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EDITORIAL

Living In, and Thinking About, the World in Pandemic Times

Kuntala Lahiri-Dutt [*]

Queen Elizabeth II famously labelled 1992 as an *annus horribilis*—"terrible year"—a year that saw a fire and a scandal that ravaged British society and the royal family. When 2020 kick-started the new decade, little did we know what lay in store. In Australia, where I live, the wildfires started earlier in the year, were more widespread, and were more devastating. As the country had been in an El Nino–induced draught phase, it had not rained for several months prior to the onset of summer. Dry undergrowth provided fuel and high wind speeds allowed the fires to spread quickly, jumping across clearings, rivers, and roads, claiming several properties and much indigenous, innocent wildlife. The fires were eventually quenched, but this time by a spate of hailstorm—hail the size of golf balls crushed everything left outdoors; buildings were damaged and some beyond repair. The ongoing and unending debates on climate change—whether global warming is causing the extended xeric conditions, uncontrollable fires, and unpredictable weather—had not quite settled down when the pandemic arrived.

Interestingly, like the Black Death, COVID-19 for all practical purposes arrived in Australia by boat—a cruise boat offloading not rats but over a hundred passengers exhibiting symptoms of the illness. The pandemic does not spare anyone; like the plague, it is a great leveller. In his 1947 book, *The Plague*, Albert Camus wrote how epidemics do not discriminate: "The plague was no respecter of persons and under its despotic rule everyone,

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from the Governor down to the humblest delinquent, was under the sentence and, perhaps for the first time, impartial justice reigned…" (p. 140). Unlike SARS, MERS, and Ebola, COVID-19 brought illness to everyone's doorstep. As one country after another fell prey, global resentment against China grew, and no one could pinpoint one particular factor that might have worked to keep the pandemic at bay. For example, if the wealthy northern Italian province of Lombardy had allowed its public-funded hospital system to retreat, which led to a higher incidence of COVID-19 deaths, Britain's well-built National Health Service, one of the largest and best state-funded healthcare provision system in the world, also failed miserably in dealing with the deadly virus. Still, broadly, the experience of the USA is indicating the need for more and better state-funded public healthcare in all countries.

This is one area where India—with its multibillion-dollar healthcare and pharmaceutical industries located in metropolitan cities that attract patients from all around the world and produce the largest range of drugs—has logged an abysmal record. According to the World Health Organization, India has one of the lowest doctor–population ratios, with only 7.7 doctors per 10,000 people. The ratio is much lower than what is prevalent in other developing countries and, in fact, is closer to that of some deeply poor countries in Africa such as Sudan. Moreover, the pathetic and run-down condition of state-run hospitals puts India to shame, and more than a third of Indians aged between 15 and 49 years remain undernourished. It is no wonder then that the pandemic exposed the systemic weaknesses and inconsistencies that perpetrate the vulnerabilities of the poor, those who must move around in search of cash incomes, work in insecure and risky jobs for a basic wage, and those without a home.

The "big question" that arose, one that will be intensely debated in the future as we recover and rebuild, is about the future of the citizen–state relationship. In the last four decades, we have allowed the unprecedented retreat of the state from healthcare and education in India. The extraordinary situation brought about by the pandemic has now forced us to encounter the multifaceted ramifications of this withdrawal. We must create a more sustainable—and desirable—world for our future generations, and COVID-19 has offered us this rare opportunity. Gaps between the rich and the poor, genders, ethnicities, religions, and castes must cease to exist. Respect for nature and our relationship with it must be prioritised. Our cities must be made more liveable. The state must ensure the well-being, good health, and mental upliftment of all through education. If this sounds utopian, let me point out that not all of this is a product of my imagination. Our Sustainable Development Goals, agreements to reduce

fossil fuel use, and many other global initiatives and processes have already agreed to the ideal of a more sustainable, equal, and just world where humans and nature no longer act as adversaries. We cannot allow "business" to run "as usual", for already the securitization of the pandemic emergency is underway in some countries. Let us now stop and reflect: do we want a big, top-heavy government to take advantage of the extreme disruptions caused by the pandemic and/or sell the inheritance of future generations—India's invaluable natural resources—to private interests so that they can accumulate surplus and generate windfall financial gains? Alternatively, could we take this opportunity to envision a novel way to be governed and use this historical moment to lead us to a collective transformative experience?

The commentaries in this EES issue further shed light on the relevance of community in a post–COVID-19 world. Research papers on arsenic pollution, the challenges of marine conservation, and flood mitigation in an environment of growing climate threats highlight, from their disciplinary perspectives, the need to find community-based solutions to our present-day pressing environmental challenges. The environment—and its conservation—holds different meanings for different communities, and our quest for a more inclusive and sustainable future should be based on a deep understanding of these differences. The special section on "new epistemologies of water" also emphasizes these understandings in the context of water resources.

The issue is being published only halfway into this horrendous year. We dread the future and worry about what other misfortunes remain hidden. Yet, we remain hopeful and ever so optimistic about humankind's ability to re-imagine and reinvent ourselves.

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COMMENTARY

THE POST-COVID INDIA: MAKING SCIENCE AND TECHNOLOGY SOCIALLY AND ENVIRONMENTALLY RELEVANT

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The authors represent a multi-disciplinary group brought together for a discussion on COVID-19 in May 2020 by the echo network, Center for Cellular and Molecular Platforms, (C-Camp), UAS-GKVK Campus, Bellary Road, Bangalore 560 065, India.

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1. INTRODUCTION

The ongoing global pandemic and its health and economic effects have aggravated multiple existing systemic vulnerabilities linked to human and environmental systems, both in India and around the globe. Science and technology offer evidence- and data-driven strategies to address these challenges, but they ought to be grounded in an overall value framework that applies evidence and data to strengthen human, social, and ecological resilience. Critical to identifying successful solutions is an interdisciplinary approach.

2. DIALOGUE ACROSS DISCIPLINES

In May 2020, steered by the echo network,[1] the authors of this commentary—a group of economists, public health professionals, lawyers, environmental scholars, policymakers, activists, journalists, and CEOs—assembled over three online discussions to identify the urgent problems created, revealed, or exacerbated by the current crisis; clarify priorities for rejuvenating India; and establish immediate starting points. Our goal was to stimulate further discussions on the role of science and technology as India readies itself to address and move beyond COVID-19.

The online dialogue started with a survey to identify pressing COVID-19 related concerns. At the first online meeting, participants identified a series of priority challenges that were later categorized into broader concepts. A second discussion streamlined these constructs into the "compass points" that we outline below. The final conversation led to the drawing up of recommendations to which science, including social science and local knowledge systems, and technology can contribute. These are meant to serve as triggers for deeper dialogue across sectors on knowledge gaps and methods for targeted interdisciplinary research. This process, through a progressive funnelling of ideas from challenges to concepts to recommendations, allowed diverse viewpoints to be recognized and synthesized (echo network 2020).

[1] Please see https://www.echonetwork.in/.

3. PREVENTIVE AND RESPONSIVE PUBLIC HEALTH SYSTEMS

While life expectancy has steadily increased in India, morbidity and mortality risks vary significantly across the country based on location and socio-economic status (Ravindran and Gaitonde 2018; ISDBIC 2017). Thus, the current pandemic calls for a careful diagnostic assessment of disease and accident risk across Indian states and the environmental, agricultural, and livelihood sources of risk. Further, the decentralized and intersectoral management of interactions among people, livestock, wildlife, forests, and water is essential to prevent and respond to infectious diseases. Science and technology have a role to play in facilitating OneHealth[2] approaches that recognize the interconnections among people, animals, and plants and their shared environment (Chatterjee *et al.* 2016; Vanak and Paul 2020).

In addition, we need a system-wide overhaul of primary healthcare, with investments in infrastructure and provisions, disease surveillance based on OneHealth principles, and local health governance supported by trained public health professionals rather than specialist doctors, who currently dominate public health and infectious disease management. For instance, providing essential public health workers, such as the million women ASHAs (accredited social health activists) at the forefront of the Government of India's COVID response, with training, equipment, and strategies to cope with any negative societal responses to their work, is critical. There are serious capacity gaps at the district level in primary and secondary healthcare and educational programmes on nutrition, safety, and hygiene. These gaps need to be filled with the support of nodal public health research and training centres. Earlier efforts, including the High-Level Expert Group on Universal Health Coverage, can offer guidance on such investments (Planning Commission of India, 2011, Takhur 2011, Patel *et al.* 2015). The National Mission on Biodiversity and Human Well Being, the United Nations Sustainable Development Goals (SDGs), and the Global Health Security Agenda provide specific targets and indicators.[3]

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[2] OneHealth is defined by the Centers for Disease Control (CDC) as "a collaborative, multisectoral, and transdisciplinary approach—working at the local, regional, national, and global levels—with the goal of achieving optimal health outcomes recognizing the interconnection between people, animals, plants, and their shared environment" (see the CDC website for more information: https://www.cdc.gov/onehealth/index.html.)

[3] Please see http://psa.gov.in/pmstiac-mssions/national-biodiversity-mission for National Biodiversity Mission, Office of the Principal Scientific Advisor to the Government of India. Please see https://www.un.org/sustainabledevelopment/sustainable-development-goals/ for the 17 interconnected SDGs. The Global Health Security Agenda (GHSA) is a group of

4. COMMUNITIES WITH DIGNITY AND EQUITY

The current crisis has aggravated as well as focused attention on the glaring inequities within India's population, with some staying at home without the ability to practise physical distancing and others returning home under extremely difficult circumstances. It has also brought into stark relief the invisible work undertaken by two demographic groups—migrants and women caregivers. The mass migration of Indians as a result of COVID-19, in particular, has put a spotlight on two critical issues: a) the need for mandatory registration of employees at the lowest administrative levels of businesses (to enable assessment and communication); and b) decentralized data-driven public service delivery (to meet basic needs). A series of recommendations are available in the 2017 Working Group on Migration (MHUPA 2017). Importantly, significant progress is possible by enforcing existing laws such as the Interstate Migrant Workmen's Act of 1979 (Chief Labour Commissioner 2020).

Supporting vulnerable mobile populations will require decentralized action by smart, inclusive, and sustainable communities. Thus, local governments (urban and rural) need to be empowered to deliver quality public services—and particularly health and safety information and services—while simultaneously enabling residents to access information and data at their source. Medium-term strategies may include establishing central- and state-level commissions (with public representation) to examine current inequities in service access and district-level citizen-focused public emergency funds. Some immediate actions, supported by evidence-based research on impacts on nature and the livelihoods of both men and women, can help with long-term sustainable development. Public works programmes such as the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) [4] and Pradhan Manthri Krishi Sinchayee Yojana can be used to restore ecosystems, build agricultural infrastructure, and conserve water resources, especially in rural districts with high tribal, returning migrant, or daily wage worker populations.

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67 countries, international organizations, non-government organizations, and private-sector companies that have come together to address threats posed by infectious diseases. https://ghsagenda.org/.

[4] Please see Narayan (2020) on MGNREGA's potential to address economic crisis-related challenges.

5. SUSTAINABLE LIVELIHOODS

With the economy in crisis, the pandemic has brought attention to India's persistently large informal sector (Ghani *et al.* 2013), which provides over 90% of jobs (Mehrotra and Parida 2019), and the dominant role of micro, small, and medium enterprises (MSMEs). Urgent action to support MSMEs would include payment of public-sector outstanding dues and a time-bound government credit guarantee on incremental loans to induce lending to MSMEs. Further, a recovery package that includes low-interest credit to promote climate- and biodiversity-friendly business practices and investments in clean R&D, waste management, energy generation, grid development, and regenerative agriculture would nudge India onto a climate-smart and nature-positive pathway.

Successful examples of distributed market linkages point to how we may be able to move the economy forward with a united focus on jobs, growth, and sustainability. New scientific and technological innovations in distributed and decentralized energy, water, and sanitation infrastructure, sustainable cooling, regenerative agriculture, and rural value chains can support both rural and urban economies (Ghosh *et al.* 2020). Human, livestock, and agri-residue waste offer additional potential resources for conversion to energy or farm nutrients. These new sources of growth would require research, capital, and public education to bolster rural entrepreneurship. Collaborations between industry, education, and the government can provide pedagogical and technical training for the production, use, and repair of new technologies and services. With the active participation of Indian youth, both men and women, this interdisciplinary space where science, technology, social science, and policy intersect can generate innovation. Women's labour force participation in India was already on the decline (32% in 2005 to 21% in 2018 [ILO 2020]) and any job rebound from COVID-19 is likely to be far easier for men than women. Hence, technical training would need to pay attention to drawing Indian women into the labour force.

6. SECURE HUMAN AND ENVIRONMENTAL ECOSYSTEMS

Modern scientific knowledge, traditional ecological knowledge, and SDG targets can be combined into a roadmap that prevents environmental degradation and strengthens ecosystem protection and restoration. This roadmap would need to be guided by careful research and analyses of biodiversity and ecosystem service losses and predictions regarding disease emergence, climate change impacts, and economic and health implications. Rigorous environmental, social, and economic assessments, combined with

stakeholder participation, and lifecycle analyses of infrastructure and industry planning can help incorporate the benefits of ecological goods and services into decision-making. To be effective, research would need to be coupled with local monitoring. The National Mission on Biodiversity and Human Well Being can assist in this process (Krishnan 2020).

Closely entwined with the loss in biodiversity and ecosystem services is agriculture, which is fundamental to India's food security and for securing livelihoods. Making agriculture both more competitive and increasingly nature-positive and climate-responsive is a critical challenge. Research to foster integrated watershed development and regenerative agricultural practices would need to go hand-in-hand with investments in upgrading rural skills, technology adoption across value chains, and efficient post-harvest activities.

7. CONCLUSIONS

The pandemic has brought to the forefront systemic issues that require an interdisciplinary focus to generate effective solutions. Innovations in science and technology have the potential to drive positive social, economic, and environmental change, but they need to be explicitly leveraged for this purpose. Interdisciplinary research can facilitate reforms that are more sustainable and equitable. We hope that our efforts will stimulate new science and additional conversations across sectors and geographic boundaries to identify ways to better embed scientific discourse into society.

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COMMENTARY

COVID-19: Urban Density's Poetic Justice

Nitin Pandit [*]

1. INTRODUCTION

Following centuries of pandemics and unplanned urbanization, Charles Dickens laid bare the physical filth and amoral inequities that beset English society in *Bleak House* in the nineteenth century. Thereafter, slow but steady improvements in science and sanitation have led to longer lives and greater prosperity in the western world, despite intermittent setbacks including wars, recessions, genocides, and pandemics. The concomitant growth in population and industry has resulted in individuals hoping that some day they too could add to the increasing globalization of filth and inequities by becoming part of the one percent. As for the accumulating warnings from Rachel Carson, the Club of Rome, climate change activists, collapsing ecosystems, and vanishing bees, we have sort of muddled through, till now.

Along came a bat, perhaps also a pangolin, and it rattled the entire apple cart where greed had become, in fact, *laissez-faire*. The vulnerabilities of human artifacts like governments, markets, and institutions were made visible by small edible lifeforms at a global scale. Oh, the inconvenience of it all, bringing back nightmares of other indiscriminate marauders like the Spanish Flu! Just when we had been lulled into slumber, having controlled SARS/MERS and restricted Ebola! We find it convenient to shift the blame to some meat markets (Paul and Vanak 2020) and go back to sleep over a Bob Dylan rant:[1]

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[1] Bob Dylan, "When You Gonna Wake Up?", in *Slow Train Coming*, 1979.

God don't make no promises that He don't keep
You got some big dreams, baby,
But in order to dream you gotta still be asleep

2. DENSITY v. SPRAWL

Since the energy crisis of the 1970s, urban planners have criticized American suburbia, or sprawl, as the quintessential indicator of profligate and individualistic consumption driven by inefficient use of energy. "Network effects" became the new buzzword, defined by high-density living and intense interactions among people. While increased energy efficiency provided tremendous benefits, total energy use skyrocketed through the convenience of consuming products and services that density provided. The tremendous economic growth that followed was fuelled by the convenience of urbanized consumption.

By March 2020, there was reason to worry because COVID-19 was clearly multiplying in the urban centres central to our economic growth and we were hosting it. As people are both vectors and victims, social distancing became the necessary band aid, but it went against the very grain of density—the primary measure and holy grail of design for urban planners. Coronavirus changed it all and started haunting urban planners when urban centres started seeing its rapid spread. "It's about density," said New York's Governor Andrew Cuomo (Shoichet and Jones 2020), having seen first-hand how increased interactions in dense areas were convenient for people and also facilitated the rapid spread of COVID-19.

Stalwarts like Paul Krugman came to the defence, extolling the other virtues of urban density in New York (Krugman 2020), while influencers like Joel Kotkin highlighted how the urban sprawl in Los Angeles (Kotkin 2020) helped flatten the curve. One knows that all interventions against the virus are experimental and, therefore, suspect, even as inequities and the plight of the urban poor are exposed threadbare. So, premier thought leaders in city planning are moving quickly to retain their place in the sun by calling for polycentric or decentralized cities, offering patterns of smart density for the new normal (Zeljic 2020). The love affair with urban density is intense and not to be abandoned easily.

3. SLUMDOG MILLIONAIRES

In populous, rural, developing countries like India, city planners have quickly bought into the idea of dense cities as a solution to weakening rural livelihoods in line with western ideals of planning. Glorified rags-to-riches stories have masked over the abhorrent living conditions of the urban poor, and dense urbanization in slums fragmented by concrete towers have become the reality. The urban setting—devoid of the buffered protection that biodiversity offers—created the ideal conditions for the disaster that followed.

It took a virus to show that western urban planning solutions do not translate well to the Indian context (Lakshmi 2020), where millions of migrant workers in the slums of Mumbai and other megacities have been rendered vulnerable to the novel coronavirus and in the government lockdowns that followed. Urban planners in India continue to adopt western ideas centred on dense urban cores to facilitate transport and provision of other public services, accompanied tree planting (CNBC Sustainable Energy 2020). The overdue emphasis on constructing more parks in cities and building eco-friendly buildings (Mathews and Gupta 2020) may make the recommendations sound like old wine in a new bottle to the poor who are confronted with a life-and-death situation.

The city of Mumbai—fuelled over many decades by commerce and Bollywood—has become a dense centre that demands resources far beyond the capacity of natural systems. While defenders of the status quo are asking for more investments for the provision of basic urban systems that never got implemented (Pai 2020), one wonders why these rich and dense cities, engines of growth, have not made these provisions for so long. In fact, when provisions were made—as in the case of Mumbai—urban planners designed a substantial public transport system to move its poor efficiently to their jobs but neglected to provide basic amenities where they lived.

The theory goes that densely populated areas exhibit the network effect through increased interactions. However, they are also underserved areas as well as red zones for disease transmission in Mumbai for precisely the same reason. Network effects can have a positive impact on some parameters, but they are also a "thick interface" for negative vulnerabilities like COVID-19. This fact challenges the traditional urban planning mindset, where density-driven design is justified with rushed analysis (Fang and Wahba 2020) to ensure a continuous stream of investments. Political power also grows more concentrated with greater density, and, naturally, the powerful demand more resources for their constituencies. A classic vicious cycle sets in, driven by the suppliers of goods and services who strive to

feed the beast, which grows bigger in turn with what economists call a rebound effect.

Meanwhile, with the risks being borne largely by those in slums and the shanty towns of Mumbai, there is no reason why the vulnerable poor shouldn't be sceptical of who will benefit from the glistening portrayals of unlimited or smart urban density. Surely the affected urban poor can see through the edifice, which will last at most till the magic vaccine becomes available! They may also know that a reinvigorated return to the "old normal" will not change the behaviour of critical urban stakeholders such as the builder-developers, who are able to glide past most developmental and environmental norms through political patronage. With the risks of such virulent shocks transferred to the poor, one can hear the re-established old guard get comfortably numb again as they chant Jethro Tull's ballad:[2]

> Let's bungle in the jungle
> Well, that's all right by me
> I'm a tiger when I want love
> But I'm a snake if we disagree

4. EPILOGUE

It is obvious there needs to be a better balance than what can be achieved by density-driven design alone (Gohil 2020). We will continue to debate solutions that are systemic, from *A Prosperous Way Down* (Odum and Odum 2008) to incremental ones through a series of lifestyle changes (Bhar 2020), but we cannot hide now that the vulnerability of our fundamental conception of a rapidly dense and urbanized planet is quite clear.

Meanwhile, some migrants, disenchanted by an urban system that has let them down, will remain in their villages to regain their dignity. Perhaps, as Italo Calvino notes, we will remain a part of the urban inferno (Calvino 1978) or become vigilant citizens. Or maybe some of us urbanites will enjoy the return of nature into our concrete jungles and reminisce a bit about "Daffodils", a childhood favourite by William Wordsworth. But that's a scenario that doesn't fit into business-as-usual.

[2] Jethro Tull, "Bungle in the Jungle", in *Bungle in the Jungle*, 1974.

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COMMENTARY

India's Energy Strategy for Inclusive Sustainable Development

Kirit S. Parikh *

1. INTRODUCTION

While energy is critical for economic growth, it is also a crucial factor in improving the quality of human development. Energy does not comprise only electricity; it also includes fuels used for cooking and mobility. Energy use has led to much environmental and ecological degradation: air pollution from the use of fossil fuels, land degradation due to coal mining, and deforestation resulting from hydro development. Moreover, burning fossil fuels contributes to climate change. India aspires to be a global economic power that balances inclusive growth for human development and the challenges of pollution and climate change.

In view of the COVID-19 pandemic, the need for inclusive growth has become even stronger. India's energy strategy has to help fulfil these aspirations.

1.1. The current energy scene

In 2018, the Indian economy consumed a total of 809 million tonnes of oil equivalent (Mtoe) and 1,547 billion-kilowatt hour (BkWh) of electricity. That same year, in per capita terms, China's consumption of electricity was nearly five times that of India.

India imports all major fossil fuels. In 2019–20, 87% of crude oil (227 million tonnes [MT]) used in the country was imported. However, the net export of petroleum products was 22 MT (PPAC n.d.[a]). Thus, nearly 80%

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of the country's consumption of petroleum products comes from imported crude oil. In the case of natural gas, India imported nearly 50% of its domestic requirement. While India's domestic oil and gas resources are limited, it has an abundance of coal. Still, nearly 24% of the country's total coal consumption was imported.

The 2006 report of the expert group set up by the Planning Commission on Integrated Energy Policy (IEP) notes that extractable coal reserves in India will be exhausted in 35–40 years if coal consumption keeps growing, and, in the long term, India will have to shift to renewable resources such as wind and solar energy (Parikh *et al.* 2006). As a consequence, and as a part of the National Action Plan for Climate Change (NAPCC) to promote solar power, the Jawaharlal Nehru National Solar Mission was launched in January 2010 with the aim of generating 20,000 megawatt (MW) of solar capacity by 2022. The government recognized that subsidies for solar power generation in the form of assured feed-in tariffs (FIT) would have to be provided during the initial stages. However, to incentivize efficiency and cost reduction, competitive reverse bidding for the required FIT was initiated. As a result, the required FIT came down from ₹13.5/kWh in 2010 to around ₹2.5/kWh in 2017, and it has further come down to ₹2.36/kWh in June 2020.

1.2. Energy use and local environmental pollution

Our current energy use patterns cause a great deal of local environmental pollution. Coal mines degrade the land and cause deforestation. Fossil fuel use causes severe air pollution in our cities. All mines are required to restore the land that they have adversely affected. All firms that cause deforestation are also required to carry out compensatory afforestation and contribute to the Compensatory Afforestation Management and Planning Agency (CAMPA) Fund. Unfortunately, however, the funds remain largely unutilized. Unless the government is serious about it, afforestation is not implemented effectively. Therefore, a better strategy would be to prevent deforestation.

2. ENERGY POLICIES FOR LOW-CARBON INCLUSIVE SUSTAINABLE DEVELOPMENT

In recent years, concerns regarding the growing dependence on imports, climate change, and severe air pollution in cities across India, as well as the falling costs of solar photovoltaics (PV), have led to changes in energy policies in India.

2.1. Reducing greenhouse gas emissions

Even before the Paris COP[1] in 2015, India had declared its intentions to reduce its emissions intensity by 30–35% by 2030 (compared to 2005), and to increase the share of non-fossil power generation in the total installed capacity to 40% by 2030. The Planning Commission set up an expert group, which I chaired, to examine the low-carbon strategy for inclusive growth (LCSIG). The LCSIG reports (Parikh, Chawla, and Pande 2011; Parikh *et al.* 2014) suggest various measures to reach these goals: promoting energy efficiency in households, industry, transport, and buildings; emphasizing solar and wind; and substituting imported fuels with locally sourced ones. Subsequently, the government has stepped up its goal to installing 175 GW (gigawatt) of renewable energy capacity consisting of small hydro projects, biomass gasifiers, biomass power, urban and industrial waste power, and solar and wind energy by 2022.

At the end of March 2020, the share of renewable energy capacity was around 23.5% of the total generating capacity of 370 GW (Ministry of Power 2020). The share of renewable resources in the energy mix in 2018–19 was less than 8.5%, as renewable resources such as solar and wind do not generate electricity round the clock. Nevertheless, the growth of renewable capacity indicates that India will reach its target of 175 GW perhaps a year or two after 2022. India is also pushing for importing nuclear power. Unfortunately, the construction of nuclear plants takes a long time and is, therefore, expensive. Private foreign investments in nuclear plants also face issues of liability.

2.2. Measures for inclusive growth

The goal of inclusive growth is considered non-negotiable by India's policy-makers and many in the civil society, and thus it demands the highest priority. For this, a projected 1 kWh of electricity per day per household, six liquified petroleum gas (LPG) cylinders per year per household, 100% access to electricity and clean water, *pucca* (durable) houses, education, and health services for all are to be made available by 2030. This has been the goal of both the present and previous governments. Using their top-down–bottom-up model, which maximizes private consumption and provides all these benefits by increasing government expenditure and supplementing income transfer, Parikh *et al.* (2013) have shown that inclusive growth does not have to sacrifice economic growth.

[1] Conference of Parties signatory to the UN Framework Convention on Climate Change proposed at the Earth Summit in Rio de Janeiro in 1992.

The Government of India launched the Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY) in April 2005 to provide electricity to rural households. The goal was to electrify 1.10 lakh unelectrified or de-electrified villages and provide free electricity connections to 2.3 crore below poverty line (BPL) households. By April 2012, 1.05 lakh villages had been electrified and free connections had been given to 1.95 crore BPL households. The Modi government stepped up the programme under the name of Deendayal Upadhyaya Gram Jyoti Yojana to connect all households and provide stable electricity supply to all by 2019. While nearly 100% of households are now connected, the quality of supply needs to be improved.

Along with access to electricity, clean cooking fuels are equally important for well-being. The use of dung, firewood, and agricultural waste as cooking fuel causes severe indoor air pollution, which cause millions of premature deaths annually in India. Smith (2000) estimated that approximately 0.4–0.55 million deaths resulted due to this cause in the late 1990s. The IEP emphasized the importance of clean cooking fuel in its 2006 report. In 2001, only 11% of households used LPG (6% rural; 17% urban); this increased to 29% in 2011 (12% rural; 66% urban). The IEP recommended the provision of six LPG cylinders per household per year and a subsidy through smart cards as direct benefit transfer (DBT)—this is now the accepted mode as the Modi government has increased the ease of DBT through the expansion of JAM (Jan Dhan, Aadhar, Mobile) (Government of India 2016). LPG customers increased from 137 million in 2011–12 to 257 million in 2017–18 (PPAC 2018). This rise has increased the import of LPG from 5.8 MT in 2011–12 to 13.2 MT in 2018–19.

2.3. Measures for increasing energy efficiency and security

Increasing energy efficiency means using less energy to produce the same output. Energy intensity in the Indian economy has experienced an annual improvement of almost 3.25% over 2011–12 to 2018–19 (MOSPI 2020 Table 6.3) with a GDP growth of 5.27%, giving energy efficiency of about 2% per year.

In the household sector, the substitution of 40 W incandescent light bulbs for light emitting diode (LED) bulbs that provide the same amount of light with electricity consumption of only 7 W can save energy. As of 31 March 2020, the Ministry of Power's National Ujala Dashboard reported that more than 36.2 crore LED bulbs had been distributed to households in the country, with estimated savings of 47 billion kWh per year and emissions of 38 $MtCO_2$ per year (Ministry of Power n.d.). The appliance labelling programme, under which appliances are rated with one (least efficient) to

five stars (most efficient) depending on their energy efficiency, has the potential to reduce energy consumption by 13–40% by 2030 (Parikh and Parikh 2016).

To promote energy efficiency, the Bureau of Energy Efficiency (BEE) was set up within the Ministry of Power in 2002 under the Energy Conservation Act of 2001. The Perform, Achieve, and Trade (PAT) Scheme sets targets for energy reduction in specific industrial units of energy-intensive industries. The Energy Conservation Building Code (ECBC), launched by the Ministry of Power in May 2007 to make commercial buildings energy efficient, has been made compulsory for the building sector in many states. Parikh *et al.* (2014) have projected a reduction of 131 MT of CO_2 emissions in 2030, which comprises 10% of emissions from commercial buildings. These savings are in addition to savings from energy-efficient equipment.

Energy use in the transport sector can also be reduced if a large share of freight traffic is shifted to the railway sector. To move one tonne over one kilometre, a truck consumes five to seven times the diesel a train would.

Moreover, railways have been losing their freight share, as trucks provide secure, on-time, and door-to-door service. To encourage freight movement by train, two dedicated freight train corridors are under construction: one between Mumbai and Delhi, and the other between Punjab and West Bengal. Four others are still in the planning stage. Train corridors such as these can replace freight movement by road while significantly reducing energy consumption.

Even for coal-based power, the Government of India has mandated that all new power plants should be supercritical, which means that they should generate steam at a higher temperature and pressure and use 10–15% less coal per kWh compared to subcritical plants.

2.4. Measures to increase energy security

Efforts to increase the domestic production of oil and gas have not been very successful; our domestic production of crude oil has ranged between 32–35.9 MT over the last 20 years (PPAC n.d.[b]). Thus, the best option at hand is to substitute petroleum products with domestic energy sources such as biofuels and/or electricity. The main thrust of government policies is the electrification of railways and the promotion of electric vehicles. Due to the cost of batteries, electric vehicles are more expensive today than conventional internal combustion vehicles. Based on what they consider realistic rates of the penetration of electric vehicles, Parikh *et al.* (2016) estimate that the consumption of petroleum products for road transport in 2030 will decrease only marginally. Increasing fuel efficiency norms for

vehicles would yield a much larger reduction. Of course, the greater use of public transport and non-motorized transport such as cycling and walking could have an even larger impact.

3. THE WAY AHEAD

Most projections show that the substantial use of coal will continue. We can curb the growth of coal consumption with a significant reduction in the cost of solar power and batteries for storing electricity. Thus, we should have a technological mission: to bring down the costs of solar PV and batteries by 50%. This will render coal power economically obsolete and keep our CO_2 emissions within the 1.5ºC global warming target (Parikh, Parikh, and Ghosh 2018) without any loss of economic growth.

If coal has to be used, then to curtail air pollution, we should insist on the installation of modern electrostatic precipitators to trap 2.5 micron particulates in all new plants as well as the retrofitting of old plants. Coal plants should have flue-gas desulphurization (FGD) and selective catalytic reduction that can substantially eliminate SO_x and NO_x pollution. They do, however, cost more, but the additional cost would be most likely less than the cost of the health impact of air pollution.

The COVID lockdowns have shown that air quality can improve. The use of electric vehicles, public transport, cycling and walking, clean Bharat Standard-6 fuel as well as increased vehicle fuel efficiency and can cut down air pollution in cities. We can indeed have an energy future that is clean and sustainable.

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COMMENTARY

A Call to Redefine 'the Field' in Nature Conservation Studies in India

Madhuri Ramesh *

1. INTRODUCTION

Nature conservation has undergone significant shifts since the early 2000s. To begin with, the International Union for Conservation of Nature (IUCN), the arm of the United Nations that steers the global conservation agenda, has become an increasingly neoliberal institution—it has marginalized concerns regarding the impacts of capitalism and, instead, has promoted market-based tools for conservation and sought partnerships with a range of industries including mining corporations (MacDonald 2010). A second change is that in some parts of the world, there is militarized management of protected areas (PAs). The default assumption of the states/organizations involved is that poachers are linked to terrorist or drug-trafficking networks and thereby pose a major security threat (Duffy 2014). Similarly, some states favour the establishment of vast PAs as an assertion of geopolitical power. This is commonly seen in the case of marine protected areas (MPAs), which have a history of territorial dispute. Such MPAs may continue to be accessed or managed by military establishments (De Santo 2020). Finally, and in contrast to these top–down trends, there has been a surge in calls over the past few years to decolonize conservation by directly challenging the Global North's fundamentally unjust and racist approach (Mbaria and Ogada 2016; Aini and West 2018). These threads extend to India, too, as recent studies indicate that nature conservation here is closely linked to issues of neoliberalism (Ramesh and Rai 2017), national security (Muralidharan and Rai 2020), and social

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discrimination (Kabra 2019). Now more than ever, nature conservation is not just about saving biodiversity—it is a domain marked by economic, political, and social contestation.

These realities raise an important question with respect to conservation research: what exactly do we mean by 'the field' today? Where do its boundaries lie? Although we tend to treat this concept as self-evident, I propose here that we first need to acknowledge that the field is a constructed notion; second, recognizing the politics integral to its construction can help us redefine its boundaries in more progressive ways. I draw parallels between conservation science and anthropology because the latter began with a similarly narrow view of the field but has radically evolved over a few decades.

2. EARLY CONNECTIONS

Anthropology has much in common with nature conservation with respect to the idea that doing research in 'the field' is an integral part of the disciplinary identity. This is because around the late 1800s, anthropologists borrowed heavily from natural scientists who practised their craft outdoors—the latter chose a limited and distant area (the field) within which they carried out intensive, systematic, and direct observations (fieldwork). Therefore, similar to primatologists of that period who studied animal communities in their 'pristine' state, anthropologists took a naturalistic, albeit racist, approach to studying so-called primitive human communities in their 'native' states. The anthropology of this period was simply an extension of natural history. However, by the late 1900s, anthropology underwent a metamorphosis. For example, it dispensed with the reductionist nature–culture dichotomy; became sensitive to how power relations between researchers and the researched influenced the production of knowledge; and revised the traditional idea of 'the field' (as a culturally exotic and geographically distant place) to bring more European places, institutions, and communities under its analytical gaze. It even examined how institutional structures and funding trends a priori disqualified the work of most researchers from being recognized as 'rigorous' because to meet this yardstick, one had to have the social capital of an athletic, white, middle-class male, or equivalent (Gupta and Ferguson 1997).

3. THE INDIAN SITUATION

Most conservation researchers in India appear to follow the orthodox standards of the nineteenth century. As one scientist said, for many of us, "nature is simply where culture is not".[1] Therefore, we still maintain what Gupta and Ferguson (1997) describe as "a hierarchy of purity" with respect to field sites: research carried out in human-inhabited areas of any kind—industrial or non-industrial—is not valued as much as research conducted in 'wild' sites. For many of us conservation scientists, 'real fieldwork' still involves spending long periods of time in a site that is as notable for the presence of flora or fauna as for the absence of any (obvious) human activity. If we cannot readily find such sites in today's world, we engage in discursive erasure: we describe them in our studies as though they were uninhabited or disconnected from modernity. But how relevant and ethical is such an understanding and treatment of the field, given the current changes occurring in the domain of conservation?

I argue here that this traditional concept of the field is not an innocent one; it comes laden with colonial baggage and contributes to the social injustices perpetrated by hard-line conservation models. This is because such a narrow delimitation of the field as pristine nature confines the researcher's gaze to the proximate causes of degradation and perpetuates the 'traditional' conservation narrative that local communities and practices pose the single greatest threat to nature. It forecloses the possibility of tracing the drain and damage caused by urbanization, industrialization, and elite ways of life, as these remain outside the boundaries of the field (as it is usually defined) and, therefore, are closed to academic scrutiny. This and the absence of reflexive writing in the natural sciences (which dominate conservation research in India) mean that as an academic community, we have little understanding of how our gender, caste, class, linguistic ability, etc. might influence our access to the field and, in the process, either limit or facilitate the production of conservation knowledge in the Indian context. Even our popular articles often unthinkingly reproduce the colonial 'green hero' tone of narration and shed little light on lived experiences and dilemmas associated with doing fieldwork.

[1] Kartik Shanker, 2013. He made this comment as a general observation and not as a statement of his own position.

4. RECHARTING THE FIELD

Recognizing these pitfalls of typical conservation studies, some researchers look for ways "to add a social component". However, with this we run the risk of tokenism and, worse, we find that our analytical frame continues to be impoverished. This is one reason why we still publish far more studies on the damaging effects of firewood, grazing, and non-timber forest produce (NTFP) collection in India than we do on mining, luxury tourism, or misguided corporate social responsibility projects. A second reason is that the neoliberal orientation of the IUCN and other major conservation organizations limits the funding available to certain types of studies (a detailed discussion is beyond the scope of this article). Nevertheless, I suggest that to make any significant change to the status quo, we need to need to take a leaf from the contemporary anthropologist's book and revise our ideas of the field. We need to accept it as a multidimensional, socially constructed space that has biodiversity, history, politics, culture, etc. Even if our focus is on the former, we could at least acknowledge the existence of these other dimensions in our descriptions of study areas.

Fortunately, we do have some conservation studies in India that show us how an expansive notion of the field can enrich our efforts; for example, the well-known "Report of the Western Ghats Ecology Expert Panel" (Gadgil 2011) delves into the key ecological, economic, and social factors that make this a composite social-ecological landscape. It critiques the effect of "conservation by exclusion" coupled with "development by exclusion" and, instead, advocates an adaptive co-management approach for biodiverse areas, i.e., an approach that recognizes the existence and rights of people in "wilderness" areas as well as the value of incremental, experiential learning in conservation practice (Berkes and Turner 2006). Other examples, albeit on a limited scale, include conservation projects for turtles (Sharma 2006), elephants (Evanescence Studios 2014), and leopards (Ghosal and Kjosavik 2015).

It is only with such efforts that we can begin to truly do justice to the complexities of undertaking conservation, particularly in the Global South. Our training institutions also need to incorporate insights that the conservation community has acquired from hard-earned experience; for instance, a working knowledge of the stratifications in Indian society, regional economies, and struggles around environmental justice would certainly give fresh researchers a sharper sense of reality and a more ethical orientation, which would preclude the need for them to reinvent the wheel with each study. We need to develop a more realistic sense of 'the field' individually and institutionally so that we can chart a progressive vision for nature conservation in India.

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RESEARCH PAPER

Revisiting the Economic Costs of Arsenicosis: A PSM Approach

Sanjana Chakraborty [*] and Vivekananda Mukherjee [**]

Abstract: The present paper uses the propensity score matching (PSM) method to calculate the economic loss of arsenicosis-affected households. In contrast to prior studies, whose estimates of income loss were limited to labour-market sources, the PSM method controls for labour market and other sources of income, as well as demographic and educational factors, to identify losses from social discrimination. It first establishes that arsenicosis-affected households are subject to social discrimination, and then shows that this leads to a significant loss of expenditure. Second, it proves that overlooking social discrimination leads to an underestimation of income loss. The results have important implications, both for understanding the plight of arsenicosis-affected households and for cost–benefit calculations in the adoption of policies for fighting arsenic contamination.

Keywords: Arsenicosis, Economic Cost, Propensity Score Matching, Social Discrimination

1. INTRODUCTION

Arsenic is a metalloid that is found throughout the Earth's crust and in soil, sediments, water, air, and living organisms. The estimated global prevalence of arsenic in soil is 5 μg/kg (microgram per kilogram), but concentrations may vary considerably in different geological regions; the variations range from 0.1 to 4,000 μg/kg. Across different countries, arsenic is used as a drug as well as a poison**.**

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Arsenic can enter the human body directly through the consumption of contaminated drinking water and indirectly through the food chain, if arsenic-contaminated groundwater is used in agricultural production. Arsenic consumption leads to health hazards such as skin, lung, liver, bladder, and kidney cancer. It can harm the central and peripheral nervous systems as well as the heart and blood vessels. It may also cause birth defects and problems in the reproductive system. Arsenic-related health hazards may be classified into two types: (i) acute: including gastrointestinal discomfort, vomiting, diarrhoea, convulsions, coma, and ultimately death; (ii) chronic: including skin lesions (arsenicosis or arsenical dermatitis) that are characterized by hyper-pigmentation, hyperkeratosis, and hypo-pigmentation. Acute toxicity, however, is infrequent. Arsenic's effects on the victim are not immediately perceptible. Gradual arsenic poisoning from drinking tainted water can take years to ravage the body, producing pigment patches and scaly skin; swollen limbs and joints; and tumorous growths on limbs and feet. By the time even early symptoms are visible, the person is often riddled with cancer. Thus, arsenic has a cumulative toxic effect that destroys the human body, leading to inevitable death. Since rural areas, especially in developing countries, are seldomly supplied with treated surface water, people living there face a much higher threat of developing arsenicosis.

While arsenic contamination has been reported in 38 countries in the world (Chakraborti *et al.* 2009), Asian countries have been affected more than others. Globally, the countries most affected by arsenic contamination are all from Asia: India, Bangladesh, China, and Taiwan, with India having the highest and Taiwan having the lowest incidence. The Ganga–Meghna–Brahmaputra (GMB) plain of India and Bangladesh is the worst affected area in the world, giving cause for alarm. More than 500 million people living in the GMB plain may potentially be at risk from groundwater arsenic contamination (Nahar, Hossain, and Hossain 2008; BGS and DPHE 2001).

Arsenicosis affects the health and well-being of both the affected individuals and their families (Hanchett 2004; Roy 2008). The people affected by arsenic poisoning suffer from symptoms like gradual loss of energy, physical weakness, loss of appetite, lethargy, sleeplessness, diminishing ability to work, gastrointestinal distress, burning sensations, and gradually progressive debilitation, which lead to an inability to work, and loss in income. It also leads to strained relations within the family and social stress. When the symptoms of arsenicosis become more evident, various agonizing social issues often arise, such as affected persons being fired from their jobs, children being debarred from their schools, girls being denied marriage, and married women facing marital problems and even divorce.

The affected people are often socially boycotted and ostracized from social functions as they are mistakenly considered to be contagious. These social barriers create economic challenges for the affected people and their families (Becker 1971).[1]

Although arsenicosis cannot be cured, it can be adapted to and mitigated. The medical expenditures borne by affected households to treat arsenicosis are an example of adaptation. There are mitigation approaches that the affected persons can take as well: (i) using arsenic-safe water sources such as dugwells and deep tubewells that are regularly monitored for arsenic, piped water projects, etc., and (ii) improving one's nutritional status by adopting a healthy diet with plenty of vitamins such as A, C, and E (Quamruzzaman *et al.* 2003; Milton 2003).[2] The government may undertake policies to promote and complement these mitigation efforts. For example, it may spread awareness about arsenic-safe sources of drinking water and nutritional foods to combat arsenicosis. It may also undertake piped water projects and mark arsenic-safe tubewells.[3] The economic impact of arsenicosis on a household, therefore, depends on the adaptation and mitigation efforts of the household as well as various social and policy parameters.

While several studies have investigated arsenic contamination, most of them have explored its geological aspects, the related health problems, and technologies for its removal. Studies like Mandal *et al.* (1996), Chowdhury *et al.* (1999), Chowdhury *et al.* (2000), Chakraborti *et al.* (2002, 2003, 2009), and Ahmed *et al.* (2006) have mapped the spatial spread of arsenic risk zones in West Bengal, India, and in Bangladesh. These studies have also evaluated the scale of the problem in terms of the at-risk population. The geological aspects of groundwater arsenic contamination have been studied by Harvey *et al.* (2002, 2005), Akai *et al.* (2004), Acharyya and Shah (2007), Biswas *et al.* (2012), and Planer-Friedrich *et al.* (2012). Studies on epidemiological issues and adverse health effects related to chronic arsenic toxicity include Datta (1976), Milton (2003), Chakraborti *et al.* (2004), Kapaj (2006), Ghosh (2008), Vahter (2009), and Rahman *et al.* (2009). Substantial literature is also available on mitigation strategies and technologies for arsenic removal (Misbahuddin and Fariduddin 2002; Hossain *et al.* 2006). As mentioned before, besides its chronic effects, groundwater arsenic

[1] A publication by the World Health Organization points out that the social problems arising from groundwater arsenic contamination increase the pressure on the economies of the affected areas (Curry *et al.* 2000).

[2] Malnutrition slows down the elimination of toxic arsenic from the body and aggravates arsenicosis.

[3] Arsenic-safe tubewells are coloured green and unsafe tubewells are coloured red.

contamination creates widespread social and psychological problems for the affected people and their families. Over the last decade, a number of studies, mostly in Bangladesh, have highlighted the social, socio-cultural, socio-economic, psychosocial, and mental health effects of arsenic poisoning (Curry *et al.* 2000; Barkat 2004; Hadi and Parveen 2004; Hanchett 2004; Hassan *et al.* 2005; Ahmad *et al.* 2007; Nahar, Hossain, and Hossain 2008; Brinkel *et al.* 2009; Sarker 2010; Mahmood and Halder 2011; Sultana *et al.* 2012; Syed *et al.* 2012). However, there is a dearth of such valuable studies that examine the social dimension of arsenic contamination in the Indian context.

Studies evaluating the economic cost of arsenic contamination are limited, but designing any arsenic mitigation programme would require cost estimates. This study attempts to derive such an estimate of the costs involved. Studies like Khan (2007), Roy (2008), Mahanta *et al.* (2016), and Thakur *et al.* (2019) have measured the arsenic-affected households' willingness to pay for mitigation projects by estimating their losses from labour market participation and remedial medical expenditures. Additionally, affected households also experience losses due to the social discrimination they face. The methodologies adopted by Khan (2007), Roy (2008), Mahanta *et al.* (2016), and Thakur *et al.* (2019) overlook this dimension of income loss. The present paper attempts to fill this gap.

This paper accounts for the income loss of arsenic-affected households from reduced labour market participation as well as social discrimination. First, it shows that calculating the economic cost based on the labour market alone would lead to underestimation, as such calculations will not account for losses caused by social discrimination. Then, it estimates the labour supply behaviour and spending behaviour of the households facing social discrimination. It shows that in the presence of sufficiently strong social discrimination, households may work more, and when the labour market effects are controlled, such households spend less than other households.

This theory is supported by survey data collected in 2005–06 from arsenic-affected and unaffected households in Kolsur village in North 24 Parganas district, West Bengal, India. Our estimation of the economic cost compares the incomes of arsenic-affected households and observationally similar households which differ only in terms of the presence of arsenicosis. The observational match has been found using the propensity score matching

(PSM) method pioneered by Rosenbaum and Rubin (1985).[4] With PSM, we control for the labour market and other sources of earning like working on their own land or on land owned by others, the household's per capita working days per month in different seasons (summer, winter, and monsoon), adaptive expenditure to avoid labour market loss, and a host of other demographic and educational factors. We show that social discrimination exists and estimate the income loss that it creates. The results show that the measure of income loss per capita derived by Roy (2008) based on labour market outcomes alone, in a similar geographical region and during a similar time period, is an underestimation.[5]

The paper contributes to the literature by providing a broader measure of the economic costs of arsenicosis by including the costs of the social discrimination faced by arsenic-affected households. It argues that the economic costs are greater than any estimate generated based on labour market outcomes alone. The results of the paper are important from a policy point of view, as the suggested method of economic cost calculation may make viable several arsenic removal programmes that are stalled due to unfavourable cost–benefit calculations. The paper also highlights the importance of policies in eliminating the social discrimination against arsenic-affected households, as it leads to significant economic losses for them.

The paper is organized as follows: Section 2 presents a theoretical model to illustrate the way arsenicosis affects a household's labour supply, income, and expenditure. It also shows that considering only labour market effects underestimates the welfare loss of arsenic-affected households and why a technique like PSM is required for this purpose. Sections 3 and 4 describe the methodology and data collection, respectively. Section 5 analyses the data and discusses the results. Section 6 presents the conclusions.

2. THEORETICAL FOUNDATIONS

Consider a representative arsenic-affected household that derives its utility from the consumption of commodities and leisure. The expenditure on commodities is represented by x. The time endowment of the household is represented by $T(A)$ hours, out of which L hours is consumed as leisure.

[4] See Caliendo and Kopeinig (2008), Imbens and Wooldridge (2009), Heinrich *et al.* (2010), and Kassie *et al.* (2010) for recent reviews of the literature.

[5] Our result is not directly comparable to those of either Mahanta *et al.* (2016) or Thakur *et al.* (2019) due to geographic and temporal dissimilarities.

The utility function of the household is: $U = U(x, L)$, which is maximized by the choice of $\{x, L\}$ subject to the budget constraint:

$$x = w(T(A) - L) + M(A) \quad (1)$$

In Equation (1), w stands for the market wage rate and $M(A)$ stands for the non-labour income of the household. In our model, $A > 0$ is an index of the severity of arsenicosis in the household. A high value of A implies a high severity of arsenicosis. We assume that $T'(A) < 0$ that is, the more severely a household is affected with arsenicosis, the less time it has both for work and leisure. We also assume that $M'(A) < 0$, that is, the greater the severity of arsenicosis in a household, the lower the non-labour income of the household. We treat $M(A)$ as an indicator of the social capital enjoyed by the household. We assume that the lower non-labour income of an affected household reflects the social discrimination it faces.

Assuming the existence of an interior solution $\{x^* > 0, T(A) > L^* > 0\}$ to the household's utility maximization problem, the equilibrium amount of labour supply and the equilibrium expenditure of the household are written as:

$$L^* = T(A) - L^*[w, T(A), M(A)] \quad (2)$$

and

$$x^* = wL^* + M(A) \quad (3)$$

respectively. Since leisure is a normal good, by income effect it follows that $\frac{\partial L^*}{\partial T} > 0$, $\frac{\partial L^*}{\partial M} > 0$ and $\frac{\partial L^*}{\partial A} = \frac{\partial L^*}{\partial T} T'(A) < 0$.

Substituting $\{x^* > 0, T(A) > L^* > 0\}$ in the utility function above, the indirect utility function of the household is defined as:

$$v(A) = U[x^*(A), L^*(A)] \quad (4)$$

Proposition 1: The welfare loss of households due to arsenicosis calculated based only on labour market outcomes leads to underestimation.

Proof: Applying the first-order conditions of the household's utility maximization problem from Equations (3) and (4), we derive:

$$\frac{\partial v}{\partial A} = \frac{\partial U}{\partial x}[wT'(A) + M'(A)] \quad (5)$$

The first term of the RHS of Equation (5) captures the loss in welfare due to the labour market effect, and the second term captures the loss due to lack of social capital, which is due to social discrimination.

From the assumptions of the model, we know $\frac{\partial U}{\partial x} > 0$, $w > 0$, $T'(A) < 0$ and $M'(A) < 0$. Therefore, the RHS of Equation (5) is negative. Hence, the statement of the proposition follows.

Proposition 1 justifies the use of the PSM method for estimating the welfare loss of a representative arsenic-affected household. The method also captures the loss of income that arises due to the erosion of the social capital of such households, which previous studies have failed to capture.

Proposition 2: (a) $\frac{\partial L^*}{\partial A} \geq$ or < 0 *if and only if* $T'(A) \geq$ or $< [T'(A)\frac{\partial L^*}{\partial T} + M'(A)\frac{\partial L^*}{\partial M}]$;

(b) (i) *if* $T'(A) \geq [T'(A)\frac{\partial L^*}{\partial T} + M'(A)\frac{\partial L^*}{\partial M}]$, $\frac{\partial x^*}{\partial A} < 0$

(ii) *if* $T'(A) < [T'(A)\frac{\partial L^*}{\partial T} + M'(A)\frac{\partial L^*}{\partial M}]$, $\frac{\partial x^*}{\partial A} \geq$ or < 0

if and only if $w\frac{\partial L^*}{\partial A} \geq$ or $< -[M'(A)]$.

Proof: From (2) we obtain:

$$\frac{\partial L^*}{\partial A} = T'(A) - T'(A)[\frac{\partial L^*}{\partial T} + M'(A)\frac{\partial L^*}{\partial M}];$$

and from (3) we obtain:

$$\frac{\partial x^*}{\partial A} = w\frac{\partial L^*}{\partial A} + M'(A)$$

The statement of the proposition follows.

As the incidence of arsenicosis escalates in a household, the endowment of time and social capital shrinks. In terms of labour supply, this evokes two kinds of reactions from the household. First, a direct effect of the reduction of time endowment $T'(A)$ through which its supply of labour falls. Second, an indirect effect $[T'(A)\frac{\partial L^*}{\partial T} + M^*(A)\frac{\partial L^*}{\partial M}]$ through which the change in

income causes a decline in consumption and leisure but an increase in labour supply. The household's supply of labour falls if the direct effect dominates the indirect effect. For such households, consumption expenditure falls as well. However, if the indirect effect dominates, the labour supply rises, i.e., the household works more. If social discrimination is strong, i.e., $M'(A)$ has a large magnitude, the indirect effect would also be strong. If it is strong enough, as Proposition 2 suggests, it is perfectly possible that an arsenic-affected household works more than an arsenic-unaffected household, and its consumption expenditure is more than that of an arsenic-unaffected household. However, if the labour supply remains unchanged or rises, social discrimination would imply a fall in the consumption expenditure of arsenic-affected households.

Earlier studies like Khan (2007), Roy (2008), Mahanta *et al.* (2016), and Thakur *et al.* (2019), which do not consider the theoretical possibility of social discrimination and do not apply the PSM method as their empirical methodology, found that the labour supply and, consequently, the welfare of affected households, declined due to arsenicosis. The data and the methodology applied in this paper yielded a different result, which we explain at the end of Section 4.

3. EMPIRICS: METHODOLOGY

Impact evaluations (causal inferences) are fundamentally based on randomized experiments. In the case of successful randomization, the treated or affected group and the untreated or control group are identical with respect to all observed and unobserved characteristics except the treatment status. The two groups are thus totally interchangeable. Although a perfectly randomized experiment is considered a theoretically ideal, in practice, randomization is mostly infeasible, specifically in social science experiments or social behavioural research studies. Under such circumstances, non-experimental methods are used. But the non-random observational studies or non-experimental methods usually suffer from a selection bias (a bias in the sample selection). Techniques like multivariate regression analysis, instrumental variable method, quasi-experimental method, and PSM are used to minimize the selection bias. In this paper, we use the PSM method.

The propensity score $\{P(X)\}$ is defined as the probability of participating in a programme given the observed set of variables X. Unlike with randomization, in PSM, the two groups are identical only in their observed characteristics. Dealing with multiple covariates, confounding background

covariates, and observed background characteristics is too troublesome due to both computational and data problems. So, Rosenbaum and Rubin (1985) suggested the use of a propensity score, which acts as a balancing score. When the set of variables to match is large, the applied matching procedure based on this unidimensional balancing score is known as PSM. In other words, PSM refers to the pairing of the treatment and control or comparison units with similar values on the propensity score, possibly discarding all unmatched units (Rubin 2001).

3.1. Evaluation framework and matching basics

Inferences about the impact of the treatment on the outcome of an individual involves speculation about how this individual would have performed without the treatment. The standard framework to discuss this problem is the potential outcome approach or Roy-Rubin model (or Rubin causal model). In the case of a dichotomous/binary treatment, the treatment indicator $D_i = 1$ if an individual i receives the treatment or is affected and zero otherwise. The framework assumes that there are two potential outcomes Y_1 and Y_0 corresponding with $(D_i = 1)$ and $(D_i = 0)$. Importantly, a unit i can only be in one state (either $D_i = 1$ or $D_i = 0$) at one point of time, so only one of the two outcomes (Y_1 or Y_0) is observed. If, say, Y_1 is observed, the unobserved outcome Y_0 is taken as the "missing link". The unobservable outcome of this framework is termed as "counterfactual" since it is counter to fact (Winship and Morgan 1999), i.e., what the outcome would be without the programme at the same point of time. Hence, we need a comparison group that will allow us to attribute any change in the treatment group to the programme to gauge causality properly. The PSM method matches the treatment and the comparison/control group based on their observed characteristics and investigates the impact of the treatment.

In the present study, we consider the incidence of arsenicosis as the treatment. The outcome variables are per capita monthly household income and per capita monthly household expenditure. The use of the PSM method ensures that any selection bias is minimized with regard to observable characteristics.

In applying PSM, we adopt the three-step analytic process described by Guo and Fraser (2010). The steps are as follows:

Step 1: Selection of background covariates

The first is to search for and select the best background covariates that could be causing an imbalance between the treated and control groups. The treatment group (arsenic-affected group) and the control group (arsenic-unaffected group) are compulsorily made to share a similar set of background covariates.

Step 2: Calculation of propensity scores

The propensity scores are calculated for each household using binary logistic regression or a binary discrete choice model (Gujarati and Sangeetha 2007). Denoting the binary treatment condition as D_i, we define $D_i = 1$ if a household is in the treatment condition (arsenic-affected) and $D_i = 0$ if a household is in the control condition (arsenic-unaffected).

The vector of the conditioning variables is denoted as X_i and the vector of the regression parameters is denoted as β_i. The binary logistic regression depicts the conditional probability of receiving the treatment as follows:

$$P(D_i \mid X_i) = E(D_i) = \frac{e^{X_i\beta_i}}{1+e^{X_i\beta_i}} = \frac{1}{1+e^{-X_i\beta_i}} \qquad (6)$$

Note that this is a nonlinear model, as D_i is not a linear function of the vector of conditioning variables X_i. But the transformed equation through the logit function (i.e., the natural logarithm of odds or $\log[\frac{P(Di)}{1-P(D_i)}]$ becomes a linear function of X_i. The logit model being estimated is specified as:[6]

$$L_i = \log_e(\frac{p}{1-p}) = X_i\beta_i \qquad (7)$$

where P denotes $P(D_i)$. The propensity score is the estimated value of $P_i = P(D_i)$. As PSM is applied for the comparison of the outcomes of the two groups, the two assumptions mentioned below need to be satisfied.

Assumption 1: D_i s are independent over all i.

The non-randomized data of this study ensure that Assumption 1 holds.

[6] Alternatively, a probit model or a discriminating analysis can be used for the same purpose.

Assumption 2: Conditional independence assumption (CIA): $Y(0), Y(1) \cup D \mid X$.

Assumption 2 implies that given a set of observable covariates X, which are not affected by the treatment, potential outcomes are independent of the treatment status. That is, it is assumed that the outcomes $Y(0), Y(1)$ are independent of the treatment status conditional on X. In this study, we assume that the CIA holds.

As we have considered several background covariates, there is a problem of multidimensionality. To reduce this multidimensionality, the propensity scores are estimated. The background covariates are described in Section 4. The questionnaire based on which the data on the selected background or confounding covariates was collected is given in Appendix 1. After the propensity scores are calculated, we use them to match the two groups.

Step 3: Matching

After the propensity score estimation, the PSM is implemented. We construct matched pairs between the two types of households, i.e., the arsenic-affected households (treatment group) and the arsenic-unaffected households (control group) based on the maximum closeness of their propensity scores. Before matching, we must satisfy the following assumption.

Assumption 3: Common support or overlap condition: $0 < P(D = 1 \mid X) < 1$.

To identify the common support region, we adopt the "minima and maxima criterion" approach, which eliminates all observations whose propensity scores are smaller than the minimum and larger than the maximum in the opposite group. Observations that lie outside the described region are discarded from the analysis.

In the present study, we applied the most straightforward, traditional pair-wise matching method (Rubin 1973), nearest neighbour (NN) matching, where households from the comparison group are chosen as a matching partner for the treated household that is closest in terms of the propensity score. NN matching is of two types: "with replacement" and "without replacement". In the former case, an untreated/control household can be used more than once as a match, whereas in the latter case, it is considered only once (i.e., once a treated case is matched to a non-treated case, both cases are removed from the pool). In the present study, the sample size of the control group is large, so we use NN matching without replacement.

Formally, if P_i and P_j represent the respective propensity scores of the treated and control participants, and if I_1 and I_0 represent the respective sets of treated and control participants, a neighbourhood $C(P_i)$ contains a control participant j (i.e., $j \in I_0$) as a match for the treated participant i (i.e., $i \in I_1$) if the absolute difference in propensity scores is the smallest among all possible pairs of propensity scores between i and j, as:

$$C(P_i) = \min | |P_i - P_j| |, j \in I_0$$

Once j matches to i, j is removed from I_0 without replacement. If for each i there is only a single j found to fall into $C(P_i)$, then the NN matching is 1-to-1 matching. If for each i there are n participants found to fall into $C(P_i)$, then the NN matching is 1-to-n matching. Note that here we are not imposing any kind of restriction on the distance between P_i and P_j as long as j is the NN to i in terms of the estimated propensity score. Even if $||P_i - P_j||$ is large (i.e., j's propensity score is vastly different from i's), j would still be considered a match to i. To overcome this problem, the following condition is derived, where the absolute distance between the propensity scores of the two participants will be less than the pre-specified tolerance for matching or a calliper (ε) satisfying:

$$||P_i - P_j|| < \varepsilon, j \in I_0 \qquad (8)$$

Rosenbaum and Rubin (1985) suggest that the size of the calliper be 0.25 of the standard deviation of the sample estimated propensity scores (σ_p)(i.e., $\varepsilon \leq 0.25\sigma_p$). This variety of NN matching, which has been adopted in the present study, is known as calliper matching. Here, we are using NN matching without replacement within a calliper. By adopting this method, we get a subsample of the control participants and treated participants whose propensity scores have been matched.

Step 4: Post-matching analysis

After the matched treatment and control groups are formed, we compare the average of the outcome variables for the two groups and check if they are significantly different or not. The questionnaire about the outcome variables is presented in Appendix 1.

4. DATA

The data used in the empirical analysis are drawn from a household database created by School of Environmental Studies, Jadavpur University (SOES, JU), using a primary survey during 2005–2006 in the arsenic-affected village of Kolsur located in Deganga block, North 24 Parganas district (West Bengal, India). The database was a complete enumeration of 1,000 households in the village. Of these, 374 households were arsenicosis affected, and the rest (i.e., 626 households) were unaffected. In our study, we included all the 374 affected households in the treatment group. The control group was constituted by unaffected households living within a radius of 6–9m from each of the affected households. Selected in this way, there were 392 households in the control group. Both the treatment and control households were deliberately chosen from the same geographical area so that they did not differ much in terms of socio-economic and demographic characteristics, and the unobserved heterogeneity of the households was not too vast. All the households in both the groups had the same source of drinking water, which was arsenic-affected. We have collected household data on two outcome variables: per capita monthly income and per capita monthly expenditure (both in Indian National Rupee [INR]).[7] The descriptive statistics and the comparison of the outcome variables are presented in the Table 1.

Table 1: Descriptive statistics and comparison of the outcome variables of arsenic-affected households and arsenic-unaffected households

Outcome variables	Arsenic-affected (no. of observations = 374)			Arsenic-unaffected (no. of observations = 392)			Mean difference
	Mean	Min	Max	Mean	Min	Max	
Per capita monthly household income (INR)	1,475.52 (495.15)	500	4,000	2,187.11 (832.20)	833	6,000	-711.59*
Per capita monthly household expenditure (INR)	1,300.81 (277.97)	677	3,725	1,730.33 (555.28)	677	5,033	-429.52*

Note: Standard deviations are in parentheses and *, **, *** denote a 1%, 5%, and 10% level of significance, respectively.

[7] INR 1 = $0.02 on 4 May 2005. See Pound Sterling Live (2005). Roy (2008) also uses the same exchange rate.

In both the outcome variables, on average, the control group performs better than the treatment group (Table 1). They earn more and spend more. They differ significantly in terms of their per capita monthly income and per capita monthly expenditure. On average, the arsenic-affected households and the arsenic-unaffected households earn ₹1,475.52 and ₹2,187.11 per month per capita, respectively, and spend ₹1,300.81 and ₹1,730.33 per month per capita, respectively (see Table 1). The standard deviations of both the income and expenditure variables are high, with income showing more variation than expenditure.

We consider three different sets of background covariates for our study. The first set relates to the demographic characteristics of the households and contains variables like religion, percentage of male and female members, and percentage of people of working age (15–64 years old) in the household. The second set relates to the income as well as medical expenditure of the households. This includes whether the household earns farm or non-farm income. Under farm income, whether the income is earned by working on one's own land or on land owned by others is considered. Other variables included are the household's per capita working days per month in different seasons (summer, winter, and monsoon) and the household's per capita monthly medical expenditure (INR), which we use to approximate the adaptive measures taken by the household to avoid possible labour market loss. The third set includes variables that capture the level of educational attainment in the households. This includes the percentage of household members having attained middle-school education (passed class 8), higher-secondary education (passed class 12), and graduate education, and the percentage of household members who are literate. Land being the major asset in rural areas, we also include the per capita land ownership of households in terms of *katha*[8] to record the wealth of the households.[9] We describe the data on the background covariates in Table 2.

There are more female members in arsenic-unaffected households compared to arsenic-affected households (significant at 5% level). Among the income as well as medical expenditure–related variables, the treatment group and the control group are significantly different on three counts.

[8] 1 katha = 0.017 acre.

[9] We have not included the source of drinking water as a background covariate since in our sample, as arsenic-contaminated ground water is consumed both by the treatment (arsenic-affected) households and the control (arsenic-unaffected) households. Therefore, it is not a source of variation in explaining the observed incidence of arsenicosis. We thank one of the referees for bringing up this issue.

Table 2: Descriptive statistics and comparison of the background covariates of arsenic-affected households and arsenic-unaffected households

Background variables	Arsenic-affected (no. of observations = 374)			Arsenic-unaffected (no. of observations = 392)			Mean difference
	Mean	Min	Max	Mean	Min	Max	
Religion dummy (Hindu = 1, Muslim = 0)	0.40 (0.49)	0	1	0.48 (0.50)	0	1	-0.08
% of males in the household	36.07 (14.13)	0	75	37.61 (12.83)	0	66.67	-1.54
% of females in the household	33.70 (12.86)	0	75	36.87 (12.97)	0	66.67	-3.17**
% of household members of working age (15–64 years)	74.75 (20.55)	33.33	100	75.73 (22.37)	0	100	-0.98
Working on own land *	0.47 (0.50)	0	1	0.48 (0.50)	0	1	-0.01*
Working on others' land *	0.23 (0.42)	0	1	0.19 (0.39)	0	1	0.04***
Other source of income (non-farm)	0.60 (0.49)	0	1	0.53 (0.50)	0	1	0.07
Per capita working days p.m. in summer	9.70 (3.42)	3.33	30	9.76 (3.20)	4.33	15	-0.06
Per capita working days p.m. in winter	9.71 (3.44)	3.33	30	9.76 (3.20)	4.33	15	-0.05
Per capita working days p.m. in monsoon	9.53 (3.51)	0	30	9.66 (3.21)	3.75	15	-0.13
Per capita monthly household medical expenditure (INR)	24.02 (21.16)	10	225	13.56 (6.54)	4	50	10.46*
Middle school (up to class 8) (%)	75.64 (24.39)	0	100	77.44 (24.42)	0	100	-1.8
Higher secondary (%)	1.85 (7.34)	0	50	1.90 (7.80)	0	50	-0.05
Graduate (%)	1.01 (5.32)	0	50	0.76 (4.70)	0	50	0.25
Literate persons (%)	72.96 (23.55)	0	100	75.24 (24.19)	0	100	-2.28
Per capita land ownership (in katha)	6.87 (7.36)	0.5	55.5	5.78 (5.73)	0.67	40	1.09*

Note 1: Standard deviations are in parentheses and *, **, *** denote a 1%, 5% and 10% level of significance, respectively).

Note 2: * implies Yes = 1, No = 0.

Note 3: p.m. = per month.

There are more households in the control group who work on their own land compared to the treatment group (at a 1% level of significance). But there are more households in the treatment group who work on others' land compared to the control group (significant at a 10% level). Again, the per capita monthly medical expenditure of the arsenic-affected households is more compared to that of the arsenic-unaffected households (significant at a 1% level), which confirms our apprehension that the per capita monthly medical expenditure essentially reflects the adaptive expenditure of the arsenic-affected households from possible labour market loss. The two groups are not significantly different in any other aspect except that the treatment group has more per capita ownership of land than the control group (significant at a 1% level). The similarity in the number of per capita working days across the groups shows (Proposition 1) that the direct and indirect effects of arsenicosis almost balance each other out, which indicates the social discrimination of the arsenic-affected group.

5. ANALYSIS AND RESULTS

We performed the PSM analysis using the Stata 12 software. Through PSM, we first paired the households in the treatment group with the households in the control group who observationally possess similar characteristics. To do this, we identified the common support region between the treatment and control groups in terms of their propensity scores. PSM can be performed only on the observations in the common support region between the two groups. From the propensity score calculations, we found 329 households of the treatment group (i.e., arsenic-affected group) and 392 households of the control group (i.e., arsenic-unaffected group) in the common support region. The rest (45 households) of the treatment group were out of the common support region. The 329 households (on support) of the treatment group were matched with exactly 329 households (on support) of the control group. According to the methodology described above, we used the standard deviation of the propensity scores (estimated as 0.26) to calculate the value of the calliper as 0.0656.

The differences in the mean outcomes of the matched pairs were interpreted as the impact of the treatment, i.e., the economic loss suffered due to arsenicosis. Table 3 describes the results of the comparison of the outcome variables of the two groups. From Table 3, it can be observed that the mean of the monthly household per capita income of the 329 households of the treatment group is obtained as ₹1,485.98 per month per capita, while for the 329 households of the control group it is ₹2,174.17 per

month per capita. The former is lower than the latter by ₹688.20 (equivalent to $13.76) per month per capita, which turns out to be significant at a 1% level. We can take this figure as a measure of welfare loss per capita due to arsenicosis on account of social discrimination.[10] Note that this figure is more than the income loss figure calculated by Roy (2008), which stands at ₹350 (equivalent to $7).The difference arises because while Roy (2008)[11] calculates the income loss which arises only due to adverse labour market outcomes, our figure captures the income loss from non-labour sources like social discrimination as well. Therefore, the empirical findings of the paper confirm that the figures provided by Roy (2008) underestimate the economic loss due to arsenicosis as claimed in Proposition 1 stated in Section 2.

Table 3: Comparison of the outcome variables of matched households (no. of observations = 329)

Outcome variables	Arsenic-affected			Arsenic-unaffected			Mean difference	S.E.	T-stat
	Mean	Min	Max	Mean	Min	Max			
Per capita monthly household income (INR)	1,485.98 (515.64)	640	4,000	2,174.17 (888.33)	1,000	6,000	-688.20*	70.38	-9.78
Per capita monthly household expenditure (INR)	1,309.06 (309.42)	677	3,725	1,751.85 (596.65)	765	5,033	-442.78*	46.05	-9.61

Note: Standard deviations are in parentheses and *, **, *** denote a 1%, 5% and 10% level of significance, respectively).

We have also compared the per capita average monthly household expenditure for both the treatment and control groups. While the mean of the per capita monthly household expenditure of the treatment (arsenic-affected) group was ₹1,309.06, the same for the control (arsenic-unaffected) group was ₹1,751.85; this is a difference of ₹442.78 (equivalent to $8.86) per month per capita, which is significant at a 1% level. Since we have controlled for the labour market effects (and other kinds of wealth effects

[10] The treatment and control groups of our study are matched in terms of their hours of labour supply in different seasons of the year and their adaptive medical expenditure. This controls for labour market effects on the household income.

[11] More recently, Mahanta *et al.* (2016) and Thakur *et al.* (2019) as well.

like land holding) in our empirical study, according to Proposition 2 derived in Section 2, this can happen only if social discrimination against arsenic-affected households exists.[12]

6. CONCLUSIONS

The present paper proves two points. First, social discrimination exists against arsenicosis-affected households and, consequently, these households suffer from significant economic losses, both in terms of per capita income and per capita consumption. Second, the existence of social discrimination leads to an underestimation of income loss when calculated only based on labour market sources. The results have important implications for cost–benefit calculations in the adoption of policies tackling the problem of arsenicosis.

While prior studies that estimate economic loss due to arsenicosis concentrate only on loss of labour income due to illness, the present paper constructs a theoretical model to argue that such a method underestimates the true economic loss of these households as they also face social discrimination. We argue that the PSM method, when applied properly, offers a way to estimate the loss from non-labour market sources like social discrimination. In this study, we apply the method on a dataset collected from a household survey in an arsenic-affected village in West Bengal, India, to estimate the income and consumption loss due to social discrimination. We then compare the estimates with a previous study by Roy (2008) during a similar time period to show the extent of possible underestimation. On a policy front, the paper highlights two aspects. First, since the paper shows that social discrimination against arsenic-affected households exists and causes them significant losses in income and expenditure, there should be policies to build awareness against the social discrimination faced by such households. Second, the cost–benefit analysis conducted for projects aimed at solving the arsenic problem should take into account the losses from social discrimination, which are significantly high, as we show in this paper. Projects that were previous considered

[12] This argument follows from the fact that the differences in labour supply between the treatment and control households across all seasons were not significantly different (statistically) from zero (Table 2), and that there is no evidence in our survey that there exists more than one wage rate in the market (the labour supply on one's own land also fetches the market wage rate [in the sense of opportunity cost]). Moreover, our PSM study with per capita working days per month in the three seasons as an outcome variable showed that the treatment households supplied significantly more labour compared to their matched control households in the sample. We report the results in Appendix 2 of the paper.

unviable because of an unfavourable cost–benefit analysis may become viable in this new method.

The study suffers from an important limitation. Social discrimination is an unobserved factor in this study, which causes significant per capita income and expenditure differences between the treatment and control group households. A direct measure of social discrimination would have made the results robust. The present study faces data limitations on this count. This work can be updated with a more recent and comprehensive database. The impact of various policy interventions on the arsenic-affected households can also be studied. These remain as future research agenda.

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APPENDIX 1

Table A.1: The questionnaire

Name of the head of the family						
Family size	Male	Female	Total		Religion dummy	
					Hindu (1)	Muslim (0)
No. of literate persons					Percentage of literate persons	
Percentage of males in the household					Percentage of females in the household	
Working in own land		Working on others land			Other source of income (non-farm)	
Yes (1)	No (0)	Yes (1)	No (0)		Yes (1)	No (0)

House-hold members	Education level			Education level (in %)			Age (years)	Percentage of household of working age range
	Middle school (up to class 8) (1)	Higher secondary (2)	Graduate (3)	(1)	(2)	(3)		
1.								
2.								
3.								
4.								

Total land ownership of the household (katha)	
Per capita land ownership of the household (katha)	
Total monthly household income (₹)	
Per capita monthly household income (₹)	

Household working days per month in different seasons

Summer		Winter		Monsoon	

Household per capita working days per month in different seasons

Summer		Winter		Monsoon	

Total monthly household expenditure (₹)	
Per capita monthly household expenditure (₹)	
Total monthly household medical expenditure (₹)	
Per capita monthly household medical expenditure (₹)	

APPENDIX 2

Table A.2: Comparison of labour supply of matched households (no. of observations = 329)

Outcome variables	Arsenic-affected			Arsenic-unaffected			Mean difference	S.E.	T-stat
	Mean	Min	Max	Mean	Min	Max			
Per capita working days per month in summer	9.76 (3.49)	3.33	30	9.21 (2.95)	4.33	15	0.55**	0.25	2.19
Per capita working days per month in winter	9.77 (3.50)	3.33	30	9.21 (2.94)	4.33	15	0.57**	0.25	2.24
Per capita working days per month in monsoon	9.59 (3.58)	0	30	9.10 (2.94)	3.75	15	0.49	0.26	1.94

Note: Standard deviations are in parentheses and *, **, *** denote a 1%, 5% and 10% level of significance, respectively.

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RESEARCH PAPER

Role of Marine National Park for Sustainable Livelihoods of Artisan Fisherfolk: A Case Study of MNP, Jamnagar

Rohit Magotra, [*] Pushkar Pandey, [**] Mohit Kumar, [***] Mohit Kumar Gupta, [+] Asha Kaushik, [++] and Jyoti Parikh [+++]

Abstract: Over the past few decades, marine conservation has become a global concern due to increasing anthropogenic activities in the vicinity of coastal areas, which has led to the development of the concept of Marine Protected Areas (MPAs) for the conservation of marine ecology and its biodiversity. Conservation and acceptance of MPAs can only be achieved if coastal communities and fisherfolk are included as significant stakeholders because MPAs have direct relevance to their livelihood. To capture their acceptance towards the Gulf of Kachchh Marine National Park (MNP), Jamnagar, artisanal fisherfolk fishing in and around the MNP were surveyed to determine whether the presence of a well-managed MNP has any positive effects on the adjacent fishing communities since its establishment. The survey was carried out at six sites along the coast of southern Gulf of Kachchh (Sachana, Jodiya, Sikka, Salaya, Arambada, and Bet Dwarka) using structured questionnaires. The findings showed that the total fish catch was observed to increase over the years, but there has been a perceived decline in total catch in recent years. Similarly, while the total fish catch data recorded an increasing trend, discussions with the fisherfolk revealed a sharp decline in "catch per unit

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effort" in recent years. Fisherfolk from all the study sites showed interest in the development of the MNP and were keen to be involved in conservation planning and the management of the MNP.

Keywords: Gulf of Kachchh, Marine National Park (MNP), Fisherfolk, Sustainable Livelihood, Community Based Management.

1. INTRODUCTION

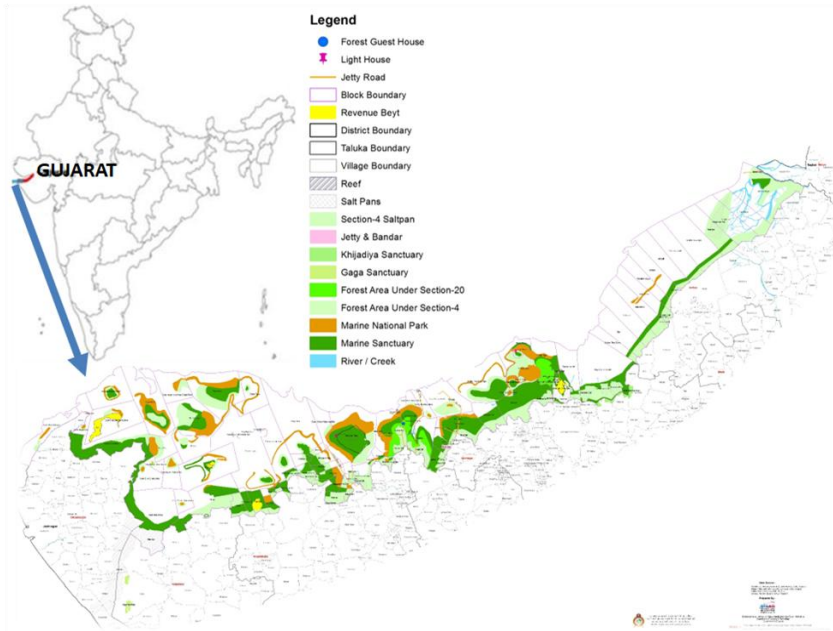
Establishing Marine Protected Areas (MPAs) in coastal and marine environments is considered essential for the conservation and protection of coastal and marine biodiversity. MPAs are governed by policy regulations that are meant to restrict and regulate human activities within a predefined area. As stated by the International Union for Conservation of Nature (IUCN) General Assembly in 1988, an MPA is "an area of intertidal or sub-tidal terrain together with its overlying water and associated flora, fauna, historical and cultural features, which has been reserved by law or other effective means to protect part or all of the enclosed environment" [Resolution 17.38 of the IUCN General Assembly, 1988, reaffirmed in Resolution 19.46 (1994)].

Though they are mandated by government regulations, the success of an MPA depends on its acceptance by local stakeholders such as fisherfolk (Klein *et al.* 2008). In particular, the active participation of local stakeholders in the management and governance of MPAs greatly aids their functioning (Klein *et al.* 2008; Gleason *et al.* 2010). Examples from around the world show that MPAs were more successful in strengthening and protecting local marine biodiversity when their management strategy changed from a governmental, top–down approach to a co-management system involving locals along with the government (Alcala and Russ 2006; Uychiaoco *et al.* 2005). In addition, research also shows that excluding local stakeholders leads to the loss of trust and support among locals, thus consigning the MPA to failure (Himes 2003). However, MPAs are usually established by the government without consulting the locals. Therefore, it is important to periodically assess the role of MPAs in the lives of local stakeholders such as artisanal fisherfolk and their acceptance of MPAs as government institutions.

In this paper, we report the perceptions and opinions of the most important stakeholders in the Gulf of Kachchh Marine National Park and Sanctuary (MNP&S)—fisherfolk—about its establishment and impact in the Gulf of Kachchh (GoK), Gujarat, India. The GoK is a semi-enclosed basin located between the 20° 15' N and 23° 35' N latitudes and the 68° 15'

and 70° 22' E longitudes. It is one of two highly energetic, macro-tidal systems of the north-eastern Arabian Sea, where tidal ranges may go up to 7.2 m (Vethamony and Babu 2010). The southern coast of the GoK was first declared a Marine Sanctuary (MS) in 1980, and then some parts of it were made a Marine National Park (MNP) in 1982 to provide more protection to its marine ecology (Singh 2003). The MNP spans 162.89 sq km, whereas the MS covers an area of 457.92 sq km (see Figure 1). Administratively, the MNP&S stretches across the Jamnagar, Morbi, and Devbhumi Dwarka districts. There are 42 islands along the southern coast of the GoK, of which 37 islands fall in the MNP area and the remaining five islands under the MS area.

Figure 1: Location of Gulf of Kachchh Marine National Park and Sanctuary



Source: Office of the Chief Conservator of Forests, Marine National Park, Jamnagar

2. HYPOTHESIS AND OBJECTIVES OF THE STUDY

In this study, we investigate the hypothesis that establishing the MNP&S along the southern coast of the GoK is a sustainable option and is acceptable to local fishing communities. The objectives of the study are

- to assess how fisherfolk living along the southern coast of the GoK perceive the MNP&S;
- to examine perceived changes in marine life resulting from the establishment of the MNP&S, by means of a social survey of fisherfolk; and
- to assess, based on local perceptions, attitudes, knowledge, and resource-use patterns, the positive and negative impacts of the MNP&S on the fishing community.

3. LITERATURE REVIEW

MPAs can help in managing and conserving coastal and marine biodiversity if they are accepted by local communities. It is, therefore, important that local stakeholders—like fisherfolk—are consulted about such establishments. Locals can significantly contribute to making MPAs successful by providing historical catch trends, information about traditional practices, and data on changes in the local environment (Jentoft 2000; Himes 2003).

The literature from around the world shows that engaging with local people helps build trust in the government management of MPAs (Beaumont 1997; Himes 2003; Alcala and Puss 2006). In addition, involving local communities can help increase the ease and cost-effectiveness of MPA maintenance (Uychiaoco *et al.* 2005). Indeed, studies have shown that fishers are keen to participate in such endeavours and have a negative reaction to being excluded from decision-making (Pita *et al.* 2010). Further, Hamilton (2012) shows a high level of acceptance of MPAs among fisherfolk in Cambodia and the Philippines, while Mascia *et al.* (2010) demonstrate that MPAs affect the social well-being and political power of fishers by providing food security and control over the governance of local marine resources.

Mascia *et al.* (2010) reviewed the impact of MPAs across 11 countries on five aspects of fisherfolk's welfare: food security, resource rights, employment, community organization, and income. They found that MPAs affect the social well-being and political power of fishers by providing food security and control over the governance of local marine resources. They examined the data of 70 fishing subgroups from 20 MPAs located in 11 countries and reported that "Following MPA establishment, food security generally remained stable or increased ($df = 2$, $\chi^2 = 12.46$; $p = 0.002$), but it declined for 16% of the fishing subgroups" (1426). They concluded that

MPAs may be a viable strategy for empowering local communities and enhancing their food security; however, the study showed that their social impact varies within and among different groups and subgroups.

In India, Karnad *et al.* (2014) surveyed 342 fisherfolk in two states—154 from 39 villages in Maharashtra and 188 from 23 villages in Tamil Nadu—to examine the perceptions of fisherfolk about the state of fish stocks and current fishing practices and management strategies in the country. They reported that a majority of the fisherfolk surveyed—90% in Maharashtra and 83% in Tamil Nadu—perceived declines in total catch due to which they have modified their fishing practices. They found that the socio-economic characteristics of fisherfolk, like income and experience, influenced their perception of the state of fishery in the country. They concluded, "The convoluted interactions between ineffective community and state regulations guiding their actions has prevented fishermen from developing successful models of sustainable fisheries management" (218).

Sridhar (2017) studied the MPAs in India and highlighted the challenges in managing fisheries in such protected areas. She noted:

> The challenges of managing fisheries is not uncomplicated by any means. Traditional management systems based on restricting activities work well only where fishing communities are an integral part of the monitoring and enforcing mechanisms. The idea of intense resource-use was not organic to traditional fisher communities. There is an active effort to promote such a perspective from the hinterland (significantly through technology upgradation schemes of the state). These rapid technological advancements in fisheries and a noticeable systemic breakdown within the fishing communities make conformity to rules difficult. Only where fishing communities are better organised and the level of awareness and political representation greater have these communities been able to enforce some form of rules (traditional or official).

4. STUDY AREA

Of the various coastal states of India, Gujarat has the second-longest coastline (Rajawat *et al.* 2015) and is endowed with a bounty of natural resources. Two of the three gulf regions of the country lie in this state. The southern coast of the GoK, in particular, boasts a diversity of coastal and marine life. However, this region has been heavily exploited for human development activities dating back to the 1930s, when coral mining began (Magotra *et al.* 2017). Subsequent development in this region includes the establishment of Bedi Port in 1933, a unit of Tata Chemicals Ltd., along the coast in Mithapur village in 1937, Digvijay Cement Company at Sikka in 1940, Sikka Port in 1949, and Navlakhi Port in 1955. These occurrences led

to the clearing of large tracts of mangroves for the creation of salt pans in 1970 and the laying of the subsea pipeline of the Indian Oil Corporation Ltd. (IOCL) in 1978 (Magotra *et al.* 2017). These activities took a heavy toll on marine life in the region, and realizing its importance, the state government declared some parts of this coast a marine sanctuary in 1980. In 1982, the area of the MS was expanded, and some parts were declared an MNP to provide them with more protection. Overall, the MNP&S includes 118.32 sq km of reserved forests, 347.90 sq km of unclassified forests, and 98.20 sq km of Indian territorial waters (Biswas 2009). The Forest Department of Gujarat manages the whole area.

This region supports a variety of marine biodiversity due to the availability of a range of habitats, viz. coral reefs, mangrove forests, sandy beaches, mudflats, creeks, rocky coasts, seagrass beds, etc. The region is home to 108 species of algae, 70 species of sponges, 72 species of hard and soft corals, more than 200 species of fishes, 27 species of prawns, 30 species of crabs, 4 species of seagrass, 3 species of sea turtles, 3 species of sea mammals, over 200 species of molluscs, 94 species of water birds, 78 species of birds, 92 species of bivalves, 55 species of gastropods, and more (Magotra *et al.* 2017). Diverse habitats cater to the needs of thousands of species, providing them with suitable shelter and sustenance.

The two major coastal ecosystems of this MNP are mangroves and coral reefs. The total area of reefs in the MNP is 443.49 sq km, whereas mangroves occupy approximately 173 sq km (Kumar *et al.* 2017). These coral reefs are of immense importance and provide a range of goods and services that benefit the people and environment. As per an economic valuation by the Gujarat Ecological Commission (GEC), the total estimated annual value of the benefits from coral reefs (mainly in the MNP in the GoK region) is ₹220.024 crore (Dixit *et al.* 2010).

This area supports a diverse range of fishes. The vast intertidal mudflats also support traditional fishing operations using indigenously developed gear (Biswas 2009). In 2005–2006, the average value of the marine fish landed in Jamnagar (₹52.33) was over 70% higher than the average value of the catch for Gujarat (₹30.36) (Biswas 2009). During 2005–2006, Jamnagar contributed 10.01% of the total marine fish production in the state (Biswas 2009), and during the decade of 2004–2005 and 2014–2015, the district contributed 9.73% of the total share of the state (Sharma *et al.* 2016).

There are 110 villages along the southern coast of the GoK, which administratively fall under the Jamnagar, Morbi, and Devbhumi Dwarka districts of Gujarat. Of these 110 villages, 56 coastal villages were selected

for the World Bank–funded Integrated Coastal Zone Management (ICZM) Project launched in 2010. Its primary focus is capacity-building of local communities for the protection, conservation, and regeneration of mangroves of MNP&S (GEC 2009).

Based on the socio-economic information collected under the ICZM project and provided to us by the Office of the Gulf of Kachchh Marine National Park, we selected six villages located along the coast in the vicinity of the MNP—Sachana, Jodiya, Sikka, Salaya, Arambada, and Bet Dwarka (see Figure 2). Village selection was based on occupational structure, i.e., we chose villages with good fishing populations. We have provided the socio-economic details of the selected villages, along with their occupation-wise involvement, in Table 1.

Figure 2: Study sites of primary surveys



Source: Authors and Google Earth

Table 1: Socio-economic details of the villages selected for the primary survey

Village name	Total house-holds	Total population			Occupation-wise households						
		Male	Female	Total	Agri-culture	Animal husbandry	Fishing	Saltpans	Agriculture and animal husbandry	Misc.	Other work
Sachana	602	2, 292	2, 266	4, 558	107	12	405	0	0	68	10
Sikka	150	626	424	1, 050	0	0	150	0	0	0	0
Jodiya	600	1, 147	1, 053	2, 200	0	0	350	0	0	232	18
Salaya	600	1, 900	2, 100	4, 000	0	0	600	0	0	0	0
Arambada	750	2, 241	2, 259	4, 500	64	15	358	63	8	148	94
Bet Dwarka	407	1, 609	1, 338	2, 947	0	0	407	0	0	0	0

Source: Office of the Chief Conservator of Forests, Marine National Park, Jamnagar

5. QUESTIONNAIRE DESIGN AND SURVEY METHODOLOGY

We used a structured survey adapted from the literature (Hamilton 2012) and edited for site-specificity, with inputs from the Marine National Park Forest Department, Jamnagar, which added more detailed information (presented in the Annexure). The survey included open- and close-ended questions on household demographics, attitudes, awareness, and resource use. Focus group discussions (FGDs) were also held to gain a deeper understanding of the related issues. FGDs involved a discussion with fisherfolk belonging to one village and provided a glimpse of the common understanding of most of the fisherfolk of that village regarding MNP-related issues. It was a form of qualitative investigation where questions related to MNP were asked to find out about the perceptions, attitudes, beliefs, opinions, and ideas of fisherfolk.

The questionnaire was divided into two sections: Section (A), which sought general information about the fisherfolk, including their basic profiles (such as their age, fishing methods, and the species they caught most frequently); and Section (B), which sought their opinions on the perceived impact of the MNP and their willingness to be involved in the management process. Most questions in Section (B) used a Likert scale answering system, with options ranging from "Strongly Disagree" to "Strongly Agree". Other questions had categorical answers, such as "Yes" or "No". We calculated an attitude score for each respondent based on their responses to the questions.

We tabulated the responses from Section (A) to show the mean and standard deviation of continuous data and the frequencies of occurrence (as percentages) of categorical data. We also tabulated data from Section (B) to show the percentage of each response to each question. In this study, we present categorical responses as "Yes", "No", and "Maybe", in which "Maybe" and "Don't know" responses are combined. We measured ordinal responses on a five-point Likert scale ranging from "Strongly agree" to "Strongly disagree" and then reduced it to a three-point Likert scale due to the small sample size; this contained only the responses "Agree", "Neutral" (neither agree nor disagree), and "Disagree". We present the Likert scale responses as percentages of each response from the fishers surveyed at each study site.

We carried out these surveys with the support of the Forest Department at Jamnagar, a local translator, the village-level fishing community head, and social scientists from the Office of the Marine National Park, Jamnagar. We chose fisherfolk randomly at all six sites along the coast and in landing centres. We conducted surveys opportunistically, as the fisherfolk could only be contacted in the morning, during the low tide. It took roughly 15–

20 minutes to complete each survey. We surveyed a total of 35 fisherfolk each in Sachana, Jodiya, Salaya, Okha, and Arambada taluka, and 24 in Sikka. Thus, we surveyed a total of 199 fisherfolk in the MNP&S.

6. RESULTS

We have summarized the information about the socio-economic backgrounds of the surveyed fisherfolk in Table 2. The mean age of all the surveyed fisherfolk was 43.5 years.

The mean age of surveyed fisherfolk ranged from 48 to 39 years in each of the sites. The mean number of years of experience ranged from 23 to 49.83 years. The traditional knowledge of fisherfolk is useful for successfully managing the MPA. The age of fishers can influence their actions and perceptions, including their opinions towards the management of their fishery (Tzanatos *et al.* 2006). Older and more experienced fishers may have better knowledge about coastal and marine resources than younger individuals. Therefore, we attempted to include a greater number of older and experienced fishermen. The fishing gear that they operated varied from one site to another; fixed bag nets, boat seines, and hooks and lines were common across all the sites, whereas in Salaya, our survey showed that most fisherfolk (45.71%) use trawl longlines for fishing. There were significant overlaps between the species they caught—at all sites, fisherfolk caught prawns, pomfret, blue fish, and crabs.

Most fisherfolk we surveyed across the six study sites did not have any occupation or sources of income outside of fishing. Of all the fisherfolk we surveyed in Salaya, Sachana, and Bet Dwarka, 2.86% informed us that apart from fishing activities, they did have other sources of income. In the other sites, the participants reported that they had no other income sources.

The mean boat length varied across sites: it was 26 m in Sachana, 36.46 m in Arambada, 35.09 m in Salaya, 25.77 m in Jodiya, 31.42 m in Sikka, and 38.6 m in Bet Dwarka. We found that the mean boat power was much higher in Salaya (84.86 HP),[1] Sikka (94.75 HP), Bet Dwarka (61.3 HP), and Arambada (54.03 HP) than in Sachana (39 HP) and Jodiya (17.10 HP). The mean distance that fisherfolk travelled to reach the fishing grounds was 79.7 km in Salaya, 56.88 km in Sikka, 46.81 km in Jodiya, 42.44 km in Bet Dwarka, 39.16 km in Arambada, and 36.23 km in Sachana. It seems that the fisherfolk at Salaya and Sikka used more powerful boats as they had to go further into the ocean to catch the fish. This indicates the dwindling availability of fish near the coast in Salaya and Sikka.

[1] HP = Horse Power.

Table 2: Primary survey findings

Village	Sachana (n = 35)		Salaya (n = 35)		Jodiya (n = 35)		Sikka (n = 24)		Bet Dwarka (n = 35)		Arambada (n = 35)	
Socio-economic characteristics												
	Mean (Std. Dev.)	%	Mean (Std. Dev.)	%	Mean (Std. Dev.)	%	Mean (Std. Dev.)	%	Mean (Std. Dev.)	%	Mean (Std. Dev.)	%
Age (years)	39 (14.82)	–	43.6 (10.23)	–	41.69 (13.08)	–	46.21 (9.09)	–	48 (8.86)	–	40.69 (9.67)	–
Experience fishing (years)	23 (14.13)	–	29.74 (9.98)	–	26.49 (12.81)	–	32.17 (8.20)	–	33.4 (14.5)	–	23.80 (7.12)	–
Any other occupation	–	2.86	–	2.86	–	0	–	0	–	2.86	–	0
Fishing characteristics												
	Mean (Std. Dev.)		Mean (Std. Dev.)		Mean (Std. Dev.)		Mean (Std. Dev.)		Mean (Std. Dev.)		Mean (Std. Dev.)	
Boat length (m)	26 (4.02)		35.09 (8.19)		25.77 (3.40)		31.42 (4.05)		38.6 (19.6)		36.46 (12.72)	
Boat power (HP)	39 (28.71)		84.86 (21.29)		17.90 (14.41)		94.75 (7.30)		61.3 (50.7)		54.03 (42.66)	

Source: Authors

Note: % signifies frequency of occurrence

...continued

Village	Sachana (n = 35)	Salaya (n = 35)	Jodiya (n = 35)	Sikka (n = 24)	Bet Dwarka (n = 35)	Arambada (n = 35)
Fishing methods						
	%	%	%	%	%	%
Fixed bag net	65.71	68.57	82.86	–	42.86	25.71
Boat seine	31.43	11.43	62.86	–	–	–
Drift net		8.57	–	–	–	–
Gillnet (large)		–	71.43	100.00	57.14	68.57
Gillnet (small)		68.57	31.43	–	–	8.57
Hooks and line		11.43	5.71	70.83	34.29	5.71
Ring seine		–	–	–	–	–
Traps	25.71	–	11.43	–	–	–
Trawl longlines		45.71	–	8.33	–	–
Scoop net		–	–	–	–	–
Other	–	–	–	–	–	–
Fishing operations						
	Mean (Std. Dev.)	Mean (Std. Dev.)	Mean (Std. Dev.)	Mean (Std. Dev.)	Mean (Std. Dev.)	Mean (Std. Dev.)
Distance from coast (km)	36.23 (13.54)	79.7 (46.65)	46.81 (33.35)	56.88 (14.43)	42.44 (33.07)	39.16 (32.60)
Times per week	4.11 (1.12)	4.26 (0.98)	4.77 (1.73)	4.33 (0.82)	4.8 (1.18)	4 (1.16)

Source: Authors
Note: % signifies frequency of occurrence

...continued

Village	Sachana (n = 35)	Salaya (n = 35)	Jodiya (n = 35)	Sikka (n = 24)	Bet Dwarka (n = 35)	Arambada (n = 35)
Species present in catch						
	%	%	%	%	%	%
Prawns	14.29	97.14	45.71	41.67	77.14	82.86
Shrimps	–	–	–	–	–	60.00
Pomfret	94.29	97.14	91.43	50.00	–	42.86
Crab	–	11.43	85.71	37.50	57.14	17.14
Bluefish (*surmai*)	48.57	25.71	14.29	33.33	45.71	51.43
Lobster	–	8.57	80	–	42.86	25.71
Threadfish (*Dara* fish)	42.86	–	–	–	5.71	25.71
Dutia	5.71	–	8.57	–	–	8.57
Bombay duck (*bumbla*)	–	–	–	8.33	20.00	40.00
Other clupeids (*palli*)	–	–	–	–	14.29	8.57
Kuth	8.57	14.29	–	–	–	–
Sak	–	–	–	–	8.57	–
Catfish	–	–	–	–	48.57	–
Goldfish	40.00	–	17.14	8.33	22.86	11.43
Tuna	–	–	–	–	5.71	–

Source: Authors
Note: % signifies frequency of occurrence

Figure 3: Fisherfolk's opinions about the MNP&S

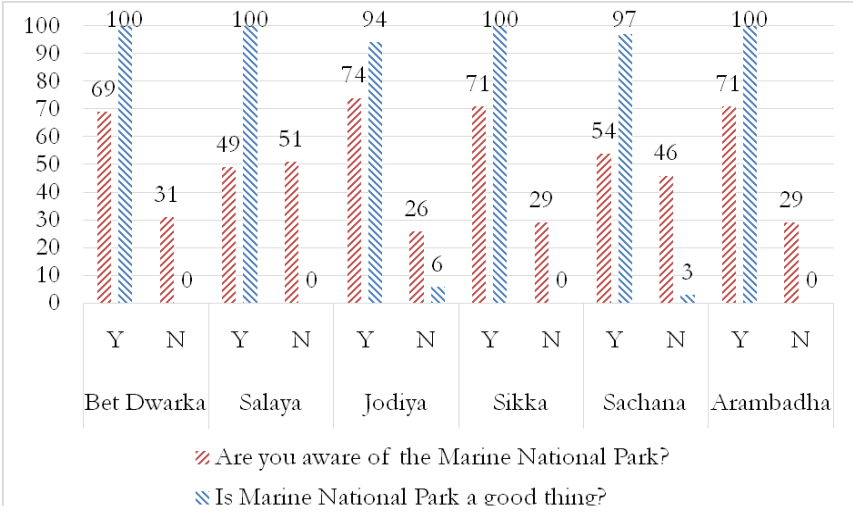
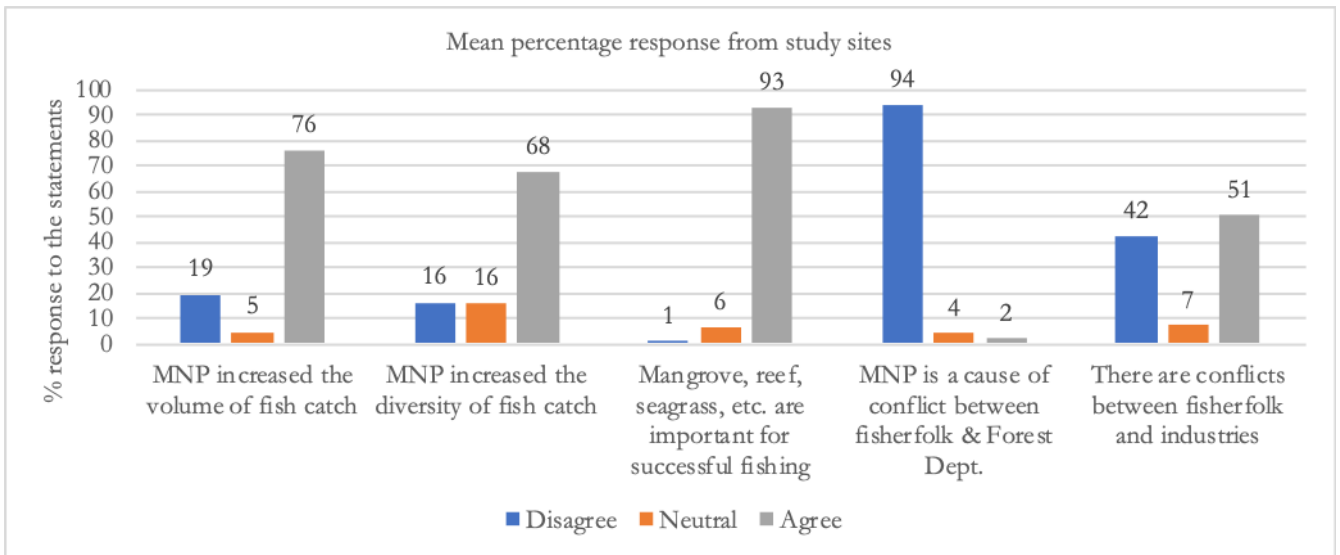


Figure 3 shows that a large percentage of fisherfolk are aware of the MNP; however, a significant minority (a mean of 35.34%) are not aware of the MNP and its importance. This highlights the failure of the regulating body to generate awareness among the general public living along the coast. During the survey, our team provided a brief description of the MNP to the respondents and their families, especially those who were not aware of its benefits. We asked respondents who were aware of the MNP: "Is the establishment of a marine national park/marine protected area a good thing?" About 98.10% of fisherfolk across all the study sites responded positively to the question, with 100% positive responses in Salaya and Sikka. But in Jodiya, some 5.71% of fisherfolk were not happy with mangrove plantation activities because mangrove roots trap sediments, which block creeks and prevent fish from entering; this means that the fisherfolk have to venture out into the open ocean for fishing. The fisherfolk's opinions on sedimentation due to mangroves do not reveal antagonism towards the MNP; rather, the fisherfolk suggested that the concerned regulatory body should work on removing excess sedimentation that is blocking the creeks.

Figure 4: Descriptive statistics on survey statements designed to quantify fisherfolk's opinions about the MNP



Source: Authors

Note: We measured responses to statements on a five-point Likert scale and subsequently reduced it to a three-point Likert scale: Disagree (D), Neutral/neither agree nor disagree (N), and Agree (A).

Figure 4 shows that when questioned about the impact of the MNP on the volume of catch and diversity of fish species caught, there were significant differences between the responses of the fisherfolk from each study site. Most fisherfolk from all six sites (ranging from 63% to 83%) agreed that the establishment of the MNP has increased the volume of their catch. Only in Bet Dwarka, 49% of fisherfolk responded that they had not found any different types of fish species in their catch because their fishing operations were not active near the MNP area; they go further out to sea, far from the MNP area, to fish. This should be a matter of concern for the MNP authorities as fishermen have to move out of the coastal belt for fishing, which may pose more risks for them. MNP authorities should take measures to increase the diversity and abundance of fish species near the coastal area of Bet Dwarka.

Most of the fisherfolk we surveyed—91% in Sachana, 100% in Sikka, 100% in Salaya, 100% in Arambada, 89% in Bet Dwarka, and 77% in Jodiya—felt that mangroves, coral reefs, and seagrasses are important for fishing and fish growth in coastal areas.

Fisherfolk reported positive relations with the Forest Department in all the areas surveyed. A small fraction (6% in Sachana and 6% in Bet Dwarka) reported conflicts with the Forest Department regarding the mismanagement of the monitoring activities of the MNP, the fishing gear that neighbouring villagers used, and the patrolling activities of the Indian Coast Guard near the coast in Bet Dwarka.

There were significant differences in the responses of fisherfolk regarding the presence of conflicts with the industries operating along the coast in southern GoK. Fisherfolk in all the areas we surveyed reported negative relationships with the industries because of their polluting production processes and the dumping of their wastes into the sea, which cause a reduction in fish catch around the coast. According to them, industrial growth benefits some people, but it should not pollute the environment. We found that 86% of the fisherfolk we surveyed in Salaya and 92% in Sikka reported that due to the establishment of industries along the coast, the condition of fish and marine life has deteriorated over a period of three decades, affecting catch size, fish size, and weight. However, in Bet Dwarka and Arambada, only 23% and 34% of fisherfolk, respectively, responded negatively to the establishment of industries; this could be because they have adapted to the changes. According to them, large industries have been operating there for the last 60–70 years, and people living in their vicinity know that they will rarely find fish within 1–2 km of these industries.

Table 3: Fisherfolk's opinions about the state of resources

% response in	Bet Dwarka		Salaya		Jodiya		Sikka		Sachana		Aram-badha	
In the last five years, compared to 10–15 years ago, I've noticed a difference in the catch	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N
Number of (most fished species in) the catch	91	9	97	3	86	29	100	0	71	29	83	17
Size of (most fished species in) the catch	86	14	97	3	77	23	100	0	77	23	83	17
Number of species present in the catch	80	20	83	17	77	23	88	12	71	29	91	9

Source: Authors

Table 3 shows the fisherfolk's opinions about the state of fisheries in and around the MNP. We gathered opinions from all the study sites, comparing changes that the fisherfolk had noticed in the last five years to those they had seen over 10–15 years. Most fisherfolk reported that they had noticed a difference in the state of marine resources over the last 10–15 years. The most common response to a perceived change in the number of fish was "Yes"; most fisherfolk reported an increase in the fished species present in their catch (ranging from 71% in Sachana to 100% in Sikka), the sizes of the most targeted species (ranging from 77 % to 100%) and the number of different species caught (71% to 91%) (see Table 3). All fisherfolk who reported that they had noticed a difference in the state of resources felt that there had been better resources 10–15 years ago. Reasons may vary from area to area; for example, in Sachana, most respondents identified industrial pollution as the major threat to fish in and around their fishing area and the use of small nets by big trawlers from Salaya village as the reason for a decrease in the number of fish and size of their catch. Biswas (2009, 26) also noted similar observations: "Traditional fishers point out that trawler owners are often able to use political and money power to escape penalties. In most places, traditional fishers identified trawling as one of the key reasons for the depletion of fish stocks and destruction of their gear. In the industrialized coastal belt, oil and chemical contamination, salt works and increasing port activity were stated as the reasons for declining catches".

Most fisherfolk in all six study sites stated that they had been asked to change their fishing methods and gear (63% in Bet Dwarka, 86% in Salaya, 77% in Jodiya, 100% in Sikka, 86% in Arambada, and 89% in Sachana). The Department of Fisheries has prohibited them from using small nets for fishing because they capture too many small fish that are not big enough to eat; the catch is therefore wasteful, as these small fish will not have the opportunity to grow large enough to provide a good meal or a good price. Though 86% of the fisherfolk surveyed in Salaya said that they have been asked to stop fishing with small nets, most still use them. During the survey, we observed that fisherfolk from the neighbouring villages, like Sachana and Jodiya, also responded negatively to the Salaya villagers' use of small fishing nets, and demanded that they be banned indefinitely.

Most fisherfolk (ranging from 89% in Bet Dwarka to 100% in Sachana) claimed that they were not aware of any of the MNP's management strategies. However, almost all of them (94% in Bet Dwarka, 94% in Jodiya, and 100% in Arambada, Salaya, Sikka, and Sachana) were keen on being involved in conservation and management planning procedures. Fishing community residents at all six sites responded positively and said that they were ready to support the government in any kind of conservation activities, but being among the key stakeholders, fisherfolk and the fishing community want to be consulted and involved in the preparation of any management or conservation plan.

7. DISCUSSIONS

The hypothesis we investigated in our survey concerned fisherfolk's acceptance of an MNP, based on a survey of fisherfolk at six sites along the coast. The results showed the differences in fisherfolk's attitudes towards the MNP and highlighted factors that influenced their opinions. The small sample size (35 in Sachana, 35 in Jodiya, 24 in Sikka, 35 in Salaya, 35 in Arambada, and 35 in Bet Dwarka) was the main limitation of this study. However, the study does provide some insights into fisherfolk's opinions and acceptance of MPAs—like MNPs—at all the sites we surveyed, and may act as a pilot that could aid the design of more comprehensive research in the future. Any future studies should aim to collect data from a larger sample size of fishers for more robust statistical outputs.

The fishers at all the sites in our survey were concerned about better MNP management to help conserve coral reefs and mangroves. According to the fisherfolk, while the total fish catch has shown an overall increasing trend over the years, there has been a decline in their "catch per unit effort" in

recent years. This is mainly owing to the overall environmental degradation of fishing areas due to rapid industrial development and the construction of breakwaters for ports, jetties, and single point mooring (SPM) stations.

The planning, implementation, and management of any MPA is dependent on stakeholders' opinions on conservation. There is a need to pay adequate attention to gaining the acceptance of those dependent on the resources in that area. A high level of acceptance of the MNP is important for effective, community-based management and conservation. Attempts to conserve the ecology of this marine area could become ineffective if the regulator has low levels of support from artisanal fisherfolk and other related stakeholders. Our survey observations suggest that fisherfolk with little or no knowledge about MNPs are ready to support it and be part of its planning and management, so that conservation efforts do not affect fishing activities. Results from our survey also indicate that most respondents—an average of 98.10% from all surveyed sites—felt that an MPA or MNP is good for the marine ecosystem and for their livelihoods; this is likely due to the fisherfolk having already seen the benefits of the Jamnagar MNP reflected in their catches. Though "catch per unit effort" has declined, an overall increasing trend has been perceived. The decline was noticed because of industrial pollution and big trawlers. As a legally protected area, these activities should be strictly regulated in the MNP. However, at present, these activities are not strictly regulated. The fisherfolk further suggested that they would like to be involved in the management or conservation planning of the MNP.

8. CONCLUSIONS AND RECOMMENDATIONS

We found similarities and differences in the responses of fisherfolk from each study site. The widespread acceptance of MNPs or MPAs in all study sites is encouraging. Our survey shows that fisherfolk from all six study sites support MNPs or MPAs as a conservation management strategy as long as they feel that their fishing activities will not be affected. The MNP&S in GoK is an economic and ecological hotspot; its establishment has certainly slowed down ecological exploitation and contributed to the conservation of biodiversity. Without the creation of the MNP&S, this fragile ecosystem might have been at risk of endangerment or even extinction. Fisherfolk livelihoods might also have been compromised in its absence.

One possible trade-off of setting up an MPA along the southern coast of GoK is the restriction it may pose to uncontrolled resource utilization.

Earlier, extensive utilization of mangroves and coral reefs led to a significant reduction in the area of these two important coastal ecosystems (Kumar *et al.* 2017). However, their degradation has been controlled substantially after the area was declared "legally protected" (Kumar *et al.* 2017). Still, one of the major reasons for the loss of biodiversity in fishing catches and the fall in catch size is the degradation of ecological support structures, such as coral reefs and mangroves. The Central Marine Fisheries Research Institute (CMFRI) has indicated that the most conspicuous change in resource composition over the years was the replacement of quality fish like pomfret and large sciaenid and penaeid prawns with lower-value fish such as ribbon fishes, threadfin breams, carangids, non-penaeid prawns, and smaller crabs (Mohanraj *et al.* 2009). Therefore, conserving mangroves and coral reefs will eventually help increase the biodiversity and the number of fishes in the MNP. Another possible trade-off could be that the fisheries in the GoK are managed so that local fishing as well as open water fishing are practised, and certain areas are regulated to create nursery areas for fish by creating protective mangroves and coral reefs (Singh 2003). This could, however, propel fisherfolk to fish at greater distances in the open ocean, putting them at greater risk. Some fishermen in Jodiya also complained that mangrove plantation activities have resulted in the blocking of creeks, so fisherfolk have to move further out to sea to fish.

Although the fisherfolk had mixed views about some aspects of the MNP (such as the issues causing conflict), in general, they welcomed it and acknowledged the benefits they had received from it in the past. Fisherfolk at all six sites favoured community-based management of MNPs or MPAs. Effective management and local involvement are important for optimal success, and community-based management may be the method favoured by small, artisanal fishing communities in other areas.

The Forest Department should increase the involvement of local communities and village panchayats by assigning them roles and responsibilities in the management and conservation framework of the MPA. This will also decrease conflicts among local communities and other stakeholders. The Forest Department should ensure effective participation of local communities in management and conservation activities, such as mangrove planting, considering the understanding and knowledge that communities have about their ecosystems and how their economic activities relate to their social environment. Local people should be made aware of types of mangroves, the environmental conditions required for their planting, and their contribution to the water table. Local communities should not be used just as labour; rather, they should be trained in mangrove planting and be involved in the long term, so that after planting

they will be able to take care of the mangroves. The department and the local community must have a dialogue on the ecosystem services that the mangroves provide.

We received positive opinions about awareness campaigns from fisherfolk in all our study areas. During FGDs, fisherfolk suggested that there is a need for more awareness campaigns among fishing villages so that wrongful fishing methods can be stopped to increase the fish production in and around the MNP. The Forest Department should consider organizing more awareness campaigns.

This study provides lessons and inputs on the perceived importance and value of the MNP&S. Future work should include studies with larger sample sizes to investigate the opinions of fisherfolk living in the vicinity of MPAs, not only in Gujarat, but also in other states of India that have MNPs. This can provide important policy inputs for promoting the co-existence of economic and ecological hotspots. These two hotspots can co-exist, if rules of co-existence can be sharpened, followed, and strictly monitored. This requires capacity-building of fisherfolk and institutions that work with them on a regular basis. Strict guidelines and monitoring mechanisms need to be in place. International protocols that could be adjusted to local situations should be the starting point.

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RESEARCH PAPER

Flood Mitigation, Climate Change Adaptation, and Technological Lock-in in Assam

Robert Wasson, [*] Arupjyoti Saikia, [**] Priya Bansal, [***] and Chong Joon Chuah [****]

Abstract: Climate change adaptation requires communities and policymakers to be flexible in order to cope with high levels of uncertainty in climate projections, particularly of precipitation, flood magnitude and frequency, and changing human exposure and vulnerability to floods—which are even less predictable than the climate. Most of the world's major rivers are embanked to "protect" communities from floods. Embankments—which represent a significant investment largely of public funds—are a manifestation of the professionalism of engineers and hydrologists. They are also the result of professional and political entrapment and a technological frame that grows in strength (probably non-linearly) by positive feedback to produce technological lock-in. This results in inertia in large socio-technological systems, with little incentive to adopt more adaptive and flexible solutions, including non-structural measures—such as land-use zoning—even in the face of evidence that structural measures do not always reduce damage and, in some cases, actually make it worse. Where embankment breaches are common, damage is likely to increase as climate change induces larger floods, and lock-in and path dependence increase risk. Therefore, there is an urgent need for the mitigation of floods through non-structural measures that complement embankments. While

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the phenomena we describe in this paper are common in many countries, as well as in many states in India, it will focus on data from the Brahmaputra River catchment in Assam.

Keywords: Flood Damage, Assam, Embankments, Technological Lock-in

1. INTRODUCTION

Even before Independence, India's main flood mitigation policy intervention has been the construction of embankments. While there are other flood mitigation strategies, including issuing warnings; providing refuges; creating rescue plans and emergency medical facilities; river dredging; and facilitating education, embankments are widespread and appear to dominate the thinking of decision-makers—if the speeches made by politicians after floods are any guide. The dominance of embankments appears to be an example of technological lock-in, whereby one solution gains ground and others are marginalized. Lock-ins produce inflexibility in decision-making, which, we argue, reduces the region's adaptive capacity given both current circumstances and future climatic conditions that may produce larger floods.

Climate change is likely to be accompanied by more intense rainfall and higher flood peaks in many of India's rivers (Kumar *et al.* 2013), but the uncertainties attached to climate projections make it unpredictable. This problem prompted Kumar *et al.* (2013) to comment that adaptation strategies should be both robust and flexible. In other words, keep your options open—which is the opposite of a lock-in, where options can be extremely limited. Before proceeding to a case study of embankment construction in Assam, we will make a foray into the key concepts of technological lock-in. While embankments are not particularly high-tech, we will show that the analysis of high-tech industries and activities can be applied to flood mitigation to generate useful findings. We suggest that the conceptual framework applied to high-tech industries and environmental management may have wider applications.

2. KEY CONCEPTS

2.1. Technological lock-in and system dynamics

Most studies of technological lock-in have been in the realm of manufacturing, particularly the production of high-tech goods. But some have also paid attention to examples in environmental management (Kline 2001), such as the lock-in of pesticide use for pest management and in

hydrocarbon-intensive industries (Arthur 1996; Unruh 2002). While they differ from the case of embankments as a form of technological lock-in, studies of high-tech manufacturers nonetheless provide useful guidance and analogues for key concepts that help explain historical trends in flood mitigation policies. They also identify ways to unlock the locked.

There are two general explanations of lock-in. The first is the idea that lock-in reflects what Nelson and Winter (1977) describe as "technological regimes" (or epistemic communities), whereby rules, heuristics, or principles define the boundaries of thought and action, particularly those of technocrats such as engineers. This leads to specific directions of development that build on past experience, becoming very powerful means that exclude other solutions (Dosi 1982). Second is the idea of increasing returns (or benefits). This involves positive feedback, whereby the attractiveness of a particular technology increases the more it is adopted (David 1985; Arthur 1989). Positive feedback (also known as reinforcing feedback or "success to the successful") is a system dynamics (SD) concept according to which the direction of change is reinforced (Meadows 2008). That is, if variable A increases (or decreases) then variable B will increase (or decrease), all else being equal. But variable B can also affect variable A, thereby forming a positive feedback loop. In different words, a feedback process (or loop) involves at least two coupled variables, where an initial change (or perturbation) of one (A) causes a change in the other (B), which causes further change in the first (A). For more insights into these processes in relation to floods, see Barendrecht, Viglione, and Blöschl (2017), Srinivasan *et al.* (2017), and Newell and Wasson (2002).

2.2 Socio-technological realms, techno-politics, technological frames, and political and professional entrapment

The variables in SD are usually represented as stocks, that is, accumulations of materials, information, or ideas in a system over time (Meadows 2008). The feedback between stocks is conceptualized as flows that change their size. In relation to the problem of technological lock-in concerning flood mitigation, it is useful to refer to the idea of technological regimes, whereby a set of ideas (and methods) among engineers, bureaucrats, and politicians shape the development of policy and its implementation in a socio-technological realm (Colven 2017) where society is moulded by technology and vice versa—creating another set of feedbacks. But in the words of Bijker (2007), dikes (also known as embankments, levees, or bunds) and dams are thick with politics (with a lower case "p", so not only the politics of politicians). That is, they are not just a technical matter that need design and implementation. This idea can also be constructed as a form of techno-

politics, where technology, politics, and society are co-produced, and a techno-political network formed, bringing together political-economic interests, globalized expertise (consultants in particular), and flows of capital (Sneddon 2015), all by the medium of positive feedback. Kaika (2006) goes further to argue that large water infrastructure projects are central to state-building, developmentalist agendas and the pursuit of modernity, and symbolize the control of nature.

While positive feedback is in place, the system will head in a particular direction. But the construction of embankments will eventually lead to the development of a negative feedback loop as, for example, the cost of maintenance increases. A negative feedback loop is one in which as variable A increases (or decreases), variable B decreases (or increases) and then feeds back to variable A. This is a stabilizing loop.

Though some believe there is a trend toward softer approaches to flood mitigation to complement (or even replace) hard engineering solutions—which have dominated in the so-called "hydraulic age", most notably in the Netherlands (Rijke *et al.* 2012)—the creation of technological regimes, socio-technological realms, and techno-politics, all with strong positive feedback, have created, in many countries, obdurate practices and value systems. As Bijker (2007) sees it, people deeply engaged in these technological frames have difficulty imagining other ways of dealing with risk. A good example of this is the US Army Corps of Engineers, whose only solution to flooding for many decades was the construction of levees. The "hydraulic age" is not over, as we can see in Indonesia, India, China, Australia, and elsewhere. In fact, it never went away, as evidenced by the recent upsurge in the construction of large dams (Merme *et al.* 2014).

For Brown, Ashley, and Farrelly (2011), these technological frames represent political and professional entrapment where there is political risk in moving in a different direction or not taking action after a flood—for example, by promising more (visible) protective infrastructure, fearfulness on the part of professionals in government agencies to speak their minds and therefore challenge the agency's position. There is also a fear among professional government agencies of losing their power if a broader set of mitigation strategies is contemplated, especially if there is to be a hybrid governance system that involves wide participation. Obdurate institutional arrangements, technological frames, and political and professional entrapment maintain and enhance the status quo, whatever it may be. To this rich mix, we can add the financialization of infrastructure (Loftus and March 2015). Investment in infrastructure is considered a way of mopping up over-accumulated capital in the over-developed world. Analogous to the

case of the London desalination plant (whose main objective, according to Loftus and March (2015), was ensuring inflation-protected returns for institutional investors rather than the provision of clean water), embankment construction in many less developed countries appears to be about securing profits for construction companies, kickbacks to elites, and political power. Many countries do not emulate the objectives of the Dutch, who build dikes to keep the water out at all costs. By contrast, in the United States, the government accepts flooding, even in the presence of dikes, and places more reliance on insurance and warnings based on predictions (Bijker 2007). Both countries, of course, have a very different set of experiences of floods, and in the Netherlands, flood protection is an existential issue. In India, the objectives are the protection of lives, property, and revenues to the state by the total exclusion of floods from areas beyond embanked rivers.

2.3. Historical triggers

The Brahmaputra River in Northeast India rises in Tibet and flows through the Tsangpo Gorge to become the Siang River. Then, after being joined by many tributaries, it becomes the Brahmaputra, and leaves India at the Bangladesh border (Figure 1). In Assam, the floodplains of the Brahmaputra and its tributaries are extremely flood-prone, having experienced a total economic damage of ₹20,772.76 crore (10^7) to crops, housing, and public utilities between 1953 and 2011 and an average annual economic damage of ₹352.08 crore (in 2017 prices), according to data made available by the Central Water Commission (CWC). The range of annual total flood damage in Assam is enormous, from an estimated minimum of zero (which is of uncertain veracity) to ₹3,394.84 crore. The people of Assam would be better off with more effective flood mitigation. But first the government would need to reduce its reliance on embankments and help overcome technological lock-in.

As we have already explained, technological lock-in is a result of positive feedback that produces path dependence—continued adherence to a product or idea because of the historical trajectories of ideas and decisions, even in the presence of better products and ideas (Liebowitz and Margolis 1995). These trajectories may start from small beginnings or triggering events. This suggests that history matters in lock-in, an idea brought to the fore by Arthur (1989) in the case of competing technologies.

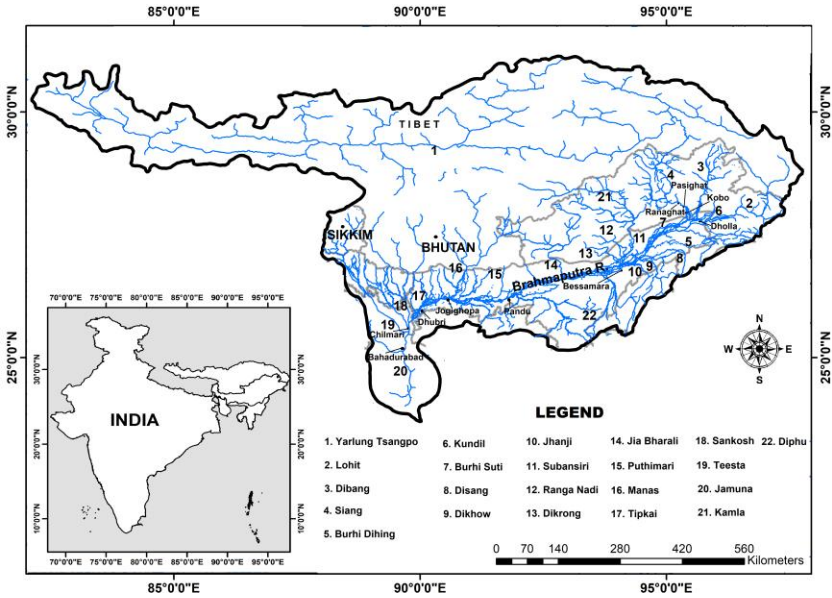
For positive feedback systems, it is worth quoting Arthur (1989):

> Insignificant circumstances become magnified by positive feedbacks to "tip" the system into the actual outcome "selected". The small events of history

> become important. Where we observe the predominance of one technology or one economic outcome over its competitors, we should be cautious of any exercise that seeks the means by which the winner's innate "superiority" came to be translated into adoption. (127)

In other words, that a particular technology, such as embankments, has won the race does not make it superior to its alternatives. The superiority of any technology needs to be demonstrated independent of the path by which it came to dominate the field.

Figure 1: A map of the Brahmaputra River and its catchment from Tibet to Bangladesh



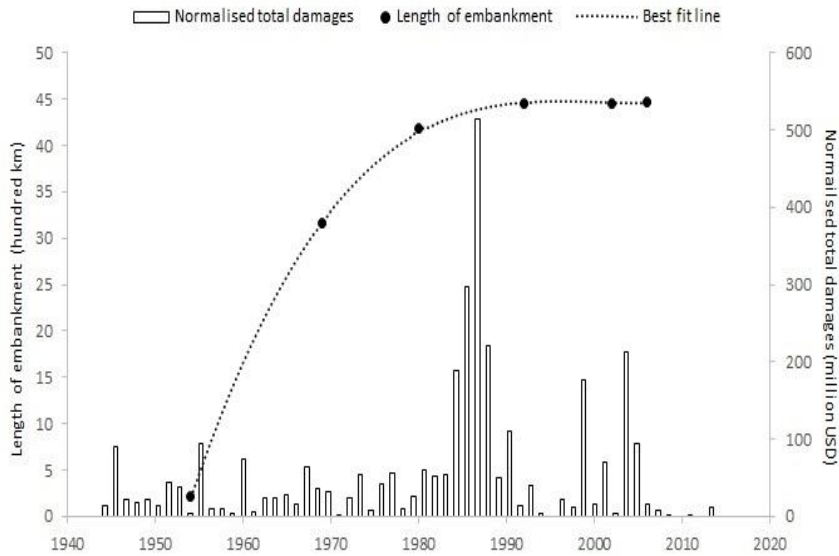
Source: Shukla Acharjee, Dibrugarh University

The disproportionate response to a "small event" (in this case, a flood)—the building of many hundreds of kilometres of embankments—shows that the positive feedback is non-linear. The quantitative nature of this relationship is unlikely to be exponential or super-exponential, because each of these functions implies increasing resourcing at an accelerating rate. The most commonly used function to describe the diffusion of innovation, including infrastructure, is the logistic curve:

$$f(X) = L/1 + e^{-K(X-X_0)}$$

where e is the natural logarithmic base, X_0 is the X -value of the sigmoid's midpoint, L is the curve's maximum value, and K is the steepness of the curve. The curve is S-shaped, rising to the midpoint; then it increases at a decreasing rate. This function has been used to model the spread of innovation, with an initial exponential spurt of activity and then a slowdown, as competitors become more effective (Grübler 1990).

Figure 2: Length of embankments and normalized total economic flood-related economic damages in Assam from 1953 to 2012



Source: Partha Jyoti Das, pers. comm. 2018 for embankment data and Central Water Commission for the damage data.

Data from Assam (Partha Jyoti Das, pers. comm., 2018) suggest a variant of the standard logistic curve, with a rapid increase in cumulative embankment length, which increases at a decreasing rate until the rate of change drops to zero from the early 1990s (Figure 2). The initial increase is a result of the early effects of positive feedback with high levels of enthusiasm, expectations, and resourcing. The slowdown may be a result of decreasing opportunities for construction, rising costs of maintenance, and a slowing of revenue injections as other priorities take over. We would require a detailed history of embankment construction and associated costs to test these explanations of the curve in Figure 2. However, the Comptroller and Auditor General of India (2017) provides some insights into the possible reasons for the slowdown: delays and shortfalls in the sanctioning of funds;

the diversion of funds sanctioned for flood control to unapproved work; major delays in work; poor design and implementation, leading to embankment failure; and weak technical skills in the states responsible for flood protection. All of these factors can slow the development of flood mitigation infrastructure.

Figure 2 is an example of an external-influence logistic function, the basic model for which is

$$\frac{dN(t)}{dT} = a[Nt - N(t)]$$

where $N(t)$ is the cumulative number of adopters at time t, N_t is the total number of potential adopters at time t, $\frac{dN(t)}{dT}$ is the rate of diffusion at time t, and the constant a is a change agent that is equal to the coefficient of diffusion (Kumar 2015). For application to the problem of embankment construction, adopters and potential adopters are assumed to be equivalent to the length of embankments. The key difference between this equation and others presented by Kumar (2015) for cases where there are external influences, and mixtures of external and internal influences, is the inclusion of the constant a, a change agent. When influence comes from outside the wider society, decision-making is directed from the top, and communication is strongly hierarchical (Kijek and Kijek 2010; Kumar 2015). In Assam, the change agent is the politico-bureaucratic system.

The best least squares fit for the trajectory of cumulative embankment length in Assam (Figure 2) is a four-parameter logistic curve:

$$Y = -11.43 + \frac{(44.76 + 11.43)}{1 + 10^{(\log 1961 - X)0.06751}}$$

where Y is cumulative length (100s of km), X is calendar date, the halfway point is 1961, and the r^2 is 0.99, but with only six data points.

2.4. Unlocking the locked

The obvious way to unlock the locked is to initiate negative feedback. According to Arthur (1989), small historical events, such as small-scale trials of non-structural mitigation, will have no effect on this type of system, and history will be the carrier or deliverer of the inevitable. But a major flood that devastates an area where alternatives to embankments have been trialled could tip the system back into its former state of positive feedback, leading to the construction of more embankments.

There is, however, a larger problem. As we have seen, technological frames, professional and political entrapment, and lock-in are highly resistant to change. An easy exit from a locked-in trajectory is unlikely because of significant sunk construction costs, the development and application of particular kinds of expertise, the political capital expenditure a change would entail, and reputational risk if a decades-long policy is suddenly reversed. For example, revenues to construction companies in the case of large infrastructure projects and kickbacks to elites will also be at risk if a major policy change is instituted. Nevertheless, according to Islas (1997), hybridization can allow marginalized solutions to emerge beside the dominant one, but only in niches not occupied by the dominant solution.

2.5. Summary of key concepts

A technological lock-in results from technological frames—stocks of ideas developed by professionals and decision-makers—that limit the range of solutions considered during policy formulation. Locked-in solutions are not necessarily superior just because they have been overwhelmingly adopted. We must determine superiority independently. There are many elements to technological frames, including socio-technological realms, political-technological networks, and professional and political entrapment. A system's trajectory will be unidirectional if positive feedback is in play once a historical event triggers a trajectory—and therefore path dependence—that favours one technology or solution. As adoption increases, positive feedback in response to the ideas in the technological frame increases its power and acceptance, and more resources may become available, driving a non-linear response. In this process, other solutions are swept aside in the battle of ideas and the struggle for resources. There could be a slowing in the rate of adoption of embankments as space for easy construction reduces. Enthusiasm may also wane, especially in light of the damage created by breaches; and maintenance costs may increase along with other calls on the public purse. The result is a positive feedback function in Assam, which is a variant of a logistic curve that denotes external influences on the construction of embankments.

It may be possible to unlock the locked by creating a negative feedback system, a prospect that is extremely difficult to achieve if the lock-in is obdurate. A path more likely to succeed would involve the development of a hybridized set of solutions, where we can find alternatives to the dominant solution in niches that it does not necessarily deal with well—or we could find solutions that complement the dominant one.

3. THE HISTORICAL DEVELOPMENT OF A TECHNOLOGICAL FRAME IN ASSAM

Colven (2017) notes that to understand the allure of big infrastructure, "we need to trace the emergence and evolution of the geographically and historically contingent techno-political networks through which such projects emerge" (261). This section attempts for Assam what Colven suggests, and is based mainly on Saikia (2019, Chapters 2, 7, and 11).

As early as the sixteenth and seventeenth centuries, embankments (also known as *alis* in Assam) were constructed to protect small areas from floods, and for many years, farmers used low-level bunds to reduce the impact of floods but also to allow water and sediment to reach fields. This resulted in localized and moderate benefits. By the first few years of the twentieth century, there were only 180 km of high embankments in Assam. A committee established by J. B. Fuller, the Chief Commissioner of Assam under the British Raj, investigated the possibility that embankments could allow larger areas to be cultivated and damage to crops reduced. It examined additional questions that are still pertinent today, many of which have not been answered satisfactorily, such as: what would be the consequences of depriving land of silt and its natural fertilizing role? Peasants interviewed by the committee raised this issue; they also raised issues of waterlogging behind embankments, pointing out their failure. In addition, they asked if riverbeds would rise relative to floodplains because of sediment accumulation between embankments and due to sediment starvation on the floodplains behind embankments. The committee also wanted to know if larger areas of cultivation would increase revenue, a key concern for the British Raj.

The Fuller committee received varying opinions about the wisdom of embankment construction, ranging from views that embankments were not necessary for the protection of agriculture—as there was plenty of cultivable land—to beliefs that riverbeds may either rise by sediment accumulation (relative to floodplains) or decline because of erosion by high-velocity flood flows trapped between embankments, and concerns that the revenue increase from protected land would be much smaller than the cost of constructing and maintaining embankments. However, the committee found evidence in favour of embankments, and in 1903, received approval for the construction of new embankments on two tributaries of the Brahmaputra, followed by increased land revenue assessment.

But the debate about the wisdom of embankments continued, largely revolving around concerns regarding the lack of natural fertilization and the problem of waterlogging, as embankments prevented the drainage of

floodwater and presumably ponded rainwater (Hart 1906). In the past, during particularly wet seasons, peasants would relocate to drier land, but this became difficult when property laws became less flexible and the population and the area of settled agriculture increased during the British period, thereby making the relinquishment of land almost impossible. For some people, waterlogging became an intractable problem. The agricultural chemist and soil scientist, A. A. Meggitt, supported the peasants' view that natural fertilizing was essential, and suggested the installation of flood sluice gates to enable this process (Chief Secretary 1909). Lechmere-Oertel (1918), an engineer with the Public Works Department, argued against embankments on the same grounds as Meggitt. Additionally, Spring (1903), the Chief Engineer of India's Public Works Department, wrote in praise of the traditional method of living with floods, whereby people moved their meagre possessions to higher ground in family boats.

To this contentious milieu was added the construction of railway lines on embankments from 1903 onward, most of which were built on floodplains by 1930 (Public Works Department 1929–30). These embankments disturbed lowland drainage paths and therefore blocked the drainage of floodwaters, rendering some low-lying areas unfit for cultivation and causing havoc when they breached (The Times of India 1934). An investigative committee formed after the 1929 flood found conflicting views among peasants, depending on whether they lived "inside" or "outside" a railway embankment (Lines 1930). Those "outside" the embankments were content, while those "inside" were not.

By the mid-1930s, flooding in Assam was gaining more attention from both the government and the international press (e.g., Western Argus 1934) with widespread destruction of crops, houses, and livestock (Wall Street Journal 1934). For the colonial government, the impact on revenue of the destruction of jute crop was particularly important, as the Brahmaputra Valley had become the principal jute-growing area in South Asia by the 1930s. This widespread cultivation of jute followed debates about the wisdom of using land that the local people did not cultivate because of flooding, except for temporary mustard and vegetable crops during the winter and some summer rice, although jute was believed capable of withstanding floods (Saikia 2015). But the influx of peasants, mainly from East Bengal (now Bangladesh), mostly to grow jute, was well underway, making the debate almost pointless. Between the censuses of 1911 and 1951, 1–1.5 million migrants had moved into Assam, constituting between one-tenth and one-sixth of the total population. The cropped area approximately doubled, areas of settlement increased, and the cultivation of jute, sugarcane, mustard, and winter and autumn rice increased in the areas

occupied by these hard-working migrants (Doullah 2003; Goswami 1994; Chakraborty 2012). This transformation of agriculture in Assam was not only aided by the construction of embankments—embankments were themselves necessary for the maintenance of increased revenue flow to the government's coffers.

After the flood of 1934, Shaw (1935), an engineer with the Public Works Department, prepared a report in which he noted that the area was prone to some of the heaviest rainfall in the world and, when combined with large-scale reclamation of land for jute cultivation, much of the lower valley was at risk of economically damaging floods. Shaw also argued against embankments, writing that they "constitute a gross interference with the natural regime of the river" (8). He listed solutions such as relief payments to peasants, remission of land revenue, and new land grants, some of which were enacted (Saikia 2014). In addition, he found that the new migrants who arrived to grow jute did not grow food, so they became vulnerable to flood-induced food shortages.

The 1946 flood in Assam spawned yet another report, this time by S. C. Majumdar, an engineer with considerable experience of floods in Bengal. Majumdar (1948, 1956) concluded inter alia that embankments defy nature and should only be used on rivers that are relatively stable, and that embankments can cause disasters by raising the intensity with which floods reach floodplains, because of sedimentation within channels between embankments, thereby causing more damage than would occur without embankments and also resulting in the need for higher and stronger embankments until they provide no protection. He added that embankments should not be viewed as permanent solutions, and the old embankments of the sixteenth and seventeenth centuries CE created vast swamps at a lower level than the surrounding land, which continued to receive sediment. Majumdar made the obvious remark that floods are shallower and less dangerous if allowed to spread across floodplains rather than being pent up behind embankments that can easily breach.

The bureaucrats of Assam continued to oppose embankments, so that by 1947, there were only 11 km of new embankments (RBA 1980). The Government of India declared embankments unsuccessful as flood protection devices (Ministry of Information and Broadcasting 1949); after the 1950 earthquake and floods, the technocrat G. C. Garg and Kumud Bhushan Ray (special officer for rivers in Assam's Public Works Department) advised against embankments. Ray (1954) concluded that embankments were costly and non-remunerative, and did not provide protection against large floods.

Prior to 1954, there was no unified technological frame in favour of embankments in Assam. Many bureaucrats and engineers were not convinced of the efficacy of embankments. They cited the unintended consequences of waterlogging, sand deposition on agricultural land during breaching, and reduced natural fertilization of fields through sedimentation. By this time, there had been many flood events (the "small events" referenced in Arthur [1989]) that could have triggered the consolidation of a technological frame in support of embankments, particularly in 1929, the mid-1930s (especially 1934), 1946, and 1950, each of which was followed by a government investigation. But none of these events triggered this consolidation.

The 1950 earthquake, with a magnitude of 8.6, devastated Assam, and was followed in 1952, 1953, 1954, and 1955 by severe floods that damaged crops worth ₹13.5 crore in 1953–1955 (₹520 crore and US$2.1 million in 2017 prices; there are no data for 1952) and destroyed 65% of the paddy and 53% of the jute. It was claimed that inundation covered 31,000 sq km (an implausible 40% of the state), and affected about 1.2 million people (Assam Government 1956). These floods eroded riverbanks and swept away agricultural land, villages, and lives, depositing sand on land that had once been cultivable. Some towns vanished while others faced massive erosion. The town of Dibrugarh had begun serious attempts at riverbank protection in 1935 after the 1934 flood, with anchored trees, brushwood screens, tree branch revetments, and anchored floating bamboo cages. Some 450 m of a planned 6 km stone revetment was finished before the monsoon of 1954 struck, and floodwaters outflanked the entire structure. The situation was so serious that the then Prime Minister, Pundit Jawaharlal Nehru, took charge and paid a visit, entrusting to the Central Water and Power Commission (CPWC) with the responsibility of protecting the town from further floods (Ray 1956; Singh *et al.* 2004).

The flood of 1954 not only swept away lives—it also swept away apprehensions about embankments, at least in government offices. A simplified version of the Assam Embankment and Drainage Act 1941, enacted in 1954, enabled embankment construction. About 855 km of embankments were completed swiftly (Verghese 1954). An Indian delegation to China reinforced the value of embankments (Sain 1954) and Reddy (1954) provided a glowing report on China's use of embankments to control floods. Engineers of the CPWC began arriving in Assam, training in surveying and construction methods was arranged, and labour for embankment construction recruited (Verghese 1854).

The flood of 1954 was the "small event" in Arthur's (1989) conceptualization of how positive feedback is triggered by a seemingly insignificant event and leads to an outcome that is disproportionally large. As a result, one option gets locked-in, and path dependence begins. These small events of history are important, and although the residents of Assam who lost their property and loved ones may not see the floods of the 1950s as "small events", they appear to meet the requirements of Arthur's model. But why did the earlier floods not create the same path dependence? The answer may lie in the personal intervention of India's first prime minister and the institutionalization of a response in the CPWC. Whatever the answer, it is clear that the 1954 flood turned the tide of government opinion—and thus path dependence began.

The most visible protection works were in the town of Dibrugarh, which had suffered serious flood damage. Embankments built in 1954–1956 were raised and strengthened in 1963–1966, 1977, and 1980, and again after flood damage in 1988, and to this day continue to be refurbished, partly as a result of the heightened level of floods resulting from the increasing channel bed level (UN-Habitat 2002; ADB 2009).

Other ideas were proffered to mitigate floods, such as cleaning drainage channels, digging a deeper channel for the Brahmaputra (which has now been trialled), beginning reforestation of the catchment to slow storm runoff, raising villages, and constructing storage reservoirs (Kingdon-Ward 1950; The Times of India 1954; Ray 1956). But the push for embankments was well underway, along with the restoration of some abandoned channels to promote drainage, the digging of new drains, and the promotion of sedimentation in some areas to raise land levels (RBA 1980). Although some still doubted the efficacy of embankments in the face of mighty natural forces, by 1978, a total of 4,000 km of embankments had been constructed in Assam, along with at least 700 km of drainage channels. Breaches had occurred in some new embankments within a year of construction, and some caused conflicts with villagers, but construction continued, as those in favour of the policy continued to accrue political and economic benefits. By the end of the twentieth century, about 1,000 km of embankments had been constructed along the Brahmaputra, measuring about two-thirds the total length of the river. Since then, embankments have been further extended along tributaries. Rivers in about 50% of Assam's total flood-prone area were embanked about a decade ago (Asian Development Bank 2010).

Our field observations and informal discussions with villagers and government officials in Upper Assam show that many people have now

become dependent on embankments for refuge during the worst floods. Some have replaced their traditional stilt houses with concrete constructions on the ground. Similarly, they have also built schools and meeting halls near embankments; and they are now using previously uncultivated land just behind embankments. Hazarika *et al.* (2016) found from surveys in Dhemaji District that the construction of embankments has attracted several people to live and cultivate the land near the rivers, and that the occurrence of floods, in the minds of local people, is synonymous with breaching of embankments. According to their study, even though embankments are refuges, breaches do more damage than floods in places where there are no embankments.

Many factors have produced the current, embankment-dominated flood policy in Assam. The most important ones appear to be a need to protect valuable assets such as towns and cultivated areas; increase the area of cultivation; and protect and increase government revenue from cash crops, the most important of which was jute. This process has a history of more than a century, with the establishment of jute and the importation of migrants from East Bengal to grow the jute, both initiated by the colonial government. The path dependence of increasing embankments resulted from positive feedback between the maintenance and protection of cash crops and revenues, and from technological entrapment and a growing technological frame.

The historical trigger for this path dependence was the flood of 1954, even though there had been earlier floods of similar magnitude with similar destructive outcomes. Political involvement and institutionalized responses appear to have tipped the balance in favour of embankments, and the technological frame established was able to sideline differing views about the efficacy of embankments.

4. THE FITNESS OF EMBANKMENTS

Fitness is a concept that analysts of high-technology products use to decide whether path dependence produces the most fit goods—or something that is sub-optimal. While Arthur (1989) argued that sub-optimal outcomes are common, later researchers criticized this conclusion (e.g., Islas 1997).

While a full exposition of ongoing research by the authors into this important topic is not possible here, we have analysed data from the CWC for trends in death and economic damage, normalized by total population and GDP/capita, respectively. Using the non-parametric Mann-Kendall Tau (b) test for all-India data, we have found an increasing trend in adjusted

damage from 1953 to 2011 ($p<0.01$), but no trend in adjusted deaths. However, from 1982 to 2011, when embankments were much more extensive than earlier, normalized deaths decreased ($p<0.01$), but there is no trend in normalized damage. The area affected by floods also declined between 1982 and 2011 ($p<0.01$), confounding any simple explanation of these results, although the smaller area of flood-affected land may explain the reduced deaths. This complication notwithstanding, Figure 2 shows that normalized total economic damage was at its highest between 1986 and 1989, when the length of embankments was almost at its greatest extent. It is not at all clear whether embankments make a large difference to deaths and damage because breaches occur during large floods, or because embankments are outflanked when incomplete—a result consistent with the modelling results of Barendrecht *et al.* (2017).

5. RIVER LINKING: ANOTHER POWERFUL TECHNOLOGICAL FRAME

The long-standing technological frame created by engineers, hydrologists, bureaucrats, and politicians lives on in India, exemplified by the River Linking Plan (Alley 2004; Rao 2003). This ambitious plan to link India's major rivers aims to provide irrigation water to drought-prone areas, generate additional hydroelectric power, and reduce the extent of flooding. The scheme calls for the construction of a great many dams and canals. It is not at all clear how the plan will alleviate floods, except possibly by building large dams to absorb flood flows—an uncertain option if the dams are mainly intended for the supply of irrigation water and the generation of hydroelectricity. Simultaneously meeting these three objectives is not easy. Rao (2003) notes that the likely transfer from the Ganga to the Cauvery River, for example, will amount to only 2.5% of the maximum flood flow in the Ganga, a figure too small to have any effect on floods in the Ganga. But there do not appear to have been any publicly available analyses of the ways in which the plan may alleviate flooding. Alley (2004) argues that scientific data and detailed plans for the scheme are deliberately withheld from public scrutiny, leaving non-government experts and members of NGOs no option but to polarize the debate and reject the scheme, given that its risks cannot be analysed independently and appear large in the absence of other information.

The solution to big water problems in India continues to be big infrastructure projects, where a strong technological frame sidelines all objections and alternatives. The creation of a broad-based and knowledgeable epistemic community is not possible, so aspects of the

scheme that should be assessed outside its formative technological frame are not assessed, and serious problems may emerge. For example, about 34% of the gross erosion of Indian soils is deposited in reservoirs, with a resulting annual average water storage loss of 1.04% and an upper value of 0.8% per annum in large reservoirs (51>1000 mm^3 capacity) (Sharda and Ojasvi 2016). Is this loss of storage capacity, and the attendant loss of flood absorption, being considered in government planning for river linking? Further, the state has prepared Emergency Action Plans for only 7% of the existing large dams in India and Operating Manuals for only 5% (Comptroller and Auditor General of India 2017). If the river linking scheme is to generate many more large dams, how will it ensure their safety, given the slow development of preparedness to date?

6. CONCLUDING REMARKS

From the analysis presented here, it appears that there has been lock-in of embankments in Assam as the main flood mitigation strategy. This is a region characterized by an extraordinarily volatile and fluid landscape, and it appears that lock-in may also have occurred in other Indian states as well (see D'Souza 2006). An analysis of death and damage data shows that though embankments have had some effect, they have certainly not solved the problem. In some cases, they have exacerbated deaths and damage when they have breached or have been outflanked. So lock-in has produced a sub-optimal result, but one that has nonetheless had some benefits, such as acting as a refuge and protecting some land and villages.

A major shift in Indian flood mitigation policy away from embankments appears to be unlikely, since it is driven by a top–down approach. We have seen this in the external influence logistic descriptor of the history of embankment construction in Assam and the prevailing strong and obdurate technological frame, exemplified by the river linking project. It is more likely that policies that complement embankments will succeed only if they fill a niche not already occupied by embankments. Such policies are floodplain planning and the enforcement of zoning; better warnings; implementation of the building code; insurance; relief schemes tailored to levels of risk, so that those who choose to live or rebuild in high-risk areas get little or no flood relief apart from humanitarian aid during and immediately after a flood; and relocation of highly exposed and vulnerable populations. These solutions may be applicable where embankments have not been built, and in the long run, they could demonstrate an approach that will replace embankments.

We require a more flexible and holistic set of flood mitigation policies in the face of climate change, given that rainfall intensities and flood peaks are likely to get larger. Embankments alone are insufficient, and at times, even dangerous.

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SPECIAL SECTION: New Epistemologies of Water in India

Editorial: Setting the Context

Jenia Mukherjee [*]

The Anthropocene and the "nine planetary boundaries" framework have informed, and in turn have been informed by, rigorous quantitative models and in-depth qualitative studies across global, regional, and local units of analyses.[1] Contemporary water research, by critically revisiting existing ontologies and epistemologies with the agenda of addressing "wicked problems", is an advancement in this direction.[2] Wesslink, Kooy, and Warner (2017) point out that the motivation to combine disciplinary methodologies and study water from both the natural science and social science perspectives was driven by the need to collectively understand complex and interdependent water-related societal challenges. This has led to the emergence of fields such as socio-hydrology and hydrosocial research, which can be considered epistemological departures, as they perceive "water—and the systems within which it flows—as both social and natural" (Wesslink, Kooy, and Warner 2017, 2). However, socio-hydrology and hydrosocial research differ in their methodological designs and applications—the outcomes of their different disciplinary orientations and ideological affiliations. To contextualize hydrological science, socio-

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[1] The nine planetary boundaries include: climate change, ocean acidification, stratospheric ozone depletion, atmospheric aerosol loading, biogeochemical flows: interference with P and N cycles, global freshwater use, land-system change, rate of biodiversity loss and chemical pollution (Rockström *et al.* 2009).

[2] Problems are "wicked" when they are multi-layered, interconnected, difficult to define or delineate, cannot be solved with quick fixes or technical solutions, and keep reappearing time and again unless perceived as a composite whole and addressed at their roots (Rittel and Webber 1973).

hydrology often relies on quantitative or mathematical modelling to represent the water–human relationship. On the other hand, hydrosocial analysis aims to reveal how power operates in water–society connections, and how water shapes and is shaped by society (Lafaye de Micheaux and Mukherjee, *forthcoming*). However, despite the methodological and political challenges of transdisciplinarity (Wesselink, Kooy, and Wagner 2017), through which socio-hydrologists and hydrosocial researchers can actually come up with shared research designs and courses of action, water researchers are now ascribing value to "disciplinary trespassing" (Rusca and Baldassarre 2019). Drawing on their own research experience and expertise, Rusca and Baldassarre (2019) demonstrate the multiple ways in which different natural science and social science water research frameworks can converge and become compatible and complementary to each other. Reflecting on the significance of "reciprocal learning" for water researchers, Evers *et al.* (2017) have conceptualized a "pluralistic water research" approach that is "integrative and interdisciplinary" and which aims to "coherently and comprehensively integrate human-water dimensions".

The South Asian water scene is huge and diverse, leading to the exploration and analysis of complex problems using natural science and social science approaches, such as socio-hydrology, environmental history, and political ecology (including hydrosocial studies).[3] While transdisciplinarity is yet to emerge in India (with the exception of very recent large-scale projects that have brought hydrologists and social scientists together—for example, ATCHA and EqUIP), contemporary social science-based water research is limited to the analysis of power relations among multiple actors, much like the mainstream political ecology of water (Mukherjee 2020).[4] This is problematic, as there is "something distinct to water, to water experiences and water knowledges in Asia" (Baghel, Stepan, and Hill 2017, 2). This special section advances alternative new epistemologies of water (NEW) within the South Asian—and particularly the Indian context.

In the opening article, "Knowledge Others, Others' Knowledge", Lahiri-Dutt clearly explains why NEW is imperative for the Global South. She

[3] The socio-hydrological framework is still novel in the Indian context, with very few case studies to date (Wescoat 2013; Srinivasan 2015; Nüsser *et al.* 2019). A detailed historiography on water social science paradigms is available in Mukherjee (2018).

[4] The ATCHA project (https://www6.inrae.fr/atcha/Presentation) combines an integrated biophysical model with a participatory approach that aims to help farming systems adapt to climate change in a network of experimental watersheds in Karnataka, India. The EU-India sponsored EqUIP Project (2019–2022), which aims to analyse "fluid governance" paradigms in the Rhone and Ganga Deltas, comprises an interdisciplinary, international team of geomorphologists, political ecologists, historians, cultural studies researchers, and critical physical geographers.

critically interrogates the hegemony of western epistemology, where water is commodified into "modern water" (Linton 2010) or "normal water" (Schmidt 2017), abstracted from social, political, and cultural dimensions. The author talks about the need to transcend a singular "way of knowing" water by recognizing alternative forms, and thus postulates "an anti-hegemonic ecology of knowledges" (p. 121). Based on her study of the lives of islanders "dancing with rivers" in Bengal, Lahiri-Dutt evolves her theoretical conviction, which finds strong manifestation in her arguments. With her expertise and strong grasp of ethno-theoretical discourse, Lahiri-Dutt discusses the need for, and potential of, feminist epistemologies using examples from global projects—such as the Sustainable Development Investment Portfolio (SDIP) at the Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia—to provide directions through which gender can be integrated into the study of rivers and riverine communities.

Moreover, spatial diversities and specificities (like tropical-deltaic materialities), coupled with rich customary practices and traditions, underlie socio–water enmeshings that need to be unveiled, understood, documented, and analysed for both academic and policy interventions as well as the intersections between the two. Mukherjee and Ghosh apply the "hydrosocial" lens to the *chars* (riverine islands) of the Lower Ganga Basin in the Malda and Murshidabad districts, West Bengal, to capture the micro-realities of everyday life and livelihood dynamics in the "muddyscapes". They question western knowledge of "solid" (land) and "liquid" (flowing waters) to formulate a "fluid epistemology" and enrich the "hydrosocial" through the proposition of the "hydro(sediment)social" that incorporates complex interactions between water, society, and mud. The article advances why and how it is imperative to rethink sediment beyond their physical-geomorphological existence and as social sites of interaction. It activates the agency of sediment by not only understanding it as an emblem of uncertainties and volatilities, but also as a zone of opportunity and possibility bestowed with rich ecosystem services and the collective resilience of the *choruas* (islanders; people inhabiting *chars*).

Sen, Unnikrishnan, and Nagendra's article on "imperilled waterscapes" uses history and political ecology to provide a long-term narrative of social and ecological change in Bengaluru's lake system, with a particular focus on Bellandur Lake, the largest lake in the city. The major systemic change that the article discusses is a rupture in the connectivity between lakes, which has caused a reversal in both the imagination and reality of the lake from a "flowing" to a "static" network of water. Using historical sources such as inscriptions, archival records, historical maps, oral history interviews, and

primary fieldwork spanning the past six years, the authors document urban waters and identify rapid urbanization as the main cause that led to these water bodies losing their connectivity and the reason for their physical transformation into stagnant, isolated pools of water in different parts of Bengaluru. The article familiarizes readers with ancient stories, myths, legends, and practices surrounding Bellandur Lake, and re-contextualizes water within social and cultural systems. Modern infrastructure, like piped water and sewage disposal systems, not only led to the drying up of these lakes and their transformation into sewage-filled water bodies, but also altered the cultural practices associated with them. The authors lament that protest and petition drives remain sporadic; isolated and compartmentalized attempts to restore particular lakes have failed as the significance of lakes as an interconnected system has already lost ground, leading to "a lack of systemic engagement with the dynamics of this complex social-ecological system" (p. 132). By making "invisible epistemologies of water visible again" (p. 133) through historical and ethnographic narratives, the authors emphasize the role of lakes as "systems" in augmenting urban environmental resilience.

NEW not only acknowledges the need to broaden and enrich the vista of Indian water research by unravelling multi-layered and interdependent historical and political complexities and cultural specificities, but it also introduces integrated frameworks through which this can be scientifically done. Combining political ecology and *mésologie*, Lafaye de Micheaux and Kull imagine a new "environmental geography of rivers" to capture how both the ideas and materialities of rivers operate in the contemporary social order. The article chronicles diverse ways of knowing rivers across historical conjectures, from antiquity through the Renaissance and to contemporary times. The authors demonstrate how post-modernist approaches emerging since the 1980s are a departure from the long-lasting modernist perspective. Post-modern scholars have revisited and reconceptualized the complex relations between objects and subjects and humans and non-humans, focussing on hybrids instead, with binaries and boundaries becoming dysfunctional. The post-modern moment facilitated "non-modern" ontological and epistemological ruptures, evident in contemporary water research frameworks like political ecology (more specifically the "hydrosocial") and mésologie. While the political ecological perspective enables researchers to account for the *dialectical* and *internal* relation between water and society, *mésologie*, propounded by the French geo-philosopher Augustin Berque, focuses on the "milieu", which is simultaneously physical, ecological, and based on human interpretation (Berque 2014). The authors argue that by integrating these two frameworks, emotions and attachments

towards rivers can be understood as embedded within the strategic field of power relations. They discuss the significance of applying "hydrocosmological" and "mesopolitical" lenses, draw our attention to case studies, and explain why and how Indian rivers—like the Ganga—offer the most appropriate context for analysis along these lines.

NEW also brings hydroculturality to the fore in an empirical manner through field realities and shows how the Indic perspective shapes our "pre-modern" (non-Western) water perceptions. DasGupta's article on the Sundarbans deploys the water culture lens to underline the evolution of human history through the propulsion of religious water customs. DasGupta reflects on water-centric quotidian actualities through nuanced readings of oral histories collected from the field and examines their relation to the local religious literature. By analysing regional narratives and customary practices in relation to the local religious culture, as evident in the folklore and traditions of the Sundarbans Delta, the article explores cultural and historical imaginations surrounding water that influence—and, in turn, are determined by—the island archipelagos and their inhabitants. The application of the "hydrocultural" framework enables us to know and understand the multiple ways through which water and cultural practices have shaped each other historically; this provides an opportunity to rethink the aqua-centrism of communities at the margins of social development. Mukhopadhyay and Choudry's article on "Indic hydro-epistemologies" explores the sacrality (and secrecy) of things revealed by water, i.e., visible, tangible gifts and assets, and things hidden in water, such as tactile experiences. It deliberately focuses on those sacred functions of water in the Indic traditions "that often escape our critical gaze" (p. 168). The authors analyse the limits of western theoretical frameworks, like Eliade's "hierophany" or Taylor's "sea spirituality", to capture the complexity of Indic religious cultures, as "the spectrum of the sacred is bafflingly wide and all-pervasive" (p. 163). By drawing attention to the array of sacred things in Indic cultures that are both revealed by water and hidden in it—like the conch shell, *bana linga*, *svarnamukhi shila*, *shaligrama shila*, and petrified body parts of Goddess Sati—the authors contribute to the hydro-epistemology of sacred things, where water does not remain restricted as an *object* of worship, but engages in an active play with the very epistemes of sacrality. [5]

[5] *Bana linga,* also known as *Svayambhu* (i.e. self-born) *Linga,* is an ellipsoid stone worshipped by Hindus. The stone symbolizes Lord Shiva, the supreme god of power in the Hindu Trinity (Brahma-Vishnu-Maheshwar). The stone is commonly found in the bed of the Narmada River in Madhya Pradesh, India. *Svarnamukhi shila* is the natural divine stone obtained from the Swarnamukhi River in Andhra Pradesh. And, *shaligrama shila*, collected

NEW in India aims to transcend the political to reach and move towards the plural by making invisible feedback loops—which are embedded in our rituals, belief systems, coping practices, and power hierarchies—visible. These short articles are appetizers and avenues, provoking fresh empirical investigations and methodological innovations that lead towards larger theoretical frameworks that can be applied at scale. NEW is also ambitious and politically committed to advancing theoretical understandings on water beyond academia through reciprocal and mutual learning among academic and "non-academic" sectors (like policy circles, civil society, user groups, and others) towards a just, democratic, and resilient transformation along challenging yet possible lines of transition from epistemology (or epistemic pluralities) to (multiple) axiology.

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SPECIAL SECTION: New Epistemologies of Water in India

Knowledge Others, Others' Knowledge: The Need for a New Epistemology of Water

Kuntala Lahiri-Dutt [*]

Abstract: This paper examines the ways in which knowledge about water has conventionally been generated by modern water scientists and illuminates how this approach leaves out the diverse "ways of knowing" water and how scientism creates a trap of concrete evidential certainty. Through the example of a failed conversation, it questions the basic epistemological underpinnings of understanding water in modern scientific inquiries—the means of knowing rivers, and how they conflict with feminist epistemologies and fail to account for the "knowledge others" and "others' knowledge". The paper concludes with observations on why we need new epistemologies of water in the Anthropocene.

Keywords: Water, Epistemology, Rivers, Feminist Methods, Scientific Methods

1. EPISTEMICIDE?

Social science researchers studying water are aware of the hegemony of western epistemology, particularly the limits of a singular "way of knowing" water. This western epistemology has shaped critical projects that involve managing, controlling, and modifying water. A growing body of literature argues that these projects are based on the contextually irrelevant experiences and perspectives of the West, and hence provide too few parameters or none at all, both analytically and conceptually. Thus, in the Global South, the challenge is to develop an anti-hegemonic ecology of knowledge that is free from the domination of western epistemology. To address this challenge, one must acknowledge the alternative ways of

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knowing water and living with it, and perhaps then understand the costs associated with this annihilation. According to a leading critical theorist, Boaventura de Sousa Santos, the mass extinction of non-western knowledges can be termed as "epistemicide". In his landmark book, *Epistemologies of the South* (2014), de Sousa Santos establishes the parameters for a contemporary critical theory that considers the historical and analytical limits of Marxism and proposes an epistemology that is global, anti-colonial, anti-capitalist, and anti-patriarchal. In another article, de Sousa Santos (2016, 18) follows up on this argument and notes that awareness of this epistemicide encourages researchers to depart from the established, mainstream knowledge that derives from the Eurocentric tradition. Knowing that an epistemicide is in force can also lead researchers to undertake a crucial epistemological transformation that has the potential to reinvent social emancipation and sovereignty on a global scale. Finally, the understanding can also evoke plural ways of relating to nature that are not simply based on a scientific conception of the world. Much of this limited epistemology of water, as it is known, is propagated through tertiary education (and research) institutions, where pedagogy remains strictly discipline-based. Each discipline remains bound by its methodological imperatives and proposes a particular understanding of the subjects within their boundaries.

For a complex resource such as water, these limitations invariably invite reductionism, as each discipline examines different aspects of water, expecting to see the material in its entirety. Within this scenario, geography exerts a proprietary claim over the physical containers and carriers of water such as rivers, lakes, and other water bodies. Baghel, Stepan, and Hill (2017, 3) explain how "epistemic communities"—groups or networks of experts who share common norms, principles, and beliefs, causal credence, notions of validity, and strategies—have a common belief framework to explain the production of challenges. Epistemic communities primarily focus on transnational policymaking, international regimes, and expert groups using science and technology; they operate within a culture of metrics, models, projections, and warnings. The science-based epistemic community presents (and perpetuates) only a partial view of water and discusses its abundance and scarcity in terms of human security. Moreover, Baghel, Stepan, and Hill (2017) argue that there is "something distinct to water, to water experiences and water knowledges in Asia" (2). In addition to the distinctiveness of water as a resource, there is also an explicit recognition of the differences that "place" makes to knowledge. Social and feminist geographers have consistently argued that knowledge is placed in (and is defined by) its context. As Massey (2005) reminds us: "Without space, no

multiplicity; without multiplicity, no space" (9). It is this multiplicity of contexts that makes knowledges of water so special, and feminist voices contribute to the plurality of these knowledges. Based on my personal encounters working within and outside disciplinary boundaries, this paper uses two examples to analyse epistemicide in the context of water and ends with some thoughts on feminist epistemologies, which might be one of the "new" alternative knowledge forms in the Anthropocene.

2. KNOWING WATER, UNDERSTANDING THE EPISTEMICIDE

Even if the language and terminology remain different, the idea of an epistemicide is not new in water studies. It has been expressed differently elsewhere, for example, in Linton's (2010) argument that "modern water" is a discursive construction that has helped harness and control extensive parts of the hydrosocial cycle. This acquisition, according to Linton, was accomplished through large hydraulic infrastructures including dam construction, wetland draining, irrigation engineering, and water diversion into the circulatory systems of urban centres. Schmidt (2017) calls this discourse of modernity "normal water", that is, a discourse that repackages the political project of human adjustment into notions of adaptation that naturalize a certain way of thinking about water as the only possible option. Roberts and Philips (2019) argue that "water is not a neutral and external substance or object, but something that is inextricably woven into social, economic and political rationalities" (5). To understand water "as we make" meaning of it, Strang (2010) adopts an anthropological approach to explore communities' relationships with water. This relationship develops through landscapes, cultures, religions, spirituality, as well as gender (Lahiri-Dutt 2006). The first effect of epistemicide, therefore, is the production of a number of geological, technical, and social ideas that conceptualize water as a *resource* that can, and should, be managed to follow an evolutionary model of postcolonial progress.

The second effect is the transformation of nature through science and technology. This is enabled by the discourse that supplies of water and solutions to shortages fall within the realm of science and technology, leading to an objectification and categorization of the natural world (Sjolander-Lindqvist 2005). Water, which was previously considered a part of nature, has now been transformed into an important urban commodity that can be engineered (Stuart 2007). These urban water supply systems and networks, Swyngedouw (2006) argues, "are the mediations through which the perpetual process of transformation of nature … takes place" (106).

Nature is transformed into products to meet human needs, and market and regulatory mechanisms price these products for human consumption, which then enter the market as commodities (Bakker 2006). Scholars (for example D'Souza 2007) have emphasized this point in their study of dams and other colonial water infrastructure. This knowledge of water is walled in by scientism as a highly intellectualized, application-oriented and rationalized field where, as de Sousa Santos (2014) says, "the relation between knowing and acting has lost its general character and been reduced to the relation between knowledge validated by modern science and rational social engineering" (5). Outside of this wall, it presumes, lies the dark world of beliefs, faith, values, myths, and the world of the unsayable, where theory and practice are disentangled from each other. The example that follows exemplifies this point by showing how scientism becomes incapable of conversing with feminist epistemologies even if the scientists themselves want to include feminist visions in their work.

3. CONVERSING WITH RIVER BASIN MODELLERS ON GENDER

Established in 1916, the Commonwealth Scientific and Industrial Research Organisation (CSIRO) is Australia's national science agency and one of its oldest research organizations. In 2013, it initiated a research programme to generate tools and evidence to improve the management of several South Asian river basins. Funded by the Department of Foreign Affairs and Trade (DFAT) and CSIRO, the Sustainable Development Investment Portfolio (SDIP) project at CSIRO uses river system modelling to generate water development scenarios—an activity in which the CSIRO has had considerable expertise and strength. The aim of the SDIP is to increase water, food, and energy security in South Asian countries for the poorest and most vulnerable. With women being over-represented in the poor and vulnerable groups in the region, CSIRO needed a gender expert. But how does one even begin a conversation between natural scientists working on basin modelling and gender scholars working with social science tools and methodologies? Scientists dealing with the intricately complex river basins of South Asia had no robust methodological tools to integrate interdisciplinary pluralism and explain the sociocultural contexts within which the water is being allocated, shared, and used. To resolve this impasse, CSIRO took a big (and unprecedented) step by hiring an ANU-CSIRO joint appointee gender expert who would divide their time between my (social science) department in ANU (The Australian National University) and CSIRO. Under my mentorship, the appointee would help the scientists integrate gender into their areas of work. Being a feminist who

is not uncomfortable working with physical scientists, I was pleased to take on the project.

Sadly, in reality, this profoundly innovative initiative encountered several roadblocks and challenges. A series of multifaceted events are evidence of its slow and painful failure. The primary problem was of communication between vastly different disciplinary orientations. The gender expert, who had a strong background in the domestic decision-making research space, found it difficult to converse with the (mostly male) scientists, and vice versa. Did this failure occur because the project presented itself to these scientists as one of those much-maligned "add women and stir" type initiatives? Or are feminist approaches to knowledge inherently *different*?

Indeed, some branches of feminism rely on empiricism, or can confer with empiricists quite easily and confidently, as evidenced in journals such as *Feminist Economist* or in the innumerable mapping and quantitative works carried out by leading feminists. These are significant bodies of work that have used quantitative methods and conversed with the harder, physical sciences, have sensitized scientists, and made significant contributions to a feminist re-envisionings. On the other hand, some feminists have consistently argued that our task is not to follow established epistemologies, but to reject them altogether and adopt new methods and tools to change the existing (scientific) methods. Perhaps this second approach has more merit, given the assumed hierarchies between the social and natural sciences and within disciplines. These hierarchies of knowledge prevent the kind of conversation and integration in which their disparate epistemologies can meld with each other.

In this instance, the scientists' disciplinary training equipped them to apply quantitative tools for river basin management at a macro level. These tools do not lend themselves to an understanding of gender roles and relations, which require going beyond the macro and focussing on the micro—the minutiae of interactions and dynamics within households and families and interpersonal as well as inter-community relations.

So how does one articulate the multi-directional relationship between rivers and human societies and integrate gender into the study of rivers and riverine communities? River scientist, Plewa (2010), presents rivers as part of the earth's hydrosphere and as being determined by geology and climate, which in turn determine the river's hydraulic properties and hence its channel mechanics and chemistry. The epistemic community of classical river scientists, therefore, teaches students that although rivers are inert parts of the physical environment, they are almost like organisms because of their life cycles. This way, a river is imagined outside of the human

domain (Lahiri-Dutt 1999). If humans were separated from the physical world, then the epistemology of geomorphology would be characterized by the separation of human elements from rivers. Lahiri-Dutt (2015) has discussed the consequence of considering fluvial systems as part of the larger environmental system, "a meaningful arrangement of things" (Schumm 1977, 2), a whole that is formed as the sum of many parts. This knowledge invisibilizes human lives, their histories, and their various social and cultural connections with rivers and exemplifies how epistemicide is legitimized through disciplinary edifices.

Castree (2005) argues that knowledges are "produced by myriad knowledge-communities who possess sometimes similar (and sometimes different) outlooks on nature" (xiv). Therefore, what we perceive as "societal" understandings of the natural world are actually "local" understandings that have emanated from their production sites to be considered as real, and hence valid, to different communities. According to Castree (2013), these sites are not only universities and research organizations, which have conventionally presented themselves as the principal knowledge communities of professional geographers.

People who create knowledge through their lives and day-to-day interactions with rivers are described by Castree (2013) as "epistemic workers". These epistemic workers, through face-to-face and virtual interactions, comprise epistemic communities. These communities have more or less distinctive languages and ways of communicating. Lave (2015) argues that a new era of knowledge production is emerging in this manner. She suggests that in this knowledge regime, academia has significantly less clout than ever before. The knowledge claims that are broadly seen as legitimate are increasingly developed outside of the academy.

River scientists, who claim to be the primary community producing knowledge about rivers, have failed to produce holistic knowledge that shows rivers as products of human history, interferences, attachments, and imaginations. Without these humane aspects, our knowledge of rivers remains incomplete. More importantly, with the humane aspects, the kinds of nature knowledges that are produced would simply and truthfully depict things that scientism does not seem understand, recognise, or value. Ekers and Loftus (2012) underline this perspective and suggest that central to the making of nature knowledges are specific embodied practices across particular temporal and spatial conjectures that require a historicized and geographically rooted understanding of nature.

River scientists have tried to establish standardized, universal, and appropriate conditions and settings for the creation of water knowledge

that can be translated into a model that all knowledge production (and knowledge-seeking) can look up to. This knowledge yields empirical certainty and considers itself robust enough to effectively silence the sceptics or "non-believers" of this worldview.

Feminists question the presumed certainty of this approach by asking first if the sex of the knower is epistemologically significant (Code 1981) and second, how masculine and feminine needs, interests, rights, and water uses can be illuminated in a gender-differentiated form, across or as "stretching over" space. Commenting on the first, the masculine production of knowledge, Lorraine Code (2014) observes:

> Any hint of relativism such as is implicit in the suggestion that sex—a non-intellectual, non-rational, individual characteristic of the putative knowers—could play a constitutive part in the production of knowledge threatened to undermine the founding principles of 'the epistemological project (9).

Questioning the sex of the knower could problematize knowledge and subjectivity, shifting the focus to what Haraway (1988) considers "situated knowledges"—knowledges that allow an examination of multiple intersections of subjectivity and positionality and their epistemological implications—and questions the "credibility, marginality, epistemic responsibility and the politics of testimony" (Code 2014, 10). This is a simple but first step in understanding differences in epistemologies; in the story narrated above, it was not always men who failed to understand the roles that gender could play in the lives of riverine communities.

As noted, some feminists reconcile the difficulties of conversing with natural or harder sciences by adopting different forms of empiricism. They present numbers, numerical data, and measurements, and maps as accurate and scientific evidence. Indeed, this was possibly what might have been envisaged by CSIRO at the outset. Therefore, instead of a *gender expert*, what they truly required was an empiricist who can deal with sex-disaggregated social, economic, and related data, and incorporate them into river basin modelling data of water-flows, sediment load, rainfall, and so on. However, is this co-option of sex-based social-economic indicators into the measurement and modelling work of the predictive sciences a solution? The feminist philosopher of science, Sandra Harding, in her influential book *The Science Question in Feminism* (1986) opposes these attempts and argues that feminist standpoint theory rather than feminist empiricism actually offers "strong objectivity". Feminist standpoint theory unfurls a more inclusive and just scrutiny than older conceptualizations of objective analyses and addresses the historical-material diversity from which knowledge is produced by women and men. The feminist water scholar Zwarteveen

(2006) outlines similar difficulties during her attempts to engage with irrigation engineers in a conversation on gender. She claims that the masculinity of the creators of water knowledges is responsible for the difficulties in finding novel ways of understanding and explaining the concept of water.

Returning to the story told above, was this initiative slated to fail because of the predictable collision of the two epistemologies? Would it have been better not to mention gender at all in CSIRO's project? We now know that funding agencies feel compelled to "mainstream" gender in each area of their work, and funding imperatives might have pushed CSIRO to even want to integrate gender into the work of their river scientists. We also know that sometimes well-meaning initiatives such as this one lead to disastrous results (Eerdewijk and Davids 2014), failure of projects (Staudt 2003), unintended consequences (Walby 2005), and, most importantly, a depoliticization (Brouwers 2013) and instrumentalization of feminist politics that is at the heart of mainstreaming gender (Daly 2005; Mukhopadhyay 2014). On the other hand, is it not also true that the effort to integrate gender is better than not trying it at all?

The most significant challenge for the present discussion is that many disciplines in the social and natural sciences that analyse water as a resource frequently tie water management problems to a society-nature dualism (Schmidt 2017). This dualism is no longer tenable, yet our discipline-based knowledge production has not yet facilitated the kind of boundary transgressions or co-production of knowledge that was envisaged when mainstreaming gender in the work of scientists (Barry and Born 2013). Addressing this problem, Jasanoff (2004) invokes the need for a generative discourse on the role of science and technology in society, because they are interwoven with the meanings, values, and power in considering a critical inquiry on water. Further, contextual hybridities are described by Jasanoff (2004) as the "rambunctious storyline of modernity", because they refuse to conform to "any singular narrative of enlightenment, underlining how nature, knowledge, institutions, and identities are co-produced, and showing how other ways of knowing water can contribute to alternative and expanded knowledges of water" (3). No certitude exists within this flux. Jasanoff (2004) argues that the "familiar ingredients of modern life continually rearrange themselves in unpredicted patterns, creating rupture, violence, and difference alongside the sense of increasing liberation, convergence, and control" (13). The truth of this statement becomes evident in considering the implications of the story narrated here.

4. CONCLUSION: NEW WATER EPISTEMOLOGIES FOR THE ANTHROPOCENE?

What could be the implications of this epistemicide in our relations to water in the Anthropocene? We are now living in a time when humans are considered as a force of nature in a geological sense, thereby conjoining nature and humans in ways that enable an immediate co-production of each other. How do we think about water epistemologies in these times? In situations like this, "traditional disciplinary discourses fall short" (Mehta, Huff, and Allouche 2019, 223). It falls upon each discipline to reimagine itself, to increase the porousness of its borders to encourage cross-fertilization, and to inspire younger generations of scholars to think more independently whilst also collaborating with others, thus developing an anti-hegemonic ecology of knowledges that are liberated from the domination of western epistemology. Growing evidence shows that conventional epistemologies based on the certitude of accurately measuring, modelling, and consequently, controlling water bodies are not working. Perhaps this realization should help us chart our future course, particularly in the countries of the Global South, as against western epistemology-based visualizations of water.

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SPECIAL SECTION: New Epistemologies of Water in India

Imperilled Waterscapes: The Social-Ecological Transformation of Lakes in Bengaluru

Amrita Sen,[*] Hita Unnikrishnan,[**] and Harini Nagendra [***]

> The water in this lake was very clear. You could see a silver coin in its depths—the water flowed and it was healthy. Today, if you drop a coin into this lake—even if you can fish it out, which I don't think is possible—it will be black. There is no flow. The water is not pure; it is dirty.
>
> – Real estate owner and former agriculturist, 70, Bellandur Lake, Bengaluru
>
> (translated from Kannada; Interview conducted by Hita Unnikrishnan on 20 February, 2015)

Abstract: This paper examines the historical waterscapes of Bengaluru, now imperilled by development. Earlier a garden city, the agrarian landscape of Bengaluru was formerly supplied with water from an interconnected lake system. This system has since been fragmented due to urbanization and changes in land cover, impacting local institutions and livelihoods dependent on the lakes. In this paper, we use the case of the city's largest lake, Bellandur, to demonstrate the transformation of the waterscape from an open semi-arid landscape pre-dating the city into an agrarian water-dependent landscape characterized by flows of water in pre-colonial and colonial Bengaluru, and finally into a concretized landscape and the individualization of lakes in the "modern" city. Claims to and associations with the lake ecosystem have altered through changing hydrological, institutional, and social relations, leading to shifts in imaginations of the lake as well.

Keywords: Waterscapes, Lakes, Urbanisation, Bellandur, Bengaluru

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1. INTRODUCTION

Since ancient times, water has been imbued with various imaginaries depending upon its perceived utility. At the same time, it is feared for its ability to destroy lives through floods, disease, or accidents. Water is simultaneously seen as an economic good, a provisioning service, a common pool resource, a sacred entity, and an untameable force of nature (Rodriguez-Labajos and Martinez-Alier 2015; Wright-Contreras 2018), even in urban contexts (Nagendra 2016; Mukherjee 2018; Goh 2019).

Imaginaries of water play an important role in shaping urban waterscapes—they contribute to a city's resilience and adaptive capacities in today's context of global environmental change (Van Ginkel *et al.* 2018). Contemporary cities are facing unprecedented water availability crises; several cities, such as Cape Town, Chennai, and Bengaluru, are running out of water or are poised to do so in the near future. Most of these cities have polluted their waterbodies. How did this crisis occur? What caused the shift in the meanings ascribed to these important infrastructures? These are some of the questions we address in this article.

We illustrate our case using the former cascaded irrigation tank (now lake) network in the city of Bengaluru. Specifically, we consider the case of Bellandur Lake to demonstrate the link between changing imaginaries of water and the transformation of Bengaluru's waterscape. From a semi-arid region with limited water availability prior to the formation of the city, Bengaluru evolved into a market city characterized by the flow of water, and, more recently, into a global city filled with stagnant and polluted water. We used a mixed methods approach that combined an analysis of historical sources (inscriptions, archival records, historical maps, and oral history interviews) and primary fieldwork conducted by the authors over the past six years. A series of field interviews were conducted in February–May in 2013 and 2014, October–December in 2013 and 2014, July 2018, and April 2019.

2. THE TANK SYSTEM OF BENGALURU

Tanks in South India, as Mosse (1999) points out, are man-made reservoirs created by embanking river water. Apart from irrigation, they help with percolation and groundwater recharge, flood control, and silt capture. These tanks were constructed because the region was semi-arid and lacked any major perennial water source required for agriculture (Gurukkal 1986). This locally crafted system of transforming an essentially semi-arid landscape of thorny scrub to an irrigated one helped craft liveable spaces

out of harsh geographies, although they were often built on a structure of deep social inequity (Shah 2012; Unnikrishnan, Mundoli, and Nagendra 2017).

In Bengaluru, these tank networks date back to at least the sixth century CE, as documented by stone inscriptions. Tanks operated in association with common village grazing lands and wooded groves to support local livelihoods through a system of collective governance (Mundoli, Manjunatha, and Nagendra 2017). The water within the tanks was a resource that was simultaneously venerated and controlled. Successive dynasties attempted to expand their political and territorial domains by creating and extending tank systems; thus, many discourses hold that the system was not exclusively of local design but was also supported by the state (Mosse 1997). Inscriptional sources testify that tanks were also built for different social, economic, and religious reasons (Nagendra 2016).

With the introduction of piped water systems in the mid to late nineteenth century, tanks began to lose their significance. Many tanks became polluted due to the impacts of urbanization (Nagendra 2010). Rapid industrialization coupled with growing real estate demands meant that several tanks and the channels connecting them were repurposed into land for built structures, while others were transformed into conduits for sewage disposal within the landlocked city. Tanks thus lost their interlinkages and physically transformed into stagnant, isolated pools of water in many parts of the city.

A system once characterized by engineered water flow was transformed into one with mostly stagnant water. This change brought with it different perceptions of the waterbodies that testified to changing epistemologies of water within this landscape. Community narratives, which once mentioned a self-sufficient and sustainable social ecology with a flowing waterscape that supported livelihoods, now refer to these waterbodies as inert, static, and barren. Once considered tanks, they transformed in the public imagination into lakes: ecological and recreational spaces, rather than being water reservoirs for irrigation. As such, village communities regard the present lakes as recreational spaces that are patrolled by security guards. Thus, the lakes have been severed from their traditional usage patterns and are no longer seen as a source of livelihood (Unnikrishnan *et al.* 2016, 10).

The next section demonstrates these changing narratives—using the case of the iconic Bellandur Lake—that are representative of Bengaluru's shifting waterscape.

3. CHANGING IMAGINATIONS: BELLANDUR LAKE IN BENGALURU

Bellandur is the largest lake in Bengaluru, situated in the south-eastern part of the city and covering approximately 892 acres. The lake was once a lifeline for 18 villages and supported local economies dependent on agriculture, fishing, livestock, and orchards. In recent years, the lake has attracted international attention because of frothing due to contamination (Sengupta, Pallavi, and Goswami 2017). Residents living close by suffer from a range of health problems as a result of living in close proximity to the contaminated lake.

3.1. Myths, legends, and the production of an urban social-ecological system

The earliest reference to the system of lakes is from a stone inscription dated to 870 CE and attributed to the region's Ganga dynasty (Rice 1915). The inscription reads: "Be it well. In the victorious year of the S'rirajya, under Satyavakya-Permmadi's Kali-yuga Hanuman, Nagattara—the Irvvuliyur odeya, Irugamayya's son Siriyamayya fixed sluices to the two tanks, had the eastern tank built, and obtained the bittmatta of the three tanks. Imprecation" (17).

While not directly referencing Bellandur Lake, this inscription refers to Agara Lake, which is situated upstream, and gives us a sense of how old these waterbodies are. As with anything that represents a connection to people who lived centuries ago, these waterbodies are associated with myths of inception and survival, which have endured through stories that have been passed down over several generations.

In multiple interviews, we heard various versions of the legend of the origin of Bellandur Lake. All versions speak of a hungry and thirsty woman (in some versions she is old, and in others she is young and pregnant) who approached the local villagers for food and water. She is always credited with creating the lake from a barren landscape; the idea of barrenness assumes multiple meanings depending on whether she was offered help or turned away. One version of the legend, narrated to us by an elderly respondent, is this:

> There was a hungry old woman who visited Bellandur Village. There was no lake then; there was only a village here. She went from house to house begging for alms, but not one single person helped her. No one gave her food or water. She became angry, and in her anger, very powerful. She cursed the villagers by creating a flood—the water swept away many people and their homes and

> belongings. The water has remained since then, as a reminder of what happens when people do not help those in need.[1]

Barrenness here assumes a metaphorical meaning—the barren nature of human society was made fluid (and more empathetic) with the influx of water. Water then became a purifier that washed away sins, thus creating a kinder social system.

The lake was surrounded by open wells that tapped into shallow aquifers that it recharged. Communities had strict rules about managing the waterbody and specific members of the community performed particular roles in relation to this. In the words of another elderly interviewee:

> The *neerganti* (village waterman) would let out the right amount of water into each field using the sluice gates; he would also monitor the level of water in the lake. There was a stone placed on each bank of the lake that would tell us the level of water each year. If the water levels went up or down, we would pray to the lake goddess to help us. The town crier would also make announcements if there was a chance that the village was going to be flooded or if a drought was likely. [2]

Bellandur Lake is associated with two female deities—Gangamma and Dugalamma—who are locally worshipped through practices that evoke the plural ways in which the lake has both sustained and endangered the lives and livelihoods of the nearby communities. The legend of Dugalamma, for instance, is invoked when people are in danger of drowning in the deep waters of the lake. One interviewee told us, "In days long past, there were not as many roads that people could travel on. To get to another part of this area, we had to cross a canal that was deep and dangerous. Before crossing this canal, it was our custom to pray to Dugalamma to protect and return us safely to our families."[3]

Even today, locals worship this goddess, especially when they are about to undertake long journeys. Indeed, present-day road accidents in the locality continue to be attributed to her wrath and are interpreted as a sign that the deity's temple should be renovated or improved.

Different occupational groups had multiple ways of invoking divine protection, often relating to the ways in which they used the lake. Women provided clothes or ornaments as offerings to enhance the well-being of those in the village. Farmers and livestock owners performed other rituals involving the sacrifice of sheep or buffaloes and the sprinkling of sacrificial

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[1] Interview conducted by Hita Unnikrishnan on February 20, 2015.
[2] Interview conducted by Hita Unnikrishnan on February 22, 2015.
[3] Interview conducted by Hita Unnikrishnan with priestess of the Dugalamma Temple on 28 July, 2016.

blood on farmland. There were also village processions and community feasts to pray for adequate supplies of water or to invoke blessings for a healthy crop.

Our interviewees recalled stories of how the daily upkeep and maintenance of the waterbody was considered both important and sacred; further, these everyday practices were intimately intertwined with the cultural landscape of the area. For instance, it was important that silt deposits within the channels and lakebed were monitored and managed. This was done in a rather unique fashion; in the words of one of our interviewees, "It was important to remove the mud from the *kaluves* (channels) and the *kere* (lake). The lake is so big that a few people alone could not do it. So prisoners were brought from the jail to help. This was their community service—they had to remove the mud from the lakebed and channels."[4]

The collected silt was then used to make religious idols, once again invoking the sacrality attributed to the waterbody. All these narratives provide fascinating insights into how the lake, the benefits people drew from it, as well as the dangers associated with the waterbody were highly integrated into the belief systems, rituals, and everyday practices of people. This produced a distinctive urban space that contributed to shaping, and in turn was shaped by, both societal and natural elements of the social-ecological system.

3.2. Engineered flows and transformations within the urban social-ecological system

Oral history interviews conducted around Bellandur reflect the importance attached to the flow of water within the network of lakes and channels. One of our respondents said, "Before all these buildings came up here, water would flow in and out of the lake—it was clean water; it was pure. We could drink it."[5] Another noted, "The water was so pure that it tasted like tender coconut water."[6]

This system of flow represented a fundamental change within the social-ecological landscape of the city. It transformed a landscape devoid of flowing water into one where water could be channelled, harnessed, and used over large swathes of land.

Other commons were associated with Bellandur Lake, including nearby grazing lands and *gunda thopes* (village forests) that provided shelter to

[4] Interview conducted with elderly resident of the area by Hita Unnikrishnan on February 23, 2015.
[5] Interview conducted on September 11, 2018 by Amrita Sen, with a villager from Bellandur.
[6] Interview conducted on September 11, 2018 by Amrita Sen, with a villager from Bellandur.

nomadic communities and functioned as a collective resource for wood. The deity Gangamma was worshipped through a massive celebration (Gange Puje) when the lake filled up and overflowed. During the festival, people cleaned and whitewashed their homes, made lamps, and sacrificed buffaloes and lambs to celebrate. Songs were sung to appease and thank the lake goddess for her benevolence; she was believed to be extremely powerful and was considered the protector of the lake bund.

The advent of piped water in Bengaluru during the late eighteenth century signalled the arrival of a new era of transformation within the social-ecological system. The luxury afforded by pipes bringing water from distant sources meant that the lakes no longer occupied a central position in meeting the needs of villagers. Although Bellandur was located outside the main city of Bengaluru then, many smaller lakes within the older parts of the city were connected to Bellandur Lake. Some of these lakes and their interconnecting channels were slowly built over, while others were filled with sewage. Several smaller lakes began to dry up as connectivity and, therefore, the flow of water into these lakes reduced. Other lakes within the network transformed from seasonal, rain-filled lakes into perennial, sewage-filled lakes because of the continuous supply of sewage into them. The quality of water deteriorated, and native fish populations declined. Most agriculturists moved away or adopted other occupations, and the domestic use of the lake water reduced.

The associated cultural practices also evolved. Today, lake deities are not worshipped in relation to the waterbody with which they were once associated, but for their own characteristics (such as providing protection to people undertaking a long journey). Additionally, ceremonies associated with the flow of water are not practised anymore or have dramatically reduced. In the words of one of our interviewees, "We go to the lakes every day, but we don't use the water. We go to the bund to perform religious rituals, but we take clean water from our homes. The frequency of annual worships has also decreased. I won't feel sad if this polluted lake dries up. I'll actually be happy if this dirty water clears out of here and the menace reduces!"[7]

3.3. Negotiating previously networked waters as standalone waterbodies

Every year since the early 2000s, Bellandur Lake has attracted both national and international attention as it froths up during the monsoon. Headlines such as "It's not Switzerland! Bengaluru's Bellandur Lake Spews 10-ft High

[7] Interview conducted by Hita Unnikrishnan on 20 February, 2015.

Toxic Foam" are accompanied by dramatic pictures of the toxic foam (The Economic Times 2018).

Barely a few yards from this foam, real estate boards advertise the benefits of their premium "lake-facing apartments", lending irony to this scene of chaos. Local governments assure citizens that the lake will be cleaned and sewage diverted and promise to allocate large sums of money for these activities. Several community collectives have been formed to organize clean-up drives, protests, and online petitions to restore the lake. These diverse and often conflicting activities around Bellandur Lake have one thing in common—an internalization of the new static identity of Bengaluru's lakes. Bellandur Lake is now seen as a standalone waterbody, whose connections to lakes either upstream or downstream have been rendered invisible. The significance of lakes within an interconnected system loses ground, thus giving way to isolated and compartmentalized attempts at restoring them, which do not often succeed due to a lack of systemic engagement with the dynamics of this complex social-ecological system.

3.4. Changing epistemologies and an evolving waterscape: conclusions

Despite the physical transformation of the landscape and the discursive shifts in the way the lake is perceived, in many ways, Bellandur remains an integral part of the city's fractured waterscape. The froth and fire that disrupted life around this lake are, in part, the effects of activities occurring upstream. Similarly, water flowing out of the lake affects other areas and lakes downstream. Where connections between individual lakes have been lost, monsoons wreak havoc, causing widespread flooding and damage, especially in those areas formerly occupied by a waterbody or its channels. It is these systemic connections that need to be re-engaged within this waterscape. The idea is that the water contained within these lakes is part of a larger urban circulatory network and that actions taken in one part of the city can indeed affect events occurring elsewhere.

The history of Bellandur Lake informs us that restorative activities should be directed at the network and not just at individual lakes. This leads to the key message of this article—the need for cities, municipal bodies, and policy analysts to recognize the effective role that lakes as "systems" can play in augmenting urban environmental resilience. Systemic activities also need to recognize that a lake is not just a hydrological or ecological entity, but a social-ecological space. Restoration needs to move beyond the current focus on hydrology and technology and aim to bring back the cultural connect to the waterbody. This can be achieved by making decisions that

include under-represented voices and engaging with local traditions that respect the flow of water, while providing incentives to continue such engagement. In doing so, the city of Bengaluru must seek to make invisible epistemologies of water visible again.

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SPECIAL SECTION: New Epistemologies of Water in India

Fluid Epistemologies: The Social Saga of Sediment in Bengal

Jenia Mukherjee [*] and Pritwinath Ghosh [**]

Abstract: By using the term "fluid", this article critically interrogates western ontologies of "solid" (land) and "liquid" (flowing waters), which were transplanted in colonial South Asia and transmitted in post-Independence river/water policies and actions with severe socio-ecological implications. Drawing lessons from recent environmental history and political ecology of water ("hydrosocial") literature that shed light on liminal scapes beyond the mainstream land/water binary in hydrological studies, this study conceptualizes "fluidscapes" by drawing on field research in the river islands (*chars*) of Lower Bengal. By capturing snippets of livelihoods in the chars of the Malda and Murshidabad districts, West Bengal, situated upstream and downstream of the Farakka Barrage respectively, this article advances why and how it is imperative to rethink sediment beyond its physical-geomorphological existence and to see it as social sites of interactions. It unravels avenues through which chars can be perceived as not only emblems of uncertainty but also as zones of possibility bestowed with rich ecosystem services and the collective resilience of *choruas*.

Keywords: River Islands, Sediments, Ecosystem Services, Ganga, Bengal

1. INTRODUCTION

The Anthropocene, loaded with a planetary doomsday message and a clarion call to collectively understand complex systems like the environment, has made for epistemic pluralities dedicated to challenging

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and surpassing various forms of Cartesian binaries that have operated for long, constricting our mindscapes and actions. The formulation of the "fluid" or of "fluidscapes" is an attempt to critically interrogate western ontologies of "solid" (land) and "liquid" (flowing water), which were transplanted to colonial South Asia and transmitted into post-Independence river/water policies and actions with severe socio-ecological implications. Drawing on lessons from environmental history and the political ecology of water (including "hydrosocial") literature, which shed light on the liminal, nebulous scapes beyond the mainstream land/water binary in hydrological studies, this article conceptualizes "fluidscapes" based on information and insights from field research conducted on the river islands (*chars*) of the Lower Ganga Basin, West Bengal.

We shed light on two chars: Hamidpur in Malda District and Nirmal in Murshidabad District, West Bengal, situated upstream and downstream of the Farakka Barrage, respectively. The barrage has intensified erosion and sedimentation by interrupting the natural flow of the River Ganga in its lower course. These chars have complex histories of land submergence and emergence, which in turn have shaped the lives and livelihoods of the *choruas*.[1] These areas have also been marked by conflicts arising from contestations of inter-state (Bangladesh) and intra-state (Jharkhand) boundaries due to the constant shifting of the river. Moreover, the residents of Hamidpur Char recently gained citizenship rights in India by mobilizing the choruas with the support of non-statist organizations.

The literature on river islands is scarce and features overtly declensional narratives. By capturing snippets from the lives and livelihoods of people living in chars, and exploring the everyday lived and embodied realities of choruas in these shifting sediments, this article advances why and how it is imperative to rethink sediment beyond its physical-geomorphological existence and perceive it as a site of social interaction. The multilayered physicality of sediment, along with its ephemerality in estuarine contexts, comprises dense social stories woven within the web of temporality, crafting inexplicable trajectories awaiting explorations from a pluralistic research lens. Here, we attempt to unravel the avenues through which chars can be considered not only emblems of uncertainty but also as zones of possibility, which are bestowed with rich ecosystem services and the collective resilience of the choruas.

[1] In the Bengali dialect, people inhabiting chars are known as *choruas*.

2. THEORETICAL APPROACHES

The social dimensions of sediment can be contextualized within the environmental history and political ecology of water studies and, more specifically, hydrosociality. Till date, the significance of sediment has been studied mainly from technical perspectives—physical geographical, sedimentological, fluvial geomorphological, hydrological, and hydrobiological—that attest to the significance of sediment circulation in riverine systems. However, these perspectives ignore the sediment–society connect, i.e., livelihoods that depend on sediment, which are thickly populated by ecosystem-dependent marginalized communities that adapt to these "muddyscapes". By addressing problems relating to the implementation of "colonial hydrology" (D'Souza 2006), South Asian environmental social science scholarship has exposed us to multilayered realities surrounding human engagements with muddy terrains in tropical-deltaic-estuarine geographies across time (Mukherjee 2011; Lahiri-Dutt and Samanta 2013; Baruah and Mukherjee 2018; de Micheaux, Mukherjee, and Kull 2018).

The hydrosocial cycle describes how "water and society make and remake each other over space and time" (Linton and Budds 2014, 170). While early hydrosocial literature mainly dealt with political and social injustices around water services in urban landscapes, the recent thrust has been on rivers, and specifically on issues surrounding dam construction and the related controversies, irrigation maintenance and conflicts, and river basin governance (Baruah and Mukherjee 2018; de Micheaux, Mukherjee, and Kull 2018). What happens when hydrosociality encounters sediment? De Micheaux, Mukherjee, and Kull (2018) have postulated a "hydro(sediment)social" (HSS) cycle by advancing hydrosocial analysis with an enhanced consideration of the sediment component of river materiality. The HSS cycle encompasses the manifold ways in which humans and non-humans mesh in hydrological and social relations, impinging on water circulation, distribution, and quality, along with the materials that the water gathers—muddy sediment (Mukherjee 2018). The formulation becomes extremely relevant and meaningful in the tropical deltaic-estuarine contexts of South Asia. The conceptualization challenges "colonial hydrology" and its continued legacy and implications for river discourses, management, and governance paradigms and actions. Drawing on the work of geographers and anthropologists (Appadurai and Breckenridge 2009; Lahiri-Dutt 2014; Krause 2017), researchers have very recently coined the term "fluidscape",

which combines "moving" biophysical and social realities, and includes water flows, sediment, river channels, populations, etc.[2]

3. SCHOLARSHIP ON RIVER ISLANDS

Despite a growing interest in island studies, river islands have been largely ignored (Baruah and Mukherjee 2018). In the words of Lahiri-Dutt (2014), "[River islands] exist in the vocabulary neither of those who study rivers, nor those who study islands, and have largely remained beyond the mainstream discussions on nature/culture" (22). Within the (eastern) Indian context, Lahiri-Dutt and Samanta (2013) offer an intimate glimpse into the microcosmic world of the (Damodar) chars. They depict coping mechanisms rooted in the embodied experiences of choruas who keep "dancing with the river" and drifting in the nebulous space. However, Mukherjee (2011), while describing empirical realities in the Ganga chars, explains why coping should not be romanticized, but should rather be understood as a "compulsory exercise".

The recently edited volume by Basu, Roy, and Samaddar (2018) employs a political ecology perspective to explore riverine erosion in the Brahmaputra chars, crises relating to resource allocation, massive displacements in deltaic Bengal, and challenges emanating from migration resulting from floods in the Barak River in Northeast India. Going beyond this declensionism implicit in political ecology narratives, we explore both the challenges and potentials of river islands, which, we argue, can be harnessed in the long run to reimagine the fates of chars and choruas across shifting material and social realities.

4. METHODOLOGY

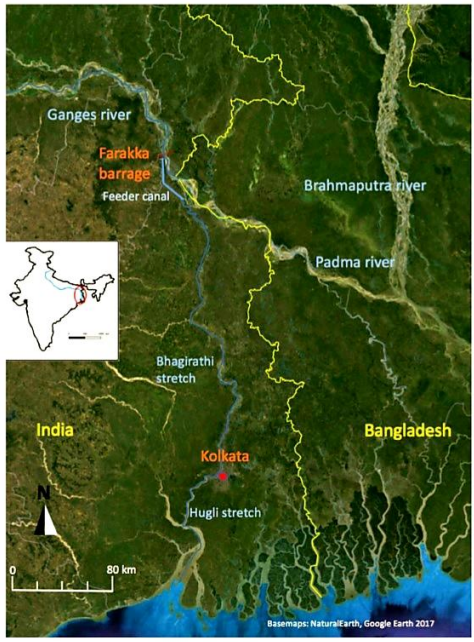
This article is based on a series of field explorations conducted upstream (Malda) and downstream (Murshidabad) of the Farakka Barrage as part of a International Union for Conservation of Nature (IUCN) Project (2011–12), in which teams from India and Bangladesh documented existing ecosystem services in the chars. This research was followed by another exchange grant (Indian Council of Social Science Research-University of Lausanne) between Indian and Swiss scholars (2015–17), which allowed for the livelihood dynamics in these fragile fluidscapes to be explored (Map 1).

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[2] The EU-India funded EqUIP Project (of which the lead author is the Indian Principal Investigator) uses "fluidscape" as the theoretical traction to forge "fluid governance" in the Ganga and Rhône Deltas.

In January 2020, a field visit was conducted to generate more up-to-date information on the quotidian realities of the choruas. These realities are determined and shaped by river erosion and floods; the roles played by several statist and non-statist actors like block development officers, *panchayat pradhans*[3], non-governmental organizations (NGOs), and grassroots organizations; and an array of situated adaptive practices pursued by the choruas for sustenance and survival in the chars. Field explorations were conducted during different seasons (summer, winter, and monsoon) to observe whether livelihood equations are affected by seasonal variations. Detailed ethnography through the application of qualitative methods like focus group discussions (FGDs), key informant interviews (KIIs), and case narratives were pursued to validate and cross-validate information across a range of actors, from government officials to choruas.

Map 1: The Lower Ganga Basin, West Bengal



Source: Google Maps. Accessed on 23 January, 2020.

5. LESSONS FROM THE FIELD

Char formation is a natural occurrence in the Lower Ganga Basin. However, the implementation of the Farakka Barrage Project has impacted patterns of riverine sedimentation with repercussions on the formation, consolidation, and dissolution of chars. The upstream and downstream of the barrage is dotted with more temporary chars; the constant emergence and submergence phenomena has forged repetitive cycles of settlement—displacement—resettlement—re-displacement (SDRR), in turn shaping

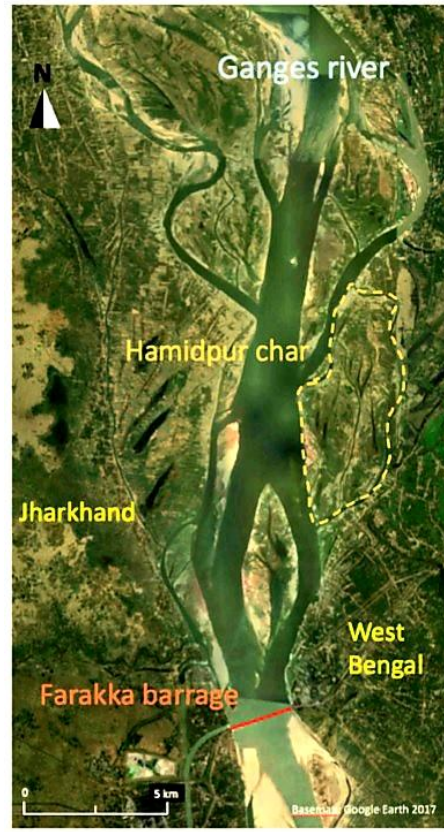
[3] The elected head or decision-maker of the lowest unit of the village administration—the panchayat.

vulnerability and adaptive practices among choruas (Mukherjee 2011). The two empirical case studies presented here will validate this proposition.

5.1. Case study 1: Hamidpur Char, Malda

Hamidpur Char is located in Kaliachak II Block, Malda District (Map 2). It is situated 15 km upstream of the Farakka Barrage. It spans 15,700 ha and about 210,000 people inhabit the char. Agriculture is the primary occupation in this char. Kaliachak II is one of the most environmentally vulnerable blocks among Malda's 15 blocks. There are disastrous floods and erosions almost every year during the monsoon. In the last 20 years, one-fourth of the territory of Kaliachak II has been eroded, 22 villages have been completely destroyed, and 8 villages have been partially swallowed by the river. Within the Hamidpur Gram Panchayat (GP) boundary, eight villages were completely waterlogged during frequent floods in 2011, 2013, 2015, and 2016.[4]

Map 2: Hamidpur Char



Source: Google Maps. Accessed on 23 January, 2020

With the eastward shifting of the Ganga since the 1970s, villages on mainland Hamidpur have been submerged, and new chars have emerged on the other bank of the river, adjacent to Jharkhand, the neighbouring state. The flood and erosion victims were compelled to migrate and settle in the newly emerged chars to pursue their livelihoods. Hamidpur Char is one such island with a settled population. Indeed, the desperate attempt of those who lost their homes on

[4] Interview conducted with the Kaliachak II Block Development Officer in July, 2017.

mainland Hamidpur to retain their old connections and memories is evident in the nomenclature of the char.

Although the choruas have established some basic mechanisms to sustain themselves on Hamidpur Char, the government does not recognize their tenurial rights. The char is considered as *shikasti* (governmental non-revenue land) according to the Revenue Bill (an outcome of the Bengal Alluvion and Diluvion Act, 1825), which states that if a piece of land that was previous submerged in water re-emerges, it becomes state property; as such, no revenue can be generated on the re-emerged char. Due to the lack of governmental recognition, people in Hamidpur Char suffer from a lack of access to basic infrastructural facilities like schools, roads, health centres, etc. There have also been instances of illegal trafficking of cattle, crops, medicines, etc. and other criminal activities, including the trafficking of women. Trafficking occurs most during the winter and monsoon because the fog and rain act as significant barriers to Indian Border Security Force (BSF) personnel operating from check posts.

The continuous shifting of the river and the emergence and submergence of chars are crucial variables that complicate the story of citizenship or non-citizenship in this "fluidscape" (Figure 1). While the Government of West Bengal has remained indifferent to granting citizenship rights to the choruas settled in Hamidpur Char, the Jharkhand Government issued voter ID cards to some of the villagers (particularly to those inhabiting villages in the western part of the char, close to Jharkhand) in 1990. When the char started eroding on the western side in 1998 and the choruas migrated to the eastern part, they still retained the voter ID cards issued by the Jharkhand Government but could not avail of any facilities as they could not access the state directly; the river lay between them and Jharkhand.

Figure 1: An interview respondent showing documentary evidence of land entitlement



Source: Authors (19 November 2011)

In 1998, troubled by material losses and the government's apathy, educated and informed villagers formed the Ganga Bhangan Pratirodh Action Nagorik Committee (GBPANC). These villagers were supported by active researchers working in the area. Soon, a grassroots movement emerged with the support of action groups and NGOs like Child Rights and You (CRY).

The movement aimed to secure disaster relief and better rehabilitation for the choruas. The action groups mapped and surveyed the chars and attempted to initiate the institutionalization of these islands to ensure better protection and eligibility to access government welfare schemes for the *choruas*.

These efforts finally culminated in the choruas in Hamidpur Char collectively demanding recognition and their citizenship rights. Scholar-activists like Kalyan Rudra promoted and supported the movement. Rudra's technical findings shed light on the Farakka Barrage's role in disrupting the natural flow of the Ganga and in turn aggravating floods and erosion in the Malda and Murshidabad districts (Rudra 2003); his work provided a much-needed scientific edge to the choruas' cause. In December 2010, GBPANC organized a multi-stakeholder meeting in Hamidpur Char. At that event, the choruas got the opportunity to show their (past) property entitlements to the additional district magistrate (ADM) of Malda District. As a direct consequence of this event, the choruas received identity cards and voter ID cards from the government in 2011.

Once the char received governmental recognition, two primary schools and a junior school were constructed between 2012 and 2015, and electricity access was ensured in 2015. Emergency centres were also built. Since 2014, a woman from Hamidpur Char has represented her people as an elected member of the Hamidpur Gram Panchayat. Official recognition also paved the way for the political participation of the choruas. They are now the beneficiaries of numerous government initiatives and schemes such as *Nirmal Bangla* (Clean Mission, Bengal), Madhyamik Siksha Kendras (MSK) and Sishu Siksha Kendras (SSK), pulse polio and other immunization programmes. The char residents can now reap the benefits of government schemes through continuous activism and simultaneously remain free of having to pay agricultural revenues, as it still enjoys the status of shikasti. The choruas access an array of environmental services from this fertile land (Annexure); they get immense livelihood benefits, evident in the remark of the block development officer (BDO), Kaliachak II, "People are no longer poor there".[5]

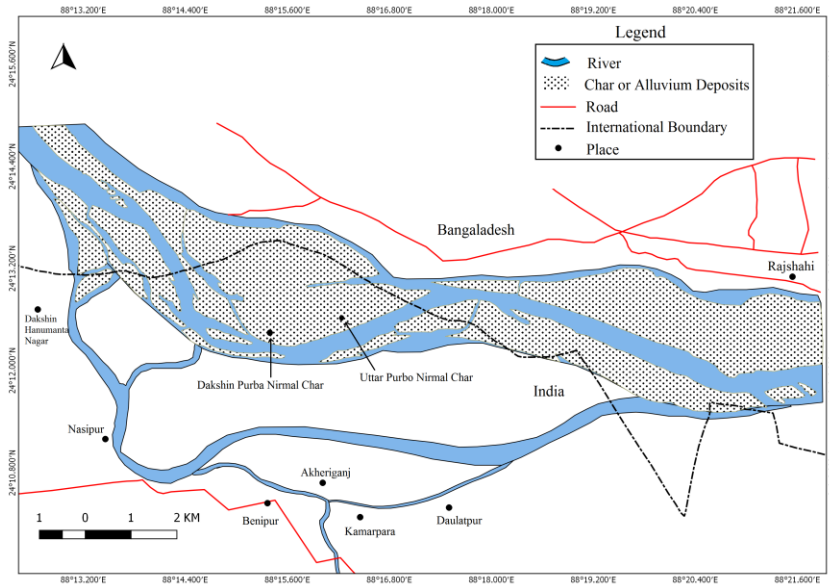
5.2. Case study 2: Nirmal Char, Murshidabad

A severe flood in 1989–1990 caused major erosion and led to the submergence of Akherigunj in Block Bhagwangola II, Murshidabad District. "Akherigunj", which literally means "the last settlement", disappeared from the map. The disastrous erosion engulfed 2,766 houses

[5] Interview conducted in July 2017.

and left 23,394 persons homeless (Rudra 2003). Nirmal Char emerged on the opposite bank of the river between 1990 and 1992 (Map 3). The erosion victims migrated and settled in the newly emerged char. Another massive flood occurred in 1998, following which Nirmal Char took its present shape (Map 3). The northeastern part of Nirmal Char has a big village that covers 571.42 ha under the Akherigunj Gram Panchayat; it has a population of 24,754.[6]

Map 3: Nirmal Char



Source: Authors

Agriculture is the major occupation there; however, people have other livelihoods as well. Some women are involved in cultivation and livestock rearing (Table 1). The women also take part in manufacturing fuel wood (using jute sticks and cow dung) and in small-scale agro-based production (Figure 2). Floods and erosion are common phenomena during the monsoon (between June and September) every year. The oscillating river downstream of the Farakka Barrage claims acres of the char and impacts the lives and livelihoods of choruas. Crops are destroyed and the quality of yield is reduced, which further lowers the market selling price of crops.

[6] Interview conducted with the village resource person (VRP) in January 2020. The VRP is a contractual post which was created in 2013. VRPs are recruited by the district social unit of the state government.

After every disaster, people suffer from diarrhoea, fungal infections, snakebites, etc. and cannot afford to go to the health sub-centre of the Akherigunj GP, as communication gets disrupted.

Table 1: Occupations in Nirmal Char

Sex	Occupation	Percentage
Male	Farming	78
	Livestock	10
	Fishing	11
	Other jobs	1
Female	Farming	2
	Livestock	1
	Cooking (midday meal)	5
	Housewives/domestic help	92

Source: Records provided by the VRP (29 January, 2020)

Nirmal Char shares a boundary with the Rajshahi District of Bangladesh. Due to acute poverty, especially after floods, competing claims among the farmers of the two countries intensify, and choruas become desperate to set up farming operations in the "zero point". As such, this is highly risky, as it is illegal to farm on this "no-man's land". Indeed, there are strict security restrictions imposed by the Bangladesh BSF.

Figure 2: Women engaged in work



Source: Authors (28 January 2020)

A series of field explorations between 2011 and 2020 captured changes in this char in terms of availability and access to public infrastructures. Nine primary schools, seven Integrated Child Development Services (ICDS) centres, one primary health centre, and one flood centre now operate here. The people receive benefits under various government welfare schemes: National Rural Employment Guarantee Act (NREGA), *Swachh Bharat Abhiyan* (Open Defecation Free Village), etc.

There was a dearth of disaster awareness and response until quite recently. AID USA distributed food (rice, pulses, potatoes, etc.) to 367 families and polythene tent materials to 70 families during the 2011 floods. Since 2015, an NGO called Future Achievement has implemented local disaster mitigation measures. Moreover, the choruas pursue adaptive practices using intergenerational social skill sets to combat the lack of adequate policy-driven initiatives. The ecosystem services not only allow the choruas to sustain themselves in this fragile landscape, but they are also significant flood resilient mechanisms (Annexure).

When the char is waterlogged, choruas live on their *machas* (rooftops) for several days until the water recedes. They arrange wooden cots on bamboo poles and use polythene tents as covers. Their houses are made from *jiyal*

Figure 3: Houses made from *jiyal* trees



Source: Authors (19 November 2011)

Figure 4: *Donga* or *chui nouka*



Source: Authors (19 November 2011)

trees, the roots of which are deeply entrenched in the soil, making the houses storm resistant (Figure 3). Boats made of tin sheets called *donga* or *chui nouka* can accommodate up to two persons (Figure 4). These act as effective modes of communication between char villages; they connect families during times of disrupted communication.

6. Conclusion

"Human technology, livelihoods, social relations and power equations are just as imbricated with river sediment processes as they are with simply water" (Baruah and Mukherjee 2018, 335). While the global discourse of the Anthropocene presents islands as "hazardscapes" that are vulnerable to climate change (particularly sea-level rise), the social analysis of local realities in shifting sediment across historical and political dimensions depict chars as "not lines of separation but zones of interaction…transformation, transgression and possibility" (Howitt 2001, 240). While these ephemeral and transient river islands are exposed to erosion and the far-flung impacts of climate change, the intensity of vulnerability is lower, as it depends on a combination of factors, including

the community's exposure and sensitivity to hazards and their adaptive capacity and collective resilience (Das 2012; Das and D'Souza 2020). The embodied experience, knowledge, and capabilities of the choruas are forged by and aligned to the chars. The livelihood capabilities, cultural practices, and perceptions of the choruas await detailed documentation; these can shed light on the array of coping mechanisms that can be considered significant from the climate change perspective. Sediment-enriched hydrosocial realities have to be incorporated into policy formulation related to floods, climate change, etc., making way for neither solid nor liquid but "fluid governance", especially within tropical-estuarine-deltaic contexts.

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ANNEXURE

Table: Ecosystem services

Types	Services	Benefits
Provisioning	Food crops: rice (varieties: *ayush* and *boro*), wheat, pulses (*kalai*), vegetables (gourd, eggplant, cauliflower, etc.) Cash crops: jute, corn, chillies, turmeric Fruit: watermelon, banana, cucumber, etc.	Subsistence; surplus sold in mainland markets
	Livestock: cow, buffalo, goat, sheep, poultry	Subsistence; transportation; agriculture; assets during times of crises (floods and erosion)
	Fish: *rui*, *tangra*, *boal*, *katla*, *chingri*, *ritha*, *chital* (indigenous names)	Subsistence; surplus sold in the market against cash income
	Medicines (herbs): *keshra* (a grass variety)	Locally used by *ojhas* (traditional healers) or non-certified rural healthcare providers
	Fuel wood: cow dung (*ghunte*), dried jute sticks and cow dung (*lodha*)	Natural energy resource for cooking, lighting, etc.
	Water: groundwater (accessed through tube wells), the river (and its sediment)	Drinking; cultivation; transportation
	Housing: mud (floor), straw (roofs), bundles of jute sticks (walls), *jiyal* trees (pillars), etc.	Flood resistant makeshift houses
Regulating	Water regulation: recharged floodplains after every flood	Fertile soil for agriculture Recharged groundwater
	Pollution control: flushing of waste and pollutants after heavy floods	Regenerated soil
Supporting	Navigation	Transportation
	Natural resource for livestock feed: *kaishas* (a local variety of grass)	Livestock nutrition
Cultural	Water festivals and rituals; folk songs; lores by the Chais (a local ethnic community)	Cultural bonding, collective living, resilience

Source: Field explorations by the authors (2011/2017/2020)

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SPECIAL SECTION: New Epistemologies of Water in India

Combining Political Ecology and "Mésologie" for a New Geography of Rivers?

Flore Lafaye de Micheaux [*] and Christian Kull [**]

Abstract: How do we rethink the integrated management of river basins? This article is mainly a theoretical contribution that aims to reflect on ways of knowing rivers in the context of the Anthropocene. The authors suggest a new framework based on post-positivist geographies for a deeper understanding of environmental, political, and social conflicts related to rivers. They highlight the potential of combining political ecology and its hydrosocial cycle framework with the *mésologie* of Augustin Berque. This approach, inspired by non-modern ontologies, helps to account for the full texture of the relationship between society and rivers. It emphasizes human–environment relations and the concept of "milieu". It particularly captures the role of lived experience in river–human relationships, by accounting for the emotions and interpretations that link people to rivers both collectively and individually. This is particularly appropriate in the Indian context where rivers are ritually revered.

Keywords: River; Anthropocene; Political Ecology; *Mésologie*; Hydrosocial Cycle.

1. INTRODUCTION

While there are ongoing debates about whether the Anthropocene should be acknowledged as a new geological period, the acceleration of physical changes on the Earth's surface since the mid-twentieth century has created challenges for human societies. This acceleration has been both in

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amplitude and in rhythm and is being experienced through land degradation, natural resource depletion, river valley reshaping, and climate change. In response, Chartier and Rodary (2016) call for geographers in France to take environmental change seriously and counter the "eco-scepticism" of some French geographers who believe that technology can solve global environmental issues. They propose reinterpreting the episteme of geography in the contemporary context and shifting to an "environmental geography".

In this paper, we elaborate on a new theoretical framework for the environmental geography of rivers with the objective of rethinking existing practices of river management. We do so by questioning the "grey epistemology" of rivers, such as the one promoted within the integrated water resources management (IWRM) approach.[1] Deliberately departing from the river basin perspective, we wish to imagine a new geography of rivers to capture how the ideas and materialities of rivers operate in the contemporary social order. We discuss combining political ecology with *mésologie* (propounded by the French geo-philosopher Augustin Berque, it is a non-modern ontology inspired by phenomenological perspectives [Berque 2014]) to cover the full texture of the relationships between society and rivers.

2. RIVER STUDIES: WHAT KIND OF "OBJECT" IS A RIVER?

In this section, we provide a brief history of the study of rivers to explore what kind of "object" a river is. We do this by accounting for the diverse ways of knowing rivers and by revealing the hegemonic meanings of rivers. We borrow this approach from geographer Jamie Linton, who highlighted the hegemonic meanings of water while reconstituting "the story of a modern abstraction" (Linton 2010). For our analysis, we consider three schematic chronological phases: the pre-modern, modern, and post-modern.[2]

The pre-modern phase encompasses antiquity and the entire medieval period up to the Renaissance. Examples drawn from ancient texts and archaeological evidences as presented by Metchnikoff (1889), the scientific secretary and collaborator of the French geographer Elisée Reclus, illustrate

[1] IWRM is an international reference for water management. Its initial guiding principles (Dublin Statement, January 1992) gave way to a more technical and less political approach and was also introduced within the European Water Framework Directive (2000).

[2] Here "post-modern" refers to all critical approaches, though sometimes contradictory, that emerged in the 1980s and that oppose the positivist approach. This proposal is in line with Mark Moberg's discussion about anthropological theories (Moberg 2013).

the significance of rivers as providers of water and fertile sediment for agriculture and livestock rearing.[3] The *Hymn to the Nile*, found on the Sellier Papyrus, explicitly states "Rises he [the Nile], the earth is filled with joy, every belly rejoices, every being receives his food, every tooth grinds" (translation from Metchnikoff 1889, 211). During this phase, humans developed river knowledge primarily to help them manage their dependence on the river, as in the case of irrigation work. This river–society dynamic is also evident in Sanskrit literature (NIH 2018; Mukherjee and Choudry 2018). The pre-modern agenda was to make the most of the river and to try to minimize its destruction—offerings to the deified river were one such modality—without questioning society's dependence on the river. The river–human relationship was characterized by adaptation or "accommodation" in Reclus' framing (Metchnikoff 1889).

After the Renaissance, a conceptual distance between human actors and rivers emerged in the West. Scientists used mathematics and physics to explain the world and natural phenomena, independent of religious perspectives. In parallel, dualist views as seen in the philosophical works of René Descartes separated nature from society. New scientific tools emerged to control nature and rivers. The technologies developed during the Age of Exploration allowed for elaborate hydrography, which was also driven by military and strategic imperatives. There was a growing specialization of sciences, and disciplines such as hydraulics, hydrology, sedimentology, hydrogeology gradually emerged, alongside a scrutiny of the quality of water and its biology. The mathematical approach, as well as the complexities encountered by engineers in the applied sphere (such as while engineering large dams and river valley infrastructure), led to fragmenting problems and increasing specialization to reduce the number of factors considered and minimize the errors in mathematical modelling (Pardé 1959). The social dimensions of the problems tackled by "river scientists" were dismissed, particularly the question of anthropogenic impacts on rivers. Humans were not included among the objects of the studies.

Diverse reactions to the modernist model became more prominent in the second half of the twentieth century, during the post-modern phase. One of them was the increasing interest in environmental sciences among researchers in order to address the anthropogenic impacts on the

[3] Leon Metchnikoff was a close friend and collaborator of Elisée Reclus and was part of a group of exiled Russian anarchist geographers in Switzerland which also included Pierre Kropotkin (Pelletier 2013); he was also a professor at the Academy of Neuchâtel. His opening address at the *Société Neuchâteloise de Géographie*, published in the Bulletin de la SNG in 1885, was the subject of comments recently published by Patrick Rérat and Etienne Piguet (Rerat and Piguet 2011).

environment. The scientific community then developed new fields of study such as eco-toxicology and bio-indicators for rivers. In parallel to this push for "more science", a critique of modern science emerged in the 1980s within various post-modernist approaches; research started focusing on the relationship between objects and subjects, humans and non-humans, and the related arrangements and hybrids (Latour 1991). Braun (2008) proposed the term "non-modern ontologies" to describe Anglo-Saxon works, which brought about an epistemological and ontological rupture, particularly in geography (Braun 2008). These theories assumed that the boundaries of "what is", especially between humans and non-humans, were no longer fixed, but in perpetual recombination, following the concept of networks from actor-network theory (Latour 1991).

These non-modern ontologies permeate recent works in emotional ecology (Smith 2013), political ecology of emotions (Sultana 2015), and hydrosocial studies within the political ecology of water. The latter approach explores the features and dynamics of the "hydrosocial cycle" that account for the *dialectical* and *internal* relations between water and society (Linton and Budds 2014). In the same ontological vein, but according to a different conceptualization based on phenomenological perspectives,[4] Augustin Berque (2014, 2016) has developed mésologie[5] or the study of the milieu, i.e., the neither entirely objective nor entirely subjective relation between humans and their environment. In Berque's works, the milieu is simultaneously physical and ecological and human interpretation (2014). As in other non-modern ontologies such as actor-network theory, Berque's mésologie breaks the object–subject conceptual divide and renews our understanding of the human–environment relation as a mutually and internally shaping connection, parallel to the concept of a hydrosocial cycle in the political ecology of water framework.

3. TOWARDS AN ENVIRONMENTAL GEOGRAPHY OF RIVERS: WHAT DOES POLITICAL ECOLOGY TEACH US?

Political ecology of water provokes a reconceptualizing of water; it provides a radical critique of the capitalist mode of production and of "natural" approaches to water that ignore water's social construction. It addresses the call for a cosmopolitical geography that explicitly explores the role of

[4] Here, "objects and subjects interpenetrate each other to form a geographical world that is only accessible through lived experience" (Pradeau 2013).

[5] This term should not be equated with the *mesology* developed by Charles Robin, a disciple of Auguste Comte, in the nineteenth century, which presents a positivist and determinist epistemology (Berque 2014).

politics in creating a "geography of justice" (Chartier and Rodary 2016, 41–43). New conceptual tools have been proposed, such as the hydrosocial cycle, which differs from the hydrological cycle in that it accounts for the material as well as discursive co-production of water and society (Bakker 2000; Swyngedouw *et al.* 2002; Linton and Budds 2014). It also invites researchers to reinterpret discourses and representations of water in order to reveal the political dimensions they contain and the social injustices that they may entail (Linton and Budds 2014). Several of these works on rivers, therefore, highlight the blind spots of policies and river management practices (Bakker 1999; Sneddon and Fox 2006; Norman and Bakker 2009; Graefe 2011; Tvedt 2011; Alatout 2012; Bouleau 2014; Bourblanc and Blanchon 2014). These works often relate to "politics of scale" analyses (Swyngedouw and Heynen 2003; Rangan and Kull 2009), which also bring to the fore the social construction of scales that are often misinterpreted as a given. Some authors have also questioned the hegemonic use of the watershed concept, promoted by international organizations and the European Commission (Molle 2009; Graefe 2011). Others investigate rescaling measures in river management, shedding light on the biases involved (Sneddon and Fox 2006; Norman and Bakker 2009; Vogel 2012; Bourblanc and Blanchon 2014). These works successfully address a classic theme in political ecology, i.e., the social distribution of benefits and costs within the nested perimeters of river management policies (Molle 2005; Matthews 2012; Vogel 2012).

However, political ecology does not deeply engage with the materiality of rivers, nor with the emotions and attachments towards rivers. This observation concurs with critiques from works that strongly engage with the material dimension such as "bodily" or feminist geographies,[6] and with critical physical geography that aims to develop dialogues between physical geography and critical approaches (Lave 2015). This observation also draws on approaches that seek to integrate the emotional dimension that permeates the world with academic works (Smith 2013; Sultana 2015; Chartier and Rodary 2016). In particular, the symbolic, ethical, religious, and emotional dimensions of rivers are not subject to specific analyses in political ecology's river narratives, even though the authors acknowledge the significance and roles of river imaginaries (Bakker 1999; Molle 2005; Sneddon and Fox 2006; Alatout 2012; Bouleau 2014).

[6] We must note here at least two exceptions: Peterson (2000) proposes to model a river in its socio-political context as an ecosystem interacting with its own environment in his case study on the Columbia River in US. Bouleau (2014) details the biological indicators for the Rhone and Seine rivers in France and shows how these reflect the co-production of science and waterscapes.

We argue that these bonds and attachments are likely to play a significant role in the "strategic field of power relations" (Foucault *et al.* 2001, 241) through collective and/or individual actions. Dallman *et al.* (2013) presented the spiritual and emotional connections between the Winnemem Wintu tribe and its residual sacred spaces that were threatened by the extension of the Shasta Dam in California. The research demonstrated how these connections, perceived as inseparable from the identity and memory of the tribe, triggered the tribe's struggle—however symbolic—against the dam project. Drew (2017) investigated the extent to which women's religious devotion, beliefs, and practices involving the Ganga River catalysed and shaped political mobilizations against dam projects in the upper Ganges Basin. Boelens (2014) proposed the concept of a "hydrocosmological cycle" to extend hydrosocial analyses to the examination of "ancient and modern myths [that] attempt to normalize and subjugate actors to control by the dominant groups in water society" (245). However, these approaches do not particularly investigate the ontological dimensions that underpin these perspectives. Our proposition, as presented in the next section, will therefore turn to Berque's mésologie.

4. THE CONTOURS OF THE "ENVIRONMENTAL GEOGRAPHY OF RIVERS" IN THE INDIAN CONTEXT

Based on the richness of river–society relations that the existing literature highlights, we call for hydrosocial analyses to incorporate a focus on the materiality of rivers and the emotions and interpretations attached to them simultaneously.[7] An environmental geography of rivers should scrutinize how the emotional and metaphoric, which could be the cultural, ethical, ideological, or spiritual dimensions of rivers, enrich the hydrosocial cycle. Emotions and interpretations emerge from sensitive relationships between individuals and rivers but also from collective representations, systems of preferences, and values, religions, and ideologies. Swyngedouw (2007) emphasized the importance of ideologies in his analysis of Franco's "hydrosocial dream" for Spain, as did Alatout (2012) in his "geopolitical imaginaries" of the Jordan River. Religious beliefs and rituals are inseparable from several rivers in India, particularly the Ganges. The attachment to rivers operates simultaneously at the physical and spiritual levels. In the Indian context, bodily interactions with rivers are central to human–river relations. Many rituals involve bathing and ablutions with water from the Ganges or even taking a sip from it. Haberman recalls

[7] For example: Sharma (2009), Eck (2012), and Singh (2013) shed light on the Indian context of revered rivers.

(2000) that Vallabhacarya, a sixteenth-century Hindu saint, indicated that human relations with the material river condition one's capacity to relate with the two more elevated stages of the river—the spiritual river and the goddess river. Reciting *mantras* and uttering the name of Ganga also play an important role in the Hindu faith (Eck 2012). These are ways to invoke the goddess' presence in rituals at home. In her study on the Bhagirathi Valley, Drew (2017) showed how contemporary devotees in Uttarkashi city, especially women, recite chants dedicated to the river to actualize and strengthen the human–river relation. Therefore, the rituals strongly connect devotees to the river and contribute to shaping it as "socionature", both materially and discursively.[8]

At a collective level, the sacredness of rivers has also acted as an intrinsic trigger for the mobilization of activist movements since the 1980s; for example, the Ganga Ahvaan Forum promoted the maintenance of the pristine upper stretch of the Bhagirathi River (Uttarakhand) by avoiding the construction of hydroelectric dams. The present Indian government (2020) has also chosen to leverage the reverence for the river in its landmark Namami Gange Programme launched in 2014. However, this programme is also a counter example. The attention given to the cultural and ontological values of the river for political matters is socially counterproductive, as it may divert the authorities' efforts from precisely documenting the social impacts of the environmental condition of the river and questioning the representativeness and legitimacy of policy priorities (Lafaye de Micheaux 2019).

In response to the "principle of sensitive geography", which calls for engaging with senses, practices, and emotions (Chartier and Rodary 2016), Berque's mésologie singularly complements political ecology with its concepts of milieu and trajection (the relationship, necessarily historical, of reciprocal and iterative transformation between the milieu and humans [Berque 2014]). Advancing the socionatural approach, mésologie captures the full extent of river meanings—i.e., the complex links between the material dimensions (sensory perceptions and practices also mediated by technologies) and the emotional and conceptual dimensions (value-charged representations) of rivers. It also refines the notion of temporalities: "the reality of the milieu is simultaneously present, past and possible" (Berque 1986, 151). We read this sentence as an invitation for researchers to expand

[8] Geographer Erik Swyngedouw formed this neologism to reflect that society and nature are hybrids, internally connected and co-produced (1999). This proposition builds on a view of dialectics as internal relations (Harvey 1996) and on the actor network theory developed by Bruno Latour (1991). "Socionature" encompasses material and discursive dimensions of nature in a historical-geographical production process (Swyngedouw 1999).

the spectrum of elements incorporated in their studies, such as mythological or religious narratives that defy rational space–time conventions. As a typical example of how these narratives may shape the governing of rivers, following New Zealand's Whanganui River, the Indian court also conferred legal and human entity to the River Ganges, justifying the action through religious (or traditional indigenous) perspectives that consider rivers as more than objects.

5. CONCLUSION

The combination of the hydrosocial framework with mésologie allows for a deepening of our understanding of stakeholders' perspectives and their positionality along with the full range and texture of the components that shape the hydrosocial cycle. Through this integrated framework, the social, ecological, political, and ontological issues raised around river management initiatives and their interlinkages can be better apprehended. Within the Indian context, where society has revered rivers since the days of antiquity, "colonial hydrology" (D'Souza 2006) was the major departure from the traditional perspective that conferred *intrinsic* and *relational values* to the river (Pascual *et al.* 2017). In its contemporary legacy, evident in lofty national agendas like the interlinking of rivers, an "environmental geography of rivers" can be a provocative approach to address questions from "what changes?" to "who changes?" if rivers are intervened upon beyond redemption.

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SPECIAL SECTION: New Epistemologies of Water in India

Revealed by Water, Hidden in Water: Indic Hydro-epistemologies of Sacred Things

Anway Mukhopadhyay [*] and Anuradha Choudry [**]

Abstract: This essay explores two basic trajectories of the hydro-epistemology of sacred things in Indic cultures: things revealed by water—the visible gifts of water—and things hidden in water with which we can communicate only indirectly, by touching the water. Unlike Mircea Eliade's concept of hierophany, this represents a mode of the sacred that cannot be auto-manifest and depends on water for radiating its sacrality. While the sacred things revealed by water—the conch shell, the *bana linga*, the *svarnamukhi shila*, the *shaligrama shila*—are water's gifts to the Indic religions, there are things that are hidden by water; their hiddenness maintains their secrecy and sacrality. For instance, in certain Sati *pithas*, the petrified body parts of Goddess Sati are said to remain submerged in water. One can only touch them indirectly, by touching the water that is in touch with the Sati's body. This article illustrates this two-pronged epistemology of the sacred that is propelled by water in Indic religious cultures.

Keywords: Hydro-epistemology, Sacrality, Indic, Sati Pithas, Hierophany

1. INTRODUCTION

When we set out to explore the hydro-epistemology of sacred things in Indic traditions, we found two basic trajectories: things revealed by the water—gifts that dot the boundary between nature and culture—and things hidden in the water that we can touch only indirectly, by touching the water. Sacred things from the water include the conch shell (Hinduism and

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Buddhism), the *bana linga*, the *svarnamukhi shila*, and the *shaligrama shila* (Hinduism);[1] these are the gifts of water to Indic religions. There are also other sacred tokens that the water hides; their concealment ensures or enhances their sacrality. For instance, in various Sati *pithas* (sacred sites of Devi worship associated with her avatar, Sati), petrified body parts of Goddess Sati are said to be submerged in the water, thereby making the water sacred. One cannot directly touch these hidden tokens from the Sati myth; one can only touch Sati indirectly by touching the water in which the petrified flesh of Sati is hidden. This article illustrates this two-pronged epistemology of the sacred that is induced by water in Indic religious cultures.

2. THEORETICAL FRAMEWORKS

We find that Mircea Eliade's concept of "hierophany" is not adequate to account for the phenomena on which we focus in this article. While Eliade's idea of "hierophany" focuses on the self-manifestation of the sacred, the gifts of water revealed by its waves, as well as the sacred things hidden in its bosom, represent a mode of the sacred that is not and cannot be auto-manifest and rather depend on water for its location and function within the epistemology of the sacred. Eliade (1959) opines, "Man (*sic.*) becomes aware of the sacred because it manifests itself, shows itself, as something wholly different from the profane. To designate the *act of manifestation* of the sacred, we have proposed the term *hierophany*" (11).

In this article, however, we argue that in the case of waterborne sacred objects or those hidden in water, the sacred does *not* manifest or show itself. Instead, the water shows or refuses to show it. When unseen, it is still considered sacred; indeed, its sacredness is grounded in that it remains hidden by the water. On the other hand, when it is seen, it does not show itself but is revealed by running water that drops it on the shore. Here, hierophany does not refer to the agency of the sacred itself, but rather the agency of the mother of sacred things: water.

In order to explore specific forms of water-induced spirituality prevalent in various Indic modes of religiosity, we draw and elaborate on Bron Taylor's

[1] *Bana linga*—also known as *svayambhu* (i.e., self-born) linga is an ellipsoid stone that Hindus worship. The stone symbolizes Lord Shiva, the supreme god of power in the Hindu Trinity (Brahma–Vishnu–Maheshvara). The stone is commonly found on the bed of the Narmada River in Madhya Pradesh, India. *Svarnamukhi shila* is the natural stone obtained from the Svarnamukhi River in Andhra Pradesh and it represents Shakti/Devi. *Shaligrama shila*, collected from the Gandaki River in Nepal, is a fossilized shell worshipped as a manifestation of Lord Vishnu.

(2014) idea of "sea spirituality". While speaking of "sea spirituality" in the context of surfing, Taylor dwells on the ocean as the source of life—"Mother Ocean". According to Taylor, "there is not much we know with certainty about the origins of life other than that the ocean is literally the source" (230). This we can say without having a clue why a spirituality that evolved in close contact with the sea developed not in isolation from the senses but rather through them. This sort of "sensible spirituality", Taylor insists, "celebrates the energies of the universe and life itself" and "does not require metaphysical speculation that reaches far beyond our ken" (230).

The mode of religiosity on which we focus in this article is sensory in nature: one has to touch the holy stones revealed by water and blow the conch shell, a gift from water, by pressing one's mouth to its mouth. However, the trajectory we follow is different from that of Taylor's on sea spirituality. While the surfer, as a sea spiritualist, rides a wave and in doing so connects to the ocean (Taylor 2014, 230), the spiritualist or religious person who worships sacred stones or blows the sacred conch shell ritualistically hears the roiling sea or the laughter of the river in the conch shell or sacred stone, respectively. Thus, the sea spiritualist moves closer to the sea; this happy recipient of the gifts of water waits on the shore for the water to reveal, with maternal affection, her enormous riches.

3. REVEALED BY WATER

Sacred things have various connotations and functions in Indic religions. In Hinduism, where the spectrum of the sacred is bafflingly wide and all-pervasive, the sacred thing is often not just a thing, but a manifestation of the divine itself. For instance, the *bana linga*, *shaligrama shila*, and *svarnamukhi shila* are all natural objects that are seen as varied manifestations of the divine. Even though one might be tempted to associate their sacrality with the Eliadean idea of "hierophany", we need to first look at their origins. Water is a primordial mother, the manifester of sacred objects, and the bringer of sacred gifts to the people who love and are loved by it; to find the sacred stone, you must go to the river. However, we need to consider here that water in general, not just rivers, is the mother of gods. Water brings sacred gifts—the stony manifestations of the divine—to the shore, which simultaneously separates and connects nature and culture; thus, religion begins its course.

The stone's sacrality is essentially embedded in, and curiously coterminous with, the sacrality of the water that carries it. In this context, we can see the water, carrying the sacred stones that are to be worshipped as gods/goddesses, has the palpable, physical presence of the Vedic Aditi who,

as Tracy Pintchman (1994) observes, "shares her maternal nature with the waters and the earth" (32–33). Pintchman says, "Aditi, the waters, and earth may on some level be different aspects of one another, for they are homologized by being cited collectively as mother of the gods" (32–33). If we dissociate the rivers carrying these sacred stones from the complex mythological frames that may occasionally downplay the primacy of "water as mother" and see the *jalatva* (water-ness) of the river water as the actual source of the sacrality of the divine stones nurtured in the riverbed—that is to say, if we train ourselves to read the sacred differently and non-conventionally, from a physical or tangible perspective—we come to understand how important it is to acknowledge and appreciate the power of water to bring the gods as its gifts to us.

As Shrikala Warrier (2014) rightly observes, all the *bana lingas* in the Narmada River are said to be Shiva himself. Warrier reminds us that the five main deities of Hinduism, foregrounded in the *Panchayatana*[2] worship initiated by Shankaracharya, "are worshipped in the form of stones found in five sacred rivers" (140–141). Interestingly, these stones are also associated with the five primordial elements of creation in Hindu cosmologies—ether, air, fire, water, and earth. Nevertheless, even though these five sacred stones are supposed to represent the five primordial elements, including water, it is water that nurtures and carries them to the religious Hindu. Water, in a way, becomes the all-encompassing entity that manifests the sacrality of all the elements, in effect becoming the ultimate agency behind the hierophany of the five sacred stones. These five stones are born of water and are manifested as sacred entities (not just "things") through its flow. Here, we come to the spiritual dynamics of water revealing rather than hiding the sacred. The hydro-epistemology of the hierophany of these stones becomes comprehensible to us when we adopt Taylor's (2014) framework of "sensible spirituality" and touch the heart of the sacred epistemes of popular Hinduism in their simplest forms, shorn of the scriptural superstructure that, when over-emphasized, often smothers unadorned nature.

Eliade (1959) explains that for the religious person, "the *sacred* is equivalent to a *power*, and, in the last analysis, to *reality*" (12). However, in the case of sacred things brought by water to the domain of religion, true power and reality are in water itself. While the *bana linga* or the *shaligrama shila* may be seen as *svayambhu* (self-born), in the final analysis, they are the offspring of water. The maternal agency of water cannot be overlooked, when a non-

[2] Panchayatana refers to the veneration of the five Hindu deities: Shiva, Vishnu, Shakti/ Parvati, Surya, and Ganesha.

biased "contemplative cultural critic" (Mani 2009, 1–4), capable of overcoming an obsession with scriptures, touches these sacred stones with love and reverence and hears in them the laughter of waves. Kapila Vatsyayan (2010), while discussing sacred stones like the *shaligrama shila* and *bana linga* in the context of Indic water myths, focuses on the ecological message that "these simple stones" convey, which facilitates "a sensitive comprehension of ecology" (xiv). Indeed, by worshipping these stones, we celebrate the primordial motherhood of water. It is in the water as a physical matrix that different ideas and figurations of the sacred take shape. As the origin of all sacrality, water weaves a complex web of the sacred by revealing certain things and hiding others.

From the sacred objects that are considered direct manifestations of the divine, we now move to those tokens of the sacred that do not ontologically overlap with the divine, but are nevertheless associated with it or have other sacred functions. Take, for example, the *shankha* (conch shell). As Gautam Chatterjee (2001) elaborates, the conch shell "symbolises the cosmic space of which the attribute is *sabda* or sound" (77). While the sacred stones representing the five deities are gifts from the rivers, the conch shell is a gift from the sea. However, its relationship with the sea is quite complex—the sea, as it were, remains alive within the physical body of the shell. "Like the insides of the sea, conch-interiors are considered innately sacred, and devotees adorn their entire physical and spiritual selves and homes by using its internal parts" (Sarbadhikary 2019, 7). Even though the conch shell has many sacred functions in Hindu rituals, "the conch's sacrality rests with the object's naturalness, not ritual value" (Sarbadhikary 2019, 8). In other words, it is a *natural* gift from the sea.

Following Sarbadhikary's (2019) insistence that the conch shell, "when sounded every dusk", makes "the home open out to the sea again" (8), we can say that it is a peculiar gift from water that opens our hearts to the sea and to the ultimate abundance of water. Drawing on the view that the shankha always reminds us of "nature's innate freedom" (Sarbadhikary 2019, 8), we argue that water gives us the conch shell to help us recognize, again and again, its source in primordial waters when we hear the sound of the sea emerging from its cavity.

In Tibetan Buddhism, the conch shell is a "symbol of the proclamation of the Buddha's teachings, which fearlessly resounded throughout the ten directions" (Beer 2003, 171). Once again, we find in the conch shell, which is a gift from the rolling waters of the sea, the cadence of the waves. The sacred gifts that come to us from water cross the boundary that separates nature and culture; thus, we understand that culture is, in the context of the

hydro-sacred, not a process of transcending nature but one of celebrating its gifts.

4. HIDDEN IN WATER

Now, we shall focus on the ways water hides sacred objects and invites the religious person to touch the water—this is the only way to access what is hidden underwater: the unrevealed sacred. Here, the secret and the sacred become one. Water preserves the sacrality and secrecy of the hidden object, forcing us to understand that water is not just a matrix of sacred stones, but also a medium for communicating with that mode of sacredness that revels in its inaccessibility. Here, you do not dive into the water to find or grab the sacred object; you simply touch the water or take a dip in it, without presumptuously trying to discover the sacred thing hidden in the water. In certain Sati *pithas*—sacred spots where lie hidden parts of the corpse of Goddess Sati, dismembered by Vishnu's *chakra* after her self-immolation and the destruction of the *yajna* arranged by her father, Daksha (Mukhopadhyay 2018, 10–11, 7–681)[3]—one recognizes this phenomenon of water hiding the sacred beneath its surface. Sati's sacred body parts, in petrified form, are hidden in the water, out of reach. One can only touch the water, take a dip in it, or sprinkle it on one's body; it is only by touching the water that the person, indirectly, accesses the sacred aura of the goddess's petrified body parts and pays tribute to them. In these cases, one cannot directly touch the body of the goddess; one's respectful touch must be mediated by water. In the case of tantric Shaktism, there are many ritualistic contexts in which touching the goddess becomes an important way of paying tribute to her and being blessed by her touch. Touch is mutual—whatever you touch also touches you, especially within the panentheistic vision of tantric Shaktism (Williamson 1984, 253–254). However, in the case of the sacred body parts of Sati, hidden by water, the sacred touch, although mutual, is *mediated*. You touch the water that is in touch (literally) with the sacred body parts of Sati, and the water touches you back, on behalf of the goddess. Just as with the revelation of sacred objects, in the case of hiding sacred objects too, water enjoys the agency of ensuring the sacred function of those objects.

In the Sati Pitha of Kankalitala, adjacent to Shantiniketan in the district of Birbhum, West Bengal, there is a *kund* (a small water body) beside the

[3] *Chakra* or *Sudarshana Chakra* is the divine discus that is the weapon of Vishnu. *Yajna* is a ritual that is performed in front of a sacred fire and is accompanied by chants (*mantras*). It is part of the ancient Indian tradition and has been referred to in Vedic literature (especially the *Brahmanas* and the *Yajurveda*).

temple of Goddess Kali. According to legend, Sati's waist fell here and is still submerged in this water body (Clark 2011; Devasharman 2015, 100). In a piece on the Sati Pitha of Kankalitala, William Clark (2011) expresses wonder about the invisibility and inaccessibility of Sati's actual body part at this site:

> I cannot help but wonder if at the bottom of the *kund* there may be some sort of rock formation corresponding to the fallen body part of Ma Sati. It seems likely that an isolated, shallow pond such as the Kankalitala *kund* would periodically dry up during periods of draught, exposing the bottom. If and when this does occur, is an object revealed that was the initial source of attraction for ancient people to this sacred site, or is the Kankalitala *kund* merely a pond that has acquired sacred status for reasons unknown?

However, as Yatinandan Devasharman (2015, 100) points out, the kund at Kankalitala never actually dries up fully. Even during the summer, when the entire Birbhum district reels under scorching heat, this kund remains full. According to legend, it has a subterranean connection with the Manikarnika Ghat of Varanasi. Devasharman informs us that devotees of the goddess consider the water of the *kund* to be as holy as that of the Ganges. They convey their secret desires to this *kund* and, when their desires are fulfilled, they place sweets and paper boats on the surface of the water. They sprinkle the water on their heads while expressing their desires and sip the water. In other words, for the devotees of the goddess, the water of the kund is alive; it listens and responds to their pleas. The water is precious because it is the only medium of communication with the sacred part of Sati's corpse that is submerged in it. The devotee conveys their plea to the petrified body part of Sati, and the response comes through the water. They have to touch the water to convey their heart's desires to what is hidden in it; the benediction of the sacred remains of the goddess are also conveyed through the water. Without loving the water and being loved by it, you cannot engage in a loving relationship with the feminine divine enshrined in this Sati *pitha*.

In the context of sacred objects hidden by water, another example would be Lake Manasarovara, which is famous as one of the holiest and most important Hindu pilgrim spots. According to the myths of Shaktism, Sati's right hand fell into the Manasa Sarovara, which is now located in Tibet and is called Manasarovar (Devasharman 2015, 191–194). While for Hindus in general the water of this lake sacred in itself, the Shakti worshipper experiences this sacrality from a different perspective. Here too, Sati's body part is submerged in the Manasarovara—it is not accessible. Only water remains before the eyes and hands of the devotee. The Shakti worshipper conveys the message of devotion to the goddess only by touching the water of the lake, which keeps Sati's petrified hand hidden beneath its surface.

5. CONCLUSION

We have shed light on those sacred functions of water in Indic traditions that often escape our critical gaze. While Indic water epistemologies typically focus on the sacrality of water itself (Vatsyayan 2010, xiii–xviii), we have underlined the intricate ways in which water determines the epistemology of the sacred in India. Rather than being an apparently passive, abstract instance of the sacred, or an *object* of worship, water engages in active play with the very epistemes of sacrality. It conditions, modulates, and determines the modalities of the manifestation (the sacred objects it reveals) or non-manifestation (the sacred things it hides) of the sacred things that are at the heart of the religious cultures of India. Whether it reveals or hides them, the agency lies in the waves and ripples of the water.

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SPECIAL SECTION: New Epistemologies of Water in India

Hydrocultural Histories and Narratives: Insights from the Sundarbans

Amrita DasGupta [*]

> To put water at the heart of the narrative is to demand that we adopt a more flexible conception of space
>
> *Unruly Waters: How Mountain Rivers and Monsoons Have Shaped South Asia's History* (Sunil Amrith 2018, 9)

Abstract: This article focuses on water-centric quotidian-actualities by bringing to the fore collected oral histories from the field and their relation to the local religious literature—*Bonbibi'r Johuranama, Raimangal, Manasa Mangal.* When asked about the water history of the region, the narratives of the locals reflect the desire to shift the attention from terrestrial–aquatic tyranny to climatic despotism. To put this into perspective, the islanders, at present, are conscious about how climate change holistically affects their deltaic ecosystem. The realization does not stop the community from engaging in age-old religious practices that have acquired habitual existence in the lower Bengal delta. This provides an entry point to a new cultural system re-centred on historical imaginations and novel spatialities, which in every aspect is exemplary for contemporary policy-makers.

Keywords: Hydroculture, Water, Culture, Bonbibi, Sunderbans

1. INTRODUCTION

From cultural and political transitions, modern history has shifted its focus to water, owing to the escalation of the irrecoverable existential threats induced by climate change (Amrith 2018). The literature on agrarian history

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from the 1970s and 1980s is strewn with studies on irrigation, as harnessing water was the main concern for Indian society then (Chaudhuri 1970; Stokes 1978; Stone 1979; Bose 1986; Kaiwar 1992). The age-old presence of step-wells in Rajasthan, Gujarat, and Delhi, followed by the modern construction of dams in South India, bear testimony to the historic preoccupation in agriculturally motivated India with finding methods to battle water depletion and disappearance. The pursuit and belief in the security of water for agricultural purposes in delta regions, supported by the idea of India as a repository of the monsoon, propelled people to migrate to deltas from the latter half of the twentieth century, particularly in the face of accelerating poverty and inequality. However, the growing potential of water to shape national history and rural communities was largely neglected after the 1990s till the first half of the twenty-first century, as most historians shifted their focus to water's effect on urban culture. It should have been otherwise, as India is primarily agriculture-dependent.

The landscapes of South Asia and the development of its urban centres are influenced by water. This is best illustrated in the religious values of the bay dwellers. In the Sundarbans, water acts as a social leveller that benefits and impairs all its inhabitants equally. Religious practices centred on water in different communities, through the divine personification of the same as gods (Poseidon, Greek mythology) and goddesses (Ganga, Indian mythology), have not only assigned undying importance to the element but have also facilitated recent legal developments that have enshrined the importance of water. Some recent examples include the National Water Framework Bill (2016), which calls for the rejuvenation of river systems through local community participation and the inclusion of rainwater harvesting in new urban constructions under the Kerala Municipality Building Rules, 1999 (amended 2004).

Evidently, religious practices are influential enough to propel the crafting of policies that not only protect these community practices but also draw from them to institute water security measures at scale. This paper, drawing on empirical insights from the Sundarbans, examines the importance of water in sustaining a community and how the local inhabitants religiously revere it.

2. WATER IN MANGROVE RELIGIONS AND RITUALS: ENMESHED HUMAN–NON-HUMAN REALITIES

The study focuses on the region's history after Partition (1947), which resulted in the geopolitical remapping of India. New borders dissecting rivers, created based on bureaucratic ratiocination of the environment, have

resulted in mismanagement of disasters caused by cyclonic storms, flooding, heat stress, and sea-level rise. These incidents have led to a shift in the focus of modern history to the evaluation of natural uncertainties in the coastal region (Amrith 2018). Subsequently, it becomes imperative that policymaking is informed by the reimagining of the philosophy behind the cultural, religious, and eco-centric imaginations of water-dependent forest inhabitants. Thus, this paper aims to bring to the fore the quotidian realities of the Sundarban islanders in relation to the life lived in and around water. A study of religious dictates and folklores associated with the people of the *Bhatir Desh* (land of ebb and tides) will facilitate the endeavour.

For the specific case that this paper makes, it is imperative to mention that the gods and goddesses of the Sundarbans are believed to preside over the forests, its resources, and the animals of the region. Religious narratives include norms associated with divine appeasement through austerity and death rituals. The islanders also practise certain religious rituals they believe will protect their livelihood. Given the geographical location of the Sundarbans, the islanders depend on the forests and rivers for survival. The salinity of the water renders the land unfit for cultivation. Thus, they have to penetrate the forest to secure wood, wax, and fruits, bearing in mind the risk of attacks by wild animals—mostly the tiger. In the river, they may encounter crocodiles and snakes. The evolution of a syncretic religion in this reserve forest is driven by an all-encompassing fear of life loss related to specific animals, which naturally induces the prominence of the worship of inferior Bengal goddesses who exclusively have control over the actions of these animals. This explains the psychological dependence of the islanders on lesser deities—Bonbibi, Dakhin Rai, Kalu Ray, Manasa, and Makal Thakur. This paper examines their divine alliance with forest animals—tigers, crocodiles, snakes, and fish. Despite belonging to the pantheon of inferior gods, the actions people take to seek their blessings follow *bhodrolok*[1] Hindu procedures.

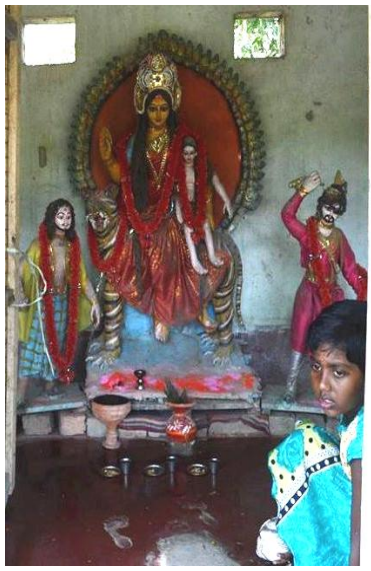
2.1. The mythologies of Bonbibi and water

Bonbibi, or the tiger goddess, is worshipped by all those who use the forest resources of the Sundarbans (Figure 1). Her worship is most widespread in the *atharo bhatir desh* (land of the 18 ebb tides). However, there has been a systematic shift towards worshipping Kali (the Hindu female goddess of

[1] Pertaining to the Hindu upper/middle class identity, *bhodrolok* translates to "gentleman." The idea came into existence between 1757 and 1947, along with the rise of British Raj in India. It was used to refer to any person who has wealth and polished (mostly English-like) manners. This segment of colonized society zealously exhibited their religious practices and ultimately normalized it within the public sphere.

prowess; the destroyer of evil forces) by prawn seed collectors, as the community believes the occupation to be deadly because of its symbolic association with the rage of Kali (Jalais 2010). The risks of working in water are immense as compared to that of working on land in this region; camouflaged and submerged crocodiles can attack without warning. The worship of Kali can also be attributed to urban encroachment in the delta. Unlike the *mohule* (those who work in the forest), prawn seed collectors are all women, who perceive the water as not only their source of livelihood but also metaphorically as a temple. The islanders believe that the attacks on land and sea are punishments from the resident goddess, Bonbibi, who mandates the loss of life of anyone who consumes forest resources out of greed. Therefore, while wading through the river, these women immerse their hands in the water and, with devotion, evoke the mercy of their benevolent mother. They sing no specific chants. Their devotion stems from the spontaneous desire for a good catch and security of life.

Figure 1: Bonbibi



Source: Author, 25 January 2018

Gender equations become important here. Although women are allowed to be the occupational partners of their husbands, these same women are denied access to fishing boats once they are widowed. The same thing happens with the prawn seed collectors; once widowed, they are restricted from entering their occupational temple, in an

Figure 2: Glimpse of the preparatory stages of fishing in Bakkhali, West Bengal



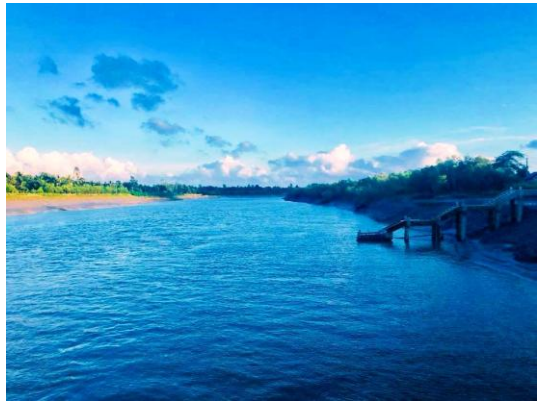
Source: Author, 26 May 2017

androcentric ostracization based on Hindu laws. The water, though not a part of the rituals except for being housed in the *mangalghat* (a ritual urn) to assure the wellness of worshippers, assumes layers of meanings in the daily lives of islanders (Figure 2).

2.2. Representing the realms of forests and water through empirical information

At the Ashrom ferry ghat (Gosaba), from where the boats leave for Bali Island, there stands a temple of Mother Ganga. Locals[2] recounted the need to rebuild the temple just after Cyclone Aila (2009), when the land was engulfed by the sea, embankments were broken, and habitats were ruined by the rising sea level. No amount of blowing of conch shells could calm the anarchic sea. The main *purohit* (priest) of the temple mentioned the need to provide alms to the water goddess occasionally, to keep her calm. The women of Gosaba are often seen setting lamps and fruit afloat on banana leaves at the ferry ghats (Figure 3). Here, we often find the families of fishers engrossed in prayers, pleading to the mother to be compassionate to their breadwinners in the open delta. Thus, the inherent fright of the animal-fearing community of the river compels scrutiny of the mythical tri-party relationship between Ganga, Parvati, and Manasa (Hindu female goddesses), as described in the *Manasa Mangal Kavya*.[3]

Figure 3: Bidyadhari, the performative sphere of Ganga worship adjoining the Ganga temple in Ashrom Ferry ghat



Source: Author, 28 August 2018

Manasa, the snake goddess, was not allowed to enter heaven; the *Manasa Mangal* recounts her promotion to a greater goddess from being a folk deity. On achieving greatness, she performed a myriad of miracles in several places, including the Sundarbans. Parvati always hated Manasa, as she believed that her husband was sexually interested in Manasa. On

[2] Based on interview in Dulki Sunderbans on 25 January 2018.

[3] The oldest of all, *Mangal Kavyas* recounts the initiation and spread of the snake goddess' worship in Bengal by the conversion of a devotee of Lord Shiva into a devotee of Manasa, the snake goddess.

the contrary, Manasa was like a daughter to Parvati's husband. Ganga tried her best to make Parvati understand the father–daughter relation that Mahadev and Manasa shared, but to her dismay, nothing helped. This familial discontentment compelled Ganga to take pity on Manasa and support her through the struggle. Therefore, the islanders worship the snake goddess to avoid snakebites, and, in the process, they also please Mother Ganga.

Specific death rituals were performed for those who died from snakebites in the region, to maintain the social order of the Sundarbans (obscure). The dead body of the snakebite victim was supposed to be set afloat on a bamboo raft, and the widow was to accompany her dead husband. During the journey, the widow was expected to chant the glory of the snake goddess and Ganga so that the river remains calm and the widow successfully reaches her destination. Mythologically, the destination was heaven and the journey was undertaken by *behula*—a woman determined to please Mahadev in order to restore her husband's life. Here, the water is personified as the goddess; when angry, she can devastate all that is around her but, when satisfied, is the best ally.

According to the scriptures, Bhagiratha brought River Ganga to earth from the heavens. On ascending to the throne of the Sagara Dynasty, he became aware of the miseries of his forefathers, who burned in the fires of hell. To repent for the mistakes of his ancestors, Bhagiratha left his kingly responsibilities to embrace a life of austerity in the mountains. On the advice of his guru, Trithala, he aimed to satisfy Ganga through his penance. Ganga, as the myth proceeds, is capable of washing away the mortal sins of humans, and only she could offer salvation to Bhagiratha's forefathers from the curse of saint Kapila. It required the purgation of the soul by an offering of water by the son to his forefathers—ritualistically, this is called *tarpana*—and *niravapanjali* or the ceremonious immersion of the ashes in the holy water after cremation. The tradition still continues in Hindu death rites (*sraddha*), where water plays an important role; it cleanses the soul of impurities and prepares it for birth after the successful completion of *pind daan* (offering of food and water to dead forefathers). The Sundarbans, as a part of the larger Bengali culture, adheres to these age-old death rituals. Concurrently, the pilgrimage to Sagar Island during Makar Sankranti[4] is important. The island is situated on the continental shelf of the Bay of Bengal; it is a place for Hindu pilgrimage. Every year, on the day of Makar

[4] Makar Sankranti celebrates the transition of the sun (Hindu god, Surya) into Capricorn (*Makara*). Hindus rejoice on this day to mark the beginning of longer days and the end of the month of the winter solstice.

Sankranti (in the middle of January), thousands of pilgrims gather to enjoy a holy dip in the confluence of the Ganga, Brahmaputra, and Meghna, followed by a trip to the adjoining Kapil Muni Temple. Although this is a festival for the sun god, Surya Dev (sun god) accepts no offerings and prayers until the people take a dip in the *sangam* (where the river meets the sea) to cleanse themselves of mortal evils.

Figure 4: Bonbibi with Dukhey in her lap



Source: Author (25 January 2018)

Figure 5: Dakhin Rai



Source: Author (25 January 2018)

Local scriptures, such as *Bonbibi'r Johuranama* (The Miracles of Bonbibi) and the *Raimangal*, shed light on the distribution of forest resources. After saving Dukhey from the monstrous Dakhin Rai, Bonbibi commanded that forest resources should be distributed equally among the animals and humans in the presence of Barkhan Gazi[5] (Figures 4 and 5). The shape-shifting tiger Dakhin Rai protects forest produce like honey and wood from human consumption, but there is no reference to the riverine commons, which testifies to how the scripture refers to forest resources as land resources. This leaves the readers wondering how water resources are to be shared and whose refuge is to be sought when dealing with resources from the water. Nevertheless, the islanders pray to Kalu Ray and Makal Thakur

[5] *Bonbibi'r Johuranama* (The Miracles of Bonbibi) tells the tale of the birth of Bonbibi and her brother Shah Jongoli and their winning over of the Sundarbans. They were sent to the Sundarbans by Allah to save its people from the villainous tiger, Dakshin Rai, who could take human form. He would take the lives of the people who came searching for wood, food, wax, or honey in the Sundarbans. Dukhey was given as sacrifice to Dakhin Rai in lieu of the resources garnered by his uncle from Rai's forests. Dukhey, scared by his fate, sought the security of the forest goddess. Bonbibi waged a war against Rai and ultimately won. Barkhan Gazi, a resident of the forest (now remembered as a pious saint), requested Bonbibi to spare Rai's life and establish order in the forest. She did as she was requested by equally dividing the forest resources among the animals and forest dwellers.

to resolve issues relating to crocodiles and varieties of fish—the most significant non-human inhabitants of the sea. *Raimangal* aptly underscores that forest resources are mainly considered inland resources. Dakhin Rai hankers to protect his resources and demands human sacrifices in exchange for wax and honey taken from his forest:

> *Yabat na daya more narabali puja* (So long as human sacrifice is not offered to me)
>
> *Nahi diba mon-modhu- dekhaiba moja* (I will not give you wax or honey; I will have fun)
>
> *Jodi tumi narabali puja para dita* (If you are successful in offering me a human sacrifice)
>
> *Sat dinga mom diba tomar dalite* (I will give you seven boatloads of wax)[6](Das *et al.* 1980, 86).

Water and sand are integral to the belief system relating to animal exorcism in the area. Animal exorcism is facilitated by *fakirs* (tiger-charmers). Woodcutters, honey gatherers, and wax collectors are advised not to enter the forest without their *fakirs*. The *fakir* is believed to have the power to disperse tigers and to prevent life-threatening attacks. Faith in the *fakir* is so strong that he is believed to have command over crocodiles, control over the level of seawater, and the power to prevent animal attacks even when the attackers are close to the mouth of the river. No work commences in the forest until the *fakir* has recited his charms and incantations and performed the ceremonial act of drawing lines with mud (a mixture of water and sand) for the dispersal of all dangerous animals. When the woodcutters start their work, the *fakirs* sit on anchored boats and chant; there is the imminent possibility of the occurrence of a fluvial catastrophe if the chant fails:

> In the name of my brothers Hingli, Bingli and Mangala, and the horses of Ghazi Saheb, also in the name of Barkat (God). O mother Kameswari, thou art uppermost in my mind. I have put Azrael, the rider, on the backs of the tigers and tigresses of this jungle. Go eastward, thou of colour of fire; go eastward or westward, go to the right-about, I command thee, and feed thyself by killing deer and pig. If this my charm fails, may the top-knot of Mahadeva fall at the feet of Kali. (O'Malley 1908, 62–63)

In the Sundarbans, there are two types of boat rituals that use water. These rituals can be broadly classified as business-centric and women-centric (Naskar 2017). To secure the expansion of the family business and the health of their husbands at sea, the women of the islands perform the rites of *bhora bhashan*. For this, 17 types of leaves tied together by a red thread and 17 types of fruits are offered to the river goddess. The day after the

[6] English translation by the author.

worship, all these items are submerged in the river as a token of thanks for the blessings of the goddess. The same ritual is repeated every Tuesday, which is evident from its name, *joy mongolbar* (*mongol* is the Bengali word for Tuesday).

The women-centric boat rituals are elaborate. The river water becomes the foundation of the boat-temple. As the idol of Sashti is enshrined within the boat, the vessel itself becomes a temple. This simply means that the women of the household turn the boats of their husbands into temples by placing the idol of Goddess Sashti in them. They perform rites to invoke her benevolence and seek divine empowerment in an attempt to safeguard the lives of their husbands at sea. It is necessary to understand that a riverine community includes water in every survival strategy—these are occupational and god-fearing observances.

3. HYDROCULTURAL REALITIES DEFINING EVERYDAY LIVES: CONCLUSIONS

Given the dangers surrounding the inhabitants of the Sundarbans, their psychological serenity is ensured by their faith in dedicated ritualistic practices. Hence, water is not only salient because of its importance for their occupational identity, but it is also crucial to their geographic and personal identities. The people not only share a fear-based relationship with the environment but also nurture a friendly attitude towards it. Their ideas of submission to nature and of seeking its benevolence are rooted in their fear of dying. The sources of danger constitute a recurrent theme in religious texts and quotidian practices. Water has the same ritualistic importance in all religions practised in the region, as it is the absolver of sin. Owing to this preconceived idea of how water can dissolve one's sins, the islanders equate it to a means of forgiveness, in addition to depending on it for survival. Water assumes the omnipotent position of the gods and goddesses of the Sundarbans, manifesting the strong syncretism prevalent in the region.

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NOTES FROM THE FIELD

Himal Rakshaks of Sikkim: The Burden of Being the Flag-bearers of Community-based Conservation

Rashmi Singh [*]

1. INTRODUCTION

In October 2017, one of my respondents, Karma, an ex-herder in West Sikkim, made a statement: "People who keep animals are much more concerned for the *himal* (mountains) here than the Himal Rakshaks (the honorary guardians of mountains); just because we do not go and pick up plastic from the mountains (i.e., support the conservation agency driven mountain cleaning campaign) or wear T-shirts with conservation slogans does not make us the destroyers and them the protectors." Karma's father used to live in the temperate and alpine regions of Khangchendzonga National Park (KNP) and Khangchendzonga Biosphere Reserve (KBR) for a large part of the year as part of the seasonal movement necessary for yak herding. His son and other family members would accompany him to the forest during the summer; the entire family would stay in the pastures and help with the day-to-day tasks associated with livestock management. But in 1998, a grazing ban policy was formulated by the Government of Sikkim, and pastoral communities were removed from KNP and KBR between 2002 and 2004.

My research project in Sikkim focussed on a wide range of questions about historical and recent changes in traditional pasture management. However, during the field study, the Himal Rakshaks (HRs) repeatedly surfaced in my

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interactions with local communities. But who are these people? And what made them subject to the anger of the ex-herders of West Sikkim?

This article examines the contentions that surround the HRs in West Sikkim, as epitomized by Karma's statement. Based on my ethnographic research, I show how the honour associated with being an HR is locally contested and influences the everyday lives of the HRs. While conservation initiatives may benefit biodiversity conservation, they may also have far-reaching societal consequences for local actors, particularly those who become the "face" of conservation initiatives. It is paramount to pay attention to these consequences, as they may perpetuate or reproduce social inequalities or systematic exclusion and, in some cases, further ecological harm.

2. RANGELAND CONSERVATION AND THE HIMAL RAKSHAKS

While the resource management practices of pastoral societies can be considered as adaptations to regional and climatic conditions (Behnke and Scoones 1992; Niamir-Fuller 1999; Scoones 1994), conservation plans in high-altitude rangelands are still based on the principles of the equilibrium model of rangeland management. The equilibrium paradigm assumes that rangeland ecosystems are potentially stable systems that are destabilized by improper use by pastoral communities, which causes degradation (Brown 1971; Stebbings 1935). Almost as if tracing the steps of fortress conservation, which has *assumed* rather than *demonstrated* gains of human removal (Kabra 2018), the state of Sikkim implemented a grazing ban with the aim of conserving the biodiversity in and around KNP and KBR. However, following the ban, the Forest Department found it difficult to manage the natural resources in the remote and rugged mountain terrain.

This led to the recognition of the crucial role of traditional knowledge and the experience of local herders in the management of high alpines. Based on this realization, a participatory conservation of *himal* (mountains) was proposed (Shrestha *et al.*, 2013). In 2006, the Forest Department initiated the HR programme, under which 21 individuals were recognized as "the honorary guardians of mountains" and were given stewardship of the alpine areas. This initiative was indeed unique, due to its aspiration of capacity-building among local community members to help conserve the high reaches of KNP. The HRs were trained by organizations like The Mountain Institute (TMI), World Wildlife Fund (WWF), and Khangchendzonga Conservation Committee (KCC) in basic biodiversity monitoring techniques and in documenting and reporting wildlife crimes and instances

of illegal grazing in and around KNP and KBR. As many HRs were also the Eco-Development Committee (EDC) members who had helped to remove the herders from KNP and were expected to report grazing and other wildlife-related crimes, conflicts with other community members were bound to happen.

3. BEING HIMAL RAKSHAKS: SOCIAL INEQUALITIES AND SYSTEMATIC EXCLUSION

While there seemed to be an evident sense of pride in being honorary guardians of their own mountains, the HRs mentioned that they often have to deal with hostility and social exclusion in the villages within the studied area. This was apparent in some of my interviews; ex-herders showed signs of agitation towards the HRs. In November 2019, one HR mentioned that while explaining the impact of grazing to his fellow villagers, he had gotten into a fight with them. Moreover, after that incident, his brother did not speak to him for 10 years. In another incident, in November 2019, two HRs mentioned that during a discussion on the need to conserve the forest, a locally influential herder stated that the HRs had betrayed the community. They mentioned that even after more than 15 years since the implementation of the grazing ban, some households that had previously been involved in livestock herding harboured feelings of hatred and betrayal towards the HRs because the latter had supported the forest department in the removal of their own community members from the forests.

During the field surveys, five of the HRs mentioned that they bore the cost of conservation in their daily lives, as they were excluded from local social events and the associated livelihood opportunities. Social capital is extremely crucial in this region to attain the benefits of seasonal livelihood opportunities associated with trekking tours (as porters and tour guides), seasonal labour in agricultural fields, and daily wage labour under the Mahatma Gandhi National Rural Employment Guarantee Act, 2005 (MGNREGA). Currently, some ex-herders hold influential positions and, therefore, play a critical role in providing livelihood opportunities in the region. HRs, therefore, lose out on many livelihood opportunities that are controlled by ex-herders because of systematic exclusion.

HRs, as the face of conservation in West Sikkim, have borne the brunt of social exclusion, loss of livelihood opportunities, and antagonism from their own community. These social exclusions are seldom, if ever, considered when evaluating the impacts of conservation policies and decisions.

4. CONCLUSION

Natural resource management, which includes community participation in the name of the Himal Rakshak programme in Sikkim, shares some similarities with earlier stories of community-based conservation in India, where the devolution of policies and community participation emerged as an extension of state control (Lele 2004; Sarin, Singh, Sundar, and Bhogal 2003). However, while the Himal Rakshak initiative started with the aim of conserving KNP and KBR by involving knowledgeable local individuals in the monitoring of protected areas, it has a unique angle in that it valorizes local knowledge *only* in forms and actions that dovetail state policy. All the while, HRs have mixed feelings of contentment and pride on one hand and disappointment arising from having to bear the cost of conservation and social exclusion on a daily basis on the other. There has been a rapid increase in the discourse around community participation and local knowledge in conservation policy and practices. However, the unique case of the HRs in the Sikkim Himalayas points to the risks and vulnerabilities that emerge from the implementation of community-based conservation initiatives that do not pay adequate attention to long-term social outcomes for the members of the local community who become the flag-bearers of conservation programmes.

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NOTES FROM THE FIELD

Why Regulations Come Up Short? Some Observations from a Field Study of the Kanpur Leather Industry

Aparajita Singh [*] and Haripriya Gundimeda [**]

1. INTRODUCTION

Poor water quality adversely impacts the environment and public health. The quality of river water in India has been declining drastically. The number of "severely polluted" river stretches increased from 34 to 45 during 2015–2017 (CPCB 2018). CPCB (2019) has identified 17 categories of highly polluting industries, of which the leather industry is among the most damaging. Effluents from leather factories contain toxic chemicals such as chromium, sulphates, and chlorides. Exposure to tannery pollutants is hazardous to human health and can cause diseases such as stomach and lung cancer; further, improper disposal of pollutants can adversely affect soil and groundwater quality (Bosnic *et al.* 2000; Pure Earth 2016).

The Government of India has set an upper limit for effluent discharge from leather industries and provides technical support to install effluent treatment plants to treat wastewater before it is discharged into water bodies. Despite stringent regulatory standards, the quality of water bodies remains alarmingly low in leather clusters. Thus, this study examines why regulations have failed in addressing the problem of leather pollution. We undertook a field study of Kanpur's leather industry, one of India's most polluted leather clusters and a significant contributor of pollution in the Ganges (CLRI 2012). Our field survey of the tanning industry in Kanpur in

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2018 showed that asymmetric information and the lack of incentives within environmental regulations are responsible for the industry's unresolved pollution problem.

2. KANPUR LEATHER INDUSTRY

The Kanpur leather industry was founded at the beginning of the nineteenth century. It developed rapidly under British rule due to the demand for leather boots, saddlery, and harness equipment. Easy access to the cantonment area that was in continual need of military equipment, such as leather boots, the availability of water supply from the Ganges, labour, raw materials, and large areas of vacant land, led to the development of the cluster (CLRI 2012). Kanpur has two leather clusters—Jajmau in Kanpur city has 250 operational tanneries and Unnao, 35 km from Kanpur, has 50 operational tanneries.

Table 1. Number of tanneries in non-compliance with effluent standards

Region / Year	Jajmau	Unnao
2016	20 out of 198 (10%)	8 out 42 (19%)
2015	28 out of 173 (16%)	7 out of 47 (14%)
2014	26 out of 129 (20%)	12 out of 43 (27%)
2013	14 out of 105 (13%)	10 out of 43 (23%)

Source: UPPCB Kanpur

The responsibility of ensuring that Kanpur leather tanneries conform with regulatory norms lies with the Uttar Pradesh Pollution Control Board (UPPCB), which records data on pollution and levies penalties on defaulters. About 85% of the tanneries operating in Kanpur are small scale and have a primary effluent treatment plant (PETP) to pre-treat their pollutant discharge before it is treated at a common effluent treatment plant (CETP). The UPPCB monitors two parameters of the effluent discharge from the PETPs—total suspended solids (TSS) and chromium (Cr), the permissible limits being 600 mg/l and 2 mg/l, respectively. We analyzed the UPPCB pollution data for 2013–2016 and found that 80% of the tanneries discharge effluents that meet permissible limits (See Table 1). The official data seemed quite puzzling given the severity of the pollution problem in the cluster (Mukherjee 2013; Parthasarathy 2016; Sengupta 2017; Koshy 2018). The discrepancy compelled us to study the regulation and monitoring of these industries.

3. ISSUES OF ASYMMETRIC INFORMATION AND INCENTIVE COMPATIBILITY WITHIN REGULATIONS

The objectives of our field study were two-fold. Firstly, we studied the loopholes in the monitoring of pollutants in tanneries, and secondly, we examined if the regulations adequately incentivize tanneries to treat their industrial discharge.

3.1. Asymmetric information

The UPPCB monitors tanneries at random using the "grab sampling" method, wherein the sample collected reflects the concentration of pollutants only at one point in time. However, the concentration of effluents in discharge varies for different processes in leather manufacturing. Thus, the results may be misleading as the pollutant concentration may vary across the day. Tanneries often discharge pollutants illegally at night. Thus, random checks are inadequate to monitor such practices.

Furthermore, pollution data shows that most tanneries are inspected only four to five times a year. There is also scope for manipulation during sample collection. One of the officials we interviewed mentioned that once news of an upcoming inspection spreads among tanners, they reduce the concentration of pollutants by re-arranging the on-going leather manufacturing process. In such cases, the official sample does not reflect the actual toxicity of discharge (personal conversation with a UPPCB officer, March 25, 2018). Thus, we find that a classic example of information asymmetry emerges, where the polluters know more about their pollutant discharge than the regulators.

Our interaction with the tanners revealed that there is rampant corruption during the monitoring of tanneries. UPPCB officials take bribes to manipulate the collected sample. For example, instances of tannery units providing a sample of mineral water instead of the discharge from the PETP were reported by one of the tanners. Another tanner revealed that tanneries pay UPPCB officials to continue operating illegal tanneries that were officially shut down by the UPPCB. Bribes are predominant even if firms abide by the law. Corruption discourages firms from adopting cleaner technologies, as tanneries prefer to pollute and bribe than to reduce pollution. A higher concentration of effluents is found in the inflows of wastewater at the CETP, indicating that norms are not strictly followed (personal conversation with CETP Manager, April 5, 2018). Thus, informational asymmetries and rent-seeking practices undermine the monitoring process.

3.2. Incentives incompatibility

The command and control regulations impose the same standards on all and fail to recognize the differential ability of firms of varying sizes to meet effluent standards. Our conversation with a few members of the Kanpur Tannery Association revealed that the primary aim of tanners is to meet the increasing demand for their products rather than to meet environmental hazard reduction requirements. Big exporting houses like Mirza International and Super House Ltd. are more interested in ensuring the quality of leather exported to the European market. Europe has enforced the stringent REACH (Registration, Evaluation, Authorization and Restrictions of Chemicals) policy, which regulates the use of hazardous chemicals like azo dyes, formaldehyde, and chromium by the exporter in their leather products. One of the tanneries reported that importing countries often send their teams to inspect the leather manufacturing process and the quality of chemicals used by their exporting houses. Central Leather Research Institute (CLRI) certifies exporting firms to ensure the quality and fulfilment of chemical limits. CLRI undertakes a thorough examination of the leather samples from tanneries, and samples are kept with them in case of re-evaluation/falsification later. The exported leather is checked at the ports of the importing European countries to examine whether they meet the standards of the REACH policy, wherein non-compliance will lead to the rejection of the shipment. Therefore, big exporting tanneries have adequate incentives to voluntarily comply with strict environmental standards to maintain the reputation of, and demand for, their products.

On the other hand, small tanneries operate in a highly price-competitive domestic market with meagre profit margins. Hence, small leather firms prefer to use cheap chemicals over environment-friendly chemicals while manufacturing leather goods. Discussions with one CLRI official revealed that only 12 big tanneries in the cluster had adopted expensive cleaner technologies like waterless chrome tanning, which helps to increase the uptake of chemicals so that fewer chemicals are discharged in the wastewater. The large firms are incentivized to adopt sustainable practices through duty drawback to export high quality, sustainable leather goods. In contrast, small firms that sell in the domestic market have no such incentive. Furthermore, regulations require tanneries to contribute to the CETP's operational costs based on their production capacity. Since the contribution to CETP's operational cost is based on production capacity, the tanneries have no incentive to reduce pollution below effluent standards. Rather, the tanneries under-report their official production capacity to reduce monetary burden.

4. CONCLUSION

Our field observations highlight that the poor quality of pollution data presents a flawed picture of regulatory compliance by tanneries who, in reality, evade pollution norms. The main driver of this problem is asymmetric information and lack of incentives to treat pollution. We have the following recommendations to address the issue.

Firstly, a shift from the present monitoring practice of "grab sampling" to "composite sampling" for evaluating the discharge from tanneries effectively is required. Composite sampling will require the collection of discrete samples at regular intervals over 24 hours and will represent the average performance of effluent treatment plants during the collection period. Random monitoring at different hours of the day, including the night, can also be fruitful to catch the defaulters. Involving third parties like research institutions and non-governmental organizations (NGOs) in monitoring may help reduce the probability of corruption. Secondly, designing policies to incentivize small tanners to reduce pollution is urgently needed. The incentive could be linked to a measurable outcome—in this case, recovery of chrome from the effluent. The subsidy amount can be linked to the extent of chromium recovered and reused. Where the tanners adopt waterless chrome tanning, the subsidy can be linked to avoided use of chromium. Disbursal of subsidies in the form of direct benefit transfer would act as an incentive for tanners and improve compliance. Loans could be extended to tanners for investing in technologies to treat sludge and wastewater. Targeted subsidies based on a measurable outcome will offer incentives for reducing effluent discharge and shift the burden of monitoring and demonstrating compliance from pollution control authorities to the tanneries themselves. Targeted subsidies will act as a premium for tanneries to reveal accurate information about their pollution abatement levels and reduce the cost of enforcing regulations.

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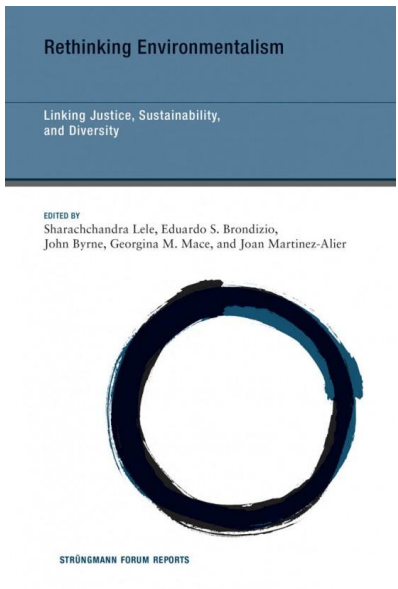
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BOOK REVIEW

Building Inclusive Frameworks

Lavanya Suresh [*]

Sharachchandra Lele, Eduardo S. Brondizio, John Byrne, Georgina M. Mace, and Joan Martinez-Alier, eds. 2018. *Rethinking Environmentalism: Linking Justice, Sustainability, and Diversity*. Cambridge and London: MIT Press. ISBN: 978-0-262-03896-6, pp. 302, USD 45.00 (PB).



This book is an outcome of the discussions held at the Ernst Strüngmann Forum on "Rethinking Environmentalism: Justice, Sustainability, and Diversity" on June 19–24, 2016, in Frankfurt am Main, Germany. The participants of the forum, who are stalwarts in their respective fields, authored the chapters in this book. It provides a comprehensive review of the justice, sustainability, and diversity frameworks used to study environmental problems, and I am tempted to call it a reader.

In *The Critique of Pure Reason*, Immanuel Kant suggested that our ideas do not conform to the objects of the world

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around us; instead, objects are defined by the world of our ideas (Kant 1882). The constructivist approach builds on this idea and claims that processes, concepts, analytical frameworks, and definitions are normative and should be understood based on their socio-political context.

This book falls squarely within this field of thought and seeks to provide a self-reflective understanding of environmentalism by considering "how differences in framing environmental problems are driven by differences in normative and theoretical positions, as well as ways in which more inclusive framings might enable more societally relevant and impactful research and more concerted action/practice" (p. 154). However, the book goes beyond just reviewing these frameworks by calling into question the value-neutral claims of different theoretical and analytical frameworks applied in the study of environmental phenomena. Thereby, it brings the politics of environmentalism to the fore. The book addresses a significant gap in the literature on environmentalism by demonstrating how conceptual and analytical framings are socially constructed and are products of socio-political power structures (p. 103).

The central theme of the book is its enquiry into "frameworks". Frameworks trigger a set of emotions and ideas—including stereotypes (p. 5)—and articulate the relationship between power and knowledge that pervades the production of discourse and practice that, in turn, shapes definitions (p. 58). A footnote in Chapter 4 states,

> We understand framings as a set of concepts and perspectives based on how individuals, groups, and societies organise, perceive, and communicate about reality. It involves a social construction of phenomena. Framing selects certain aspects of an issue and makes them more prominent so as to elicit certain interpretations and evaluations of an issue.

Therefore, frameworks are understood as epistemic developments that are constructed and used to understand the world (p. 75). In evaluating these frameworks, the authors also suggest ways to make them more inclusive. At the normative level, they consider a frame to be more inclusive when it addresses more than one of the three broad values of environmentalism: sustainability, justice, and diversity. At the theoretical level, the inclusivity of a frame is determined by its ability to incorporate or reconcile different representations of social and natural reality (p. 252).

The chapters are organized into four themes: forests and other high biodiversity ecosystems, urban environments, energy and climate change, and water. Under each theme, there are descriptive chapters and one synthesis chapter that ties the whole theme together. Often, books that are a product of conferences have different papers that are put together as

chapters, and there is no connection or coherence between them. This is not the case here. In each of the descriptive chapters, the authors remain faithful to the overall aim of the book, which is to evaluate how inclusive frameworks are in socio-environmental research. The synthesis chapter that summarizes the theme reflects on not only the broader literature but also draws upon the content in the other chapters in that section. Some chapters address more normative questions whereas others focus on descriptive aspects. The strength of this book lies in the ability of its authors to provide a cohesive narrative throughout the book.

In the introductory chapter, the book's editors set the stage by explaining that the book seeks to answer the question of who gains and who loses when different theoretical, epistemological, and socio-political perspectives are used to address socio-environmental problems. Chapters 2–4 address the theme of forests and other high biodiversity areas. In Chapter 2, Kent Redford and Georgina Mace focus on traditional biodiversity conservation and point to the malleable aspects in the definition of biodiversity. They argue that although biodiversity is thought of as a unitary concept, it has multiple meanings that differ in technical and value-based ways (p. 23). To understand conservation, they outline four conservation frameworks that have evolved since the 1960s (p. 30). This helps to shed light on a set of tensions underlying the way biodiversity conservation is defined (p. 34) and enables them to conclude that biodiversity conservation is not a term with a universally agreed-upon definition, but rather, it is a value proposition.

Ecosystem services that humans derive from nature are an important concept in sustainability and conservation. In Chapter 3, Peter Minang explores the connections between values and incentives in the context of ecosystem services in high-diversity tropical forest systems. He highlights the potential linkages between held, assigned, and relational values and multiple incentive typologies through two main decision-making framings: rational choice and bounded rationality (p. 41). The chapter explores the implicit theory of change present in every frame that is based on an incentive structure. This aspect of frameworks based on incentives is rarely articulated in terms of the context within which the incentive will take place and how it will operate differently in a different setting, which is referred to as a theory of place (p. 51).

The synthesis chapter for this theme, written by Leticia Merino-Pérez *et al.*, presents a detailed review of how varied framings of biodiversity and forests approach issues of justice and governance, which, in turn, influence conservation and sustainable management programmes (p. 59). The chapter reflects on thematic and conceptual focal points: causes and drivers of

forest and biodiversity losses and the proposed prescriptions in different framings. In doing so, it evaluates the values explicitly or implicitly held by these frames (p. 62) in the fields of conservation biology, ecological economics, political ecology and collective action, and institutional analysis theory. Further, the chapter analyses eight initiatives from these fields that represent different approaches to biodiversity conservation. It addresses the normative concerns that drive these diverse initiatives, the interaction of frameworks and values, and conceptual and ethical framings about the main challenges faced by these conservation approaches (p. 75).

The second theme of urban environments is covered in Chapters 5–7. The two background chapters in this section demonstrate how broad the theme of environmental framings can be. In Chapter 5, Amita Baviskar presents an eloquent account of how social position and political-economic power influence the framing of urban environmental problems. She demonstrates how unequal urban spaces in India operate by comparing two neighbours: an upper-middle-class family living in a comfortable high-rise apartment and their housemaid, whose family occupies a shack next door. This chapter argues that the power to define and address an issue as an environmental problem is unequally distributed and that social location and cultural capital shape interpretive frameworks and capacities to act (p. 85). This chapter stands out for its distinctive narrative style and the two environmentalisms it depicts (p. 139).

In Chapter 6, Nancy Grimm and Seth Schindler use a social-ecological-technological system framing (SETS) to discuss the nature *of* cities as well as nature *in* cities, which encompasses issues relevant to both the Global North and South (p. 99). This chapter addresses the issue that ecology is often hard to see in the city (p. 90), which is why the urban poor have not been able to wield environmentalism as a discursive resource to secure their interests (p. 91). The authors argue that bourgeois concerns drive environmentalism in cities where concerns over air and water quality are articulated in ways that penalize the poor while ignoring the culpability of other classes (p. 95). Cities continue to be ecosystems (p. 107) and the contrasting challenges associated with cities of the Global South compared with those of the North need to be seen as being interwoven into the design of various dimensions of cities, their infrastructure, and inhabitants (p. 120).

In Chapter 7, Xuemei Bai *et al.* provide a comprehensive review of five framings of urban environmentalism—SETS, urban metabolism, complex urban environments, environmental justice, and cities as solutions from different normative and theoretical positions (p. 127). The chapter also addresses four conventional dichotomies that influence conceptual and

analytical framings—the urban–rural framing, Global North versus Global South, the brown versus green agenda in cities, and private rights versus environmental commons. The authors then propose that a more inclusive definition of the urban environment will enable frameworks that take into consideration issues of justice and bring recognition to the fact that cities are complex, dynamic, and evolving systems with non-linear trajectories, influenced by a variety of urban constituencies (p. 128).

The third theme of energy and climate change has two background chapters by Patrick Bond (Chapter 8) and Manfred Fischedick *et al.* (Chapter 9), who take the Paris 2015 Climate Agreement as a starting point. Bond traces the positions taken by four individual South African environmentalists and a set of environmental organizations that have all been highly critical of the inadequate progress in international climate negotiations. Chapter 8 explores the dichotomy that is often drawn between two major civil society forces within climate activism: international nongovernmental organizations (INGOs) and grassroots climate justice activists (p. 156–159). He recommends that climate justice movement organizations should attempt to link up more decisively with each other, as it will enable them to confront neoliberal discourses (p. 178) directly.

On the other hand, Fischedick *et al.* in Chapter 9 recognize the top-down character of most international climate change discourses and posit that the Paris Agreement allows for more decentralized, polycentric decision-making and design in climate change policy. They point out that local and regional planning and campaigns are adopted more quickly than national and international efforts. Decentralized efforts also put a greater emphasis on inclusiveness and transparency, which allows for explicit climate justice commitments (p. 183). Through a set of three hypotheses, the authors demonstrate that climate justice—with its emphasis on unequal distribution across local communities—has an inherent bottom-up feature and provides an opportunity for a polycentric paradigm that distinguishes itself from the mainstream techno-centric strategy of control. This will instead allow for creativity, experimentation, and innovation (p. 198).

In the synthesis chapter by Sun-Jin Yun *et al.* (Chapter 10), there is a detailed typology of framing of the energy and climate debate. The authors draw specific attention to the increasingly problematic status of market-based arguments and policies. They focus on discourses of climate justice, energy sovereignty, and green economy (p. 207). In their extensive review of 12 framings on energy and climate, four frames focus on the market, three on analytical frameworks, and five on post-market aspects of the economy. The chapter captures the key ideas, values, and concerns that

emerged from framings of the energy–climate debate and speaks of ways to promote dialogue among them (p. 210).

The last theme, water, has only two chapters. Chapter 11 by Margreet Zwarteveen *et al.* addresses the issue of water accounting and how it is employed to solve water problems. The authors take on a social constructivist position and critique new science policy initiatives that involve water (p. 227) by addressing the performative aspects of knowledge (p. 231). The chapter establishes how water accounting claims objectivity by being characterized as modern, which, in turn, leads to its legitimization and all-pervasiveness. The chapter focuses on whether water accounting meets its own modernist claims and ends with a discussion on how water accounting tools can be used in less modernist ways to meet goals of equity and diversity, rather than just efficiency (p. 232).

The synthesis chapter (Chapter 12) by Amber Wutich *et al.* examines seven frames in water research and analyses them based on their normative and theoretical positions, different views on progress (p. 252), and definitions and perspectives (p. 252). The chapter demonstrates how the frames vary widely in terms of inclusiveness and justice (p. 255). For each of the frames, the chapter assesses six aspects that range from their intellectual history to their political effectiveness. These aspects are illustrated under each frame through case studies. The chapter also demonstrates how inclusive frameworks can work in practice (p. 279). By assessing the frames on water through a standard set of criteria, the authors have demonstrated points of tension, overlap, and disconnect between them (p. 283).

Overall, this book is an intense and lucid compilation of various dimensions of environmental frameworks analysed through the lens of sustainability, justice, and diversity. The authors convincingly argue that frameworks should be more inclusive. However, one drawback is the lack of a conclusion chapter. The focus of this book is so broad that there is a need to consolidate the arguments made under each of the themes. I was hoping that given the calibre of the authors involved in this project, they would have concluded the book by theorizing on the concept of "frames," which would have been a great addition to the existing literature on the constructivist approach. Nevertheless, this book is a must-read for academicians, students, practitioners, and activists who work on environmental issues.

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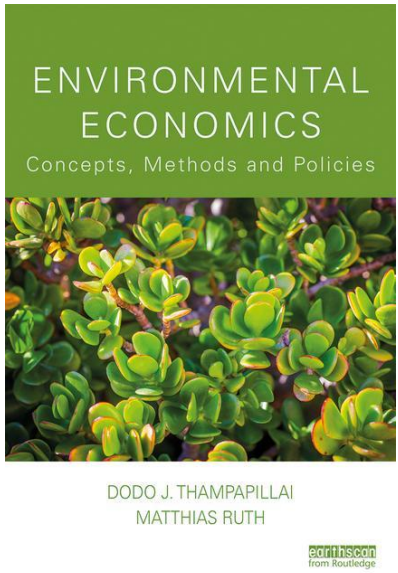
Ecology, Economy and Society–the INSEE Journal 3 (2): 197–201, July 2020

BOOK REVIEW

Revisiting Environmental Economics: Concepts, Methods, and Policies

Ramprasad Sengupta [*]

Dodo J. Thampapillai and Matthius Ruth. 2019. *Environmental Economics: Concepts, Methods and Policies*. London: Earthscan. ISBN: 978-1-138-06005-0, pp. 324, GBP 34.99 (PB).



Humans constitute one of the innumerable species inhabiting Earth, particularly its biospheric segment. Like other species, humans have developed a relationship with their natural environment, comprising both living organisms as well as their abiotic environment. However, the relationship between humans and nature has changed vastly over time, resulting in major changes in the biosphere, with climate change and biodiversity loss being two major consequences. The main concern of economic science has been the development of human material well-being, which depends on the production, consumption, and

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distribution of resources among individuals in society. In the process of production, a variety of material and energy resources are drawn from ecosystems and are converted through chemical, biological, and physical transformations into products and ultimately into waste at the end of the economic life cycle. In the process of humans rearranging matter through conversions of resources into waste, the molecular structure of resource systems is disordered, raising their level of entropy (or the degree of disorder). This results in a loss of efficiency in their ability to effect similar conversions that ensure the well-being of human society.

If the waste flows exceed the absorptive capacity of nature, the unabsorbed wastes accumulate as pollutants and contaminants in the ecosystem, generating adverse health effects for humans as well as the ecosystem. We may define environmental capital as the total stock and fluxes of all resources of ecosystems, including their waste absorptive capacity. For long, economists have neglected the role of entropy and other ecological laws in economic processes and the specific role of environmental capital in the process of economic development.

Conventional environmental economics addresses the problems arising from the loss of environmental capital as a consequence of market failure due to the public good and non-tradable nature of many of the ecoservices as well as the externalities caused by the residuals of material resources. The latter arise as waste at the various stages of production, transportation, and use of the products thereafter. At the microeconomic level, the analytical framework used for these issues has essentially been one of applied welfare economics. On the other hand, at the macroeconomic level, environmental economics has focussed mostly on the sustainable accounting of national income and its growth.

These micro- and macro-level analyses do not, however, factor in the role of *environmental capital* explicitly, nor do they articulate methods of analysis that consider environmental issues as derivatives of the role of environmental capital.

The book *Environmental Economics: Concepts, Methods and Policies* by Dodo J. Thampapillai and Mathias Ruth (2019) fills this gap in the construction of an analytical framework of environmental economics. The book provides an understanding of the connection between environmental capital and the allocation of resources at the micro level and the growth of income and capital accumulation at the macro level; here, capital is redefined to include all stocks of resources, natural or human-made.

The book is divided into the following five parts:

(1) The environment and economy: This part shows how environmental capital operates in the circular flow of values among households, firms, and governments while revealing the connections with the external sector of trade as well.

(2) Microeconomics and the environment: This part is concerned with issues relating to consumer demand, the economics of renewable and non-renewable resources, production, costs and supply at the firm level and, finally, market organization in the context of allocation of resources, including environmental capital and human-made capital and labour.

(3) Macroeconomics and the environment: This part discusses the adaptation of both short-run and long-run macroeconomics for the explicit incorporation of the role of environmental capital—its depreciation as well as investments in capital and associated technologies. Finally, this part contextualizes environmental capital in the analysis of the trade policies and globalization.

(4) Theory of valuation and estimation of environmental capital: A framework to assess the sustainability of an economic system that interacts with ecosystems and to derive policies based on this.

(5) Environmental policies: Finally, the book discusses environmental policies aimed at the sustenance of environmental capital by reducing its damage as well as investment policies for abating damages and restoring environmental capital.

The book is lucidly and elegantly written, making it an extremely useful reference text on environmental economics. I would, in addition, like to highlight a few novel features in the analysis in the context of issues that arise while adapting the standard economic theory for environmental effects.

1. At the level of microeconomic analysis, the adaptation of the standard theory of consumer behaviour for environmental effects has shown how the endowment effect of consumption due to a price change may cause a shift in the preference structure (indifference map) involving a choice between environmental and non-environmental goods and services. This may help to explain the difference between the result of a price change and that of its reversal. Such analytics also helps us to explain the divergence between the willingness to pay and the willingness to accept a change in the environmental endowment and that of a reversal of such change. The concerned chapter (Chapter 7) also shows how the

environmental attributes of consumer goods, along with income and other factors like advertisement spending, can influence market demands along with the elasticity of the environmental quality of the consumption good.

2. The chapters covering production, costs, and supply show how an increase in the use of labour and human-made capital leads to an increasing use of environmental capital (KN—the notation used in the book), resulting in its increasing fragility due to a rise in entropy. The latter is shown to set a limit on the maximum output yielded by a production function, which in turn would shift downwards with the shrinking KN. Capital is defined in the book as inclusive of both human-made and natural capital, with such choice of their respective numeraires that they are additive. Such a redefinition of capital yields a production function that points to the overstatement of output (in a comparative sense) by the conventional production function, which considers capital only as human-made or manufactured. The concerned chapters show the implication of the absolute bounds on the achievable output and the sharp rise in marginal cost as the output rises up to the limit set by the entropy law. The adaptation of isoquants and cost curves in such an analysis is shown to have important implications regarding the firm-level equilibrium and expansion path of output with changes in firm-level budgetary conditions. The concerned chapters point out the important implications of the short-run and long-run planning of a firm for the scale of production, resource use, and costs.

Finally, at the micro level of analysis, the impact of environmental capital's use on the market equilibrium supply and unwanted emissions is discussed both under the conditions of perfect competition and monopoly and are compared with the benchmark of the sustainability condition. The analysis is insightful in showing the conditions under which the perfectly competitive market equilibrium is a better benchmark than a monopoly within the context of sustainability, which is defined with reference to the absorptive limit of the ecosystems.

3. The treatment of the role of environmental capital in short-term and long-term macroeconomics has, in my opinion, been the most significant contribution of this book. It elegantly presents how the analysis of aggregate demand and aggregate supply, as functions of price level, can be adapted to the limitation of productive capacity due to the limit of environmental capital. It discusses the possibility of incorporating the impact of the depreciation of environmental capital on the one hand and of investment in KN on the other in short-term equilibrium income, employment and price level, etc. The implication of

such equilibrium is also compared with the benchmark of full-employment equilibrium in cases of both linear and non-linear depreciation of KN with the rise in production.

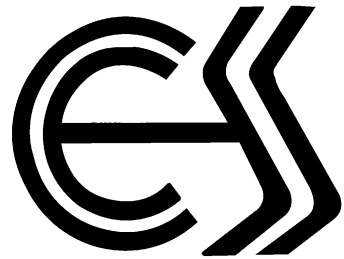
The book further reworks the analytical framework of environmental macroeconomics to consider both the waste absorptive role of environmental capital and the impact of its entropic depreciation on income and output. The implications of the results are important for ecological sustainability, full employment, and the stabilization of economic fluctuations. It is also important to examine if such varying objectives would have any conflicting considerations with regard to the choice of policies.

4. The long-run macro analysis in the book has shown how the standard versions of Harrod, Solow-Swan, Romer, and other endogenous growth models can be adjusted to incorporate the role of environmental capital as distinct from that of human-made capital and their joint implications with respect to a steady state solution. The models recognize the role of the productivity of the KN service and also incorporate the feedback effect of depreciation of KN on growth rate and on the character of its steady state solution. The chapters have also illustrated the results of both short- and long-term macroeconomic indicators as well as those of long-term growth for Australian and South Korean economies, respectively.

Before concluding the book, the authors deal with trade, the valuation of environmental capital, and environmental policies, extending the same consistent framework of adapting economic analysis to accommodate environmental capital. Taking an overview of the various chapters, one can conclude that the book provides a highly useful alternative text for environmental economics, which is firmly rooted in ecological principles and entropy law, the latter being the source of resource scarcity and a limitation to economic scale or growth. The book fulfils the interdisciplinary purpose of integrating ecological laws into the models of functioning of an economy at both the micro and macro level. A reader will be able to discern how interdisciplinary considerations relating to ecological limits can be built into economic theory with appropriate adaptations. Such theoretical reformulations that adapt to environmental concerns will be helpful for both understanding and interpreting the economic consequences of the environmental crises of today as well as for developing the appropriate policy insights for achieving sustainable development in the future.

THANKS

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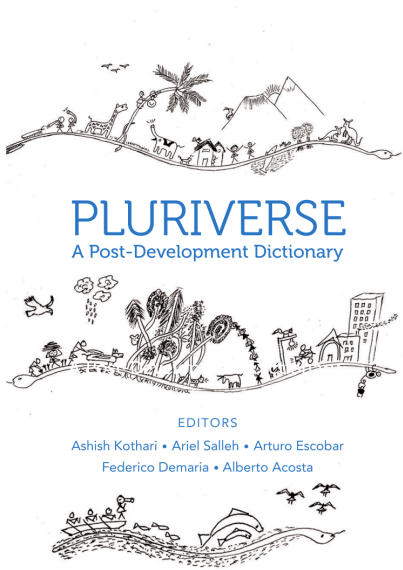
Ecology, Economy and Society–the INSEE Journal 3 (2): 203–207, July 2020

BOOK REVIEW

In Search of Post-development Futures

Anirban Dasgupta *

Ashish Kothari, Ariel Salleh, Alberto Acosta, Arturo Escobar, and Fedrico Demaria, eds. 2019. *Pluriverse: A Post-development Dictionary*. New Delhi: AuthorsUpFront and Tulika Books. ISBN: 978-8-193-73298-4, pp. 384, ₹950 (PB).



While writing this review in Delhi during a seemingly endless lockdown, I am struck with some keen realizations. Such a "natural disaster" at a global scale is unprecedented in my lifetime. However, as we affirm our humility with respect to nature and try to become more mindful of human transgressions against the non-human, some of us are equally hopeful that science will ultimately conquer the virus. Such are the fears and hopes that dominate my mind as I engage with the ambitious volume under review.

Pluriverse follows an engaging academic tradition of post-development writing that began in the 1980s and acquired

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considerable intellectual heft throughout the 1990s. Post-development literature, in essence, sought to challenge several of the claims that called for pursuing industrial development in the "third world" in the period following the Second World War. Post-development scholars, in fact, largely viewed unbridled development projects and plans as being both ecologically unsustainable and economically unjust.

Pluriverse has a three-part structure, beginning with scholars located on different continents reflecting on the crisis of development in the contemporary world. This is followed by a set of critical write-ups on mainstream "reformist" ideas that acknowledge some shortcomings in the current development agenda and proffer suggestions to fix them. The final, and longest, section compiles the various transformative and radical ways to reimagine the functioning of the world once development in its current avatar is dethroned.

The volume comprises a diverse set of contributions that range from relatively well-known schools of thought like agroecology, *buen vivir*, and degrowth to the relatively lesser known writings on eco-anarchism, Jain ecology, and sea ontologies. The editors, however, are careful to emphasize that the origins of these visions spring from diverse world views such as indigenous cultures, social movements, and ancient philosophical and religious traditions. Importantly, they point out that although these perspectives are marked by differences, they can also be understood as "complementary notions and practices".

Before going into detail about the content, it is important to alert the reader about the form in which the hundred plus entries have been written up. The average entry is only two-and-a-half pages long, and the reader is required to distil the crux of the argument from such brief summaries. Setting aside the unavoidable variation in the quality of the writing across the volume, it is safe to say that even the best pieces often fall short of communicating their key concepts. One cannot help recalling the longer and more substantive entries in the earlier *Development Dictionary* (Sachs 1992), where the contributors had ample space to introduce and elaborate upon their subjects, and provided an annotated bibliography for further reading. The undue compression of the contributions is less than ideal for intellectually curious readers who would have gained from more detail and elaboration. It is possible that each contributor was given limited space because the editors were keen to accommodate as many perspectives as possible.

The development perspectives presented in the first section illustrate the issue I have indicated above. The six pieces by authors based in the six

continents (not including Antarctica) are highly uneven in their coverage and treatment. While Nnimmo Bassey, Maristella Svampa, and Kirk Hoffman write about contemporary development processes and their critiques of the same by focussing on "developing" regions of Africa, Latin America, and the island nations in Oceania, respectively, the two-and-a-half page remit does not allow them to even scratch the surface of the task at hand. Interestingly, the two scholars based in the Global North, Philip McMichael and Jose Maria Tortosa, do not write on North America or Europe specifically but comment more generally on chosen aspects of global development. At the risk of sounding pedantic, I wonder why the northern scholars do not have anything particular to report on the development in their own geographical contexts. Are development and its shortcomings only visible in the Global South? It can be said, of course, that authors should not be limited to their continent of origin. If so, it still appears incongruous that it is the scholars based in the Global North who have the privilege to comment on development projects across the world.

The second section, aimed at debunking some of the "buzzwords" in the mainstream development discourse, is particularly interesting. Despite the limited space available to the authors, some have managed to communicate the core of their criticism compellingly. Jeremy Gould, in his entry on "development aid", takes a fresh look at how development practices have become a much more forceful form of corporate funded aid. Larry Lohman is successful in lucidly explaining the advent of trading in ecosystem services, while making his key criticisms clear. Deepak Malghan writes engagingly on efficiency, one of the building blocks of technocratic development, before finishing off rather hurriedly and unsatisfactorily with the following statement: "the efficiency revolution has run its course" (52). Other articles that deal with popular ideas like "green economy" and "smart cities", which are regularly peddled around in mainstream development as magic bullets, turn out to be similarly unsatisfactory as they are not allowed to run their full explanatory course due to a paucity of space.

Clearly, the most compelling parts of the book, which also justify its title, are the reflections that make up the "people's pluriverse"—the myriad imaginings of a post-development transformative future. The range of ideas presented in these entries is truly remarkable, moving between long-standing lines of radical thought like deep ecology, liberation theology, and worker-led production to recent entrants in the post-development lexicon like *minobimaatisiiwin* and *kametsa asaike*, representing indigenous quests for a fulfilling and harmonious life. Given the large number of entries in this section, it is not only impossible to comment on each piece individually but also difficult to make statements that relate to the section as a whole.

I particularly want to raise the issue that delving into conventional religions for post-development wisdom leaves me dissatisfied. This may be the result of my inability to engage with religious thought seriously given my materialist predisposition or the realization that "doing good" to fellow humans and non-humans is taught in all religious texts, making it less about subscribing to a particular religion and more about the humanist undercurrent present in all major religions. But humanism as a universalist tenet par excellence may sit uncomfortably with post-developmentalism and, as such, there is no entry under humanism in the *Pluriverse*. Moreover, since all major religions have been deeply entrenched in social power hierarchies, often by justifying oppressive practices, it is problematic to talk about a given religion's vision of a post-development egalitarian society without owning up to its own legacies of injustices.

Another disturbing aspect of several entries in this section is the lack of critical perspective on the ideas presented. A case in point is the contribution on Gross National Happiness (GNH) in Bhutan. A minor rage in the international development community in recent years, it remains the official development framework in Bhutan and is used extensively while planning government interventions in different domains. While the concept of GNH is not trivial and deserves serious intellectual engagement, it is striking that the author avoids any mention of the various criticisms of the GNH and related development choices that exist prominently in the literature.

Degrowth is another concept on which productive engagement with naysayers is avoided entirely. In particular, the debate on whether the framework of degrowth should entirely reject growth or if we are better off growing within limits went unaddressed. It is also critical to examine the applicability of degrowth for the Global South. Can poorer countries actually afford degrowth? It would have been a valuable addition to the volume if the authors engaged with some of these arguments. In these omissions, one senses a lack of interest in taking on the difficult task of critiquing the development mainstream. I am reminded of Wolfgang Sachs' comment in the preface to the second edition of the *Development Dictionary*:

> Looking at the *Development Dictionary* today, it is striking that we had not really appreciated the extent to which the development idea has been charged with hopes for redress and self-affirmation. It certainly was an invention of the West, as we showed at length, but not just an imposition on the rest. On the contrary, as the desire for recognition and equity is framed in terms of the civilizational model of the powerful nations, the South has emerged as the staunchest defender of development. Countries in general do not aspire to become more "Indian", more "Brazilian" or for that matter more "Islamic";

> instead, assertions to the contrary notwithstanding, they long to achieve industrial modernity. (2010, viii)

Sachs' insight succinctly captures the challenge of moving beyond the contemporary development paradigm, which cannot be overcome without a serious engagement with both development orthodoxies and the popular sentiments that sustain them. I am not suggesting that post-development literature as a whole has shied away from this responsibility, but this volume could surely have taken on such questions more directly.

Post-development thinking has played an important role in questioning some of the fundamental elements of the global development project—industrial accumulation and the accompanying unsustainable levels of consumption. Adopting such ideas would undoubtedly be key in formulating plans for a sustainable and just future. The problem, however, has always been in the inability of scholar-activists to construct feasible models for the future and envision pathways for attaining them. Going back to my initial thoughts in the time of the pandemic, post-development thought definitely helps me to place human beings within the larger natural system and makes me aware of the risk of imbalance in human–nature relations. But it does not provide a framework to generate and use scientific knowledge in a globally collaborative way to come up with solutions for the pandemic related crises that we face today.

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THANKS

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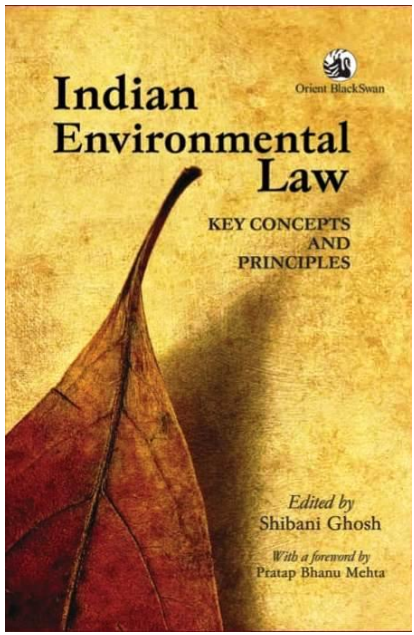
Ecology, Economy and Society–the INSEE Journal 3 (2): 209–213, July 2020

BOOK REVIEW

Can the Twain Ever Meet? Environmental Jurisprudence and Justice in India

Manshi Asher [*]

Shibani Ghosh, ed. 2019. *Indian Environmental Law: Key Concepts and Principles*. New Delhi: Orient Blackswan. ISBN: 978-9-352-87579-5, pp. 360, ₹925 (HB).



Indian Environmental Law Key Concepts and Principles (2019), a collection of essays edited by Shibani Ghosh, discusses the evolution and application of various conceptual frameworks for understanding environmental jurisprudence in India. In the first two chapters, Lovleen Bhullar and Shibani Ghosh, respectively, draw out the constitutional basis and procedural rights that govern people's "right to environment" in India today. In the subsequent chapters (3 to 6), the evolution and current usage of key legal principles that are considered critical to the making of environmental rules are subject to searching scrutiny. Notably, these

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chapters bring into focus the debates and implications in the legal rendering of principles such as sustainable development (Saptarishi Bandhopadhyay), the polluter pays principle (Lovleen Bhullar), the precautionary principle (Lavanya Rajamani), and the public trust doctrine (Shibani Ghosh). These four essays help trace the origins of these legal doctrines in the Indian courts and focus, in particular, on how environmental decision-making gets inserted into case law. In Chapter 7, which is the final one, Dhvani Mehta carries out a detailed review of how compliance with judicial orders and their enforcement and effectiveness in terms of implementation play out on the ground.

In essence, this book debates and discusses the interpretation, reinterpretation, distortion, and dilution of these various legal principles when applied in court cases. It questions the robustness of the concepts that currently inform existing environmental laws in India and debates whether they rest on sound legal premises, claims, and practices. Given that the themes covered by the collection are vast in scope, this brief review will comment on what the reader could take away from this book with regard to environmental jurisprudence and its implications for environmental justice in contemporary India.

Since the 1980s, judicial activism in India has, in fact, often been lauded for contributing to environmental policy and governance. As Bhullar shows in the first chapter, domestic jurisprudence has clearly linked the "right to environment" with Article 21 (Right to Life) of the Indian Constitution, among other articles (47, 48A, and 51A(g)), and Indian courts have played a critical role in this process. However, as this and the following essays in the book suggest, this right becomes difficult to realize due to the "varied" and "flexible" application of concepts by the judiciary in environmental decision-making.

Shibani Ghosh, in the following chapter, while laying out the various laws and rules that guarantee procedural rights—the right to information, the right to public participation, and the right to access to justice—argues that these procedural environmental rights are on "firmer legal foundations" (103) than substantive environmental rights in India. However, given the systematic onslaught on procedural rights (especially in the last few years) with the dilution of the Right to Information Act (RTI) and the Environmental Impact Assessment (EIA) Notification 1994 (Ghosal 2018), a careful reassessment of the stability of procedural rights is called for.

Delving into the Narmada case, Bandhopadhyay comments on the instrumental use of "sustainable development" as a principle by Indian courts. He critiques the "pick and choose" approach of the judiciary,

particularly how the latter treats the notion of sustainability as a handmaiden of the interests of urban citizens, with their modernist vision of the future (150). Bhullar's essay highlights how the term "polluter pays" has not been interpreted as a preventive measure. Instead, domestic courts have focussed on its curative rather than justice dimension. While reviewing its evolution, one misses the critical assessment that at their very core, concepts like "polluter pays" were intended to only "manage" the environmental impact of neo-liberal economic development directed at higher growth (and thus more corporate profit), without ever having to compromise on or question the idea of "growth" and its inherent ecologically destructive or socially exploitative character (Lohman 2019).

Interestingly, Lavanya Rajamani's essay observes how the "precautionary principle" has not come of age in environmental law in India, due to the courts' balancing of environmental concerns with those of "sustainable development". Her commentary also speaks about the overreach of the judiciary and courts. The starkest evidence of this elite bias is in judicial decisions in the domain of forest conservation that is particularly made evident in the Godavarman case (Mate 2015).

While discussing the public trust doctrine, Ghosh walks us through how Indian courts have relied on this principle in cases involving various natural resources, since its use in the Kamal Nath judgment of 1996. She argues that for the doctrine to be effective, it must be interpreted or defined more sharply and put in application by the executive rather than the judiciary alone. Given the changing nature of the state and the increasing privatization of public resources, there is a need to review how this doctrine is being rendered irrelevant.

Dhvani Mehta in the final chapter critically analyses the issues around mechanisms set up by the court (like the Central Empowered Committee) and existing executive regulatory bodies (like the State Pollution Control Boards) in ensuring compliance with law and court orders. Acknowledging that a variety of social, political, and economic factors influence the functioning of these agencies, she cautions against the creation of newer authorities in the name of "institutional reforms".

We cannot ignore that India has suffered a 36-point drop in its global Environment Performance Index (EPI) as of 2018. India is now in the bottom 5 of 180 countries (PTI 2019). India was cited as the fourth-most dangerous country in the world for environmental activists in 2016 by a UK-based watchdog group, Global Witness. This book cites several instances of environmental crises in which Indian courts have intervened, but fails to meaningfully explain why project-affected communities

continue to lose their access to natural ecosystems. The Indian judiciary is arguably undergoing a severe internal crisis and its credibility is questionable as constitutional democracy weakens and incidents of political interference in judicial decision-making are repeatedly flagged (Bhatia 2014). Specifically, the highly acclaimed instrument of access to environmental justice—India's decade-old National Green Tribunal—is now being increasingly divested of its powers to enforce and prevent environmental destruction (Dutta 2019).

Environmental governance in India, inside and outside of judicial territory, is increasingly revolving around techno-managerial solutions that further push for monetary valuation and commoditization of nature. It is apparent that collective access to and ownership of natural habitats/territories by marginal communities (like Adivasi people) and their right to conserve ecological spaces remains at the periphery of the environmental discourse, even today. The challenge lies before the active community of researchers, lawyers, practitioners, and activists to adopt a more multidisciplinary, holistic, and radical critique of the existing enviro-legal order in India and to work together towards realizing environmental justice.

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THANKS

The Indian Society for Ecological Economics (INSEE) thanks the following organisations for their contributions to its Tenth Biennial Conference "Climate Change and Disasters: Challenges, Opportunities and Responses", Centre for Economic and Social Studies, Hyderabad, 6 - 8 November 2019.

Indian Council for Social Science Research

NABARD

Ecology, Economy and Society–the INSEE Journal 3 (2): 215–218, July 2020

REPORT

A Report on the INSEE-CESS International Conference on "Climate Change and Disasters: Challenges, Opportunities, and Responses"

Jeena T. Srinivasan [*]

The Tenth Biennial Conference of the Indian Society for Ecological Economics (INSEE) on Climate Change and Disasters: Challenges, Opportunities and Responses was organized jointly with and hosted by the Centre for Economic and Social Studies (CESS), Hyderabad, in partnership with the Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ, India) and the National Institute of Rural Development and Panchayati Raj (NIRDPR). It took place in Hyderabad during November 6–8, 2019.

In the context of the increased risk of climate-related natural disasters such as floods, heatwaves, and storms, both predicted by scientific studies and recently experienced in different parts of the world and India, the objectives of the conference were to discuss the following: What are the likely impacts of climate change on human and natural systems? How will climate change affect different sectors and sections of society? What are the alternative policy options to address the risks that climate change and extreme weather events pose? The three-day conference comprised discussions on these issues across various plenary, panel, and technical sessions in addition to inaugural and valedictory sessions. Springer Nature also organized a special session on ethical publishing. The conference received considerable media coverage and hosted over 200 delegates, including a few from abroad.

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In the inaugural address, Vinod Thomas (Former Senior Vice President, World Bank) noted that India and South and Southeast Asia are not only highly vulnerable with regards the climate crisis, but are also ill-prepared to handle it. This was the perfect start to the conference, and it set the pace for the deliberations that followed. Thomas opined that countries must be prepared to tackle disasters, develop and adopt measures to reduce risks and exposure, and build resilience within the next few years.

In his presidential address, K. N. Ninan (President, INSEE) gave an illuminating presentation on the growth and development of ecological economics in India, and on climate change and disasters from an Indian perspective. The inaugural session also featured speeches by the representatives of the collaborating organizations, who reflected on climate change issues, possible solutions, information needs, decentralized approaches, and civil society initiatives aimed at mitigation and adaptation. There was also a video message from Clóvis Cavalcanti (President, ISEE), which was played at the conference.

The conference had five illuminating keynote addresses by distinguished scholars on specific sub-themes. Rajeev Ahal (GIZ, India) talked about the need to improve water security, climate resilience, and efficiency of water use in agriculture and industry. He emphasized the need for cooperation between the private and public sectors to ensure the integrated climate-adapted management of water. Kirit Parikh (Integrated Research and Action for Development/IRADe, New Delhi), who spoke on the need to develop a low carbon strategy for inclusive growth, emphasized that India should focus on renewable energies and link inclusive growth requirements with factors like housing, drinking water supply, sanitation, education, healthcare, electrification, provision of cooking gas, the infant mortality rate (IMR), and fertility.

Taking a more global perspective, Thomas Sterner (University of Gothenburg, Sweden) spoke about the twin issues of climate policy efficiency and fairness/feasibility, and the policy instruments needed to prevent worsening of the environment. In his talk on climate change, forests, and biodiversity, N. H. Ravindranath (Indian Institute of Science/IISc, Bengaluru) pointed out an increase in tree mortality, ecosystem disturbances, and the effects of climate-related extremes; he stressed that many ecosystems are more vulnerable than humans. Madhu Verma (Indian Institute of Forest Management/IIFM, Bhopal) presented the economic value of the ecosystem services of 16 tiger reserves in India using a value plus approach, and emphasized the use of valuation to justify enhancing investments in conservation.

The conference had 10 engaging and thought-provoking panel discussions. While one panel discussed the complex interlinkages of water with other critical systems such as food, energy, and the economy, and how integrated water resources management (IWRM) can contribute to climate resilience, another showed the importance of hazard vulnerability maps and planning for disaster resilient cities. The third panel discussed how cities in countries like Nepal and Bangladesh were coping with hydro-meteorological events and floods, and the role of hard and soft interventions in mitigating such disasters. A fourth panel discussed the efficacy of local self-governance and the climate change action plans initiated by panchayats in Kerala, India. Another panel discussed Martin Weitzman's contributions to environmental economics and his seminal works on climate catastrophes. The contribution of the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) to climate mitigation and adaptation in terms of carbon sequestration was the theme deliberated by the sixth panel. The seventh panel discussed the quantitative methods used to assess climate change impacts on agriculture, and the eighth panel considered climate change and mitigation in rainfed areas. Building climate resilience through the restoration of common lands was the theme considered by the ninth panel. The last panel discussed the findings of a climate change vulnerability assessment in the Indian Himalayan region, which experiences frequent floods, storms, and landslides; women and children in this region are amongst the most vulnerable.

Another highlight was the outreach event organized by the Intergovernmental Panel on Climate Change (IPCC) in partnership with INSEE. The IPCC authors presented the Special Reports of the IPCC and the ongoing AR6 (Sixth Assessment Report). There were presentations on the physical and scientific bases for climate systems, climate models, and projections; the impact of global warming and the importance of mitigation activities for achieving the Sustainable Development Goals; land management and the interaction of the atmosphere with land resources; and, finally, the effects of climate change on marine life and coastal livelihoods.

Further, 56 papers contributed by participants were presented in 12 technical sessions. Some papers discussed the macroeconomic dimensions of climate change, including fiscal transfers and the political economy of disaster management. Others discussed gender issues, food security, and the Sustainable Development Goals. A few papers analysed the effects of floods, recovery patterns, and the effectiveness of early warning systems, and highlighted the role of the state and civil society. Others attempted to quantify the damage caused by floods and the risks at the community level

and on the ecosystem. There were also papers on environmental and climate justice, institutional interventions, agricultural adaptations to climate change, and the role of MGNREGA in building the adaptive capacity of rural communities, renewable energy, and infrastructure to mitigate climate change impacts.

Gopal Kadekodi (Former President, INSEE), in his valedictory address, spoke about the dynamic interlinkages between ecosystem services and their stakeholders, and the need for changes in climate strategy.

For their outstanding contributions to ecological economics, INSEE conferred the Lifetime Achievements Award on C. H. Hanumantha Rao; the title of INSEE Fellow on M. N. Murty, Ramprasad Sengupta, and Madhu Verma; and the Bina Agarwal Prize for Ecological Economics to Joan Martinez-Alier.

Public lectures by INSEE members were organized in three reputed institutions in Hyderabad as curtain-raiser events. A pre-conference workshop on "Behavioural and Environmental Economics" and a post-conference workshop in association with the South Asian Network for Development and Environmental Economics (SANDEE) on "Non-market Valuation of Environmental Goods and Services", each attended by 35–40 participants, also took place.

Overall, the conference was rich in terms of the variety of topics covered as well as in participation. The delegates had many opportunities to engage in academic and social interactions and to build their networks. The cultural event showcasing Telangana folk dances and culture added colour to the conference, and the sumptuous menu included organic, millet-based ethnic food. The conference received generous financial and in-kind support from various governmental and non-governmental organizations.

Ecology, Economy and Society–the INSEE Journal 3 (2): 219–222, July 2020

IN MEMORY

Narpat S. Jodha: Forever Restless

Pranab Mukhopadhyay [*] and Rucha Ghate [**]

Pranab first met Narpatji in Kathmandu in a small Thakali restaurant in 2004, as part of a meeting organized by Manik Duggar (the then Programme Manager of the South Asian Network for Development and Environmental Economics, SANDEE). Narpatji, Rucha, and Pranab were to edit a book together soon. So Priya Shyamsundar (Programme Director of SANDEE) suggested that we get to know each other. We (Rucha and Pranab) had, of course, heard of him and he, of course, had not heard of us. The first thing that struck us was that the man we saw seemed far removed from Narpatji's name and fame. He had no airs about himself; he appeared to be the quintessential common man. Since this first meeting, Rucha had the privilege of working with him as a colleague at the International Centre for Integrated Mountain Development (ICIMOD) from 2013 to 2015.

Narpatji was easy to converse with. In fact, once he got started, one could sit back with a cup of tea while he happily narrated stories about his field insights, each one weaving into the next. His stories were utterly believable in the village context but challenged urban economic rational expectations.

Narpatji was sceptical of econometric studies that relied on complicated models with restrictive assumptions. He often spoke about his experience during his stint at the World Bank—he was a misfit and often disagreed with others there. He was primarily a "concept" researcher who believed in

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Rucha Ghate and Pranab Mukhopadhyay co-edited a book with Narpat Singh Jodha titled *Promise, Trust and Evolution: Managing the Commons of South Asia*, which was published by Oxford University Press, UK, in 2008. This is a note in memory of one of our mentors.

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making generalizations based on direct observations. He opined that the problem with econometricians was that they "tortured" the data until the latter "confessed" what the former wanted them to say.

Narpatji is probably the least known among the famous economists that graduated from the Delhi School of Economics (D School). One of the stories that he would tell everyone he met was about this struggle with English and, therefore, economics, while at D School. Indeed, he conducted many failed searches at the Ratan Tata Library for an economics book in Hindi. The average graduate student might have dropped out of D School under these circumstances. But not Narpatji. He used to say, "Keep trying; it will happen", which was a lesson he had internalized in his long struggle through many professional challenges.



Narpat Singh Jodha at the Ninth Biennial of the International Society for Ecological Economics (ISEE), held at the India Habitat Centre, New Delhi in December 2006. [Image courtesy: INSEE]

His work on livelihood dependence on common property resources (CPRs) in semi-arid regions was completely unfashionable for his time (1986). What made his work so unique was his ability to grasp what many of us routinely see but do not recognize. His was a skill that was impossible to pick up within the four walls of a classroom.

What also made him stand out was his relentless work ethic. We once spoke to him about the poverty debate between Utsa Patnaik, Jean Drèze, and Angus Deaton. At this, Narpatji reminded us that he had published a paper

as early as 1988 on the errors of conventional poverty measures. On another occasion, we were talking about climate change and the South Asian contribution to this domain of research. Here, he reminded us that he was one of the early contributors to this body of work (in 1989). His 2005 paper on mountain-specific poverty, which highlighted the limited accessibility, fragility, marginality, and diversity in mountainous regions that create specific circumstances, laid the foundation for poverty studies in ICIMOD in particular. While they were colleagues, he would sometimes share some of his writing with Rucha and ask for comments. He would likewise talk to freshers and young researchers with humility. He was a regular attendee of the guest lectures in ICIMOD, and almost always had a question that would prompt long conversations that continued over tea or lunch.

When we worked together on the edited *Commons* volume, we thought that he would take only a fleeting interest, given his age; however, he proved us wrong. He was very much present and systematically worked on the project, adding editorial comments for each paper. As his retirement from ICIMOD drew closer, his biggest worry was what to do with the books and documents that he had accumulated over time. After formally retiring from ICIMOD, he would often sit in the SANDEE library (which was then on the ICIMOD campus) and make himself available to anyone who wanted to pick his brain.

As the years went by, we were less frequently in touch. But we knew he was still active, writing and publishing as recently as 2019. It takes a lot to keep going, but that was Narpatji—forever restless.

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Ecology, Economy and Society–the INSEE Journal 3 (2): 223–226, July 2020

IN MEMORY

Karl-Göran Mäler: the *Adi-Guru* of Environmental Economics

Saudamini Das [*]

Karl-Göran Mäler, one of the most loved and revered environmental economists of the century, passed away on May 20, 2020 in Stockholm. Born on March 3, 1939 in a small town in Västernorrlands County in northern Sweden, Karl-Göran grew up to be one of the most significant ecological economists in the world, contributing enormously to the discipline as well as helping to spread it across the globe. His passing leaves a permanent vacuum in the world.

Karl-Göran was a professor of economics at the Stockholm School of Economics (1975–2002), a member of the Royal Swedish Academy of Sciences (1981–1994), a member of the Committee for the Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel (1982–1994) and the head of this Committee during 1986–87, director of the Beijer Institute of Ecological Economics (1991–2006), and then a professor emeritus at this institute. He co-founded Beijer Institute of Ecological Economics together with Partha Dasgupta in 1991. He was one of the founding members and then a council member of the European Association for Environmental and Resource Economists (EAERE), a recipient of the Volvo Environment Prize in 2002 (shared with Partha Dasgupta), and a recipient of the European Lifetime Achievement Award in Environmental Economics in 2005 (shared with David Pearce). However, to the ecological economics fraternity, he was a global professor of environmental and resource economics sans boundaries and nationalities.

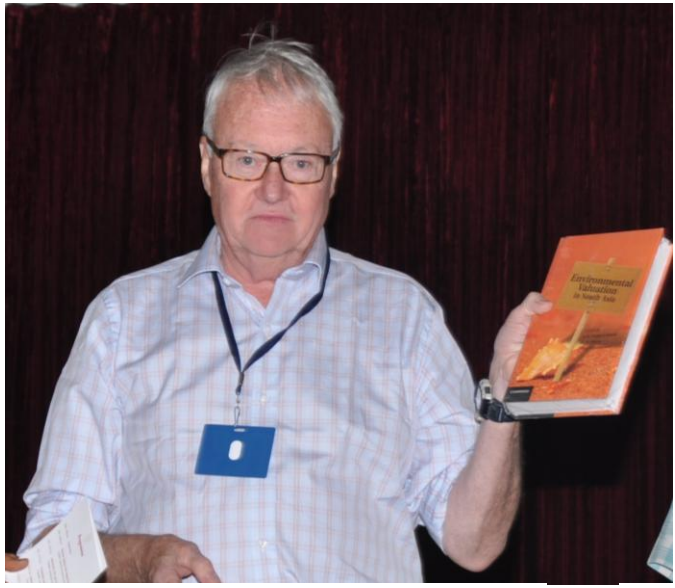
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Karl-Göran Mäler releasing *Environmental Valuation in South Asia* at the "Nature, Economy and Society: Understanding the Linkages" Sixth Biennial Conference of Indian Society for Ecological Economics, 20–22 October 2011, Centre for Economic and Social Studies (CESS), Hyderabad. [Image courtesy: INSEE]

Karl-Göran was an original thinker in the field of the environment; he produced seminal works on varied subjects such as pollution, environmental protection, property rights, poverty, theory of sustainable economic development, regime shifts, and irreversibility in natural systems, among others. His first book, *Environmental Economics: A Theoretical Inquiry* (1974) is a foundational volume for environmental economics. This book was published when the field was first evolving and, thus, helped its ideas grow. His books such as *Environment and Development: An Economic Approach* (with Jan Bojö and Lena Unemo), *Economic Measurement of Environmental Damage: A Technical Handbook* (with Ronald E. Wyzga), various edited volumes (with different colleagues), and many research publications in several top international journals are all significant contributions and speak volumes about his scholarship.

His highly influential research "The Acid Rain Game" (1989) was probably the first paper to provide an economic rationale (through a compensatory payment mechanism) to encourage international cooperation to resolve critical transboundary environmental problems. His seminal paper "National Accounts and Environmental Resources", published in *Environment and Resource Economics* (1991), made a compelling case for incorporating nature in national income accounting. Equally revolutionary

were his lectures on intermediate ecosystem services and the problem of double counting if the value of supporting services is separately accounted for in the total economic value measures of ecosystem services.

Karl-Göran has initiated several pioneering activities; the two worth mentioning are the Askö meetings and capacity-building work in the Global South. He envisioned that a combination of the two disciplines, economics and ecology, would be necessary to find a sustainable solution to the catastrophic environmental problems in the world. He strengthened this interdisciplinary approach by bringing the world's leading ecologists and economists under one roof in the famous Askö meetings of Beijer Institute, the deliberations of which are published as the Askö Series and also in some of the top journals of the world.

Karl-Göran, along with Partha Dasgupta, initiated network programmes in environmental economics research and teaching in the Global South that resulted in the formation of these regional networks: South Asian Network for Environment and Developmental Economics (SANDEE), Centre for Environmental Economics and Policy in Africa (CEEPA, previously RANESA), and Latin American and Caribbean Environmental Economics Program (LACEEP). These networks provided training through research and training workshops (R&T), mentoring of early-career researchers by globally renowned professors, guidance in proposal and manuscript writing, and so on. They revolutionized environmental economics research and teaching, helped the careers of hundreds of early-career researchers, and transformed perceptions and attitudes towards the environment and environmental policymaking in the Global South.

In India, SANDEE was and still is a lifeline for environmental research. Karl-Göran was attached to SANDEE and enjoyed great camaraderie with leading Indian environmental economists and SANDEE associates such as Kanchan Chopra, Gopal Kadekodi, M. N. Murthy, and the late Narpat Singh Jodha, to name a few. He never missed his SANDEE research and training workshops and summer schools (for as long as he was able to travel), a bond he never shared with others. We, the SANDEE researchers, would look forward to the opportunity to present our work to him at the R&T workshops, be reprimanded by him, and then work further, day and night, for the next presentation. The R&Ts, our real *gurukul*, have provided us with a strong foundation for our careers and helped us integrate with global research. Karl-Göran will always remain the father of the environmental economics capacity-building programmes in South Asia.

As with SANDEE, Karl-Göran's association with the Indian Society for Ecological Economics (INSEE) was equally strong and dear. He delivered a

keynote address during the Sixth INSEE Biennial Conference in Hyderabad. Initially, he was supposed to come to New Delhi for a meeting on the Government of India's invitation and then travel to Hyderabad. The Delhi meeting was eventually cancelled, but Karl-Göran still travelled to India so that he could keep his promise with INSEE and meet his Indian colleagues at the conference. We will always remember this gracious gesture.

On a personal note, two people had a profound impact on his life—his father, Karl Mäler, and his wife, Sara Aniyar. His father, born in the Nordic forests of Sweden, rose to become an elected member of the Swedish Parliament. Karl-Göran was a proud son and always kept his father's lessons close to his heart; even when he was at the care home, he kept his father's statue with him. Karl-Göran met Sara at a workshop in Jamaica and their beautiful life together started then. Sara complemented him perfectly and was always by his side; she spent two months in quarantine in the care home with him and Karl-Göran left for his heavenly abode still holding her hand.

I was fortunate to be mentored by Karl-Göran and to have enjoyed a personal friendship with him and Sara while I was a Mäler scholar at the Beijer Institute. I loved visiting museums, exhibitions, historical sites, and eateries with them in Stockholm. I was always amazed at the way Karl-Göran could stand at the corner of a street and narrate interesting stories about the street, the histories of the main buildings, the chronologies of architectural innovations, the evolutions of the famous eating joints in the area, and the exact spot from which he got the best view of the Northern Lights during his childhood. He was as madly in love with his country, people, and dear city of Stockholm as he was with his discipline. His energy, ideas, persistence, and gentle chiding will inspire us for years.

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Aims and Scope

Ecology, Economy and Society–the INSEE Journal is an open access peer reviewed journal.
The journal aims to offer authors a forum to address socio-environmental issues from, across and within the natural and social sciences. The journal welcomes contributions at the ecology-economy-society interface that contribute to informed debates. Contributions could be conceptual or theoretical pieces or be methodological and empirical. In order to meet the sustainability challenges, the Journal believes in 'methodological pluralism' and contributions may address broader developmental considerations vis-à-vis ecological systems, sustainability, equity and justice.

It would encourage papers that connect theory with the practice. We welcome trans/inter-disciplinary approaches including (but not limited to) ecological economics, environmental economics, political ecology, energy analysis, environmental science & engineering, political economy, environmental sociology, ecological and environmental history, social ecology and human ecology.

Papers could focus on issues such as (indicative and not exhaustive) forests, water, energy, climate change, biodiversity, pollution, agriculture, eco-restoration and conservation, poverty-environment nexus; demography and bio-physical resource base; land-use changes; sustainability and sustainable development (ecological, economic, social, political, etc.); alternative development pathways; socio-ecological transitions and social metabolism; cultural, anthropological and economic analysis of environmental changes; eco-socialist approaches; ecological modelling; environmentalism and ecologic-economic conflicts; environmental law and governance; industrial ecology; valuation of natural resources and green accounting; alternative well-being matrices.

Contributions should be academically rigorous, logically consistent and offer expositional clarity. Contributors could be academics and activists, civil society and policymakers, professionals and students.

Submission Guidelines for Authors

The Journal has the following sections:

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- **RESEARCH PAPER:** address *substantive* research questions, contribute *new* insight and/or provide new findings in the relevant knowledge domain. Must report original research.
- **THEMATIC ESSAY/SURVEY**: provide an e*xhaustive* account of relevant knowledge domains. Does not report original research.
- **COMMENTARY**: short pieces on matters of *contemporary relevance*.
- **NOTES FROM THE FIELD**: capture *interesting* observations or insights gained from the field, that may not be included in a research paper.
- **BOOK REVIEW**: offers a critical *evaluation* of the content, quality, significance of a book.
- **REPORT**: synoptic coverage of conferences, workshops, seminars, meetings, symposium and other such, for general dissemination.

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About Indian Society for Ecological Economics

INSEE was conceived at a meeting held in New Delhi on 24 September 1998 and within four months it was registered under the Societies Registration Act (1860), as a regional society affiliated to the International Society for Ecological Economics (ISEE).

Its aims and objects include the following:

- To encourage multi-disciplinary, scientific and technological research on the integration of Ecology, Economics and related disciplines and to promote general understanding of the results of that research through education, policy analysis, communication and other appropriate means.
- To promote sustainability at the global, regional, national and local levels.
- To foster inter-disciplinary discourse within and between the social and natural sciences in India and other countries.
- To provide an Indian and South Asian regional focus for activities in Ecological Economics.
- To establish and maintain interaction with the International Society of Ecological Economics and other international organisations working in the same field

It aims to further the cause of sustainable development by providing a forum for dialogue among scholars, practitioners, and policy analysts from various disciplines, particularly economics and ecological sciences on a range of issues of national and international interests, such as climate change, natural resources, energy, waste, ecosystem services and valuation.

INSEE's major activities include the following: Biennial Conferences, Seminars, Workshops, Policy Dialogues and Training Programmes, Networking nationally and internationally, Publication of Collection of Research Works, and Dissemination through Web-based Platforms.

Publications



Global Change, Ecosystems, Sustainability
Edited by Pranab Mukhopadhyay, Nandan Nawn and Kalyan Das (Sage, 2017)



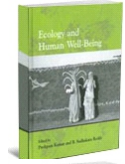
INSEE is Twenty: Looking Back, Thinking Ahead
Edited by Nandan Nawn (INSEE, 2017)



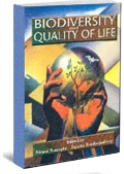
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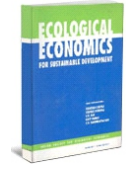
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