not contained within the central climate change

discourse, and which is largely centred on the decarbonisation of economies. Habitat loss, loss of biodiversity, rapid extinction of non-human animals, excessive mining, marine plastics and other wastes, water scarcity, and an overall deterioration of ecosystems, etc., are some other vulnerabilities. The United Nations recently published a report on the global decline of nature, with unprecedented rates in human history, causing an accelerated extinction of animal species.

The questions are not only about the scientific facts of climate change, but also of their communication. Possibly, the problem lies in the exclusive nature of how science is itself produced. Science has developed into a system represented by 'experts', ratified by others, and bound by specific disciplinary and methodological boundaries. Recognising other disciplines (multi-disciplinarity), or carrying out research of the same object of study from different perspectives (pluri-disciplinarity) is insufficient. Instead, a common objective must be established, and efforts made to transfer methods and epistemological contributions from one discipline to another. Such a dialogue is the aim of interdisciplinarity. For example, the impact of the changes in the coastal landscape referred to earlier will have very different readings when carried out by, say, a physicist, a marine biologist, an anthropologist or a cultural theorist. However, as a 'lived' landscape, it is enmeshed with culture, nature and societal perspectives—all together. Further, what is often not considered are ways of knowing and observing nature, as part of people's experiences or their ways of relating to the landscape. The question that arises is whether climate science can be produced in association with such other ways of knowing and experiencing. By doing so, will not the issue of communication of the crisis not be 'after the fact', but during the very production of science? Thus, the climate crisis provides an opportunity to reconsider more fundamental questions of knowledge production.

This volume seeks to not only outline the specific conditions and responses to climate change in India, but also takes an unusual ground-up approach of including the voices of those who are researching landscapes and observing changes in them, across disciplines and practices. The wide range of contributions in this volume are testimony to this. From a policy perspective, Navroz K. Dubash and Lavanya Rajamani suggest a rethinking of India's approach to climate change from a diplomatic issue to a

developmental challenge by strengthening institutional structures and internalising climate change considerations as a departure from past approaches, especially since India is facing huge consequences and impacts as a result of climate change. Sagar Dhara brings in a South Asia perspective on India's vulnerability, despite it having historically low emissions per capita. The contentious issue of land is dealt with by Wischnewski, et al., who encourage India to take a global lead in creating an enabling environment by taking concrete actions on land tenure and gender mainstreaming.

One of the key shifts India will have to make is in the energy sector. Kaveri K. Iychettira highlights the electricity sector to outline its bottlenecks. In a scenario where dependence on coal is established, the inability to absorb the variability of renewable energy could be a problem in meeting stated targets. India is very vulnerable in the health sector and the impact climate change will have on it. Soumya Swaminathan and Poornima Prabhakaran point towards the multiple ways in which Indian populations are at risk—especially vulnerable groups—from vector-based diseases, impacts of heat and cold waves, nutritional status, etc., and suggest ways for its mitigation. K. J. Joy and Veena Srinivasan analyse the impacts of climate change on freshwater resources, while Ghazala Shahabuddin discusses the importance of forest conservation and regeneration. Janki Andharia draws linkages between climate change and extreme weather events, which are increasing in frequency, and argues for risk informed planning. Suman Sahai examines the impacts on another key sector—agriculture—across different types of ecosystems, as well as on fisheries, and suggests ways to adapt. Srinivasaiah, et al., discuss the adaptations in elephant behaviour as a result of landscape changes and the importance of factoring in climate change in animal management strategies, which is currently lacking. Madhuri Ramesh puts the lens on India's coastline and the lack of emphasis on this critical and populated landscape. The normally overlooked area of national security from a climate change perspective is brought in by Uttam Kumar Sinha. Nitya Rao calls for recognising the complex power and privilege structures in which gender, caste and race are located, and the differential impacts of climate change. She argues for creating 'longer-term enabling environments for innovative and creative adaptations to climate change' on the ground. Urban environments are being inundated

with plastics, an outcome of the fossil fuel-based petrochemicals sector, and Aravindhan Nagarajan lays this problem threadbare.

This volume attempts to include another, and unusual, spectrum of responses which are often left out in science and policy circles—these include holistic or alternate, literary and the arts, and grassroots movements' perspectives. Soumya Dutta lays out the concern and topography of the climate justice movement. The poet Nitoo Das brings in the question, 'What is the future of language, poetry, story-telling in the Anthropocene?' As a dancer, Navtej Johar questions the very categorisation of 'ecology' and proposes a 'visceral variety of performance' as a reconstitutive idea of nature. Bharat Dogra speaks of a more holistic approach to climate change. Locating her research in the Inupiaq Natives—the indigenous people of the far Artic—and those of Jharkhand in India, Vandana Singh states that the system is poorly equipped to engage with a problem as vast and complex as climate change, and lays out the challenges of adopting 'a cross-curricular transdisciplinary model of pedagogy, where educators from different disciplines collaborate and would be far more effective and powerful'. Finally, Paulina Lopez and Ravi Agarwal draw out the difficulties as well as possibilities of implementing a Gandhian way of thinking in a global economy. As a visual contribution is included a portfolio by artist Ayeshe Sadr.

The remedy to climate change may need more than changing energy choices or technologies. It must include ethical responses, and a reconfiguration of ideas of justice which extend to animal species, gender, race, caste, and ways to recover the multiplicity of man–nature relationships from the current binary one.

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NEW IMPERATIVES FOR INTERNATIONAL AND DOMESTIC CLIMATE POLICY

Rethinking India's Approach

NAVROZ K. DUBASH

LAVANYA RAJAMANI

INTRODUCTION

India has traditionally approached climate change as a diplomatic issue, insisting that the developed world, because of its disproportionate role in causing the problem, should lead the way in reducing emissions, and provide finance and technology to the developing world. While this approach is justifiable, and has served India well in the past, there are compelling reasons for India to rethink its approach to international and domestic climate policy. First, climate change is likely to have profound and devastating impacts in India, impacts that will make the task of development and poverty eradication considerably harder. Second, there are several cost-effective actions that India can take that serve both its development as well as climate interests. Rethinking our approach would translate internationally into our joining—even leading—a 'coalition of the willing' in advocating for an ambitious and strong, rules-based global climate regime. It would translate domestically into a proactive exploration of lower-carbon opportunities for growth that foster development, while investing in climate adaptation and resilience. Rethinking our approach at the international and domestic levels will also require strong institutions for climate governance.

This paper, after a brief context-setting section, lays out elements of an approach to international and domestic climate policy we believe will better serve India in the long run.

CONTEXT

Climate change, often characterised as the 'defining issue of our age',

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is predicted to have profound 'impacts on natural and human systems on all continents and across the oceans' (IPCC, 2014: 6). These impacts are likely to cause devastation in India, a country with 7,500 km of coastline, extensive tracts of low-lying areas, high population density, poor infrastructure, and continued reliance on agriculture for livelihoods. With the 1°C warming that has already occurred since pre-industrial times, Himalayan glaciers have begun to retreat, and there has been a marked increase in the frequency and intensity of heatwaves,[1] droughts, extreme rainfall events (IPCC, 2018a: 263). If the world warms to between 2.6°C and 3.2°C, as the UN climate secretariat estimates it will, based on current country pledges, this will have serious, pervasive and irreversible consequences for India—not just in terms of impacts on peoples and ecosystems, but also on economic growth, livelihoods and well-being. Climate change is predicted, for instance, to reduce agricultural incomes by 15–25 per cent by the end of the century in India.[2]

INTERNATIONAL CLIMATE POLICY

India's position in the international climate negotiations is set within the larger geopolitical developments that must inform and influence not just India's position in climate negotiations, but India's broader foreign and energy policy. With the United States' retreat from the Paris Agreement, the Brazilian President Bolsonaro's equivocation on it, and the defeat of the Labour Party in Australia that had advocated strong climate measures, the momentum that led to the Paris Agreement has begun to dissipate. There is a leadership and imagination vacuum in global climate politics, which India could seek to fill.

For example, India could reach out to China, long its negotiating partner in retaining differentiated responsibility, to forge a mutually beneficial alliance on the global solar energy transition. India leads the International Solar Alliance and provides a substantial market, while China has technological leadership in solar panels and storage technologies. Both countries are involved in the Asia Infrastructure Investment Bank. As the Africa region develops its infrastructure, an India–China alliance could help provide a vision of and the technological and financial means for realising a low-carbon yet cost-effective future. In addition, and consistent with this approach, India could seek to realise its potential as a leader of vulnerable nations. Doing so would also be viewed

favourably in the South Asia region by vulnerable countries such as Bangladesh, Bhutan and Nepal. Notably, these measures allow India to be a climate leader even as it takes advantage of opportunities for economic and political gain; it does not require India to sacrifice economic gain and political position for climate policy.

Based on approaches such as these, India could join forces with others to form part of the 'coalition of the willing' in global climate politics. Such a coalition is a particular need at this juncture in the negotiations. With the conclusion of the Paris Rulebook negotiations in Katowice, Poland, in December 2018, the politically charged negotiations on obligations, rules and institutions are at an end, and the regime has shifted gears to the day-to-day business of implementation. The Paris Agreement builds on nationally determined contributions (or NDCs) from countries to reduce greenhouse gases, complemented by a normative expectation of progression and 'highest possible ambition' that calls for these contributions to be strengthened over time.[3] These terms—'progression' and 'highest possible ambition'—are not defined either in the Paris Agreement or its Rulebook. Further, while the Rulebook fleshes out informational requirements, and operationalises the enhanced transparency framework, global stock take, and implementation and compliance mechanism, it still preserves, of political necessity, considerable flexibility, autonomy and discretion for states, in particular in their near-absolute control over the content of their NDCs (Rajamani and Bodansky, 2019). States could choose to exploit this discretion and create a political and implementation drag in the process, or they could choose to progressively strengthen their NDCs, enhance the quality of the ex-ante and ex-post information they provide, and trigger a virtuous cycle of ever-ambitious actions necessary to meet the temperature goal of the Paris Agreement. The Chile Madrid Time for Action, agreed at Madrid—COP–25—highlights the 'urgent' need to address the 'significant gap' between the aggregate effect of countries' current NDCs and pathways to meet the Paris goals, and urges parties to reflect their 'highest possible ambition' in their NDCs due in March 2020. It is in India's interest to be part of the 'coalition of the willing' that seeks to progressively strengthen its NDC, and enhance its ability to meet the procedural requirements of the Paris Agreement and its Rulebook, as well as the substantive objective of the climate change regime.

Specifically, first, India should provide information on its NDC, set against the larger context of India's development aspirations and resource constraints.[4] This information should include the planning processes India has engaged in in reaching its NDC, which in turn should include meaningful stakeholder consultations, and attentiveness to the human rights impacts of climate change action, and inaction.

Second, India should clearly explain how its NDC is fair and ambitious, and the basis of its objective criteria and benchmarks. This approach would allow India to ask how these criteria and benchmarks could be applied to other countries' NDCs as well, turning its long emphasis on the principle of equity in climate change negotiations into a practical and applied measure. It is in providing robust information in the context of its NDC that such criteria and benchmarks that assess 'relative fair shares' could be introduced into the global assessment of progress.

Third, in relation to ex-post tracking of progress in implementing its NDC,[5] India should identify objective defensible indicators to assess its progress with its NDC, make proactive efforts to address capacity gaps in implementation and reporting, and gradually improve the quality, precision and detail of the information it provides. India's implementation should demonstrate a high degree of 'due diligence' (best possible efforts) in relation to meeting the objectives of its NDC.

Fourth, in relation to the Paris Agreement-mandated global stock-take process every five years,[6] India should work with negotiating partners like South Africa, and vulnerable nations, to ensure that the 'hooks' in the Paris Agreement and Rulebook on equity are duly exploited. India ought to submit its vision of equitable burden sharing, and 'relative fair shares', to enable a meaningful assessment, albeit collective, at the international level of progress towards the global temperature goal.

Finally, in relation to the rules on markets, that nations have twice—at COP–24 in Katowice, and COP–25 in Madrid—failed to reach agreement, India would be well advised to press for a system that preserves environmental integrity, protects against double counting and limits the carryover of Kyoto credits. A system that does not do this is likely to further weaken the ambition of current mitigation efforts, and be detrimental to India's long-term interests.

India's ability to take a leadership position in this 'coalition of the willing' will require a substantial scaling up of capacity and resources—human, financial, legal, research, institutional—India devotes to engaging in the international negotiations, and complementary back-channel processes.[7] India's delegations to the climate negotiations are considerably smaller than those of other nations of comparable size and stature. The composition of these delegations tends to favour bureaucrats rather than experts, and there are limited formal channels for national positions to be informed by outputs from the growing research community working in these areas in India. In rethinking our approach to climate policy, international and domestic, India must also rethink its engagement with experts, and the processes for doing so.

Ultimately, the effectiveness of the Paris Agreement, given its hybrid architecture, lies in the strength of the NDCs that parties submit. The strength of NDCs will in turn depend on international processes that can catalyse more ambitious domestic actions, as well as domestic political will and institutional capacity for formulating and delivering ambitious NDCs. It is to these domestic issues that we now turn.

DOMESTIC CLIMATE POLICY

As the reality of climate change looms, and its impacts become more real, India, as do other countries, increasingly needs to view climate change as a developmental challenge, and not merely as a diplomatic one. Simply put, climate change will make development outcomes more challenging. For example, global pressures to limit greenhouse gases and the emergence of new technologies will make it more complicated for India to power its industries and provide electricity to its citizens in conventional ways. Agriculture, on which a substantial portion of the population still depends for livelihoods, may be particularly hard hit. Cities and coastlines may be subject to disruptions from climate-related events. Water cycles may be disrupted, and the timing and availability of water through rainfall and in India's rivers may shift. And heatwaves and shifting disease vectors will complicate the problem of ensuring public health. Climate change is not an isolated challenge to be addressed in one part of government; it is a problem that requires the mainstreaming of climate considerations through all parts of the government's

decision-making apparatus.

As this discussion suggests, the institutional requirements of managing climate change are considerable. In the last few years, India has begun planning for climate change, including through a National Action Plan, eight national missions covering adaptation and mitigation, and 32 state action plans and greater investment in scientific infrastructure. Yet, a deeper dive into these efforts reveals that the research and analytical capacity in each of these areas is weak, coordination is limited, implementation is patchy across these efforts, and the strategic thinking for truly transformative approaches is lacking (Rattani, 2018; Dubash and Joseph, 2016; Chella Rajan and Byravan, 2012).

Building the Indian states' capacity to address the complex challenges of climate change is but in its infancy. India needs to go much further down this path, devising and implementing a robust institutional structure that can generate appropriate knowledge, design policy and infrastructure interventions, coordinate across sectoral line departments and scales of governance, ensure accountability for implementation, and provide an interface to business and civil society groups. Development remains India's number one priority. But development innocent of climate change is no longer possible. Addressing climate change adds to India's problem of developing adequate state capacity. A series of papers in an edited volume explores how India can truly internalise climate concerns in both its energy consumption and natural resource sectors so as to address climate mitigation and adaptation (Dubash, 2019).

MITIGATION

Climate change mitigation, or the limitation of greenhouse gas emissions, has always been tied to India's global negotiating stance. If wealthier countries, and not India, are largely responsible for the problem, why should India undertake costly mitigation actions? A decade ago, the National Action Plan on Climate Change proposed exploring actions that lead to both development and climate benefits. This principle of 'co-benefits' has since guided our actions, but actions that meet this principle have not been fully pursued and developed. Here, India's status as a late developer is an advantage: we have not, as yet, locked-in to energy production and

consumption patterns, and so can take advantage of new technology and knowledge to build a lower carbon development path.

India's cities provide a particularly good example (Khosla and Bhardwaj, 2018). India is rapidly urbanising, but much of urban India remains to be built. The next couple of decades afford an opportunity to build cities where transport needs (and hence emissions, but also congestion) are lower as a result of sensible planning that locates work and living spaces near each other; the travel needs that remain are met increasingly with high-quality public transport, and walking over private automobiles; new buildings are designed to need less cooling and heating through intelligent design; and planning processes for urban spaces are built around the multiple objectives that we seek to meet with cities—of livability, low congestion, efficient functioning and a small environmental footprint.

India's electricity system provides another instructive case (Sreenivas and Gambhir, 2019; Dubash, et al., 2018). Long ridden with problems of unreliability, poor service and loss-making, Indian electricity is likely to be shaken up by the recent steep decline in costs of renewable electricity to levels where it is competitive with coal power. The transition is likely to be turbulent, creating winners and losers. For example, industries may choose to shift to renewables, thereby increasing the financial burden on distribution companies. Coal mining regions may, over time, have to transition to other industries (Dubash, et al., 2019).

Notably, these changes are inevitable and are being driven by global technology trends, not by national climate policies alone. Recently, Tata Power became the most recent example of a company that is planning to pivot from coal to solar for economic reasons.[8] But planning for this future under the rubric of a transition to a low-carbon economy could help unlock possible synergies between green power, energy access and energy security. Alternatively, failure to plan for this transition may be costly, particularly for the poor. Moreover, the likelihood of green, yet competitive, electricity opens the door to electrifying other sectors, such as transportation and cooking. But the challenges involved in managing these transitions, in terms of hardware required, institutional rules, and making sure potential losers are not left behind, are substantial and require analysis and planning now.

India's cities and electricity sector are but two examples. Mitigation also encompasses transportation networks, including for freight, industries, agriculture, forest management and use, and food consumption patterns to name a few. For India, a consistent approach, built around understanding the synergies and trade-offs across multiple development objectives and climate mitigation, needs to become part of the policy framework across these sectors.

ADAPTATION

It is increasingly clear that despite our best efforts, countries collectively are unlikely to mitigate sufficiently to avoid at least some, and potentially significant, effects of climate change (IPCC, 2018b). India, even more than other nations, perhaps, has to pay greater attention to adaptation and resilience of our economy and society.

Doing so is as complex as reducing greenhouse gas emissions, and perhaps even more so. For example, adaptation in agriculture requires preparing India's agricultural systems for heat stress and unpredictable rainfall patterns against a backdrop of existing farmer distress, a creaky system of price stabilisation prone to rent-seeking, and decidedly inadequate insurance and risk-management mechanisms available to farmers. In this context, large existing entry points into and around food security and employment, such as the public distribution system and the Mahatma Gandhi National Rural Employment Guarantee programme, respectively, could usefully be rethought and repurposed from the perspective of providing climate resilience. In brief, the scale and scope of potential climate impacts requires 'mainstreaming' climate considerations systematically across development programmes, rather than an approach that rests on marginal additional Band-Aids.

In another example, India's long coastline is particularly vulnerable to climate impacts (Rohan, 2019). Climate change is likely to decrease the productivity of fisheries from changes in ocean temperature and acidity levels, already stressed by non-climate effects such as fertiliser run-off, with impacts on livelihoods of fisher communities. Because these effects are non-linear, beyond a point, coastal systems may be stressed beyond the point of recovery. In addition, extreme weather events and sea level rise are likely to reshape coastal zones, and increase risks and costs of inhabitation

on coasts. Addressing these challenges includes but goes beyond disaster preparedness. It requires, for example, coordinating the work of different departments, some of whom have a protective mandate, and others to maximise production—these need to be harmonised around coastal resilience.

Agriculture and coasts provide but two examples. The challenge is no less complex in urban areas, forests and water management. In all these areas, the challenges of mainstreaming climate change are simultaneously scientific, economic, social and institutional.

CONCLUSION

As the fingerprint of climate change grows ever clearer, it is becoming increasingly obvious that pursuing development without internalising climate change considerations risks ignoring a big piece of the puzzle. A central element of the new government's agenda must thus be to internalise and mainstream climate considerations.

Fortunately, in relation to international policy, addressing climate change can also bring economic and political gains. It can enable India to work its alliances to become a leader of an impending global clean energy transition. And it opens up possibilities for political leadership, notably of vulnerable nations.

Domestically, there is considerable work to be done. This involves re-thinking India's energy system in a world that prioritises clean energy, including tackling the thorny question of remaking India's problematic electricity distribution sector. To manage impacts on agriculture, coasts, cities, water and forests, India will need to invest in dedicated scientific and institutional capacity, and task them with addressing the challenge of energy access and management in an increasingly low-carbon world, and internalise the implications climate change holds for development.

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NOTES

1. In 2015, a heatwave in India killed more than 2,000 people. See Hallegatte, *et al*. (2017).
2. MoF (2018: 82).
3. Article 4 (3), UNFCCC, Paris Agreement (2015).
4. Article 4 (8), UNFCCC, Paris Agreement (2015).

5. Article 13, UNFCCC, Paris Agreement (2015).
6. Article 14, UNFCCC, Paris Agreement (2015).
7. For a full discussion of legal capacity constraints and its substantive effects on India's negotiating position, see Rajamani (2017).
8. PTI (2019).

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INDIA'S MOMENT TO LEAD THE WORLD TO SUSTAINABILITY IS HERE

WAGAKI WISCHNEWSKI
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In September 2019, over 6,000 participants drawn from the 196 countries that are Parties to the United Nations Convention to Combat Desertification (UNCCD) converged in Greater Noida, India, to agree on policies for making land and people part of the solution to environmental degradation. This was the fourteenth time the Parties to the Convention met as a Conference, thus called COP–14. The Conference agreed on 33 binding decisions[1] that will be implemented over the next two years.

Prime Minister Narendra Modi presided over the opening of the ministerial segment of the Conference, and announced India's voluntary commitment to restore and rehabilitate 5 million more hectares of degraded land. This voluntary initiative is part of India's global commitment, under Sustainable Development Goal (SDG)15, to achieve land degradation neutrality by 2030. With this additional commitment, India would recover and restore around 26 million hectares of degraded land by 2030.

This, and other important commitments, such as the New Delhi Declaration, are COP–14's main outcomes. The start of the Conference also marked the beginning of a two-year period during which India's Minister of Environment, Forests and Climate Change will serve as the President of the Convention's governing body—the Bureau of COP–14.

The actions that will take place in countries and across the global community, resulting from the work of Parties at COP–14, cover a wide range of issues related to desertification, land degradation and drought. What do these achievements really mean? Why are they a big deal for the international community? Why is India's leadership so vital at this time?

Winter 2019–Spring 2020, Volume 46, Numbers 3 & 4

This article provides the backdrop to and substance of the outcomes of COP–14, and why they matter for all governments, especially countries such as India with large rural populations and where droughts are increasingly recurrent, more widespread and getting severer. The article details some of the policies which prescribe action (known as decisions) that countries agreed to undertake, including new and emerging issues identified by scientists. These policies would both benefit India's future path to a green economy and development, and help move the world from the self-destructive growth path we have followed until now.

In this regard, the article explains the meaning of land degradation neutrality (LDN) and its potential for rapid transformative change. It explains the causes of land degradation, especially the place of unsustainable consumption and production. It shows India's critical position to lead global change, and the domestic benefits it stands to gain.

The end game of restoring degraded land globally is to achieve five strategic objectives over the next decade: (i) decrease the proportion of the poor located in the world's degraded or dryland areas; (ii) enable ecosystems affected by land degradation to recover; (iii) help communities in all regions affected by drought to become more resilient; (iv) work in partnership to achieve these goals; and (v) ensure the benefits from this global collaboration reach both local communities and those far away. The urgency of investing in the land is relevant in both developed and developing countries seeking to accelerate sustainable growth and development, particularly among rural populations that are feeling left behind, and thus agitating for positive and transformative change.

WHAT IS LAND DEGRADATION AND HOW CAN IT BE SOLVED?

In the language of the Convention, land refers to all the things found in a terrestrial bio-productive system, such as soil, vegetation and biological diversity. In any given location, the focus is on the two processes at work: the hydrological processes (rainfall, the climate, surface and groundwater flows, etc.); and the ecological processes, such as the vitality of plants and animals, and how they interact with their environment. Land degradation occurs when the natural capital of land (often defined as natural resources and their productivity)

declines significantly, impacting human well-being and ecosystem health. It is called desertification when the process occurs in the drylands: the arid, semi-arid and dry sub-humid areas of the world (other than the polar and subpolar regions).

In 2015, the international community adopted a global target on land restoration to be achieved by 2030. Its aim is to slow the pace of land degradation and, eventually, ensure that the amount of productive land available for future generations at least remains stable. Realising this target is known as achieving land degradation neutrality. It requires taking three concurrent actions: (i) avoiding further land degradation; (ii) reducing the pace of land degradation; and (iii) recovering land that is already degraded through restoration or rehabilitation. This was the commitment Prime Minister Modi made when he announced the restoration of around 26 million hectares of land.

But why would India be motivated to restore 26 million hectares of degraded land?

The Sustainable Development Goal target 15.3.1, calling on members states to achieve land degradation neutrality, was born of pragmatism and built on science—pragmatism, because of the growing competition for land to meet ever-growing needs, which makes it unrealistic to assume that land degradation can be halted altogether. Land degradation neutrality also takes into account that natural ecosystems are already significantly transformed, and restoring all degraded land or any land back to its original glory is virtually impossible. The failure to act and continue with a business-as-usual approach would lead to a transformation of up to 90 per cent of all land by 2050 (Scholes, et al., 2018).

What is possible is the prevention of further degradation of natural ecosystems. What is also possible is the reversal of the process of degradation where it is in progress. It is also possible to ensure that where degradation inevitably happens, it is compensated for by the restoration of already degraded land, ideally in the same ecosystem or landscape.

What LDN demands is a rational approach to how the land is used and managed. The approach promotes the idea of optimising land use: doing the right thing, in the right place, at the right scale. This pragmatic approach can ensure land degradation, at worst, does not increase, and, at best, declines. COP–14 agreed that 2015 would serve as the base year for assessing the future loss or recovery of productive land.

The approach to achieving LDN is built on science. The purpose was to ensure the anticipated benefits are robust and measurable. Therefore, achieving LDN is considered successful if there is a positive change in three areas: land cover, land productivity and the carbon content in the soil. An area that is successfully restored must register increases in all these aspects. But if change fails in just one aspect, LDN would not be achieved (Orr, et al., 2017), even if degraded land has been restored or rehabilitated.

Bringing the pragmatic and scientific approaches together provides a stronger assurance that a restoration activity improves ecosystem health and land productivity in a country. It also discourages land users, especially governments, from converting new land whenever a development activity is planned. Instead, priority is given to using land that was already converted to other uses.

Prime Minister Modi announced India's commitment to achieve LDN in September, and by mid-November 2019 at least 89 countries had set their targets—five more than had done so at the start of the Conference.

WHY DOES LAND DEGRADATION MATTER FOR INDIA?

India, the seventh largest country in the world, is a subcontinent covering nearly 329 million hectares of land. Just under 100 m ha of this land is now considered degraded, which means close to 30 per cent of India's productive land is in decline. But why does this matter?

As the Convention celebrates its 25th anniversary, it is arguable that we have learned more about desertification, land degradation and drought over the last three years than over the previous 22. The five major reports released recently have uncovered the extent to which we have transformed our planet, and the consequences on terrestrial systems and on half of the global population.

The assessments agree that between 70 and 75 per cent of the land surface has been transformed—mostly over the past 50 years—and that one in five hectares of what has been transformed is no longer productive.[2] More alarming is that the rates of both land transformation and land degradation will continue to accelerate if no deliberate interventions are made to reduce and reverse

land degradation. Land-use change, particularly the expansion of agriculture aimed at providing food for humans and feed for animals, is the primary driver of this transformation. As a result, one million of the eight million species on the planet face extinction as a consequence of changes in how we use both the land and sea.[3]

The biodiversity above and below the ground are both vital for the productivity and health of the land. Estimates suggest 'a single teaspoon of garden soil contains thousands of species, millions of individuals and a hundred meters of fungal networks'.[4] Yet, only 1 per cent of the micro-organisms in the soil had been identified as recently as a decade ago (Scholes, et al., 2018: 22). When this biological diversity below the ground is taken into account, the potential loss of biological diversity through land degradation may be much higher.

Land degradation also drives climate change. About 23 per cent of the greenhouse gases emitted into the atmosphere come from land-use change. This rises to 37 per cent when post-production of the global food system is included. Emissions from the global food system account for 16–27 per cent at the farm-level (the production side), and 5–10 per cent outside the farm gate. Emissions from agriculture are expected to grow because of population and income growth, as well as changes in consumption patterns.

Climate change poses major risks: from water scarcity in dryland areas, to soil erosion, vegetation loss, wildfire damage, permafrost degradation (in the Himalayas, for instance), decline in crop yields in the tropics and unstable food supply. For example, degraded land is incapable of holding very much water, yet the frequency and intensity of extreme rainfall events are projected to increase in many regions. Similarly, changes in forest cover will affect regional surface temperatures;[5] for example, negatively in the case of deforestation, and positively where afforestation and reforestation take place.

Climate change impacts the land in at least two significant ways. First, it destroys ecosystems. Climate change exacerbates land degradation through, for instance, flooding, drought frequency and severity. Second, these changes impact people negatively. As land degradation unfolds, its knock-on effects—increased exposure to poor health through dust and sand storms that originate from degraded land, chronic hunger, food crises, the loss of homes and

livelihoods, internal displacement or forced migration—become apparent. A survey of 1,000 people who left their homes in Africa's Sahel region for Morocco identified drought as one of the important reasons for migrating.[6]

The impacts of drought are particularly noteworthy because they are a growing concern in India. Climate change exacerbates drought and its impacts. Droughts are becoming more frequent, more widespread and more acute, particularly in drought-prone areas, with devastating impact on communities: from loss of life and livelihoods, to water scarcity and food insecurity. From 1961 to 2013, for instance, the global area affected by drought increased, on average, by slightly more than 1 per cent per year in the world's drylands, where droughts are frequent (annual).[7]

Land degradation is a major driver of drought (see Table 1) in the drylands. Globally, land degradation affects 1.3 billion people directly, and indirectly impacts the livelihoods of another 1.9 billion, amounting to almost half of the global population. It punishes people, taxes ecosystems and exacerbates climate change. Land degradation is a 'slow onset' disaster, because it reduces the resilience of communities and ecosystems and increases their vulnerability to shocks, transforming 'challenges' into disasters, in some cases. Worse, it is often the populations living under dire social, political and economic challenges that are most vulnerable to the impacts of desertification and land degradation.

The Intergovernmental Panel on Climate Change (IPCC), however, argues that these climate change outcomes are not pre-determined. Rather, they play out depending on how the land is managed. In essence, how the future unfolds at the domestic level will depend not only on the rise in temperature, but also on how land is managed at local levels.

So, what can be done?

THE CAUSES OF LAND DEGRADATION

Effective action begins with an understanding of the problem.

A summary of the direct and indirect drivers of land degradation identified in the most recent assessment of land degradation is presented in Table 1 of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services' (IPBES) 'Land Degradation and Restoration Assessment' claims

that the expansion of cropping and grazing lands are the main direct drivers of land degradation, and its associated biodiversity loss, globally.

Table 1: Direct and Indirect Drivers of Land Degradation

Direct Drivers	Indirect Drivers
• Deforestation and clearing of other vegetation • Grazing land management • Cropland and agroforestry management • Native and planted forest management • Non-timber natural resource extraction • Fire regime change • Invasive alien species • Land abandonment • Mineral resource extraction • Infrastructure, industry, urbanisation • Climate change	• Demography (e.g., migration & population growth) • Economic (e.g., poverty consumer behaviour) • Science, knowledge & technology (e.g., technology & education) • Institutions and governance (e.g., property rights) • Cultural (e.g., religion, diet, consumer behaviour)

(ICCD/COP(14)/23/Add.1)[8]

In their biennial reports to COP–14, governments identified the drivers of land degradation in their own countries, an exercise that has become a key element of reporting. During COP–15 in 2021, governments will review the drivers identified by IPBES against those commonly presented in country reports. This is particularly important for clarifying the salience of the drivers listed in the Table, both globally and by region.[9]

In India, the loss of productive land is attributable to various factors, but by far the most important drivers are water erosion, vegetation loss and wind erosion, in that order. However, in arid areas, the main driver is wind erosion, whereas water and loss of vegetation are key drivers in the semi-arid and dry sub-humid areas.[10] The direct drivers of land degradation outlined in Table 1 can be grouped into the broad categories identified by India. And yet these drivers only tell part of the story, because there is no single cause of land degradation. Rather, a combination of factors drives it, some of which are relatively new and not previously anticipated. Still, the recent assessments of land degradation reached two important and similar conclusions.

First, the drivers of land degradation at the local level have not changed. They are significantly influenced by the outcomes of

land-use change decisions. For example, when forests are converted to farmland, or grasslands to livestock areas, the natural capital provided by the land declines and some ecosystem services are lost, even as the service of food provision increases.

Second, the indirect drivers of land degradation often reflect environmental, social and economic tradeoffs. Globalisation, in particular, has enhanced the impact of the indirect drivers of land degradation. In a new trend, unsustainable production and consumption patterns are now the leading drivers of land degradation.

For example, changing diets increase the demand for foreign foods all year round. Keeping up with this growing demand may result in further land conversion and land-use practices that overexploit soils in farming areas as well as vegetation cover in rangelands and forests. But the impacts of consumption are not limited to soils. For example, the increased damming of rivers to meet such demand has caused alarming declines in surface and groundwater that were not foreseen at the start of this millennium.

While globalisation creates market opportunities for farmers, there is a growing disconnect between the production and consumption of food as well as animal feed. This process—whereby the demand for a resource in one region drives land degradation in a different part of the world, or food export contributes to groundwater decline in the country where the food is sourced—is known as tele-coupling, and is considered one of the most important emerging issues requiring urgent government attention.

It presents a major dilemma for consumers committed to sustainability. They are unable to induce positive change by rewarding good land stewardship through their market choices, because the costs to land associated with unsustainable practices are not part of product labels and barcodes. The formal recognition of the indirect, and yet significant, impacts of consumption and production on land led to agreement on various actions to change the negative trends related to consumption on the land.

At COP–14, governments agreed for the first time that it is necessary to systematically link the flows of consumption to the land that produces what is being consumed. They also recognised the need to identify strategies to minimise the economic, social and environmental externalities arising from land degradation.

COP–14 also agreed with the conclusions of its Committee

on Science and Technology regarding the need for policy action to address land management at three levels. First, the diffusion of sustainable land management practices at the farm level in order to contain soil erosion among individual farmers. For instance, soil erosion can be over 100 times higher than soil formation under conventional tillage. This drops to about 10 to 20 times higher where there is no tillage.[11] But these actions are most effective when rolled out at scale, because it helps entire ecosystems to recover. Second, governments therefore agreed to restore degraded land at scale. Third, governments recognised that land-use planning will be critical going forward, because development projects tend to target degradation of new ecosystems over the reuse of degraded or transformed land.

SUSTAINABLE PRODUCTION AND CONSUMPTION, AND INDIA'S COMPARATIVE ADVANTAGE

These global trends informed the actions taken by the Conference. India's advances in science and technology, its long and active history of engagement in sustainable development issues and on-the-ground realities of domestic priorities suggest these policy issues are known to or on the radar screens of its policy community.

But from the vantage point of the international community, India is in the enviable position of having both the opportunity to transition quickly to a sustainable development path and the means to do so, and reap huge benefits. In fact, India is set to influence—for better or worse—the development path the global community takes going forward, into 2050. It can drive this change through the land sector, by transforming its agriculture sector. In this regard, India has three clear advantages over most countries.

First, it has a large rural agricultural population that is capable and ready to transition to a sustainable growth and development path. Second, there is a large domestic and growing urban market that can consume what is produced from its agriculture. Third, India has an entrepreneurial community that is advancing this transition by applying the latest information technologies to link producers to consumers.

India has an edge on the production side. The country has the largest rural population globally, of 893 million, even if it is expected to decline by about 111 million by 2050.[12] A vast majority

of its rural poor still depends on agriculture. Of the 500 million small family farmers around the world, about 120 million (24 per cent) are in India (Lowder, et al., 2014). The country also accounts for over 20 per cent of global livestock today (Takpa and Kohli, 2018: 136–40).

The growing burden of debt and declining land productivity is moving many small holder farmers in India in search of alternatives. The move to organic farming in some states in India signals a deep desire for change. Agriculture is the main driver of land degradation globally, with soil erosion from agricultural fields estimated to be currently higher than the soil formation rate.[13] This presents a huge potential for change, because numerous improved agricultural technologies to stem land degradation and reduce the reliance on fertiliser to increase productivity are available. India's strong science, technology and financial resources can support this production and help its rural farmers to overcome the challenges they face. Furthermore, unlike in the developed countries, India is not locked in an agricultural system that is backed by powerful organised agricultural lobbies that resist and undermine change.

At the consumer end, India is the second most populous nation in the world, with over 1.2 billion people or 18 per cent of the global population (Takpa and Kohli, 2018: 136–40). This population is expected to grow by 273 million between 2019 and 2050, and will make India the world's most populous nation in less than a decade (by 2027).[14] It will remain in this position into 2050, with a population of 1.5 billion.[15] During this period, India's urban population will grow by 416 million.

This is a large domestic consumer base that can be harnessed to drive the shift to a sustainable agriculture sector. India's young middle class is large, growing, health and environment conscious, and is demanding sustainably produced goods: food, feed and fibre. Using technological innovations—which show every step of the supply chain through Blockchain technology—can help these consumers to scan a product barcode and answer three fundamental questions about the food (or product) they are buying in order to reinforce government efforts to incentivise positive change: Where did the product come from? How good is it for me? How good is it for the environment?

Lastly, the emergence of new entrepreneurial schemes in India that link producers to consumers in mutually supportive ways can bridge critical gaps that have kept producers in debt and left consumers unable to make healthy food choices. The new crop of entrepreneurs setting up systems that link producers to specific consumers are charting news paths for sustainable production and consumption processes. They enlist consumers who invest in the farmers. This creates a trusted food system that can provide, on the one hand, long-term finance, and a reliable and predictable market for the farmers. On the other hand, it provides consumers, as the investors, with immediate returns in the form of fresh, healthy and sustainably produced goods, and a guaranteed high return from their investment in the future, when the farmers start making profits.

These approaches, when combined with good policy and other cutting-edge technology developments, are potential game changers for production and consumption patterns.

In the Netherlands, for instance, Supply Chain Information Management (SIM), a private technology company dedicated to making visible where products and ingredients are produced, joined forces with the largest Dutch supermarket chain Albert Heijn to make the entire value chain transparent to shoppers through a scan of a bar code.[16] In a similar vein, IBM launched 'Food Trust Blockchain' for commercial use, and it is being tested by companies such as Carrefour, Topco Associates, Kroger, Tyson Foods and Unilever.[17] In Switzerland, TE-Foods' 'farm-to-table' food traceability blockchain solution has been implemented by Migros, the largest retailer in Switzerland.[18]

The more transparent the supply chains become, the more important it will be for the leading food producers in the world, such as India, to transition early to sustainable land-use practices if they wish to keep their market edge and share.

INDIA'S ADDITIONAL BENEFITS OF ACHIEVING LDN

There are other additional advantages that India stands to gain by achieving land degradation neutrality.

First, India will save costs by taking action and earn a substantial return on investment, if degraded land is restored now, not later. The impact of climate change on land is real, and the

health of the land and its ecosystems are important for the resilience of communities. The IPCC Report found that the negative impacts of climate change, such as drought or flooding, play out depending on how the land is managed. For instance, drier soil conditions resulting from climate change can increase the severity of heat waves, whereas wetter soil conditions have the opposite effect. All this potential to sink organic carbon in the soil, however, is best harnessed sooner rather than later, as the impacts of climate change would then counteract it.[19]

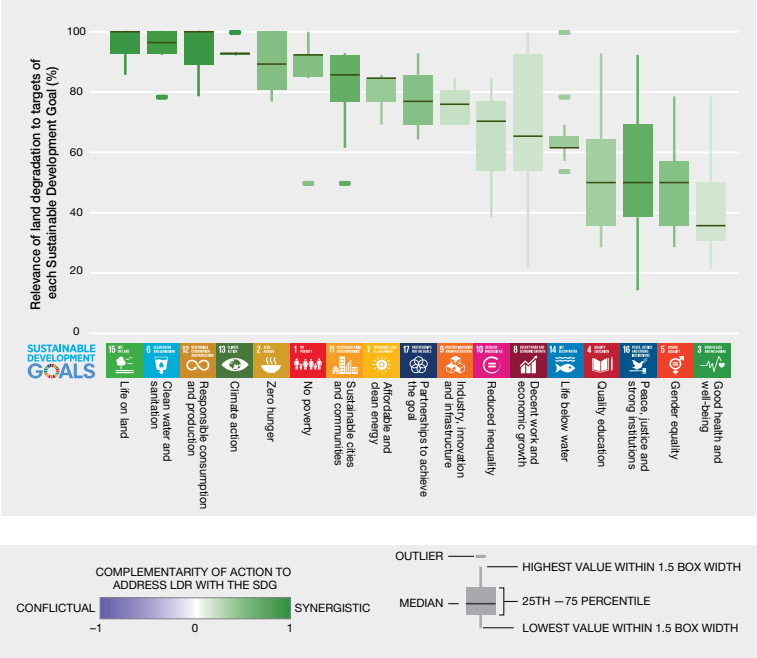
Cost is the second compelling argument for an early transition. Global studies show the cost of restoring degraded land now is a fraction of the cost of doing so in the future, with positive returns earned by investing in good land-use practices. For example, the economic losses from deforestation and land degradation in 2008 were estimated at EUR1.5–3.4 trillion or 3.3–7.5 per cent of the global Gross Domestic Product. By contrast, the benefits from transformational policies that support sustainable land management were estimated at $75.6 trillion.[20]

Third, there are domestic efficiencies to be made and benefits to be gained by addressing multiple environmental and developmental goals where land serves as the entry point for achieving global commitments.

The 'Land Degradation and Restoration Assessment' shows that restoring degraded land benefits all the 17 SDGs, some more than others. Figure 1 shows that achieving land degradation neutrality is at least 50 per cent relevant for 14 of the Goals, and compatible with the other three remaining goals. It confirms the UN General Assembly's recognition that implementing LDN helps countries both to accelerate the achievement and to integrate the implementation of SDGs.

A recent study mapped the coincidence of poverty and the areas affected by land degradation in about 800 subnational regions of the world.[21] It compared various dimensions, including impacts on rural and urban populations, geographic regions and income groups. Preliminary analyses show that the world's poorest people live on the most unfavourable lands, and as land degradation increases so does extreme rural poverty. Furthermore, land degradation has unequal impacts in society and increases the gap among income groups.

Figure 1: Relevance of Land Restoration/Rehabilitation for each Sustainable Development Goal

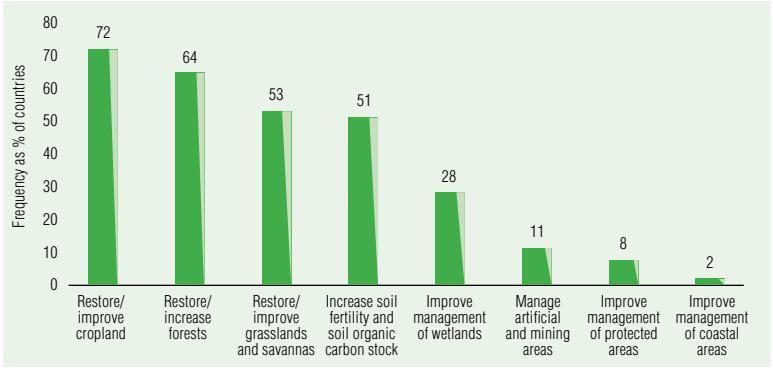


Source: 2017, IPBES[22]

Under the Paris Agreement, most countries will carry out activities designed to store carbon in the land as part of their Nationally Determined Contributions (NDCs). Sinking carbon in the soil is one of the three measures of achieving LDN. Countries whose contributions are land-based can achieve multiple goals by making LDN their ultimate objective and selecting the most appropriate sustainable land management practices to do so (Sanz, et al., 2017). Well-designed efforts to sink carbon in the soil, for instance, can build the resilience of agricultural systems to drought or increase food-grain production in Africa, Latin America and Asia by over 30 million tons per year (Lal, 2006: 197–209).

An analysis of LDN commitments by countries also shows that a substantial number of commitments will focus on restoring or improving forests and/or grasslands, with direct benefits to the conservation of biodiversity.

Figure 2: Frequency of LDN Targets by Target Group for all LDN-reporting Countries, as of November 2018



Source: 'Land Degradation Neutrality for Biodiversity Conservation'

Recognising the efficiencies and positive gains developing countries can make by implementing the Convention (COP–14) encouraged the national focal points of the three Rio sister conventions on Biological Diversity, Climate Change and Desertification, as well as national institutions that report on SDGs and focal points for other relevant multilateral environmental agreements, to support coordinated activities to implement LDN measures. The benefits of this approach at the country level cannot be overstated.

CONCLUSION

Land has played a critical, foundational role for economic growth and development throughout history, including in India. Nonetheless, it has come at a significantly high cost. Despite the transformation of 70–75 per cent of the Earth, a majority of the global population still languishes in poverty, a great deal of biological diversity will disappear, and climate change impacts are damaging ecosystems and breaking up communities.

Transitioning towards a sustainable development course that can restore the health of badly damaged land is a matter of enlightened self-interest for households, communities, governments and the international community alike.

Healthy land is the foundation of life on Earth. It feeds the world. It is essential for tackling climate change, purifying and conserving fresh water and for human well-being. Avoiding, reducing

and reversing land degradation is a strategic tool for meeting SDGs. By restoring 5 million hectares of degrading land to fulfil SDG 15.3.1, India can motivate small holder farmers to adopt better land-use practices, inspire responsible and healthy lifestyle choices among producers and consumers, and influence the domestic and international food, feed and fibre supply chains. The country can also create new, attractive jobs to eradicate poverty in rural areas and develop urban and rural spaces that will be resilient to climate change. This is what makes the initiatives to restore degraded land, including the one announced by Prime Minister Modi in September, and other actions in progress in the country, so critical.

The Convention (COP–14) encouraged countries that have not set their voluntary targets to do so, and to set the enabling environment for their achievement, taking concrete actions on land tenure and gender mainstreaming, more specifically. It also urged countries to integrate the targets in their national strategies, plans and programmes, and to implement them in synergy with activities related to climate change and biodiversity conventions. These actions would make implementation not only cost-effective, but highly beneficial in generating a wide array of benefits both locally and internationally.

India is one of the important nations best-positioned to lead this transition. It has the advantages of demography, scope for policy choice and access to science, technological and financial resources on their side. The demand for change, both at the domestic and global levels, means the environment for change is ripe. The systems needed for change exist. India's opportunity to change and to trigger the desired global transformation towards sustainability is wide open. Will she seize it?

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DISASTER MANAGEMENT

Institutionalising Risk-Informed Planning

JANKI ANDHARIA

INTRODUCTION

Humankind is confronting the sixth mass extinction of species in the history of life on Earth, with human activity as the major cause for the first time (Heise, 2016; Andharia, 2019). Both natural disasters and climate change[1] are not new to Earth, but recent anthropogenic activities have exacerbated risks and challenges associated with the same. The idea of planetary boundaries, safe operating limits and the concept of 'tipping point' suggests that we have exceeded boundaries in four of nine spheres—climate change, biochemical cycles/flows, land-use systems and biosphere integrity (Rockstorm, et al., 2009). On a regional scale, even more boundaries have been crossed. Further, climate science is producing undeniable evidence of the complex factors involved in the making of a disaster and creation of extreme weather events. We are indeed witnessing a world out of balance, and a planet on which humans have caused havoc in the name of progress and development (Macfarlane, 2016). Scientists, researchers, practitioners and policy makers are now striving to systematically understand these challenges and formulate measures to mitigate them.

This paper presents the global trends of rising disasters, discusses efforts to reduce disaster risks, and the imperative to adapt to climate change. It further stresses the need to forge greater synergies among researchers, policy makers and practitioners in order to be more effective. It also argues for risk-informed planning and programming with greater emphasis on at-risk populations, keeping the idea of enhancing social and climate justice at centre stage of all efforts.

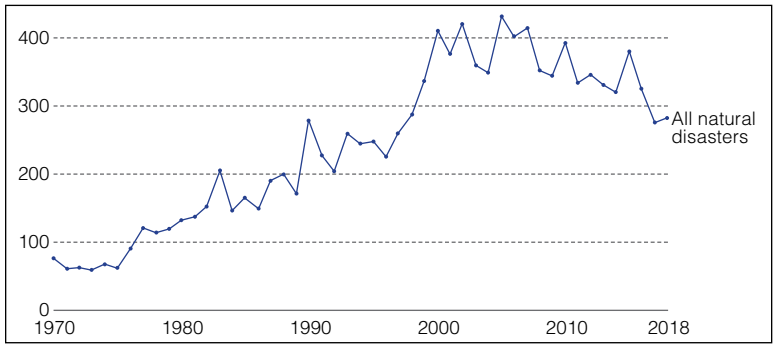
Winter 2019–Spring 2020, Volume 46, Numbers 3 & 4

GLOBAL TREND OF RISING DISASTERS AND EXTREME EVENTS

The Intergovernmental Panel on Climate Change Report (IPCC, 2012) evaluated the influence of natural climate variability and anthropogenic climate change on climate extremes, and other weather and climate events that contribute to disasters. It also emphasised that high vulnerability and exposure are generally the outcomes of 'skewed development processes, such as those associated with environmental mismanagement, demographic changes, rapid and unplanned urbanisation in hazardous areas, failed governance, and the scarcity of livelihood options for the poor' (ibid.: 67). The Report suggests that exposure and vulnerability to weather and climate events determine the likelihood and impact of disasters (disaster risk), which in turn further enhance the exposure and vulnerability of human society and natural ecosystems, making them even more fragile. It also considers 'the role of development in the changing trends in exposure and vulnerability, implications for disaster risk, and interactions between disasters and development' (ibid.: 4).

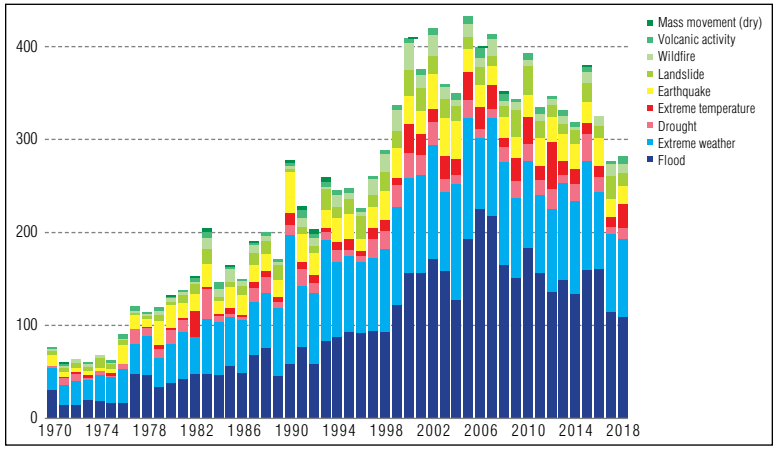
In the 21st century, natural disasters and climate change emerge as key challenges that are global in scope and unprecedented in scale. Ever since the 1900s, the total number of recorded natural disasters has been on the rise (see Figures 1 and 2 for global trends). According to the Centre for Research on the Epidemiology of Disasters (CRED), which maintains a global database on disasters, a total of 315 natural disaster events were recorded in 2018 alone, with 11,804 deaths and over 68 million affected. The economic losses attributed to these disasters were estimated to be $131.7 billion, worldwide. Earthquakes accounted for about 45 per cent of total deaths, whereas flooding accounted for nearly 50 per cent of the total affected population, followed by storms that accounted for 28 per cent. Significantly, this burden was not shared equally across the globe. Asia endured the highest impact, relative to the rest of the world. The region accounted for 45 per cent of total disaster events, recorded about 80 per cent of total deaths, and 76 per cent of total affected population. Intense seismic activity in Indonesia, a string of disasters in Japan, and floods in India have been occupying the headlines in Asia throughout 2018. Nearly half the total deaths (47 per cent) were from Indonesia, and the highest number affected was recorded in India (35 per cent). This high-disaster impact can be attributed to Asia's large land mass, very high population and multiple hazard risks (CRED, 2018).

Figure 1: Total Number of Natural Disaster Events Recorded



Source: EM–Dat (2019) CRED International Disaster Data Base (in ourworlddata.org)

Figure 2: Total Recorded Natural Disaster Events by Type



Source: EM–Dat (2017) CRED International Disaster Data Base (in ourworlddata.org)

THE IMPACT OF DISASTERS AND CLIMATE CHANGE

The fifth assessment report by IPCC presents both near-term (up to the mid-21st century)[2] as well as long-term (21st century and beyond) projections of climate change.[3] In 2018, IPCC also published a Special Report that details the grave impact of global warming of 1.5°C.[4]

Currently, anthropogenic activities are estimated to have caused approximately 1.0°C of global warming above pre-industrial levels. The IPCC (2018b) projects that global warming is very likely

to reach 1.5°C between 2030 and 2052, if greenhouse gas emissions remain unabated. Many scientists believe that even with immediate efforts to reduce such emissions, it is only possible to delay, but not prevent, global warming of 1.5°C.

Sea levels are expected to continue to rise well beyond the year 2100, and the magnitude and rate of this rise would depend on future emission pathways. The Report projects increases in the frequency, duration and magnitude of hot extremes, along with heat stress; nonetheless, occasional cold extremes in winter are also expected. The frequency and intensity of heavy precipitation events over land is also likely to increase, but will not be uniform across regions because of the natural variability and possible influence of anthropogenic aerosols. The Arctic sea cover is likely to continue to shrink year-round over the course of the 21st century. New research shows that some 150 million people are currently living on land that will be below the high-tide line by mid-century (Lu and Flavelle, 2019). Rising seas will erase numerous great coastal cities, including huge portions of Ho Chi Minh City, Bangkok, Shanghai, Mumbai, Alexandria and Basra.

Moreover, climate-related risks to health, livelihoods, food security, water supply, human security and economic growth are projected to increase with global warming of 1.5°C, and increase further at 2°C. Limiting (and stabilising) global warming at 1.5°C, compared to 2°C, would thus help diminish the grave impact on ecosystems, human communities and economies. However, besides the rate of warming, climate risks also depend on such numerous other factors as geographic location, the level of development, extent of vulnerability, and effectiveness of adaptation and mitigation activities.

Alarmingly, IPCC points out that a large portion of climate change is 'irreversible on human time scale' unless carbon emissions are negative over a sustained period. In order to keep a check on global warming and reduce the risk of climate change, several measures are laid out by IPCC reports. These are wide ranging and require unprecedented efforts (IPCC, 2018a).

INTERNATIONAL EFFORTS TO ADDRESS CLIMATE CHANGE AND REDUCE DISASTER RISKS

International cooperation is identified as one of the critical enablers for adaptation. Thus, institutions such as United Nations

Framework Convention on Climate Change (UNFCCC) and United Nations Office for Disaster Risk Reduction (UNISDR) were set up to address climate change adaptations and disaster risk management on a global scale. In 2015, at the 21st Conference of Parties (COP) conducted by UNFCCC, the historical Paris Agreement was adopted wherein 195 nations agreed to keep global temperatures well below 2°C, and unleash actions and investment towards a low-carbon, resilient and sustainable future. This Agreement brought together all the nations fighting for a common cause for the first time ever. In 2016, COP–22 moved forward on writing the rule-book of the Paris Agreement and launched the Marrakech Partnership for Climate Action. COP–23 delved further into technical affairs and continued to negotiate the finer details of the Agreement, along with the launch of such numerous innovative action plans and partnerships as the Talanoa Dialogue, Gender Action Plan, Ocean Pathway Partnership, InsuReliance Global Partnership, and much more. The 23rd Conference was also the first set of negotiations since the United States expressed its intention to pull out of the Paris Agreement. At COP–24, the 'Katowice Climate Package', a set of robust guidelines that operationalises the Paris Agreement was adopted. However, many believe that these targets are unlikely to be achieved mainly because: (i) it entails a major downscaling of economic activities (about 4–6 per cent per year for industrialised countries); (ii) many countries are unable to even meet their self-imposed targets of reducing carbon emissions; and (iii) even if countries meet their targets, the planet would still heat up beyond 2°C in excess of pre-industrial levels (Hickel, 2017; Plumer and Popovich, 2018). The United States' withdrawal from the Agreement may be cited as a fitting example to validate this line of reasoning.

However, it is imperative to make every conceivable effort to reduce risks and vulnerabilities as much as possible, given the existing level of damage. Accordingly, another noteworthy effort is that of UNISDR that shaped the Hyogo Framework for Action (2005–2015),[5] followed by the Sendai Framework for Action (2015–2030).[6] While the Hyogo Framework focused on disaster preparedness and building effective disaster-response strategies, the Sendai Framework nurses a broader perspective. With very ambitious targets, this Framework focuses on prevention and mitigation, rather than response and recovery. Disaster risk

reduction strategies are emphasised, and countries across the globe are encouraged to adopt locally relevant measures within global guidelines to reduce risks effectively.

Besides this, international refugee laws, human rights laws, etc., have been used to address issues of climate change adaptation and disaster risk management, such as displacement as a result of climate-induced disasters, issues of climate change that impact the enjoyment of human rights, among others. However, such efforts have not been particularly successful so far.

The significance of these global efforts cannot be overstated as recent years have seen an increase in climate-induced disasters around the world, and their grave consequences. With 1.0°C global warming in the past decade, the planet witnessed numerous record-breaking hazards—storms, forest fires, heatwaves, floods, droughts and coral bleaching. Much of this is only likely to worsen substantially with the current projection of 1.5°C.

LINKAGES BETWEEN CLIMATE CHANGE AND EXTREME WEATHER EVENTS/DISASTERS

The relationship or link between climate change and disasters is complex and tricky to decipher. First, it is important to note that climate-induced natural hazards do not cause disasters by themselves; they turn into disasters only when an exposed, vulnerable and unprepared population is affected by a hazard, and suffers damage and loss. Therefore, climate change can exacerbate disaster risk in two ways: (i) an increase in the frequency of climate-induced hazard events that can be potentially disastrous; and (ii) by aggravating the vulnerability of the population through the degradation of ecosystems, destruction of livelihoods, etc. (UNISDR, 2008).

According to the projections made by IPCC, climate change is likely to cause more frequent heatwaves, leading to an increase in the number of deaths. It is also likely to cause dry spells in many regions, leading to drought. This would have major ramifications with respect to land, crop yield, livestock deaths and an increased risk of wildfire. Furthermore, climate change is also expected to increase the frequency of precipitation in certain regions, which is likely to trigger floods and landslides, thus disrupting agriculture, livelihoods, community settlements, transport, children's education, etc. Cyclones, hurricanes and tsunamis are but a few climate-induced hazards that can become catastrophic, especially for coastal regions.

Climate change also compounds the pressure exerted on natural resources by rapid industrialisation, unplanned urbanisation, unchecked economic growth, among others. In the absence of countermeasures, climate change can prove to be—and has already proven to be—disastrous.

In the last few decades, researchers have carried out detection and attribution studies to better understand the nature of ongoing climate change and related disasters. Detection studies refer to those studies that aim to verify and demonstrate that climate change has occurred, and attribution studies are those that try to ascertain the most likely cause of this detected climate change. Scientists have developed climate models that help examine the extent to which anthropogenic climate change has influenced extreme weather events and natural disasters. However, while the influence of anthropogenic climate change can be identified clearly in events such as heatwaves, heavy precipitation or drought, it is harder to establish for more complex phenomena such as hurricanes and cyclones.

In 2004, a paper titled 'Human Contribution to the European Heatwave of 2003' was published, which is widely regarded as one of the first extreme-event attribution studies. The study assessed the influence of climate change on the European heatwave in 2003 that took about 70,000 lives (Stott, et al., 2004). The paper concluded that 'it is very likely that human influence has at least doubled the risk of a heatwave exceeding this threshold magnitude'. Ever since, such extreme weather attribution studies have grown significantly, constituting one of the most rapidly expanding areas of climate science. Moreover, the special Report, titled 'Explaining Extreme Events in 2016 from a Climate Perspective' by BAMS (Bulletin of the American Meterological Society) also ascertained that many of the extreme weather events, such as the 2016 heatwave in Asia that caused the death of approximately 580 people in India alone, and the warm blob of water along the Alaskan coast, etc., would not have occurred were it not for human-induced climate change (Herring, et al., 2018). The Report stated that it is 'extremely unlikely that natural variability [in climate] alone led to the observed anomalies'.

These findings prove that climate change is not only one of the components of extreme weather events, but is in fact an essential causal factor for some.

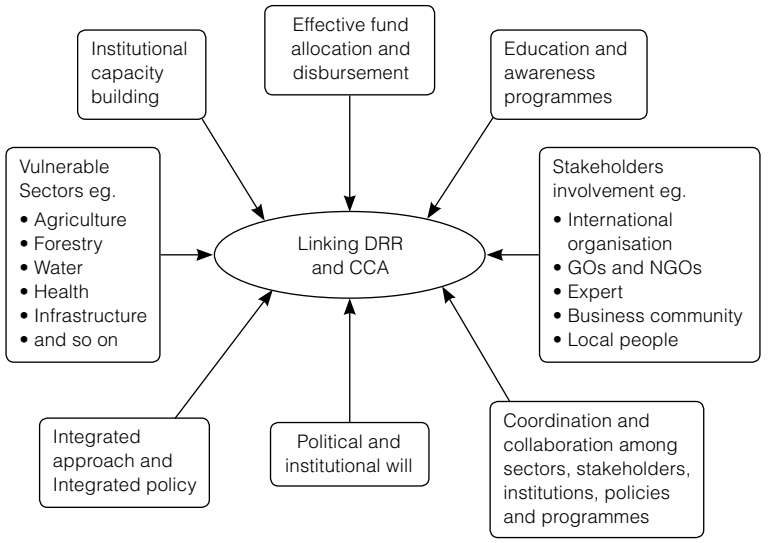
Being able to attribute extreme weather events and disasters to climate change is significant for climate adaptation as well as climate litigation. In a broader sense, this would enable the country to pursue a more sustainable development path and build resilience. However, the geographical coverage of the study as well as the types of climate events covered remains limited (Stott, et al., 2016). Such studies are mostly done in developed countries like the United Kingdom, Germany, the United States, etc. The lack of data is one of the primary challenges for developing countries.

In addition to challenges in attribution, there are numerous other aspects that render the linking of disaster risk and climate change a difficult task. As pointed out by Birkmann and Teichman (2010), there exist spatial, temporal and functional scale challenges. Mismatches on the spatial scale evolve because, up until now, climate change issues have been assessed mainly on a global scale, whereas disasters have been analysed more or less on a local/regional scale. Temporal scale mismatches materialise when climate change adaptation strategies are perceived from a long-term perspective; this is not always the case with disaster risk reduction strategies in practice. On a functional scale, there exist mismatches because in many countries, Climate Change Adaptation (CCA) and Disaster Risk Reduction (DRR) come under the ambit of two different ministries that hardly collaborate as a routine.

Clearly, there are several gaps in operational linkage between CCA and DRR. First, there is a need for a detailed conceptual framework that explains or furthers our understanding of linkages between DRR and CCA at the local, national and global levels. This has been illustrated by Begum, et al. (2014), as shown in Figure 3.

It is to be noted that disaster risk is not only exacerbated by climate change, but also by other factors such as rapid urbanisation, poor infrastructure, increasing informal settlements, deficiencies in governance, excessive mining, etc. These drivers of disaster risk also need to be addressed in order to build resilience. The UNISDR Report (2009) rightly points out that disaster risk would continue to magnify, even if climate change is mitigated, if other drivers of risk are not addressed.

Figure 3: Conceptual Framework Linking DRR and CCA



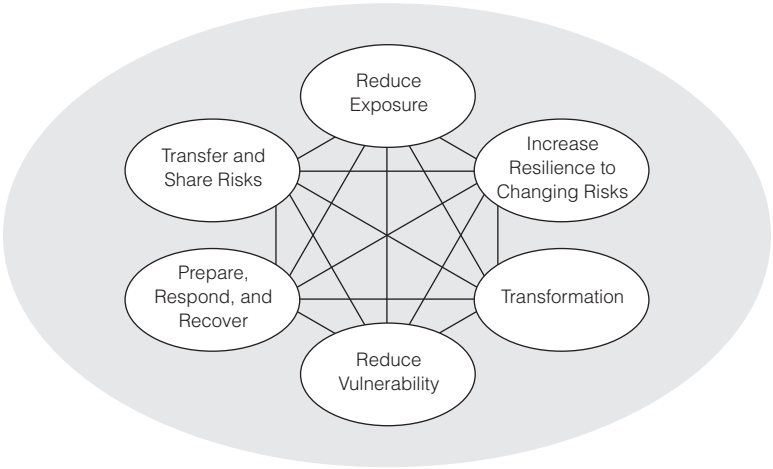
Conceptual framework II: factors involvements to linking DRR and CCA.

Source: Begum, et al. (2014)

Thus, it is important to ensure greater interaction between disaster risk, climate change and development. It is vital to formulate integrated agendas wherein disaster risk reduction and climate change are incorporated in development plans (Schipper and Pelling, 2006). Countries such as the Philippines and Vietnam are attempting to take effective measures with respect to climate change adaptation and disaster risk reduction with interdisciplinary approaches to policy, regulation and budget. But, unfortunately, such countries remain a minority. Most countries are yet to understand the interlinkages between climate change and disasters, and continue to maintain distinct boundaries in their policies and action plans (SEI, 2014).

It is also important to invest in climate education at all levels, which would contribute to sustainable development. Alarmingly, almost 65 per cent of the Indian population is unaware of climate change, despite living in places that are very likely to become climate hotspots by 2050. This supports the argument that climate change education still remains at a nascent stage in India. It is important that it becomes part of structured education which would help in promoting awareness, capacity building and innovation (Goel, 2018).

Figure 4: Adaptation and Disaster Risk Management Approach for a Changing Climate



Source: IPCC (2012)

There is a need to build the ability of communities, societies and systems to resist and recover from climate change and disasters, while also improving their well-being. Adaptation, mitigation and preparedness are indeed critical to achieve sustainable development and a safe tomorrow.

RISK-INFORMED PLANNING FOR CLIMATE JUSTICE

The impact of disasters and climate change is being felt most acutely by millions in the world's most vulnerable and marginalised communities. Climate change is at once a social and environmental justice issue, an ecological issue, and an issue of economic and political domination (Stallworthy, 2009; Barry, et al., 2013; Mummery and Mummery, 2019). The risks faced by the poor and marginalised demand the lens of justice.

Risk is not synonymous with threat or vulnerability; it is a description of potential outcomes if a threat were to occur. The UNISDR defines (disaster) risk as 'the potential loss of life, injury, or destroyed or damaged assets which could occur to a system, society or a community in a specific period of time, determined probabilistically as a function of hazard, exposure, vulnerability and capacity. Hazards may be natural, anthropogenic or socio-natural in origin' (2016).

In a highly interconnected and interdependent world, a country's interaction with nature leads to complex risks that transcend borders. Further, it is increasingly recognised that there is a close interface between development and risk. Unsustainable and unequal development can exacerbate risks and may even create new risks. Unplanned urbanisation, illegal settlements in hazardous areas, increased deforestation for developmental activities, impromptu constructions, etc., increase disaster risks and reduce resilience. While no development can be risk-free, risk-informed development planning can certainly facilitate a resilient and sustainable development process.

Global initiatives, such as the Sendai Framework for Disaster Risk Reduction 2015–2030, emphasise the integration into development planning of risk related to human and natural threats. The Paris Agreement under UNFCCC calls for climate change risk reduction through well thought out adaptation strategies. The 2030 Agenda for Sustainable Development will be nearly impossible to achieve unless multiple threats and associated risks are accounted for. Thus, infusing development policies and plans at all administrative levels and sectors with a requisite risk dimension is an imperative (Opitz-Stapleton, et al., 2019).

However, effective risk-informed planning involves numerous challenges. The pathway to mainstream risk-informed planning into development is neither linear nor uniform across countries. Each country has diverse topographical and climatic conditions, a unique history, political ideologies and aspirations. It is not possible to have a common blueprint to accomplish risk-informed planning; rather, a dynamic approach with context-specific efforts is the key.

The institutionalisation of risk-informed planning across all sectors and levels requires an integrated approach and coordinated efforts from government authorities, non-governmental organisations, communities and other relevant decision makers. Responsible actors, available resources, potential entry points—all need to be identified systematically to provide a strong foundation for action. Civic engagement in planning and decision making processes needs to be encouraged to enable the inclusion of community identified priorities, needs and capacities which would facilitate the effectiveness of risk-informed planning.

Further strategic actions include strengthening regulatory frameworks, creating skilled and trained professionals at all levels of administration across sectors, creating a strong evidence base through systematic risk assessment, and effective dissemination of risk information amongst those who need it most (ibid.). Ensuring adequate budgetary allocation to carry out operational strategies is indeed indispensable.

While monitoring and evaluation are vital for any endeavour, creating benchmarks or indicators to measure progress in risk-informed planning initiatives is important. Therefore, an innovative monitoring framework also needs to be developed.

Exploring ideas around institutionalisation and implementation of risk-informed planning within governments would not only enable a reduction in the impact of disasters and climate change, but also ensure that development gains are sustained at local and regional levels.

While most countries now have a legal, institutional and policy framework for climate and disaster risk management, most countries do not have a well-institutionalised operational framework for mainstreaming risk in multi-sectoral development planning. Although operationalising risk-informed planning may seem complex, it is time to ensure that development decisions take cognizance of climate and disaster risks, and create a framework for effective risk-informed planning.

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NOTES

1. According to IPCC (2018a), climate change refers to 'a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcing, or to persistent anthropogenic changes in the composition of the atmosphere or in land use.'
2. https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5_Chapter11_FINAL.pdf.
3. https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5_Chapter12_FINAL.pdf.
4. https://www.ipcc.ch/site/assets/uploads/sites/2/2019/06/SR15_Headline-statements.pdf.
5. https://www.unisdr.org/files/1037_hyogoframeworkforactionenglish.pdf.
6. https://www.unisdr.org/files/43291_sendaiframeworkfordrren.pdf.

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CATCH 22 AND DOUBLE WHAMMY FOR SOUTH ASIA IN A WARMING WORLD

SAGAR DHARA

MORE GAS: GROWING GREENHOUSE GAS (GHG) EMISSIONS GAP

The origin of fossil fuels dates back to the Carboniferous period—to more than 300 million years ago—when huge plants (and animals) that existed then died, and were baked at high pressure and temperature by layers of earth and converted into fossil fuels. They lay dormant till humans learnt to use them as recently as 300 years ago, after the Industrial Revolution began.

In the last three centuries, about 40 per cent of the known 1,700 Giga tonnes (Gt) of conventional fossil fuel reserves have been consumed, and a third of the 60 million km^2 of forest that then existed has been converted into farm land and pasture. Together, these two processes have emitted about 2,200 Gt[1] of CO_2e (known as historic emissions, i.e., cumulative from 1751 to 2019), increasing the atmospheric CO_2 concentration that was stable at 280–300 ppm for 800,000 years prior to the Industrial Revolution, to 408 ppm today. This has raised the average global temperature by 1.1°C[2] above pre-industrial times.

The second Intergovernmental Agreement on climate change, signed in Paris in 2015, aims to limit global warming to 1.5–2°C above pre-industrial times, above which, scientists warn, catastrophic consequence may ensue—rapid glacier melt, rising sea levels, acidifying oceans, greater rainfall and temperature unpredictability, frequent extreme weather events, rise in species extinction rates, decrease in food and water security, and consequent rise in malnutrition and disease.

Under the Paris Agreement, nations have made non-binding pledges, called Nationally Determined Contributions (NDCs), to tackle

climate change, i.e., take measures to reduce their GHG emissions and sequester additional CO_2 emissions. The United Nations Environment Programme (UNEP) makes an annual assessment of the efficacy of the global effort to mitigate GHG emissions. In its most recent report,[3] UNEP states that 'we are on the brink of missing the opportunity to limit global warming to 1.5°C'. Another recently published Report by UNEP was, 'Lessons from a Decade of Emissions Gap Assessment'.[4] The EGR10 compares the emission gap predictions it made 10 years ago with today's, and concludes that 'despite a decade of increasing political and societal focus on climate change and the milestone Paris Agreement, global GHG emissions have not been curbed, and the emissions gap is larger than ever'. Together, both Reports indicate that the gap between climate science and climate policy has never been wider, and that to avoid descending into an apocalypse, drastic corrective measures must be taken immediately.

In the last decade, GHG emissions rose by 1.5 per cent per annum,[3] reaching a record high of 55.3 $GtCO_2e$[3] (with land-use change) in 2018, indicating that the early years of the Paris Agreement have not reduced emissions growth. To restrict warming to 1.5°C, the EGR2019 indicates that GHG emissions must drop to 25 $GtCO_2e$ by 2030, i.e., less than half of what it is today. If that process starts now, GHG emissions must decrease by a 7.6 per cent every year for the next 10 years.[3] A 5-year delay, i.e., a 2025 start for an emissions reduction to begin, will increase the GHG reduction rate to 15.4 per cent per year.[3]

In November 2019, the United States announced its intention to pull out of the Paris Agreement. In the last decade, US emissions, which are 14.6 per cent of global emissions, remained constant at about 6.8 $GtCO_2e$ per annum. Assuming that they continue to remain so till 2030, and GHG emissions were to reduce to 25 $GtCO_2e$ by 2030 to be 1.5°C compliant to compensate for US intransigence, countries other than the United States would have to reduce their emissions by 9.5 per cent per annum till 2030. There is a dichotomy between the Paris Agreement's aim to reduce emissions and their unabated increase.

IT'S GETTING HOT: OBSERVED CLIMATE CHANGE IMPACTS

The World Meteorological Organization's recent Report[5] provides a picture of the latest climate change observations. The main findings are summarised here:

- Ice melt: The daily Arctic ice extent minimum in September 2019 was the second lowest in satellite records. In 2019, Antarctica saw record low ice in some months.
- Sea rise: Between 1900 and 2010, the global mean sea level rose by 0.19 m, about half of which took place in the last 27 years. The average sea level rise is 3.25 mm/year.
- Extreme weather events: Europe experienced record temperatures in the summer of 2019. Vérargues in Southern France recorded 46°C on 28 June 2019. The United States Midwest experienced a cold spell through most of 2019, with Mount Carrol in Illinois state recording a temperature of -38.9°C on 31 January 2019. Rainfall in India in 2019 was 10 per cent above the 1961–2010 average, with about 1,000 lives lost in floods.
- Storms and floods: In the first half of 2019, seven million people were displaced by hydro-meteorological events in Africa, Asia and the Caribbean. To avoid Cyclone Bulbul, two million people were evacuated in Bangladesh and eastern India in November 2019.
- Food security: Between 2006 and 2016, developing countries lost about 26 per cent of their agricultural produce to climate-related disasters, in which floods caused two-thirds of crop losses, and drought caused the loss of 90 per cent of livestock. After a decade of decline, hunger is rising again—over 820 million people in the world suffered from hunger in 2018. The situation is most acute in sub-Saharan Africa. Drought has increased food insecurity in many Central African countries. Floods have added to hunger in Malawi, Mozambique and Zimbabwe. The Mekong Basin, the Laos–China border, and parts of Australia and Central America experienced drought in 2019.
- Health effects: In France, 1,462 excess deaths that occurred in the summer of 2019 are attributed to heatwaves. About three million temperature rise-related dengue cases, including around 1,250 deaths, were reported from the Americas in 2019.
- Vulnerability of displaced populations: Kutupalong in Bangladesh, where nearly one million Rohingya refugees from Myanmar were resettled, was hit by floods, landslides and wind storms in 2019. An intense drought in 2018, followed by flash floods in Afghanistan in April 2019, displaced over 30,000 in Herat.

IT MAY GET EVEN HOTTER: LIKELY IMPACTS OF A HOTTER WORLD

At the current global GHG emission growth rate, the world will warm by 1.5–2°C in a few decades. Assuming that the NDCs will be fully implemented and in the specified timescale, scientists forecast that the temperature rise by 2100 may be between 3–4°C above pre-industrial periods. The EGR10[4] warns, 'Unless mitigation ambition and action increase substantially and immediately, exceeding the 1.5°C goal can no longer be avoided', and the EGR2019[3] states that 'if we rely only on the current climate commitments of the Paris Agreement, temperatures can be expected to rise to 3.2°C this century'. In other words, the average temperature in future may be nearly as high as that which meteorological departments currently classify as heatwaves.

A 3–4°C global average temperature rise may cause the following impacts:

- *extreme heat waves* over land with temperatures soaring 4–10°C above what they are today;
- *alter precipitation patterns* that would turn many areas arid, and increase precipitation in others;
- increase the frequency and intensity of *extreme weather events*;
- *raise sea levels* by 1–2 m, by 2100, particularly on the east coasts of Asia, Africa and the Americas;
- *create millions of climate refugees* of those displaced from coastal areas and small island nations, a process that will continue for a considerable time after net GHG emissions are reduced to zero;
- *shrink glaciers* and reduce the Arctic sea's ice extent;
- *create environmental exiles* as a result of an increase in the frequency of glacial lake outburst floods (GLOFs) and extreme weather events;
- cause *food and water shortages*;
- i*ncrease hunger, deprivation, malnutrition, disease and poverty* as a consequence of temperature and precipitation variations; and a decrease in eco-system services as a

result of degraded environment, soil moisture changes, desertification, and ocean and water body acidification;
- *raise the incidence of mortality and morbidity* as a result of lack of work and consequent decrease in nutritional intake, spread of vector-borne diseases as a result of temperature rise, extreme weather events such as storms, floods, drought and increased lawlessness;
- *loss of forests and biodiversity and decrease the eco-system services they provide* on account of energy shortages, temperature and precipitation changes, forest fires, land use change;
- a *sixth mass species extinction*;
- *loss of employment and work opportunities* as a result of energy price hikes and consequent disruption of the global economy;
- *disruption of the global social and political order,* and consequent disruption of the global economy and increase of lawlessness;
- *trigger social conflict*.

A warming of over 3°C may also make feedforward mechanisms kick in, which might accelerate warming without GHG emission rates increasing. These mechanisms include the melting of the Arctic ice sheet, which will decrease albedo and increase solar radiation absorption by the Arctic Sea; the releasing of large quantities of methane (global warming potential of methane is 25 times that of CO_2) as a result of the warming of the Arctic permafrost and undersea clathrates; and, the weakening of thermohaline circulation.

Recent scientific findings are noteworthy. The first concludes that abrupt and irreversible changes in the climate system pose a higher risk at lower global average temperatures.[6] The second states that climate systems separated by thousands of kilometres—e.g., the Arctic sea ice and the Amazon forests—may be interconnected, and that exceeding tipping points in one system can increase the risk of crossing them in others.[6] The third is that new climate models being used for the Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report, to be released in 2021, predict that temperature rise by 2100 may be as high as 6.5–7°C.[7] At those temperatures, all biota will be severely affected, and human society will not exist in its present form.

WINNERS: NORTH NATIONS DEVELOPED USING FOSSIL FUELS

The Industrial Revolution began in Europe in the 18th century, and immediately after spread to North America, before moving to Asia, South America and Africa in the late-19th and early-20th centuries. Animate and biomass energies, the main energy sources for human society until the 17th century, were gradually replaced by fossil fuels.

With the head start that North nations (Europe, the United States, Canada, Australia and Japan) had for using fossil fuels since the Industrial Revolution began, the average per capita GDP of high-income countries in 2018 was $44,787, i.e., 10-fold greater than that of low- and middle-income countries ($4,971), and 20 times that of South Asia ($1,903). There is a correlation between material development, measured by per capita GDP and Human Development Index (HDI), and per capita energy consumption and CO_2 emissions. North countries have historically used more energy (per capita energy use today is 4.6 toe [toe-tonne of oil equivalent, i.e., energy contained in 1 t of oil = 42 Giga Joules]) and, consequently, have higher historic CO_2 emissions (North nations that have a population of 16 per cent of the global population today have consumed 69 per cent of all fossil fuels expended since the Industrial Revolution began), and therefore are materially more developed than South nations (South nations have 84 per cent of the world's population today, but their current per capita energy consumption is only 1.3 toe, and their per capita CO_2 emissions is 3.5 tCO_2). The per capita historic emissions of North and South nations are 1,200 and 85 t/person,[i] respectively (India: 35 t/person).

LOSERS: SOUTH NATIONS IN A CATCH 22 SITUATION

The world's remaining available carbon space to be compliant with a warming of <1.5°C is about 500 $GtCO_2$. This space will shrink with the thawing of permafrost and further loss of the Amazon and boreal forests, leaving as little as 100 $GtCO_2$ of carbon space to remain compliant with a warming of 1.5°C. At the current emission rate of 40 $GtCO_2$, the remaining carbon space will be erased in the next few years.

i. Per capita historic emissions are computed by dividing the historic emissions (1751–2017) of a country/region by the current population.

Correlation Between Material Development and Energy Consumption and CO_2 Emissions

Region/ Country	Demography and Material Development				Percent of Global Energy Consumption & CO_2 Emissions			Per Capita Energy Consumption & CO_2 Emissions		
	Population 2018[8]	Per capita GDP 2018 (@ current rates)[9]	Percent population below national poverty line 2017[10]	Human development index rank 2016[10]	Current energy consumption as % of global consumption 2014[11] [ii]	Current CO_2 emissions[iii] as % of global emissions 2014[12] [iv]/ 2017[13] [iii]	Historic CO_2 emissions as % of global historic emissions 1751-2017[13]	Current per capita energy consumption 2014/2015[11]	Current per capita CO_2 emissions 2014[14] [v]/ 2017[13] [iv]	Annual per capita CO_2 emissions growth 1990/ 1992-2014[vi]
	%	US$	%	Rank	%	%	%	toe	tCO2	%
World	100 (7.6 Trillion)	11,313			100	100	100	1.92	5.0	0.72
High income countries[vii]	16.1	44,787			42.0	35.8	69	4.6	10.9	-0.17
North America	4.8	61,117			18.8	16.0	29.8	6.9	16.4	-0.61
USA	4.3	62,795		12	16.7	14.6	26.1	6.8	16.2	-0.66
Europe+ Central Asia[viii]	12.1	25,107			21.0	15.78	33.6	3.2	6.9	-1.2
EU	6.8	36,568			21.0	9.8	23.1	3.2	6.4	-1.2
Russia	1.9	11,289		49	5.3	4.7	6.6	4.9	11.8	-0.75
UK	0.9	42,944		14	1.4	1.1	5.0	2.8	5.8	-1.7
Japan	1.7	39,290		19	3.3	3.3	4.0	3.5	9.5	0.3
Australia	0.3	57,374		3	0.9	1.1	1.1	5.3	16.9	-0.02
Low+middle income countries[vii]	83.9	4,971			58.4	58.8	31	1.3	3.5	2.1
China	18.3	9,771	3.1	86	22.9	27.21	12.7	2.2	7.0	5.4
South Asia	23.9	1,903			7.4	7.24	3.64	0.57	1.5	3.6
Afghanistan	0.49	521	35.8	168	<0.01	0.04	0.01	0.09	0.4	1.4
Bangladesh	2.1	1,698	24.3	136	0.27	0.24	0.09	0.24	0.5	4.9
Bhutan	0.01	3,360	12.0	134	<0.01	0.003	<0.01	0.09	1.4	7.6
India	17.8	2,010	22.0	130	6.2	6.82	3.2	0.71	1.8	3.8
Maldives	0.007	10,331	15.7	101	<0.01	0.004	<0.01		3.6	5.9
Nepal	0.37	1,034	25.2	149	0.09	0.03	<0.01	0.44	0.3	9.0
Pakistan	2.8	1,482	29.5	150	0.68	0.55	0.28	0.5	1.0	1.2
Sri Lanka	0.29	4,103		76	0.08	0.06	0.03	0.57	1.1	5.9

ii. Computed by author from World Bank indicators Table 3.6.

iii. Current and historical CO_2 emissions are territorial emissions

iv. Data for World, High-Income countries, North America, Europe, Low+Middle Income countries, South Asia are from World Bank data for 2014 from Note 12. Data for the United States, EU, Russia, the United Kingdom, Japan, Australia, China and all South Asian countries are for 2017 from Note 12.

v. 2014 data for World, High-Income countries, North America, Europe+Central Asia, South Asia, Low+Middle Income countries are from World Bank data in Note 14. Data for the United States, the United Kingdom, Japan, Australia, Russia, China and all South Asian countries are for 2017 from Note 13.

vi. Computed by author from Note 14 for all regions and countries except for Europe+Central Asia and Russia for 1990–2014. For Europe+Central Asia and Russia computations are over 1992–2014.

vii. Per World Bank classification.

viii. Central Asia consists of Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan. Their country statistics are clubbed with that of Europe as they are former Soviet republics and were earlier reported as part of the Soviet Union. Since their combined population in 2018 was 72.5 million, i.e., 0.95 per cent of global population, and their per capita energy consumption and CO_2 emissions are relatively low, combining their statistics with Europe will not alter the understanding of Europe significantly.

ix. Data for Europe and Europe+Central Asia for 2017 from Note 12.

South nations are caught in a Catch 22 situation. If they burn more fossil fuels to 'develop', they will contribute to temperature rise crossing the 1.5–2°C redlines, and thus risk a runaway temperature rise if feedforward mechanisms kick in. If they control their emissions to avoid crossing these temperature-rise redlines, they will remain permanently backward in comparison to the North countries. There is no visible alternative energy source replacement for fossil fuels that currently contribute 79 per cent of the world's commercial energy. Even if the entire remaining carbon space of 500 $GtCO_2$ is given to the South countries, they cannot achieve the material development standards of North countries.

India's example illustrates this dilemma. India's contribution to historic emissions is 3.2 per cent. With 18 per cent of the world's population, its current emissions are 6.8 per cent of global emissions. Its per capita CO_2 emissions are well below half the global average of 5 $GtCO_2$. To achieve its aspired GDP growth rate of 8–10 per cent per annum, India will have to increase its energy consumption (75 per cent of India's commercial energy is from fossil fuels) significantly, and therefore also its emissions. If it did that, as the fourth largest GHG emitter, India will contribute even more to climate change. If India chooses to restrict its emissions by reducing fossil fuel use, it will decrease GDP growth and condemn 22 per cent of its population that is below the poverty line to remain there for a prolonged period, as India has chosen to use the flawed trickle-down theory of development.

DOUBLE WHAMMY: VULNERABILITY OF SOUTH NATIONS AND EXTREME VULNERABILITY OF SOUTH ASIA

South nations are more vulnerable to climate change than North nations, because of their geography and their lower capacity to meet disasters. 'The Global Climate Risk Index 2020'[15] states that 'of the ten most affected countries and territories in the period 1999 to 2018, seven were developing countries in the low-income or lower-middle-income country group, two were classified as upper-middle-income countries (Thailand and Dominica), and one was an advanced economy generating high income (Puerto Rico)'.

South Asia is particularly vulnerable to climate change impacts. Along with the Sahel region of Africa, South Asia is considered to be one of two regions that will be most affected by

climate change. It has a quarter of the world's population, but has emitted only 3.6 per cent of the world's historic emissions. South Asia's vulnerability is caused by two factors. Its geography heightens the severity of climate change impacts. Its large landmass makes heat-waves more severe; its river deltas promote increased sea rise; and, decreased snow and glacier melt with warming will cause decreased water flow in snow-fed rivers and, consequently, cause water stress. Second, low economic and material development makes its population less resilient to meet climate change impacts. Its current per capita GDP is less than a fifth of the global average, and its low per capita energy use is reflected in low per capita CO_2 emissions which are less than a third of the global average.

Based on climate-related impacts causing loss of life and property between 1999 and 2018, the RI2020 places three South Asian countries—Pakistan (Rank #5), Bangladesh (#7) and Nepal (#9)—in the top 10 most vulnerable nations in the world, and another two—India (#17) and Sri Lanka (#22)—in the top 25 most vulnerable nations. The Maldives and Afghanistan bear a very high risk at a future date, the former as a result of sea rise, and the latter on account of extreme water stress.

The current understanding of the likely pattern of temperature and precipitation variations across South Asia in future is not very good. Consequently, it is difficult to predict climate change impacts that are dependent on temperature and precipitation variations with a high degree of confidence, e.g., changes in crop yields. The general statements made in a previous section vis-à-vis the likely impacts in a hotter world hold true for South Asia as well.

It is easier to predict such climate change impacts as sea rise, water stress, and the incidence of GLOFs as these can be done with greater confidence. The sections that follow discuss one major impact likely to affect each South Asian country: high confidence levels.

SEA RISE

Sea rise will impact all South Asian countries, except Afghanistan and Bhutan. However, Bangladesh and the Maldives will be hardest hit. The historic CO_2 emissions of these countries are 0.1 per cent and <0.01 per cent of the world's historic emissions, respectively. Their CO_2 emissions were 0.24 per cent and 0.004 per cent of the

world's CO_2 emissions in 2017. Despite their negligible contribution to global warming, they are going to be impacted severely by 2100.

BANGLADESH

SEA RISE: A combination of several factors—subsidence of the Sundarbans area (the world's largest mangrove forest spread along the coast of Bangladesh and West Bengal) that causes the uplift of its estuary beds as a result of large sediment deposits, tidal range amplification in the estuaries, and decrease of fresh water discharge—seem to have contributed to an observed sea rise of 2.8–8.8 mm per annum and an increase of high water levels in the polder zones (low-lying land enclosed by dikes) of 15.9–17.2 mm per annum.[16] Sea rise in the Sundarbans is significantly higher than the global average sea rise of 2.8-3.2 mm per annum,[17] observed for the period 1990–2009.

Recent research[18] indicates that by 2100, the hydro-fracturing of Antarctica's ice shelves and collapse of its ice cliffs, along with atmospheric warming, has the potential to double previously estimated sea rise. As a result of these factors, sea rise in the Sundarbans is estimated to be in the range of 2–4 m by 2100,[18,19] as compared to the predicted global average sea rise of 1–2 m (1 m, without significant Antarctica ice melt; and 2 m, with significant Antarctica ice melt).

While it is not possible to draw an accurate map of the Sundarbans area with actual sea rise in 2100, it is possible to do a sensitivity analysis by generating several maps of the area with a sea rise of different heights, and compare these maps with the current map of the Sundarbans. Such an exercise was done with modelling tools available on the Climate Central website.[20] With a likely 3–4 m sea rise in the Sundarbans area, the modelling results indicate that a large portion of the Sundarbans mangrove forests would be lost to the sea, and Bangladesh will lose somewhere between 15 and 25 per cent of its land mass by 2100.

Sea ingress will turn surface and ground water sources saline in vast tracts of land. Agriculture, fisheries and other livelihoods will be affected. Human and animal habitats will be lost, and along with them, domestic animals and wildlife. As global temperatures rise, the intensity of cyclones hitting Bangladesh will increase, and there will be a greater number of extreme weather events. Existing and

proposed projects in the Sundarbans area (for example, the thermal power plant at Rampal), will be affected.

CONSEQUENT IMPACTS

Tariq Karim, former Bangladesh High Commissioner to India, estimates that 50 million Bangladeshi climate refugees would leave the country[21] by 2050. That number will swell by the end of the 21st century, and will trigger considerable stress and, possibly, conflict in South Asia. Being extremely poor, these climate refugees will be forced to migrate to north Bangladesh, and into neighbouring countries. Having lost their livelihood, they will be subject to all manner of indignity and abuse—unemployment, disease, child trafficking, etc.—in the refugee camps.

With sea water intrusion, the salinity of inland water sources close to the ever-shifting coastline will render them unusable for drinking and agriculture. The Bangladesh coast is an area prone to cyclones. With sea rise, the mangroves of the Sundarbans forest will erode, and with it the protection it offers against storm surges during cyclones will diminish.

MALDIVES

The Maldives are an archipelago of about 1,200 beautiful, but low-lying, islands and atolls located in the Indian Ocean. Its economy is based largely on fishing and tourism. It attracts 600,000 tourists annually. By 2100, Maldives will become all but uninhabited as sea rise will drown almost the entire island state, as 80 per cent of the islands lie <1 m above mean sea level (amsl), and maximum elevation of the remaining islands is 3 m amsl. The entire population of the Maldives will become climate refugees (current population: approximately 500,000).

WATER STRESS

The Himalayan mountains are the water towers for Asian countries that receive water through rivers originating from these mountains. Global warming is expected to significantly impact snow and glacier melt in the Himalayas.[22]

Water stress will impact all South Asian countries, except Bhutan. Despite their very small contribution to global warming, Afghanistan, Pakistan and Sri Lanka will be severely water stressed

in the coming decades. Their historic CO_2 emissions were 0.01 per cent, 0.3 per cent and 0.03 per cent, respectively, of the world's historic emissions. Their CO_2 emissions in 2017 were 0.04 per cent, 0.55 per cent and 0.06 per cent of the worlds CO_2 emissions, respectively.

AFGHANISTAN AND PAKISTAN

'Recent reviews of all available field and remote sensing studies that quantify changes in glacier extent and mass balance in the Himalayas and the Karakoram indicate that glaciers have generally been losing mass, except in the Karakoram mountain range where there are indications of mass gain,' concludes a paper[23] on the impact of climate change on Himalayan glaciers. By 2100, about half the glacial ice that spreads across 75,000 km^2 of the Himalayas today may be lost,[24] including most of those in the 5,500 km^2 of the Everest region.

As the glaciers melt, they will initially cause an increase in melt water in snow-fed rivers, followed by a decline. One study[25] concludes, 'Projected increases in precipitation are insufficient to offset the increased glacier melt.' Glacial melt will impact all major snow-fed South Asian rivers—Brahmaputra (India, Bangladesh), Ganga (India, Bangladesh), Indus (India, Pakistan), Amu Darya (which provides approximately 50 per cent of all river water discharge in Afghanistan) and their tributaries.

Several studies have estimated the climate change-influenced flow changes of these rivers during this century. Their results vary on account of differences in methodologies and definitions of parameters being measured. For example, some studies dealt with flows only above 2,000 m, while others studied flows along the entire river basin. Some studies used such disaggregated data as melt from snow on land, snow on ice and from exposed glaciers, while others used a single parameter like glacier melt. However, there is generally agreement that the impact of global warming on the total discharge of Brahmaputra and Ganga will be minimal, whereas the impact on the Indus will be significant.

One data set regarding the contribution of snow and glacier melt to total downstream discharge, presented in the table that follows, quoted earlier in the paper,[24] illustrates the variation between major South Asian rivers.

Basin Characteristics and Snow/Glacier Melt Contribution to Downstream Discharge

Parameter	Ganga	Brahmaputra	Indus	Amu Darya
Population (million)	477.9	62.4	209.6	
Annual basin precipitation (mm)	1,035	1,071	423	
Basin area (km^2)	990,316	529,797	1,005.7	451,074
Irrigated area (km^2)	156,300	5,989	144,900	450
Mean discharge (m^3/sec)	18.691	19,824	5,533	
Snow and glacier melt contribution to downstream discharge (%)[x]	8.7[24]	21[24]	60[24]	77[26]

Source: For Ganga, Brahmaputra and Indus, see Notes 23 and 24

Snow and glacier melt contribute a significantly lower amount to the total discharge of the Ganga and Brahmaputra in comparison to that of the Indus and Amu Darya. Since they are located in the more humid Central and Eastern Himalayas, the Ganga and Brahmaputra's discharges are contributed by a significantly higher fraction of the monsoon precipitation, augmented by glacier melt. The western mountains—the Karakorum, where the Indus originates; the Pamir mountains where the Amu Darya originates—are colder and dryer than the Central and Eastern Himalayas. They have little precipitation in summer, and are therefore more dependent on snow and glacier melt in summer.

The Indus basin is largely in Pakistan, and a part of the Amu Darya basin is in Afghanistan. These basins receive lower precipitation than those of the Ganga and Brahmaputra. Moreover, the Indus is the only major river that flows through Pakistan. In a warming world, the discharge of the Indus and Amu Darya is likely to decrease significantly, causing severe water stress in large parts of Pakistan and parts of northeastern Afghanistan.

CONSEQUENT IMPACTS

Water stress will compromise water and food security of millions of

x. Data for Ganga, Brahmaputra and Indus are from Note 24, and for Amu Darya from Note 26. It is important to note that the discharge figures for Amu Darya is for elevations >2,000 m, whereas the figures for Ganga, Brahmaputra and Indus are for total discharges. While the contribution of snow and glacier melt as a fraction of discharge that is quoted in this paper is probably higher than for the total discharge of this river, as much of the Amu Darya drainage is in the Pamir mountains with elevations >1,000-2,000 m. The figure quoted in this paper provides the reader with an approximate idea of the probable percentage contribution of snow and glacier melt to this river.

people[27] living in the Indus and Amu Darya basins. The fate of these people as future climate refugees is still not well understood.

The World Resources Institute (WRI) and World Bank (WB) have assessed the risk of water stress, hunger and drought in Afghanistan, Pakistan and Sri Lanka. All three countries will be highly water stressed by 2040–2050, and will be at high risk of having repeated and severe drought.

Water stress and hunger risk assessed by WRI[28] for Afghanistan for the year 2040 indicates that almost the entire nation will be moderately to severely water stressed, with the region above Herat particularly severely stressed, and that the population at risk of hunger is expected to be 38.1 per cent. The risk of drought by 2050, assessed by WB,[29] indicates that the entire country will be at moderate risk, with the regions around Kabul at high risk of drought.

Water stress and hunger risk assessed by WRI[30] for Pakistan for 2040 indicates that large portions of central and northwestern Pakistan will be moderately to severely water stressed, with the region above Islamabad and close to Karachi particularly severely stressed, and that the population at risk of hunger is expected to be 12.6 per cent. The risk of drought by 2050 assessed by WB[29] indicates that the entire country, except some areas bordering India, will be at moderate risk, and some regions in central Pakistan will be at high risk.

SRI LANKA

Sri Lanka does not have any major rivers. Although it is not water stressed today, it is expected to become so by 2040–2050. Water stress and hunger risk assessed by WRI[31] for Sri Lanka for 2040 indicates that the entire nation will be moderately to severely water stressed, with the lower half of the country severely stressed, and that the population at risk of hunger is expected to be 17.7 per cent. The risk of drought by 2050, assessed by WB,[32] indicates that the entire country, except the central hilly regions around Kandy, will be at moderate risk of drought.

GLACIAL LAKE OUTBURST FLOODS (GLOFS)

Bhutan and Nepal each have CO_2 historic emissions that are <0.01 per cent of the world's historic emissions, and current CO_2 emissions of 0.003 per cent and <0.01 per cent of the world's current emissions, and will be impacted by GLOFs.

As glaciers melt, the volume of water in a glacial lake, located

at the mouth of many glaciers, increases and exerts greater pressure on the moraine dam (consisting of rock and debris) that holds it. When the water pressure on a moraine dam exceeds its material failure limit, it gives way and empties the glacial lake of millions of tonnes of water, causing a GLOF, the impact of which is felt for up to 100–150 km downstream in the form of villages and fields, and everything else that is in its path being washed out. For example, a moraine dam collapse that released water from the Nagma Pokhari lake in Nepal washed out villages for 70 km downstream. GLOFs have occurred in Bhutan, Nepal and other parts of the Himalayas.

Past GLOFs in the Himalayas have caused catastrophic fatalities and destructions in downstream zones. GLOFs have occurred recently at Cirenmaco in 1981, in the Sun Koshi River basin in China, Dig Tsho in 1985, Tam Pokhari in 1998, in Dudh Koshi in Nepal, Chorabari Lake in 2013, and in the Alaknanda river basin in India. Central and Eastern Himalayas are more prone to GLOF occurrences.

A recent study[33] compiled an inventory of 62 GLOFs that have occurred in the Himalayas in the last 80 years. Of these, 39 GLOFs could be given a date. The following table indicates that their frequency of occurrence has increased over time.

Frequency of GLOF occurrence in the Last Century

Time Period	Central Himalayas	Eastern Himalayas	Percent Occurrence
	Nos	Nos	%
1930–1939	1		3
1940–1959	0	5	13
1960–1979	7	2	23
1980–1999	9	4	33
2000–2019	8	3	28
Total	25	14	100

Source: Note 33

With climate change, the frequency of GLOFs is expected to increase in the Himalayas.

EXTREME WEATHER EVENTS

INDIA

With 17.8 per cent of the world's population, India's contribution to global historic and current emissions is 6.8 per cent and 3.2 per cent,

respectively. India will be impacted by many types of climate change-related events—sea rise, GLOFs, extreme weather events (abnormally high temperatures or precipitation), floods, drought, cyclones, significant crop yield losses, heat stress, etc. Of these, a large number of extreme weather events have occurred in India in the last 15 years, indicating that more are likely to take place in future.

Extreme Weather Events in India in the 21st Century

Year	Event	Location	Estimated deaths
2005	Very heavy rainfall	Mumbai	1,100
2013	Cloudburst	Kedarnath	>5,000
2015	Very heavy rainfall	Chennai	500
2018	Heatwave	All over India	2,405
2018	Very heavy rainfall	Kerala	500
2019	Very high temperatures	Maharashtra, MP	50
2019	Heavy rainfall & floods	Maharashtra, Karnataka, Goa, Kerala	~300

A large number of lives were lost in the 2013 Kedarnath cloudburst, as people were washed away by flood waters of the Mandakini River. A number of lives were lost in 2018, in very heavy rainfall in Kerala, as a consequence of landslides. Plantations replaced forests in the Western Ghats of Kerala in the last century. The roots of plantation species, being shorter than those of forest species, lack the same soil-gripping capacity. Consequently, most of the heavy-rainfall-triggered landslides occurred in the plantation areas in the hills. Landslides took place without warning and destroyed the houses, temples, churches and mosques in their paths.

The direct effects of heat stress are fatigue, rash, syncope, cramp, exhaustion, heatstroke; and the indirect effects are reduced work performance, increased accidents, reproductive problems, heart and lung strain, and an increase in disease-carrying vectors at higher temperatures.

A study[34] on heat stress and mortality in Surat concludes that 'there is an increase of 11 per cent all-cause mortality when temperature crossed 40°C. There is a direct relationship between mortality and HI (high heat index). Mean daily mortality shows a significant association with daily maximum temperature and HI'.

Another recent study[35] established a correlation between high temperatures and chronic kidney disease (CKD) in rural areas, by reviewing studies in several continents—Asia, North and South America and Africa. The study found study sites in India, Sri Lanka, Costa Rica, Nicaragua, El Salvador and Guatemala as confirmed sites where CKD had a correlation with heat stress, and found other study sites in India, Thailand, Saudi Arabia, Sudan, Mexico and the United States, where it suspects that CKD incidence is associated with heat stress. The study concludes,

> One of the consequences of climate-related extreme heat exposure is dehydration and volume loss, leading to acute mortality from exacerbations of pre-existing chronic disease, as well as from outright heat exhaustion and heat stroke. Recent studies have also shown that recurrent heat exposure with physical exertion and inadequate hydration can lead to CKD that is distinct from that caused by diabetes, hypertension, or GN. Epidemics of CKD consistent with heat stress nephropathy are now occurring across the world.

CONCLUSIONS

South Asia has nearly a quarter of the world's current population, but its historic CO_2 emissions are only 3.64 per cent of the world's historic emissions, and its current emissions are 7.24 per cent of the world's emissions. Yet, it is extremely vulnerable to various climate change impacts, because of its geography and the low resilience of its population to withstand climate change impacts.

Climate change can only be tackled if the principles of sustainability, equity, decentralised, democratic and transparent governance, environmental restoration, and taking responsibility for causing climate change are accepted by all countries. The principle of 'taking responsibility for causing climate change' is particularly important for South Asia as its contribution to climate change is small—yet, it will be impacted disproportionately. South Asia has yet to figure out how to convince countries that have historically emitted significant amounts of CO_2 that they should take responsibility for the injury that climate change will cause to South Asia.

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FORESTS AND CLIMATE CHANGE IN THE ANTHROPOCENE

GHAZALA SHAHABUDDIN

Many solutions have been suggested for the mitigation of the warming effects of carbon-enrichment in the Anthropocene. For instance, much public attention has been focused on behavioural changes for reducing personal carbon footprints, the replacement of fossil fuels with other energy sources, and extensive recycling of disposables. However, in understanding and tackling the effects of global warming, the critical role of forests has simply not got the attention it deserves. With the recent news of extensive Amazonian deforestation (Watts, 2019), and raging forest fires in Australia in 2019–2020,[1] global attention has once again turned to forests and their possible ecological role in ameliorating global warming.

In this article, I use recent advances in scientific as well as social–ecological knowledge to explore the role of forests in mitigating global warming, as well as possible policy changes that are required for sustainable mitigatory action in the Indian context. In particular, I emphasise the importance of protecting and restoring natural forest as opposed to monocultural plantation. I also propose possible amelioratory processes, based on direct financial payments to communities, NGOs, scientists, corporate bodies and local government, as a way to incentivise future forest restoration. Such direct payments are proposed so as to build on the growing numbers of small-scale initiatives in forest restoration and protection that are being undertaken across the country, and to trigger ecosystem conservation action amongst forest-dependent village communities in the face of growing agrarian distress.

Winter 2019–Spring 2020, Volume 46, Numbers 3 & 4

FORESTS AND CARBON

Healthy natural forests absorb carbon dioxide from the atmosphere, incorporate it into plant material and emit life-invigorating oxygen, being a net absorber of carbon dioxide. It has been estimated that the clearing, conversion and degradation of forests contributes to as much as 23–27 per cent of all greenhouse gases in the atmosphere.[2] In other words, if we protect existing forests on Earth, we could avoid the production of 23–27 per cent of greenhouse gases produced annually. Another more recent study estimates that forest-based solutions can offer over two-thirds of all mitigation (based on land-management changes) needed to hold global warming below 2°C, in the form of avoided deforestation, reforestation and plantation (Griscom, et al., 2017). Consequently, natural forest conservation should be a priority not only for climate change mitigation, but also for a whole host of accompanying ecosystem services important to social well-being, such as providing forest goods, protecting biodiversity and the hydrological balance, maintaining soil fertility and climatic modulation.

It is also important that while the current estimate of reduction in carbon emissions by forests is 23–27 per cent, the recovery of forests all over the globe can potentially add much more to this figure. For instance, growing or regenerating a one-hectare patch of tropical rainforest can lead to the additional absorption of between 3.2 and 10 tonnes of carbon each year.[3] This implies that we can offset a great deal of carbon-emitting activities by simply protecting or regenerating degraded or cleared forests on our land (Baccini, et al., 2017).

It is also important to realise that restoring or maintaining natural forests requires minimal inputs from us—forests meet all of their ecosystem functions and much more, simply by virtue of their existence. Moreover, we do not need to 'grow forests'; regenerating degraded forests often merely needs a push in the right direction, such as protection from intensive use, water conservation, removing invasive species or planting of fast-growing 'nurse' species. Thus, there cannot be a more cost-effective way of mitigating warming than to simply restore the friendly neighbourhood forest patch, or protect old-growth forests where they are still extant.

Unfortunately, despite the important role of forests in staving off the severe effects of climate change, forest loss continues globally.

Worldwide, governments of even such developed economies as Australia have been unable to preserve the forests they have left. In 2019–2020, there have been huge losses of forest cover from Australia, as a consequence of large-scale fires in New South Wales (almost 100,000 sq km), and it has been estimated that approximately 10,000 sq km of rainforests of the Amazon basin have been lost in 2019 (Cannon, 2019). As a recent review of forest cover research shows, in India, too, there has been a significant loss of natural forests in a number of different biomes in recent years, although official figures suggest otherwise (Padma, 2018). It is feared that the recent episode of massive fires in Australia has contributed significantly to the carbon dioxide in the atmosphere, and brought several animal species to the brink of extinction.

WHAT IS A FOREST?

But what is this 'forest'? Is a forest simply a collection of big trees growing together? Particularly in the context of climate change mitigation, it is necessary to point out that natural forests are intrinsically different in many ways from recreational parks, plantations and managed/used forests. This difference is based on scientific knowledge as well as lived experience. Natural forest is composed of intricate and complex webs of food chains and resources, which are highly diversified in form and function, both along the vertical and horizontal axes. For instance, in addition to trees, forests harbour saplings of different ages, shrubs, creepers, ferns, mosses, bacteria, micro-organisms and lichens, among many other life forms. The adult trees themselves belong to a vast diversity of species, the number varying from biome to biome. Further, 'canopy gaps' are interspersed, where trees have died naturally or otherwise, creating a mosaic of varied light situations. Dead, decaying tree trunks and other plant material lie on the forest floor, providing homes for a range of organisms, including fungi. Such structural and biological diversity of natural forests is in sharp contrast to that in used forests and plantations, which are much more homogeneous, in terms of not only species and structure, but also functionality.

But how is forest structure and diversity relevant to climate change mitigation? It is an ecological axiom that ecological diversity begets efficiency in function (Reiss, et al., 2009; Adair, et al., 2018),

whether we are talking about photosynthesis—the biochemical process of plants creating food from water, carbon dioxide and sunlight—or water conservation or provision of forest goods to people. The reason is that different species of plants have different forms and functions and, therefore, together they can work much more efficiently than by themselves. Further, new research indicates some forms of communication among trees in a forest, which allows a much better collective response to danger, drought and pest attacks than by single trees (Wohlleben, 2015). Scientific knowledge is amply corroborated by local perception that thick forests are undoubtedly better for improving water availability throughout the year and for climatic modulation as compared to monocultural plantations or degraded forests (Shahabuddin and Thadani, 2018: 109–31).

The same efficiency principle applies to carbon sequestration, which has become a critical ecosystem function in the mitigation of warming impacts. As a consequence of overall higher rates of carbon sequestration as compared to artificial plantations or degraded forests, natural forest may be more effective in combating climate change impacts (Dooley and Mackey, 2019; Lecina-Diaz, et al., 2018). The other reason for improved efficiency is that native plant species are adapted to prevailing climatic conditions, and therefore survive better as part of the ecosystem whole, rather than as monocultural stands of exotic trees. An ecosystem with a greater diversity of native tree species is also more resilient to climatic extremes that are becoming more commonplace. Thus, in any discussion about climate change mitigation, the quality and type of forest is as important as its area. It is necessary to restore and regenerate natural forests as widely as possible if we are to combat warming effects worldwide (Dooley and Mackey, 2019).

The ecological difference between natural forests and plantations is important in the urban context as well. In the territory of Delhi, for instance, while government figures for 2015 to 2018 state that the overall forest cover has increased slightly in a few places, this increase has been attributed largely to the growth in artificial plantations, roadside trees and parks, rather than the restoration of natural forests.[4] Natural forests in Delhi remain in smaller fragments in such sites as Jawaharlal Nehru University, Sanjay Van, Central Ridge, Aravalli Biodiversity Park, among others,

while most of the area is now dominated by the exotic invasive (weedy) species, *Prosopis juliflora*. Accordingly, the extent the forest cover for Delhi that will be effective in controlling climate change impacts needs to be researched. Sustainable cities that can contribute to preserving ecosystem services require afforestation with native species, otherwise they can become a drag on surrounding ecosystems, both natural and agricultural.

PEOPLE AND FORESTS

The 23 per cent of India's area that is legally 'forest' physically includes forests, fallows, cultivation, grasslands, degraded forests, artificial plantations, roadside verges and abandoned weedy lots. Under various forest and wildlife laws, we have Protected Areas (PAs), Reserved Forests, Protected Forests, Village Forests and Private Forests, among several other tenurial categories. Given the variety of forest land cover categories as well as land tenure mechanisms, it stands to reason that a variety of governance regimes are required, which are suited to optimally manage and conserve forests for climate change mitigation.

The protection of forests in India has historically been dominated by state-controlled exclusionary measures in the form of formal PAs, such as wildlife sanctuaries and national parks (Shahabuddin, 2010). Such protected areas have facilitated the preservation of forests, wetlands and coastal ecosystems on a wide scale since 1947, and some of the best forests remain in PAs today, particularly in such densely populated states as Rajasthan. However, state-controlled apparatus depends on the restriction of access to local people who have been traditionally living in the area for a long time, and even eviction in many cases. The PA system is thus challenged not only by social activists, who point out historical injustices done to forest-dependent populations in and around PAs, but also by biologists, who find that flora and fauna are declining in many PAs despite legal protection. A number of reforms and improvements are required for a sustainable and effective PA network that could contribute to climate change mitigation.

Moreover, the area of land under PAs is nowhere as much as the area of forests required for ecosystem services: only 6 per cent of India's land area is under PAs. Even this area is scattered and fragmented across the country; this statistic includes deserts, alpine

areas, wetlands and marine PAs as well. We need to conserve forests across larger landscapes, especially in areas that are under use of some kind.

A large chunk of forests that are not under protected areas are actually under community control, both *de facto* and *de juris*. Forests have been the mainstay of local agrarian economies, and forest use is intricately connected with agriculture and animal husbandry. Forests are a sort of safety net for many and are seen by local people as their survival kit, and thus protected by them traditionally, although the extent of protection varies from site to site. With all their flaws, Indian forest laws have allowed for a number of tenurial arrangements under which forests can be managed locally by such village groups as Joint Forest Management (JFM) and Community Forest Management (CFM).

In Uttarakhand, the unique Van Panchayat system allows considerable local control in forest management. Most of these co-managed systems depend on the reciprocity between people and forests. While people benefit from forests near and around themselves, they invest in its protection and regeneration. However, while processes such as JFM and CFM have been useful as methods to conserve forests in the past, local communities are slowly moving away from such arrangements, because of pressures of the market economy and plummeting forest productivity as a result of climate change.

Formal arrangements notwithstanding, not all of which are working that well, there has been an upsurge of other small-scale local efforts in forest protection and restoration, most of which are being undertaken as a necessity, rather than being forced by any laws. Communities are becoming more and more aware of the need for ecologically sensitive development in and around their apartment complexes, houses, fields and villages, and are realising the link between natural ecosystems and water quality, air quality, water availability and recreational potential. In the city, today, the health benefits of living next to green areas are paramount in making family decisions as to where to live. There are innumerable village communities putting aside forest areas for conservation, or even urban municipalities investing in natural biodiversity parks where native forest types are being restored (Dasgupta, 2018). Many individuals are taking up businesses and livelihoods that depend

on forests and wetlands, although in more commercial ways such as tourism. A country-wide revival of a green conservation ethos is being seen amongst urban citizens as well. Recently, the proposal of an alternative highway between Delhi and Gurgaon—that would cut through one of the prominent afforested areas of Gurgaon—saw a huge turnout of locals to protest against this development, and PILs were filed in court for the protection of this area (ibid.).

However, in an overwhelming proportion of natural ecosystems, local populations are slowly losing interest in forests as a result of poor agricultural productivity, climate change and declining employment. Forest-based employment is being substituted by tourism and transport services near the villages, and menial jobs in the cities when families migrate. Yet, local communities are still emotionally and practically connected to their forests over which they feel a sense of responsibility. Many individuals retain their village lands to which they hope to return sooner or later, even when decisions to migrate are made. It is this emotional connection to forests that will once again need to be sustained and nurtured through incentives, both financial as well as sociopolitical.

INCENTIVISING COMMUNITIES, PRIVATE OWNERS AND CORPORATE BODIES

Can we incentivise populations to protect their forests and aid in regenerating forests, so that the trickle of restoration projects can become a flood? While many such projects have taken shape organically and spontaneously, without any external support, there are also many sites where small-scale monetary incentives can considerably speed up the process and allow more projects to be initiated. With the current level of economic distress in agrarian areas, direct payments might be one way to nurture the remnant sense of the connection that rural communities still have with forests. The model is similar to the one envisaged in JFM; only the benefits to the protectors would be in cash rather than in kind, as was the case earlier (in the form of fuelwood, fodder). It is important to note that while types of forest extraction would have to be limited in scope for adequate restoration programmes, types of use can be negotiated carefully with the local leadership, so as not to displace forest dependency of the poor or certain commercially important products. Further, forest dependency has reduced considerably

over the past decade in response to easier availability of LPG and declining animal husbandry over large parts of India, which makes such agreements easier to undertake.

Cash transfers may be made to individuals' bank accounts, village funds, or to registered societies, private individuals and NGOs (in the urban context), in which case they can be used for forest protection, village-level infrastructure and other local developmental activities. Direct cash transfers to citizens have increasingly become the norm in India in many other contexts (such as health and education), or as payment-for-work schemes (such as the Mahatma Gandhi National Rural Employment Guarantee Programme [MGNREGP]). Most Indian citizens are part of the digital network for electronic payments of various kinds directly into their bank accounts, such as government subsidies. Such digital networks that already exist are extremely conducive to the implementation of cash transfers for forest conservation programmes.

One of the possible ways to fund cash transfers for forest protection in India is via Compensatory Afforestation Management Authority (CAMPA), a federally created and administered fund that has been created out of offsets paid by private and governmental bodies for forest diversion (for developmental activities). At present, the national CAMPA fund amounts to the monumental sum of ₹54,000 crore nationally (Rautray, 2019). So, a Gram Sabha, or a private land owner (a company or private party that wants to restore and protect forests) could apply and receive the funds easily to cover costs. Since every district has one or more forest offices with field staff, forest staff could be deployed to annually check on the condition of the forest, using such quick and easy indicators as basal area, canopy closure and plant diversity. The continued payments from CAMPA could be based on the survey of such forest indicators which can be agreed on, beforehand, with the project leaders.

CONNECTING TO THE LARGER WHOLE

As an approach to mitigating warming effects, there can be nothing better than natural forest restoration that not only improves carbon sequestration rates, but also provides immense ecosystem services along the way. With some enabling policies, such efforts, currently few and far between, can become far more widespread and easier to execute.

The good news is that there has been a veritable explosion of both private and public efforts in forest restoration and regeneration during the last decade or so. Such efforts have been rather organic and show a kind of social response to the visible ill-effects of forest loss and degradation; most are small scale in nature, on the order of hectares, rather than square kilometres. The agents of such change include city-dwellers with an environmental mission (Arasu, 2016), rural communities,[5] scientists (Mudappa and Raman, 2007: 210–40), city municipalities[6] and many others, including corporate institutions. Such agents of change are setting aside and restoring forests within their management domain, or carrying out cultivation on degraded land within the communities with which they work.

Can this expanding patchwork of scattered forests, disorderly and small though they might be, coalesce to become a significant driver of restoration in the near future? It, of course, remains to be seen. But given the right facilitatory policies, such efforts could prove to be major agents of climate change mitigation in the Anthropocene—but only if the reforestation is done through means that are highly participatory and science-based, and which recognise local opportunity costs of land set-asides.

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ADAPTING AGRICULTURE TO CLIMATE TURBULENCE

SUMAN SAHAI

INTRODUCTION

We have known about global warming and climate change for years. From the 1990s onwards, the extent to which climate change could impact agriculture has been debated. The consensus was that there would not be a problem; that the increased carbon dioxide concentrations would lead to higher photosynthesis, hence higher production. If there were any impacts on food production and food deficits, these could be offset by favourable trade. By the early 2000s, there was an acknowledgement that while there were problems with agriculture, those problems would be manageable. This cynical position was held by the developed world which, by then, had recognised that agriculture in their countries would benefit from global warming, but that of the Least Developed Countries (LDCs) would suffer, leading to a higher risk of hunger. Trade—from developed to developing countries, naturally—was still projected as the panacea.

Progressing into the decade of the 2000s, there was tacit admission that the problems were indeed larger than anticipated, and that the benefits to the agriculture of developed countries were not going to be significant. Still holding on to the hope of beneficial CO_2 fertilisation, mavens of developed countries continued to promote trade as the equaliser when climate change would hit food availability in the global South (Nelson, 2009). Today, it has become abundantly clear that higher CO_2, accompanied by high temperatures, will damage crops across the spectrum and geographical zones. Scientists record a higher incidence of pest and disease when CO_2 levels rise.

Developing countries in the tropics are more susceptible to climate change damage than temperate countries, most of which will be beneficiaries. The worst impacts of climate change on food production are expected to be felt in Africa and South Asia. For the latter, where agriculture remains largely monsoon-dependent, disturbances in the monsoon cycle, as we know it, could have grave implications for food and water security. If the monsoon falters, so does our agricultural production as well as the livelihood security of large parts of the population. The higher frequency of such extreme weather events as floods and cyclones is taking an additional toll.

Changes in rainfall patterns and temperature regimes influence the local water balance and disturb the optimal cultivation period for particular crops, known as the Length of Growing Period (LGP). According to climate data, land with good LGP will decrease by over 51 million ha worldwide.

Adequate LGP is required to ensure that medium-to-long-duration crops can successfully grow to maturity. Some crop varieties ripen quickly and are ready for use in a shorter period (short duration varieties). Others, especially among cereals, require longer duration to mature. When the LGP in an agro-climatic zone is long, a variety of crops from short duration to long duration can be cultivated throughout the growing season. This means higher food production. When, on the other hand, the LGP contracts, the growing season is shortened, fewer crops can be cultivated, with implications for food production. Most climate models predict large increases in the LGP of today's temperate and Arctic regions. This means that temperate regions, which are currently one-crop zones (growing just one crop per year), will become two-crop zones (growing two crops per year), resulting in a doubling of food production.

Climate-related impacts on food production will be geographically unevenly distributed. In a perverse irony, developed (industrialised) countries will experience an increase in agricultural productivity potential as temperate regions get warmer. The regions which, because of their industrialisation and huge emissions of greenhouse gases (GHGs), are responsible for the climate change phenomenon, will actually end up being its beneficiaries with respect to food production. On the other hand, today's developing world in the tropics, which has not contributed to creating this climate hazard, will be its worst victim, and will suffer a loss in

agricultural productivity, with serious consequences for food availability and hunger.

About 40 poor and food-insecure countries, with a projected total population (in 2080) of 1–3 billion, will lose 10–20 per cent of their cereal production potential. Of these, Africa will be the worst affected and South Asia will be badly affected. Crop production losses, as a result of climate change, could further worsen the prevalence and depth of hunger. This burden will fall disproportionately on the poorest and most vulnerable. To compound the damage, the overall trend of reduced food production will create market imbalances, which will push up international prices, making it even more difficult for governments of food-scarce countries to access food for their poor.

According to estimates, a little less than half the production potential in certain developing countries could be lost. In South Asia, the biggest blow to food production is expected from the loss of multiple cropping zones. The worst-affected are predicted to be the double- and triple-cropping areas. This means areas where two-to-three crops are produced in a year and which are predicted to turn into single-crop zones, where only one crop can be taken in a year because the rest of the season will be too hot and dry to support cultivation.

Impact of Climate Change on the Global Economy by 2100

India will lose 10% of its economy by 2100 if nothing is done to address climate change

The US will lose 10.5% of its gross domestic product (GDP)

Canada would lose 13% of its income

Japan and New Zealand will lose 10% of their income

Switzerland will lose 12% of GDP

Russia will lose 9% of GDP

UK will lose 4% of its GDP.

If it's business as usual, the global loss of income would amount to 7%

BUT if Paris Agreement implemented, emissions controlled, temperature rise arrested, then impact of global warming will be reduced. For e.g., US and Canada would lose only 2% of their GDP.

Source: *NBER Working Paper No. 26167, August, 2019*

There is a broad consensus that tropical areas are slated to see an expansion of arid zones. This will be accompanied by a contraction

of 31–51 million ha of favourable cultivation areas and a significant reduction in food production in the most vulnerable, where population density is high and food is already scarce. Nearly one billion affected people live in these vulnerable environments, dependent on agriculture. These vulnerable populations have a limited capacity to protect themselves from the environmental hazards that will accompany climate change, such as drought and floods, and will suffer most from climate damage, such as land degradation and biodiversity loss.

THE IMPACT OF CLIMATE CHANGE ON AGRICULTURE IN INDIA

DISRUPTED RAINFALL

Cropping systems have developed, depending on the rainfall patterns of the region. When this pattern is disrupted, as it is now, and there is greater variability in the intra-rain period, there is a negative impact on crop production.

Take for example the millet crop in mountain areas such as Uttarakhand. Here, nurseries of finger and barnyard millet were traditionally planted end May to early June. The monsoon usually started in the first week of June and nurtured the nurseries. The seedlings were transplanted by late June. Now the monsoon comes by end June to early July, and the whole millet cultivation cycle is disrupted.

Precipitation patterns are changing across all ecosystems, with unseasonal rains leading to unpredictable floods and drought. The southwest monsoon, India's lifeline for food production, has diminished by about 15 per cent. For a country where the majority depend on rainfed agriculture, and which gets most of its precipitation from the summer monsoon, 15 per cent is a substantial reduction. At the same time, rainfall intensity is rising, increasing surface runoff and, with it, the depletion of soil nutrients.

A common misunderstanding is that even if the rains are delayed or disrupted, the deficit can be made up if it rains enough later. Media reports convey that areas that had received a shortfall had now received sufficient rain. This conveys the impression that all is well—it is not. Deficit rain being made up later will work to increase the water levels in dams, revive tanks and wells, and recharge aquifers, but rain that comes at the wrong time is bad for agriculture; it actually damages crops because it disrupts the cropping cycle.

In October 2019, when the southwest monsoon should have started withdrawing, Madhya Pradesh, Jharkhand, Chattisgarh, Gujarat, Maharashtra, Rajasthan, Orissa, Kerala and Karnataka received large amounts of rain. Far from making up anything, this unseasonal rain caused substantial damage to standing crops. Amongst the worst hit was Karnataka, where 10.2 million ha of farmland was affected, causing huge losses to farmers.[1]

IMPACT ON DIVERSE ECOSYSTEMS

There are many diverse ecosystems in India, ranging from high mountain ranges to the vast plains of the Indo-Gangetic basin, the biodiverse Western Ghats and the coastal areas along India's long coastline. It is clear that climate change will have different kinds of impacts in these diverse regions. For example, while large parts of Rajasthan, Andhra Pradesh, Gujarat and even Orissa and Uttar Pradesh face frequent drought, some 40 million ha of land in the north and northeastern belt are prone to recurrent floods.

INDO-GANGETIC PLAINS

The Indo-Gangetic Plains (IGP), stretching from Punjab, through Haryana, Uttar Pradesh, Bihar, up to West Bengal, has some of the most productive agricultural land in South Asia, providing food for over 400 million, primarily through a rice–wheat rotation system. Over the past few decades, however, rice and wheat yields have declined and, in some cases, as in the Punjab, stagnated. This alarming signal from India's major food bowl needs urgent attention by adopting adaptive measures and building climate resilience in the food systems. Climate change is taking its toll in the IGP, which is already suffering from diminishing soil fertility, soil nutrient imbalances, and a buildup of diverse pests and pathogens. Groundwater levels have sunk dangerously low, because this belt has based its rice–wheat production largely on groundwater.

Climate change is expected to amplify the adverse impacts of existing pressures. Already, wheat is being cultivated close to its maximum temperature threshold. Any rise in temperatures will have an immediate and decisive impact on wheat yields. Even now, higher temperatures during the grain-filling stage are becoming yield-limiting in much of the IGP. It is estimated that by 2050, approximately half the highly productive wheat areas

of the IGP could be downgraded as a heat-stressed, short-season production zone.

Not just wheat, rice production is also likely to go down by 10 per cent for every 1°C rise in night temperatures. If projected estimates for South Asia come true, and temperatures do indeed rise by 3.3°C by the 2080s, then rice yields will suffer a major blow (Sahai, 2012). Added to this, higher temperatures (hence, higher evapotranspiration) will increase the seasonal variability in rainfall, and the eventual loss of seasonal glacial meltwater will put even greater pressure on water availability, leading to increased salinity. Climate change may already be contributing to productivity decline in the IGP as a consequence of lower solar radiation and increased minimum temperatures. These factors drive down rice yields by decreasing photosynthesis and increasing respiration losses.

COASTAL AREAS AND RIVER DELTAS

The melting of polar ice caps and sea ice, and the steady melting of land-based glaciers, is expected to raise sea levels by up to 20 inches by the middle of the next century. Low-lying coastal areas are being threatened by the incursion of sea water, leading to the increased salinisation of arable land and aquifers.

This region has both rainfed and irrigated agriculture. Rice is the main crop in both the kharif and rabi seasons, and coconut the prevalent plantation crop. Besides crops, brackish water fisheries are the important economic activities of coastal populations.

The area is prone to cyclones, and their frequency is increasing as climate change kicks in. Extreme weather episodes and seawater incursion are beginning to take a toll on both crop production and aquaculture.

MANGROVES

The Sunderbans mangrove forests, one of the most exotic and important wildlife habitats in the world, are particularly vulnerable to changes in temperature and CO_2 levels, altered rainfall patterns, high-intensity storms, and rise in sea level. All these directly impact the integrity of mangrove ecosystems, and this impact will be felt economically as agriculture and fishery are affected. Mangroves are the spawning grounds of crustaceans, chiefly prawn of high value that serve as food and the source of good incomes.

Besides the mangroves, negative impacts will be experienced in other parts of the delta regions of Peninsular India, affecting productive agriculture. While the Mahanadi, Godavari and Cauvery Rivers are considered to be moderately vulnerable, the Krishna is estimated to be highly vulnerable to climate change.

In the long run, the most pressing threat from anthropogenic climate change in coastal areas will be the rise in sea level and increases in precipitation. In a worst-case scenario, the temperature could increase between 1°C and 7°C by 2070. This would translate into a 60 cm increase by 2100,[2] destroying swathes of extremely productive rice fields, aquaculture and coastal fisheries.

SEMI-ARID AND ARID REGIONS

Semi-arid and arid regions are defined by water shortages, which are likely to worsen in the coming days. This will have a significant impact on agriculture and food availability.

The semi-arid zone comprises the northern plains and the central Malwa highlands, which are largely in Madhya Pradesh, with portions of Bundelkhand and Rajasthan, and the Deccan plateau. The Deccan plateau includes central and western Maharashtra, northern Karnataka and western Andhra Pradesh. Agriculture here is largely rainfed.

Climate impacts are projected to vary in this region. The western belt is slated to receive higher rainfall, but the central part will likely experience a shortfall of 10 to 20 per cent by 2050. The northern plains will see a significant rise in surface temperatures, anticipated to range from 3.5 to 5°C by the end of the century. According to the Department of Agricultural Meteorology, higher temperatures and CO_2 concentrations are already reducing the yield of wheat and maize in this belt (Trivedi, 2013).

The Thar desert, located mostly in Rajasthan, is flanked by the Indus River plain in the west, Punjab in the north and northeast, the Aravalli Range touching Delhi and Haryana in the southeast, and the Rann of Kutch in the south. Life in the desert is becoming even more challenging as temperatures rise and fresh water sources become more saline. Freak rains—even floods—as a consequence of climate change, have raised the water table. As a result, salt in the deeper layers rises up to contaminate sweet water.

The unusual flooding in Barmer in August 2006, and again in Jodhpur in 2009, has created ecological imbalances. The excessive precipitation in desert areas is destructive to the ecosystem and affects livelihoods adapted to live with water scarcity. Besides the disruption of crop cycles and varieties adapted to low water availability, natural vegetation used as food and fodder is also disturbed. The loss of such traditional food sources hits rural and pastoral communities particularly hard (Nandi, 2006).

MOUNTAIN AREAS

The mountain areas will see considerable upheavals triggered by climate change. According to a review conducted by the International Centre for Integrated Mountain Development,[3] by 2050, temperatures across the mountains of the Hindu Kush Himalayan region could increase up to 4–5°C in some places. The monsoon is expected to become longer and more erratic, disrupting the cycle of water availability. Although the trend is for fewer extreme rainfall events, these are becoming more intense and destructive.

Glaciers are melting at unprecedented rates, and rising temperatures are leading to earlier and faster spring snowmelt. The worst impacts are being seen in the Indus basin.

Greater river flow—with higher variability in the flows, and greater volumes in the pre-monsoon months—is projected for the short term. This will lead to more frequent and unexpected floods and droughts, negatively affecting agriculture and livelihood security in riparian regions.

Climate Change Impact on Darjeeling Tea

Tea grows best between 600 and 2000 meters, at temperatures from 18°C to 30°C and relative humidity of 95 to 98%

Climate change has upset all this in last 20 years

Temperature rise of 0.5°, decline in annual rainfall of 152 cm and relative humidity lower by 16%

Production of Darjeeling tea down from 11.3 mio kg in 1994 to 8-8.5 mio kg in 2018, a decline of about 30%

Highly prized aroma of the tea diluted

Source: *Darjeeling Tea Research & Development Center, Kurseong, Darjeeling*

Another outcome of higher temperatures in mountain areas is that instead of winter snow, there is more winter rain. This has two negative fallouts. Snow sits longer on the ground, and, melting slowly, it nourishes roots and recharges aquifers. Rain, on the other hand, flows away faster, causing greater soil erosion and failing to trickle into aquifers or recharge springs. Intense bursts of heavy rain carry away more sediment and soil nutrients than snowmelt, all of which makes agriculture and horticulture less productive.

IMPACT ON CROPS, ANIMAL HUSBANDRY AND FISHERIES

According to the Intergovernmental Panel on Climate Change (IPCC) and other studies, rising temperatures will result in as much as 10 to 40 per cent reduction in crop production by 2080–2100 (Parry, et al., 2004).

WHEAT

Uttar Pradesh, Punjab, Haryana, Uttarakhand and Himachal Pradesh are some of the major wheat-producing states, where wheat is the main winter crop. Here, the impact of climate change will be profound because in the plains of Uttar Pradesh, Punjab and Haryana, a mere 1°C rise in temperature could dramatically reduce wheat yields. One year, when night temperatures rose significantly in Haryana, wheat production dropped from 4,106 kg/ha to 3,937 kg/ha (Cooshalle, 2007). Research in India shows that for every 1°C rise in temperature, wheat production will go down by 4–5 million tonnes (Aggarwal and Sinha, 1993; Saseendran, et al., 2000).

RICE

Rice yields will start getting impacted if temperatures rise above 1°C. Grain yield will then reduce by 10 per cent for every degree rise in temperature (Singh, et al., 2009: 45). Thus, global warming will impact world rice production, creating the possibility of a shortfall. Basmati rice is particularly vulnerable to higher temperatures, leading to reduced grain formation. This will directly impact premium Basmati export earnings.

Studies show (Aggarwal, et al., 2000) that rice yields have been decreasing in the Indo-Gangetic belt, as also in the Philippines (Peng, et al., 2004). The increased carbon dioxide in the atmosphere, as a consequence of global warming, could initially result in higher

levels of photosynthesis and hence some yield advantage in certain crops such as mustard, peas, tomato, onion and garlic. However, all these show a decline in yields as temperatures rise (Aggarwal, 2008).

Climate Change Impact on Rice

Yield of IR 8, the high yielding 'Miracle Rice' is down by 15%

Hotter nights, changes in soil due to increased flooding and air pollution have driven down yield

Rice crops imperiled by sea level rise inundating hundred thousands of coastal rice fields

Increase in powerful tropical storms have devastated rice crops

Cyclone Sidr hit Bangladesh in 2007, reducing the rice harvest by almost 2 million metric tons

Cyclone Nargis hit Myanmar in 2008, destroying the Irrawady River Delta which could not plant rice, leading to a shortfall of about 1.5 million tons

http://www.asiasentinel.com/index.php?option=com_content&task=view&id=2743&Itemid=232

MAIZE

Maize is a particularly important crop in mountain and desert regions, where its production is critically dependent on rainfall, with variations in rainfall patterns and temperature negatively impacting the crops. In Tamil Nadu, assessments indicate a reduction in maize yield by up to 18 per cent by 2080 (Geethalakshmi, et al., 2007: 18). The maize yield during the monsoon could be reduced by up to 35 per cent in most of the Southern Plateau region, and up to 55 per cent in the Mid Indo-Gangetic Plain, whereas the Upper Indo-Gangetic Plain is expected to be relatively unaffected (Byjesh, et al., 2010).

ANIMAL HUSBANDRY

Besides crops, animal husbandry is an integral part of Indian agriculture. This is of special relevance to small farmers and landless agricultural labour who depend on animal outputs for their income. Although such small ruminants as sheep and goats are popular, it is largely cattle and buffaloes that bring in assured incomes because of the milk chains that have been set up to collect milk practically from the farmers' doorsteps. Dairying gives

landless agricultural labour 2.5 times more return than crop-based agriculture (Sahai, 2019).

India is the world's largest producer of milk. The milk revolution is based on high-performance cattle, such as crossbred Holstein–Friesian and Jersey. Although they are good milk yielders, such cattle are also extremely sensitive to high heat and water stress, and are thus very vulnerable to climate change. Climate change reduces the performance of hybrid cattle significantly for a number of reasons. Milk yield in such cattle can go down by as much as 40 per cent (Garg, 2010). The demand for drinking water, already high, rises when it is hot—something that is not always easy to meet in dryland areas.

FISHERIES

With its extensive coastline, fisheries have been an integral part of the agriculture and food production landscape of India. Both marine and fresh water fishery have nurtured entire communities over generations. Climate change presents a significant threat to the food and nutritional security of these fishing communities as well as their incomes. Ocean temperatures affect the life cycle of marine fish. Spawning is especially sensitive to the temperature on the sea surface. Climate change is having a direct and visible impact on the survival and size of fish populations. This impacts the availability of commercially important fish in traditional fishing grounds.

India also has a large network of rivers, tanks and ponds, which support a wide variety of fresh water fish that are the livelihood base of fishing communities living along rivers. Changes in rainfall

Climate Change—Nutrition

- Nutrient rich crops are more vulnerable to drought, temperature variation, pests and disease
- Higher temperatures will cause soil degradation, reducing nutrients, producing nutrient deficit crops
- Higher CO_2 levels in atmosphere will reduce nutrient content of crops
- Higher CO_2 concentrations will reduce the amount of iron and zinc in staples like rice, wheat and pulses
- Iron and zinc deficiency will further exacerbate already high incidence of anemia globally

patterns and lower precipitation alter the flow and turbidity of river water, affecting the breeding patterns of various fish species (Vivekanandan, et al., 2009: 93).

Higher temperatures and changes in rainfall patterns have caused a shift in the distribution of fish in the Ganges. Warm-water fish species, earlier found mid-river, are now found upstream in what used to be colder waters near Haridwar (Das, 2009: 102).

CHANGING PEST PROFILES

The evolution of new pests and pathogens, changes in pest–pathogen virulence, and the altered timings of pest and disease attacks are all features of pest and disease behaviour under changed climatic conditions, disrupting existing crop protection strategies.

Farmers have known the pests and diseases that are likely to affect their crops, and the season in which they are likely to manifest, and develop appropriate coping strategies accordingly. Unfortunately, integrated pest management has been discarded by the research establishment and toxic pesticides are recommended to farmers (Sahai, 2019). But even their use has a seasonality, which is not anymore in sync with the changes in pest profile and the new timing of pest/disease attacks. What is apparent is that the uncertainty and unpredictability associated with climate change makes preparedness difficult. This, coupled with our scanty knowledge of insect and pathogen behaviour and the wide range of pests present in tropical countries, compounds the problem (Chalam and Kheterpal, 2010).

ADAPTING TO CLIMATE CHANGE

The ability of a country to cope with the impact of climate change on agriculture will depend on a number of factors. India has technical skills in the agriculture sector and a sophisticated farming community capable of combining indigenous knowledge with recent scientific advances to overcome challenges. The country is rich in biodiversity, and community experiences from diverse agro-ecological zones in the country offer a number of options to find solutions to current problems. All this would enable the agriculture of a region to cope with climate change impacts, provided a comprehensive and effective policy response is put into action at once.

Coping with changes induced by global warming will require early detection and careful management of such factors

as land degradation and aridity, diminishing water bodies and water scarcity, reduced forest cover and biodiversity loss. Policies that reduce pressure on resources and improve the management of environmental risks will help to improve adaptive capacities and increase the welfare of the poor by developing better coping mechanisms. If climate change impacts can be incorporated into the design and implementation of development programmes immediately, it will help to reduce vulnerability (Sahai, 2010).

PROTECTING CROPS

Agro-biodiversity, along with indigenous knowledge, is a powerful resource to build resilience into crop production. We have hundreds, if not thousands, of varieties of each crop. Farmers know the varieties that are drought or flood tolerant, those that are early or late maturing, and those varieties that are resistant or vulnerable to specific pests or diseases, etc.

Over millennia, farmers have faced adverse situations such as disease, pest attacks, high heat and drought, floods and excessive humidity, and salinity or acidic soils. Every time they have faced adversity, they have noted those varieties that survived and have had the wisdom to save them, knowing that adverse weather conditions would come again. The farmers of Rajasthan have crop diversity suited to the extremely high heat and arid conditions of the desert, and those of Ladakh have maintained crop varieties that can withstand the biting cold and low moisture conditions of the cold desert area. This genetic diversity provides the farmer with crop choices when the climate starts changing (Sahai, 2013).

COPING WITH WHEAT LOSS

For South Asia, particularly India, one of the most serious impacts is anticipated in wheat production. Wheat is the single-largest winter crop of north India and states such as Punjab, Haryana and western Uttar Pradesh produce the surplus wheat that goes into the Public Distribution System (PDS).

The immediate challenge is to find a substitute for wheat. Maize could be suitable as a supplementary crop and a partial wheat replacement. Millets are as yet an unexplored option in this regard and have not been assessed for their potential. Although millets typically grow during summer in Asia, there are also

several varieties which are cultivated at high altitude. Such millet germplasm could form the basis of developing new varieties suited for cultivation during the winter season of a changed, warmer climate regime.

PROTECTING LIVESTOCK

Compared to the sensitive, hence vulnerable, crossbred cattle, indigenous breeds are hardy and far better equipped to withstand the ravages brought about by changing climate. Our strategy to maintain milk output should be to deploy locally adapted cattle and buffalo breeds, and protect and enhance their performance. Careful genetic selection to pick out high performers in native breeds as well as breed improvement programmes should be undertaken without losing any genetic diversity in cattle and all other livestock. Heat-tolerant varieties of fodder crops need to be developed, and research must enable rapid diagnoses of new diseases in both animals and plants.

SOME IMPORTANT POINTS

Besides the obvious focus needed on soil health, water management, and conservation and pest management, agriculture and food production, per se, will need to become sustainable and ecologically sound to adapt to climate turbulence.

(i) A special package for adaptation should be developed for *rainfed areas*, based on minimising risk. The production model should be diversified to include crops, livestock, fisheries, poultry and agro forestry.

(ii) A knowledge-intensive, rather than input-intensive approach, should be adopted to develop adaptation strategies. Traditional knowledge must be included.

(iii) Decentralised seed production programmes, involving local communities, should be set up. Seeds of the main crops and contingency crops (for delayed/failed monsoon or floods), as well as seeds of fodder and green manure plants specific to the agro-ecological unit, must be produced and stocked.

(iv) Agriculture credit and insurance systems must be made more comprehensive and responsive to the needs of small farmers.

Above all, we must invest in strategic research to enhance adaptive capacity. Some priority areas are:

(i) Evaluation of traditional varieties and animal breeds for valuable genes for heat tolerance, drought and salinity resistance, feed conversion efficiency and disease resistance, for use in breeding new varieties and breeds;

(ii) developing balanced ration, and feed and fodder regimes that will increase the milk yield of indigenous cattle;

(iii) participatory plant breeding to develop climate-resilient crop varieties that can tolerate higher temperatures, drought and salinity;

(iv) developing short-duration crop varieties (especially wheat) that can mature before the peak heat phase sets in;

(v) selecting genotypes in crops that have a higher per-day yield potential, to counter the yield loss from heat-induced reduction in growing periods;

(vi) developing an alternate complement of rabi crops for north India to make up for losses in wheat production.

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NOTES

1. See *The Times of India,* 2019, 'October Rainfall hits Crops on 10.2 lac hectares; Karnataka Worst Affected', 5 December. https://timesofindia.indiatimes.com/city/bengaluru/oct-rainfall-hit-crops-on-10-2-lakh-hectares-ktaka-worst-affected-state/articleshow/72374774.cms.
2. IPCC, Chapter 13, 'Sea Level Change.' https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5_Chapter13_FINAL.pdf. Accessed on 24 December 2019.
3. See Himalayan Climate Change Adaptation Programme (HICAP), International Centre for Integrated Mountain Development (ICIMOD). http://www.icimod.org/hicap/?q=4779. Accessed on 16 December 2019.

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ELEPHANTS ON THE MOVE

Implications for Human–Elephant Interaction

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INTRODUCTION

The Asian elephant, *Elephas maximus*, celebrated as the national heritage animal of India, in particular, continues to be one of the most loved and revered of all wild non-human species across both South and Southeast Asia. It belongs to the Family Elephantidae of the Order Proboscidea, and has an evolutionary history of nearly 250,000 years in the Indian subcontinent (Sukumar, 2003). Elephants are known to be highly social animals with a matriarchal family structure. The males disperse from the family from the age of 10 to 15 years to establish their own home range away from natal herds, possibly to avoid inbreeding. Being large-bodied mammals, weighing up to 5,000 kg, they consume up to 250 kg of fodder and 150 l of water each day, depending upon their body weight. In order to meet this gargantuan appetite, elephants often move over large areas, ranging from 500 to 1,000 km^2 annually (ibid.).

THE ASIAN ELEPHANT IN SOUTH ASIA

The documentation of elephant ecology and behaviour can be traced back to the ancient scripts of sage Palakapya's *Gajashastra* (5th–6th BC), a treatise on elephants. During the colonial era, Sanderson (1907) and Stracey (1963) described the methods to capture and train elephants for use in timber-logging operations. The interest in understanding the elephant during this period, however, seemed to be utilitarian in nature, for example, as use in warfare or in timber-logging operations. About four decades ago, a decline in elephant populations—as a result of over-harvesting through poaching and capture, and an increase in crop depredation by elephants because of habitat loss and fragmentation—was recognised as primary causes of endangerment of the Asian elephant. Consequently, a need to conserve elephants, using scientific knowledge available on the species, arose. This led to a renewed interest in the behaviour and ecology of wild elephants. Scientific studies on both Asian and African elephants under the broad topics of behaviour, ecology and conservation were initiated during the early 1970s.

In Asia, such studies were pioneered by McKay (1973), Sukumar (1989) and Seidensticker (in Eisenberg, et al., 1990), and ever since have been followed by exemplary studies in each topic by a number of elephant biologists. McKay's work in the south-eastern part of Sri Lanka focused on the behavioural ecology of the Asian elephant, providing insights into their behavioural and movement patterns, habitat utilisation and social organisation, while Seidensticker's work in the Mahaweli River Basin (Sri Lanka) assessed the impact of development projects on elephants and crop depredation by them, providing insights into the nature of interactions between humans and elephants (ibid.). In 1989, in the first monograph on the Asian elephant, Sukumar discussed, along with the earlier-mentioned behavioural and ecological aspects of Asian elephants, their status and distribution globally, population dynamics, feeding and nutritional ecology, elephant and human conflict, and their conservation and management.

The historical range of the Asian elephant extended from West Asia to China, covering an area of approximately nine million km^2 (Sukumar, 2003). They are today restricted in the wild to 13 countries across South and Southeast Asia. With numbers in the wild estimated to be about 44,000–56,000 (Blake and Hedges, 2004), the species has been declared to be endangered by the International Union for Conservation of Nature and Natural Resources (IUCN) as a result of rapid loss, shrinkage and degradation of their natural habitats.

THE STATE OF THE ELEPHANT IN INDIA

India alone is home to nearly 27,000–29,000 elephants, i.e., nearly 57 per cent of the global population (Choudhury, et al., 2008). Owing to the large-scale poaching of individual elephants for their tusks and rapid reduction in their habitat, the elephant was declared

a Schedule I species under the Wildlife (Protection) Act 1972 of India, providing it with the highest level of protection. Project Elephant, a scheme of the Government of India, was also launched in 1992, providing further impetus for its protection and to mitigate human–elephant conflict, which was gradually on the increase throughout the country.

Elephants are to be found in the southern, northwestern, central and northeastern regions of India, most of them within the 32 existing and/or recommended elephant reserves in 10 elephant landscapes. The total area under conservation for elephants within the country is around 65,000 km^2, encompassing national parks, wildlife sanctuaries, reserved forests, community reserves and production landscapes (Rangarajan, et al., 2010). Elephants have large home-ranges, often extending into human-use areas, and therefore their conservation and management can be challenging and complex. An elephant reserve or the movement of elephants themselves may not be limited by the state or administrative boundaries and, hence, the effective management of moving populations often requires cooperation and coordination across state boundaries. Such reserves may also often be connected with one another through corridors of forests that facilitate the movement of elephants across the larger landscape, occasionally a matrix of production landscapes, human habitations and forested habitats.

THE ASIAN ELEPHANT IN A DYNAMIC LANDSCAPE

With its vast agricultural fields, grazing pastures and ample tree cover, wild animals, including elephants, earlier roamed the rural Indian landscape quite extensively. With increasing economic growth and development of rural India, however, most non-human populations are today challenged to survive in peri-urban habitats. While rural transformations have profoundly altered the lives of human communities, their impact on non-human species has rarely been explored. In the Anthropocene, however, with more than half of all Asian elephants living in human-use landscapes outside 'inviolate' Protected Areas, human–elephant interactions have increased dramatically, with the often-antagonistic interactions being termed as human–elephant conflict. Tragically, about 400 people and 150 elephants succumb to this conflict each year in India alone (ibid.). While elephants appear to be increasingly adapting to these

changes, such negative interactions create enormous antagonism among local communities towards elephants. This has emerged as one of the greatest challenges to the survival of Asian elephants in the 21st century, across their distribution range.

With increasing economic growth and urbanisation in India, the survival of several Asian elephant populations in peri-urban habitats in and around cities, such as Bangalore, is a challenge. For elephants to endure in such unpredictable landscapes, they need to adapt rapidly to their changing local environments, at times displaying 'novel' behaviours that deviate considerably from what has been observed traditionally.

BEHAVIOURAL RESPONSE OF ELEPHANTS TO LOCAL ECOLOGICAL AND ENVIRONMENTAL SETTINGS

Given their large body size and low metabolic rates, elephants need to forage constantly, sometimes up to 18 hours a day and, hence, foraging may take precedence over other behavioural demands on the individual. Accordingly, our study elephants, too, appeared to strongly track forage-rich areas in the dry season more than in the wet season, both within Protected Areas and in the surrounding human-dominated landscape.

The relatively higher propensity of our study individuals to appear in the high-forage patches during the dry season, rather than during the wet season, clearly indicated that the elephants were selectively using the limited number of patches with high forage available to them. In the wet season, however, when forage was more abundant and distributed more uniformly across the region, their preference for particular patches was low.

Human disturbance, on the other hand, takes precedence over forage in influencing elephant decision-making when the resource is abundant, for example, during the wet season. This suggests that the study elephants avoided using human-activity areas, more so during the wet than during the dry season. In the wet season, forage was more uniformly distributed over the area and the elephants could thus afford to choose high-forage and low-human activity patches. In the dry season, however, forage availability was limited only to a few patches, which were also used by humans and their livestock. Elephants, therefore, were compelled to increasingly use these patches during this season.

Water had a weak positive influence on the ranging behaviour of the study elephants in this landscape, which could be attributed to the evenly distributed water sources, even during the driest of months, across the region. First, the landscape was generally undulating, with numerous valleys that could potentially hold water. In addition, a number of artificial and natural perennial water bodies were present in the region. Thus, water availability was not the most important factor determining behavioural decisions, at least with regard to their ranging patterns across the landscape.

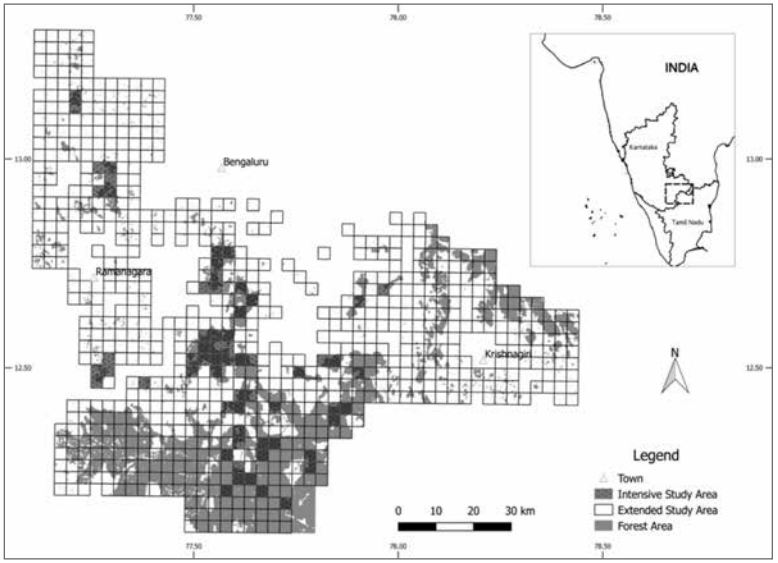
It is well known that both Asian and African elephants generally prefer large, relatively undisturbed, patches of forests with adequate forage, water and shade (Sukumar, 1989; Buij, et al., 2007; Wittemyer, et al., 2008). Such resource-seeking, but simultaneously risk-avoiding, behaviour may thus be essential for their long-term survival in any habitat, but increasingly so in human-dominated landscapes. The spatio-temporal separation shown by elephants with humans on a seasonal as well as diurnal scale may have also helped keep conflict levels—often leading to human and elephant deaths—low (Douglas-Hamilton, 1972; Bhaskaran, 1998; Mavatur and Singh, 2011).

BEHAVIOURAL RESPONSE OF ELEPHANTS TO CHANGES IN MICRO-CLIMATIC CONDITIONS

The increase in developmental activities and widespread change in land-use practices appears to be gradually, but surely, impacting the delicate synergy between humans and wildlife in rural areas across the country. Large areas such as rocky outcrops, often outside Protected Areas, are being eroded by mining activities, thus rendering them unsuitable for wildlife. India's agriculture has traditionally been rainfed and dependent on monsoon rains. The patterns of rainfed agricultural practices, however, have changed considerably in our study region along the Eastern Ghats of southern India over the last 25 years (Adhikari, et al., 2015). With development and improved technology, farmers are irrigating their lands using groundwater or irrigation canals. This has led to changes in land use in regions around forested areas, from a single crop a year to multiple crops, as well as water-intensive cropping patterns. With a concomitant loss of natural habitats, the elephants are being increasingly attracted to production landscapes in order to feed on the nutritious and easily available crops grown there, thus leading to a prolonged stay in human-dominated landscapes and a consequent change in their behaviour, including modifications in their own sociality (Figure 2).

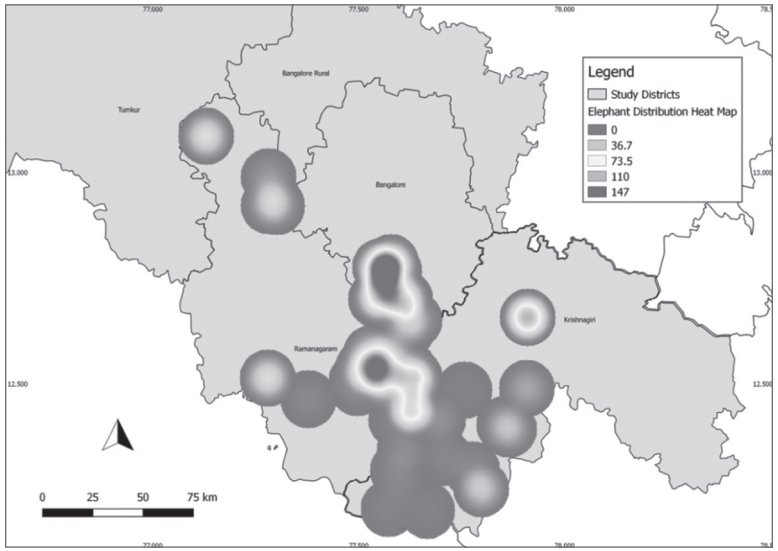
Crop-foraging bull elephants were in better physical condition than those that did not (Chiyo, et al., 2011; Chiyo, et al., 2012; Pokharel, et al., 2017; Srinivasaiah, et al., 2019). The biology of the elephant dictates that better body-conditioned males come into *musth* (a heightened state of sexual activity in males) more frequently, and can remain in this state for longer durations than can males with poor body condition (Sukumar, 2003). Studies have also suggested musth and body condition as key factors for reproductive success in male elephants (Chelliah and Sukumar, 2013). Feeding on human-grown crops is a high-risk, high-reward strategy that male Asian elephants may choose to adopt under certain circumstances; this, in turn, leads to increased human–elephant conflict (Sukumar and Gadgil, 1988; Chiyo, et al., 2011).

Figure 1. Map of the study area in southern India, showing a matrix of forested and non-forested habitats of the study elephant population, the survey area and the intensive study area.



Source: N. M. Srinivasaiah

Figure 2. Distribution of elephants in the study area. The values in the legend represent the kernel density estimates of the frequency of occurrence of elephants in the study landscape.



Source: N. M. Srinivasaiah

BEHAVIOURAL RESPONSE OF ELEPHANTS TO LARGE-SCALE CHANGES IN THEIR ECOLOGICAL AND ENVIRONMENTAL SETTINGS

Over the past three decades, elephants have been increasingly observed to move long distances, away from their natal habitats, to completely new areas, often recolonising, and sometimes colonising novel habitats. It has been reported widely that elephants from Uttarakhand started frequenting areas of Himachal Pradesh from 2006; from the early 1990s, elephants from Jharkhand have been regularly coming into south Bengal; elephants from Jharkhand and Odisha have been located more or less permanently in Chhattisgarh since the 2000s; today, elephants of north Chhattisgarh have found a forest home in Bandhavgarh Tiger Reserve in Madhya Pradesh; elephants from Dandeli in Karnataka moved into Goa and Maharashtra in the early 2000s; and elephants from Hosur in Tamil Nadu moved into Chittoor district of Andhra Pradesh during the early 1980s, and continue to do so even today. In all, since 1980, five new states in India have elephants.[1]

The proposed proximate causation for such movements has ranged from large-scale, open-cast mining that has completely decimated elephant forests in Jharkhand and Chhattisgarh, to such global climatic events as the El Nino that may have prompted the movement of elephant herds from Karnataka and Tamil Nadu into the neighbouring state of Andhra Pradesh (Sukumar, 2003). Changes in climatic conditions or large-scale destruction of elephant habitats, both of which may result in degradation of habitats with a consequent non-availability of food, water and shelter for elephants, may force them to leave their natal areas and disperse in search of new habitats. Often such dispersal would occur across human-use production landscapes, bringing elephants into conflict with people, often those who have never seen, let alone interacted, with wild elephants in their lifetime.

A recent study by Kanagaraj, et al. (2019) modelled the impending change in climate–water balance as a result of global warming, including changes in temperature and human-induced disturbances, on the distribution of the Asian elephant in India and Nepal. The results of their study seem to suggest that elephant distribution would be driven predominantly by changes in climate–water balance, temperature and human-induced disturbances. They predict that 'around 41.8% of the 256,518 km^2 of habitat available at present will be lost by the end of this century due to combined effects of climate change and human pressure' (ibid.). They also suggest that increasing droughts, also brought about by El Nino, may lead to the elephants moving to higher elevations along valleys in the Himalayan mountains, especially in a region like India where species distribution is influenced by monsoonal climates.

Elephant populations today typically occur in high densities within well-established Protected Areas across the Indian subcontinent. This is especially true for females of the species. Production landscapes such as cropfields, plantations and grazing pastures, however, cover over 60 per cent of the land area and are known to provide adequate space and resources to accommodate the coexistence of a wide array of wildlife alongside burgeoning human populations. In addition, degraded forests, forest plantations, scrublands, rocky areas and culturable wastelands, among others, amount to more than 15 per cent of the total geographical area of the country.[2] Some of these areas could also harbour elephants in densely human-dominated areas.

'EXTREME' BEHAVIOURAL MODIFICATIONS IN ELEPHANTS LIVING IN HUMAN-DOMINATED AREAS

In order to survive in human-use areas fraught with danger, elephants may need to adapt and devise strategies that help not only to improve their survival, but also reproductive fitness. Through our long-term study of Asian elephants in the highly fragmented and human-dominated landscapes of southern India, we have been able to record early behavioural changes in elephants to some of the changes discussed earlier.

The elephants that are ranging outside traditional Protected Areas, especially males, are using a high-risk, high-gain strategy (Sukumar and Gadgil, 1988), wherein they risk moving across well-guarded crop fields in order to get at the highly nutritious crops. Such behaviour is resulting in improved body condition and reduced chronic stress levels in such elephants (Pokharel, et al., 2017; Srinivasaiah, et al., 2019). It has been shown in male elephants that musth and body size are more important in determining mating success than tusk length (Chelliah and Sukumar, 2013). In order to come into musth, male elephants need to be in excellent body condition, and feeding on crops could just be the strategy required.

While ranging in production landscapes could be an adaptive strategy, there are costs to it too, with the potential to become maladaptive if not exercised with caution. To this end, the male elephants in our study landscape seem to have found safety in numbers and are forming all-male groups. These groups are novel to Asian elephant society and are formed exclusively in highly fragmented and resource-rich (crops) areas (Srinivasaiah, et al., 2019). We speculate that such grouping in male elephants helps the younger males to navigate a high-risk environment successfully by learning from the older and more experienced males that have been solitarily ranging in these areas for many years (ibid.). The older bulls, on the other hand, could benefit from these associations by distributing the risks faced from humans among their associates. The proximate and ultimate drivers of male elephant sociality, which could have made such long-term, all-male associations possible in the high-risk, human-dominated study area, however, needs further in-depth analysis.

Probably the first behaviour one would observe in elephants living outside forested areas is increased foraging activity at night

as compared to the day (Srinivasaiah, 2019). A number of male elephants that are to be found in human-use areas have also learned to avoid humans temporally by changing their behaviours from diurnal to completely nocturnal. During the day, they have been observed to take refuge in large village waterbodies or in plantations and small patches of forest (ibid.).

THE ELEPHANT IN THE ANTHROPOCENE

Nearly 70 per cent of Indians live in rural areas, with agriculture and allied sectors being the major occupation, and with nearly 55 per cent of the population dependent on this sector for their livelihoods.[3] India also has the world's largest cattle population, with over 300 million individuals.[4] Moreover, a large proportion of the rural population in India is still dependent on forests for grazing, firewood and non-timber forest produce. While people and livestock depend on forests for such resources, elephants too, at times, seek crops for food. And, hence, there is a definite overlap in resource and space utilisation between humans and elephants over the distribution range of the latter across the subcontinent.

The current conservation and management paradigm for Asian elephants is to ensure the long-term survival of viable populations of the species in large, forested habitats with minimal human confrontation. This is being achieved by strengthening the barriers around Protected Areas to keep elephants in and to otherwise enrich, protect and consolidate these once-pristine habitats. What has, however, largely been ignored, with tragic consequences, is the poor management of elephants that is increasingly occurring outside Protected Areas in largely human-dominated landscapes. Conservation strategies for the endangered elephant populations in landscapes that are predisposed to human–elephant conflicts, such as our study region, would critically require not only the management of human–elephant interactions, but also measures to ensure the welfare and well-being of local human communities.

In many habitat countries, including India, where elephants range across state/administrative borders, each state department, forest or administration is concerned in mitigating conflict only within their jurisdiction. With little inter-state consultation or cooperation to manage elephants at the landscape level, both locals and elephants, wedged between state politics and ad hoc

mitigation strategies, bear the brunt of conflict through loss of life and property. Such improper management strategies alter the regular ranging patterns of elephants, often severely disrupting their social organisation, and leading to the spread of conflict to newer areas.

Elephants and humans, the two mega-vegetarians, with the former requiring large areas to forage and range in and the latter needing vast areas to grow crops and settle in, are increasingly becoming embroiled in conflict for these shared resources. Human–elephant conflict is one of the greatest challenges to Asian elephant conservation in India, negatively influencing elephant abundance and distribution as well as the attitudes of affected people towards elephant conservation.

Several human–elephant conflict mitigation strategies, such as monetary compensation for loss of life and property damage; passive and large-scale barrier mechanisms, including the construction of elephant-proof trenches, wall and electric fences; and direct, but small-scale, mitigation measures such as elephant drives, translocation, capture and crop-guarding have been tried extensively across the Indian subcontinent, but with very limited success. The failure of such measures in mitigating conflict can usually be attributed to the lack of speedy compensation and of objectivity in assessing crop or property damage, faulty construction and lack of maintenance of elephant-proof barriers, use of unscientific driving and translocation methods, and, most importantly, to the lack of a comprehensive understanding of the ecology and behaviour of the elephant in disturbed habitats. Elephants, being cognitively complex beings, learn to overcome such passive barriers over time and are also known to respond adaptively to immediate anthropogenic stressors. Although such behaviours may aid elephants to exploit high-risk and novel human-use areas, the threat to their survival is imminent. Human-dominated landscapes are fraught with danger for elephants.

This paper, we hope, has provided vital insights into the spatial and temporal separation of humans and elephants within the study landscape, with human disturbance having a negative effect on elephants' preferences to use certain forage-rich patches. This broad strategy seems to help elephants to continue to persist in an increasingly fragmented landscape and adapt to it in the process (Stephens, et al., 2007). Elephants thus appear to actively select areas that are conducive to their daily activities, such decisions apparently

based on their knowledge of areas with high-forage productivity and historically low human disturbance. With the increasing fragmentation of elephant habitat and constriction of movement paths, many elephant herds may reach a point when behavioural adaptability in terms of modifications in time-activity budgets is not sufficient. It is at such tipping points that clans, herds and individual elephants decide to shift their range areas completely.

With the possibility of a shift in the range area of elephants in response to increased human activity and impending climate change, especially the impact of climate–water balance and increasing temperature on the availability of food and water resources, large-scale overlap of elephant home ranges with human settlements and production areas can be expected. While the focus continues on conflict mitigation strategies that are regional, it is time that the transboundary movement of elephants across states and even countries is addressed. The need of the hour is 'big thinking', to help build resilience among the farming communities and others who may be impacted by elephants in the near future from the human–elephant conflict in the country, and to plan for development taking into account the presence of the non-humans that live alongside us.

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NOTES

1. https://www.downtoearth.org.in/coverage/wildlife-and-biodiversity/jumbo-conflict-43530.
2. See State of Indian Agriculture (2016). *State of Indian Agriculture 2015–16.* Ministry of Agriculture and Farmers Welfare, Department of Agriculture, Cooperation and Farmers Welfare, Government of India, New Delhi. http://agricoop.nic.in/sites/default/files/Annual_rpt_201617_E.pdf.
3. *Ibid.*
4. See Livestock Census Report (2012). *19th Livestock Census–2012.* All India Report. Ministry of Agriculture, Department of Animal Husbandry, Dairying and Fisheries, Government of India, New Delhi. http://dahd.nic.in/sites/default/filess/Livestock%20%205_0.pdf.

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ACHIEVING GENDER EQUALITY IN THE FACE OF A CLIMATE CRISIS

NITYA RAO

INTRODUCTION

The world is in the midst of a climate emergency, with floods, unseasonal rains, heatwaves, forest fires—all occurring with increasing frequency. The Intergovernmental Panel on Climate Change (IPCC) 1.5°C Special Report interestingly compares the effects of a 1.5° and 2° rise in global temperature, and finds the latter scenario to be much worse in terms of loss of plant species (8 vs. 16 per cent), reduction in crop yield (3 vs. 7 per cent), or the decline in marine fisheries (1.5 vs. 3 million tonnes).[1] The Report also notes that the world is not on track to limit temperature to 1.5°; the current trend of emissions would need to be halved for this to happen. While affecting millions of the world's poor, the impacts are likely to be most severe for farmers and fishers, for example—who directly depend on the natural world for their livelihoods—as a consequence of loss of livelihoods, food insecurity and displacement.

This is even more so in geographies that have been termed 'hotspots', such as the arid and semi-arid lands in East Africa, or the Indian Deccan Plateau, where pastoral and farming communities are struggling with high temperatures, with drought and water scarcity leading to the death of their cattle and failure of their crops.[2] In the glacial-fed river basins of the Himalayan mountains, temperatures are predicted to rise by 3.6–4°C in a global 1.5°C scenario, much higher than in other 'hotspots'. One can already see heatwaves occurring more frequently, resulting in melting permafrost, frequent flash floods, landslides, and the disruption of water sources. The cultivation of apples and grains, which need cooler temperatures,

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have to be moved further upslope (Wester, et al., 2019). Declines in yields and productivity, and cultivation itself, has led to more men out-migrating in search of work opportunities. The large deltas in India and Bangladesh, or in West Africa, are prone to frequent floods, cyclones and coastal erosion, making agricultural livelihoods unpredictable. Fisheries and aquaculture, too, are facing risks from ocean warming, sea level rise, acidification, and a resultant loss in species.[3]

While the existence of both climatic and non-climatic risks are acknowledged in shaping vulnerabilities (Adger, 2006), with the IPCC (2019)[4] noting that climate change aggravates pre-existing socio-economic vulnerabilities, the relational and contextual dimensions of both vulnerability and adaptation continue to be overlooked. The focus of policy is primarily on predicting changes in climate and developing technical solutions to facilitate adaptation, be they drought- and flood-resistant crop varieties or cattle breeds, storm shelters, among others. The starting point of this paper is understanding vulnerability as both relational and contextual, hence focusing on unpacking the everyday politics of experiencing and responding to risks at individual and household levels. Emphasising the processual and multidimensional nature of climate–society interactions, O'Brien, et al. (2007) point to the role played by social position and identity in shaping both the experiences of vulnerability and the ability of differentially positioned people to respond to the risks they confront. There will be winners and losers in coping with change (Taylor, 2013; Ribot, 2010); in India, caste typically appears to make it more difficult for Dalits to effectively adapt to climate change. Widows, similarly, and those without any back-up financial or social support, may do worse than other groups, even when subject to the same climate shocks.

The global emphasis on gender equality has led to an emerging body of work that recognises that women and men experience climate change and other risks differently, given their specific positions and claims within social relations of production and reproduction, the distribution of resources, and the cultural norms shaping institutions of governance, politics and markets (Rao, et al., 2020). Yet, even this literature tends to homogenise men and women as distinct categories, often oppositional in nature, not paying adequate attention to critical issues of power and meaning,

of conflict and cooperation, embedded in their social identity and, critically, relationships (Sen, 1990; Carr, 2008; Turner, 2016; Djoudi, et al., 2016; Nightingale, 2017).

Gender here is understood as the unequal power relation between men and women differentiated by their intersecting identities of class, caste, race, ethnicity, stage in life-course, age, education, geographical or agro-ecological context. A nuanced exploration of such intersectionality requires simultaneous attention to privilege and oppression, across institutional and temporal scales, from the micro to the macro (Crenshaw, 1991; Yuval-Davis, 2006). While this appears complex, this complexity can be unravelled by a focus on everyday practices on the ground, whether in farming, migration or participation in community activities, and systematically exploring the mechanisms through which inequalities, including of gender, are reproduced or indeed challenged in everyday life. It is only through such an analytical approach can we ensure that adaptation efforts will not leave anyone behind.

This paper draws primarily on research conducted in the ASSAR (Adaptation at Scale in Semi-Arid Regions) Project, part of the Collaborative Adaptation Research Initiative in Asia and Africa (CARIAA), over the period 2014–2018. It also draws on my longstanding research in India, especially amongst tribal communities, on gendered changes in land and agrarian relations, and its implications for livelihoods, food security and well-being.

MICRO-ANALYSIS: INDIVIDUALS, HOUSEHOLDS AND COLLECTIVES

While human rights and gender-equality narratives view women and men as individuals, with equal rights, it is critical to also recognise that women and men are embedded in social relations of power and inequality, which in turn shape their access to resources, both material and social, opportunities for making a living, and the capacity to claim their rights. Those in disadvantaged positions—who may be less able to claim their rights, or in a context where the state is weak and law enforcement uncertain—may feel more secure under the patronage of powerful, usually male, patriarchs in the household or community (Kandiyoti, 1998). A few examples will make this clear.

Bryceson (2019), reviewing changes in land and labour relations by age and gender in Africa from 1980 to 2015, notes a

weakening of dependency ties within family units, a tendency for younger and middle-aged women to question the social worth of being a housewife, and older women providing a fallback for migrant household members. While she does not specifically contextualise these changes in relation to climate change, some of these trends became visible in research conducted in pastoralist northern Kenya between 2015 and 2017, where persistent drought and water scarcity has led to shifts in gendered patterns of work, responsibility for household maintenance, gender relations and well-being outcomes.

Aya, now 50 years old, became the second wife of a curio-seller when she was 18. The first wife took her as a sister; they got on well and shared both farming and domestic work till the death of the former. Things started getting difficult for Aya, not just in terms of managing both the farm and domestic chores, but increasingly she felt that her husband supported the children of his first wife, and discriminated against hers. She threatened to stop farming, but it had little effect, so she asked for a divorce. Her husband refused, as this would mean paying out a settlement. She is now separated, lives with her daughter and helps look after her grandchildren. The land she farmed is lying idle, but she is part of a singing group that performs at weddings and other events. She earns enough for herself and to help her daughter (Rao, 2019).

Her daughter, 26, has three children, from a series of relationships. In the context of drought, men find it increasingly difficult to provide for their wives and children. In some cases, they have left their wives; in other instances, the women themselves have opted out of the marriage, and prefer to stay with their mothers or aunts. Older women like Aya provide them with more support, with both money and care, unlike their male partners. Yet, these younger women have tough choices to make. They want to educate their children and give them a 'good life', but this does not come cheap. Many end up engaging with casual sex work or other risky enterprises, such as selling drugs and intoxicants, which, while bringing them money, could, in the absence of information on contraception or protection, end up in unwanted pregnancies and even sexually transmitted infections. Aya admitted about her daughter, 'She is an attractive girl. They see her in the market and ask if they can be friends, and she brings them home' (ibid.: 33).

This case demonstrates the different vulnerabilities, aspirations and indeed social relations, of older and younger women, and the ways in which these shape the trade-offs they confront and choices they make. The outcomes, however, are not necessarily positive in terms of their health and well-being.

Men too have different positionalities. Singh (2019) explores the impacts of different types of male migration on household dynamics and gender relations—from daily commuting and seasonal migration, to young, unmarried men moving to work in large cities, or entire family migration, either seasonal and rural or more permanent and urban. She finds that, overall, migration leads to increasing workloads and responsibilities for women, yet the pattern varies. In some cases, male migration meant a restriction in women's mobility, as they needed to stay in the village to look after home, land and livestock, often engaging in petty enterprises to maintain the household when cultivation was not possible. Younger women with children were more restricted than older women unless they had family support, especially from their maternal kin, for childcare. For others, especially lower-caste Dalit women, it meant engaging in casual labour, often for low wages. But even for young men, the experience of migration was not always easy. They travelled long distances for work, often lived in shared dormitories with poor facilities, and jobs too were not necessarily secure or well-paid (Mitra, 2018). Hence, the frequency, regularity and quantity of remittances varied, with implications for risk management, and both individual and household well-being.

Apart from individual experiences, at the next level these examples suggest that the nature of the household itself, its social networks, class position, geographical location and composition play a part in shaping both vulnerabilities and adaptive responses. A key indicator of gender equality in such contexts is women's agency, i.e., how far they are able to exercise choice, or their ability to act in relation to key decisions that affect their lives (Kabeer, 1999). While one would expect that women's agency and decision-making authority improves in nuclear households, in contexts of stress, driven by both climatic and non-climatic factors, young women may prefer to live in larger households, especially with other women. This was evident in the small towns of northern Kenya, where women, frustrated because their husbands were not earning enough, yet out

of the home most of the time in search of work, were themselves struggling to care for their children while earning enough to feed them. The money they earn is often small, for, as Bira, 22, noted, 'There are now a lot of small kiosks here and not much business. We only survive because of my mother's business in the main market' (Rao, 2019: 33). Young women like her seek interdependency and reciprocal relationships with men, but if not forthcoming, are willing to experiment with new forms of households, be it polygamy, wherein they marry an older, but wealthier man, cohabiting relationships, or even matrifocal arrangements with their mothers, aunts or sisters (Rao, 2019; Jackson, 2015).

A final point of differentiation at the micro level relates to the collective, and the support it can potentially provide to individuals and households to better cope with scarcity and stress. Typically, collectives have been imagined as self-help groups of women, often credit groups, farmers' groups, or community networks based on social identity of caste, race or ethnicity. Collective action in general is seen to have empowering effects, through enhancing a sense of connectedness and solidarity amongst individuals and groups. Gabrielsson and Ramasar (2013) describe how collectives of widows and divorced women affected by HIV/AIDs in Kenya contributed to livelihood security through the provision of credit, labour-pooling, rainwater harvesting and agro-forestry. Similarly, one finds rotating savings and credit groups of women across Africa contributing to working capital, but, equally, providing support during emergencies. Most group members, however, tend to be older women. While access to these groups does enhance women's voice within their households and vis-à-vis other stakeholders, such as state institutions (Kalpana, 2016), nevertheless a lack of funding and skill development makes livelihood outcomes less than optimal. But these groups also entail forms of exclusion, whether of younger women, or particular castes/ethnicities, who continue to remain dependent on their men, or other powerful groups, for survival.

A second dimension of collective support is caste, in the case of India, or ethnicity in much of Africa. Often, state recognition of drought conditions or other extreme events leads to compensation for particular groups, in particular settlements, depending on their social and political connections, amongst other factors. This can at times lead to conflicts between these groups, rather than

cooperation in resource use. Again, in the case of northern Kenya, we found that state-sponsored relief to one particular ethnic group of pastoralists aggravated tensions with agro-pastoralist communities in neighbouring villages, leading to violent incidents involving livestock theft, rape of women, and even some human death. As a result, cooperation amongst women of these two communities, even in the context of domestic work, such as the collection of water for household use, broke down. They each became more protective of their own sources and contacts, aggravating hardship for the marginalised, those without money to buy water, or without additional household members to help collect it from farther away (Rao, et al., 2017).

A similar situation is visible in India, when, at times of water scarcity, Dalits or Scheduled Castes are often not allowed to draw water from common taps till the upper castes have done so. With the need to engage in wage labour, they often have no time to wait for their turn, and end up using poorer quality water sources, with negative implications for their health (Mitra and Rao, 2019; Solomon and Rao, 2018; Singh, 2020).

What these examples reveal is the need to recognise cooperation and conflict between different groups of men and women within households, but, equally, within community and other social institutions. To an extent this is obvious, as their adaptive responses to climate stresses, and indeed their livelihoods, occur in the realms of both production and reproduction, and involve engagement with both members of the household and the wider community. Negotiations can take the form of adjustments in the domestic domain or can take more public and visible forms through collective action. Both strategies are important; yet, policy often targets only the productive realm, rather than paying simultaneous attention to women's increasing burdens in domestic work (Rao and Raju, 2019).

SCALING-UP INSIGHTS: RESULTS OF A META-SYNTHESIS

There is often a charge that the insistence on context-specificity and relationality in gender research makes it highly fragmented and case-based, and not amenable to uptake in global and national policy and practice (Rao, et al., 2019; Ford, et al., 2016). Women, however, are not all the same, their agency shaped by place and social identity.

We therefore tried to find a way to generalise to some extent our findings across 25 very diverse locations—14 in semi-arid regions, six in mountains and glacier-fed river basins, and five in deltas—in Asia (India, Nepal, Pakistan, Bangladesh, Tajikistan) and Africa (Kenya, Ghana, Namibia, Mali, Ethiopia, Senegal), without losing the nuance of context.

In terms of climate change, while Senegal and Mali in semi-arid West Africa, for instance, are struggling with extreme heat and persistent drought, deltas in Bangladesh, India and Ghana are facing salinity, erosion, cyclones and storm surges. Water scarcity and erratic rainfall are visible across almost all these sites. Furthermore, the nature of livelihoods, and hence risks, vary. Although the primary activity remains agriculture or pastoralism in semi-arid regions, there is growing dependence on wage labour, whether in the locality or migrant, and petty trade. Households are investing in the education of their children in the hope of securing regular jobs in the future. In terms of the socio-cultural context, most of these locations are socially stratified, whether on the basis of caste in India; land or livestock-holding in East Africa; or class, migration status, and poor access to credit and financial services in West Africa.

Generalising, therefore, was no easy task, and while experimenting with different methodological approaches, we were introduced to Qualitative Comparative Analysis (QCA) (Ragin, 2008). Aimed at analysing qualitative data from complex situations, QCA attempts to explain why change happens in some situations, but not others. Applying set theory to qualitative cases, it identifies multiple combinations of causal factors or 'conditions' that explain a particular 'outcome'. We used this technique to assess the causation behind diversity in women's agency as an 'outcome', because of varying influences of the contextual 'conditions' in climate change hotspots (Rao, et al., 2019). Without ignoring the strong dependence of the multiple cases on local context, we are nevertheless able to suggest possible entry points for moving towards sustainable, equitable and effective adaptation.

Drawing on theory, SDG (Sustainable Development Goals) indicators and our field insights, we identified seven conditions to explain women's agency, later reduced to five through a process of aggregation. Social institutions at different scales play a significant role in mediating women's agency, as discussed earlier, whether

household norms around headship, mobility or decision-making; kinship ties and social capital at the community level; or state–social protection and provisioning of basic infrastructure. The most unpredictable are labour markets, in terms of wages and working conditions, for both women and men, especially for those with no alternatives. Male migration for work does contribute to incomes that keep families going, yet the degree of such support is both uncertain and irregular (ibid.).

What we found was disturbing, though not totally unexpected. Mounting environmental and climatic stresses, including extreme weather and unpredictable seasons, heatwaves and drought, appear to disproportionately weaken the agency of women to find well-paid work and rise above enforced gender roles, even as patriarchal norms appear to be bending to provide women more space and the availability of legal entitlements. Similar stories emerged from across the hotspots. While women in semi-arid south India reported that they were working more on the farms to ensure their crops survived, as their men migrated for construction or other jobs, in the D. G. Khan district of Pakistan, as flash floods destroyed the cotton crop, and men migrated to towns, women's daily wage declined by more than 50 per cent, from ₹200 to ₹75 (ibid.: 967). Their greater engagement with productive work did not, however, translate into control over decisions on either production or consumption. In fact, in semi-arid Kenya, as men moved away with livestock, women lost control over milk for both consumption and sale, with adverse effects on their income, and, equally, nutrition. Their increasing responsibility towards maintaining the household appears here more as a burden than a source of agency or empowerment.

Combined with poor working conditions for women, the QC analysis brought forward two causal pathways that work against gender equality and women's agency in these climate hotspots, viz., the failure of social institutions and poverty. As already noted earlier, scarcity often leads to conflict, rather than cooperation, as in the case of Kenya, where we found growing conflicts over water and pasture (fodder), or Ghana, where state action seemed to impede both the traditional cohesion within communities and women's ability to diversify. A focus on cash crops, typically controlled by men, strengthened cultural norms that excluded women (Rao, et al., 2017).

In some cases, as in the Ganga–Brahmaputra delta in Bangladesh, planned relocation by the state negatively affected women's agency through the loss of jobs in export processing zones, loss of social networks and other resources. Yet, they continued to bear the primary responsibility for household maintenance (Rao, et al., 2019: 968).

The second pathway is one of poverty. Confronted with issues of everyday survival, and in the absence of any supportive infrastructure and services—whether assured drinking water or clean energy, childcare or healthcare services, or even cheap, reliable and timely availability of credit and inputs to replant or reinvest in alternate livelihoods, if required—women end up working harder, in poorer conditions, and for lower wages, across the climate hotspots studied. Linked to more generic developmental failures, burdens, however, are heavier on women who are young, less educated, and belonging to lower classes, or marginal castes and ethnicities. They may engage with risky ventures to survive, though high levels of indebtedness are also visible across these sites, alongside decline in the quality of food consumed. 'We can't afford meat, so we just eat rice and potatoes, but even for this, the quantity is not enough,' said a woman in northern Kenya (ibid.: 969). In a sense, women do have voice and agency, as they are actively engaging in both production and reproduction, yet this is not contributing to strengthening longer-term adaptive capacities, or indeed their well-being. It appears instead to be taking a toll on their health and nutrition.

CONCLUSION

In an age of globalisation, and indeed climate change, social institutions too are under pressure. On the positive side, at the household level, while patriarchy continues to shape power and privilege across different geographies (Seager and Olson, 1986), we find women using innovative means to bargain with patriarchy, whether through taking on men's roles, as in the case of cultivation, or managing their businesses in their absence. While perhaps enhancing their workloads, it has nevertheless gained them some recognition and voice within households (Kandiyoti, 1998). Competitive labour markets, however, are not working to strengthen women's agency; rather, they end up undervaluing and appropriating the labour of poor women. It is the same with migrant men, who, additionally deprived of adequate food and rest, end up sick, their

earnings spent on their treatment. While countries have signed up to the 'decent work' agenda, these are hard to implement, especially across borders.

If much of the problem is structural–institutional, we need to look beyond short-term solutions to creating a longer-term enabling environment to facilitate innovative and creative adaptation on the ground. From a gender lens, keeping in mind women's additional reproductive work burdens, limited access to productive resources, and the social and cultural restrictions they confront, it is important to draw attention to the need for universal social protection, such as the public distribution system for cereals and other grains in India, or pensions and social grants in Namibia. These provide an essential back-up support, and by relieving immediate pressures of putting food on the table, create some room for manoeuvre. Self-help groups for women are often presented as solutions, yet they lack the resources, skills and capacity to really make a difference (Ghosh, et al., 2018). Serious investments in collective action could, however, shift the balance in favour of women.

To address the climate emergency—the urgent need to bring down emissions and ensure that the temperature does not rise beyond 1.5°C in the next decade—and also make sure that all women and men have decent lives, we need to move beyond stereotypes and simplistic framings of gender, development, or indeed climate change. Such an understanding needs to inform multilateral agreements such as the United Nations Framework Convention on Climate Change, through its Gender Action Plan, commitments to gender-responsive adaptation, as outlined in the Paris Agreement, or SDGs. These frameworks and plans need to move beyond recognition of women's roles in adaptation, or their differential vulnerabilities. They must invest resources in the improvement of women's working conditions; the creation of equal opportunities for employment; universal social protection; access to financial, extension and other productive services independent of their relationships to male heads; apart of course from basic infrastructure, including domestic water, to support their household maintenance roles, amongst others. They need also to identify and target the most marginalised and excluded—young mothers, or migrant men—with appropriate support. Creative and integrated solutions to ensuring that resources, opportunities and institutions

are fair, and creating an enabling environment for differently positioned women, and indeed men, to adapt to climate change, is the only way forward for sustainable development.

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NOTES

1. See IPCC (2018).
2. http://www.assar.uct.ac.za/theme-1-point-5-degree. Also see De Souza, *et al*. (2015).
3. See IPCC (2018).
4. See IPCC (2019).

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THE FUTURE OF HEALTH IN A CLIMATE CRISIS

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The year 2015 was an inflection point in more ways than one. It saw the culmination of many years of efforts by the United Nations (UN) and its member countries, which adopted the 2030 Agenda for Sustainable Development. The 17 Sustainable Development Goals (SDGs) provide a blueprint and an urgent call for action for global efforts to end poverty, reduce inequalities in health, nutrition and education, and foster economic growth. The Paris Agreement, by the United Nations Framework Convention on Climate Change (UNFCCC), was also adopted that year. The Agreement, endorsed by 196 countries or Parties, recognises that climate change requires a commitment by all nations towards setting their development trajectories on sustainable pathways that account for intelligent and efficient resource management. The year 2015 also saw the UN Youth Resolution 2250, a historic resolution on Youth, Peace and Security.

The interwoven agendas of these landmark efforts could not have been more timely and strategic, given that unprecedented growth and economic development are closely linked to greenhouse gas (GHG) emissions causing climate change. Youth are at the centre of both, being at the receiving end, and demanding action to address this new threat. Sustainable development, even as we are addressing climate change causes and impacts with an eye on the future we leave behind for our youth, is therefore key.

CLIMATE CHANGE: AN EXISTENTIAL THREAT

Climate change is stated to be the biggest global health challenge of the 21st century, threatening to undo several decades of public

health gains if left unattended. The threats of climate change have never been more real than they are today. Increasing temperatures, altered precipitation patterns, melting glaciers and rising sea levels, the increasing frequency of such acute climatic events as heatwaves, floods and droughts have together ensured an onslaught of several climate-related disasters and their impact on Earth, on mankind, and on all levels of the ecosystem.

Globally, according to the 2018 *Lancet Countdown* Report, if temperatures continue to rise, present-day changes in labour capacity, vector-borne diseases and food security are indicative of an early warning of compounded and overwhelming impacts. Low- and middle-income countries, with the most vulnerable populations, weaker health systems and poorer infrastructure are likely to be most affected by climate change. This, in turn, translates into further widening of health and economic inequities.

While changing surface temperatures, occurring at greater rates globally than before, have been implicated as a prime cause of growing heat hotspots, anthropogenic or human-induced causes have been stated to be the major culprit of climate change phenomena. These include activities related to various sectors: agriculture, livestock, forestry, transport, power generation, industry and infrastructure development, all of which can be sources of GHG emissions and thereby global warming, causing climate change.

The recent Special Report on Global Warming by the United Nations Intergovernmental Panel on Climate Change (IPCC) underlined the need to limit global warming to 1.5°C above the pre-industrial era, rather than 2°C, the main target of the Paris Agreement. With a 'business-as-usual' approach, and temperature continuing to rise at the current rate, global warming is likely to reach 1.5°C between 2030 and 2052. According to the Report, 'Global net human-caused emissions of carbon dioxide (CO_2) would need to fall by about 45% from 2010 levels by 2030, reaching "net zero" around 2050, to stay within 1.5°C' (Masson-Delmotte, 2018).

In order to achieve this level of decarbonisation, understanding the linkages between climate change and different sectors—agriculture, nutrition, health, industry, economy—is vital to the planning and implementation of effective strategies to curtail sectoral emissions and deal with the consequences of climate change.

CLIMATE CHANGE: IMPLICATIONS FOR INDIA

India is undoubtedly one of the countries most vulnerable to the impact of climate change. According to a World Bank report that used mortality as an indicator of extreme weather events, the last decade saw nearly 10,000 deaths from floods in Bihar, Odisha, Andhra Pradesh, Tamil Nadu and Kerala, and cyclones and landslides in other parts of the country.[1] The mortality from heatwaves has not been included in this statistic, which, in itself, because of climate change, can multiply resultant mortality severalfold. While the death burden from climate change needs urgent redressal, we also need to address the huge burden of morbidity and reduced quality of life related to climate change. Climate change has huge impacts on health through direct and indirect pathways.

CLIMATE CHANGE, TEMPERATURE AND HEALTH

Studies show that temperatures in India have risen steadily with time, with the rates being higher in recent years. Between 1901 and 2007, there was an increase of more than 0.5°C in mean temperature in India, with considerable geographic variation; by the end of the 21st century, an increase of 2.2–5.5°C is predicted in northern, central and western India, reflecting a faster rise in a shorter span of time. This means that there will be a corresponding increase in the exposure of our population to heatwaves.

HEATWAVES

The Indian Meteorological Department (IMD) declares a heatwave when there is an excess of 5°C above the normal daily historical maximum temperature of less than 40°C, or an excess of 4°C above a normal maximum daily temperature of more than 40°C. If the temperature exceeds 45°C, a heatwave is declared, irrespective of the normal temperature of the location. Heatwaves are described to occur when there are three or more consecutive days of temperatures above the 85th percentile of the hottest month for a specific location.

The frequency, intensity and duration of heatwaves has increased in India over the last half-century, with 1985–2009 showing worse trends than 1960–1985. In absolute numbers, there have been an additional 40 million heatwave exposure events in India in 2016, compared to 2012, with a marked increase

in the exposure of vulnerable populations aged above 65 years (Watts, et al., 2018). This has caused a dangerous surge in the health impact of heatwaves.

IMPACT ON HEALTH

The exposure to heatwaves of varying degrees can cause heat exhaustion, heat stress, heat syncope (fainting) and heatstroke, with symptoms ranging from hot dry skin, heat rash/eruptions, headache, nausea, giddiness, excessive sweating, disturbance in vision, mental dysfunction, muscle cramp and, sometimes, loss of consciousness. Children, the elderly and those with pre-existing morbidities are particularly vulnerable, with an exacerbation of cardiovascular and respiratory illnesses becoming increasingly common. Recent years have also seen a marked rise in deaths, following the exposure to heatwaves. An analysis of the mortality trends during the 2010 Ahmedabad heatwave showed a marked increase in all-cause mortality during the peak heatwave season, equivalent to a 43 per cent excess compared to the reference periods (Azhar, et al., 2014).

Preliminary evidence from a recent US study has linked higher temperatures to rising rates of suicide as well, thereby suggesting that heatwaves also affect mental well-being and health (Burke, et al., 2018). Heat-related health effects translate into the loss of labour days with an increasing burden on health systems, apart from individual and household-level impacts that could range from requirements for care-giving to growing needs for access to and expenditure for health care.

COLD WAVES AND HEALTH

Much of our focus in recent years has been on the effects of heatwaves. However, exposure to extreme and moderately cold temperatures can also affect health, especially at extremes of age and in populations with pre-existing illnesses. A study that used nationally representative mortality data for 13 years (2001–2013) showed that moderately cold temperatures were responsible for the maximum number of deaths as a result of stroke in individuals aged between 30 and 69, and for respiratory diseases above the age of 70 (Fu, et al., 2018). The attributable risk from exposure to moderately cold temperatures was 6.3 per cent higher for deaths as a result of all medical causes, 27 per cent higher for strokes, 10 per cent

higher for ischemic heart diseases, and about 6.5 per cent higher for respiratory diseases, as compared to extremely cold, moderately hot and extremely hot temperatures.

The impact of extreme temperatures on health is therefore wide-ranging, and any adaptation and mitigation efforts must consider adequate vulnerability assessment, risk stratification, health-system capacity building, and appropriate and adequate management of those affected.

The regional Ahmedabad Heat Action Plan (HAP), developed after the 2010 heatwave, has been successfully deployed and showed that a concerted strategy for prevention at community and health-system levels can cause significant reductions in the impact of heatwaves (Knowlton, et al., 2014). The Plan comprises a coordinated effort: public awareness and community outreach campaigns; early warning systems linked to inter-agency coordination; health-system preparedness through capacity building of health care professionals; and preventive and promotive measures for reducing exposure and enhancing adaptive capacities. An annual updated HAP is prepared for Ahmedabad, and has successfully reduced the morbidities and mortalities from heatwaves in successive years. Such HAPs ought to be actively drafted, adopted and promoted in 'heat hotspots' in India that are selected through appropriate tracking and modelling of meteorological data.

CLIMATE CHANGE, AGRICULTURE AND NUTRITIONAL HEALTH

The impact of climate change on nutrition is both direct and indirect in a country such as India where agriculture contributes to 18 per cent of the GDP. This great dependence on the agricultural and farming sector implies that the impact of rising temperatures can affect agricultural output as well as livestock rearing, in turn affecting the food chain and nutrition pathways. The production and global yield potential of such staple crops as rice, wheat, maize, soya bean, etc., are affected by rising temperatures, while drought situations cause a decrease in crop productivity. The average yield potential of rice and maize has declined by almost 2 per cent in India since the 1960s. This translates into poor food security, exacerbated inequities in access to good and nutritious food, thereby affecting the availability of nutritious and diverse diets to all segments of the population. The poorer sections are always more vulnerable, being

already nutritionally compromised, and thus a vicious cycle of malnutrition and enhanced vulnerability to illness sets in. Therefore, health and economic inequities are also widened.

Extreme flood situations also have detrimental effects on farming, livestock and agricultural output. It has been shown that infants and children exposed to flood situations and its aftermath are more prone to stunting and wasting, and thereby show greater vulnerability to repeated infections. The consequent poor growth and development during childhood and adolescent years has influences on later-life adult health and economic potential.

According to the Food and Agricultural Organization (FAO), globally, crops are most affected by floods and storms, livestock by drought, and fisheries and aquaculture by storms, hurricanes and cyclones. Higher temperatures also cause an increase in insect and pest populations, with the additional use of pesticides by farmers in India causing an added adverse effect for the farmers and their families by virtue of exposure to harmful levels of chemicals. The economic consequences of pest-induced crop losses are also of increasing concern. Post-traumatic stress in farmers, on account of agricultural losses and the resulting lowered economic gain, is increasingly common. The very recent phenomenon of increased suicides by farmers, as a result of rising temperatures and lowered agricultural productivity, warrants a new strategy for adaptation and mitigation that includes a mental health lens.

A closely linked pathway between climate change and its impact on agriculture and nutrition is the increased uptake of processed food. Overall lowered agricultural output under poor climatic conditions and increasingly expensive fresh fruit and vegetables have resulted in changing dietary habits that can be held responsible for growing levels of obesity in our population. This new triad of the link or synergies between the three pandemics—climate change, undernutrition and obesity—with common drivers has been labelled the global syndemic (Swinburn, et al., 2019).

Another adverse consequence of climate change on the agricultural sector, with huge economic consequences, has been the loss of labour hours. As one of the most resource- and labour-intensive sectors, with an average metabolic spend of 400W as compared to the industrial (300W) and service (200W) sectors, agriculture has seen the largest number of labour hours lost

worldwide as a result of increasing heatwaves. A steady increase in the hours of labour lost between the years 2000 and 2017 was seen across India. For the agriculture sector alone, the labour hours lost rose from about 40,000 million hours in 2000 to about 60,000 million hours in 2017. Overall, the country lost nearly 75,000 million hours of labour in 2017, relative to about 43,000 million hours in 2000—an increase of over 30,000 million hours over two decades. For a developing economy such as India, this represents a substantial impact on the individual, household and national budget. The indirect consequences on health could manifest through lower disposable incomes impacting access to adequate, appropriate and timely health care services.

CLIMATE CHANGE AND VECTOR-BORNE DISEASE

A major consequence of climate change is that warmer temperatures and changing precipitation patterns alter the pattern of vector-borne diseases (VBDs) by changing vector biology, geographic spread, transmission windows and the intensity of disease burden. Malaria, dengue, chikungunya and Japanese encephalitis are all vector-borne diseases that are projected to increase with changing climatic conditions in India. Both the vector growth and development time for the pathogen within the vector's body (extrinsic incubation period) are affected by rising temperatures and, in turn, impact disease transmission, with vectorial capacities peaking invariably at relatively higher temperatures.

The Anopheles mosquito, which carries the malarial parasite, thrives in hot and humid areas. Altered climatic profiles influencing temperature, rainfall and humidity affect adult mosquito densities in large parts of the Indian subcontinent, and changing transmission windows can cause the spread of disease in hitherto unaffected geographies. In India alone, an estimated 9.6 million cases were reported for malaria, with 16,700 estimated deaths as a result of the disease.[2] The huge disease burden from malaria causes further stress on already burdened health care services.

Spread by the Aedes Aegypti mosquito, dengue fever has almost tripled or quadrupled in recent years, with the mosquito's survival, development and reproduction all influenced by warmer temperature, rainfall and humidity. Even hill areas are becoming increasingly prone to dengue, with the disease now ever more

prevalent in the northeastern states, and the southern states of Kerala and Tamil Nadu. Changing rainfall patterns in recent years, often surpassing decades of previous precipitation levels, have facilitated the ideal conditions for the spread of dengue across the country.

Chikungunya, also transmitted by the Aedes mosquito, has tripled in recent years. Bihar saw an unprecedented spike in chikungunya cases in 2017. The disease, transmitted by a virus, is characterised by the acute onset of symptoms of fever, joint pain, muscle pain, fatigue and rash. Its often debilitating and prolonged symptoms affect worker productivity through increased work absenteeism.

The close association between vector-borne disease patterns and changes in climatic conditions in India warrants careful planning for the prevention, surveillance, diagnosis and management of these conditions, besides building the capacity of health and allied services, such as laboratories, for early detection. Linking these efforts with forecasting by the meteorological department will ensure effective handling of the growing burden of vector-borne diseases from climate change in India.

CLIMATE CHANGE AND WATERBORNE DISEASE

Waterborne pathogens of human and animal faecal origin include several viruses, bacteria and protozoas. Many waterborne diseases, including cholera, are climate sensitive. The climatic suitability for the vibrio bacteria that causes cholera has risen by 3 per cent a year since the 1980s. Frequent and intense rainfall can result in high concentrations of pathogens in water. Access to clean drinking water and sanitation can also be seriously impacted following such acute climatic events as floods, storms and hurricanes. The combination of warmer temperature and increasing rainfall favours the spread of temperature-sensitive pathogens through water supply. This, together with abnormal sea surface temperatures and rising water levels, favours cholera and other waterborne disease outbreaks. Flood waters can cause the overflow and run-off that can spread disease agents, contaminating sewage and chemicals through water. Both surface water and ground water are eventually affected.

The altered concentrations of dissolved minerals and heavy metal contaminants are increasingly common, with high levels of

arsenic and fluoride in large parts of flood-affected areas. Dental and skeletal fluoroses are caused by excessive fluoride concentrations, while arsenic in groundwater in large areas of the Indo-Gangetic plains causes severe skin and gastrointestinal manifestations. Cancers have also been implicated through the arsenic contamination of groundwater supplies.

Gastrointestinal symptoms, such as nausea, vomiting, diarrhoea, stomach cramps and fever through waterborne diseases, can cause school and work absenteeism in affected populations. Acute gastrointestinal diseases often require hospitalisation for rehydration, in turn increasing the burden on health systems. Contaminated water used for bathing and washing can also cause skin and ear infections.

The extreme situation of water stress caused by drought situations can also cause diseases as a result of reuse and poor waste water treatment. The inextricable link between climate variability, the access to clean water, and sanitation and waterborne diseases is therefore an area of growing concern.

CLIMATE CHANGE AND AIR POLLUTION

Air pollution has been an emerging area of public health concern for India, with 14 of the world's 20 most polluted cities housed in India. In 2017, the population-weighted mean exposure to ambient outdoor fine particulate air pollution (PM 2.5) was 90 $\mu g/m^3$, more than twice the recommended values by the National Ambient Air Quality Standards (NAAQS) in India. Air pollution was held responsible for 1.2 million deaths, with more than 50 per cent occurring at premature ages (< 70 years). The current levels of air pollution exposure are stated to reduce life expectancy by 1.7 years.

Air pollution is intricately linked to climate change, with increasing temperatures causing a rise in levels of ozone—a prominent greenhouse gas. Fossil fuel combustion in thermal power plants, a continuing source of much of the energy generation in India, is one of the major sources of air pollutants and carbon emissions. The total energy supply from coal increased 11 per cent in India from 2016 to 2018. Dangerous levels of PM 2.5 contributed to about 500,000 premature deaths in 2016, nearly a fifth of those from coal. Other sources of gaseous emissions, such as increasing greenhouse gases carbon dioxide and methane, are driving factors

for climate change. Addressing the sources of air pollution, therefore, has the additional benefit of tackling the sources of climate change.

The health impact of air pollution includes respiratory and cardiovascular diseases, besides the impact on birth outcomes and neurocognitive development in children. The health impact is exacerbated in the elderly, in children, pregnant women, and in sick and vulnerable populations. An adequate knowledge of regional air quality, its sources and the pollutant profile of different regions can help address the health impact of air pollution, while simultaneously reducing the emission sources that also contribute to climate change.

CLIMATE CHANGE AND VULNERABLE POPULATIONS

> The health of a child born today will be impacted by climate change at every stage in their life. Without significant intervention, this new era will come to define the health of an entire generation (Watts, et al., 2019).

The populations at extremes of age—children and the elderly—sick individuals and pregnant mothers are all extremely vulnerable to the health impact of climate change. Special occupational groups exposed to extreme working conditions during heatwaves, flood and drought situations are also vulnerable to greater disease risk.

CLIMATE CHANGE AND MATERNAL AND CHILD HEALTH

Maternal health can be seriously impacted by climate change-related disasters. Poor nutrition during pregnancy, for instance, can give rise to anaemia and related micronutrient deficiencies in mothers. Poor maternal nutritional status can also affect birth outcomes causing premature birth, poorer birth weight, greater vulnerability to infections, and poor overall childhood physical and mental growth. Children exposed to flood and drought situations have been shown to have poorer anthropometric indicators of nutritional status, being more stunted, wasted and underweight, and also showing poorer neurocognitive development that later prevents them from achieving their full adult potential. Studies have shown that children exposed to drought situations score poorly on literacy and numeracy skills, with those being exposed in utero scoring significantly worse

on math and reading tests. The impact of such adverse influences on children can affect the demographic dividend of a young and growing economy such as India's.

These effects can often transcend generations, with the maternal (and paternal) influences often impacting the offspring of the next generations as well. Such intergenerational transmission of risk, as a consequence of climate change, is of serious concern.

CLIMATE CHANGE, OCCUPATIONAL GROUPS AND MIGRANT POPULATIONS

Acute climatic events, with changing climatic conditions, often trigger the mass movement of affected populations, either voluntarily or as a result of mandated movement by authorities handling disaster situations. The subsequent effects on the health of migrants are often the result of displaced homes, poor access to safe food and drinking water, and adequate and appropriate water, sanitation and hygiene in the new surroundings.

Migrant populations are therefore prone to developing symptoms related to waterborne disease, extreme temperature, air pollution and nutritional disorders, besides poorer physical and mental health overall. The conflict situations arising out of mass migration have been shown to trigger violence and death as well, when adversity causes insecurity over food and nutrition.

In terms of occupational risks from changes in climate, those sections of workers exposed to extreme temperature, rainfall and humidity patterns—daily wage workers, construction workers, traffic police, street vendors, and drivers of private and public transport—are all vulnerable to developing poor health conditions. Labour laws must consider the impact of climatic conditions in exposed workers, and appropriate measures for prevention and control ought to be mandated.

CLIMATE CHANGE AND HEALTH CARE

HEALTH SECTOR PREPAREDNESS, VULNERABILITY ASSESSMENTS AND ADAPTATION

With the worsening global scenario on account of climate change, regional requirements for health care are also expected to change. Physicians, nurses, hospital administrators, allied health care professionals, including laboratory services, must be aware of, and be prepared to handle, the newer and emerging waves of climate-related health impacts.

The symptoms and disease conditions associated with exposure to heatwaves, air pollution, cold temperatures, floods, droughts and post-disaster situations—including nutritional disorders, exacerbated respiratory and cardiovascular diseases, and declining mental health—all warrant a well-prepared health system capable of delivering timely and appropriate health services.

Availability and access to health care services for all sections of society also require careful vulnerability assessments and risk stratification that bring together different stakeholders: (i) the meteorological department that carries out predictions and forecasting of climate and weather conditions; (ii) health departments that build their own infrastructure and capacities to deliver adequate and appropriate services; (iii) city administrators and urban planners, for effective coordination during acute events; and (iv) policymakers, for suitable policies that facilitate all these services across sectors through an overarching, multi-sectoral climate action plan.

India has a diverse health system, ranging from central and state government hospitals, district hospitals, community health and primary health care services, private hospitals, employee state insurance hospitals, independent health services for the defence sector, railway hospitals, and a whole range of alternate health care providers, including AYUSH (Ayurveda, Yoga & Naturopathy, Unani, Siddha, Sowa Rigpa and Homoeopathy) practitioners. Irrespective of the level of the health system, all health care services need to be resilient and adequately prepared to handle all acute climatic events.

HEALTH SECTOR MITIGATION

Charged with being the first responder to climate change impacts, the health sector is, paradoxically, also a source of carbon emissions, being one of the most energy-intensive service sectors. It contributes to GHG emissions throughout care delivery by energy consumption, transport, waste generation, and by sourcing products and technologies from carbon-intensive supply chains for pharmaceuticals, medical devices, food and other products. Worldwide, the health sector contributes to 5 per cent of GHG emissions, with considerable regional differences. In 2011, it accounted for about 2.6 billion of 52 billion metric

tons of CO_2 emitted globally. Although this might appear to be a small proportion, the health and environmental co-benefits of decarbonising our health care and building climate-smart health systems are huge. Ranging from moving to 100 per cent renewable energy; energy-efficient buildings; sustainable transport, water and food consumption; and procurement and waste treatment practices, exemplars of sustainable health-sector practices are steadily increasing and promise a growing movement towards reducing our health care carbon footprints with tangible health and environmental co-benefits.

Transitioning to green buildings, to such cleaner fuel sources as solar and wind energy, becoming efficient in the use and disposal of water and food, improving biomedical waste management practices, substituting harmful chemicals with safer alternatives, and sustainable procurement practices in health care are potential mechanisms for the transformation to a decarbonised, 'climate smart' health care sector in India.

The Health Mission, identified by the Prime Minister's Council on Climate Change (PMCCC), provides an appropriate platform to build Climate Health Services under the umbrella of the National Health Mission. A key part of this initiative must focus on the strengthening of the Indian health system by facilitating 'Climate Resilient' and 'Climate Smart' health sector operations through a strong Health Sector Climate Action Plan.

THE WAY FORWARD

The impact of climate change on health in India is wide-ranging and affects all ages, genders and socio-economic strata. The 2019 *Lancet* Report shows that the public health gains achieved in the past 50 years could soon be reversed by changing climate (Swinburne, et al., 2019). A recent report places India amongst the top countries with a high social and economic cost of climate change: the cost resulting from each additional ton of carbon dioxide emission for India is $86 per tCO_2, followed by the United States at $48 and Saudi Arabia at $47, respectively (Ricke, et al., 2018).

The implications for India cannot be understated. The Prime Minister's Council on Climate Change was reconstituted in 2014 and called for a paradigm shift in global attitudes towards climate change from carbon credits to green credits.[3] The Ministry of

Health and Family Welfare (MoHFW), Government of India (GoI), had constituted a National Expert Group on Climate Change and Health in 2015–2016. A National Action Plan on Climate Change and Human Health (NAPCCHH) is under formulation. It is aimed at protecting the health of people against climate-sensitive illness, especially among children, women, and marginalised populations, and to build the capacity of health care services against the adverse impact of climate change on human health. Key actions include creating the database for researchers and institutions engaged in studies of the impact of climate vulnerability and extreme weather. India has identified health adaptation as one of the priority actions in its Intended Nationally Determined Contributions (INDCs), now known as Nationally Determined Contributions (NDCs), submitted biennially to the UNFCCC.

With these efforts already underway, together with mandated State Climate Action Plans that have health as a strong focus, a stronger coordination of multiple stakeholders must be facilitated to ensure the effective decentralised implementation of all the action plans. Additionally, certain positive changes are already evident, with global growth in renewables as a source of energy accounting for 45 per cent of total growth in power generation in 2018. India is also seeing a surge in the adoption of solar power, along with wind and hybrid models, and this must be escalated even as a strong push for phasing down and phasing out fossil fuel production and consumption can be strategically planned, keeping in mind the impact on livelihoods. The rapid, urgent and complete phase out of coal-fired power worldwide is crucial. There is also a concerted move towards electricity as a fuel for road transport to replace polluting vehicular fuels—a major source of air and climate pollutants—besides the advocacy for accessible, affordable and efficient public transport systems. Last but not least, capacity building of all stakeholders and adequate climate financing must be ensured in order to implement climate action plans at every level. Only a strong cohesive effort can help India deal with the impacts of climate change.

Never before in human history have we been so *forewarned* of a doomed destiny,

> But never before in human history have we been so *forearmed* with the knowledge and tools to alter the course of that destiny.[4]

Tackling climate change could be the greatest public health opportunity of the 21st Century (Watts, et al., 2015).

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NOTES

1. See World Bank. 2019. The Climate Change Knowledge Portal. https://climateknowledgeportal.worldbank.org/country/india/vulnerability.
2. WHO country profiles, 2018. See World Malaria Report, 2018, country profiles: India.
3. The Prime Minister's Council on Climate Change (PMCCC) was constituted in 2007 after IPCC published its fourth assessment report, warning of an increase in frequency and intensity of extreme weather events, especially in tropical and subtropical countries. The report by IPCC was accompanied by the Bali Action Plan—an outcome of the global climate meeting in Bali, Indonesia, in 2007 (aimed at sensitising countries to step up climate action). The PMCCC was later reconstituted in 2014, and during its first meeting conducted in 2015, a paradigm shift was introduced in the global attitude towards climate change, i.e., from 'carbon credit to green credit'. However, none of the initiatives specifically catered to the impacts of climate change on human health until the Paris Agreement in 2015.
4. From the statement made by K. Srinath Reddy, President, Public Health Foundation of India at the Global Climate Action Summit, San Francisco, September 2018. The Global Climate Action Summit (GCAS) was held from 12–14 September 2018 in San Francisco. The summit was hosted by California Governor Jerry Brown and aimed to address climate change by bringing together non-state actors, including elected leaders, at the state and local level.

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RETHINKING INSTITUTIONS FOR INDIA'S TRANSITIONING ELECTRICITY SECTOR

KAVERI K. IYCHETTIRA

INTRODUCTION

In August 2018, Karnataka made headlines in India for having surpassed Tamil Nadu as the state with the largest installed capacity of renewables in India. As I interviewed various organisations in Karnataka involved in the electricity sector that month, it was evident that these organisations were grappling with new challenges—challenges they were hardly prepared for. It came as a surprise to me when an official who was responsible for trading electricity from renewables on behalf of Karnataka's distribution companies asked me, the outsider from academia, to introduce them to rudimentary techniques that would help them trade renewable electricity: specifically, forecasting demand and electricity prices. This anecdote serves to represent a tiny facet of reality about how India is grappling with a transitioning energy sector.

The electricity sector is a key piece of the global transition to a low-carbon economy. Much of the rise in emissions is driven by the energy sector—a sector crucial to the country's economic and social well-being. In 2014 alone, the Indian energy sector accounted for the largest share of the country's total greenhouse gas (GHG) emissions at 68.7 per cent. At the same time, India is also amongst the world's countries most vulnerable to the adverse impacts of climate change. In 2017, India ranked second highest in climate-related fatalities in the world. This data attests to the importance of decoupling energy production and consumption from GHG emissions through a transition to low-carbon systems for climate change mitigation.

Winter 2019–Spring 2020, Volume 46, Numbers 3 & 4

Much of the rhetoric on India's energy transition revolves around the prime minister's targets for renewable energy capacity in India—175 GW by 2022, and 400 GW by 2030—and the technology and financial mechanisms required to achieve those targets. And yet, there seem to be storms brewing in various quarters. Independent rating agencies forecast that the 2022 target will not be met by as much as 42 per cent. Distribution companies across the country see their obligation to buy renewables as a burden too heavy, so much so that discoms (distribution companies) in Andhra Pradesh retroactively cancelled their long-term power purchase agreements with renewable energy developers, and courts had to be brought in to decide on the sanctity of maintaining contracts; and, despite these developments, the central government seems confident about its ability to meet renewable targets.

Like the proverbial six blind men and the elephant, each stakeholder seems to hold dear his version of truth. How do we grapple with these different narratives for integrating renewables, and what do they mean for India's energy transition? What do they mean for our incumbent institutions—norms, capabilities, rules, markets—and for competing technologies, primarily conventional ones? And finally, what is the way forward?

In this article I outline the changing roles of coal and renewable technologies in energy supply. I argue that installed capacities, especially from intermittent renewables, mean little if the energy from those power plants cannot be used effectively. Being able to use intermittent renewable energy effectively will become increasingly challenging as we have greater shares of renewables in the generation mix. Grappling with these challenges requires us to take a holistic view of the energy sector—one that carefully engages with the existing economic and regulatory imperatives of various actors.

BUT WHAT ABOUT COAL?

Despite massive state-backed investments in renewables, close to 80 per cent of India's electricity is generated by coal-fired power plants. If, hypothetically, complete decarbonisation of the energy sector was the only goal for the Indian government, the removal of coal would be critical. However, in a developing country such as ours, the idea of wishing away coal for the sake of lowering emissions is a hard

sell, and rightfully so, when hundreds of millions of people barely have access to reliable electricity. Unpacking the ethical conundrums associated with a choice between electricity for a poor household, and the distress caused as a result of increasing climate change-related drought and flooding in India is nigh impossible. How do we then go about rethinking the hegemony of coal in a way that would lead to sustainable development?

Until very recently, dominant narratives amongst both governmental and civil society organisations perceived coal-fired electricity generation as a continuing necessity if India is to be able to maintain a high rate of economic growth (Mohan and Topp, 2018). Nonetheless, during the last few years, narratives from civil society have begun to consider the possibility of no new coal plants during the next decade. A report by TERI, for instance, was amongst the first to highlight the possibility of the beginning of decarbonisation; they simulated a scenario in which India's reliance on coal-fired power plants would decline starting from 2026, if costs of storage declined sufficiently by then.[1] However, another modelling study conducted by Council on Energy, Environment and Water (CEEW) suggested that without policies specifically aimed at reducing coal consumption, coal-based generation would keep increasing in the long run.

But the choice is not simply limited to whether or not new coal plants should be installed. There are other operational ways in which coal-fired power can be instrumental in assisting energy transition in India. In power systems dominated by coal assets, making them more flexible is a key strategy to integrate large shares of renewables more effectively. Often, as the share of generation from intermittent and variable renewables increases, system operators advocate curtailing renewable power, as they claim that the existing power system cannot cope with the variability; they do not consider backing down of coal power plants. In Tamil Nadu, for instance, developers of wind power have suffered great losses as a result of the curtailment by the State Load Dispatch Centres (SLDCs). Experiences in Germany, Denmark and the United States show that existing thermal power plants can provide much more flexibility than often assumed.

Flexibility of firm power can be characterised as having the following dimensions: (i) low technical minimum load, which refers

to the lowest load the plant can run on—the lower the minimum load, the larger the range of generation capacity; (ii) a shorter start-up time, or the time it takes for a power plant to reach the minimum load; and (iii) a higher ramp rate, which would allow a power plant operator to adjust net output more rapidly. In India, the technical minimum for centrally-owned power plants is 55 per cent of their rated capacity. For comparison, in Denmark, technical minimums of coal plants were brought down to 10 per cent as their share of wind power increased. In a renewable energy-rich state such as Karnataka, state-owned thermal power plants still enjoy technical minimums as high as 70 per cent. In a report titled 'Greening the Grid', a collaboration between USAID and the Government of India's Ministry of Power, pathways to reach the goal of 175 GW were evaluated. The analyses concluded that bringing the technical minimum of India's coal plants down to 40 per cent would have the single largest impact on effectively integrating renewables over any other measure.[2]

Other independent experts suggest that 'cleaning up coal' or simply improving the efficiency of coal-fired plants might be more realistic goals, rather than weaning the country off coal-fired power generation altogether (Tongia and Gross, 2019). While this should be an essential goal for the thermal power sector, it is not clear whether the rules, incentives or resources are aligned to realise the goal. Often, objectives of low cost and high efficiency are not aligned. A recent change in market design that was meant to reduce costs—implementation of a new dispatch algorithm (SCED) for central power plants—led to increased generation from polluting plants.[3] This suggests emissions reduction must be specifically factored into operations of the power system to ensure that it is reflected in the individual operation of power plants.

ELECTRICITY MARKET DESIGN AND INTEGRATION OF RENEWABLES ARE INEXTRICABLY TIED

The variability and uncertainty of intermittent renewable power has significant economic and technical consequences for the various participants in the electricity sector. Conversely, the institutions—rules, norms and strategies—of operation also have consequences for how various technologies are used, and their ensuing technical and economic implications. In advanced electricity sectors in Europe

and the United States, integrated electricity markets and price discovery play a vital role in efficiently managing the intermittency of renewables. In this section, I discuss why integrated markets and price discovery matter. I also discuss how we could incorporate greater price discovery in the Indian power sector, while accounting for existing institutional and political constraints.

The fundamental argument behind geographically integrated markets is as follows: only when electricity can flow freely across large geographical areas, without any technical or economic constraints, can energy providers deliver the most affordable electricity to the most number of people. The 'market', or a trading platform for electricity, as for any other commodity, is merely a platform where buyers and sellers interact to make a deal most beneficial to each of them. The primary difference between electricity and other commodities is that another function—system operation—plays a role in reliably operating and balancing the system.

The electricity sector in India operates largely in islands, both economically (long-term contracts) and technically (as dispatch decisions take place at the state level). Close to 90 per cent of all electricity transactions in India are locked in lumpy, long-term contracts between generation plants and distribution or supply companies located within the same state. While this arrangement worked well so long as most power plants in the generation mix could be required to generate or powered down at will, intermittent renewables have now changed the landscape. Both solar and wind power are variable sources of supply, and need to be accommodated into the grid as and when the sun shines and the wind blows. High renewable energy states such as Gujarat, Karnataka and Tamil Nadu are already having to curtail their renewable production on certain days.

Greater interstate trade correspondingly accompanied by larger dispatch areas, therefore, are important mechanisms to ensure: (i) better balancing of demand and supply, as having access to a larger pool—more generators and demand sinks—allows access to more resources to manage the intermittency of renewables; and (ii) economic dispatch, as the least expensive resource can be used at any given time.

The price discovered through trade on a market performs another critical function: of providing information; the price is a signal of the 'value' of the commodity. It also signals where future

investments in transmission, storage or generation are most required. For instance, after the country-wide power exchange was introduced in 2008, and the country's five regional grids became technically integrated and synchronised into a single grid in 2014, price differences discovered between the southern and eastern regions of the country indicated that the best place to invest in a transmission line was between those two regions. Therefore, price contains important informational value. To adapt the electricity market design to high shares of renewables in the generation mix, scholars argue that electricity prices should be determined at a very granular temporal level—i.e., by second-to-second—for both real-time and the future, so as to reflect its value at every moment (Newbery, et al., 2018). Prices should also be determined at a spatially granular level; models have shown how such pricing approaches reduce overall costs in general, and particularly under a high renewable energy scenario (Neuhoff, et al., 2013).

Today, the Central Electricity Regulatory Commission (CERC) is actively proposing the introduction of various markets close to real-time.[4] If the CERC's proposal on redesigning day-ahead markets were to come to fruition, it would have a significant impact not only on the overall cost of operating the system, but also on the integration of renewables by allowing flexibility needs to be managed across a larger pool of resources. The new market design would uncover variable costs of the entire volume of electricity transactions, and not simply for a mere 3.7 per cent of the total volume as is true with the current power exchanges. It would also render redundant proposals such as 'round-the-clock' (RTC) by the Ministry of New and Renewable Energy, which aims to bundle disparate renewable sources to provide firm power. Such proposals, although well-intentioned, are likely to have adverse effects on efficient system operation, by making contributions of renewables lumpy in ways that are not necessarily efficient from a systemic perspective.

CRITIQUING MARKETS AS AN OPTION FOR INDIA: WHY DO STATE REGULATORS AND DISCOMS RESIST?

Overburdened and loss-making distribution utilities seem to be the biggest barriers to achieving the prime minister's ambitious targets of 175 and 400 GW of renewable capacity. Investors worry about the credit worthiness of many utilities, and the larger economic

slowdown does not help their cause. At the same time, discoms and regulators together primarily determine ways in which electricity is traded and procured in India. In addition, decisions of the power plants that need to be dispatched also follow from discoms' procurement decisions. If markets were the obvious solution, a pertinent question, then, is why do only a minuscule percentage of stakeholders adopt it? During an interview with a regulator in Bihar, he had a simple response to this question: 'Long-term contracts are the only way we have known to procure power.'

A part of the answer to the question of why trading is not prevalent in India lies in the uncertainty and volatility associated with electricity prices. Volatile electricity prices create the fear of high and unpredictable costs of electricity—and in the resource-constrained context that discoms operate, they do not have the appetite to take the risk. However, left out in this narrative of the discoms is the fact that they also take on large risks by signing 25-year contracts with generation companies. This risk, however, is driven by uncertainty in future demand growth.

Discoms sign long-term contracts in the expectation that demand will grow at a certain rate. If that rate of growth of demand is not borne out in reality, discoms are left paying large amounts of fixed costs for capacity that they do not need! It is this situation that led discoms in Andhra Pradesh to take the extreme step of retroactively cancelling their Power Purchase Agreements (PPAs), while sending shockwaves to private-sector developers. The over-reliance on long-term contracts for energy has led to massive financial burdens on already cash-strapped discoms, impacting the reliability of electricity supply.

Interviews with officials at distribution utilities indicate that their capabilities to engage with markets are limited by several factors: chiefly, very rudimentary abilities to forecast electricity demand or electricity prices, limited capacity to analyse the economic implications of procurement decisions under uncertainty, and financial reserves to engage in daily market transactions. The takeaway here is not so much that one form of procurement is better than another; it is the lack of any resource planning or scenario analyses of the economic consequences, i.e., costs, benefits and risks, of various procurement options under uncertainty. These issues lie at the heart of sustenance of the electricity sector in India.

Another part of the problem lies in the manner in which distribution companies are regulated. Almost all discoms, save for a few in metropolitan cities, are regulated under the 'cost-plus' regime. Under this regime of regulation, discoms can recover all their costs, as long as they account for them under the rules that the regulators set, and receive a 'normal rate of profit' in addition. These costs are then socialised. Discoms, therefore, do not bear the financial consequences of their own procurement decisions, leaving them with little incentive to analyse the economic implications of their decisions. Regulatory commissions often set the decision space for procurement and trade by discoms, based not on extensive resource planning analysis, but on their perceptions and preferences.

OUR IMMEDIATE PATH FORWARD

India's energy transition stands at a point where complete decarbonisation is unfathomable, at least for the next decade or so, or until costs of alternative, flexible, low-carbon technologies decline sufficiently. What we need to focus on is to massively scale up such mature, renewable technologies as solar and wind. At the same time, the existing coal-fired capacity will play an important role in integrating renewables by providing firm but highly flexible supply.

Merely adding installed capacity of renewables, however, is grossly insufficient. To effectively use the power generated from renewables, we need to align economic and operational incentives in a manner such that the power system is balanced across larger geographical areas in a competitive way. While the CERC's market design proposal is a good step, the greater challenge is to strengthen the analytical ability of discoms to undertake economically sound decisions under increasing uncertainty. An alternative regime of regulation, such as incentive-based regulation, should also be seriously considered to incentivise discoms towards greater efficiency in procurement.

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THE COAST IS UN-CLEAR

MADHURI RAMESH

'The world is waking up. And the change is coming, whether you like it or not.'

– Climate activist Greta Thunberg at the UN Climate Action Summit, 2019

INTRODUCTION

The global climate has been changing rapidly since the 1950s, and many of these changes appear to be sharp, irreversible deviations from whatever we know of the past. In technical terms, climate change refers to the change in the average weather condition over a relatively longer period of time, i.e., longer than 10 years. As is well known, climate change has, to a large extent, been caused by increased concentrations of greenhouse gases, such as carbon dioxide and methane, which are released into the atmosphere mainly by such anthropogenic activities as the burning of fossil fuels and intensive cultivation of land. There is good reason to believe that climate change has already set in motion far-reaching chains of consequences, not only for life on land but also in, and bordering, the oceans.

THE MARINE CONNECTION

Oceans are the largest ecosystem on the planet and they play an important role in maintaining life-supporting conditions: for instance, they produce 50 per cent of the oxygen we breathe, and play a pivotal role in maintaining normal thermal and hydrological cycles. In addition, the oceans serve as 'blue carbon sinks' by

soaking up 25 per cent of the greenhouse gases released, and absorb 90 per cent of the excess heat such gases trap in the atmosphere. However, studies on ocean warming indicate that this heat is not distributed equally, because some regions are heating up faster than the global average. These 24 regions have been dubbed as 'marine hotspots', and some scientists believe that close monitoring of such areas might help us understand what lies in store and prepare for a difficult future.

On the whole, this sponge-like quality of the oceans, which previously helped them function as an excellent buffer, appears to now have reached a saturation point and, instead, the excess gases and heat are beginning to alter the physical and chemical properties of the oceans themselves. To provide just one example: there have been reports that the number of 'dead zones' in the seas has quadrupled since the 1950s. Also known as oxygen minimum zones (OMZs), these regions have very low levels of dissolved oxygen caused by the weakening of water currents which, in turn, are caused by ocean warming. Such dead zones obviously cannot harbour marine organisms and therefore affect human communities that are dependent on fishing. Although such phenomena might seem to be anchored in specific locations, they have global implications because the ocean ecosystem is estimated to contribute about $1.5 trillion per annum to world economy and around 60 million people are employed in the fisheries sector, a majority of them in developing countries. Moreover, around 3 billion people around the world are dependent on access to fish to maintain a traditional healthy diet.

As even this brief example indicates, oceanic climate change can affect multiple spheres of human life such as resource extraction, trade, culture and health. There are many such issues emerging from the shifts occurring in the oceans of today, and we are still in the process of uncovering the multiple ways in which it can play out—through interlinked physical, chemical and ecological processes—as well as attempting to grapple with its social consequences.

THE INDIAN CONTEXT

With respect to discussions on climate change as a whole, India is of special interest for two main reasons. The first is a historical one because some of the oldest meteorological studies are from this country, beginning with the work of Edmund Halley in 1636

(who later lent his name to a comet) on the Indian monsoon. Next came the weather stations set up in the late 1700s by the British East India Company. In 1875, these stations were brought under the control of the Indian Meteorological Department (IMD), which began systematic data collection in 1901. From these early years, climate scientists have believed that knowledge of the Indian climate system could help them decipher the patterns driving the larger global one.

The second, more pragmatic, reason is that India is a significant voice in global negotiations on climate change because of its expanding economy and the fact that a large proportion of its population continues to be dependent on the natural environment to meet subsistence needs. For instance, historian Sunil Amrith observes that '[…] 60 percent of Indian agriculture remains rainfed, and agriculture employs 60 percent of India's population' (2018), and to emphasise this point further, he goes on to quote Sunita Narain, who said, 'India's finance minister *is* the monsoon' (2017). On a related note, India has been at the forefront of efforts by developing countries to argue for a 'common but differentiated responsibility and respective capabilities' (CBDRRC) approach so that such regions are not unduly burdened with the task of implementing climate action plans, that too at the expense of nationally important development goals.

Much has been written about the scientific and technological aspects of what mitigation as well as adaptation to climate change entails for this country, but it tends to be focused on terrestrial aspects, because these are relatively better known. However, climate change spares no ecosystem and, as mentioned earlier, the oceans too are beginning to change in fundamental ways. The Indian coastal region is an apt place to start if we want to understand how this phenomenon is making its presence felt on the landward as well as seaward side. Such a perspective is important because India has an extensive coastline of over 7,500 km, of which over 5,400 km belong to the mainland and the rest to island archipelagoes. It also has more than 200 million people living in this coastal region, of which 4 million belong to fishing communities that live close to the shoreline and are directly dependent on the marine environment. The Indian coast is a large socio-ecological system, and disturbances in one sphere have inescapable repercussions on the other.

LANDWARD EXPERIENCE: EROSION, FLOODING AND CYCLONES

Strictly speaking, the coast is an area adjoining the sea and its seaward boundary is known as the coastline or shoreline. The latter is shaped by natural factors such as wind, wave and tidal action, cyclonic storms and the sediment load of rivers, as well as such anthropogenic factors as offshore dredging, the construction of harbours, mining of beach sand and removal of mangroves. From a political perspective, coastal areas fall within nine states (Gujarat, Maharashtra, Goa, Karnataka, Kerala, Tamil Nadu, Andhra Pradesh, Odisha, West Bengal), two Union Territories (Daman–Diu and Puducherry–Karaikal), and two archipelagoes (Lakshadweep, and Andaman and Nicobar Islands).

The dynamism of coastal landscapes is well known and, over the years, multi-scalar efforts have been made to understand this aspect by mapping and analysing changes in regional shorelines. In a recent study, the National Centre for Coastal Research, under the Ministry of Earth Sciences, found that at the state-level, erosion is comparatively high in West Bengal, Puducherry, Kerala and Tamil Nadu. In places such as Lakshadweep, the average elevation of the landmass is only 1–2 msl. Hence, even a small quantum of sea-level rise (SLR), combined with the construction of coastal embankments, has had a discernible impact—for instance, this island group has lost about 5 per cent of its coastal land in less than two decades (1989–2006). Certain parts of Odisha, too (e.g., Ganjam, Puri and Kendrapara districts), are highly vulnerable to erosion as a result of a combination of such factors as cyclones, flooding and the construction of coastal embankments. Moreover, the state has already lost 28 per cent of its coastline to erosion within less than two decades (1999–2016). However, in other parts of the state, the accretion rate is quite high. Therefore, in terms of expanse, the study found that both Odisha and Gujarat have acquired more than 60 sq km of coastal land over the past three decades as a result of high accretion rates, whereas West Bengal has lost nearly 100 sq km of its coastal land.

Coastal erosion has made everyday life difficult for fishing communities, particularly because they are often unable to carry out such routine activities as berthing boats, drying fish, and using beach seine nets. It also makes their houses more vulnerable to inundation during high tide and storm surges. In many states, although the beach area is decreasing as a result of erosion, the population of coastal communities is increasing. This, in addition to the pre-existing lack of such infrastructure as waste disposal systems and sanitation facilities, has made many fishing villages congested and unsanitary places in which to live.

The second most common experience of climate change on the landward side is flooding. It is caused when there are very high levels of water in built-up spaces, and this is also influenced by the topographic and drainage features of a given region. Overall, sea-level rise (a direct outcome of ocean warming) can contribute to increasing the magnitude, frequency and duration of coastal floods. In fact, a recent study suggests that the existing models of global SLR may have significantly underestimated the vulnerability of coastal regions to flooding, as they overlook the cumulative effect of SLR combined with seasonal changes, storm surges and tidal action. This is particularly true of the tropics, because cyclones are also common here.

This puts coastal cities and small islands in this region at high risk of flooding: for instance, an SLR of 5–10 cm can double the flooding potential of many coastal locations in the Indian Ocean basin and the tropical part of the Pacific Ocean. According to current climate change models, SLR may increase to as much as 10–20 cm a year by 2050. This is of grave concern, as 40 per cent of the world's population lives within 100 km of a coastline, and it is estimated that at least 50 million people will be impacted in the coming years by coastal flooding as a result of SLR. Developing countries along the Indian Ocean rim, such as India, China, Bangladesh and Indonesia, are likely to be affected the most. In the case of India, it is estimated that 14 per cent of the total population, i.e., approximately 170 million, live in coastal districts. Moreover, in some areas, such as the northern Bay of Bengal, the rate of SLR is double the global average. Given that this area is densely populated as well, such trends are of great social concern.

Flooding often affects people in tandem with the occurrence of cyclones. Consider, for example, the Indian Sundarbans. This is a deltaic region formed by the trisection of three rivers—Ganga, Brahmaputra and Meghna—and it is the largest such formation in the world. Nevertheless, it is a dynamic and low-lying area that is susceptible to erosion. In addition, it has experienced climate change events, primarily in the form of intense cyclones and

extensive coastal flooding. Such events, especially, add strain to the lives of women, because as primary caregivers they have to travel far to find clean drinking water for the household, and despite inadequate access to health care they also have to keep the children safe from a range of waterborne diseases that proliferate afterwards. As a result of cyclones and floods, entire islands within the region, such as Lohachara and Ghoramara, are gradually getting submerged, and such production systems as agricultural fields and freshwater fish ponds have been damaged by the influx of saline water. The physical destruction of homesteads is believed to have rendered more than 30,000 homeless in the past three decades. In addition, the destruction of fields has greatly diminished the food security of local populations, and contributed to migrations to other regions in search of employment.

In the past five years, India has been affected by unusually severe cyclonic storms along the west coast too: Cyclones Nilofar, Chapala, Megh and Ockhi all originated in the Arabian Sea, and their wind speeds ranged from 155–215 kmph. Cyclone Ockhi alone damaged property across three countries (Maldives, Sri Lanka and India), caused the death of over 200 people in two countries (India and Sri Lanka), and carried over 500 fishers off course in India. Such occurrences are likely to become more frequent with ocean warming, because it is believed that the Arabian Sea has become warmer by 0.5–0.6°C over the past decade. This has added to the energy of cyclonic storms in the western region. Even sudden downpours, another feature of the erratic patterns triggered by climate change, can have a serious impact on fishing communities, because they can completely ruin fish-drying businesses which mainly use sunlight to cure the catch. This directly impacts the income of women, as they usually run such enterprises. Intense, short bursts of rain also seem to flush pollutants into the sea, because they are sometimes followed by the mass death of fish in nearshore waters.

SEAWARD EXPERIENCE: FISHING

As mentioned earlier, certain parts of the ocean are warming faster than others and are known as marine hotspots. Two such areas flank the Indian peninsula: the South East Indian hotspot lies adjacent to the districts of Ramanathapuram and Tuticorin in Tamil Nadu and covers the Gulf of Mannar, whereas the South West Indian hotspot

lies adjacent to four coastal districts of Kerala (Ernakulam, Alapuzha, Kollam and Thiruvananthapuram). These areas are also important fishing grounds; hence, such shifts are likely to have significant economic and social impact. In addition, the average sea surface temperature has increased across the world and this, too, is likely to add to the effect of the hotspots.

Taken together, it is believed that these ocean-warming phenomena can alter the species composition and abundance of phytoplankton, which are the basis of all marine ecological relations, and thereby gradually change marine food webs. This can alter the abundance and distribution of numerous species of fish as they travel greater distances in search of suitable food. For instance, studies conducted by the Central Marine Fisheries Research Institute off the coast of Kerala indicate that sardines are now found further north, and hence the state-level catch of this commercially important species has now declined. Similarly, a study on the impact of climate change on small-scale fishers on both coasts, published by the International Collective in Support of Fishworkers, found that fishers believe that breeding migrations of valuable species, such as hilsa (*Hilsa ilisha*) and bhetki (*Lates calcarifer*), are also changing in response to novel shifts in marine environment. They also report other interesting observations, such as the fact that mudskippers have completely disappeared from some parts of Maharashtra and Andhra Pradesh, while in the latter state the oil sardine (*Sardinella longiceps*) has become more common than the lesser sardine (*S. gibbosa*). In Kerala, too, there have been reports of the unusual occurrence of puffer fish, and in West Bengal octopus and grouper have suddenly become more common. In some cases, ocean warming may also induce vertical displacement of species: for instance, mackerel is now found in much deeper waters. Ocean warming is also expected to make mass coral bleaching events more frequent and this could, in turn, drive a decline in reef-based fisheries. Algal blooms are also expected to become more frequent with the warming of waters. These are known to cause widespread mortality of fish in the Arabian Sea and the Bay of Bengal. Ocean acidification, on the other hand—caused by the absorption of CO_2—could cause a steep decline in the abundance of shellfish, many of which are important export commodities.

In addition to the overall increase in temperature, marine heatwaves are also becoming more frequent and intense. They

are said to occur when high temperatures are recorded for five days or more in certain marine regions. These heatwaves damage such particularly productive ecosystems as seagrass meadows, coral reefs and kelp forests—these harbour many commercially valuable marine species. Although many marine organisms are capable of dispersing over large distances, the area covered by these heatwaves is very wide and the rise in temperature is so rapid that even mobile species cannot escape their reach. If these species are already affected by overfishing, exposure to such heatwaves can cause further population declines by reducing growth rates and fecundity. Since many areas are already extremely overfished, fishers in some regions appear to be adapting to these shifts in distribution by now trading in what were previously discarded, or considered unimportant, species: Bombay duck and sardines in West Bengal, and in Maharashtra, trawlers which used to mainly catch shrimp now also catch cuttlefish and squid.

In order to deal with these ramifications of climate change, fishers in various parts of the country have asked for adaptation measures that include a consultative identification of alternative livelihoods, access to better basic infrastructure and more robust housing. As such, their safety at sea is also compromised since many vessels have no life jackets for the crew, mast lights or compasses. At the same time, they are spending far more time at sea: the changing distribution of fish has also resulted in fishing grounds being farther away. For instance, in the Gosaba area of the Indian Sunderbans, fishing grounds are over 10 km away; in Kakdwip, they are over 100 km away. Similarly, in the Godavari region, estuarine fishing has reduced greatly and, instead, fishers have moved into marine areas. In many localities, the duration of fishing trips has also increased from a few days to a few weeks, even for small vessels. These, combined with the occurrence of extreme weather events, including freak upswells, have heightened the risk. Fishers are now beginning to recognise the urgent need to maintain boats in better condition and put in place a support network to ensure their safety at sea. Therefore, there is more willingness to use compasses and GPS devices, but they also require governmental support, especially during a crisis.

Fishing communities on either coast show slight differences in how they have attempted to adapt to climate change so far: on the

eastern side, fishers diversify into wage labour and sometimes work even as temporary crew of a west coast vessel. On the west coast, fishers tend to intensify their operations, including going farther out, to make up for fluctuations. Many women, on the other hand, have moved out of the sector altogether and try to engage in domestic, construction or agricultural labour to make up for fluctuations in household income. This, combined with the out-migration of men in search of seasonal work, has placed them under enormous pressure. Another emerging trend is that households are more willing to support the younger generation in getting an education and finding other sources of livelihood, since a majority in this sector believe that future prospects are extremely bleak. However, it is also important for us to remember that the fisheries sector in India is in any case a struggling one as a result of a host of other factors, including poorly designed policies, inadequate post-processing facilities, high intra-season price variations, intense competition between different types of fishers, and the proliferation of environmentally unsustainable practices. Therefore, not all problems can be attributed to climate change per se.

TACKLING COASTAL CLIMATE CHANGE

India will require about $2.5 trillion to put in place all the adaptation and mitigation measures it has agreed to adopt by 2030 in order to meet the international commitments it has made so far. It has already been a recipient of external aid that is directed at helping developing countries establish suitable response systems. For instance, it has received grants from the Green Climate Fund (GCF), which is one of the four new international donors set up to help with climate change adaptation in the fisheries sector. These include the modification of marine policies, research on impact on fisheries, efforts to manage harvesting levels according to changes in fish distribution and behaviour, and to improve the resilience of fishing communities.

India is an active member of such regional platforms as the Bay of Bengal Large Marine Ecosystem programme (BOBLME), where it partners with the Maldives, Sri Lanka, Bangladesh, Myanmar, Malaysia, Thailand and Indonesia. This is a sorely-required initiative, because the Bay of Bengal is fringed by a quarter of the world's population, and fishing is an important part of the economic and

cultural lives of a large proportion of these people. It is often also the last resort for internally displaced, poverty-stricken communities. For a glimpse of the intensity with which this Bay is used, consider this fact: there are so many scores of boats that go squid fishing off the coast of Thailand and Myanmar that their bright green lights (used to attract the squid) can be seen from the International Space Station. On the other hand, a dead zone of about 60,000 sq km has already been reported from the middle of the Bay, between Myanmar and India. Such physical changes, combined with such other stressors as large-scale unregulated fishing and ocean warming, can devastate the fisheries in the Bay of Bengal—and where would such doubly displaced climate change refugees go? Clearly, it is a priority for countries such as India to track changes and actively manage this important marine space.

Another collaborative effort that India is a part of is Deltas, Vulnerability and Climate Change: Migration and Adaptation (DECCMA), where it partners with Bangladesh, Ghana and some research institutions from the Global North to study and manage the highly vulnerable Sunderbans delta. Some state governments are also supported by the United Nations Environment Programme (UNEP) in their attempts to develop gender-sensitive adaptation projects, such as in Odisha, since climate change adds to the heavy social and economic burden borne by women in many coastal communities.

At the country level, India has a National Action Plan on Climate Change (NAPCC), but only a few of the initiatives covered by NAPCC are directly relevant to coastal regions. For instance, the National Mission on Sustainable Habitat (NMSH) aims to improve the urban development process by integrating aspects that will help cities deal with climate change. These include energy efficiency, better drainage and sewerage system as well as improved public transport. The National Mission on Strategic Knowledge for Climate Change is an initiative that supports research on coastal themes, such as ocean acidification and sea level rise, to be undertaken by the National Institute of Oceanography. Regional studies of climate modelling and storm surges, undertaken by IIT–Delhi, are yet another example. However, it was widely recognised that these efforts alone would not be sufficient, given the scale of the issue. Hence, in September this year, the launch of a new National Coastal Mission was announced: its primary aim will be to develop

an integrated coastal zone management plan across the 13 coastal regions (including the archipelagoes), promote stakeholder participation in the same, and enforce compliance to the Coastal Regulation Zone (CRZ) notification. This mission will be directed by the Ministry of Environment, Forests and Climate Change.

To further support its climate action work, the central government instituted the coal cess in 2011, and the monies raised were meant to be spent on clean energy alternatives and other climate action efforts all over the country. However, only around ₹7,000 crore has been spent so far on appropriate projects and the remaining amount of over ₹56,000 crore was diverted to unrelated sectors. Of equal concern is the fact that it has also steadily weakened the conditions laid down in the CRZ notification from the original version in 1991 to the current one passed in 2018, which permits many more activities close to the high-tide line. The amendments have been justified as essential for the growth of infrastructure development, shipping and tourism-related industries, and have been twinned with a dilution of how environmental impact assessments need to be conducted. Simultaneously, there has been a strong push to develop these sectors and expand existing operations, although it is unclear if adequate safeguards have been put in place to deal with the pervasive effects of climate change on coastal lives and property. Pragmatic policy measures are certainly required, but it appears that many environmental considerations are being overruled. These can only result in very short-term gains in coastal regions, and that too when the effects of climate change are becoming more pronounced than ever. Moreover, given that there is no serious dearth of funds, we clearly need a more engaged citizenry to pressurise elected political representatives to take climate action seriously, especially with respect to the coast, since this region is most vulnerable to climate change.

At the state level, a considerable proportion of climate action measures need to target urban areas as these are densely populated, already contribute significantly to global warming, and are expanding by the day. For instance, of India's 10 metropolitan cities, five are located along the coast (Kolkata, Chennai, Ahmedabad, Surat and Mumbai). Moreover, extreme flooding causes huge economic losses in these business hubs: the Maharashtra government recently estimated that flood damage in Mumbai alone

over the past 10 years (2005–2015) has caused losses to the tune of ₹14,000 crore. Therefore, global initiatives, such as WWF's One Planet City Challenge, hosted along with ICLEI–Local Governments for Sustainability, help to create interest in urban centres and provide some recognition to municipalities that are making a genuine effort to take climate action: Rajkot (Gujarat), Pune (Maharashtra), Coimbatore (Tamil Nadu), Panaji (Goa), Cochin (Kerala) and Delhi have all been national-level finalists in the past, and two of these are coastal cities.

But what of even more granular, community-based efforts? While many grassroots organisations are attempting to help people adapt to the increasingly erratic changes in weather and its cascading effect on production systems that are closely tied to natural resources, it is a difficult task for two main reasons: (i) climate change is an irreducibly large-scale phenomenon and this makes it very hard for small, non-specialist communities to either track or respond to it in an adequate manner; and (ii) it is such an unprecedented change in the recorded history of humankind that it is still beyond the grasp of our diverse systems of knowledge as well as our collective imagination. Therefore, while active community participation is certainly desirable and necessary in adapting to climate change, this is a complex issue that requires multi-scalar actors.

END NOTE

Climate change is one of those topics that confirms the truth of a statement that is popularly attributed to Isaac Asimov: 'Today's science fiction is tomorrow's science fact.' In 1891, in a fictional account, Jules Verne wrote on a group of men who set out to 'correct' the tilt of the Earth's axis and make it neatly perpendicular to its orbit. He discussed how this would change global climate as well as the political upheavals it would cause. From then to the current century, when the genre of 'cli-fi' or climate fiction has come into its own, the subject has challenged our imagination of what such a drastic alteration would mean for life as we know it—even fiction writers, who as a group are usually adept at articulating humanity's pressing concerns, have been lagging when it comes to this theme. As Amitav Ghosh asks in his essay, 'Is it perhaps too wild a stream to be navigated in the accustomed barques of narration?' (2016).This observation appears to hold true for science and politics too as we

know them today. To the extent that telling tales is one of humanity's oldest ways for making sense of the world and passing on strategies of survival to the next generation, it is urgent that we build a robust vocabulary and detailed multidimensional narratives of this strange environmental epoch. However, it is too urgent an issue to leave to the poetic community alone. It also needs pragmatists to ensure committed political leadership, sincere public participation, and serious restructuring of socio-ecological systems.

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CLIMATE CHANGE AND RURAL WATER SECURITY

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INTRODUCTION

The Report of the Intergovernmental Panel on Climate Change (IPCC) states that observational records and climate models provide abundant evidence that freshwater resources are vulnerable and likely to be strongly impacted by climate change, with wide-ranging consequences for human societies and ecosystems (Bates, et al., 2008). Several global assessments of climate change indicate that the Indian subcontinent in particular will be hard hit.

Over the last decade or so, climate change has come to occupy centre stage in most discussions on water. In recognition of this close relationship between climate change and water, one of the eight missions set up under the National Action Plan on Climate Change (NAPCC), by the Government of India, is on water—National Water Mission (NWM). An analysis of the emerging discourse, including the popular discourse, on climate change and water reveals three broad trends in the discussion of the relationship between climate change and water.

The first trend—and this seems to be the most prominent one—sees climate change as *the problem*, under which all other issues and changes are subsumed. An extension of this imagination is to see everything that is happening in the water sector—be it a drought or a flood—as a result of climate change. In other words, all the ills confronting the water sector in the country can be blamed on climate change. Human interventions or political economy/ecology factors are not problematised. This type of a 'climatization' (Wine and Davison, 2019) gives rise to either a certain 'helplessness'—a

Winter 2019–Spring 2020, Volume 46, Numbers 3 & 4

feeling that nothing can be done as it is all because of climate change—or it leads to a climate change-centric policy and practice regime as the way out of the crises faced by the water sector.

The second, which sees multiple stressors acting on the water sector and climate change, is one of the stressors granting the fact that climate change has its own specific impacts. This discourse of 'everything-change' mentions many other changes taking place in addition to changes in climate. It gives equal emphasis to both anthropogenic (for example, land-use changes) and climate change causes, and takes the position that we need to engage with both.

The third trend recognises that, apart from climate change, there are many other issues confronting the water sector, but sees climate change as a convenient 'peg', even an opportunity to confront all concerns about water. In this article, we adopt a point of view that is similar to the second school of thought, in that we frame the climate-change-water relationship from a multiple stressors' perspective.

CLIMATE CHANGE CHALLENGES FOR THE WATER SECTOR

TEMPERATURE AND RAINFALL

There is reasonable consistency in temperature projections under climate change and historical trends. Maximum temperatures have increased in most parts of India. While rising temperatures might impact the demand for water, it affects the hydrologic cycle primarily through the impact on evaporation and evapotranspirative demand by vegetation. Similarly, the anticipated rise in sea level is not disputed, although there may be variations in the degree and rate of increase.

In Himalayan sites, climate models consistently predict a strong decrease in glacier area (Ragettli, et al., 2016), with a concomitant increase in temperature and rainfall. The formation, growth and likely outbursts of glacial lakes are phenomena directly related to climate change and deglaciation (Shreshta, et al., 2010). However, the stream flow is likely to increase significantly as a result of increased precipitation and ice melt, and the transition from a snow to a rainfed river. While this may not result in seasonal changes in the hydrograph, peak flows that may increase with flooding are likely to be the biggest concern.

In contrast, rainfall trends remain confusing. There are inconsistencies between models and observed trends, and a

consistent picture has not yet emerged (Jain and Kumar, 2012). There is, however, support for the hypothesis that the frequency and intensity of extreme rainfall events over India has been increasing over the last century (Guhathakurta, et al., 2011; Krishnamurthy, et al., 2009). Nonetheless, whether future climate will be hotter and drier, or hotter and wetter, it seems clear that we must prepare for a future that entails harsher droughts (length and duration of dry spells) and floods.

IMPACT OF HYDRO-CLIMATIC VARIABLES ON WATER AVAILABILITY

The projections of future climate are necessary, but not sufficient for the water sector. From a water resources' planning and development perspective, what is needed is the translation of climate-change signals into hydrological changes, i.e., the likely direction and magnitude of changes to future ground and surface water flow (Kumar, 2011).

Traditionally, assessments of water resources have relied on the concept of 'stationarity'—i.e., natural systems fluctuate within an unchanging envelope of variability, both in terms of rainfall and stream flow—to design infrastructure and policies. For instance, dams, interstate water-sharing agreements and storm water drains are all designed based on the ideas of 'basin yield' and '100-year storm'. Many of the interstate water-sharing agreements are based on the concept of a 50 or 75 per cent dependable yield. Climate projections make it clear that the assumption of stationarity is unlikely to hold in the future (Milly, et al., 2008), and thus we need new approaches.

But not only are rainfall projections themselves inconsistent (across climate models, and when compared with historical data), the translation of rainfall into runoff and recharge is even harder. Here the 'climatization' of the water sector is being raised as a serious concern (Wine and Davison, 2019), where all observed trends are attributed to climate change. High-quality attribution research is needed to both assess and understand the role of climate change (relative to anthropogenic factors) in hydrological processes. It is only when the underlying causes of observed trends are understood will it be possible to draft adaptation policies.

Given that traditional heuristics, such as designing for a '100-year flood' or a 'basin yield of 750 TMC', no longer work, the most common approach is to build a simulation model of projected

changes in precipitation to changes in stream flow and groundwater recharge (Gosain, et al., 2011; Jin, et al., 2018). On the one hand, the lack of historical data hampers the development of robust conceptual models. On the other, watersheds are undergoing rapid human modifications in ways that completely alter their hydrology, i.e., the problem of modelling a watershed where everything is changing simultaneously, with very limited data, is a serious technical challenge. Stream flow and recharge are also determined by land use, crops, technology and infrastructure. It is meaningless to hold all these constant and only alter future climate. But these are determined by future trajectories of human activity; something we are not trained to do. Therefore, fundamentally new approaches are needed to consider alternative water futures and incorporate these into models (Srinivasan, et al., 2017).

LIMITATIONS OF THE CURRENT METHODOLOGY

The current framing of climate adaptation in the water sector has been largely inadequate for several reasons. The water sector should explicitly acknowledge the existence of multiple concerns and multiple stressors (Srinivasan, et al., 2013). This requires the mainstreaming of climate thinking into agencies, rather than creating separate climate cells in each state, which ultimately cannot do much beyond providing consistent projections.

There are many challenges in adapting to climate change: first, there are some changes induced by climate change that are sharply different from anything we have seen in the past. Sea level rise is an example. These require specific actions and capacities that water agencies may lack. The rise in sea level may impact the water sector, and the problem is likely to manifest in many different ways. Coastal flooding and increasing salinity levels in coastal rivers and aquifers is a case in point. Adapting to conditions that have never occurred before requires creative thinking, something for which our bureaucracy is not really equipped. In contrast, variability is inherently a part of the water sector, something for which agencies are already designed. Here, the opposite problem manifests. It is not often clear as to what more agencies ought to be doing specifically to tackle climate change.

Second, if climate change is to be mainstreamed, it will require the coordination of a multitude of agencies. There are various

adaptation options that exist which will need to be incorporated by agencies at different levels of government—local, state and national. Coordination between agencies is already poor—climate change will make it even harder.

TACKLING THE CLIMATE CHANGE ADAPTATION PROBLEM

ADDRESSING THE 'BIG VS. SMALL' DEBATE IN AN EVIDENCE-BASED MANNER

The unprecedented nature and pace of climate change requires creative, path-breaking (vs. incremental) solution design. The uncertainty about future rainfall projections notwithstanding, it is clear that climate change will result in more extreme events: more rain in fewer days, and longer dry spells. The conventional engineering approach to address these uncertainties associated with climate change is to build large structures, revealing a tendency in some circles to equate water security with per capita water storage. Alternatively, per capita water (surface) storage is taken as an indicator of development. To quote Briscoe and Malik (2006): 'Arid rich countries (like the United States and Australia) have built over 5000 m^3 of water storage per capita, middle income countries like China have 2500 m^3, … and India can store only about 200 m^3.'

This, however, may actually be the wrong direction in which to proceed. Besides the fact that we are running out of new locations for dams, the social and environmental consequences of large dams are well documented. The changes in flow regimes and sediment loss have had devastating consequences on aquatic ecology. It would also have serious implications on downstream (environmental) flows, impacting lives and livelihoods of downstream populations (Joy, et al., 2011). The tremendous injustice of displacement and rehabilitation of indigenous populations, who remain largely uncompensated, is a major concern. But the larger question remains: Are dams an effective way to deliver water to enhance secure livelihoods, particularly for millions of rural farmers? In the case of large deltas, the loss of sediment impounded in dams, land subsidence as a result of groundwater rise, and sea level rise causing salinisation of coastal aquifers may be additional threats.

The much bigger problem, however, is that dams only serve a fraction of India's farmers. India's colonial water management paradigm is largely imported from the British notion of centralised

water management, which emerged in a humid geography. Unlike the United Kingdom, in India's semi-arid terrain, primary production is limited by water availability, and there is simply not enough water to irrigate all cropland through canals. Less than half of India's cropland is irrigated, two-thirds of it by (unsustainable) groundwater abstraction.[1] Groundwater use is increasing in canal command areas as well. Moreover, as groundwater over-abstraction leads to stream flow declines (Penny, et al., 2017; Srinivasan, et al., 2015), the further expansion of irrigated area groundwater is only leading to declining baseflows and reservoir yields, further increasing the demand for groundwater, thus inducing a downward spiral.

Moreover, recent research shows that increasing water supply by building dams spurs higher water demand. Nonetheless, this can swiftly offset the initial benefits of reservoirs. Water from large reservoirs tends to substitute rather than supplement and strengthen local water regimes. The so-called 'reservoir effect' refers to cases where over-reliance on reservoirs increases vulnerability, and therefore exacerbates damage caused by drought (Di Baldassarre, et al., 2018).

Even increased reservoir capacity may not be enough to tide over prolonged dry spells, and this does not even begin to address the land that is rainfed. All over India, subsistence rainfed agriculture is becoming increasingly unviable, with farmers either becoming worse off or leaving agriculture for non-farm employment where it is an option (Blakeslee, et al., 2020; Patil, et al., 2017). Ultimately, the demand for protective irrigation by millions of rainfed farmers, even as rainfall becomes more erratic, will be the problem to address.

To deal with climate change-induced variability, we must tackle the challenge of climate change from first principles, rather than remain locked in the historical development pathway we have taken so far. It is essential to understand the interactions between green water (soil moisture from precipitation used by plants through transpiration, part of which is stored in biomass), blue water (freshwater in the form of surface and groundwater), and grey water (polluted water, basically in the form of return flows).

Specifically, we need to seriously rethink our approach to irrigation. Canal irrigation has notoriously failed to control cropping patterns and distribute water equitably, often with only the head-end areas receiving water to grow water-intensive crops, giving rise to what is known as 'tail-end deprivation'. The question then, is: How can

we decentralise water storage and spread water over a larger land area, instead of concentrating water use, as in the case of conventional command areas? The concentration of water use in a limited area only creates islands of high productivity (and waste), sustained by the high level of inputs that are, in turn, sustained by subsidy. In contrast, if water could be spread extensively, then generalised productivity would be much greater. This outcome would ultimately be more equitable and sustainable, but would also require a radical rethinking of our water institutions and infrastructure.

MANAGING EXISTING STORAGE BETTER

Whether or not dams are the way to manage future climate variability, India nevertheless has over 5,000 aging dams today. Managing these dams to avoid catastrophic failure will be a major task. The problem is that there are very few systematic descriptive studies of dam operations. Most studies are modelling exercises of how dams ought to be operated, not how they are actually operated in real-world conditions (Killada, et al., 2012). Recent studies that investigated the possible impacts of climate change on future flooding hazards showed an increased risk of dam failure (Mallakpour, et al., 2019). This indicates that the operational management of aging dams in a changing climate, together with adequate and timely maintenance, will be key.

In India, the problem is even more complex as a consequence of the direct conflict between flood control and the water supply objectives of dams. Releasing water ahead of a major storm to create space for flood waters is a risky proposition. Dam operators often are unwilling to make the call in a country where drought conditions are more persistent than high rainfall events, which are rare. Hydropower authorities in India are still in discussions about whether climate change is real or not. As a result, climate change factors—water availability, extreme events, flash floods and glacial lake outburst floods (GLOFs) in the case of the Himalayan region—are not taken into account in the design and operation of hydropower projects. These projects also pose serious issues of dam safety and directly impact the viability of large hydro from the point of view of both water availability and economic viability.

The empirical evidence of dam operations during floods remains sparse. Most studies point to some combination of

anthropogenic factors exacerbating climate change-induced extreme events. The analysis of data from the Kerala floods shows that extreme rainfall and almost-full reservoirs resulted in a significant release of water in a short span of time (Mishra, et al., 2018). Yet, modelling studies argue that reservoir operations could have at best attenuated the flood peak by ~20 per cent by emptying the reservoir in advance, since the bulk of the flow came from undammed catchments.

Much more work is needed to fully understand how dams ought to be operated during extreme events, given competing demands and interests. The rule curves that guide the operation of each dam might need to be reviewed in light of changes in rainfall patterns, as they were designed at a time when the rainfall regimes were relatively stable.

ANTHROPOGENIC STRESSORS, 'EVERYTHING CHANGE'

The problem is that climate change is not occurring in isolation. Dams, groundwater extraction, watershed interventions, and land-use land-cover changes are all altering ground and surface water flows. Several global analyses have shown that human water use is likely to remain the principal contributor to reduced freshwater flows globally (Grafton, et al., 2013; Vörösmarty, et al., 2010). Indeed, in India, based on recent trends in population and agricultural growth, a 40 per cent increase in groundwater withdrawals is projected, even in the baseline scenario (Amarasinghe, et al., 2007). Even if we could predict/control dams and watershed interventions, land-use land-cover change is dictated by larger macroeconomic policies and people's own aspirations for a better life.

An increasing tendency on the part of the bureaucracy to blame everything—both droughts and floods—on climate change is an attempt to 'naturalise' these events. This response is often a convenient method of justifying inaction, or such mega-projects as the interlinking of rivers. This also leads to the attempt to 'de-politicise' the climate change-water discourse through naturalising, technifying (technology can solve everything) and universalising (universal solutions) when, in fact, the problem calls for the realisation that managing water in already closed basins, where a large fraction of farmering is rainfed, is about allocation processes.

RETURN TO A BIOMASS-BASED APPROACH

This approach is possible only if we make fundamental changes—in what we eat, what we produce, and how we produce. First, we need to move away from water-intensive crops to those more water-efficient and agro-climatically suitable. A glaring example is that of sugarcane cultivation in Maharashtra, which coexists with acute drought conditions. From 1961 to 2017, sugarcane cultivation increased from 1.55 to 9.87 lakh ha, consuming about 24 BCM (billion cubic meters) of water, i.e., about 42 per cent of the 56 BCM water use estimated for agriculture in Maharashtra by a World Bank think tank (Joy and Abraham, 2019).

There are many reasons why farmers grow sugarcane, irrespective of the knowledge that it needs much more water as compared to other crops: (i) assured market and price; (ii) value addition through sugar factories; (iii) less labour intensive; (iv) sugarcane does not fail completely, unlike vegetables and horticulture; and (v) the inability of public irrigation systems to provide water according to crop-water requirement for vegetable and fruit crops that require high frequency but limited irrigation. Thus, unless one can address these structural issues—ranging from remunerative price to reforming the public irrigation system—farmers may not shift from such water-intensive corps (ibid.). A shift in food habits from wheat and rice (that come from a high-input paradigm, involving long-distance transportation), to locally grown millets (now called 'nutri-cereals') such as *jowar* (sorghum), *bajra* (pearl millet), *ragi* (finger millet), etc., and also procuring and making them available through the public distribution system (PDS), can help in this transition to more water-efficient crops.

Second, there is need to incentivise agronomical practices that can reduce water use considerably, especially in the case of such water-intensive crops as rice and sugarcane. The System of Rice Intensification (SRI)[2] and Sustainable Sugar Initiative (SSI)[3] have demonstrated that water use could be brought down considerably without compromising productivity. It is argued that by 'adopting the SRI method, India can easily meet its future demand for rice while reducing more than 30 per cent of the current water usage in paddy cultivation' (Gujja and Shaik, 2019: 225).

The third, and most comprehensive option, especially for climate change adaptation, is to see crop production as part of a broader biomass production system.[4] Here, the term biomass is used in a more restricted sense to mean photosynthetic biomass, and it could include crops (cereal, pulses, oil seed, vegetable, fruit, among others), medicinal plants, shrubs, creepers, trees, etc., and involve all parts of the plant (root, stem, branch, leaf, flower, fruit). Most of society's needs, whether traditional or modern, are met through one or other forms of biomass. Besides meeting a rural family's needs of food, fodder and fuel, the biomass-based system also produces biomass that can go back into the soil (as recyclable biomass), and also produce a surplus that can either be sold or put through value addition to generate cash income. Instead of cultivating marginal lands, crop production could be restricted to good quality land, with an applied water component to take care of long, dry spells. With nearly one-third of the biomass produced going back into the soil (in cropped areas), it not only provides nutrients, but also enhances the soil's water-holding capacity. All these methods can improve productivity considerably, thus making a family self-sufficient in food from a much smaller area. This, in turn, makes it possible for farmers to release the rest of their land for a diverse biomass production system consisting of trees, shrubs, creepers and various types of fibre-producing plants, with multi-year life cycles, and multi-tiered root systems and canopies. Unlike shallow-rooted short-duration crops, vegetation with multi-year life cycles is less sensitive to variations in rainfall regimes. In below-average rainfall years, the incremental biomass may be less, but this is more than made up in the years with above-average rainfall.

Thus, the biomass-based system is a much better adaptation strategy as compared to conventional agriculture, as it utilises available water/moisture more efficiently, copes better with shortages, and utilises surpluses (or what could be called the variable component of water, which may not be available every year) more productively. Here the role of green water, and decentralised local storages in the form of aquifers and surface storages, is very crucial.

PREVENTION OF UNINTENDED CONSEQUENCES OF CLIMATE MITIGATION EFFORTS

Thus far, much of the focus has been on understanding the impact of climate change on water resources. Yet, as pressure to address climate change increases, there are chances that some of the

measures taken on the mitigation side may also adversely impact water security. Two potential threats from mitigation efforts are afforestation and small hydropower.

PLANTING THE WRONG SORT OF TREES

Besides the efforts to adapt to climate change, some thought needs to be given to climate change mitigation efforts that are increasingly centred on afforestation. These are claimed to both sequester carbon and rejuvenate rivers. The logic for the plantation campaign is as follows: (i) forests increase rainfall by transpiring and cycling moisture in the atmosphere locally; and (ii) trees reduce soil erosion and slow down runoff during heavy rains, so that instead of flash floods, water is gradually released, contributing to dry season flows.

While there is some evidence that large expanses of natural forest can contribute to rainfall and, conversely, deforestation can decrease rainfall, science, however, suggests that the link between land cover and climatic change is tenuous. It becomes significant only when changes occur at regional to continental scales, and it depends on the species grown. In the past, large-scale afforestation programmes have resulted in deep-rooted fast-growing species, such as eucalyptus, as they are easy to plant and do not require irrigation or maintenance. However, these species consume a great deal of water and decrease groundwater recharge (Calder, et al., 1993). Studies of evapotranspiration from forests are nascent and much more work is needed (Krishnaswamy, et al., 2013).

An even bigger concern is that afforestation can have an unintended negative social or ecological impact. Reforesting traditional village commons that serve as grazing lands can deprive landless (often lower caste) communities of income. Natural grasslands (incorrectly labelled as 'wastelands') that have their own unique ecosystems are typically slated for afforestation efforts. There have been many previous efforts through compensatory afforestation programmes and the Green India Mission, and it is important to understand how those played out.

THE IMPACTS OF SMALL HYDROPOWER DAMS

There is a notion that hydropower in general, and small hydro in particular, is a climate-mitigating and climate-friendly alternative to coal (Couto and Olden, 2018). In India, such 'run-of-the-river' schemes, if they are below 25 MW installed capacity, have very few environmental clearances, including Environment Impact Assessment (EIA), because, theoretically, they do not entail the construction of dams.[5] But they do channel water away from the main course through tunnels to turbines. In many stretches, rivers have gone completely dry for kilometres. Additionally, small hydropower schemes also completely alter flow regimes in rivers.

On the one hand, when measured against coal, the emissions are considerably lower; on the other, there is evidence that large-scale adoption of hydropower in the remaining free-flowing rivers poses a significant threat to rivers, and the communities and freshwater species that depend on them (Jumani, et al., 2017). Therefore, many river activists are now protesting the channelisation of already meagre climate funds to hydropower.[6]

Project assessments do not evaluate the cumulative impact of a project within a basin. Each small hydropower plant is assessed in isolation, even if there are dozens planned simultaneously on the same river stretch. This can result in a huge underestimation of the true risks.

IMPLICATIONS FOR POLICY AND PRACTICE

INTER-SECTORAL ALLOCATION AND WATER-USE PRIORITISATION

Since increasing uncertainties surround the availability of water, the reassessment of water-use prioritisation is necessary. Although water policies give first priority to domestic water, followed by agriculture, etc., this does not amount to meeting everybody's domestic water needs before water is provided to a lower-order priority. This is because, at a project level, a certain proportion of water is earmarked for different uses. This is called proportionate water-use prioritisation. Instead, a shift to a mix of sequential and proportionate water-use prioritisation is desirable. This would mean that such higher-order priorities as domestic water (life-line water), environmental flows and water for livelihoods would be met first, only after which would the lower-order priorities of industries, commercial agriculture, and so on, be serviced.

Related to this is the issue of 'assured' and 'variable' components of water. In most years in the annual water cycle, there is a certain guaranteed amount of water (at a higher dependability), which is the assured component of water. However, in most years,

there usually is some water over and above this assured quantity, which is called variable water. Both these components of water need to be handled differently. Assured water ought to be provided for our basic needs (domestic water and water for livelihoods) in an equitable manner. A certain proportion of this water also needs to be allowed to flow as environmental flow. Variable water can be handled in many different ways: for non-crop biomass production, or given to the more enterprising farmers, or given on a first-come-first-served basis, or for commercial use.

GROUNDWATER-CONSERVING AGRICULTURAL POLICY

It is well known that the drivers of irrigated agriculture lie outside the water sector: in the free-electricity policy, in subsidies of agricultural inputs, public distribution and minimum support price policies. This failure of recognition has led to the increase in (unsustainable) groundwater irrigation. Decision makers optimistically assume cropping patterns when planning projects, but are largely unable to influence what farmers grow.

Research shows that rainfed agriculture is largely unviable as a livelihood. As farmers aspire to better lives, they either switch to irrigated agriculture, to non-farm employment (sometimes placing their land under plantations managed on contract basis), or convert land altogether (Blakeslee, et al., 2020; Patil, et al., 2017). Therefore, if the goal is to achieve water security, the drivers of unsustainable agriculture must be altered. This involves intervening on agricultural policy, as well as exploring interventions on the demand side (for instance, encouraging farmers who farm sustainably to attract awards and certifications that, in turn, attract higher prices).

BETTER DATA AND SCIENCE

We need more and better data on water. Huge strides have been made in making water data publicly available on platforms such as India WRIS (Water Resources Information System). Global datasets are being made available through cloud-based platforms, such as Google Earth Engine. Yet, there remain huge gaps in data availability. Evapotranspiration data from institutions such as ISRO and ICAR (evapotranspiration comprises 50–70 per cent of the water balance in most basins), and historical IMD (India Meteorological Department) climate data remain inaccessible. But while water

availability data is increasingly available, there is a bigger gap on the water use side. Data for commercial/industrial water use, and irrigation water use by crop and irrigation technology, remain scarce.

Furthermore, while data is available at the sub-basin to basin scale, there is very little actionable information that NGOs or gram panchayats can use—to develop village water security plans, for example. Technology is making it increasingly easy to downscale satellite data and combine it with ground-based information, but there has been no serious investment in digital tools that could help at the grassroots level.

Most available water knowledge, especially on the biophysical side (hydrology, hydrogeology, etc.), has been produced during a period of fairly stable rainfall regimes. There is an urgent need to factor in climate change from a multi-stressor perspective in the production of knowledge. It is equally important to bring in interdisciplinarity, which has been largely missing. Science–policy–stakeholder interaction (SPSI) is being suggested as a method to coproduce water knowledge (Gooch and Stalancke, 2010).

REORGANISING INSTITUTIONS AND ADAPTIVE MANAGEMENT

A necessary condition to take forward the creation of rural water security in view of multiple stressors, including climate change, is to reform our water-related institutions and to shift to an adaptive management paradigm. Every person in the water sector recognises that water-related institutions are fragmented; there is little coordination and they often function at cross-purposes. Integrated and democratic institutions, with the participation of all stakeholders at different scales, starting from the smallest unit of a micro-watershed to sub-basins and basins in a nested institutional framework, are the immediate needs. The recommendations of the Mihir Shah Committee to restructure the present Central Water Commission (CWC) and Central Ground Water Board (CGWB) into one integrated National Water Commission (NWC), with divisions of specialised functions and with a regional presence at river basins, can inform the institutional reform process.[7]

Presently, all these institutions are also engineering-centric. Instead, interdisciplinarity ought to be the organising principle. Water institutions need to work in close coordination with other related departments and institutions, especially those related to

agriculture. An institutional culture of building partnerships must be developed—partnerships between government institutions, academic institutions and civil society organisations. The capacity of these institutions at different scales to engage with the new issues being thrown up as a result of climate change and other stressors needs to be built up. The governance functions of institutions and management functions need to be separated and handled by organisations expressly crafted for these purposes.

Clearly, command and control types of management will not work anymore. With the uncertainties brought in by climate change, there ought to be a flexible approach to water management. The system must be able to engage with the rapid changes taking place in bio-physical conditions as well as social settings. Adaptive management allows changes in the manner in which water is managed, in light of the improved understanding of bio-physical and social systems, new information resulting from changed or unforeseen circumstances, and new or updated models and stakeholder preferences. It uses uncertainty as an important factor in decision making.

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NOTES

1. See MOSPI, 2017, 'Statistical Year Book'. http://mospi.nic.in/statistical-year-book-india/2017/181.
2. See for details on SRI principles: http://sri.ciifad.cornell.edu/aboutsri/methods/index.html#SRIprinciples, accessed on 16 December 2019; SRI manuals are available at: www.agsri.com, accessed on 16 December 2019.
3. See www.agsri.com for details on SSI and also for SSI manual, accessed on 16 December 2019.
4. For detailed treatment of the biomass-based approach, see Datye (1997); Paranjape and Joy (1995); and Joy (2017).
5. Most of the hydropower projects coming up in Northeast India are called 'run of the river system', but they do have dams and water pondage. Similarly, in the case of many small hydro projects, the developers keep the capacity of the single project just below 25 MW to circumvent the EIA.
6. For details on this position, see: (i) 'The false promises of hydropower: how dams fail to deliver the Paris Climate Agreement and the UN Sustainable Development Goals', the joint statement by civil society organisations on the occasion of the 2019 World Hydropower Congress in Paris, France. https://www.cenfa.org/statements/statement-the-false-promises-of-hydropower/, accessed on 7 February 2020; (ii) Civil Society Statement: 'Climate Bonds Initiative Must Abandon its Misguided Attempt to Greenwash Hydropower', 9 December 2019. https://www.internationalrivers.org/sites/default/files/attached-files/cbi_statement_final.pdf, accessed on 7 February 2020.
7. See Committee on Restructuring the CWC and CGWB, 2016, 'A 21st Century Institutional Architecture for India's Water Reforms.' Report submitted by Committee on Restructuring the CWC and CGWB, headed by Mihir Shah. http://mowr.gov.in/sites/default/files/Report_on_Restructuring_CWC_CGWB_0.pdf, accessed on 7 February 2020.

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DEALING WITH INDIA'S PLASTIC WASTE

Why Single-use Plastic Bans may not Work

ARAVINDHAN NAGARAJAN

In the context of the environmental question that we face today,[1] the terms sustainability and circular production[2] are buzzwords used across all political and economic decision-making circles (European Commission, 2016; Nidumolu, et al., 2009). One of the key claims made within this call for sustainability is to change how we produce and consume things. This includes a range of prescriptions, from reducing what we consume to banning consumption of certain products, from recycling waste to achieving zero waste in certain activities (Fischer-Kowalski, 2002; Lifset and Graedel, 2002; MacArthur, 2013; Andersen, 2007; Johansson, 2002). The consequence of these actions, it is hoped, is the decoupling of economic growth from environmental degradation. One particular issue that gained global attention is that of plastic waste. Since the early 2000s, some 127 countries have adopted a legislation to regulate plastic items, and 27 countries have put in place a partial or complete ban on single-use plastics (UNEP, 2018).

Following these global calls, the single-use plastic ban has become sine qua non for the central and all state governments in India.[3] These bans have emerged as the preferred policy option, even if there are more comprehensive regulations in place, such as the *Plastic Waste Management Rules, 2016*.[4] The single-use plastic ban seems to have replaced existing concerns of waste management, municipal waste, and issues of waste segregation at source. In fact, over the last year and a half, a nation-wide single-use plastic ban is believed to be a strong possibility.[5]

However, the consensus on India's plastic waste problem is that despite these bans, India's plastic waste is showing no signs

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of reduction.[6] Therefore, in terms of legislation, we seem to be stuck in a vicious circle: to reduce the impact of plastic waste we must reduce (ban) single-use plastics, but legislations on reducing (banning of) single-use plastic do not reduce the impact of plastic waste. This begs the question: Why are single-use plastic bans unable to address the goal of reducing the impact of plastic waste? In subsequent sections, this paper will argue that there are three plausible reasons (misleading data analyses, improper assessment of environmental impact, and ignoring aspects of production) as to why single-use plastic is a low-hanging fruit in dealing with the problem of waste, and plastic waste. By doing so, it will highlight the importance of investigating the question of production when it comes to plastic waste, and more generally in dealing with the question of sustainability.

THE CONSENSUS ON THE BAN DESPITE THE ABSENCE OF DATA AND MISLEADING ENQUIRY

Figure 1.1 maps the changing nature of plastic ban regulations in India between 2004 and 2018.[7] Currently, a partial or complete ban on plastics is present across most states and union territories in the country. From banning carry bags to complete bans on single-use plastic, most state governments perceive that such measures will have a greater impact on reducing plastic waste in general. The entire governance of plastic waste is pinned to the assumption that banned single-use plastics are the biggest contributor to waste, plastic waste and environmental pollution. However, the first issue in analysing India's plastic waste problem is an overall absence of data on the production of waste in general. This absence extends to plastic waste. There are two direct data sources used to estimate plastic waste: the vastly maligned Annual Reports for the Implementation of Plastic Waste Management Rules,[8] and the Central Pollution Control Board (CPCB) sample study.[9] Table 1.1 compares these figures, along with estimates for different waste sources in the Indian economy.

Considering this range of estimates, Municipal Solid Waste (MSW) remains a small fraction (up to 6 per cent) of total waste generated in an economy. This figure could be possibly lower, as estimates of industrial and construction waste are thought to be under-reported.[10] Plastic waste is a much smaller proportion of this figure (a maximum of 6.9 per cent of MSW), and single-use plastic

Figure 1.1 Map of Plastic Regulations in India (2004–2008)

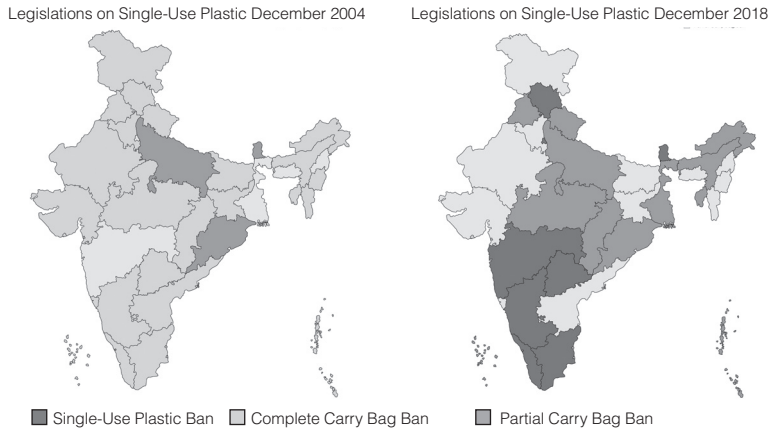

Table 1.1 Estimates of Different Types of Waste in India and its Composition

Type of Waste	Quantity (MTPA)	Year	Source
Agricultural Waste (organic)	350-600	2002	Pappu, et al., 2007
Industrial Waste (including construction)	290+	1998	Gupta, et al., 1998
Mining and Minerals	200	2002	Pappu, et al., 2007
Municipal Solid Waste	48	2002	Pappu, et al., 2007
	90	2008	Sharholy, et al., 2008
	69	2011	Annepu, 2012
Plastic Waste in MSW	1.17	1995	Gupta, et al., 1998 (3.9% of MSW)
	2.34	2005-06	Banerjee and Srivastava, 2012 (4.888% of MSW)
	4.8	2011-12	Based on Estimate of CPCB (2015) (6.92% of MSW)

Note: These figures represent a range of estimates across different baseline years. Nevertheless, percentage figures in the text are used to provide a sense of comparison across these different sources of waste. The table compiles results from two sources. For a detailed explanation of the composition and sources of these individual categories, see Pappu, et al. (2007). For a detailed summary of different sources and estimates of Municipal Solid Waste, see Doron and Jeffery (2018: 66–67).

forms an even smaller fraction of this waste.[11] Therefore, even a completely effective ban on single-use plastic is unlikely to reduce the problem of MSW and waste, in general, in an economy.[12]

CONFLATING THE ENVIRONMENTAL IMPACT OF PLASTIC WITH SINGLE-USE PLASTIC

The lacuna in understanding single-use plastic waste is also reflected in terms of assessing its environmental impact. Different state legislations call for the ban on single-use plastic, based on a consensus that it significantly contributes to ocean waste as well as the claim that it harms marine, animal and human life.[13] In terms of marine pollution, the efficacy of such bans in reducing marine plastic pollution is debatable on account of three factors. First, the biggest source of plastic waste in the oceans is plastic waste from fishing nets, agricultural implements, and other large plastic products as well as microplastics (primarily used as additives across a range of cosmetics) (Lebreton, et al., 2017, 2018; Xanthos and Walker, 2017). Of the major countries with large coastal areas, India ranks eleventh in terms of contribution to ocean pollution, and in absolute terms produces far less ocean plastic waste than other developing and developed countries (ibid.). This is recognition of poor production and consumption standards. Second, reports on the impact of plastic waste on marine and animal life are based on a small sample size (and geographical extent) and here, too, the most documented harm to marine life occurs from larger plastics, such as fishing nets.[14] Far from being a carcinogen, existing studies indicate that single-use plastic, or plastic, is not found to occur in human bodies at levels and proportions that can be considered carcinogenic or harmful.[15] Another crucial aspect of environmental impact that is missing in the analyses of single-use plastic bans is that most alternatives (glass, aluminium, cloth, paper) are far more resource intensive (energy, emissions and land) in comparison (Stephenson, 2018).

IGNORING THE UNORGANISED SECTOR AND FAILURE TO BUILD WASTE MANAGEMENT CAPACITIES

In the absence of such a comparative perspective on waste and its environmental impact, the claim of single-use plastic as the biggest source of waste (and the corresponding use of per capita plastic waste generation) is non-precise and misleading, as such representation ignores the contribution to waste by other sources in the economy (MacBride, 2012). Consequently, it does not refer to the resources, institutions and technologies available with countries

to deal with waste, and instead emphasises that the problem of waste generation is individual behaviour and consumption.

One of the reasons for implementing the ban, as stated by most state governments, is that '[n]on-biodegradable plastic waste handling of municipal solid waste becomes difficult and incurs more financial burden… [and that it represents] an increase in the non-biodegradable plastic garbage waste causing damage to environment and health'.[16] Despite its supposed non-recyclability, over the last two decades, 47 per cent of total plastic waste generated in India has been (consistently) recycled (Gupta, et al., 1998; Mutha, et al., 2006; Banerjee and Srivastava, 2012; Nandy, et al., 2015). This is largely achieved within the unorganised sector.[17] Some estimates suggest that nearly 70 per cent of all household consumer plastic waste in India is recovered and recycled.[18] Therefore, even though the quantity of plastic waste generated has increased, the proportion of plastic waste that is recycled has been maintained.[19]

By not considering this aspect of waste management, the single-use plastic ban also causes significant damage to the unorganised sector. For instance, in the case of Mumbai, the ban led to the closure of many units recycling plastic in the unorganised sector, units that could recycle more than 12 per cent of the plastic waste found in the city's landfills (Nagarajan, 2018). The shutting down of manufacturing centres in the developing world as a result of global and local environmental regulations is a general feature seen across sectors, such as plastic recycling and ship breaking (Sahu, 2014). Workers within these sectors therefore pay a dual price: occupational hazards and harm caused to them, and the loss of employment and income. Further, in terms of the plastic ban in India, large-scale producers of plastic have often received several concessions; in particular, exemption has been provided to multi-layered packaging plastic, which is rarely recovered and recycled, owing to the difficulty of collecting it (Nagarajan, 2018). Moreover, what is never implemented is the aspect of producer responsibility. Producer responsibility, as given in *Plastic Waste Management Rules, 2016*, implies that manufacturers of polymers and plastic products are mandated by law to be responsible for and to implement 'environmentally sound management of the product until the end of its life'.

This points to two important lessons: (i) the collection of waste and the removal of waste is an important argument in itself,

and requires the collection and segregation of waste, including plastic waste, within solid waste management practices; and (ii) it is not the physical or chemical properties of plastic which makes it difficult to handle, but rather the socio-economic and technological constraints in handling waste management. Therefore, in the Indian context, policy making (and, to an extent, research) on waste recovery and recycling has been based largely on very little empirical evidence (Gill, 2010).

THE WAY AHEAD: INVEST IN DATA AND WORKERS PICKING UP WASTE

So far, we have discussed the reasons why the single-use plastic ban is a low-hanging fruit in the discussion on waste and plastic waste management. What we have argued for, while making this assessment, is that the ban regulation sought to modify one aspect of plastic use, while failing to ask important questions of production: How are things produced (and disposed of), by whom, and under what circumstances? Further, in terms of environmental consequences and effects on employment, we see that our best intentions to deal with waste can come to naught if we do not pay attention to how things are produced.

Going forward, there are perspectives to which we need to pay attention. The first of these is from research in economic history, which indicates that waste recovery and recycling linkages were a traditional aspect of industrial production.[20] From the conversion of coal tar waste to aniline to the reduction of meat wastage, these studies indicate that there are certain preconditions for the creation of such closed-loop systems: (i) the presence of large scales of waste; (ii) the presence of technology to reutilise such waste; (iii) the division of labour between, and across, firms engaged in such productive activities; and (iv) and the role of regulation and compliance.

To add to this, recent research in economics suggests that in terms of improving sustainability and waste management, we need to focus on the economics of production (costs and technology for firms engaged in waste recovery and recycling), including the role played by the unorganised sector (Vogler, 1984: 244; Van Beukering, 1994; Porter, 2002; Gill, 2010; Chertow, 2008). Other developing countries (China and Latin America), which have made progress in waste recovery and recycling, have done so by increasing the productive capacities of the unorganised sector in terms of scale

and credit availability, and the improvement of working and health conditions of workers (Chi, et al., 2011; Aparcana, 2017).

The lesson for us in terms of dealing with plastic waste is the importance of understanding technical and economic aspects of the problem. This includes monitoring waste generation, improving capacities of the unorganised sector, improving working conditions and occupational safety for workers, and implementing producer responsibility in handling waste. Such an emphasis on production would also place at the centre millions of workers who would otherwise bear the brunt of such policy decisions.

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NOTES

1. Broadly speaking, the environmental problem here refers to the set of worldviews, actions and policy measures required to achieve objectives of reducing environmental harm from productive activities of conserving resources, reducing waste and improving efficiency, as well as the pressing issues of reducing and dealing with the impact of climate change.
2. Bureau of International Recycling (BIR). 2016. http://www.bir.org/about-bir/introduction/.
3. There is no standard or single definition of single-use plastic, but, broadly, the United Nations Environmental Programme (UNEP) refers to single-use plastic as 'disposable plastics, are commonly used for plastic packaging and include items intended to be used only once before they are thrown away or recycled. These include, among other items, grocery bags, food packaging, bottles, straws, containers, cups and cutlery'.
4. See *Plastic Waste Management Rules, 2016* (PWM rules), New Delhi, India. Accessed on 9 December 2019. http://www.mppcb.nic.in/proc/Plastic%20Waste%20Management%20Rules,%202016%20English.pdf.
5. Under the leadership of the Prime Minister's Office, the official Indian submission to the UN Environment Assembly in February 2019 sought to ban single-use products by 2025. This position received a severe pushback from most developing and developed countries (China, Saudi Arabia and the United States) for being impractical and harmful to the recycling and waste management sector (Goswami, 2019). More recently, Prime Minister Modi, at the 14th session of the United Nations Convention to Combat Desertification, announced, 'India will put an end to single-use plastic in the coming years.' The statement, while welcomed by some quarters, was criticised for the impact it would have within the country on employment and production in the SME–MSME.
6. The most often-repeated argument across most public discussions on the matter is the use of the figure that India's plastic waste is at 26,000 tonnes of plastic a day, which is projected to increase along with the increase in total plastic waste generated in India (22 MTPA in 2020, from 10 MTPA in 2015). See Vishnoi (2015).

7. This describes over 63 different regulations and bans on plastic use in the country. There is no pan India regulation that bans single-use plastic in India. Instead, the comprehensive *Plastic Waste Management Rules 2016* is an act of Parliament that is applicable to all states as well.
8. As part of the reporting requirements of the PWM rules, each state pollution control board is required to provide the CPCB with estimates of the amount of plastic waste generated in each state, and the steps taken to reduce it. A majority of the states do not provide information for this estimate. Second, the reliability of the reported data also does seem circumspect. Some states show a decline in plastic waste estimation in one year and a massive increase the next. However, these are the only data sources available and must be used to estimate the nature and scale of the plastic waste problem.
9. The Central Pollution Control Board (CPCB) conducted a study of plastic in MSW in 60 cities across the country (Central Pollution Control Board, 2015). These estimates of plastic waste include waste across different categories such as PET, HDPE and LDPE material. In terms of actual quantity, there are no estimates provided for lightweight single-use plastics, such as polythene bags. The report pegs the total percentage of the daily plastic waste measured at municipal sites to be around 6.92 per cent of the total municipal waste by weight. This categorises plastic based on its characteristics as LDPE, PET, HDPE, PP and PS (polystyrene). Though unclear, the proportion of single-use plastic is a small fraction of this figure.
10. The contribution of industrial waste to waste management in general has been underestimated owing to practices of open dumping and the disposal of industrial waste in municipal landfills. See Ferronato and Torretta (2019).
11. For the sake of simplicity, let us assume that half of plastic production is single-use plastic (Vishnoi, 2015), and that this is the exact ratio in which they correspond to in terms of their proportion in waste. Single-use plastic still would only be approximately 3.5 per cent of municipal solid waste.
12. This statistic of consumer sources of single-use plastic being a small fraction of the total plastic waste, and total municipal solid waste of a region (section 6.2.1) is a global feature of waste management. In the case of the United States and Canada, waste from non-municipal waste sources is between 97 and 99 per cent of the total waste in the economy. See MacBride (2012). Further, in the case of the United States, single-use plastic in the form of plastic bags only accounted for 0.28 per cent of the total municipal solid waste generated (EPA, 2013).
13. The then Maharashtra state Environment Minister Ramdas Kadam, while announcing the ban, made a blanket statement that plastic is a 'major cause behind diseases, sometimes life threatening diseases'. http://www.newindianexpress.com/nation/2018/mar/25/maharashtra-becomes-18th-state-in-india-to-impose-complete-ban-on-plastic-carry-bags-thermocol-cutl-1792272.html.
14. A review of wildlife harm associated with plastic bags claims that most reported figures on the issue predate the use of plastic bags and are from the region off Newfoundland in Canada, and are not representative of a global problem. See Mangu-Ward (2015).
15. In fact, much of the health hazards posed by plastic stem from exposure to microbeads, phthalates, plastic particulate matter and dust. See Wright and Kelly

(2017). These substances in fact are also a source of occupational hazard for workers dealing with plastic waste, and not a general human health hazard.

16. This is the text that appears in the 'Maharashtra Plastic and Thermocol (Sale, Usage, Sale, Transportation, Handling and Storage) Notification, 2018', which is the most comprehensive notification text presently available among most state regulations and laws.
17. For a comparison, if we look at the data on the materials recovery sector using the National Industrial Classification code of 2008 across the ASI 2010–2011 round, and the NSSO unorganised sector round 2010–2011, we see that the organised sector comprises 139 units, employing 4,669 workers, whereas the unorganised sector consists of 9,116 units, employing 21,878 workers.
18. Globally, the developed world has higher and better rates of collecting waste, but the developing world is where recycling actually takes place. See Van Beukering (1994) and Porter (2002). Owing to economic reasons (costs of production and demand for recycled plastic goods), this recycling takes place largely in the unorganised sector in the developing world, where this sector has been shown to outperform organised sector firms. See Scheinberg, et al. (2011).
19. This includes plastic waste recovered from MSW, as well as plastic recovered from households directly through waste pickers and itinerant purchasers of plastic waste.
20. These studies explain that the waste recovery sector emerged along with the development of large-scale industrial production on account of the presence of: (i) large scales of waste; (ii) the presence of machinery and technology required to transform waste into inputs; and (iii) the division of labour between and across firms engaged in recycling. This work in economic history includes the writings of Karl Marx, Charles Babbage and Alfred Marshal. See Desrochers (2002, 2007). It covers large-scale linkages, as observed in the conversion of aniline from coal tar as well as small-scale linkages found in the recovery of paper, iron filings, shoddy wool and meat packaging. They describe and explain characteristics of waste material linkages during the development of industrial production, which includes low-scale waste linkages across and between small manufactories and large industries. These characteristic features of waste recovery (improved scale of production, improvement of machinery and operational costs of firms) have continuing relevance in explaining the presence of waste recovery and recycling systems within the unorganised sector in the developing world.

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CLIMATE CHANGE AND SECURITY

UTTAM
KUMAR SINHA

CLIMATE CONTEXT

Climate change, an all-pervasive phenomenon, presents to the well-being of the planet an unprecedented scale of uncertainties. Carbon dioxide concentration is at its highest (411 parts per million), a level that last occurred about three million years ago. It continues to rise and is likely to bring harmful effects to a much higher percentage of the world's population. The life-sustaining resources of the planet are being consumed at a rapid rate, with a third of the world's arable soil eroding, the demand for food growing exponentially, and fresh water availability fast declining. In such circumstances, even modest impacts of climate change can create political and social instability, and present significant security challenges for countries. The world risks being overwhelmed by the climate crisis it has created, and if the global temperature is to have a good chance of not rising more than 2°C above its pre-industrial level, then worldwide emissions must strive for ambitious reduction in the coming decades. In its fear and response, climate change uncannily resonates with Hannah Arendt's expression, 'this moment of anticipation', in which the German–American philosopher goes on to dourly express,

> …Never has our future been more unpredictable, never have we depended so much on political forces that cannot be trusted to follow the rules of common sense and self-interest—forces that look like sheer insanity, if judged by the standards of other centuries (1958: vii).

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The relevance of Arendt's thoughts to our current judgements and decisions on climate change, seen more as an emergency now, becomes an interesting parallel. Yet, fundamentally, Arendt's words squarely confront the facts with marked resoluteness.

It is not that scientists were not aware of atmospheric warming and the greenhouse effect. The French scientist Joseph Fourier, in the early 19th century, led investigations on the conduction of heat and its relation to weather patterns. Several decades later, the Irish physicist John Tyndall discovered that water vapour and carbon dioxide trap heat from the atmosphere. By the turn of the 19th century, the Swedish chemist Svante Arrhenius speculated that the Ice Age was a result of low carbon dioxide in the atmosphere and that 'industrial coal' would cause the planet to warm up. The scientific world understood, but remained hesitant to publicly state the 'cause and effect' between temperature increase and its direct link to anthropogenic or human action. It took much courage of conviction by John Hansen to put the science of warming into the public domain when he wrote, 'The evidence for an increasing greenhouse effect is now sufficiently strong that it would have been irresponsible if I had not attempted to alert political leaders' (1989). While there is greater scientific robustness on climate change today—although not necessarily a complete acceptance of the science—political and social consensus remain difficult to attain.

Climate facts continue to stare us in the face. But so does the reality of politics and, more often than not, its uncompromising nature. Then there are the inescapable economic choices and intertwined security concerns. A combination of these very critical aspects not only weigh down states in coming to terms with climate issues, but also point to group interests, lobbies and the 'voice' of the marginalised community, all of which take differing positions. In its complexity and inextricability from the economic, social and political systems that underpin each nation state, climate change is the ultimate disrupter.

Climate change and security concerns tend to sit together far more comfortably in recent security debates and policy responses. In the past it was seen as an outlier and in the hierarchy of security priorities remained largely insignificant. One of the reasons why climate change was peripheral was that it was too daunting a subject to comprehend, with a range of disciplines from atmospheric science

to hydrology, on the one hand, to economics and international politics, on the other. Climate knowledge was not only dispersed, but lacked cohesiveness and even struggled to speak the same language. In effect, it required insights and new narratives to which scientific and hard data could juxtapose policy choices, and peoples' understanding and behaviour. Furthermore, the long timeline of climate impact on global systems failed to influence immediate policy reactions. Nevertheless, as knowledge was integrated and updated, and scientific models and calculations were efficiently communicated in understandable vocabulary, the reality of climate change became frightening. Global warming—with increasing air and ocean temperatures, rising sea levels, and melting of ice and permafrost in the Polar and Himalayan region—was unequivocal. Scenario building thus became a useful tool for governments and businesses to anticipate events and to develop response mechanisms or contingency plans.

CLIMATE SECURITY DEBATE

Discourses on security have long been contested, whether viewed as 'tantamount to emancipation', or whether security is seen as 'power' and 'order'. The intersection between climate change and national security considerations, foreign policy matters, human security concerns and military responses has had an interesting intellectual journey. The diplomat–historian George Keenan—noted for his 8,000-word 'long telegram' to the US Department of State, strongly advocating the containment of the Soviet Union in the Cold War days—had argued in an article in 1970 about the global scale of environmental issues, and the need for institutional responses (1970). With the environment as a theme, the UN held its first conference on the human environment (UNCHE) in Stockholm in 1972, where Prime Minister Indira Gandhi used the platform to raise the question, 'Are not poverty and need the greatest polluters?' (Ramesh, 2018: 137). Of course, we now know that there is no choice between a stable climate and the fight against poverty—without the former, the latter will certainly fail. Nonetheless, her speech on the inadequacies of development continues to dictate the climate change debate, especially when it comes to shifting the responsibility to developing countries. By the end of the decade, the definition of national security had moved away from interactions

between states towards exploring relations between humankind and nature. This change made inroads into policy planning, but remained critically undermined in the larger context of the Cold War and territorial contestations.

The year 1988 was significant, with record temperatures and widespread drought. The UN established the Intergovernmental Panel on Climate Change (IPCC) to collect and analyse climate information from around the world. With the Cold War thawing, political leaders, following Hansen's revelation, were more forthright in expressing their concerns over warming and looked at security beyond ideological confinement. In the immediate post-Cold War times of peace-dividends, institution building and new approaches to resolving conflict, security contours were viewed through a new lens. The UN Security Council Resolution, in January 1992, in a new, favourable international system, acknowledged that

> The absence of war and military conflicts amongst states does not in itself ensure international peace and security. The non-military sources of instability in the economic, social, humanitarian and ecological fields have become threats to peace and security. The United Nations membership as a whole needs to give the highest priority to the solution of these matters.[1]

Climate issues, so to speak, entered the 'security logic', despite critics arguing that the 'broadening' of the security ambit destroys '…its intellectual coherence and makes it more difficult to devise solutions to any of these important problems (Walt, 1991: 212).

RETHINKING SECURITY

To begin with, there is no single causal factor to climate-induced conflict, and neither is climate change an entity in itself. It is only one part of complex pathways to conflict that involves political, strategic, economic and territorial factors. That said, climate change has presented a compelling case to reconsider security in terms of conceptual adjustment or, in popular security discourse, 'challenging state-centric proprietorship of security'. As stated, the traditional security framework is antithetical to climate change issues for the simple reason that the impact of climate change does not respect state borders and, therefore, limits the unilateral action that can be

taken by states. Further, in terms of understanding of traditional security, the protection of territorial integrity is primarily based on the threat from an enemy—perceived or real. In the case of climate change, the threat comes from the imbalances in ecosystems that are human-induced. Moreover, in the traditional security approach, actors' contribution to enhancing the understanding of security is limited and elitist, whereas assessing climate change threats and seeking preventive measures require a broad-based participation and an interdisciplinary approach, creating unprecedented space for greater participation of the 'epistemic community' (a transnational network of experts, scholars and NGOs), and their representation in the national and international decision-making process.

The widely debated securitisation theory of the post-Cold War period argued that there is a normative dilemma to formulate responses to climate change in the language of security. In this framework, the 'securitising actor' is the state, whose role in response to climate change threats is to accord itself an exceptional level of politics, one which justifies extraordinary political action, and may even be accompanied by an armed approach. The theory underlined that the assessment of such threats is complex, comprising political choices and action, regulatory mechanisms, economic factors, such malevolent actors as terrorists, in addition to naturally occurring scarcity and disasters/calamities. However, the counter argument to the securitisation theory postulates that the language of security pushes responses away from 'developmental strategies' towards 'military and intelligence organisations', and in the process a 'threat-defence' logic emerges that potentially undermines broad cooperative mechanisms.

As the evidence of climate change increased with IPCC reports, providing regular scientific assessments to policymakers, an interesting debate emerged for the first time in the UN Security Council on the securitisation of climate change in April 2007.[2] The British Foreign Secretary Margaret Beckett, President of the Council, raised the point that climate change was not a matter of 'narrow national security', but 'our collective security in a fragile and increasingly interdependent world'.[3] Her argument stressed that climate change is grave enough to be regarded as a threat to international security and, therefore, the Security Council, as the so-called 'executive body' of the UN, ought to play a

leading role in solving the impending crisis. Beckett's argument, however, for many developing countries, was understood as an unnecessary aggrandisement of the Security Council that would, characteristically, lessen the authority of other UN bodies, such as the General Assembly and the Economic and Social Council.

Likewise, in July 2011, the German Federal Foreign Office brought the security implications of climate change to the attention of the Security Council. The debate was seen as a wider recognition of the links between climate and security and, importantly, to develop political strategies. The key message that emerged from the debate was that climate change is increasingly challenging the international community, and that most efforts in the past have been feeble. By focusing on some of the implications such as sea level rise, food security and migration, the Security Council called for collective future action. The main objectives were to raise the profile of climate change as a top priority and, importantly, to frame climate change within the foreign policy agenda. The UN Secretary General, during the debate, observed:

> The facts are clear: climate change is real and accelerating in a dangerous manner. It not only exacerbates threats to international peace and security; it is a threat to international peace and security.[4]

From being apprehensive and uncomfortable in linking climate change to security in the UNSC debates in 2007, to a growing acceptance in 2011, states increasingly realised a stronger role for diplomacy in mitigating climate threats.

UNDERSTANDING CLIMATE SECURITY

A world in which climate change is a global problem, with geopolitical ramifications, is a good starting point to understand the connection between 'sustainability–stability–security'. Essentially, the geopolitical theory is an argument of stability. Based on this tenet, climate change has to be understood as having effects 'in combination' with other major global issues, and ascertaining whether 'such interaction' is impacting the international order. When global trends are factored, there is a broad consensus today that climate change can act as a 'stress multiplier', or in its extreme as a 'threat multiplier', on states and societies. The nature of

consequences will vary according to sociopolitical indices, such as state–society dynamics, ranging from societal pressure and political instability; the type of regime, whether democratic or authoritarian; and the kind of relations a country has globally and regionally.

How, then, should the international system respond? Should climate change be co-opted into the 'state-centric security framework', or should the approach be one of 'securing the environment'? There is a sound argument, through the latter approach, to focus separately on two key components of climate change: carbon emission reduction and the food–energy–water nexus. The 'securing the environment' approach suggests trade-offs: for instance, cutting down on arms expenditure for afforestation programmes, water management, soil conservation and energy efficiency. On the other hand, viewing the impact of climate change from the 'state-centric security framework' has its pitfalls. For example, climate security can become an instrument for developed countries to impose their values on developing countries and infringe upon the latter's sovereignty—a tool of hegemonic power. Moreover, climate security rhetoric encourages beliefs that could lead nations to undertake military intervention in the name of protecting 'global resources'.

Resource scarcity, particularly of the non-renewable kind, is a critical challenge to national security with significant impact on the global order, while scarcities of renewable resources rarely cause war among states. However, strong evidence of the impact of climate change on the flow patterns of rivers, in particular, can change the historical assessment on transboundary waters, thus endangering riparian relations. By the middle of this century, the number of people exposed to water stress in South Asia will double, largely as a result of population growth, with climate change increasing the risk of flooding. Given the stress on river waters, both in terms of quantity and quality, states will try to maximise water resources and convert it into assets to augment their power. Downstream countries, highly dependent on river waters for their economic growth and well-being, will equally be motivated to seize such vital renewable resources from their neighbours, to the point of being aggressive. Increasing climate change impact on water resources shows that various levels of tensions, even possible conflict related to rivers, will be as much internal as it will significantly influence

transboundary relations. Various assessments underline the inequality of distribution and access to water as major national security concerns, and the risk of escalation will potentially increase where resource competition becomes linked to other such causes as domestic instability, internal power rivalry or regional dominance.

While the key issue in dealing with security is the recognition that climate change is truly global in character, it is equally important to understand local characteristics and their varying impact on the ecosystem. To that effect, information and transparency are important mechanisms of global sustainability governance, which is conceptually fragmented, encompassing negotiated global treaties, bilateral arrangements and subnational influences.

Another critical issue that defines the national security response to climate change is the timeline factor. Unlike in the last few millennia, particularly in the Ice Age, climate change from the post-industrial period has not been as abrupt or dramatic. Nevertheless, one of the biggest fears is that climate change is triggering events, or what is described as 'tipping events', such as frequent earthquakes and ice disintegrating off the shelf of Greenland and the Antarctic. Largely, climate change has remained a gradual phenomenon and, correspondingly, the changes on the time-scale of human economies and global ecosystems have not been disruptive. Since climate change is not conclusively a 'trigger event', it need not be seen only as a 'threat multiplier', but also as an important 'threat reducer'. For defence and security planners, this is essential. For example, snow melt in the crucial border areas of the Himalayas will, in terms of military logistics, be of considerable advantage to India. It will help swifter mobility of troops and reinforcement of supplies. It merits, in the larger security framework, the consideration of 'down-side risks' of climate change, defined as the probability of unfavourable outcomes. For example, the impact of the Antarctic or Greenland ice melt on sea level rise has not been fully estimated and remains uncertain, but as a precautionary and preventive approach, adequate measures need to be introduced to reduce risks if the probability becomes a reality. From the aspect of 'up-side risks', if climate change does not turn out to be calamitous, then policies and actions can easily be readjusted and reversed.

Another important element of the climate security framework is the ever-greater concentration of people, capital assets and

economic activity in natural hazard-prone areas. Consequently, the risk of disaster losses is rising, with India's annual average losses from disasters estimated at $10 billion per year. In India, 90 per cent of disasters are hydrometeorological phenomena such as floods, droughts and cyclones (Kishore, 2017). In the next 10–15 years, much of the world's infrastructure will be built in India, and India is expected to double its energy output, increase the length of its national highways by 50 per cent, and expand the length of metro lines by six times (ibid.). While infrastructure projects are designed for a long life cycle, climate and weather-related hazards will almost certainly impact durability. According to the Economic Survey (2017–2018), the current infrastructure gap in India stands at $526 billion, and approximately $1 trillion will be needed to make existing and future infrastructure in India climate resilient (Pandey and Sharma, 2018).

In any comprehensive national security assessment, climate impact from a socio-development perspective cannot be ignored. Keeping humans at the centre of the climate change debate is essential in formulating adaptation and mitigation policies. Sustainable development becomes the key to conserving resources and must be factored with population growth. Population pressure on scarce resources has the propensity to create social stress that could potentially erupt in violence. Population growth also encourages the overexploitation of resources. Intertwined with population growth is poverty, which forces people to overwork croplands, clear forests, and cultivate arid lands and fragile mountain slopes beyond the threshold of reversible environmental degradation. Poverty and population growth reinforce each other in terms of their negative environmental consequences. As populations grow, so will economic activities and, consequently, the consumption of fossil fuels. Worldwide estimates suggest that population growth will account for 35–50 per cent of emission growth by 2050, and slowing population growth could provide 16–29 per cent reduction in emissions by 2050 to avoid dangerous climate change.

SUMMING-UP

Climate is fast changing. The past 115 years have been the warmest in the last 2,000. Global annually averaged surface air temperature has increased by about 1.0°C since 1901, and sea levels have risen by approximately 7–8 inches since 1900, but more rapidly since 1990. In several consequential ways, climate change is transforming the manner in which security is understood today. One reason is that climate change is no longer seen primarily as an economic or an environmental issue, but encompasses an almost unmanageable array of sub-issues which are larger in scale and sharper in outline. One positive impact of climate change issues has been to challenge states to reach beyond their narrow, defined interest; to introspect and redefine their priorities. But to assess the level to which it is a 'threat', and whether it could lead to 'violent conflict', is hard to determine, as the causal factors remain difficult to ascertain. Based on various spatial-temporal assessments and analyses, in the short-to-medium term, climate change is unlikely to lead to an increase in conflicts. In the long term, unmitigated climate change could have consequences for international security.

Given the potential of climate change to exacerbate existing tensions and deepen fault lines, its interface with security requires greater acceptability. Climate change threats remain essentially non-zero-sum challenges, and, therefore, the cost of non-cooperation in ecological, social and economic terms can be unpleasantly high.

For a comprehensive national security policy, adaptation and mitigation strategies of the impact of climate change should be viewed as complements, rather than as competing alternatives. Some policies will be targeted at adaptation, most notably risk-reduction and precautionary approaches at home and abroad. Mitigation efforts will require being global in reach, involving the world's major actors. Both adaptation and mitigation will require the use of best available information for framing national security imperatives. Since climate change transgresses boundaries, national security will be linked with the concerns of other states, and there is a strong possibility of convergence of common threats to deal with climate change. However, one cannot rule out the possibility of competing interest as well, in which climate change will present an opportunity to advance states' interest.

While it is true that some uncertainties concerning the impacts of climate change remain, waiting for the ultimate proof is an undesirable option. A best estimate is far more prudent to act upon than no estimate at all.

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NOTES

1. United Press International archives. See https://www.upi.com/Archives/1992/01/31/The-following-is-the-text-of-the-Security-Council/3433696834000/.
2. For details of the Security Council Debate on Climate Change, see http://www.un.org/News/Press/docs/2007/sc9000.doc.htm.
3. *Ibid.*
4. Ban Ki-moon, Remarks to the Security Council on the Impact of Climate Change on International Peace and Security, 20 July 2011. https://www.un.org/sg/en/content/sg/speeches/2011-07-20/remarks-security-council-impact-climate-change-international-peace.

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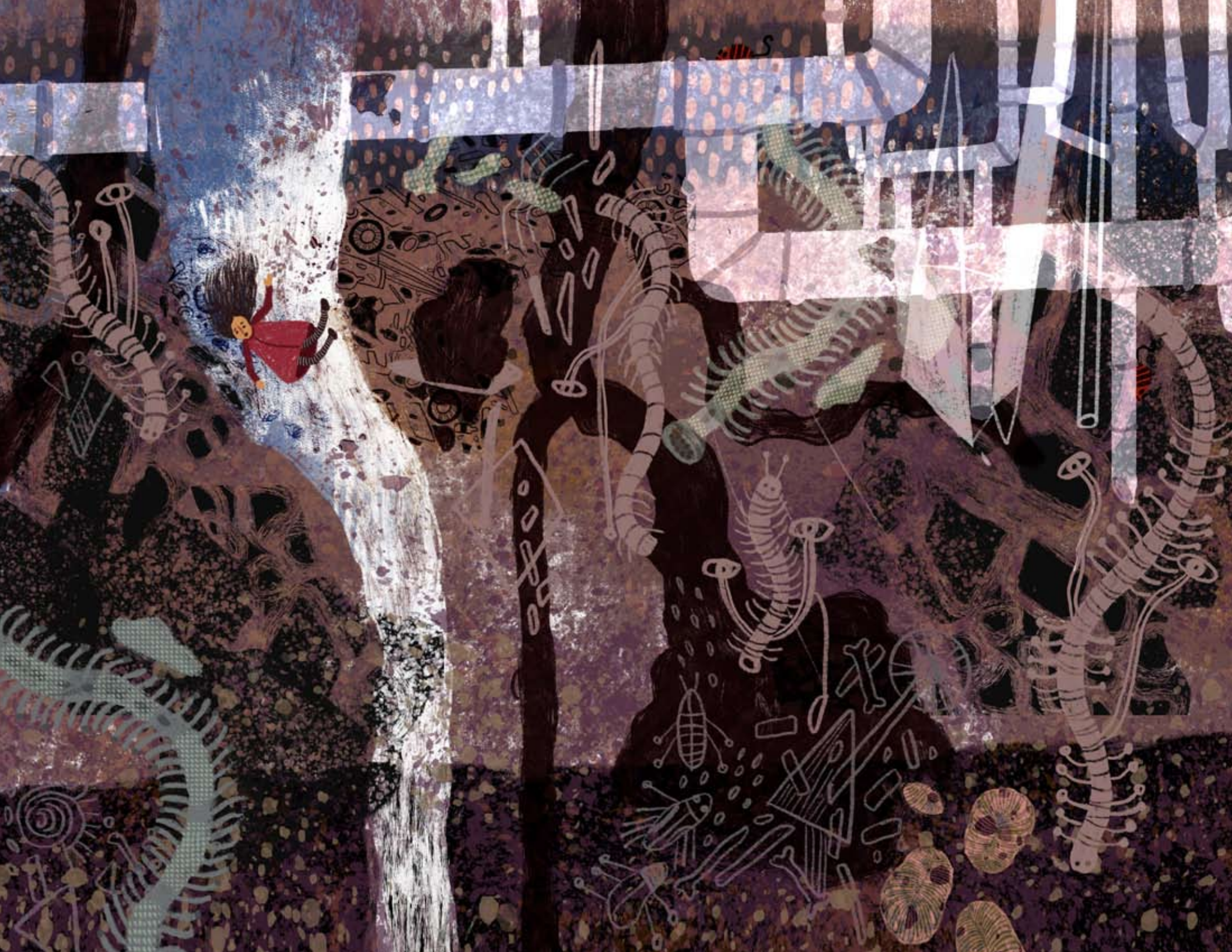

‘THE AIR IN HER LUNGS IS A DESTITUTE PIGEON’[1]

NITOO DAS

On the day I started typing out this essay, Delhi was shrouded in a moaning grey. I received news that thousands of birds had surrendered to death on the banks of a wetland they had been visiting for years on their annual migratory route. Everyone I talked to—friends, colleagues, family—spoke of an all-enveloping inertia, an inability to stir out of a darkness that weighed on them. I put away my laptop and made alphabetical lists of flower seeds to sow in my small rooftop garden—sweet alyssum, calendula, cineraria, cornflower, nasturtium, poppy, love-in-a-mist.

The alien words are a feverish escape. It is autumn, I tell myself. The time for seeds, turning over of soil, hope of fragile birth. All I can feel though a haze of opaque, particulate matter is nausea. My eyes burn, I cannot breathe through my cheap mask, and climbing the metro stairs to reach my workplace leaves me dizzy and wheezing. I search Instagram for #wildflowergarden. The hashtag gives me hours of respite. I pore over fields of pink cosmos. The images glow with the greenbluepink bokeh of gardener–photographers. I am thinking of next year. Anything to forget the brown weight of November around me. There will be clear skies, breathable air, and anticipation of a transient spring to counter the present.

In a poem titled ‘After Love’, Anindita Sengupta says this about running and breathing—‘The air in her lungs is a destitute pigeon’ (2016: 28). This line stays with me through the day. The air in my lungs is a destitute pigeon, flapping and flailing in despair. But, pigeons are ‘trash animals’, ‘filthy, feral, invasive, and unwanted’ (Johnson II and Nagy: 2013). I remember an ‘ugly’ bird of my childhood; the large silhouettes of greater adjutants framed

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against the sun setting behind the North Guwahati hills—hargila, we used to call them. We do not see them anymore, standing long-legged on the banks of the Brahmaputra, or flying overhead in their oversized, ungainly manner. They live on mountains of garbage on the outskirts of the city. When I last visited this landfill in 2011, they circled the dense evening sky like outcasts. An endangered species, with less than a thousand individuals left, they live on refuse and plastic.

What happens when something alive consumes plastic? Urvashi Bahuguna writes 'The Pilot Whales Speak' (2019: 14), which I have quoted in full.

Between Kallamozhi and Manapad, Tamil Nadu

We are surprised when they open
and find—a length of plastic like
a river swimming within us.
We did not see ourselves this way.

Hearing them speak, it appears
we are to blame. We are trying
to remember what we ate for dinner.
Who lived within us and took us

to shore? We have tribes waiting
at home. We know better than
to wait. They let us sit on our sides
like that one ship that lost its way.

We are turning into boulders,
but no water comes to circle us
in mercy. We are not sure
they sewed us back up. Are we

imagining this—small feet climb
within us to marvel at complete
darkness. As they exit, a guttural
sound, close to breathing.

A woman is wiping our eyes
with a washcloth. In the distance,
a man opening and closing
a white light many times.

The questions that arise out of a reading of this poem are many. 'We did not see ourselves this way' (ibid.). What happens when the act of seeing is overturned? The radical assumption here, in a world struggling with the politics of the gaze, is about the very word 'species'. From the Latin *specere*—'to look'—who sees whom is a crucial enquiry in the Anthropocene. Who is the 'non-human animal'? Which pronoun is to be used in opposition to the indifferent *they* in the poem? When the pilot whales speak about the river of plastic in their disembowelled depths, how does voicing occur? How is language used? Is it a '…sound, close to breathing' (ibid.)? How do we move away from the twisted history of the 'discursive tie between the colonised, the enslaved, the non-citizen, and the animal', to what Donna Harraway calls 'companion species'? (2008: 31). Thousands of marine creatures all over the world die after consuming microplastics because plastic's potential for disintegration makes it far more dangerous in water bodies than on land.

The issue of the non-human other is one that has informed my thinking for several years now. As a bird photographer, who defines and uses 'species' in much the same way that Harraway has critiqued, I wish to know how I am implicated in the processes of representation. Is this the way I see this bird's eye, that bird's beak, another bird's plumage? Do I ignore the 'destitute pigeon' when there is some other, more photo-worthy bird available? One that is not as numerous as these 'flying rodents'? When the voice of the poet becomes one with the voice of the whale, can it become an example of companion species? Harraway would perhaps say no, given the hierarchies of articulation involved, but I intuitively sense that this struggle of the imagination to 'wipe the eyes with a washcloth' (Bahuguna, 2019: 14) can lead to a clearer vision for both groups. Imminent death, 'endangering', can shift the careless 'they' to the specificities of 'a woman' and 'a man' with which the poem ends, directing it to a distant light—a code for travel (ibid.).

The land's harsh limitations change the way we inhabit our

birth and our spaces; especially lands that are at a remove from the main+stream. How curious it is to see that *stream* attached to the *main*: a stretch of water that reworks itself into a marker of demarcation. I was born in one of the most neglected regions of the nation, known contentiously as the Northeast of India. My ancestors were fisherfolk, which is why my home is still on the banks of the Brahmaputra. This fierce body of water has clung to my body like scales. Its floods and its sands, its rafts and its night songs, its waders and its rushes have etched my life.

When we look at the popular imaging of the Northeast, it appears as a land of green bounty. Anyone invested in the biopolitics of the region knows this to be untrue. On a birding trip to Majuli, for instance, I saw the land collapsing into the river right before me. The largest river island in the world, Majuli is surrounded by the Brahmaputra and its innumerable tributaries. Many tourism sites describe it thus:

> Her face uplifted to the limitless frontiers of the blue sky, her feet perpetually caressed by the lapping waters of the holy Brahmaputra, her vision stretched to the distant hills of the Himalayan and other ranges, Majuli is a creation of none other than the master craftsman who moulded the Universe—God himself.

This hyperbole is just that—hyperbole. Majuli is waiting to be swallowed by water. It stands as an example of all possible evils: global warming, governmental negligence, local laxity, criminal misappropriation of funds, etc. Coupled with this state of affairs is extensive passivity. A gentle, trust-in-fate mood that is difficult to dismantle. I was shocked to see mere sacks of sand and delicate grids of bamboo along the river banks to prevent the aggressive erosion.

In 2012, MTV's Sound Trippin' team, with Sneha Khanwalkar as host, visited Majuli to create one of 10 space- and ambient-sound inspired videos. The song, created out of a three-day discussion with the people of Majuli, translates in this manner: 'The Brahmaputra embraces my vast Majuli/This is my nature/This I will accept with all my heart.' And then there is a swing to it: 'The Brahmaputra has become vast/My Majuli has become small/But this is my nature/This I will accept with all my heart.'[2] Where does this intimacy emanate from? Is it a feeling I cannot understand in spite of my connections to the Brahmaputra? Are there methods of life, livelihood, conservation that I have ignored?

The first stanza of Nabanita Kanungo's 'Shillong' traces a break in this intimacy.

> Only memory is green,
> bathed in a certain light of reverie.
> Outside, the orchard fades from backyards,
> rivers are dead and fishes float
> in dark pools of putrid stories and new cars.
> The scent of rain is untraceable on stone
> and pines fall quietly to an irreverence
> that has grown far older than the hills (2018: 75).

The line, 'Only memory is green', foreshadows some of the other ideas in her poem: fading, changing light, ageing. Later in the poem, there are other accretions of 'sorrow and shame'. Are there alternatives possible for changed names? 'Who needs to know whether this city would be another/if it had a different name/if I had a different name…' (ibid.). In a country such as ours, where a name brings with it the concomitant underpinnings of structures of power, it is useful to wonder what an alteration in one's given identities may provoke.

When we investigate issues of land (erosion, plasticisation, degradation), we have to go back to one of the questions I posed earlier: Who can represent/voice it? Whose self-portrait can it become?

> Self-portrait as the Island on Fire
>
> The first place that flame touched earth was in a ring around my body. And for a moment I smiled, pleasured by that warmth, I who live within circles of my own making and undoing. Scarlet and gold. Then sound came to me: crackling. Stems and small conflagrations. A solar flare setting alight a dynasty of trees. Palimpsests elided into dark plumes. I breathed in smoke before awareness came, and with it—terror (Manivannan, 2017: 67).

After a forest fire rages and 'the will to live and the fear of dying' rises in 'tormented crescendo,' Sharanya Manivannan's voice as self-portraiture allows one to see both within and without (ibid.).

In a voice that is gendered, even mythological, as in this poem, the agency of fire/woman is brought into a precarious epistemic balance. Everything teeters on the edge of knowing. One is reminded of the vast forest fires that thunder through the lower Himalayas every summer, causing widespread devastation and making significant changes in the ecosystem. There are fears that the numbers of cedars, pines and rhododendrons will dwindle considerably. Even as I write this, news reaches me of bushfires in Australia laying waste the habitat of koala bears, leading to apprehensions about the acceleration of the process towards extinction.

In Bahuguna's whales and in Manivannan's burning island, there is an ethics of care that becomes evident in the poets' images. It is perhaps time to imagine the reciprocity—even a conversation—between the speaker and the subject. In anthropomorphic tales, the crisis of knowledge versus value becomes uppermost. Problematising this further is the certainty that knowledge is never value-free. When we were children, my sister's favourite story was an Assamese folktale about a young girl named Tejimola. My mother told and retold the same story for almost a year (or perhaps more) to please my sister. It was a gory account of torture, death and unfulfilled desire. Every night, inside the security of the mosquito net, we soaked in the fears of Tejimola as she turned into creepers, flowers, birds after being repeatedly killed by the archetypal evil stepmother. The moment when her small hands were crushed by the *dheki* (wooden pestle) was the moment I waited for—for my mother's breathless voice, my sister's round eyes, and the chill in my feet beneath the quilt. In the folktale, Tejimola metamorphoses from torn and tortured body parts into various life forms and speaks in their voices to the people who can 'see' her. This voicing also involves Tejimola revealing her stepmother's hand in her many murders. Every time she speaks (as creeper/flower/bird), she ends her sentence thus: *Tejimola he moi*—It is I, Tejimola. This interspecies correlation through language, breathing a song of familiarity and comprehension, is something that poetry, when used compassionately, seems to manage.

In 2015, Katie Holten published *About Trees*, which created a new typeface simply called 'Trees'. The font's alphabet is made up of tree silhouettes: A=Apple, B=Beech, C=Cedar, D=Dogwood, F=Fir, and so on. All the text in the book has one version in Walbaum, and another in Trees. Her publisher's blurb states, 'Recognizing a crisis of representation as our species adapts to life in the Anthropocene, *About Trees* considers our relationship with language, landscape, and perception.'[3] This reconsideration is indeed radical, working as it does towards constructing a language forest: something literary and visible, almost evidential in its acknowledgment of emergent requirements. When I first discovered her work in 2016, through an online share by a Facebook friend, I was stunned by the possibilities. Since then, Holten has gone on to do other work and has plans to create more fonts according to the available native trees of a place. So, New York got its own font recently, where A=Ash, B=Birch, C=Crabapple, D=Dawn Redwood, E=Elm, F=Flowering Dogwood, etc. People were urged to write to her using the Trees font; some selected essays, poems, notes, etc., were planted with new trees in the spring of 2019.

This brings me to one of my fundamental concerns: What is the future of language, poetry, storytelling in the Anthropocene? There may be voicing of a certain kind, but will there be listening too? A performative, tangible gesture like Holten's is both art and resistance. However, I cannot see the exact method working in an Indian language: Oxomiya, for instance—my first language. Newer, different, more subversive methods of reconfiguring language in the Anthropocene will have to be excavated.

In Sohini Basak's debut collection of poetry, *we live in the newness of small differences* (2018), there is a series of poems that were inspired by Katie Paterson's public project, *Framitidsbiblioteket*, which started in 2014 and will end in 2114. Contributors have been asked to send writings that will remain secret until 2114, and the collection will then be printed on paper created from the thousand spruce trees that were planted in 2014, especially for this experiment.

Basak's first poem in the sequence, 'Future Library: Some Anxieties', appears on page 36; the second, 'Future Library: A Footnote', on page 49; and the final poem, 'Future Library: Alternative Ending', on page 56. I, as reader, was surprised to see the recurring (and witty) deferral of interpretation and materialisation of the future. It is as if Basak is unable to find easy closure in one straitjacketed poem of pessimism and disaster, and needs to find other kinds of literary strategies to supplement what is already given. The words themselves—'footnote', 'alternative ending'—bring

to mind techniques and terminology of writing widespread in academia. These create a rhizome-like scattering that disrupts linearity and replicates the spreading, non-hierarchical organicity of the living world. In the poem about anxieties, Basak ends in the following manner:

> … will our
>
> children still be reading? will knowledge still be bitten in fruits
> or like vitamins, sealed in pills?
> stories will google: earth, google translate: earth. stories, say:
> foliage, say: moon, scribble love
>
> on palms or sit by our caves but stories will refuse, for tonight
> stories will go to war, stories will
> take the storyteller hostage a hundred years from now, how
> lovely that then we will all be gone (ibid.: 36).

The violence of the stories ('go to war', 'take the storyteller hostage') as they go about their work can be alleviated by the fact of our absence through death. On the other hand, my own favourite from the series—'Future Library: Alternative Ending'—begins with a chain of struck-out words.

> the opposite of dystopia
> is ~~not utopia~~,
> ~~possible, compassion~~, unprejudiced
> participation (ibid.: 56).

The attentive use of *sous rature*—under erasure—clearly envisages a nuanced typographical tactic of mediation. As I write this essay, my social media feeds are full of image and text that scream 'dystopia'. It is interesting to note how a strange word can suddenly become a cliché under changed circumstances. Moreover, the discernible '~~not utopia~~' challenges our accepted notions of language. Here are the final lines of the poem:

> breathing through masks and armed with watering cans, stories in
> your neighbourhood

> will make a comeback
> like the saiga antelope,
> fill the sky
> with screeches like an echo parakeet,
> stories will stop sitting on
> fences, stories will ferry
> cures, after counting 915 coins from the stomach of a turtle,
> stories will give up on miracles
> and take matters into their
> own hands,
> stories will
> disown gods,
> escape frameworks, mouths, the market,
> stories will never figure out how they end,
> how lovely then that we'll be able to
> say we had a hand in this (ibid.).

This exciting visual laddering of words builds in a pulsating tempo towards the gentleness of the ending that mirrors the first future ('how lovely'). It is a slanted mirroring, because we move from death ('we will all be gone') to an involvement that sharpens the sweetness of connection ('we had a hand in this') (ibid.).

This poem leaves me feeling that I should go back to making my seed lists. This small act of writing down names of flowers is a political act; 'breathing through masks and armed with watering cans', Tejimola-like, I will speak as—and with—plants and birds, and survive this winter.

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NOTES

1. See Sengupta (2016).
2. www.vimeo.com/214087324. Accessed on 26 November 2019.
3. www.katie.holten.com. Accessed on 26 November 2019.

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CLIMATE CHANGE AND BEYOND

A Holistic View

BHARAT DOGRA

The discourse on climate change will be judged ultimately by the extent to which it contributes to solutions which are just, durable and comprehensive. From this perspective, it is important to present a much more holistic view of the problem and its possible solutions than has been the case generally.

First, an obvious fact is that while climate change is no doubt the most serious environmental problem, it is at the same time only one of several serious environmental problems which can be harmful enough to disrupt the basic life-nurturing conditions of our planet. Scientists have identified about 10 such problems, and in the practical world we have to face the combined impact of all these problems taken together.

The United Nations Environment Programme (UNEP) issues periodic reports on the state of the world's environment, recent trends and future prospects. One of these, Global Environment Outlook 5, presented 'undeniable evidence that the world is speeding down an unsustainable path'. This Report voiced a clear warning that urgent changes are needed 'to avoid exceeding critical thresholds beyond which abrupt and generally irreversible changes to the life support functions of the planet could occur'.

This issue of critical significance has been taken up in greater detail in the work of scientists at the Stockholm Resilience Centre (SRC). Johan Rockstrom, director of SRC, says:

> The human pressure on the Earth System has reached a scale where abrupt global environmental change can no longer be excluded. To continue to live and operate safely, humanity has to stay away

> from critical 'hard-wired' thresholds in the Earth's environment, and respect the nature of the planet's climatic, geophysical, atmospheric and ecological processes.[1]

The scientists at SRC first identified the Earth system processes and potential biophysical thresholds, which, if crossed, could generate unacceptable environmental change for humanity. They then proposed the boundaries that ought to be respected in order to reduce the risk of crossing these thresholds. The nine boundaries identified were: climate change, stratospheric ozone, land-use change, freshwater use, biological diversity, ocean acidification, nitrogen and phosphorus inputs to the biosphere and oceans, aerosol loading, and chemical pollution. The study suggests that 'three of these boundaries (climate change, biological diversity and nitrogen input to the biosphere) may already have been transgressed'. In addition, it emphasises that 'the boundaries are strongly connected—crossing one boundary may seriously threaten the ability to stay within safe levels of the others'.[2]

The many-sided problems indicate clearly that the basic problem is one of the Earth's carrying capacity being exceeded in several ways, and unless this is attended to, any efforts focused only or primarily on reducing fossil fuels and greenhouse gas (GHG) emissions (although, of course, this aspect is certainly of very great significance) may not be adequate to check serious environmental ruin.

Second, while very serious environmental problems led by, but certainly not confined to, climate change have emerged today, this has happened when a significant part of humanity is unable to meet its most basic needs. In addition, as their habitats are encroached upon and other conditions of survival are threatened largely by human interference, many animals, birds and other species face increasingly difficult times. So, if this deprivation has to be challenged, and removed, and at the same time the environment has to be protected (in terms of reducing GHG emissions, and in other ways), then surely some significant ways of identifying large sources of ecological burden have to be identified, which can be reduced on a substantial scale. What will this be? The most obvious choices appear to be the significant reduction of weapons, and that of all harmful/hazardous/wasteful products and technologies linked

to them. This in turn links up with important life-style changes.

Third, it needs to be realised that while various environmental problems threaten life-nurturing conditions of our planet, there is another important source which can be extremely destructive. The reference here is to weapons of mass destruction, including nuclear weapons, robotic weapons—chemical and biological as well as weather warfare weapons. The world has 14,500 nuclear weapons, and the use of just one per cent of this stock can destroy most forms of life. This destruction is discussed mostly in terms of explosion, fire and radiation, but the millions of tons of dust and soot can also block the rays of the sun, heralding a nuclear winter and disrupting all food production. This, too, is climate change—a very sudden one, and very different—and this is another reason why this writer has been arguing that various environmental threats, including climate change, ought to be considered together with the very critical issue of weapons of mass destruction.

John Avery, Senior Professor of Chemistry and former Chairman of Danish Peace Academy, has written:

> The environmental consequences of a massive exchange of nuclear weapons have been treated in a number of studies by meteorologists and other experts from both East and West. They predict that a large-scale use of nuclear weapons would result in fire storms that, with very high winds and high temperatures, would burn a large proportion of the wild land fuels in the affected nations. The resulting smoke and dust would block out sunlight for a period of many months, at first only in the northern hemisphere but later also in the southern hemisphere. Temperatures in many parts would fall below freezing, and much of the earth's plant life would be killed. Animals and humans would then die of starvation.[3]

Bernard Lowen, of the Harvard School of Public Health, has commented:

> …No public health hazard ever faced by humankind equals the threat of nuclear weapons. Never before has man possessed the destructive resources to make this planet uninhabitable. …Modern medicine has nothing to offer, not even a token benefit, in the event of nuclear war.[4]

Eric Schlosser, a widely acclaimed writer on nuclear weapons, has spoken to several senior officials and commanders involved in various stages of nuclear weapons development and deployment. In the specific context of India and Pakistan, the two countries of South Asia with nuclear weapons, Schlosser writes,

> The latest studies suggest that a relatively small nuclear exchange (relative to the total number of nuclear weapons that exist in world) would have long-term effects across the globe. A war between India and Pakistan, involving a hundred atomic bombs like the kind dropped in Hiroshima, could send five million tons of dust into the atmosphere, shrink the ozone layer by as much as fifty per cent, drop worldwide temperatures to their lowest point in a thousand years, create worldwide famines and cause more than a billion casualties.[5]

Hence, the fourth point is that instead of talking only of climate change, the focus ought to be on a much broader survival crisis. Climate change and about 10 other serious environmental problems constitute one part of the survival crisis. The other part consists of all weapons of mass destruction, including nuclear weapons, robotic or Artificial Intelligence (AI) weapons, chemical and biological weapons, and weather warfare weapons. Moreover, with their huge scaling up, many conventional weapons are now taking the form of weapons of mass destruction.

Fifth, what this holistic vision makes clear is that peace and stability are an essential precondition for resolving both aspects of the survival crisis. War and all that is done in the name of war preparations are perhaps the single biggest pollutant on our planet. The kinds of international agreements and cooperation that are needed for checking climate change and other serious environmental problems as well as the arms race can be possible only under conditions of much greater peace, trust and stability (compared to what has been witnessed in the best of recent times).

Hence, what we need is a close integration of environmental and peace concerns, instead of these being segregated and taken up separately. The most critical peace and environmental issues (including climate change), constituting the two dimensions of the overwhelming survival crisis, should be resolved together within a

framework of justice and democracy. This means that in the phase of reducing the environmental burden on Earth, the basic needs of all people, particularly the poorest people of the present-day world, should still be met. This objective of a justice-based world should continue to be respected and given very high priority.

Coming more specifically to the kinds of solutions needed, more thought and specific planning are needed to meet the basic needs of all while reducing GHG emissions and all pollutants. Some suggested components of this planning are:

(i) All wasteful forms of consumption are to be listed carefully, and quantified. Those forms of wasteful consumption, which involve particularly high GHG emissions, are to be identified, and quantified. A time-bound plan ought to be prepared to reduce all wasteful consumption as much as possible.

(ii) In particular, efforts are essential to stop the production of all weapons to the maximum extent possible. Together with the previously known reasons for disarmament, there is now an additional one to curb all wasteful/harmful manufacture, because of the urgent need to reduce GHG emissions.

(iii) Possibilities of war and civil strife must be minimised, as apart from causing enormous distress to populations, modern wars and their preparation involve high GHG emissions and other forms of pollution.

(iv) A plan to increase the production of food, other essential goods and services to meet the basic needs of all in the world should be prepared, together with the most environment friendly and least GHG-emitting tecchnologies that can be used for this purpose. This plan ought to be implemented in such a way as to ensure maximum local self-reliance in meeting basic needs, so that unnecessary transport is avoided and maximum local employment is generated.

(v) The socio-economic changes that are needed to ensure the adequate availability of all goods and services to meet all basic needs that can actually be accessed by all ought to be identified and implemented.

(vi) Energy planning ought to focus on replacing fossil fuels with solar, wind and other renewable and eco-friendly solutions, which avoid or minimise GHG emissions.

(vii) All new technologies that are necessary for reducing GHG emissions and related objectives ought to be free from patents to ensure extensive use whenever needed. However, technology transfer has its limits and local solutions for local problems ought to get the most encouragement, while keeping the door open for any external input when needed.

(viii) As far as possible, no remaining natural forests should be cut. Timber needs must be curtailed as much as possible. Forest-dwellers, or people living near forests, ought to get first rights over minor forest produce, while also accepting responsibility for protecting forests. They ought not to be displaced, but instead be involved (with adequate incentives) in the protection of forests and wild life.

(ix) Very high priority ought to be given to reducing pollution and protecting habitats so that conditions for the healthy living of all life forms, whether on land or in water, can improve significantly.

(x) Farming and village-based life and livelihood patterns ought to get more help and priority compared to big industry, and city-based life and livelihood patterns. Small farmer-based farming, using environment friendly methods, to produce healthy food with care for farm animals ought to get the highest priority and help.

(xi) The highest priority ought to be given to protecting fresh water sources and conserving water.

(xii) All hazardous products, technologies, substances and chemicals ought to be carefully monitored and reduced.

In terms of significant change, perhaps the most critical issue relates to the almost complete elimination of nuclear weapons from our planet. As the use of even one per cent of existing stocks of nuclear weapons is likely to destroy most forms of life, we must think in terms of elimination, not reduction. Similarly, robotic weapons must be banned before the threat from them increases further.

This may appear to be too big a challenge to some, but there is more to come. Avoiding all future wars is also necessary for resolving the survival crisis. Without ensuring this it may not be possible to eliminate the most dangerous weapons, or to curb the arms race, or to bring down arms and arms expenditure to the massive extent that is needed. If the possibility of war remains, it will not be possible to create those unique conditions of peace and stability in which all aspects of climate change and other components of the survival crisis can be resolved.

This brings us to the unavoidable conclusion that unprecedented changes in governance and improvements in cooperation at the world level are required to resolve the survival crisis in a satisfactory and sustainable way within the framework of justice and democracy. The satisfactory resolution of the survival crisis is still possible, but it is not possible within the existing framework of international governance—with all its power-politics, narrow concerns, the domination of a few countries, and specifically those countries which have nuclear weapons and are investing heavily in robotic weapons.

Just as it is true that existing governance patterns are not in conformity with what needs to be done to resolve the survival crisis, similarly it is true that prevailing value systems in most parts of the world are, by and large, not in conformity with what needs to be done to resolve the survival crisis. While the need is for value systems based on cooperation, world harmony, equality and simplicity–frugality, prevailing value systems are generally based more on dominance, narrow nationalism (or even narrower thinking), discrimination and consumerism. These need to change before the agenda of resolving the survival crisis—based on justice, peace and environment protection—can succeed.

Therefore, efforts for big improvements in governance need to be accompanied by sustained and broad-based work at the grassroots to improve and change prevailing value systems. This includes working with communities and families, with parents and children, in schools and colleges. Just as problems are interlinked, so should efforts—efforts at one level should create openings at others. With changes in value systems, there is more pressure for governance reform in the same direction. With improvements in governance, more institutional support is available for sustained work to improve value systems.

These challenges may appear very difficult at some levels, but this is also extremely creative work. Once a support base of a certain level is created, this creativity will truly flower, and results which appear impossible today can be achieved in a relatively short time. So, let us end on this note of optimism. Very big changes are needed; these are tough—but these are possible.

WARNINGS OF SCIENTISTS

In 1992, a statement titled 'World Scientists' Warning to Humanity', signed by 1,575 scientists, declared:

> We the undersigned, senior members of world's scientific community, hereby warn all humanity of what lies ahead. A great change in our stewardship of the Earth and the life on it is required if vast human misery is to be avoided and our global home on this planet is not to be irretrievably mutilated.
>
> If not unchecked many of our current practices put at risk the future we wish for human society and the plant and animal kingdom, and may so alter the living world that it will be unable to sustain life in the manner that we know.[6]

Twenty-five years after this warning by leading scientists was voiced, another group of senior scientists, supported by 13,524 signatories from 180 countries, issued a follow-up statement titled 'World Scientists' Warning to Humanity: A Second Notice'. This follow-up statement reviewed the time series data on major problems and found that most of them were getting far worse. This statement said,

> The authors of the 1992 declaration feared that humanity was pushing Earth's ecosystems beyond their capacities to support the web of life. They described how we are fast approaching many of the limits of what the planet can tolerate without substantial and irreversible harm.
>
> ...On the 25th anniversary of their call, we look back at their warning and evaluate the human response by exploring available time series data. Since 1992, with the exception of stabilising the stratospheric ozone layer, humanity has failed to make sufficient progress in generally solving these foreseen environmental challenges, and alarmingly, most of them are getting far worse.
>
> …To prevent widespread misery and catastrophic biodiversity loss, humanity must practice a more environmentally sustainable alternative to business as usual.[7]

This prescription was well articulated by the world's leading scientists 25 years ago, but, in most respects, we have not heeded their warning. Soon it will be too late to shift course away from our failing trajectory—and time is running out. We must recognise, in our day-to-day lives and in our governing institutions, that Earth, with all its life, is our only home.

In 2019, the Bulletin of Atomic Scientists moved their widely followed Doomsday Clock further to just two minutes before midnight. It had never been placed so precariously close to midnight earlier. The midnight hour is supposed to symbolise doomsday conditions for Earth.

The decision about the exact position of the clock is taken once every year by the Bulletin's Science and Security Board, in consultation with its Board of Sponsors, which includes 15 Nobel laureates.

On the basis of these disturbing trends as well as increasing massive misuse of information technology, this statement concludes,

> By keeping the (special Doomsday) clock at two minutes—the closest it has ever been to apocalypse—the Science and Security Board today highlights an unacceptable reality that remains largely unrecognized by the public at large: the future of the world is now in extreme danger from multiple intersecting and potentially existential threats.[8]

SAVE THE EARTH NOW CAMPAIGN

Started recently by the author of this article, this campaign's wider and longer-term aim is to try to contribute to the protection of basic life-nurturing conditions of Planet Earth in various ways, but more particularly by raising public consciousness about the urgency of various related issues. Its two priority issues are: restricting global warming to 1.5°C above pre-industrial levels, and eliminating nuclear weapons—in fact, all weapons of mass destruction and robotic weapons.

To take this forward, the most immediate demand of this campaign is for the decade 2020–2030 to be declared the 'Decade

for Saving Earth'. This will help to focus public attention on this most crucial issue, and hopefully contribute to the badly needed top prioritisation at various levels. All aims of this campaign are sought to be realised within a framework of justice, peace and democracy.

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NOTES

1. https://www.stockholmresilience.org/research/research-news/2009-09-23-tipping-towards-the-unknown.html.
2. *Ibid*.
3. http://eacpe.org/app/wp-content/uploads/2017/11/Nuclear-Weapons-An-Absolute-Evil-by-John-Scales-Avery.pdf.
4. *Ibid*.
5. https://www.thestatesman.com/opinion/world-will-better-off-without-nuclear-weapons-1502735159.html.
6. https://www.ucsusa.org/resources/1992-world-scientists-warning-humanity.
7. https://academic.oup.com/bioscience/article/67/12/1026/4605229.
8. https://thebulletin.org/doomsday-clock/2019-doomsday-clock-statement/.

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A TRANSDISCIPLINARY CONCEPTUALISATION OF CLIMATE CHANGE

An Educator's Journey

VANDANA SINGH

I stand at the edge of the Arctic Ocean, trying to distinguish the land ice that lies on the tundra from the floating sea ice. It is a cloudy day in April, 2014, relatively warm at around minus 16°C, and the world is white—sky, land and ocean. Behind me lie the ice roads and metal frame houses-on-stilts of the tiny town of Utqiagvik. Here, on Alaska's North Shore, we are about 71.3° north of the Equator, only about 2,000 km from the North Pole. 'You can tell sea ice from the pressure ridges,' my Inupiaq host says, pointing to where slabs of floating ice have been pushed up against each other some distance ahead, breaking the smooth monotony of the icy plain. Sea ice has been in decline since instrumental records began in 1880.[1,2]

Most of the population of Utqiagvik consists of Inupiaq Natives, who have lived in the area for about 4,000 years. The Elders of their community are holders of ancestral memory, passed on through generations via an oral tradition. In 4,000 years, there is no record of anything like what is happening to the Arctic now: the rapid melting of the sea ice, the diminishing of multi-year ice that stayed frozen through the summers, the shift in the migration patterns of wild animals, the melting of the tundra on land, the heatwaves in a land where minus 16°C in April may be considered relatively mild.

The Arctic ice cap, like the one over the South Pole, cools the entire planet, because ice, being shiny, reflects most of the sun's heat and light back into space without absorption. The vital difference between the northern and southern ice caps is the fact that the Arctic ice floats on sea water. There is no land at the North Pole, only the frigid waters of the Arctic Ocean. When the salt water freezes, it squeezes out concentrated brine, forming sea ice—a floating layer of

ice with little salt content.[3] Because the Northern ice cap is (so far) a permanent one, the sea ice extent fluctuates with the seasons, but does not go away. In the winters, it extends from the pole to the edges of the countries that surround the Arctic ocean—the eight polar nations—the United States, Canada, Russia, Norway, Finland, Sweden, Denmark and Iceland.

All that is changing now. In 2019, five years after my visit to Alaska, the sea ice extent in the Arctic diminished dramatically, tying with 2007 and 2016 for the second lowest on record,[4] consistent with the downward trend since instrumental records began. Sea ice loss is a consequence of the warming of the globe on account of greenhouse gas (GHG) emissions by modern industrial civilisation (Notz and Marotzke, 2012). But what may not be immediately apparent is that the Arctic is also one of the controllers of global climate. It is affected by global warming—Arctic temperatures are rising at twice the global rate—and affects it in turn. Consider for example a process called the ice-albedo feedback (Kashiwase, et al., 2017). Sea ice floats on water, so when it melts, it reveals darker liquid water. Unlike ice, liquid water absorbs energy from the sun, exacerbating a process known as the greenhouse effect, which further warms the air and water. This melts more ice, which exposes more liquid water, and so on and so on, which accelerates warming with local and global consequences. This vicious cycle is technically known as an accelerating (or destabilising) feedback loop. Unfortunately, there is more than one such loop in the climate system.

The consequences of sea ice loss in the Arctic work their way through the complex dynamics of the global climate system. Thousands of kilometres from Utqiagvik, in a region of Jharkhand desertified by rapid deforestation and a changing climate, a band of women from an impoverished village are trying to protect their remaining forest.[5] They have nurtured it for 20 years, patrolling it, digging ponds for wild animals and making mud check dams, driving off axe-wielding loggers and wood thieves. The forest has come alive under their care. With the regeneration of their forest, these women have regained some food and water security. But they remember a time when the forest cover stretched unbroken for hundreds of kilometres, when tigers roamed, streams were thick with gurgling water, and the weather was cooler and more predictable. Climate model projections indicate increasing temperatures for

the Jharkhand region,[6] including the possibility of killer heatwaves as a result of the deadly combination of temperatures above 35°C and increased humidity (Im, et al., 2017). According to the State Action Plan on Climate Change,[7] Jharkhand ranks low on several welfare indicators and high on vulnerability to climatic impacts. Despite no formal education, these village women have an intimate understanding of the link between forests and water, forests and weather, and forests and well-being. Like the Inupiat, they can read their environment without the benefit of formal education. And yet they are unlikely to be featured in glossy magazines as climate heroes. Rural Jharkhand may be as remote in the minds of middle-class city dwellers as the Alaskan North Shore.

The stories from Alaska and Jharkhand reveal some ways in which the climate crisis challenges us. For one thing, we are taught to think short term and local, whereas the phenomenon of climate change spans vast temporal and spatial scales. To consider the possibility that ice melt in the Arctic, a region of the world so remote that most of us never think about it, could possibly have something to do with a heatwave in Jharkhand, requires a planet-sized imagination. Similarly, consider the fact that a large fraction of the carbon dioxide we unthinkingly put in the atmosphere today is likely to stay in the atmosphere for 100,000 years or more (Archer, 2010). We do not generally consider the impact of our actions on the next several generations. Climate change tells us that the regions of the world are intricately connected across space and time. Therefore, what happens in one place may affect what happens in another. The Earth's subsystems that give us global climate form a complex system, where causal relationships between apparently localised phenomena around the globe are not linear and direct. This inherent complexity is another key feature of the climate system that we do not learn in school or college—it generates nonlinearities and surprises (Donner, et al., 2009), leaving us unprepared for the changes that are here, and are coming in the future.

My two stories also illustrate the transdisciplinary nature of the climate problem. That climate change is real, caused by the activities of modern industrial civilisation, and is immediate and serious, has been established by climate science.[8] But its impacts on social systems and the possible ways forward call for an understanding that goes beyond science. Consider the dilemma of

the Inupiat of the far North (Singh, 2015). Since their way of life was modernised, their economy depends greatly on oil leases from companies drilling on their lands. Yet their cultural and ancestral ties connect them to their lands in ways that are hard for modern urban humans to imagine—to them, the ice has a significance that goes beyond survival, perhaps similar to how Indians feel about the monsoon rains. In the harsh winters, during which the sun stays below the horizon for months, the only fresh food to be had comes from hunting. The Inupiat hunters travel over the sea ice to where the bowhead whales swim in the frigid waters. The bowhead is a sacred animal for the Inupiat—they believe it gives itself to them at the hunt. Every part of the body is used. The meat is always shared, never sold, a remnant of the original communitarian culture in the era of cars, television, and settled rather than semi-nomadic life.

Now that the ice is melting, the seasonal migration patterns of the animals—whales, seals, polar bears, caribou and others—have changed (Phillips, et al., 2018). It is not unusual for polar bears looking for food to come into the town. When I visited Utqiagvik, a large sign greeted me as I walked into the lobby of my tiny motel: Beware of Polar Bears. The same oil economy that has given the Inupiat access to modern conveniences is also a threat to the ice, the animals, the ecosystem, and the Inupiaq way of life. With the possibility of offshore oil drilling in Alaskan waters increasing, the dilemma of the Inupiat—to go for short-term gains with business as usual, versus a profound change in direction so that a sustainable future is possible—is also the question before the rest of humanity. Implicit in the Inupiaq people's situation is the entanglement of colonialist history, economics, culture, ecology and climate (Singh, 2015). Consider the similarity to the village women in Jharkhand. They too are close to the bottom in the hierarchies of power, under constant threat from the neocolonialist forces of industrial 'development'. Class, caste, gender and economics entwine with their local ecology and climate.

Another common feature is that neither the Inupiat of Utqiagvik nor the village women from Jharkhand have caused the climate crisis. The historical blame goes to the rich nations of the West, and their propagation of an economic system based on endless growth and consumerism. Currently, India ranks third after China and the United States in GHG emissions, but there are stark differences within each country. The richest within each country

contribute the most to the problem and are affected the least.[9] The Inupiat and the rural poor of Jharkhand must deal with the worst impacts of climate breakdown. The fact that those who have done the least to contribute to climate breakdown are the ones most severely impacted makes climate change a justice issue (Robinson, 2018). At the receiving end of the impacts are indigenous people, the rural poor, the people of the Global South, and the young, who have not lived long enough to contribute substantially to a crisis that will affect them much more than previous generations.

To summarise, the challenges presented by the climate crisis, of relevance to climate pedagogy as well as to policy and action, are: (i) its vastness over spatial and temporal scales; (ii) its inherent transdisciplinarity, which includes issues of ethics and justice not generally considered in academia, except in courses specifically designed around those topics, and certainly not considered at all in science courses; and (iii) its complexity, which challenges linear thinking and simplistic causality.

It should be obvious that the modern education system (similar in its essential features across the industrialised, globalised world) is poorly equipped to meaningfully engage with a problem as vast and complex as climate change. And yet, if our young people are to have the knowledge and skills to make sound decisions, they must be taught about climate change, and taught well. In my work I elucidate what I believe are the essential features of an effective pedagogy of climate change (Singh, 2020). Such a pedagogy:

(i) Equips the student with a fundamental understanding of the basic science, impacts, and evidence of climate change, including its complex, nonlinear nature, as well as the future projections based on various scenarios: the *scientific–technological dimension*;
(ii) enables the student to understand societal and ethical implications of climate change (climate justice), including intersections with economic, cultural, human rights and sociological issues, and to critically examine proposed climate solutions from a climate justice perspective: the *social–cultural justice dimension*;
(iii) enables the student to see the climate crisis as a symptom of a social–scientific framework or paradigm,

and therefore to understand and articulate the need for new social–scientific frameworks in order to usefully engage with the crisis: the *epistemological dimension*, and;

(iv) inspires students to play an active role, if they choose, in both mitigation (prevention of further climate change) and adaptation (to climate change already under way): the *psychosocial–action dimension*.

There are, broadly speaking, two ways to proceed: one is to invest in a complete transformation of the education model, something like Finland's education revolution (Spiller, 2017). The other, which can be worked on while we are waiting for that large structural change, is to teach climate change across the curriculum, through every subject, in a way that avoids piecemeal learning and engages the student's humanity. This is challenging as well, because it involves a cooperative effort among teachers of different disciplines. But with the right training, opportunities and faculty cooperation, there is no reason why it cannot be done. My own efforts are limited for logistical reasons to a general physics college course at a small, public, mostly working-class American university. But my experience conducting three climate change teach-ins across disciplines at my institution has convinced me of the possibility of a cross-curricular approach to teaching the climate crisis.

Here I describe very briefly some key features, advantages and limitations of my still developing inter-to-transdisciplinary approach to teaching climate change in a physics classroom (Singh, 2020), which can potentially be adapted for other subjects, and perhaps even for communities.

First, a clarification: interdisciplinarity refers to a practice involving two or more disciplines in which disciplinary knowledge is integrated to some extent. There are many definitions of trans-disciplinarity, but I find that by Patricia Leavy to be especially useful.

> Transdisciplinarity is a social justice-oriented approach to research… [it] draws on knowledge from disciplines relevant to particular research issues or problems while ultimately transcending disciplinary borders and building a synergistic conceptual and methodological framework that is irreducible to the sum of its constituent parts (2011).

The implication is that new epistemological frameworks can emerge via the transdisciplinary approach.

My journey started in 2008, with the naïve assumption that teaching climate science where it intersected with topics in physics courses would be sufficient for undergraduates to be equipped with the knowledge they needed to face the future. My initial experiments were not successful, in part because climate science was necessarily piecemeal, attached to the relevant physics concepts as they were taught over the course of a semester. In addition, I had not yet realised the crucial role played by complex systems science in solidifying some key surprising features of global climate. But, also, I was surprised by student reactions, which ranged from interested, horrified and angry, to frustrated, apathetic and despairing. My students were mainly American working class, quite diverse with regard to gender and race, many of them immigrants. Most had to work at tedious, low-paying jobs to pay for college, and had responsibilities to families. They were already carrying psychological burdens, and here I was, talking about an unfolding global disaster that threatened to dash any hope for a positive future. It seemed that my good intentions had had the opposite effect—rather than inspiring students to action, I had put them in a state of frustrated anger or paralysing despair. Adding to this was the fact that piecemeal learning generated more misconceptions than it resolved.

Thus, I was confronted with a dilemma—as an educator and a scientist it was my job to tell the truth, with the requisite methodology and evidence. But it felt wrong to burden students with more than they could handle emotionally. And the logistical challenge of presenting climate science in bits and pieces via a physics course seemed impossible to overcome. But, motivated by the unremittingly bleak picture presented by climate science research, I kept reading whatever little research there was in the new field of climate pedagogy, and experimenting in the classroom. My ideal experimental stage was a class for non-science majors that I had designed, called Physics, Nature and Society. I had already been working on an interdisciplinary physics pedagogy, using embodied learning and storytelling to enhance student interest and understanding in general physics courses for science and non-science students alike. Despite the suspicions of fellow scientist–educators

that this somehow implied a lowering of standards, my approach actually challenged students to meet standards higher than were required for the course, while at the same time giving them the help and confidence they needed to meet those standards. Additionally, they had a great deal of fun getting to know their physical universe instead of living, as most people do, like oblivious strangers within it. There was a growing body of research to support these apparently eccentric approaches to science education (Skulmowski and Rey, 2018), to which I had made some modest contributions. Plus, my experience as a writer of literary science fiction had convinced me of the power and relevance of the transdisciplinary imagination. So, it seemed quite natural to me to consider an inter-to-transdisciplinary approach to teaching climate change.

My 2014 trip to the Arctic (as part of a programme award from the Association of American Colleges and Universities [AAC&U]) eventually resulted in the creation of an interdisciplinary case study on Arctic climate change as an educational tool on the AAC&U website, freely accessible to educators worldwide (Singh, 2015). This was a threshold experience for me that led to an improved understanding of how to teach climate change in a way that fitted the phenomenon itself as much as possible.

My approach attempts to address these questions:

(i) How can we present climate change science in a class that is not exclusively about climate change? Relatedly, how can we prevent piecemeal knowledge? This requires, among other things, an understanding of the key essentials of climate science, to prevent misconceptions and inoculate the student against fake news and misinformation about the subject. It also warrants some kind of unifying conceptual structure which can relate these 'key essentials' into a whole.

(ii) How can we introduce climate change holistically in such a course, so as to emphasise its inter-/transdisciplinarity, with a focus on climate justice? In addition, how can we use the history of science to understand how we got to this fraught moment where the Earth's geological history entwines with the history of our species? How can we understand the role of power hierarchies in society in the context of the climate problem? What are all the other issues connected to the fact of human-caused climate change?

(iii) How can we discuss 'solutions' through a framework informed by both science and justice? How can we distinguish between approaches that are both just and effective, and 'false solutions'?

(iv) How can we equip students, especially those already carrying a psychological burden, with the tools—individual and collective—to work through despair and anger so that they feel empowered to take positive actions on climate?

I address (i) by taking the most essential threshold concepts of climate science and presenting them through a connected 'metaconceptual' framework that is threaded through with the idea of climate justice. I use a diagram of the Earth's subsystems that contains these metaconcepts as a unifying tool that is employed every time we study climate change in the physics classroom. This iterative, layered approach helps build a holistic, rather than piecemeal, understanding of the climate system and the human role within it.

I set aside some lab time and classroom time during a 'Climate Week' in the latter half of the semester, in order to more explicitly integrate scientific concepts with lessons from the history of science, and examination of social consequences of climate impacts, especially on marginalised communities. We also study climate movements and the resilience and creativity exhibited by, for example, indigenous people and the young. We look at emerging new paradigms such as new economic theories, and study purported climate solutions through the lenses of both efficacy and justice. Student groups then embark on a project that deepens their interdisciplinary understanding of the climate issue. The project includes a service aspect that might be as simple as an educational presentation on climate change to a different class on campus (most recently an Expository Writing class and a Poetry class were the beneficiaries of my students' presentations), or as ambitious as developing a Heat Impact Awareness Tool for the elderly (among the most vulnerable group to heatwaves) for the local municipality (a project carried out by a First Year Seminar class on Arctic Climate Change). Along with Climate Week, such projects not only address the question of

transdisciplinarity, including justice and just solutions (items ii and iii), but also give students a sense of empowerment.

Finally, the fourth issue is addressed by explicitly giving time and space for students to discuss how they feel about what they are learning. It was climate scientist Steve Running who first suggested that the grief we experience when we think of what is happening to our planet is a kind of emotional trauma, and therefore must be negotiated as such. He suggests that in order to work through 'climate grief', we may need to adapt the Kübler-Ross scale, well known among psychologists as a descriptor of the stages of grieving that occur during a personal loss (Running, 2007). Denial, anger and apathy often conceal unacknowledged grief and fear, which can trap a person in that state. Fear, in particular, when not acknowledged and worked through, may make people more susceptible to the lures offered by demagogues and 'strong men' leaders, whose interests rarely coincide with social or environmental good. I have experimented with ways for students to express and share their feelings, for example through a poetry workshop conducted by a colleague who is an environmental poet. Students generally produce work that surprises them—most do not think of themselves as poets, and poetry does not have the same hold on the public imagination in the United States as it does in India. The sharing of their work and the validation of their feelings, strengthens, at least in the short term, their ability to deal with the reality of the climate crisis.

I have been encouraged by student self-reporting in surveys, as well as their answers in homework and exams, on questions about climate science and justice. But climate pedagogy is a very new field, and one cannot be complacent. Among the limitations of the current approach is that it is applied to only one class among the many that the students have to take. Whether it can have a long-term impact is unknown. This is why a cross-curricular transdisciplinary model of pedagogy, where educators from different disciplines collaborate, would be far more effective and powerful. Second, the limited short-term projects that students do are insufficient for a deeper sense of meaningful contribution and empowerment. A university-wide dedication to taking academic knowledge into the world—not with elitist arrogance, but with a view to engaging communities on an equal footing to collaboratively engage with the climate crisis—would be far more effective.

One of the things we know is that the same worldview that gave rise to the crisis cannot be depended upon to solve it. The super-rich famously lack empathy (Grewal, 2012); I suggest that they may also lack the kind of creativity and courage we need to deal with the climate crisis. Consider that technocrat billionaires dream of escaping to space, even as they construct luxury climate bunkers (Stamp, 2019) to protect themselves from both climatic extremes and what they expect will be the wrath of the masses. Thus, we must look for alternative epistemologies and not just alternative technologies. Among the lessons I have learned in my ongoing journey of understanding our fraught condition on this planet is that those who are most vulnerable to climatic impacts often have the deepest wisdoms about surviving in precarity, and about living with the environment without destroying it.

The women of the Jharkhand village lead lives of deprivation that privileged urbanites can scarcely imagine. And yet they display a degree of courage, creativity and empathy that are truly inspiring. Deforestation is a major contributor to climate breakdown; those who depend directly on the forests often have the knowledge and motivation to protect and nurture them. This is one reason why Forest Rights for traditional forest dwellers, including indigenous people, are a climate mitigation tool, something that has been acknowledged in multiple studies. Research also indicates that indigenous people, although only 5 per cent of the world's population, care for 80 per cent of the world's biodiversity, and manage nearly 300,000 million tons of carbon.[10] In the Arctic, Inupiaq Elders, who have no formal education, are partnering with climate scientists[11] because of their phenomenal ability to read the environment and make scientific inferences. But power hierarchies are such that the voices, knowledge systems and creativity of marginalised peoples are generally ignored, while the elites set the agenda for climate action. Real-world stories about people most severely impacted by the climate crisis, embedded within a transdisciplinary framework, serve to clarify climate justice to students, but also surprise and inspire them to consider alternative ways of thinking and being as essential prerequisites to building a just, sustainable society.

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PERFORMATIVITY AND ECOLOGY

NAVTEJ SINGH JOHAR

When we think of 'classical' Indian dance, we are broadly speaking of the interplay between the body, on the one hand, and a notion of God, on the other; and when we talk of ecology, we evoke Nature, which, too, in varying degrees, may conflate with the idea of God. This paper explores the ideas of nature, body and God, and how linguistic redefinitions may have influenced our perceptions, experience and treatment of them. What I am proposing is that if we are facing an ecological crisis today, it is not so much because of man's disuse of Nature, but, rather, the unsustainable definitions that may have been crafted over the last few centuries, definitions which may *allow* and sanction such disuse. And considering that all these definitions have been formed from the perspective of Modernity, it would be imperative to define the dream and scope of modernity as well, and the manner in which this dream might influence our relationship with God, nature and the body. I present my case from the perspective of a dancer, evoking the aesthetic theory of *Bhava-Rasa* (particularly the aspects of *anubhava, vibhava* and *satvika-bhava*), which calls into play both the body and an imagined poetic–object (vibhava) that can become contiguous to the notion of God.

Trying to trace the genealogy of this crisis that is not merely ecological but equally sociological, cultural, political, aesthetic and linguistic, my limited conclusion points to the gross lacuna in modernity and, even, Enlightenment—a lacuna that has been vociferously glossed over by sweeping idealisms of morality, rationality, production, ethics and purity.

Winter 2019–Spring 2020, Volume 46, Numbers 3 & 4

THE PROBLEM

At the outset, I would like to state that ecology is not a category, something distinct or distant or, more precisely, something that can be removed from day-to-day life, lying somewhere beyond the protective insulation of urbanity. Ecology lies in our very engagement with the material. Similarly, performance is not an event that takes place in the theatre, removed from ordinary life. The human body is ever-performative; we are continuously performing our concerns, functions, beliefs, isms, culture, gender, politics, etc. Performativity can be imposed and/or acquired, or else it can viscerally preoccupy our bodies from the inside. Here, I am advocating a visceral variety of performativity, not merely because I find it aesthetically more satisfying, but simply because I see it as 'ecological'.

ECOLOGY

David Abram, philosopher, cultural ecologist and performance artiste, opens his evocative book, *The Spell of the Sensuous*, with these lines:

> Humans are tuned for relationship. The eyes, the skin, the tongue, ears and nostrils—all are gates where our body receives the nourishment of otherness. This landscape of shadowed voices, these feathered bodies and antlers and tumbling streams—these breathing shapes are our family, the being with whom we are engaged, with whom we struggle and suffer and celebrate....The color of the sky, the rush of waves—every aspect of the earthly sensuous could draw us into a relationship fed with curiosity and spiced with danger. Every sound was a voice, every scrape or blunder was a meeting—with Thunder, with Oak, with Dragonfly (1996).

To be ecological in our engagement with matter, we need to not only see, feel, experience, or, in other words, 'consume' nature, but necessarily become willing to view nature as reciprocal, endowed with a will of its own that is unpredictable, risky, even dangerous. However, our encounters with nature have been so effectively insulated and 'landscaped' that its potency has become almost completely undermined in our imagination. We have grown so accustomed to nature being tamed, controlled or 'pruned' that we almost see it as normal (read 'natural'), and even expect, in fact, demand it. What we

have lost in the bargain is a primal life-partner, one that is capricious, beautiful, giving, frightful, dangerous, awe-inspiring, and infinitely greater than ourselves. In fact, it is this relationship, and more so with such an ambivalent partner, which makes us human. To look upon nature as an object and define it as a resource that can be appropriated and emptied at will for the larger human purpose of Order is un-ecological.

MODERNITY AND ORDER

By definition, modernity can only operate within the categories of order, and therefore, it is intolerant of both randomness and ambivalence. It disallows ambivalence through a variety of ways—by shaming it, colonising it, labelling it, overshadowing or overwhelming it, policing, erasing, reforming, mocking, moralising, obliterating, bulldozing, capturing or othering it; in fact, it never stops reinventing new ways of overpowering ambivalence which, in reality, can never, ever, be fully contained. It almost seems that the order of the day is employing the generous, albeit limited, resources of the planet to fight this unwinnable battle. In fact, the insanity of modernity is that it continues to remain willing to put the planet at stake for the sake of its ideal—i.e., order, which places mind over matter. This can also be translated as morality over body. This drive to control ambivalence from the outside with idealisms, and to capture the body with notions of purity and perfect discipline from the inside, is obsessive, compulsive, addictive, self-willed, self-policing and, eventually, self-destructive.

At the heart of modernity is this insatiable, obsessive desire for perfect action, perfect design, perfect technology to fix all that has the potential to move randomly or *involuntarily*, because of it being unpredictable, disruptive and disturbing of what may be the idealised design. Its stress is thus upon perpetual *doing,* countering, bettering, excelling—in short, relentlessly striving to outsmart the randomness of nature with perfectly premeditated action. It is a vicious cycle that warrants yet more stringent manipulation and redefinition that must take place both within and without; simultaneously rendering rigid our imaginations, perceptions and conditioning, on the one hand, while parallelly controlling and hollowing the world outside and around us, on the other.

That the phenomena of materiality and nature have been

rendered subordinate to a constructed 'idea' of order is problematic. But what is more troublesome is the drive to fix the internal 'unfixity' of things, ideas and concepts that may abound in our heads.

The pre-modern conception of God has historically been ambivalent. Within pre-modern religions, including in the Indian subcontinent, and more so amongst the minor religions that revolved around local or village deities, the idea of God has remained dialectical—an unfixed and unpredictable God or Goddess who could be equally benign/wrathful, sacred/erotic, a liminal entity that simultaneously embodied both-and-neither oppositional categories. I would like to point out here that exactly this unpredictability of being both/neither is what gives God 'life' in the human mind. And that this 'life' is a matter of its uncategorical definitions, i.e., God's life is linguistically assigned. A God only benign or sacred is in reality no God at all. Because, it is precisely in the erasure of the two mutually oppositional, but equally complementary, dialectical forces that a sacred middle space of potent emptiness may open up *perchance*, within which the resonant God-space may come alive.

However, over the last two centuries, our Gods have been progressively relegated to calendars, standardised and divested of their ambivalence, rendered categorically benign—thus flatted and robbed of their treacherous liminality that equated them with life, agency and 'sacredness'. Today, the flattened God appears a passive, even harmless, signifier of omniscience and auspice, reduced to an inanimate object, 'un-live' without the 'breath of flux' enlivening it from the inside. And it is to such a God—categorical, fixed and un-reciprocal—that classical dancers like me address in our beseeching *varnams, padams, ashtapadis* and *thumris*. A poetic conversation, otherwise rife with erotic devotion with a sacred/erotic God, has become reduced to making pre-learnt gestures that remain, at best, empty platitudes. However seductive in its finesse, the dance remains empty, because the God, the poetic–object or the vibhava that elicits the emotions in the dancer, has been linguistically castrated of its potent flux and, in turn, poetic reciprocity.

ABHINAYA IN INDIAN DANCE

Vibhava in *abhinaya*, a central component of Indian dance, is the poetic–object that the dancer fictitiously engages with in order to externalise an interiority of lived-feeling called bhava. The

externalisation of this inner feeling can be of two varieties: voluntary or involuntary. The voluntary includes the repertoire of appropriate gestures called anubaava that are either learnt or improvised in the moment. However, if that moment is rightfully configured, and if the vibhava is deemed dialectical and reciprocal, the moment can become alive, even heated, resulting in things happening involuntarily in the imagination and within/upon the body of the dancer–subject. But such a moment, filled with a sense of anticipation and suspension of time, may happen only perchance. And such a perchance occurrence, to me, is the promise of Indian poetics and aesthetics which I long to experience both as performer and viewer—a moment of aesthetic surprise and delight where the studied script is exceeded. Such surprising and involuntary release or surge of bhava—*satvika*-bhava—that enriches the moment is for me the very purpose and promise of Indian dance—*satva* meaning buoyant, luminous, lucid.

However, what we see today is a sequence of rehearsed reproductions of learnt and sanctioned cultural behaviours that are empty in their engagements with poetic objects that are, in turn, un-live. With God, and subsequently the vibhava becoming unidimensional, un-reciprocal and, thereby, unyielding, we are left with dance becoming a simulative act of show-and-tell, a dispensing of rehearsed emotion, rather than a live engagement, a one-way transaction empty of even expectation, possibility or anticipation of a live poetic–other. This, then, renders dance merely a lone and companionless, ever-excavating act of dispensing archived behaviours, reducing it to pure artistic labour with no room for play, surprise, anticipation, resonance or beauty. And the harder we labour, the more we encroach upon and vanquish that delicate middle-space of chance. Ironically, it might be our hard work, our perfectionist drive, our calculative premeditation, and most of all our earnestness which is drying up the middle-pool of resonance and making Indian dance empty of any chance happening or experiencing.

Thus, my strong contention is that with fixity attributed to God within modernity, which cannot allow either dialectically alive Gods, poetic–objects or, for that matter, muses, nor involuntary and unpredictable expression such as satvika-bhavas, the entire practice of representing 'sacred-dancing' has become unperformative and is actually reduced to being a sham.

NATURE

Nature, unpredictable and in flux, has also been meted with a fate similar to God. The improbability of nature has been tamed and landscaped rather effectively. We have grown accustomed and conditioned to living in the bubble of mock safety, where our bodies experience and even expect insulation from its improbability. Mock existence and mock engagement seem to have become the order of our times.

Modernity has been relentless in pushing nature to the margins; but nature, like the body, never stops leaking and bleeding and overstepping its bounds. Nature is not only unbound, but again, like the body, can also be incorrigibly abject which, in turn, makes the modern drive to plug the leak and contain the bleed equally relentless. Relentlessness becomes the emblem of the modern era, making rest or repose invalid, in fact, a foul—therefore the slogan: *aaram haram hai* (to rest is to sin).

PERFORMATIVITY

Modernity permeates and percolates our lives and bodies through its own modes of performativity. Today, all of us who find ourselves, willingly or unwittingly, subscribing to that call of order that modernity proclaims and promises are implicated in the mockery of insulated engagement with the world around us—and this includes ecology. Modernity manifests itself as both an invisible antiseptic sheath that separates us from that which surrounds us, and at the same time lives in the body as a perpetual bodily tension. A portion of our energies remains continuously locked in upholding this mockery. We continuously uphold, perform and embody the rites of insulation through our stances, mannerisms, actions, attitudes, attires, judgements, opinions, presentations, and in how we design our spaces and divide our time. And we need to remind ourselves that modernity's dream of order is categorically anti-matter and anti-ecology. Thus, our bodies, which are preoccupied in holding, performing and reinforcing the tensions and anxieties tied to the fragility of this order, are also fully implicated in this un-ecological project.

Along with improbabilities, even chance is viewed as anomaly. Within the larger design of efficiency, production and deliverability, chance does not really have a place, or, for that matter, stand a chance. The risk-free zones that are promised to us, and which we

demand and presume as our right, are designed to erase or minimise chance. Within modernity, chance almost seems a violation. We see ourselves impatient and intolerant of improbabilities; they read as failures to us, reek of unmanageability, inefficiency, irresponsibility, stupidity. And this may extend to include the improbable or chance performativity of the body, i.e., the involuntary happenings that may visit upon and within the body.

Today, within the design of dance, almost everything is pre-set, rigorously rehearsed—in fact, the rehearsal process today is designed to rule out chance, i.e., dance is made today without even the expectancy of chance. In present times, then, the very model of Indian performance aesthetics is turned upside-down, and rendered defunct of chance and reciprocity.

Thus, the crises that both ecology and performance are facing today seem to arise from the popular definitions, perceptions or conceptions of the same. My strong proposition is to place 'engagement' at the centre and begin to see the two as verbs as opposed to nouns. Both are live and will become verbs only, and only if that with which they are engaged is 'live'. And as long as we see them as nouns that can be defined, formed, reformed, preserved or saved, then we see them as inactive, inanimate objects. It is these definitions, defined by some idealism, that are not ecological.

If ecology is coming to 'bite us back', it is on account of the hubris of the mind and its by-products—the idea, the message, the paradigm, the ism, et al. The dismissal of ecology and disavowal of the body in favour of an idea, personal or collective, is tantamount to the same thing.

As I point out at the start, ecology is not distant or remote, nor does it lie outside the borders of our 'safe' time and space—it is disintegrating right under our feet. Now is the time when the euphemism 'fools dance where wise men dread to tread' feels pertinent. It is time to stop pushing harder, dancing to the glory of a higher idea, brandishing yet another idea with more pomp and cry, including the lofty ideas of preserving the nation, tradition, culture or even ecology. It is exactly the dream of the greater good that has brought us to the breaking point where we are today—ecologically, culturally, politically. It is time to stop, to take stock, to accept our powerlessness and our misapprehension of so much, and listen to and register the unrest within matter, beginning with our bodies.

The body has been used for too long as an instrument of doing, producing, showing-and-telling predetermined, fixed ideas. To assign the body the task of replicating, representing prefixed ideas is in a way dishonouring and devaluing it. The body is not the means to replicate, but to live and experience the moment—it is with this body that I enter the moment. And the moment is never still, it is never fixed, it is always rife with chance, surprise, anticipation and possibilities. And that is what renders life to the body. The body's life lies in its sensory attentiveness, alertness and responsiveness. The body is meant for and desires real interface, real play, real engagement with all things sensible, illusionary and unpredictable. To risk is to desire for the body. To risk is to be alive for the body. Therein lies the capacity of the body not to be subordinated to the safety of a fixed idea.

What I would like to propose is immersive performance that takes into account the very in-the-moment engagement with the materiality of the body, irrespective of the idea. Such an engagement with the body would be an exercise in ecology, where the body is heard and conversed with, as opposed to the body being tamed to carry and embody a message or a moral that may be seen to be loftier.

Without linguistically defining and viewing God, nature, and/or vibhava as being dialectical, the engagement with the same would be reduced to becoming a task, a repetitive labour of reiterating, dispensing, reproducing of archived performativity, as in the case of classical Indian dance that continues to reproduce a learnt cultural behaviour, and repeatedly excavates an already hollowed and emptied archive. To continue to excavate that which is neither alive nor yielding is direly un-ecological. And this exemplifies our times!

CONCLUSION

To conclude, ecology is not so much a matter of what we do wrong or right—of course, it is that, too—but, more importantly, it is a matter of definition. As long as we continue to define ecology as a thing that we need to protect, preserve, exploit and harness, our engagement with matter and the planet will remain un-ecological. To clarify, I would like to say that I am not proposing a non-intrusive relationship with nature, because to be human is also to be discontent with nature and to wish to improve or manipulate it. What I am proposing is to see—nay, define—nature as something reciprocal and live, as

opposed to being an object for gratification. To engage with it is to not use but to also to recognise resonance with it.

Ecology does not need our protection; all it needs is allowance plus a resonant engagement. It requires us to sidestep our own definitions and let go of our obsession with categorisation, management, perfectionism and order. The irony today is that if we lose our hold on categories, then modernity collapses, but if we continue to hold on to categories, our planet perishes under our very feet. In fact, the definiteness of all things with which we stabilise our modern-day world is the very root of crisis. It is our certitude that is poisoning the planet; our certitude about an undialectical God, nature, body, and so on. To hark back to the words of Abram, we will continue to die and kill our planet till such time as we begin to somatically deliver ourselves to *relate* and, subsequently, tune in to recognise a part of ourselves in whatever we see and engage with. I end by borrowing from Arindam Chakrabarti, as he cites Abhinavagupta, who, while translating the ninth 'Hand' chapter of the Natyashastra, says, 'We sing the praises of that Supreme Lord, who assumes the form of touchable sense-essence when the body wears the natural ornament of goose-flesh, due to a rapture caused by His inner touch felt all over' (Chapple and Chakrabarti, 2015: 224).

It is imperative, I feel, that 'sense-essence' be linguistically allowed to co-mingle, opening the body to 'receive the nourishment of otherness' through a 'touchy-feely' engagement with objects—real, fictitious or divined. Because these objects are not only sensible but *also* sentient. It is only through such a thrilling engagement that both performativity and ecology can become sustainable.

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THE POSSIBILITY OF ACTING IN CLIMATE CHANGE

A Gandhian Perspective

PAULINA LOPEZ

RAVI AGARWAL

INTRODUCTION

'Hardly a week goes by without a major news story about the threatened destruction of a valuable natural resource (Ostrom, 1990). These are the opening lines of *Governing the Commons: The Evolution of Institutions for Collective Action*, in which Elinor Ostrom (awarded the Nobel Prize in Economics in 2009) provided a crucial path to mitigate climate change and adapt to its impacts. On the one hand she informs us about the depletion of natural resources as a consequence of overconsumption, while, on the other, she expresses a more optimistic view than that proposed by Garrett Hardin (1968). Ostrom suggests that local communities have the capacity to implement effective systems for collective action, and reach a balance between consumption and resource availability. From this perspective, local action becomes essential to face the challenges of climate change.

Indeed, the capacity to self-organise and adapt to stresses and changes are two important dimensions of resilience.[1] Furthermore, there is a growing appeal from the scientific community and policy makers to promote Community Based Adaptation to climate change (McNamara and Buggy, 2016), which embodies small-scale and grassroots-driven adaptation practices.

Notwithstanding Ostrom's valuable contribution, even 30 years after the publication of her book we have still not been able to stop global warming, and face enormous difficulties in adapting to a highly disturbed environment. Indeed, the detection of the highest air temperature (~18°C) in the White Continent, since records exist,

and the recent rupture (February 2020) of the Pine Island glacier in West Antarctica, which released an iceberg of 300 km², are further evidence. In fact, the burning of fossil fuels and greenhouse gas (GHG) emissions have not ceased to increase since the Industrial Revolution. In particular, carbon dioxide (CO_2) emissions have currently reached 400 ppm. Consequently, the global temperature of the earth has risen by 1.1°C since 1850, and future projections indicate that global mean surface temperatures will increase in ranges from 0.3/1.7°C to 2.6/4.8°C for the years 2081–2100, relative to 1986–2005.[2]

Despite awareness of the serious impacts of climate change, why has the consumption of natural resources remained unabated? How can awareness of these facts and a lack of action coexist? The involvement of the capitalist system in climate change has been widely recognised (Barry, 2012; Storm, 2009). An imperative of economic growth, driven by capitalism, it has pushed people to consume more and more. As a result, natural resources are depleting and the climate system has already been severely affected. This system has also created inequalities and concentrations of wealth, besides being ecologically unsustainable. Yet, it is still in force.

Facilitated by a process of globalisation and an increasingly free circulation of capital (Köse and Senses, 2007), the capitalist system has only been strengthened and expanded—there is no part of the world that can escape from this (Nkrumah, 1966). It seems easier to accept climate change than to modify capitalism (Latour, 2017). It has apparently transgressed control by states, and left individuals without an agency to counter it. The omnipresence of capitalism—which is neither a political philosophy nor an economic doctrine, but a system, an organisation of society—seems to be accepted by all. We are both its victims and beneficiaries. However, considering that our lifestyles are not sustainable, something must be done. One thing is certain: we will be compelled to adapt to changes in the environments in which we live.

A central problem has been the ineffectiveness of actions to combat climate change. Attempts to reach agreements aimed at reducing GHG emissions, and policies formulated to mitigate and adapt, have clearly not led to real and effective enough solutions. Consequently, we live in fear of the end of the world, exacerbated by the growing evidence of natural catastrophes and a scarcity of

essential resources. Instead of collective action, based on common objectives, there has been inertia and passivity.

This disconnect between the response and dimensions of the crisis is rooted in an understanding of the very problem. Climate change confronts us with great complexity. It affects all countries of the world: it is multi-sectoral, involving political, economic and social sectors; and it is multi-actor, since it involves the largest possible network of actors—all the inhabitants of the planet. Additionally, the impacts of climate change are present at different spatial and temporal scales. Therefore, its analysis requires a wide range of perspectives.

FRAMING CLIMATE CHANGE

The foundation of this work is based on the ideas of conflict transformation proposed by Lederach (2003). Dealing with conflicts, and with potential conflicts, it includes a mapping of actors and their relationships to understand the broader pattern, and its gaps and transformative potential. Using a bottom-up approach, it focuses on the question, 'what we want to build', as a fundamental step to solve problems at the root and change behaviours. By treating climate change as an inherent conflict between knowledge and action, this framework provides a potential way forward. This examination proposes the framing of the current picture of climate change, subsequently modified based on Gandhi's thoughts. In both cases, actors, the manner in which they are related and their functions have been taken into consideration, with special emphasis on the relevance of scientists, and the creation of knowledge through science.

THE CURRENT PICTURE

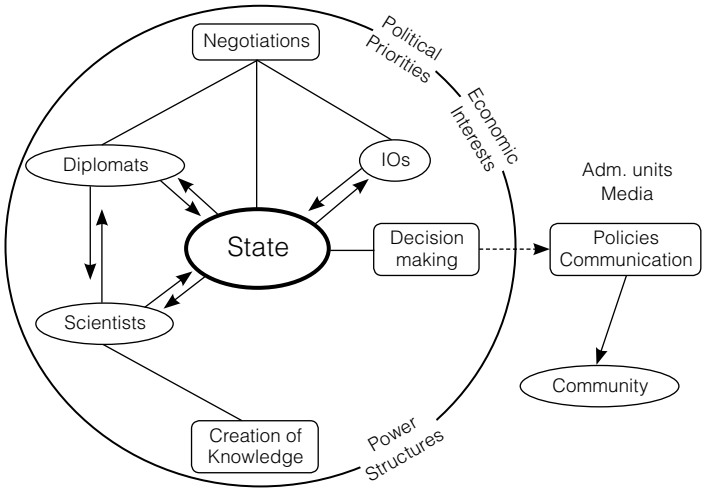
Figure 1 represents the principal actors currently responsible for framing climate change, their main functions and interactions. The state is located in the middle of the figure, since, at the national level, it is the only actor with the authority to make decisions on behalf of a country, and therefore has utmost importance. At the interstate level, besides the state, two prominent actors come to the fore: diplomats and international organisations (IOs). The diplomatic body represents the state, particularly in international negotiations, and contributes to the peaceful resolution of conflicts.

International organisations are established with the aim of pursuing the common interests of their members (Archer, 2001).

In the figure, the arrows represent interactions that take place between the mentioned actors. Arrows pointing in opposite directions depict a feedback between actors, i.e., their exchanges are synergic. However, when an arrow is uni-directional, it refers to unilateral action.

All the aforementioned actors, as well as their functions and interactions, are circumscribed in a circle that represents the closed environment in which these operations are performed. The system that develops inside 'the circle' is defined as 'closed' for two main reasons: the characteristics of the actors, and the structures that surround them. Indeed, actors share exclusive common characteristics: (i) all of them are skilled; (ii) they have received professional training, generally from institutions of the best standards, and reach high academic levels; (iii) as climate change is a global problem, the interactions are developed at the international level—therefore, a basic condition is advanced language skills (i.e., English); (iv) around each actor is a proper professional environment, through which is managed specific codes to interact with peers; and (v) they all belong to similar socio-economic conditions.

Figure 1: Representation of the main actors, their functions in the past, and current interactions related to climate change



Once the state follows the interactions as described, and carries out network-fed decision-making, it traverses 'the circle' in order to communicate its policies to the community. However, there is a disconnect between the delivered messages and the reality imposed by power structures (caste, race, gender, etc.), economic interests, political priorities, as well as the perspectives of economic and social development, which reinforce 'the circle'. Indeed, in order to apply policies, there must be institutions, investments, laws, means, appropriate governance, etc., to explain and implement them.

To give an example of a disconnect in policy: several investigations have shown that extensive, large-scale agriculture is not compatible with the measures needed to combat climate change. To reduce the environmental footprint and protect biodiversity, policy makers and IOs, such as the Food and Agriculture Organization (FAO), have been promoting agro-ecology. On the ground, however, the small, marginal farmer in India[3] trying to meet daily family needs, and with access to subsidies for fertilisers as well as free groundwater, has little incentive to adopt agro-ecology.

The creation of knowledge is located at the bottom of Figure 1, because it provides the basis for the arguments used in the chain of operations carried out within 'the circle'. Thus, it supports the state, the diplomatic body and IOs in negotiations and in decision making by furnishing expertise and information. This function is reserved exclusively for scientists. We may say then that science and scientists are the foundation of the system, thus playing a major role in framing the idea of climate change.

The influence of science in the formation of ideas related to climate change is based on the strong cultural belief that science is the bearer of truth. Moreover, the way in which science is developed (its objectives, principles and methods) acts upon our understanding of climate change. Indeed, the philosophical idea behind the definition of science today has been strongly influenced by Cartesianism since the 17th century, and in particular through *Discours de la Méthode* (Discourse on Method), published by René Descartes in 1637 (2011). This philosophical current sought truth by means of science-based deductive reasoning, thus marking a break with Scholasticism. Later, during Enlightenment, faith in science was reinforced. This philosophical standpoint determined

the epistemological perspective from which science has been developed. In that sense, one of its most characteristic aspects is the division of disciplines—the separation of exact sciences, human sciences and philosophy. This trend, which has increased over time, has led to a multiplication of specialisations, dividing the world and its complexity into increasingly smaller parcels.

It is not surprising, then, that ever since the first projections of global warming, science and scientists have been placed in the first line of discussion. Initially, scientific research focused on two main aspects: determining the magnitude of global warming through the quantification of the earth's temperature, and elucidating the origin of GHG emissions in order to assess whether or not main contributions have come from anthropogenic activities, especially those related to the burning of fossil fuel. These questions have raised major political debates, since they are closely related to economic interests (especially for great and middle powers), because countries have been expected to reduce their GHG emissions, targeted as the most important measure to decrease global earth temperature.

The main tool for that campaign has been international negotiations, leading to global agreements. The Earth Summit, held in Rio de Janeiro in 1992, was particularly important since the foundational United Nations Framework Convention on Climate Change (UNFCCC) was signed. From then on, the Conference of Parties (COP) has met annually: COP–1 (1995) took place in Berlin, and the most recent COP–25 (2019) was held in Madrid.

Scientific knowledge has been the crucial feature underlying agreements, by shaping negotiations. One example is epistemic communities, defined as networks of professionals with recognised expertise and competence in a particular domain, and an authoritative claim to policy-relevant knowledge; they have a shared set of normative beliefs and frame issues for collective debate, propose specific policies and identify salient dimensions (Haas, 1992). The epistemic community exerts an indirect influence to help bring about agreement (Sebenius, 1992). Unquestionably, scientific knowledge plays a vital and strategic role in those discussions.

The Intergovernmental Panel on Climate Change (IPCC)—implemented by the United Nations Environment Programme (UNEP), and the World Meteorological Organization (WMO) in 1988—provided the required knowledge on the state of the climate

for the negotiations. This epistemic community and its network of approximately a thousand scientists is governed by principles that are common to all its members (restricted to the country members of the UN and WMO): scientific integrity, objectivity, openness and transparency (Hulme and Mahoni, 2010). Besides the valuable knowledge about climate change that IPCC has produced, it plays a major political role. According to Adler and Haas (1992), the greater the extent to which epistemic communities are mobilised and are able to gain influence in their respective nation states, the greater is the likelihood that nation states will, in turn, exert power on behalf of the values and practices promoted by those communities, and will thus help in their international institutionalisation.

In summary, since the beginning, the issues related to climate change have been treated mainly at the international level and through interstate relations. Thus, negotiations became the most substantial interactions. In that manner, climate change has been conceptualised as an essentially political and economic problem, with the states being mainly responsible, leading to a perception of 'otherness' among communities. Moreover, the rationale is usually embodied in documents written in a technical language not comprehensible by all. Usually, explanations to the general public are widely provided by newspapers or social media with a clear tendency to sensationalism, narrowing the issue to descriptions of natural catastrophes.

THE PICTURE ACCORDING TO GANDHI

Such framings of climate change have hampered collective responses. Generally, communities have been relegated to being recipients of ideas and policies that are not necessarily in agreement with their capacities, needs and real priorities. In fact, the space provided to civil society during climate negotiations is very small.

Considering climate change's greater urgency today, all efforts should logically be brought together, regardless of their origin. Therefore, it is essential to make the processes of understanding, decision making and communication more grounded in community, moving away from the international to the local and individual level. Here, Gandhi's ideas provide an important approach to not only understand *why* integrating communities is crucial, but also *how* they can be included as active actors.

In *Hind Swaraj*, Gandhi (1938) provides his view of real progress where communities have the capacity to build an equal and sustainable economic system from below. Gandhi argued that there is a connection between means and end. For him truth, non-violence and passive resistance founded in love are the most effective ways to combat injustice, inequality and conflict resolution. Swaraj (according to Gandhi) means learning to rule ourselves, as a moral experience of each individual, a standpoint which includes Nature. In that sense, Gandhi's ideas suggest that local production, and moderate consumption according to the basic needs of each individual, would allow the maintenance of a balance with our environment. He proposed a minimal use of machines as harmful to humanity, since they lead to an overconsumption of natural resources. Gandhi's message is mainly addressed to individuals, by pointing to their abilities and responsibilities in local communities. The notion of right and duty is also a fundamental aspect that addresses climate change and raises the question of lifestyle changes.

Indeed, in the state-centric approach, which pins responsibility solely on states, individuals are relegated to the status of non-thinking entities incapable of making any change. Moreover, as the failures in outcomes of climate negotiations have shown, resting solely on the decision-making capacity of states is not an effective way to achieve solutions. Indeed, states have demonstrated a lack of capacity for cooperation since their national interest, defined in terms of power, has prevailed. In Gandhi's view, communities are the essential bedrock of the nation and the global—that which is true for families and communities is true for nations. In Gandhi's imagined communities, each individual follows his own occupation in small villages. The nation has a constitution, courts, lawyers and doctors—all as equal to any other worker.

However, despite the richness and relevance of Gandhi's messages, their application in our societies seems impossible. Not only do they imply a radical change in our lifestyles, they are also strongly based on religious belief and suggest a modification of the capitalistic political economy of the current international system as well. Notwithstanding these huge obstacles, they are relevant to climate change issues. In that sense, instead of thinking about complete application, one possibility is to start by taking small steps.

Gandhi's ideas of science provide an encouraging entry point to the question of how communities can be integrated as active actors in climate change. Indeed, Gandhi thought of science as moral (Prasad, 2001), and, in that sense, he believed it ought to be oriented for the welfare of the poor (Khoshoo and Moolakkattu, 2009).

In fact, Gandhi understood science as integral to the individual to such an extent that, according to Prasad (2001), he saw himself as a scientist constantly doing experiments (e.g., brahmacharya and food). Furthermore, Gandhi frequently resorted not only to science, but to theories of scientists as well, which he used to express or reinforce his own ideas. For example, during a speech in a meeting organised by the Muir Central College Economic Society in 1916, he referred to Alfred Russel Wallace, a scientist well known for his contribution to the development of the theory of evolution and belief in an intangible origin (Parel, 1997).

Gandhi suggested that science ought to be practised by everyone without any distinctions—of expert and layman, or of elite and subaltern—giving more importance to a research attitude, rather than scientific qualifications (Khoshoo and Moolakkattu, 2009). That is to say, with regard to the creation of scientific knowledge, every person or every worker is recognised as *part of the scientific process* without replacing the specific expertise of everyone, including that of scientists.

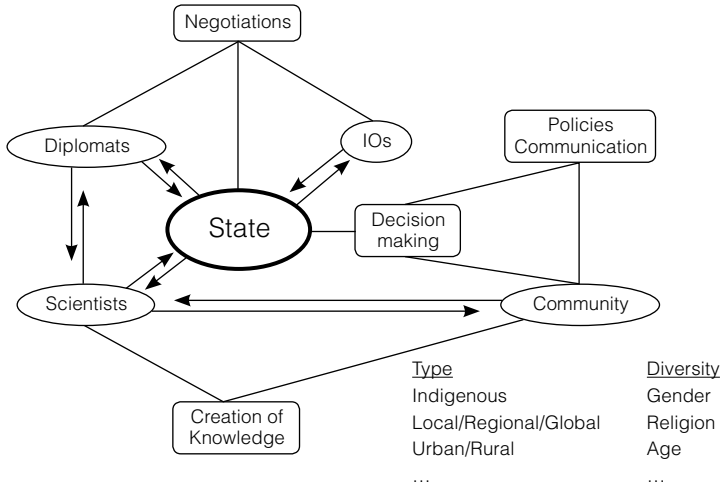
Similarly, regarding the popularisation of science (Prasad, 2001), Gandhi suggested that knowledge cannot be transferred from the expert to the lay person, but has to be a collaborative effort in which science can benefit from the process as well (Khoshoo and Moolakkattu, 2009), encouraging science to turn to the community.

As earlier mentioned, the creation of knowledge has provided the basis of all interactions related to climate change. Communities should participate not only as recipients, but also as constructors of the idea of climate change by bringing the testimonies of their realities (social, economic, political, cultural, etc.), and the knowledge they generate.

Integrating communities with the scientific process enables them to become active actors in decision making and can change their understanding of the problem. Thus, the perception of otherness could be replaced. By being part of the process, they would be transformed from objects of study to actors with their

own identity. From that standpoint, communities can comprehend that which is at stake, and the meaning of adaptation to climate change impacts. As community (along with scientists, diplomats, IOs and the state) would be part of the definition of policies, the implementation of those policies would be far more effective.

Figure 2: Representation of the main actors, their functions and interactions related to climate change from Gandhi's perspective



By changing the process thus, a new mapping of relationships could be imagined (Figure 2). In this new configuration, the circle in Figure 1 disappears, leaving the space open, recognising it as dynamic, flexible and changing. The diversity of communities themselves could be considered, and their own understanding of nature and the knowledge they create by means of their experience on the ground acknowledged. This new synergy could create a more conscious awareness through the development of a more holistic science and, by extension, a richer and more apt knowledge to face the challenges imposed by climate change.

CONCLUSION

The gap between the enormity of the crisis of climate change and its deep implications for the future, and the lack of proportionate response needs to be examined as a fundamental problem of the manner in which scientific knowledge is produced, the development

of its subsequent policy processes, and its communication. Gandhian ideas on including communities both for the production of science as well as its implication for ownership of the issue from a ground-up perspective, suggest new partnerships and an equitable and effective way forward. Climate change is also an opportunity to reconsider problematic top-down frameworks for more cooperative approaches.

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NOTES

1. See IPCC, 2014. *Climate Change 2014. Mitigation of Climate Change. Summary for Policymakers*. Geneva, Intergovernmental Panel on Climate Change.
2. *Ibid.*
3. See Government of India, 2019. 'Agriculture Census 2015–2016 (Phase-I).' New Delhi: Government of India. 86 per cent of all farmers in India have less than two hectares of land and account for 47 per cent of the crop area.

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FROM 'CLIMATE CHANGE' TO 'CLIMATE JUSTICE'

'Civil Society' Movement(s)

SOUMYA DUTTA

> Right now, we are facing a human-made disaster of global scale. Our greatest threat in thousands of years: 'Climate Change'. If we don't take action, the collapse of our civilisations and the extinction of much of the natural world is on the horizon.
>
> – Sir David Attenborough[1]

THE CLIMATE CRISIS

The 'Climate Change' scenario has fast developed into a 'Climate Crisis', globally being recognised as at least one of the defining challenges of the current century and beyond, if we fail to take drastic action right now. Once the contested ground between the well-funded 'climate denial lobby', and the scientific community and civil society, the outright denial of the reality of climate crisis has dwindled to far-right lunatics, including some politically powerful people. From celebrated naturalists like Richard Attenborough, to celebrities like Naomi Campbell, to child activists like Greta Thunberg, to the formal head of the world body—the UN Secretary General—the realisation of the gravity of the impending crisis is dawning on larger and larger numbers of people from various walks of life. Right from 8 October 2018, when the Intergovernmental Panel on Climate Change (IPCC) Special Report 1.5[2] was released—although the heightened awareness started earlier, from the IPCC Assessment Report 4 release, and publicity given to that—to the present day, almost every month has brought chilling new scenarios through the release

of some new global study: the World Health Organization (WHO) Report[3] on the humongous 'costs' of climate change-driven health impacts of December 2018; The Biodiversity Extinction Report by the Intergovernmental Science Policy Platform on Biodiversity and Ecosystem Services (IPBES);[4] IPCC Oceans and Cryosphere Report;[5] IPCC Climate Change and Land Report;[6] the Lancet Report of Health Impacts of Climate Change,[7] among others.

The world's leading climate scientists issued an ear-splitting wake-up call to the world: that climate change is running faster than we are—and we are running out of time. We see the consequences all around us—more extreme weather, rising sea levels, diminishing Arctic sea ice.

Scientists paint the most vivid picture we have ever had between a temperature rise of 1.5 degrees versus 2 degrees. A half degree in warming makes a world of difference. More heatwaves for tens of millions of people. Far greater species loss. Increased water scarcity in some of the world's most unstable regions. A ten-fold increase in Arctic ice-free summers. And a total wipeout of the world's coral reefs.…We must rise to the challenge of climate action and do what science demands before it is too late.[8]

AWARENESS AND PUBLIC PROTESTS

Globally, citizens, particularly the youth, have now become far more aware and alarmed about the fast-deteriorating climate crisis. Huge mobilisations have taken place, demanding far stronger action by all stakeholders, more than that envisaged in the Paris Agreement and the first set of Nationally Determined Contributions (NDCs).[9] In this transformation, the climate justice movements and the massive climate marches all across the globe (in which I have participated many times, in many places around the world, being a member of two such movements), have played a significant role, right from the early years of this century. But, undeniably, such scientific institutions as IPCC, NASA-Goddard Institute of Space Studies (GISS), World Meteorological Organisation (WMO), Potsdam Institute for Climate Impact Research (PIK), Met Office Hadley Centre, UK, and a few outspoken and courageous scientists (such as James Hansen) and journalists/communicators (such as George Monbiot, Bill McKibben) have also played a very significant role, in publicly presenting the unfolding of a possible catastrophe, and the

minimal actions that governments are taking to avert that. Today's Extinction Rebellion[10] and the School Strike Movement[11] owe their origin to these climate justice movements, all of which point to the fast-rising broad understanding and concern of today's youth about this massive threat to most life on Earth.

Yet, we see a widespread lack of interest on the part of citizens in India, in general, and Indian youth, in particular, about the seriousness of the challenges (the sporadic, scattered and often 'conducted participation' of youth and children in the recent climate protests notwithstanding). They seem to be oblivious to the widespread impact in many sectors of the economy and public life, the issues involved, the actions being proposed in the United Nations Framework Convention on Climate Change (UNFCCC), or outside, in the Indian domain, and even what their own futures would hold in a climate crisis-pervaded world, which is already upon us all. The irony is that India is one of the most vulnerable countries (by some counts, one of the 12 most vulnerable countries) to three of the five most severe climate impacts, according to the World Bank,[12] German Watch,[13] global vulnerability studies, etc., and South Asia is one of the two most vulnerable regions. Clearly, what happens in India in large scale is intimately connected to what South Asia sees.

We must face up to an inescapable reality: the challenges of sustainability simply overwhelm the adequacy of our responses. With some honourable exceptions, our responses are too few, too little and too late.[14]

THE BEGINNINGS

The climate justice movements have their origin in the early environmental protection movements that were the result of massive environmental pollution and consequent health and other threats, and a few writings on these. Some well-publicised environmental disasters and writings/reports that dominated public perception and moved people to act are the Minamata disaster in Japan (massive industrial dumping/leakage of mercury in Minamata Lake, causing hundreds of deaths), in February 1959; the publication of Rachel Carson's *Silent Spring*, in the United States, September 1962; the Club of Rome Report in 1972; the Chipko Andolan in present-day Uttarakhand, in 1973; the Silent Valley movement in Kerala, started

again in 1973. The following events/happenings also contributed to building this global public perception: the Stockholm Conference in Sweden in June 1972; the Bhopal gas disaster in Madhya Pradesh in December 1984; sinking of the Greenpeace ship *Rainbow Warrior* in 1985; the Narmada Bachao Andolan against the huge submergence by the Sardar Sarovar Dam in Madhya Pradesh and Maharashtra, starting in 1989; the Chernobyl nuclear disaster in the erstwhile Soviet Union (now in Ukraine) of April 1986; the European Green movements against nuclear power reactors, starting after the 1979 Three Mile Island accident in the United States.

Climate change is the single biggest thing that humans have ever done on this planet. The one thing that needs to be bigger is our movement to stop it.[15]

CLIMATE PROTECTION/JUSTICE MOVEMENTS: FROM LOCAL TO GLOBAL COMMONS

Significantly, all of the earlier-mentioned environmental disasters and the resultant protests/movements were around something 'local', confined to a small (in comparison to a state or country) geographical area. These were essentially against the pollution/destruction of local commons (although in the case of Chernobyl, the adverse impacts were felt across countries, but not realised for many years), about taking away the land and water of protesting local people, about their forest areas getting submerged or denuded, etc. In other words, this destruction/pollution was easily seen by the agitating people who could connect with what was happening and with those causing the destruction(s). Thus, these protests were either against the taking away/destruction of protesters' private resources, or an attack on their local commons. The cause of the disaster/destruction and the effects were seen at the 'locality', felt by the local people, and therefore resistance could be organised locally against local activities (such as stopping the construction of a dam, or cutting a forest), and local legal measures could be initiated.

The threat to climate systems, on the other hand, is inherently global in nature, with most 'perpetrators' often either not present anywhere near many of the worst-impacted areas, or not visible, or even outside national legal or other jurisdictions. Most of the contributing entities are richer countries—Annex-I countries, in UNFCCC terminology—which are responsible for well over

50 per cent of the cumulative greenhouse gas emissions (GHG) since the beginning of the Industrial Revolution, and disproportionately large on a per person basis, or societies or corporations. Globally, about 1,070 corporations are responsible for over 90 per cent of climate-destabilising GHG emissions, and it has been estimated that merely 100 companies are responsible for over 70 per cent of global GHG emissions—mainly the biggest fossil fuel companies. This has made it rather difficult for those suffering the many consequences of the climate crisis. The worst impacted are the poorer developing countries, which have not contributed much to the creation of this crisis, and the most vulnerable countries list includes several Least Developed Countries (LDCs) and Small Island Developing States (SIDS) whose entire landmass might disappear under the rising seas in the next few decades. The irony is that most of these societies have lived very sustainable low-consumption lifestyles, largely in harmony with nature.

THE MOVEMENT FOR JUSTICE

The movement for justice is based on the responsibility for causing 'Climate Change', and differentiated climate change impacts and coping capacities. This very skewed, upside-down reality of the impacts of climate change—where non-contributors often suffer more than the contributors to the problem—is very different from most other local environmental harm and movements to protect, though the justice angle has received prominence there too. Unlike in a wealthy city or region, where most people own and drive cars and breathe the resultant polluted air more than others far off (Delhi is an example, although many poor people too breathe the same toxic air here), climate disruptions act on a global scale, with non-polluters affected equally or even more. The vulnerability of communities/societies is even more skewed, as this depends on the coping capacity of the impacted people, which is dependent on the resources they can access, and the capacity and willingness of the 'state' to selectively intervene on behalf of the marginalised. Unfortunately, this desired selective intervention on behalf of the marginalised/impacted has not happened much, accentuating cries for justice.

The much older Environmental Protection movement posited broad ideals such as 'save the forest', 'protect the Wildlife', Earth Day

(starting 1970) and Earth Hour, Water Day, Rivers Day 'celebrations', among others, which do not hold any particular human agency more or less responsible. Neither does it identify who amongst the many segments of human society gets affected more and who ought to have more responsibility to correct wrong doings. The landmark event that helped start the early climate justice movement—not only in terms of United Nations conventions, but also for civil society from all across the globe—was the 1992 Earth Summit in Rio de Janeiro. In Rio, the many groups that came together with issues related to the multiple emerging impacts of climate change were the Indigenous Environment Networks. The early climate change movement also started similar concepts, with 'save the planet', 'stop deforestation', 'plant trees to save the Earth', etc., as part of the messaging.

In the early days of the climate movement, organised big international NGOs such as Greenpeace, World Wildlife Fund (WWF), Sierra Club, Friends of the Earth (FoE)—both the international and various chapters—Natural Resources Defence Council (NRDC), among others, were more vocal, demanding 'Global Climate Action'. The 'Big Greens', as they are often called, were/are mostly headquartered in the richer northern countries (Annex-I countries). Most of their funding also comes from these countries, and this might have partly determined the focus on the 'everyone must act' narrative. Many of these climate action groups/movements prescribed one-sided climate actions, starting from 'monitoring and preventing forest loss', 'preventing rapid rise in coal power capacity', 'methane emissions from paddy fields', 'Asian Brown Cloud' or the black aerosol emission from burning biomass in poorer Asian countries, 'more renewable energy everywhere', 'fast rise of non-vegetarian food in the Third World', which were focused on 'correcting the growing wrong trend' in poorer developing countries, while taking a much softer view of the already massive, much higher and continuing wrong of huge GHG pollution from rich OECD (Organisation for Economic Co-operation and Development) countries that continues to this day.

One key aspect that helped introduce the justice angle into the climate debate was the clear data concerning the historical contribution of countries in terms of their percentage of GHGs, the unequivocal scientific linking of atmospheric GHGs and the resultant temperature rise, and other adverse changes in global

climate systems. Many movements of marginalised people from poorer southern countries—in Latin America, especially, but also from Africa and Asia—started voicing opposition to the positioning of some of the Big Greens, such as that of the WWF, about blanket decisions for such 'environmental actions' as 'forest and wildlife protection', 'sustainable forest management', the creation of 'wildlife "conservation" areas in exclusion of living indigenous communities', etc., which imposed additional burdens on already impacted marginalised groups. These were seen as they are—'elite' environmental concerns and approaches. Some of these Big Green groups often worked in collaboration with (and funding from) northern business corporations (in fact, from the 'foundations' created by them), certified their 'sustainability practices', which very often had even more impact on indigenous people, rural folk and forest dwellers, exposing the Big Green–corporate nexus.

Forest people and river valley communities were often some of the communities which were doubly impacted by both the physical effects of climate change and the so-called climate solutions propagated by the corporate world, such as the big dam-based hydropower projects that claimed to be (wrongly) 'zero carbon', (cheap) carbon sequestration through the highly contested REDD (Reduction of Emissions through Deforestation and Forest Degradation) and REDD+ programmes, preferred by corporates and governments with help from some of the Big Greens. The North American 'forest certification standard', called Sustainable Forestry Initiative (SFI), the World Bank-supported Forest Carbon Partnership, etc., created a big rift amongst climate change movements, and formed a clear division between groups of more radical climate justice groups and others with government–business backing, asking for climate action by the market and businesses. These initiatives created a rift between the mostly northern countries-based Big Green groups, and mostly southern (but not exclusively) countries-based climate justice groups, which were clear that any 'climate change solution' would have to recognise the justice question, and let marginalised people have better access to natural resources on which they depend for life and livelihoods. The World Social Forum—itself a 'neutral platform'—provided another platform to which many other movement groups could bring actual impacts and injustices suffered by them.

The civil society/social movement groups from across the world, particularly indigenous people's groups, forest groups, peasant movements such as Via Campesina—most of these were from the southern, poorer countries with the exception of a few progressive environment groups—and left-oriented environmental groups, came together to resist these double attacks on their lives and livelihoods. Their demand was that the nation-centric CBDR-RC (Common but Differentiated Responsibility and Respective Capacities) be recognised also in terms of communities, intra country. There was (and still is) a third category of climate action civil society group, typically represented by the South Centre, Third World Network, Climate Action Network, which usually took a 'pro-southern government' stand (sometimes in conflict with the positions of marginalised people's movements). It supported the positions of many of the developing countries—that they need to have the freedom to burn much more dirty coal and oil, as their 'development deficit' cannot be met otherwise. These civil society groups, some generously supported by southern governments and corporations, often overlooked the adverse impacts these 'development deficit' projects and pathways had on the already impacted poorer people, in the 'larger interest of international equity', while largely neglecting intra-nation equity. Thus, they also spoke the language of Justice and Equity, just as the more radical, left-oriented groups did, but their narrative revolved around International Equity, not what happens within the southern nations themselves, and their marginalised communities.

In the last 12 to 15 years, another category of climate change concerning civil society groups has emerged on the global scene as well as in India, albeit on a small scale. These are the NGOs and networks that track technical issues, such as the financing of fossil fuel infrastructures and international big financial institutions (IFIs). These groups started with monitoring the climate-threatening financing activities of the World Bank, Asian Development Bank, African Development Bank, Inter-American Development Bank, etc., but later broadened their coverage to other MDBs (multilateral development banks) and other DFIs (development finance institutions), including bilateral financing institutions like KFW, various Exim Banks, etc. With the rise of bilateral funding, these institutions are also under watch by these civil society groups.

Prominent names are Bank Information Centre (BIC, headquartered in Washington, DC), Bank Track and Corporate Europe Observatory, among others. This has added much value to civil society engagement in the climate crisis, as it is these big financial institutions that drive the climate-destroying fossil-fuel push, even after the knowledge of the grave crisis is well accepted globally. Some of these civil society organisations (CSOs) also monitor the global/regional/national status of fossil fuel infrastructure, new coal mines, coal power plants, oil and gas developments, etc. Coal Swarm, End-Coal Network, Sunrise Project, Sierra Club, anti-Fracking networks like 'Frack Off' and Fermanagh Fracking Awareness Network (FFAN), are a few examples.

A clear line of differentiation between some of these groups and 'movements', all claiming 'climate justice' as their objective, can be done based on their acceptance or rejection of the present industrial–capitalist economic model as the primary driver of climate and several other ecological and social crises. The Climate Justice Now movement—which originated in European climate movements, but gave a large and decisive space to developing country groups, unlike some of the North American groups which are still largely dominated by their headquarters—claims to have originated, at least in large-scale public use, the now familiar slogan: 'Change the Economy, Keep the Climate'. In other words, for any real solution to the climate crisis, we have to discard the present industrial–capitalist global economic system, and usher in a more egalitarian, equitable, nature-respecting, justice-oriented economic and social order. In their understanding, capitalist systems, which created the crisis in the first place, cannot provide answers/solutions to that. Many climate change movements really do not subscribe to this, and look for 'climate solutions' within the 'business–industry–growth economy' domain. They are aligned with government- and industry-promoted concepts such as 'green growth', 'renewable energy powered growth', 'circular economy', 'blue economy', among others. Many of the more progressive climate justice movements are rejecting these positions, pointing out that the Earth's maximum productive capacity has already been exceeded by about 70 per cent, so there can no longer be any absolute economic growth. Any real developmental space needed by marginalised and deprived societies will have to be at the expense of drastic reduction of consumption

of both energy and material by the rich 'developed' societies. The 'de-growth' movement in Europe is premised on this, and is largely in sync with the more progressive climate justice movements. In the last couple of decades, women's groups, LGBTQ (lesbian, gay, bisexual, transgender, and questioning) groups, among others, have also entered the climate crisis sphere, as they understand its selective impact on already marginalised groups. Some European climate action groups are more inclined to this view, e.g., Advanced Tradewars, Tactical Assault and Conquer (ATTAC) groups in different EU countries, Leave it in the Ground (LINGO), Ende Gelande (EG), among others. Some of them have taken often non-violent but militant action, such as stopping coal-laden trains, occupying coal mines, barricading coal power plants, etc. Unfortunately, these committed actions have not garnered even a fraction of the global media and public attention as the much gentler Fridays for Future movement, among others.

The Climate Assemblies in several World Social Forums—a professed neutral platform of movement groups with the slogan, 'Another World is Possible'—helped shape the climate justice movement in the early 2000s. Many climate justice groups from across the world came together in 2009 at the Belem (north Brazil) World Social Forum and decided to give a clearer voice to affected communities from marginalised sections and bring in the indigenous world view of Mother Earth ('Pachamamma') to the climate justice debate. These groups included (not an exhaustive list) small and medium farmers' organisations such as La Via Campesina, Global Forest Coalition, Bolivian and other Latin American climate justice groups, Indigenous Environmental Network, global group 'Climate-Justice-Now', Asia Pacific Movement for Debt Relief, several Asian Climate Justice groups, Friends of the Earth, and many others. This was a landmark initiative, and culminated (or rather, started a new direction) in the World People's Conference on Climate Change and Rights of Mother Earth, in Cochabamba, Bolivia. This followed/coincided with the rise of the voice and power of indigenous people worldwide, but most prominently in Latin America, with the election of Evo Morales as President of Bolivia.

I was present in this very different World Conference on Climate Change (very different from the 11 UNFCCC Conference of Parties in which I actively participated and spoke). Owing

to the absence of top 'environmentalist celebrities', I was asked to represent Asian climate justice groups, along with the well-known African activist Nimmo Bassi (who represented Africa) and others. The preceding years had seen the evolution of the climate justice perspective involving the shift of focus from nation-state-based equity to issues of marginalised communities and primary recognition of the rights of Mother Earth/Nature on the ecosystem and so-called 'natural resources' (which are perspectives found in Indian Adivasi culture and practices as well). These perspectives were concretised as the demands of climate justice movements globally. These demands were opposed to business-as-usual solutions, based on more exploitation of nature, and gave primacy to Nature and dignified survival over the 'need for dirty-energy-powered development space', which is another name for carbon space or the permission to burn more coal and oil.

There was a time from the late 2000s to the early 2010s when several national governments actively sought and took inputs from their active climate justice movements while negotiating their positions at the UNFCCC Conference of Parties (COP). This was led by Latin American countries, particularly Bolivia, Ecuador, etc., but was supported by several inter-governmental organisations, including the Bolivarian Alliance of Peoples of our America (ALBA—Alianza Bolivariana para los Pueblos de nuestra America [its original name in Spanish]), Association of Small Island States (AOSIS—the earlier avatar of SIDS), the African Union (AU), etc. After the fiasco of Copenhagen COP–15, in 2009, where we, along with the whole world, expected to have some sort of progressive climate accord, and the subsequent change of the Global Climate Governance architecture in COP–16 in Cancun, Mexico, from science-based (whatever little) commitments, to the now prevalent Pledge and Review system (essentially, letting off the historically major polluters and rich countries from a much higher responsibility), global civil society climate groups and movements have also taken quite different positions. The Climate Justice Now coalition of more progressive climate justice movements went into an inactive state as a result of its 'no position imposed' stance, and the more progressive and action-demanding groups in it formed the Demand Climate Justice (DCJ) to push for a proactive agenda. Originating in North America and controlled by it, the Climate Action Network, which

at one time was closely toeing many government lines and was seen as part of the establishment, amended its position somewhat and is trying to take a more balanced but still state-centric position. The groups supporting developing country governments (not necessarily poor people's perspectives, though), such as the South Centre and the Third World Network, etc., still keep their positioning close to 'developing country' governments, but have more open views now with regard to some of the aspects, particularly as the severity of the climate crisis is dawning on everyone (well, almost everyone, as governments and businesses still think of this as a 'new business opportunity'). Meanwhile, the Latin American climate justice movements and platforms have been enfeebled after the Bolivian platform for climate justice fractured, and one of its spearheads, Pablo Solon, was expelled/exited, owing to strong opposition to the Bolivian government's position of disrespecting the indigenous voices while pushing big 'developmental' projects.

There is a new breed of organisations claiming to be civil society organisations that are gaining increasingly larger spaces in all climate and environmental negotiations, and these are promoted by front organisations of various corporate business groups. They are also known officially as BINGOs (Business and Industry Non-Government Organisations). Many or most of the more polluting corporations, coal, oil and gas companies, civil aviation industry organisations, carbon market promotion associations, forest-based industrial conglomerates, among others, have all floated their BINGOs, and the UNFCCC has accepted them as one of the 'constituencies' of non-government stakeholders. These BINGOs actively promote the primary interests of their parent business group associations, and are the main drivers of 'green-growth' pathways within both climate governance and governance structures of sustainable development goals (SDGs). Climate justice movements are vociferously demanding their exclusion from climate/environmental negotiations, as they are the principal contributors to the crisis—if nothing else, it is a clear case of 'conflict of interest'. Many of these, along with corporate-funded NGOs, have also promoted the now-proven ineffective carbon market mechanisms of ETS (Emission Trading Scheme), CDM (Clean Development Mechanism), etc., which are major conflict points in their recipient countries of the developing world. The BINGOs have a larger-than-life influence on both their national governments and the UNFCCC (and other UN bodies), much bigger than the other stakeholder groups such as ENGOs (environmental NGOs), farmers' groups, women's groups, etc., and this 'intrusion in the civil society space' is now strongly contested.

The Paris Agreement of 2015, overly hyped but not very effective in preventing global temperature rise below any of the two red marks of 1.5°C above pre-industrial, or even 2°C above, has changed some ground realities in the climate movements. As study after study has brought forth the realisation that global climate systems are moving towards catastrophic change—and doing that much faster than predicted, while country governments, the UN and the businesses that create emissions are all looking for highly inadequate incremental changes—ordinary people in several European (and other) countries, especially the youth, have started coming out on the streets in protest, and to demand much stronger climate actions. The youth protest, 'Extinction Rebellion', started in the United Kingdom recently, the fast spreading children's protest, Fridays for Future, is catching the imagination of not only children and youth, but also of adults restive with negligible action taken thus far. Their demands are not yet as sharp as the Occupy Movements were, but hopefully today's youth will mature rapidly and start making critical demands (they have already started asking tough questions of the 'authorities'). There lies some hope—quite a lot, actually.

A VERY BRIEF HISTORY OF INDIAN 'CLIMATE MOVEMENTS'

Unlike the northern countries, the general population's interest in the climate discussion or debate was, and still is, very low. Only recently has the startling climate crisis news, both from the field as well as from the IPCC reports, WHO reports, etc., started drawing attention. Somehow, our early history of strong environmental action, as demonstrated by the Bishnoi communities of Rajasthan, the 'Chipko' movement, the Silent Valley and Narmada movements, has not as yet risen to the same level to deal with this massive existential threat. From environmental concerns and resistance movements around water, dams and rivers, forests, coal power plant pollution, etc., which are plenty in India, large-scale climate connections are not very common. Even large-scale losses from climatic extreme events have not changed this sorry state too much.

Climate movements in India started in the early 2000s, with isolated groups in such cities as Hyderabad, Delhi and Kolkata getting together, sometimes under names like Hyderabad platform, Delhi platform, etc. Some international non-governmental organisations (INGOs) such as Focus on the Global South, Climate Action Network South Asia and Greenpeace started organising events and helped concretise these small protest marches, demands, etc. The Climate Action Network–South Asia (CAN–SA) and the All India People's Science Network (AIPSN) also engaged in several activities around climate change/crisis. It was in 2008–2009, when, after almost two years of efforts, over 60 groups from various parts of India gathered in Ranchi to launch what was called the India Climate Justice platform (ICJ). The encouraging point was that many genuine grassroots people's movements, networks, workers' unions, etc., came together on this platform. Simultaneously, groups traditionally engaged with particular sectors such as women, ethics, etc., also became active in climate concerns. The Indian Network of Ethics and Climate Change (INECC), All India Women's Conference (AIWC) and All India Revolutionary Students Organisation (AIRSO) began to take an active role in disseminating and acting upon climate issues. Civil society groups, which were earlier focused on 'developmental financing', also actively entered into climate concerns and monitoring. Groups such as Centre for Financial Accountability (CFA—its earlier avatar was BIC–South Asia), later creations such as Working Group on International Financial Institutions (WGOIFIs), Financial Accountability Network of India (FAN–India), are good examples, along with the Indian branches of international groups like Accountability Counsel.

Parallelly, several small efforts were continuing, mostly in cities, and also by sectoral groups, where CSOs engaging with resisting coal power projects, big dams, coal mines, mega-coastal projects, waste workers and forest diversions were trying to connect with larger climate issues. Chintan/Safai Sena, the National Forum of Forest People and Forest Workers (NFFPFW), the National Forum of Fishworkers (NFF), the National Platform of Small Scale Fishworkers (Inland) (NPSSFW[I]) are a few names that immediately come to mind.

The 2008 release of the National Action Plan for Climate Change (NAPCC) and subsequent State Action Plans for Climate

Change (SAPCCs), and the eight National Climate Missions, provided another broad area for civil society groups in India to engage with climate change governance in the country. Several groups in India started doing so more frequently, analysing, critiquing, suggesting better measures, etc., on these policies. Some examples of such groups are the South Asian Network for Dams, Rivers, People (SANDRP), Beyond Copenhagen Collective (BCPH—a collective of 42 organisations in India, of which the author is convenor of climate and energy group [this collective is now renamed MAUSAM]) and its Delhi coordinating group Public Advocacy Initiatives for Rights and Values in India (PAIRVI), the India Climate Justice platform (ICJ) and some of its constituents, Indian Network of Ethics and Climate Change (INECC), Climate Action Network–South Asia (CAN–SA), among others.

From India Climate Justice, a completely voluntary initiative with no formal funding sought or received, a quarterly journal on Climate Justice, *Mausam: Talking Climate in the Public Space*, was launched, and though the frequency was not always quarterly, several read-worthy issues came out and were hosted on multiple websites across the world. The BCPH network organised some climate justice tribunals and published the testimonials of impacted people. They also started engaging with the UNFCCC process, with regular 'side events' and other programmes, to bring the perspective from South Asia into this global arena. Several large consultations were also organised in India and Nepal. Another noteworthy intervention in the Indian climate change governance mechanism by BCPH was to organise multi-stakeholder consultations on seven to eight SAPCCs, from Manipur to Bihar to UP to Uttarakhand to Madhya Pradesh. In between, several well-funded knowledge-centric NGOs emerged, such as the Centre for Policy Research (CPR) and Observer Research Foundation (ORF), which started to analyse and engage in the national climate change governance sphere.

Despite these activities, the actual engagement of large sections of people, as in several European and Latin American countries, has not yet transpired. The last two to three years saw several isolated efforts at reaching out to youth and teachers, through the organisation of short duration 'climate *shalas*' (climate schools), but it is far from what is needed. The domain of climate crisis intervention in India is still the playground of formal NGOs

and government/semi-government agencies. In the last seven to eight years, the level of engagement by people's movements/social movements with this critical issue of our times has not increased. This needs to be addressed and corrected urgently. In an attempt to address this, a reasonably large effort was made by a collective of civil society groups, including trade unions, environmental groups and natural resource rights groups, and a South Asian People's Action of Climate Crisis (SAPACC) was organised in September 2019 at Hyderabad. This has given impetus to the climate justice movement in India, and we now see SAPACC inspired/organised at hundreds of places. On 1 January 2020, over 5,000 children, youth and adults gathered in Kochi, Kerala, demanding 'Keep the Climate, Change the Economy', and other such similar demands. Hopefully, these new beginnings will herald a much more energetic climate justice movement in India and South Asia.

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NOTES

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    Also see South Asian People's Action on Climate Crisis, SAPACC. https://www.sa-pacc.org.

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