IndiaSpend

Azim Premji University

EARTHCHECK

HANDBOOK

CONTENTS

Hello,

Welcome to Azim Premji University and IndiaSpend's EarthCheck workshop.

The EarthCheck series of workshops is your chance to join the tribe of climate change journalists across the global south and gain a deeper understanding on the pressing issues related to climate change and its impact on your region.

Throughout the workshop, you will have the opportunity to hear from experts in the field, as well as engage in discussions with your peers. We are confident that the information and insights shared during this workshop will be of value to your work.

In addition to the masterclasses and lectures, there will be opportunities for networking, and we encourage you to take full advantage and expand your professional network.

We are grateful to our partners, Cotton University and EastMojo for their support in making this workshop possible.

We look forward to your active participation and engagement in the workshop.

Wishing you all the success.

Govindraj Ethiraj

Harini Nagendra

AGENDA

Earthcheck: Guwahati Edition

Day 1

Date: Friday, 3 February 2023

Heading	Session details	Time	Led by
Registration	Registration, Wi-Fi connection and tech check.	09.45am – 10.00am	
Inaugural session	Welcome address	10.00am– 10.20am	Prof. Rahul Mahanta & Santonu Goswami
Defining impact	This session focuses on the core purpose of the EarthCheck initiative and identifies gaps that this initiative aims to address. Why building a frontline of climate change journalists is crucial for the subcontinent, and more importantly, what does success look like.	10.20am– 10.30am	Govindraj Ethiraj
Lecture	India and the climate abyss – A concise overview of rising temperatures and its impact in the near future.	10.30am– 10.50am	Prof. Santonu Goswami
Coffee Break	***Group photograph***	***10.50am – 11.15am***	
Masterclass: Building blocks of a data-backed and evidence-based climate change report	In this session you will understand how to structure a climate change article - the rigor in planning, analyzing data and policy, identifying sources, fact checking and nuances in field reporting so as to gain perspective on the best practices in reporting climate change stories. You will be equipped with a checklist on what constitutes a robust report. Using published work, essentially the author's articles and reports, various aspects of reporting will be deconstructed and analyzed from different points of view. This is a working session and participants will be involved in the analysis of articles.	11.15am – 01.00pm	Nihar Gokhale
Lunch break		***01.00pm- 02.00pm***	
Meeting the editor's expectations	The success of a high quality article or report is almost always a good and robust pitch. This session will piece the pitch puzzle and participants will get an understanding on what an ideal pitch should cover from an editor's perspective.	02.00pm – 02.30pm	Shreya Shah
The reporter's dilemma	An open discussion on access to resources, current and quality datasets and sources, sector experts and spokespersons, academic and research papers, visualizations and factchecking.	02.30pm– 03.00pm	Karma Paljor & Sushanta Talukdar
Mapping the field, listening to people	A preview into an upcoming series of articles documenting the impact of climate change in the north-east.	03.00pm- 04.00pm	Sanjoy Hazarika
Quick recap	Address any pending questions	04.00pm- 04.15pm	Rwit Ghosh

AGENDA

Day 2

Date: Saturday, 4 February 2023

Heading	Session details	Time	Led by
Updates and announcements	Goal setting for the day	10.00am - 10.05am	Prof. Santonu Goswami
Guest speaker	Prof Goswami's efforts in installing state of the art Climate Prediction system and short and medium range weather prediction system at India Meteorological Department (IMD) has led to perceptible improvement in the skill of weather and climate forecasts in the country. This has improved confidence of the common man as well as the policy makers on the forecasts by IMD. The economic benefit to the farmers from the improved climate and weather forecasts is estimated to be about Rs. 50,000 Crores per year.	10.05am – 10.45am	Prof. B N Goswami
Masterclass	The art of data storytelling highlights the role of visualizations in unpacking complex and layered data-driven narratives into a simple and structured story. By weaving visualizations into storytelling, reports stand a better chance in terms of gaining traction and are bound to resonate with a wider audience.	10.45am – 11.30am	Richie Lionel
Practical session	A step-by-step classroom session on how to use basic creative tools to tell stories – Create GIFS, memes and use of comics to tell a story.	11.30am – 01.00pm	Richie Lionel
Lunch break		***01.00 pm – 02.00pm***	
Masterclass: Disinformation, misinformation, and verification	This session will train you to detect the difference between disinformation and misinformation, verify images, text, and videos you receive on WhatsApp, Twitter, Facebook, and other social media platforms. You will learn how to access online factchecking tools and gain hands on experience of applying them in your daily routine.	02.00pm – 04.00pm	Divya Chandra
Vote of Thanks	Handover of certificates	04.15pm – 04.45pm.	Prof. Mahanta & Santonu Goswami
High tea		***4.45pm onwards***	

FACULTY MEMBERS

RAHUL MAHANTA

Dr. Rahul Mahanta has more than 25 years experience in teaching and research at the Department of Physics, Cotton University, Guwahati.
Rahul Mahanta has been a leading researcher of considerable standing on various aspects of climate change. The quality and content of research on weather and Climate variability over North East India carried out by him has established a benchmark that sets the standard for several of his peers and provides a platform for young researchers.

In his book " Present Tense Future Expensive – Climate change in Northeast India", he has provided a comprehensive analysis of various aspects of climate change in Northeast India which he begins by examining the physical and biological aspects of climate change and a detailed analysis of the science of the climate system. He is actively engaged in instructional design, curriculum development, blended learning, E-learning, Web-based training, multimedia development in Environmental and Climate Science topics. He has been involved in environmental issues since the 1980s. Apart from being an Associate Professor in Physics, Dr. Mahanta is currently founder and director of Interdisciplinary Climate Research Center at Cotton University.He has been teaching environment and climate Science to undergraduate and postgraduate students for over 20 years. He has been associated with several projects funded by the DST, the Ministry of Environmental and Forests and several other government agencies and ISRO. Further he has major collaboration with five Universities of Japan, including Tokyo University and Kyoto University, along with Tribhuvan University of Nepal and Jahangirnagar University, Bangladesh.

He has to his credit a number of research papers in international journals, one of which won IITM, Pune Silver Jubilee Award. Further he has documented the climate change, environment and social challenges of a changing environment in Northeast India for over 20 years. He likes to work with graduate students individually or cooperatively with other faculty members on a variety of research problems. Strongly believes that student interests can often dictate new research opportunities and directions. He also like to work with undergraduate students from other disciplines on research projects designed to stimulate their interest in atmospheric science.

GOVINDRAJ ETHIRAJ

Founder: IndiaSpend & BOOMLive

Govindraj Ethiraj is a television and print journalist who has reported and written on Indian business for over 25 years.

He is a media executive and entrepreneur whose public interest journalism ventures use data to tell stories in areas like health, education and climate as well as safeguard the transparency, accuracy, and integrity of news.

Most recently, he founded BOOM (www.boomlive.in), an independent journalism initiative that fights misinformation and explains issues with the larger objective of making the internet safer.He also founded the award-winning IndiaSpend (indiaspend.org), a public interest journalism outfit which use data to write and syndicate stories in areas like health, education, environment and FactChecker (factchecker.in)which monitors media, politicians and other figures for accuracy.

BOOM and FactChecker were India's first verified members of the International Fact Checking Network (IFCN), affiliated with Poynter Institute. IndiaSpend is a member of the Global Investigative Journalism Network (GIJN). Govindraj also sits on the global board of the St.Petersburg, US, headquartered IFCN since inception. Previously, he was Founder-Editor in Chief of Bloomberg TV India, a 24-hours business news service launched out of Mumbai in 2008.

Prior to setting up Bloomberg TV, he worked with Business Standard newspaper as Editor (New Media), and before that, Govindraj spent five years with television channel CNBC-TV18 where he actively drove most of the channels' programming growth and expansion. Prior to television, he worked in print in The Economic Times and leading business magazines. Govindraj was named a 2018 McNulty Prize Laureate in recognition for his leadership with BOOM, IndiaSpend, and FactChecker. He is a Fellow of the Inaugural Class of Ananta Aspen's India Leadership Initiative and the Aspen Global Leadership Network, and winner of the 2014 BMW Responsible Leaders Awards.

SANTONU GOSWAMI

I joined the University in December 2021 after working as a Senior Scientist within the Earth and Climate Science Area of the National Remote Sensing Centre, ISRO, Hyderabad for five and a half years. Prior to this, I worked as a Research Scientist in the Centre for Urban Science and Progress at New York University, New York, USA and Postdoctoral Scientist within the Climate Change Institute at Oak Ridge National Laboratory in Oak Ridge, TN, USA. My current work is focused upon a better understanding of the impacts of climate change across Indian vulnerable ecosystems to provide key insights to help policymaking and developing strategies for climate mitigation and adaptation. My prior research involved studying long-term changes in the Indian coastal ecosystems using archival remote sensing data, Himalayan ecosystem change, degrading permafrost landscapes in the European and North American Arctic by conducting extensive fieldwork and modelling studies. My research also involved studying New York city neighbourhoods using a data-driven approach. In 2021, I founded an open-source community named 'Community Climate Lab' (www.cclindia.org).

NIHAR GOKHALE

Nihar Gokhale leads our Chaos coverage at The Morning Context. Nihar writes on the environment, the economy and resource conflicts in India. He has reported from across the country on everything from displacement, pollution and environmental violations to land regulation, corruption and human rights. He was earlier associate editor at Land Conflict and his work has appeared in Scroll, The Wire, IndiaSpend, The Caravan and Mongabay India.

SHREYA SHAH

Shreya Shah is a writer and editor at IndiaSpend.

She is a graduate of the Global Human Development program at Georgetown University, Washington D.C. and has previously worked with the Mumbai bureau of The Wall Street Journal. There she researched for a series on drug resistant tuberculosis and wrote on a number of topics, ranging from reservation for women in Indian politics to the black and yellow taxis plying the city's roads. Her report on a pilot TB care programme in Gujarat's Mehsana district won the 2017 REACH Media Award for excellence in reporting on TB. She has also worked in education and early childhood development with organizations in Washington D.C., India and Jordan.

KARMA PALJOR

Karma Paljor is an award-winning Indian journalist and entrepreneur who co-founded Atvi Infotainment, a content creation company, in 2018. The business verticals include EastMojo.com, a digital news website that reports extensively on northeast India to bring out the lesser-known stories of life in this otherwise ignored region. Karma's career spans 22 years, having started with The Times of India. His first brush with broadcast journalism was with CNBC TV18, where he spent 5 years and moved on to be a founding employee of CNN News18, where he spent 12 years heading various teams and programs.

He was awarded 'Reporter of the Year' by Indiantelevision.com in 2010. He won the prestigious Ramnath Goenka Award for Excellence in Journalism for investigative ground reports in 2011 and 2014. Karma was part of the CNN News18 team that won the award for Best National News Coverage in English at the exchange4media News Broadcasting Awards (ENBA) for their coverage of the devastating Uttrakhand floods in 2013. In 2014, Karma won the ENBA Award in the Best Spot News Reporting (English) category for his coverage of the 'Cyclone Phailin' in Orissa. He has produced, directed, and anchored several award-winning programmes for CNN News 18, including Budget Yatra, Axe the Tax, Reporters Project, and India Positive. He is a Fellow of the sixth class of the Kamalnayan Bajaj Fellowship and a member of the Aspen Global Leadership Network.

SUSHANTA TALUKDAR

Sushanta Talukdar has 30 years of experience of covering India's Northeast region for local and national dailies. Formerly, a Senior Assistant Editor of The Hindu, he is currently the Editor, nezine.com- a bilingual online magazine on Northeast, and a regular contributor to FRONTLINE on political happenings, conflict situation, development, environment, and governance issues in the region. Prior to his association with The Hindu, he also covered Assam and neighbouring states for The Telegraph, The Northeast Daily, The Eastern Clarion and The Northeast Times. He visits Tezpur University and otton University regularly and Gauhati University and Don Bosco University occasionally to interact with students of journalism and mass communications to help them sharpen their storytelling skills. CA recipient of Parag Kumar Das Journalism award, he took part in the 9th Bangladesh China India Myanmar (BCIM) forum in Kunming in China and India Bangladesh Studies in Dhaka in 2011. He was the Principal Investigator of the Research project on "Assam at the crossroads of deepening India-Bhutan engagement: Realignment of policy regimes for cross-border trade and Border Area Development Programme" sanctioned by the Centre for Southeast Asian Studies, Gauhati University.

SANJOY HAZARIKA

Sanjoy Hazarika is a Columnist, author of the acclaimed books, Strangers of the Mist and Strangers no More, researcher, rights activist and filmmaker, Sanjoy Hazarika returns to journeying on the Brahmaputra, rediscovering the river, learning about the new challenges that it and its people face in the uncertainties of climate change and human interventions. Hazarika, who is working on a travelogue on his journeys on the Brahmaputra, from Tibet to the Bay of Bengal, is also the founder of the Centre for North East Studies and Policy Research.

BHUPENDRA NATH GOSWAMI

Bhupendra Nath Goswami is an Indian meteorologist, climatologist, a former director of the Indian Institute of Tropical Meteorology (IITM) and a Pisharoty Chair Professor at the Indian Institute of Science Education and Research. He is known for his research on India's monsoon dynamics and was awarded the Shanti Swarup Bhatnagar Prize for Science and Technology for his contributions to Earth, Atmosphere, Ocean and Planetary Sciences in 1995.

DIVYA CHANDRA

Divya Chandra is Producer, Workshops and Training at BOOM FactCheck.

She conducts training sessions and LIVE workshops to teach the art of fact-checking. Previously, she was Correspondent-Fact Check at The Quint. She did her Masters in Journalism from Symbiosis Institute of Media & Communication, Pune. When not fact-checking, you can find her at a cafe next door.

GLOSSARY

Abrupt climate change: A large-scale change in the climate system that takes place over a few decades or less, persists (or is anticipated to persist) for at least a few decades, and causes substantial disruptions in human and natural systems.

Adaptation Fund: A Fund established under the Kyoto Protocol in 2001 and officially launched in 2007. The Fund finances adaptation projects and programs in developing countries that are Parties to the Kyoto Protocol. Financing comes mainly from sales of Certified Emissions Reductions (CERs) and a share of proceeds amounting to 2 % of the value of CERs issued each year for Clean Development Mechanism (CDM) projects. The Adaptation Fund can also receive funds from government, private sector, and individuals

Adaptive capacity: The ability of systems, institutions, humans, and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences.

Additionality: Mitigation projects (e. g., under the Kyoto Mechanisms), mitigation policies, or climate finance are additional if they go beyond a business-as-usual level, or baseline. Additionality is required to guarantee the environmental integrity of project-based offset mechanisms, but difficult to establish in practice due to the counterfactual nature of the baseline.

Adverse side-effects: The negative effects that a policy or measure aimed at one objective might have on other objectives, without yet evaluating the net effect on overall social welfare. Adverse side-effects are often subject to uncertainty and depend on, among others, local circumstances and implementation practices.

Aerosol: A suspension of airborne solid or liquid particles, with a typical size between a few nanometers and 10 nm that reside in the atmosphere for at least several hours.

Afforestation: Planting of new forests on lands that historically have not contained forests. Afforestation projects are eligible under several schemes including, among others, Joint Implementation (JI) and the Clean Development Mechanism (CDM) under the Kyoto Protocol for which particular criteria apply (e. g., proof must be given that the land was not forested for at least 50 years or converted to alternative uses before 31 December 1989).

Albedo: The fraction of solar radiation reflected by a surface or object, often expressed as a percentage. Snow-covered surfaces have a high albedo, the albedo of soils ranges from high to low, and vegetation-covered surfaces and oceans have a low albedo. The earth's planetary albedo varies mainly through varying cloudiness, snow, ice, leaf area and land cover changes.

Alliance of Small Island States (AOSIS): The Alliance of Small Island States (AOSIS) is a coalition of small islands and low-lying coastal countries with a membership of 44 states and observers that share and are active in global debates and negotiations on the environment, especially those related to their vulnerability to the adverse effects ofclimate change.

Atmosphere: The gaseous envelope surrounding the earth, divided into five layers — the troposphere which contains half of the earth's atmosphere, the stratosphere, the mesosphere, the thermosphere, and the exosphere, which is the outer limit of the atmosphere.

Biochar: Biomass stabilization can be an alternative or enhancement to bioenergy in a land-based mitigation strategy. Heating biomass with exclusion of air produces a stable carbon-rich co-product (char).
When added to soil a system, char creates a system that has greater abatement potential than typical bioenergy. The relative benefit of bio- char systems is increased if changes in crop yield and soil emissions of methane (CH - 4) and nitrous oxide (N2O) are taken into account.

Biochemical oxygen demand (BOD): The amount of dissolved oxygen consumed by microorganisms (bacteria) in the biochemical oxidation of organic and inorganic matter in wastewater.

Biodiversity: The variability among living organisms from terrestrial, marine, and other ecosystems. Biodiversity includes variability at the genetic, species, and ecosystem levels

Bioenergy: Energy derived from any form of biomass such as recently living organisms or their metabolic by-products.

Bioethanol: Ethanol produced from biomass (e. g., sugar cane or corn).

Biofuel: A fuel, generally in liquid form, produced from organic matter or combustible oils produced by living or recently living plants. Examples of biofuel include alcohol (bioethanol), black liquor from the paper-manufacturing process, and soybean oil.

First-generation manufactured biofuel: First-generation manufactured biofuel is derived from grains, oilseeds, animal fats, and waste vegetable oils with mature conversion technologies.

Second-generation biofuel: Second-generation biofuel uses non-traditional biochemical and thermochemical conversion processes and feedstock mostly derived from the lignocellulosic fractions of, for example, agricultural and forestry residues, municipal solid waste, etc.

Third-generation biofuel: Third-generation biofuel would be derived from feedstocks such as algae and energy crops by advanced processes still under development. These second- and third-generation biofuels produced through new processes are also referred to as next-generation or advanced biofuels, or advanced biofuel technologies.

Biomass: The total mass of living organisms in each area or volume; dead plant material can be included as dead biomass. Biomass includes products, by-products, and waste of biological origin (plants or animal matter), excluding material embedded in geological formations and transformed to fossil fuels or peat.

Traditional biomass: Traditional biomass refers to the biomass — fuelwood, charcoal, agricultural residues, and animal dung — used with the so-called traditional technologies such as open fires for cooking, rustic kilns and ovens for small industries. Widely used in developing countries, where about 2.6 billion people cook with open wood fires, and hundreds of thousands small- industries. The use of these rustic technologies leads to high pollution levels and, in specific circumstances, to forest degradation and deforestation.

Modern biomass: All biomass used in high efficiency conversion systems.

Biomass burning: Biomass burning is the burning of living and dead vegetation.

Biosphere (terrestrial and marine): The part of the earth system comprising all ecosystems and living organisms, in the atmosphere, on land (terrestrial biosphere) or in the oceans (marine biosphere), including derived dead organic matter, such as litter, soil organic matter and oceanic detritus.

Black carbon (BC): Operationally defined aerosol species based on measurement of light absorption and chemical reactivity and/or thermal stability. It is sometimes referred to as soot. Black Carbon is mostly formed by the incomplete combustion of fossil fuels, biofuels, and biomass but it also occurs naturally. It stays in the atmosphere only for days or weeks. It is the most strongly light-absorbing component of particulate matter (PM) and has a warming effect by absorbing heat into the atmosphere and reducing the albedo when deposited on ice or snow.

Burden sharing (also referred to as Effort sharing): In the context of mitigation, burden sharing refers to sharing the effort of reducing the sources or enhancing the sinks of greenhouse gases (GHGs) from historical or projected levels, usually allocated by some criteria, as well as sharing the cost burden across countries.

Cancún Agreements: A set of decisions adopted at the 16th Session of the Conference of the Parties (COP) to the United Nations Framework Convention on Climate Change (UNFCCC), including the following, among others: the newly established Green Climate Fund (GCF), a newly established technology mechanism, a process for advancing discussions on adaptation, a formal process for reporting mitigation commitments, a goal of limiting global mean surface temperature increase to 2 °C, and an agreement on MRV — Measuring, Reporting and Verifying for those countries that receive international support for their mitigation efforts.

Cancún Pledges: During 2010, many countries submitted their existing plans for controlling greenhouse gas (GHG) emissions to the Climate Change Secretariat and these proposals have now been formally acknowledged under the United Nations Framework Convention on Climate Change (UNFCCC). Developed countries presented their plans in the shape of economy-wide targets to reduce emissions, up to 2020, while developing countries proposed ways to limit their growth of emissions in the shape of plans of action.

Carbon budget: The area under a greenhouse gas (GHG) emissions trajectory that satisfies assumptions about limits on cumulative emissions estimated to avoid a certain level of global mean surface temperature rise. Carbon budgets may be defined at the global level, national, or sub-national levels.

Carbon cycle: The term used to describe the flow of carbon (in various forms, e. g., as carbon dioxide) through the atmosphere, ocean, terrestrial and marine biosphere and lithosphere.

Carbon dioxide (CO_2): A naturally occurring gas, also a by-product of burning fossil fuels from fossil carbon deposits, such as oil, gas and coal, of burning biomass, of land use changes (LUC) and of industrial processes (e. g., cement production). It is the principal anthropogenic greenhouse gas (GHG) that affects the earth's radiative balance. It is the reference gas against which other GHGs are measured and therefore has a Global Warming Potential (GWP)

Carbon Dioxide Capture and Storage (CCS): A process in which a relatively pure stream of carbon dioxide (CO_2) from industrial and energy-related sources is separated (captured), conditioned, compressed, and transported to a storage location for long-term isolation from the atmosphere.

Carbon dioxide fertilization: The enhancement of the growth of plants as a result of increased atmospheric carbon dioxide (CO_2) concentration.

Carbon Dioxide Removal (CDR): Carbon Dioxide Removal methods refer to a set of techniques that aim to remove carbon dioxide (CO_2) directly from the atmosphere by either (1) increasing natural sinks for carbon or (2) using chemical engineering to remove the CO 2, with the intent of reducing the atmospheric CO_2 concentration.

Carbon footprint: Measure of the exclusive total amount of emissions of carbon dioxide (CO_2) that is directly and indirectly caused by an activity or is accumulated over the life stages of a product

Carbon price: The price for avoided or released carbon dioxide (CO_2) or CO_2-equivalent emissions. This may refer to the rate of a carbon tax, or the price of emission permits. In many models that are used to assess the economic costs of mitigation, carbon prices are used as a proxy to represent the level of effort in mitigation policies.

Carbon tax: A levy on the carbon content of fossil fuels. Because virtually all of the carbon in fossil fuels is ultimately emitted as carbon dioxide (CO_2), a carbon tax is equivalent to an emission tax on CO_2 emissions.

Chemical oxygen demand (COD): The quantity of oxygen required for the complete oxidation of organic chemical compounds in water; used as a measure of the level of organic pollutants in natural and waste waters.

Chlorofluorocarbons (CFCs): A chlorofluorocarbon is an organic compound that contains chlorine, carbon, hydrogen, and fluorine and is used for refrigeration, air conditioning, packaging, plastic foam, insulation, solvents, or aerosol propellants.

Clean Development Mechanism (CDM): A mechanism defined under Article 12 of the Kyoto Protocol through which investors (governments or companies) from developed countries may finance greenhouse gas (GHG) emission reduction or removal projects in developing countries and receive Certified Emission Reduction Units (CERs) for doing so.

Climate: Climate in a narrow sense is usually defined as the average weather, or more rigorously, as the statistical description in terms of the mean and variability of relevant quantities over a period ranging from months to thousands or millions of years.

Climate change commitment: Due to the thermal inertia of the ocean and slow processes in the cryosphere and land surfaces, the climate would continue to change even if the atmospheric composition were held fixed at today's values.

Climate finance: There is no agreed definition of climate finance. The term 'climate finance' is applied both to the financial resources devoted to addressing climate change globally and to financial flows to developing countries to assist them in addressing climate change.

Climate model (spectrum or hierarchy): A numerical representation of the climate system based on the physical, chemical and biological properties of its components, their interactions and feedback processes, and accounting for some of its known properties.

Climate prediction: A climate prediction or climate forecast is the result of an attempt to produce (starting from a particular state of the climate system) an estimate of the actual evolution of the climate in the future, for example, at seasonal, interannual, or decadal time scales.

Climate projection: A climate projection is the simulated response of the climate system to a scenario of future emission or concentration of greenhouse gases (GHGs) and aerosols, generally derived using climate models.

Climate scenario: A plausible and often simplified representation of the future climate, based on an internally consistent set of climatological relationships that has been constructed for explicit use in investigating the potential consequences of anthropogenic climate change, often serving as input to impact models.

Climate sensitivity: In IPCC reports, equilibrium climate sensitivity (units: °C) refers to the equilibrium (steady state) change in the annual global mean surface temperature following a doubling of the atmospheric CO2 equivalent concentration.

Climate system: The climate system is the highly complex system consisting of five major components: the atmosphere, the hydrosphere, the cryosphere, the lithosphere and the biosphere, and the interactions between them.

Climate threshold: A limit within the climate system that, when crossed, induces a non-linear response to a given forcing.

Climate variability: Climate variability refers to variations in the mean state and other statistics (such as standard deviations, the occurrence of extremes, etc.) of the climate on all spatial and temporal scales beyond that of individual weather events.

CO2-equivalent concentration: The concentration of carbon dioxide (CO2) that would cause the same radiative forcing as a given mixture of CO2 and other forcing components.

CO2 equivalent emission: The amount of carbon dioxide (CO2) emission that would cause the same integrated radiative forcing, over a given time horizon, as an emitted amount of a greenhouse gas (GHG) or a mixture of GHGs.

Co-benefits: The positive effects that a policy or measure aimed at one objective might have on other objectives, without yet evaluating the net effect on overall social welfare.

Cogeneration: Cogeneration (also referred to as combined heat and power, or CHP) is the simultaneous generation and useful application of electricity and useful heat.

Conference of the Parties (COP): The supreme body of the United Nations Framework Convention on Climate Change (UNFCCC), comprising countries with a right to vote that have ratified or acceded to the convention.

Consumption-based accounting: Consumption-based accounting provides a measure of emissions released to the atmosphere in order to generate the goods and services consumed by a certain entity (e. g., person, firm, country, or region).

Copenhagen Accord: The political (as opposed to legal) agreement that emerged at the 15th Session of the Conference of the Parties (COP) at which delegates 'agreed to take note' due to a lack of consensus that an agreement would require.

Cost-benefit analysis (CBA): Monetary measurement of all negative and positive impacts associated with a given action. Costs and benefits are compared in terms of their difference and / or ratio as an indicator of how a given investment or other policy effort pays off seen from the society's point of view.

Cost-effectiveness: A policy is more cost-effective if it achieves a goal, such as a given pollution abatement level, at lower cost. A critical condition for cost-effectiveness is that marginal abatement costs be equal among obligated parties.

Cost-effectiveness analysis (CEA): A tool based on constrained optimization for comparing policies designed to meet a prespecified target.

Crediting period, Clean Development Mechanism (CDM): The time during which a project activity can generate Certified Emission Reduction Units (CERs). Under certain conditions, the crediting period can be renewed up to two times.

Cropland management: The system of practices on land on which agricultural crops are grown and on land that is set aside or temporarily not being used for crop production (UNFCCC, 2002).

Decarbonization: The process by which countries or other entities aim to achieve a low-carbon economy, or by which individuals aim to reduce their carbon consumption.

Deforestation: Conversion of forest to non-forest is one of the major sources of greenhouse gas (GHG) emissions.

Dematerialization: The ambition to reduce the total material inputs required to deliver a final service.

Desertification: Land degradation in arid, semi-arid, and dry sub-humid areas resulting from various factors, including climatic variations and human activities. Land degradation in arid, semi-arid, and dry sub-humid areas is a reduction or loss of the biological or economic productivity and complexity of rainfed cropland, irrigated cropland, or range, pasture, forest, and woodlands resulting from land uses or from a process or combination of processes, including processes arising from human activities and habitation patterns, such as (1) soil erosion caused by wind and / or water; (2) deterioration of the physical, chemical, biological, or economic properties of soil; and (3) long-term loss of natural vegetation (UNCCD, 1994)

Development pathway: An evolution based on an array of technological, economic, social, institutional, cultural, and biophysical characteristics that determine the interactions between human and natural systems, including consumption and production patterns in all countries, over time at a particular scale

Direct Air Capture (DAC): Chemical process by which a pure carbon dioxide (CO2) stream is produced by capturing CO2 from the ambient air.

Discounting: A mathematical operation making monetary (or other) amounts received or expended at different times (years) comparable across time.

Double dividend: The extent to which revenue-generating instruments, such as carbon taxes or auctioned (tradable) emission permits can (1) contribute to mitigation and (2) offset at least part of the potential welfare losses of climate policies through recycling the revenue in the economy to reduce other taxes likely to cause distortions.

Drivers of behavior: Determinants of human decisions and actions, including peoples' values and goals and the factors that constrain action, including economic factors and incentives, information access, regulatory and technological constraints, cognitive and emotional processing capacity, and social norms.

Drivers of emissions: Drivers of emissions refer to the processes, mechanisms and properties that influence emissions through factors. Factors comprise the terms in a decomposition of emissions. Factors and drivers may in return affect policies, measures and other drivers.

Economic efficiency: Economic efficiency refers to an economy's allocation of resources (goods, services, inputs, productive activities). An allocation is efficient if it is not possible to reallocate resources so as to make at least one person better off without making someone else worse off.

Economies in Transition (EITs): Countries with their economies changing from a planned economic system to a market economy.

Ecosystem: A functional unit consisting of living organisms, their non- living environment, and the interactions within and between them.

Ecosystem services: Ecological processes or functions having monetary or non-monetary value to individuals or society at large.

Emission factor / Emissions intensity: The emissions released per unit of activity.

Emission permit: An entitlement allocated by a government to a legal entity (company or other emitter) to emit a specified amount of a substance.

Emission quota: The portion of total allowable emissions assigned to a country or group of countries within a framework of maximum total emissions.

Emission scenario: A plausible representation of the future development of emissions of substances that are potentially radiatively active (e. g., greenhouse gases, aerosols) based on a coherent and internally consistent set of assumptions about driving forces (such as demographic and socioeconomic development, technological change, energy and land use) and their key relationships.

Emission trajectories: A projected development in time of the emission of a greenhouse gas (GHG) or group of GHGs, aerosols, and GHG precursors.

Agricultural emissions: Emissions associated with agricultural systems — predominantly methane (CH_4) or nitrous oxide (N_2O). These include emissions from enteric fermentation in domestic livestock, manure management, rice cultivation, prescribed burning of savannas and grassland, and from soils (IPCC, 2006).

Anthropogenic emissions: Emissions of greenhouse gases (GHGs), aerosols, and precursors of a GHG or aerosol caused by human activities. These activities include the burning of fossil fuels, deforestation, land use changes (LUC), livestock production, fertilization, waste management, and industrial processes.

Direct emissions: Emissions that physically arise from activities within well-defined boundaries of, for instance, a region, an economic sector, a company, or a process.

Embodied emissions: Emissions that arise from the production and delivery of a good or service or the build-up of infrastructure.

Indirect emissions: Emissions that are a consequence of the activities within well-defined boundaries of, for instance, a region, an economic sector, a company or process, but which occur outside the specified boundaries. For example, emissions are described as indirect if they relate to the use of heat but physically arise outside the boundaries of the heat user, or to electricity production but physically arise outside of the boundaries of the power supply sector.

Emission standard: An emission level that, by law or by voluntary agreement, may not be exceeded.

Emissions trading: A market-based instrument used to limit emissions. The environmental objective or sum of total allowed emissions is expressed as an emissions cap. The cap is divided in tradable emission permits that are allocated — either by auctioning or handing out for free (grandfathering) — to entities within the jurisdiction of the trading scheme. Entities need to surrender emission permits equal to the amount of their emissions (e. g., tons of carbon dioxide). An entity may sell excess permits.

Energy: The power of ‘doing work’ possessed at any instant by a body or system of bodies.

Energy access: Access to clean, reliable and affordable energy services for cooking and heating, lighting communications, and productive uses (AGECC, 2010).

Energy carrier: A substance for delivering mechanical work or transfer of heat. Examples of energy carriers include solid, liquid, or gaseous fuels (e. g., biomass, coal, oil, natural gas, hydrogen); pressurized / heated / cooled fluids (air, water, steam); and electric current.

Energy density: The ratio of stored energy to the volume or mass of a fuel or battery.

Energy efficiency (EE): The ratio of useful energy output of a system, conversion process, or activity to its energy input. In economics, the term may describe the ratio of economic output to energy input.

Energy intensity: The ratio of energy use to economic or physical output.

Energy poverty: A lack of access to modern energy services.

Energy security: The goal of a given country, or the global community, to maintain an adequate, stable, and predictable energy supply. Measures encompass safeguarding the sufficiency of energy resources to meet national energy demand at competitive and stable prices and the resilience of the energy supply; enabling development and deployment of

technologies; building sufficient infrastructure to generate, store and transmit energy supplies; and ensuring enforceable contracts of delivery.

Energy services: An energy service is the benefit received as a result of energy use.

Energy system: The energy system comprises all components related to the production, conversion, delivery, and use of energy.

Environmental effectiveness: A policy is environmentally effective to the extent by which it achieves its expected environmental target.

Environmental input-output analysis: An analytical method used to allocate environmental impacts arising in production to categories of final consumption, by means of the Leontief inverse of a country's economic input-output tables.

Environmental Kuznets Curve: The hypothesis that various environ- mental impacts first increase and then eventually decrease as income per capita increases.

Evidence: Information indicating the degree to which a belief or proposition is true or valid. In this report, the degree of evidence reflects the amount, quality, and consistency of scientific / technical information on which the Lead Authors are basing their findings.

Externality / external cost / external benefit: Externalities arise from a human activity when agents responsible for the activity do not take full account of the activity's impacts on others' production and consumption possibilities, and no compensation exists for such impacts. When the impacts are negative, they are external costs. When the impacts are positive, they are external benefits.

Feed-in tariff (FIT): The price per unit of electricity (heat) that a utility or power (heat) supplier has to pay for distributed or renewable electricity (heat) fed into the power grid (heat supply system) by non-utility generators. A public authority regulates the tariff.

Flaring: Open air burning of waste gases and volatile liquids, through a chimney, at oil wells or rigs, in refineries or chemical plants, and at land-fills.

Food security: A state that prevails when people have secure access to sufficient amounts of safe and nutritious food for normal growth, development, and an active and healthy life.

Forest: A vegetation type dominated by trees. Many definitions of the term forest are in use throughout the world, reflecting wide differences in bio geophysical conditions, social structure and economics. According to the 2005 United Nations Framework Convention on Climate Change (UNFCCC) definition a forest is an area of land of at least 0.05 – 1 hectare, of which more than 10 – 30 % is covered by tree canopy. Trees must have a potential to reach a minimum of 25 meters at maturity in situates. Parties to the Convention can choose to define a forest from within those ranges. Currently, the definition does not recognize different biomes, nor do they distinguish natural forests from plantations, an anomaly being pointed out by many as in need of rectification.

Forest management: A system of practices for stewardship and use of forest land aimed at fulfilling relevant ecological (including biological diversity), economic and social functions of the forest in a sustainable manner (UNFCCC, 2002)

Fossil fuels: Carbon-based fuels from fossil hydrocarbon deposits, including coal, peat, oil, and natural gas.

Free Rider: One who benefits from a common good without contributing to its creation or preservation

Fuel cell: A fuel cell generates electricity in a direct and continuous way from the controlled electrochemical reaction of hydrogen or another fuel and oxygen. With hydrogen as fuel the cell emits only water and heat (no carbon dioxide) and the heat can be utilized.

Fuel poverty: A condition in which a household is unable to guarantee a certain level of consumption of domestic energy services (especially heating) or suffers disproportionate expenditure burdens to meet these needs.

Fuel switching: In general, fuel switching refers to substituting fuel A for fuel B. In the context of mitigation, it is implicit that fuel A has lower carbon content than fuel B, e. g., switching from natural gas to coal.

Geoengineering: Geoengineering refers to a broad set of methods and technologies that aim to deliberately alter the climate system in order to alleviate the impacts of climate change.

Geothermal energy: Accessible thermal energy stored in the earth's interior.

Global mean surface temperature: An estimate of the global mean surface air temperature. However, for changes over time, only anomalies, as departures from a climatology, are used, most based on the area-weighted global average of the sea surface temperature anomaly and land surface air temperature anomaly.

Global warming: Global warming refers to the gradual increase, observed or projected, in global surface temperature, as one of the consequences of radiative forcing caused by anthropogenic emissions.

Global Warming Potential (GWP): An index, based on radiative properties of greenhouse gases (GHGs), measuring the radiative forcing following a pulse emission of a unit mass of a given GHG in the present-day atmosphere integrated over a chosen time horizon, relative to that of carbon dioxide (CO_2).

Governance: A comprehensive and inclusive concept of the full range of means for deciding, managing, and implementing policies and measures. Whereas government is defined strictly in terms of the nation-state, the more inclusive concept of governance recognizes the contributions of various levels of government (global, international, regional, local) and the contributing roles of the private sector, of nongovernmental actors, and of civil society to addressing the many types of issues facing the global community.

Grazing land management: The system of practices on land used for livestock production aimed at manipulating the amount and type of vegetation and livestock produced (UNFCCC, 2002)

Green Climate Fund (GCF): The Green Climate Fund was established by the 16th Session of the Conference of the Parties (COP) in 2010 as an operating entity of the financial mechanism of the United Nations Framework Convention on Climate Change (UNFCCC), in accordance with Article 11 of the Convention, to support projects, programs and policies and other activities in developing country Parties. The Fund is governed by a Board and will receive guidance of the COP. The Fund is headquartered in Songdo, Republic of Korea

Greenhouse effect: The infrared radiative effect of all infrared- absorbing constituents in the atmosphere. Greenhouse gases (GHGs), clouds, and (to a small extent) aerosols absorb terrestrial radiation emitted by the earth's surface and elsewhere in the atmosphere. These substances emit infrared radiation in all directions, but everything else being equal, the net amount emitted to space is normally less than would have been emitted in the absence of these absorbers because of the decline of temperature with altitude in the troposphere and the consequent weakening of emission. An increase in the concentration of GHGs increases the magnitude of this effect; the difference is sometimes called the enhanced greenhouse effect. The change in a GHG concentration because of anthropogenic emissions contributes to an instantaneous radiative forcing.

Surface temperature and troposphere warm in response to this forcing, gradually restoring the radiative balance at the top of the atmosphere.

Greenhouse gas (GHG): Greenhouse gases are those gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of terrestrial radiation emitted by the earth's surface, the atmosphere itself, and by clouds. This property causes the greenhouse effect. Water vapor (H2O), carbon dioxide (CO2), nitrous oxide (N2O), methane (CH4) and ozone (O3) are the primary GHGs in the earth's atmosphere.

Gross domestic product (GDP): The sum of gross value added, at purchasers' prices, by all resident and non-resident producers in the economy, plus any taxes and minus any subsidies not included in the value of the products in a country or a geographic region for a given period, normally one year. GDP is calculated without deducting for depreciation of fabricated assets or depletion and degradation of natural resources.

Gross national expenditure (GNE): The total amount of public and private consumption and capital expenditures of a nation. In general, national account is balanced such that gross domestic product (GDP) + import = GNE + export.
Gross national product: The value added from domestic and foreign sources claimed by residents. GNP comprises gross domestic product (GDP) plus net receipts of primary income from non-resident income.

Gross world product: An aggregation of the individual country's gross domestic products (GDP) to obtain the world or global GDP.

Heat island: The relative warmth of a city compared with surrounding rural areas, associated with changes in runoff, effects on heat retention, and changes in surface albedo.

Human Development Index (HDI): The Human Development Index allows the assessment of countries' progress regarding social and economic development as a composite index of three indicators: (1) health measured by life expectancy at birth; (2) knowledge as measured by a combination of the adult literacy rate and the combined primary, secondary and tertiary school enrolment ratio; and (3) standard of living as gross domestic product (GDP) per capita (in purchasing power parity).

Hybrid vehicle: Any vehicle that employs two sources of propulsion, particularly a vehicle that combines an internal combustion engine with an electric motor.

Hydrofluorocarbons (HFCs): One of the six types of greenhouse gases (GHGs) or groups of GHGs to be mitigated under the Kyoto Protocol. They are produced commercially as a substitute for chlorofluorocarbons (CFCs). HFCs largely are used in refrigeration and semiconductor manufacturing.

Indigenous peoples: Indigenous peoples and nations are those that, having a historical continuity with pre-invasion and pre-colonial societies that developed on their territories, consider themselves distinct from other sectors of the societies now prevailing on those territories, or parts of them. They form at present principally non-dominant sectors of society and are often determined to preserve, develop, and transmit to future generations their ancestral territories, and their ethnic identity, as the basis of their continued existence as peoples, in accordance with their own cultural patterns, social institutions, and common law system.

Industrial Revolution: A period of rapid industrial growth with far reaching social and economic consequences, beginning in Britain during the second half of the 18th century and spreading to Europe and later to other countries including the United States. The invention of the steam engine was an important trigger of this development. The industrial revolution marks the beginning of a strong increase in the use of fossil fuels and emission of fossil carbon dioxide.

Industrialized countries / developing countries: There are a diversity of approaches for categorizing countries based on their level of development, and for defining terms such as industrialized, developed, or developing.

Institution: Institutions are rules and norms held in common by social actors that guide, constrain and shape human interaction. Institutions can be formal, such as laws and policies, or informal, such as norms and conventions. Organizations — such as parliaments, regulatory agencies, private firms, and community bodies — develop and act in response to institutional frameworks and the incentives they frame. Institutions can guide, constrain and shape human interaction through direct control, through incentives, and through processes of socialization.

Institutional feasibility: Institutional feasibility has two key parts: (1) the extent of administrative workload, both for public authorities and for regulated entities, and (2) the extent to which the policy is viewed as legitimate, gains acceptance, is adopted, and is implemented.

IPAT identity: IPAT is the lettering of a formula put forward to describe the impact of human activity on the environment. Impact (I) is viewed as the product of population size (P), affluence (A=GDP / person) and technology (T= impact per GDP unit). In this conceptualization, population growth by definition leads to greater environmental impact if A and T are constant, and likewise higher income leads to more impact (Ehrlich and Holden, 1971).

Joint Implementation (JI): A mechanism defined in Article 6 of the Kyoto Protocol, through which investors (governments or companies) from developed countries may implement projects jointly that limit or reduce emissions or enhance sinks, and to share the Emissions Reduction Units (ERU).

Kaya identity: In this identity global emissions are equal to the population size, multiplied by per capita output (gross world product), multiplied by the energy intensity of production, multiplied by the carbon intensity of energy.

Kyoto Mechanisms (also referred to as Flexibility Mechanisms): Market-based mechanisms that Parties to the Kyoto Protocol can use to lessen the potential economic impacts of their commitment to limit or reduce greenhouse gas (GHG) emissions. They include Joint Implementation (JI) (Article 6), Clean Development Mechanism (CDM) (Article 12), and Emissions trading (Article 17).

Kyoto Protocol: The Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC) was adopted in 1997 in Kyoto, Japan, at the Third Session of the Conference of the Parties (COP) to the UNFCCC. It contains legally binding commitments, in addition to those included in the UNFCCC. Countries included in Annex B of the Protocol (most Organization for Economic Cooperation and Development countries and countries with economies in transition) agreed to reduce their anthropogenic greenhouse gas (GHG) emissions (carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and Sulphur hexafluoride (SF_6)) by at least 5 % below 1990 levels in the commitment period 2008 – 2012.The Kyoto Protocol entered into force on 16 February 2005.

Land use (change, direct and indirect): Land use refers to the total of arrangements, activities and inputs undertaken in a certain land cover type (a set of human actions). The term land use is also used in the sense of the social and economic purposes for which land is managed (e. g., grazing, timber extraction and conservation). In urban settlements it is related to land uses within cities and their hinterlands.

Urban land use has implications on city management, structure, and form and thus on energy demand, greenhouse gas (GHG) emissions, and mobility, among other aspects.

Land use change (LUC): Land use change refers to a change in the use or management of land by humans, which may lead to a change in land cover. Land cover and LUC may have an impact on the surface albedo, evapotranspiration, sources and sinks of GHGs, or other properties of the climate system and may thus give rise to radiative forcing and / or other impacts on climate, locally or glob- ally.

Indirect land use change (I LUC): Indirect land use change refers to shifts in land use induced by a change in the production level of an agricultural product elsewhere, often mediated by markets or driven by policies. For example, if agricultural land is diverted to fuel production, forest clearance may occur elsewhere to replace the former agricultural production.

Land use, land use change and forestry (LULUCF): A greenhouse gas (GHG) inventory sector that covers emissions and removals of GHGs resulting from direct human-induced land use, land use change and forestry activities excluding agricultural emissions.

Land value capture: A financing mechanism usually based around transit systems, or other infrastructure and services, that captures the increased value of land due to improved accessibility.

Learning curve / rate: Decreasing cost-prices of technologies shown as a function of increasing (total or yearly) supplies. The learning rate is the percent decrease of the cost-price for every doubling of the cumulative supplies (also called progress ratio).

Least Developed Countries (LDCs): A list of countries designated by the Economic and Social Council of the United Nations (ECOSOC) as meeting three criteria: (1) a low-income criterion below a certain threshold of gross national income per capita of between USD 750 and USD 900, (2) a human resource weakness based on indicators of health, education, adult literacy, and (3) an economic vulnerability based on indicators on instability of agricultural production, instability of export of goods and services, economic importance of non-traditional activities, merchandise export concentration, and the handicap of economic smallness. Countries in this category are eligible for several programs focused on assisting countries most in need. These privileges include certain benefits under the articles of the United Nations Framework Convention on Climate Change (UNFCCC)

Likelihood: The chance of a specific outcome occurring, where this might be estimated probabilistically.

Lock-in: Lock-in occurs when a market is stuck with a standard even though participants would be better off with an alternative.

Marginal abatement cost (MAC): The cost of one unit of additional mitigation.

Market barriers: In the context of climate change mitigation, market barriers are conditions that prevent or impede the diffusion of cost-effective technologies or practices that would mitigate greenhouse gas (GHG) emissions.

Market-based mechanisms, GHG emissions: Regulatory approaches using price mechanisms (e. g., taxes and auctioned emission permits), among other instruments, to reduce the sources or enhance the sinks of greenhouse gases (GHGs).

Market exchange rate (MER): The rate at which foreign currencies are exchanged. Most economies post such rates daily and they vary little across all the exchanges. For some developing economies, official rates and black-market rates may differ significantly and the MER is difficult to pin down.

Market failure: When private decisions are based on market prices that do not reflect the real scarcity of goods and services but rather reflect market distortions, they do not generate an efficient allocation of resources but cause welfare losses.

A market distortion is any event in which a market reaches a market clearing price that is substantially different from the price that a market would achieve while operating under conditions of perfect competition and state enforcement of legal contracts and the ownership of private property. Examples of factors causing market prices to deviate from real economic scarcity are environmental externalities, public goods, monopoly power, information asymmetry, transaction costs, and non-rational behavior.

Measures: In climate policy, measures are technologies, processes or practices that contribute to mitigation, for example renewable energy (RE) technologies, waste minimization processes, public transport commuting practices.

Meeting of the Parties (CMP): The Conference of the Parties (COP) to the United Nations Framework Convention on Climate Change (UNFCCC) serves as the CMP, the supreme body of the Kyoto Protocol, since the latter entered into force on 16 February 2005. Only Parties to the Kyoto Protocol may participate in deliberations and make decisions.

Methane (CH_4): One of the six greenhouse gases (GHGs) to be mitigated under the Kyoto Protocol and is the major component of natural gas and associated with all hydrocarbon fuels. Significant emissions occur as a result of animal husbandry and agriculture and their managements represents a major mitigation option.

Methane recovery: Any process by which methane (CH_4) emissions (e.g., from oil or gas wells, coal beds, peat bogs, gas transmission pipelines, landfills, or anaerobic digesters) are captured and used as a fuel or for some other economic purpose (e. g., chemical feedstock).

Millennium Development Goals (MDGs): A set of eight time-bound and measurable goals for combating poverty, hunger, disease, illiteracy, discrimination against women and environmental degradation. These goals were agreed to at the UN Millennium Summit in 2000 together with an action plan to reach the goals.

Mitigation (of climate change): A human intervention to reduce the sources or enhance the sinks of greenhouse gases (GHGs).

Mitigation capacity: A country's ability to reduce anthropogenic greenhouse gas (GHG) emissions or to enhance natural sinks, where ability refers to skills, competencies, fitness, and proficiencies that a country has attained and depends on technology, institutions, wealth, equity, infrastructure, and information. Mitigative capacity is rooted in a country's sustainable development (SD) path.

Mitigation scenario: A plausible description of the future that describes how the (studied) system responds to the implementation of mitigation policies and measures.

Models: Structured imitations of a system's attributes and mechanisms to mimic appearance or functioning of systems, for example, the climate, the economy of a country, or a crop.

Mathematical models assemble (many) variables and relations (often in a computer code) to simulate system functioning and performance for variations in parameters and inputs.

Montreal Protocol: The Montreal Protocol on Substances that Deplete the Ozone Layer was adopted in Montreal in 1987, and subsequently adjusted and amended in London (1990), Copenhagen (1992), Vienna (1995), Montreal (1997) and Beijing (1999). It controls the consumption and production of chlorine- and bromine- containing chemicals that destroy stratospheric ozone (O_3), such as chlorofluorocarbons (CFCs), methyl chloroform, carbon tetrachloride and many others.

Multi-gas: Next to carbon dioxide (CO_2), there are other forcing components considered in, e. g., achieving reduction for a basket of greenhouse gas (GHG) emissions (CO_2, methane (CH_4), nitrous oxide (N_2O), and fluorinated gases) or stabilization of CO_2 equivalent concentrations (multi-gas stabilization, including GHGs and aerosols).

Nationally Appropriate Mitigation Action (NAMA): Nationally Appropriate Mitigation Actions are a concept for recognizing and financing emission reductions by developing countries in a post-2012 climate regime achieved through action considered appropriate in each national context. The concept was first introduced in the Bali Action Plan in 2007 and is contained in the Cancún Agreements.

Nitrogen oxides (NOX): Any of several oxides of nitrogen. Nitrous oxide (N2 O): One of the six greenhouse gases (GHGs) to be mitigated under the Kyoto Protocol. The main anthropogenic source of N2O is agriculture (soil and animal manure management), but important contributions also come from sewage treatment, fossil fuel combustion, and chemical industrial processes. N2O is also produced naturally from a wide variety of biological sources in soil and water, particularly microbial action in wet tropical forests.

Non-Annex I Parties / countries: Non-Annex I Parties are mostly developing countries. Certain groups of developing countries are recognized by the Convention as being especially vulnerable to the adverse impacts of climate change, including countries with low-lying coastal areas and those prone to desertification and drought. Others, such as countries that rely heavily on income from fossil fuel production and commerce, feel more vulnerable to the potential economic impacts of climate change response measures. The Convention emphasizes activities that promise to answer the special needs and concerns of these vulnerable countries, such as investment, insurance, and technology transfer.

Ocean energy: Energy obtained from the ocean via waves, tidal ranges, tidal and ocean currents, and thermal and saline gradients.

Offset (in climate policy): A unit of CO2 -equivalent emissions that is reduced, avoided, or sequestered to compensate for emissions occurring elsewhere.

Oil sands and oil shale: Unconsolidated porous sands, sandstone rock, and shales containing bituminous material that can be mined and converted to a liquid fuel.

Overshoot pathways: Emissions, concentration, or temperature pathways in which the metric of interest temporarily exceeds, or 'over- shoots', the long-term goal.

Ozone (O_3): Ozone, the triatomic form of oxygen (O3), is a gaseous atmospheric constituent. In the troposphere, it is created both naturally and by photochemical reactions involving gases resulting from human activities (smog). Tropospheric O3 acts as a greenhouse gas (GHG). In the stratosphere, it is created by the interaction between solar ultraviolet radiation and molecular oxygen (O2). Stratospheric O3 plays a dominant role in the stratospheric radiative balance. Its concentration is highest in the O3 layer.

Pareto optimum: A state in which no one's welfare can be increased without reducing someone else's welfare.

Particulate matter (PM): Very small solid particles emitted during the combustion of biomass and fossil fuels. PM may consist of a wide variety of substances. Of greatest concern for health are particulates of diameter less than or equal to 10 nanometers, usually designated as PM10.

Passive design: The word 'passive' in this context implies the ideal target that the only energy required to use the designed product or service comes from renewable sources.

Path dependence: The generic situation where decisions, events, or outcomes at one point in time constrain adaptation, mitigation, or other actions or options at a later point in time.

Payback period: Mostly used in investment appraisal as financial payback, which is the time needed to repay the initial investment by the returns of a project. A payback gap exists when, for example, private investors and micro-financing schemes require higher profitability rates from renewable energy (RE) projects than from fossil-fired projects.

Energy payback is the time an energy project needs to deliver as much energy as had been used for setting the project online.

Carbon payback is the time a renewable energy (RE) project needs to deliver as much net greenhouse gas (GHG) savings (with respect to the fossil reference energy system) as its realization has caused GHG emissions from a perspective of life cycle assessment (LCA) (including land use changes (LUC) and loss of terrestrial carbon stocks).

Perfluorocarbons (PFCs): One of the six types of greenhouse gases (GHGs) or groups of GHGs to be mitigated under the Kyoto Protocol. PFCs are by-products of aluminum smelting and uranium enrichment. They also replace chlorofluorocarbons (CFCs) in manufacturing semi- conductors.

Photovoltaic cells (PV): Electronic devices that generate electricity from light energy. See also Solar energy.
Policies (for mitigation of or adaptation to climate change): Policies are a course of action taken and / or mandated by a government, e. g., to enhance mitigation and adaptation. Examples of policies aimed at mitigation are support mechanisms for renewable energy (RE) supplies, carbon or energy taxes, fuel efficiency standards for automobiles.

Polluter pays principle (PPP): The party causing the pollution is responsible for paying for remediation or for compensating the damage.

Potential: The possibility of something happening, or of someone doing something in the future.

Technical potential: Technical potential is the amount by which it is possible to pursue a specific objective through an increase in deployment of technologies or implementation of processes and practices that were not previously used or implemented.

Precautionary principle: A provision under Article 3 of the United Nations Framework Convention on Climate Change (UNFCCC), stipulating that the Parties should take precautionary measures to anticipate, prevent, or minimize the causes of climate change and mitigate its adverse effects. Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason to postpone such measures, considering that policies and measures to deal with climate change should be cost-effective in order to ensure global benefits at the lowest possible cost.

Precursors: Atmospheric compounds that are not greenhouse gases (GHGs) or aerosols, but that influence GHG or aerosol concentrations by taking part in physical or chemical processes regulating their production or destruction rates.

Present value: Amounts of money available at different dates in the future are discounted back to a present value and summed to get the present value of a series of future cash flows.

Primary production: All forms of production accomplished by plants, also called primary producers

Private costs: Private costs are carried by individuals, companies or other private entities that undertake an action, whereas social costs include additionally the external costs on the environment and on society. Quantitative estimates of both private and social costs may be incomplete, because of difficulties in measuring all relevant effects.

Production-based accounting: Production-based accounting provides a measure of emissions released to the atmosphere for the production of goods and services by a certain entity (e. g., person, firm, country, or region).

Public good: Public goods are non-rivalrous (goods whose consumption by one consumer does not prevent simultaneous consumption by other consumers) and non-excludable (goods for which it is not possible to prevent people who have not paid for it from having access to it).

Purchasing power parity (PPP): The purchasing power of a currency is expressed using a basket of goods and services that can be bought with a given amount in the home country. International comparison of, for example, gross domestic products (GDP) of countries can be based on the purchasing power of currencies rather than on current exchange rates. PPP

estimates tend to lower per capita GDP in industrialized countries and raise per capita GDP in developing countries. (PPP is also an acronym for polluter pays principle).

Reducing Emissions from Deforestation and Forest Degradation (REDD): An effort to create financial value for the carbon stored in forests, offering incentives for developing countries to reduce emissions from forested lands and invest in low-carbon paths to sustainable development (SD). It is therefore a mechanism for mitigation that results from avoiding deforestation. REDD+ goes beyond reforestation and forest degradation, and includes the role of conservation, sustainable management of forests and enhancement of forest carbon stocks. The concept was first introduced in 2005 in the 11th Session of the Conference of the Parties (COP) in Montreal and later given greater recognition in the 13th Session of the COP in 2007 at Bali and inclusion in the Bali Action Plan which called for "policy approaches and positive incentives on issues relating to reducing emissions to deforestation and forest degradation in developing countries (REDD) and the role of conservation, sustainable management of forests and enhancement of forest carbon stock in developing countries". Since then, support for REDD has increased and has slowly become a framework for action supported by several countries.

Reforestation: Planting of forests on lands that have previously sustained forests but that have been converted to some other use. Under the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol, reforestation is the direct human- induced conversion of non-forested land to forested land through planting, seeding, and / or human-induced promotion of natural seed sources, on land that was previously forested but converted to non- forested land. For the first commitment period of the Kyoto Protocol, reforestation activities will be limited to reforestation occurring on those lands that did not contain forest on 31 December 1989.

Reservoir: A component of the climate system, other than the atmosphere, which has the capacity to store, accumulate or release a substance of concern, for example, carbon, a greenhouse gas (GHG) or a precursor. Oceans, soils and forests are examples of reservoirs of carbon. Pool is an equivalent term (note that the definition of pool often includes the atmosphere). The absolute quantity of the substance of concern held within a reservoir at a specified time is called the stock. In the context of Carbon Dioxide Capture and Storage (CCS), this term is sometimes used to refer to a geological carbon dioxide (CO) storage location.

Resilience: The capacity of social, economic, and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and transformation (Arctic Council, 2013).

Revegetation: A direct human-induced activity to increase carbon stocks on sites through the establishment of vegetation that covers a minimum area of 0.05 hectares and does not meet the definitions of afforestation and reforestation.

Risk: The term risk is often used to refer to the potential, when the outcome is uncertain, for adverse consequences on lives, livelihoods, health, ecosystems and species, economic, social and cultural assets, services (including environmental services), and infrastructure.

Risk assessment: The qualitative and / or quantitative scientific estimation of risks.

Risk management: The plans, actions, or policies to reduce the likelihood and / or consequences of a given risk.

Risk perception: The subjective judgment that people make about the characteristics and severity of a risk.
Risk tradeoff: The change in the portfolio of risks that occurs when a countervailing risk is generated (knowingly or inadvertently) by an intervention to reduce the target risk (Wiener and Graham, 2009).

Risk transfer: The practice of formally or informally shifting the risk of financial consequences for negative events from one party to another.

Scenario: A plausible description of how the future may develop based on a coherent and internally consistent set of assumptions about key driving forces (e. g., rate of technological change (TC), prices) and relationships. Note that scenarios are neither predictions nor forecasts, but are useful to provide a view of the implications of developments and actions.

Sequestration: The uptake (i. e., the addition of a substance of concern to a reservoir) of carbon containing substances, in particular carbon dioxide (CO2), in terrestrial or marine reservoirs. Biological sequestration includes direct removal of CO2 from the atmosphere through land-use change (LUC), afforestation, reforestation, revegetation, carbon storage in landfills, and practices that enhance soil carbon in agriculture (cropland management, grazing land management).

Shadow pricing: Setting prices of goods and services that are not, or are incompletely, priced by market forces or by administrative regulation, at the height of their social marginal value. This technique is used in cost-benefit analysis (CBA).

Shared socio-economic pathways (SSPs): Currently, the idea of SSPs is developed as a basis for new emissions and socio-economic scenarios. An SSP is one of a collection of pathways that describe alternative futures of socio-economic development in the absence of climate policy intervention. The combination of SSP-based socio-economic scenarios and Representative Concentration Pathway (RCP) based climate projections should provide a useful integrative frame for climate impact and policy analysis.

Short-lived climate pollutant (SLCP): Pollutant emissions that have a warming influence on climate and have a relatively short lifetime in the atmosphere (a few days to a few decades). The main SLCPs are black carbon (BC) ('soot'), methane (CH4) and some hydrofluorocarbons (HFCs) some of which are regulated under the Kyoto Protocol. Some pollutants of this type, including CH4, are also precursors to the formation of tropospheric ozone (O3), a strong warming agent. These pollutants are of interest for at least two reasons. First, because they are short-lived, efforts to control them will have prompt effects on global warming — unlike long-lived pollutants that build up in the atmosphere and respond to changes in emissions at a more sluggish pace. Second, many of these pollutants also have adverse local impacts such as on human health.

Sink: Any process, activity or mechanism that removes a greenhouse gas (GHG), an aerosol, or a precursor of a GHG or aerosol from the atmosphere.

Smart grids: A smart grid uses information and communications technology to gather data on the behaviors of suppliers and consumers in the production, distribution, and use of electricity. Through automated responses or the provision of price signals, this information can then be used to improve the efficiency, reliability, economics, and sustainability of the electricity network.

Smart meter: A meter that communicates consumption of electricity or gas back to the utility provider.

Social cost of carbon (SCC): The net present value of climate damages (with harmful damages expressed as a positive number) from one more ton of carbon in the form of carbon dioxide (CO2), conditional on a global emissions trajectory over time.

Socio-economic scenario: A scenario that describes a possible future in terms of population, gross domestic product (GDP), and other socio-economic factors relevant to understanding the implications of climate change.

Solar energy: Energy from the sun. Often the phrase is used to mean energy that is captured from solar radiation either as heat, as light that is converted into chemical energy by natural or artificial photosynthesis, or by photovoltaic panels and converted directly into electricity.

Solar Radiation Management (SRM): Solar Radiation Management refers to the intentional modification of the earth's shortwave radiative budget with the aim to reduce climate change according to a given metric (e. g., surface temperature, precipitation, regional impacts.). Artificial injection of stratospheric aerosols and cloud brightening are two examples of SRM techniques. Methods to modify some fast-responding elements of the longwave radiative budget (such as cirrus clouds), although not strictly speaking SRM, can be related to SRM.

Source: Any process, activity or mechanism that releases a green-house gas (GHG), an aerosol or a precursor of a GHG or aerosol into the atmosphere. Source can also refer to, e. g., an energy source.

Spill-over effect: The effects of domestic or sector mitigation measures on other countries or sectors. Spill-over effects can be positive or negative and include effects on trade, (carbon) leakage, transfer of innovations, and diffusion of environmentally sound technology and other issues.

Stabilization (of GHG or CO2-equivalent concentration): A state in which the atmospheric concentrations of one greenhouse gas (GHG) (e. g., carbon dioxide) or of a CO2-equivalent basket of GHGs (or a combination of GHGs and aerosols) remains constant over time.

Standards: Set of rules or codes mandating or defining product performance (e. g., grades, dimensions, characteristics, test methods, and rules for use). Product, technology or performance standards establish minimum requirements for affected products or technologies. Standards impose reductions in greenhouse gas (GHG) emissions associated with the manufacture or use of the products and / or application of the technology.

Stratosphere: The highly stratified region of the atmosphere above the troposphere extending from about 10 km (ranging from 9 km at high latitudes to 16 km in the tropics on average) to about 50 km altitude.

Structural change: Changes, for example, in the relative share of gross domestic product (GDP) produced by the industrial, agricultural, or services sectors of an economy, or more generally, systems transformations whereby some components are either replaced or potentially substituted by other components.

Subsidiarity: The principle that decisions of government (other things being equal) are best made and implemented, if possible, at the lowest most decentralized level, that is, closest to the citizen. Subsidiarity is designed to strengthen accountability and reduce the dangers of making decisions in places remote from their point of application. The principle does not necessarily limit or constrain the action of higher orders of government, but merely counsels against the unnecessary assumption of responsibilities at a higher level.

Sulphur hexafluoride (SF6): One of the six types of greenhouse gases (GHGs) to be mitigated under the Kyoto Protocol. SF6 is largely used in heavy industry to insulate high-voltage equipment and to assist in the manufacturing of cable-cooling systems and semi-conductors.

Sustainability: A dynamic process that guarantees the persistence of natural and human systems in an equitable manner.

Sustainable development (SD): Development that meets the needs of the present without compromising the ability of future generations to meet their own needs (WCED, 1987).

Trace gas: A minor constituent of the atmosphere, next to nitrogen and oxygen that together make up 99 % of all volume. The most important trace gases contributing to the greenhouse effect are carbon dioxide (CO2), ozone (O 3), methane (CH4), nitrous oxide (N2O), perfluorocarbons (PFCs), chlorofluorocarbons (CFCs), hydrofluorocarbons (HFCs), Sulphur hexafluoride (SF 6) and water vapor (H2O).

Tradable (green) certificates scheme: A market-based mechanism to achieve an environmentally desirable outcome (renewable energy (RE) generation, energy efficiency (EE) requirements) in a cost-effective way by allowing purchase and sale of certificates representing under and over-compliance respectively with a quota.

Transaction costs: The costs that arise from initiating and completing transactions, such as finding partners, negotiating, consulting with lawyers or other experts, monitoring agreements, or opportunity costs, such as lost time or resources.

Transformation pathway: The trajectory taken over time to meet different goals for greenhouse gas (GHG) emissions, atmospheric concentrations, or global mean surface temperature change that implies a set of economic, technological, and behavioral changes. This can encompass changes in the way energy and infrastructure is used and produced, natural resources are managed, institutions are set up, and in the pace and direction of technological change (TC).

Transit oriented development (TOD): Urban development within walking distance of a transit station, usually dense and mixed with the character of a walkable environment.

Troposphere: The lowest part of the atmosphere, from the surface to about 10 km in altitude at mid-latitudes (ranging from 9 km at high latitudes to 16 km in the tropics on average), where clouds and weather phenomena occur. In the troposphere, temperatures generally decrease with height. See also Stratosphere

Uncertainty: A cognitive state of incomplete knowledge that can result from a lack of information or from disagreement about what is known or even knowable. It may have many types of sources, from imprecision in the data to ambiguously defined concepts or terminology, or uncertain projections of human behavior. Uncertainty can therefore, be represented by quantitative measures (e. g., a probability density function) or by qualitative statements.

Unconventional resources: A loose term to describe fossil fuel reserves that cannot be extracted by the well-established drilling and mining processes that dominated extraction of coal, gas, and oil throughout the 20th century. The boundary between conventional and unconventional resources is not clearly defined. Unconventional oils include oil shales, tar sands / bitumen, heavy and extra heavy crude oils, and deep-sea oil occurrences. Unconventional natural gas includes gas in Devonian shales, tight sandstone formations, geopressured aquifers, coal-bed gas, and methane (CH 4) in clathrate structures (gas hydrates) (Rogner, 1997).

United Nations Framework Convention on Climate Change (UNFCCC): The Convention was adopted on 9 May 1992 in New York and signed at the 1992 Earth Summit in Rio de Janeiro by more than 150 countries and the European Community. Its ultimate objective is the ‘stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system’. It contains commitments for all Parties under the principle of ‘common but differentiated responsibilities. Under the Convention, Parties included in Annex I aimed to return greenhouse gas (GHG) emissions not controlled by the Montreal Protocol to 1990 levels by the year 2000. The convention entered in force in March 1994. In 1997, the UNFCCC adopted the Kyoto Protocol.

Verified Emissions Reductions: Emission reductions that are verified by an independent third party outside the framework of the United Nations Framework Convention on Climate Change (UNFCCC) and its Kyoto Protocol. Also called ‘Voluntary Emission Reductions’.

Volatile Organic Compounds (VOCs): Important class of organic chemical air pollutants that are volatile at ambient air conditions. Other terms used to represent VOCs are hydrocarbons (HCs), reactive organic gases (ROGs) and non-methane volatile organic compounds (NMVOCs). NMVOCs are major contributors — together with nitrogen oxides (NOX), and carbon monoxide (CO) — to the formation of photo- chemical oxidants such as ozone (O3).

Voluntary action: Informal programs, self-commitments, and declarations, where the parties (individual companies or groups of companies) entering into the action set their own targets and often do their own monitoring and reporting.

Voluntary agreement (VA): An agreement between a government authority and one or more private parties to achieve environmental objectives or to improve environmental performance beyond compliance with regulated obligations. Not all voluntary agreements are truly voluntary; some include rewards and / or penalties associated with joining or achieving commitments.

Wind energy: Kinetic energy from air currents arising from uneven heating of the earth's surface. A wind turbine is a rotating machine for converting the kinetic energy of the wind to mechanical shaft energy to generate electricity. A windmill has oblique vanes or sails and the mechanical power obtained is mostly used directly, for example, for water pumping. A wind farm, wind project, or wind power plant is a group of wind turbines interconnected to a common utility system through a system of transformers, distribution lines, and (usually) one substation.

Weather vs climate: It's all about timing when it comes to differentiating weather and climate. Weather refers to atmospheric conditions in the short term, including changes in temperature, humidity, precipitation, cloudiness, brightness, wind, and visibility. While the weather is always changing, especially over the short term, climate is the average of weather patterns over a longer period of time (usually 30 or more years).

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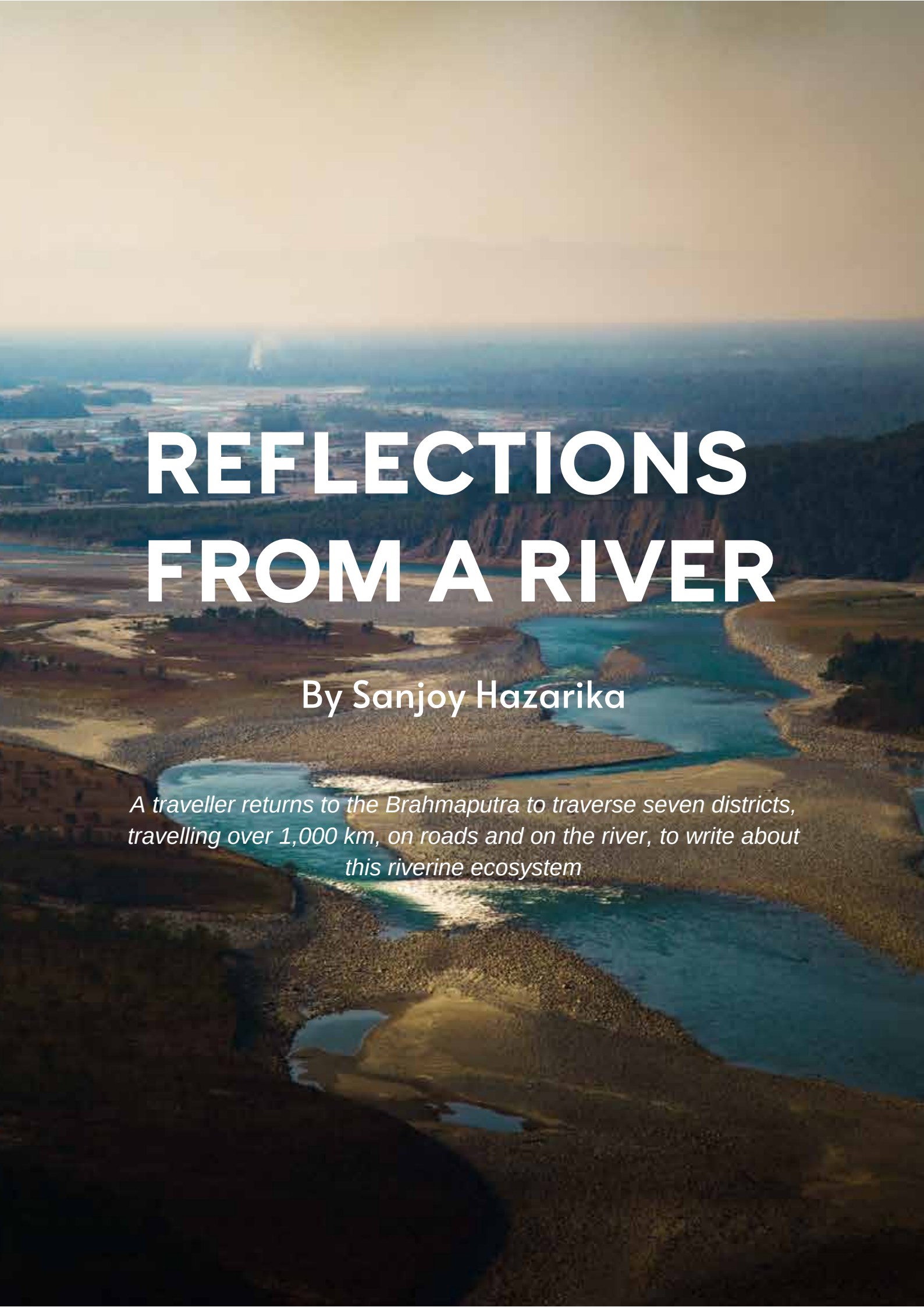


REFLECTIONS FROM A RIVER

By Sanjoy Hazarika

A traveller returns to the Brahmaputra to traverse seven districts, travelling over 1,000 km, on roads and on the river, to write about this riverine ecosystem

Chapter 1 : Returning To The Brahmaputra

It was broad, the water level was high, and it flowed perilously close to the road leading to Dibrugarh, the tea capital of Assam and India's tea city.

It was the last week of April. From decades of travel in the region, I knew that the Brahmaputra would attain such heights and width--but only in the May-June period. It was unusual, even portentous, that it had already reached those levels a month earlier.

As is its nature, the river had divided itself into multiple channels, with the main stem a little further away. And in the distance the blue hills of Arunachal Pradesh towered over this landscape, silently watching.

Parliamentarian and writer Hem Barua had titled his classic 1954 book on his home state "The Red River and the Blue Hill", but I think "The Muddy River", P.A. Krishnan's title for his novel about power, corruption, insurgency, kidnapping and extortion during the 1990s, is a more appropriate description, as it reflects the many issues on, in, and around the river and the valley through which it runs.

Hindu mythology enshrines the Brahmaputra as a male river-- the son of Brahma and Amogha, the beautiful wife of the sage Shantanu with whom Brahma fell in love, leading to the birth of a boy who flowed down as water. Shantanu placed the 'son of Brahma' in the middle of four great mountains, where he grew into a great lake--the Brahma Kund. Parasuram, so the myth runs, was advised to bathe there to absolve himself of the sin of killing his mother. So that all mankind could benefit, Parasuram took his axe and cleaved a channel on one side of the mountain to allow the river to flow to the plains below.

The Brahmaputra has a uniquely powerful pull on all who have seen it--and much of that fascination stems from its ever-changing, even contradictory, nature. It flows fast and turbulent in stretches; elsewhere, its surface is still, mirror-like; then again it gurgles in eddies and little whirlpools.

On the bank of this moody river, a group of fishermen cast small nets in the shade of an ancient, weather-beaten tree I had seen since I first came to Dibrugarh, in Upper Assam, decades earlier. Stacks of neatly chopped firewood were piled on the sand, just a few metres away from where the water lapped at the shores.

A trademark sight when the Brahmaputra swells and rises is of thousands of clumps of water hyacinths, torn from their shelters in ponds and beels (shallow lake-like wetland), bobbing along the surface, carried along by the restless tide.

That restlessness is emblematic of the river's nearly 2,900 km journey during which it traverses three countries and changes its name four times. It is the restlessness of a constant jajabor or traveller that reflects its nature--and mine. It's been many years since I undertook a series of river journeys. I'm older now; although I work long hours and keep reasonably fit, river journeys--particularly on this most turbulent of Indian rivers--are not to be taken lightly. The Brahmaputra is a different entity than its peers, and one has to recognise and respect that difference--a lesson ingrained in me since childhood.

zMy first sight of the river was when we travelled from Shillong, capital of the then undivided Assam, to Guwahati as a young child.

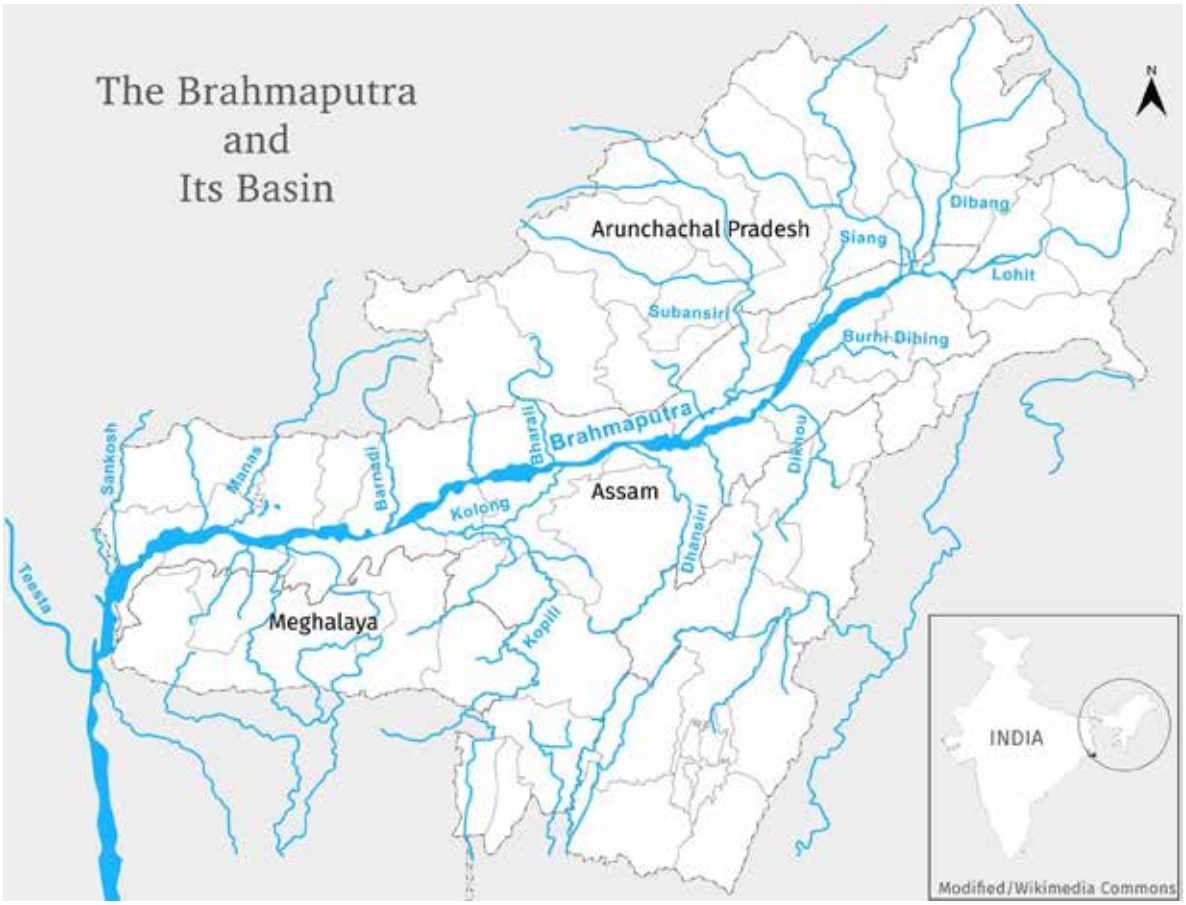
I remember being impressed by its girth, even though at that point it is probably at its narrowest, with a fetching waist. That is why the first-ever bridge on the river anywhere on its course from Tibet to the Bay of Bengal, built around 1962, came to be constructed right there--the width and flow were just right.

I recall the entrancing sight of dolphins frolicking in the middle of the river at Guwahati--today, you have to travel long distances to catch sight of even one, thanks to human interventions and the pollution near the city.

On occasion we would drive from Nogaon, then a sleepy provincial town in central Assam and home to my maternal grandparents, to Tezpur and watch the ferries and steamers carrying people and their bicycles. Today, there are fewer ferries thanks to the new bridges and fine roads that have sprung up to connect the growing populations on either side of the river. The ferries carry fewer cycles; instead there are gleaming motorbikes, small and large cars of various makes, and smartly attired men and women (and children) on these ferries.

These are the sights and sounds I am familiar with on a river that has captivated me since childhood, and they are comforting in a fast-changing and uncertain world, markers of an earlier, perhaps gentler time, but also of stability and recognition of the timeless nature of rivers and river journeys.

The Brahmaputra's main characteristic is its vastness, its immensity. People who see photographs and videos taken from small vessels plying on the river exclaim at its size: "That's not a river, that is a sea."



It starts as a glacial flow in Tibet, picks up size and heft and speeds nearly 2,000 km across the sprawling Tibetan Plateau. Until a few years ago, this flow was unimpeded; these days the Chinese have built, and are building, dams for power generation, and these dams at critical points are changing the nature of the river and its free flow.

The impacts of these interventions are being felt downstream, but the most critical challenge to the ecosystem of the river is in the Great Bend, the horseshoe-shaped turn that the Tsangpo takes after hitting an obstinate mountain and turning on itself to flow south towards Arunachal Pradesh.

This is where Kinthup, the Sikkimese tailor turned spy-explorer sent by the Survey of India in the late 19th century, locatezd the great falls later named after him, which plunge 200 feet down, giving greater impetus to the Tsangpo as it thunders down the narrow gorge in its journey to Arunachal Pradesh, Assam and eventually Bangladesh before debouching in the Bay of Bengal.

It is here, in the heart of Pemako, the hidden land of heavenly spirits and eternal peace, sacred to Tibetan Buddhists, that energy-hungry China is preparing to build the mother of all dams--one which, when it materialises, threatens to destroy the magnificent tropical and temperate landscapes, a priceless treasure of rich wildlife and extraordinarily rugged beauty that has existed since time immemorial. And what this will do downstream on the Brahmaputra and its companion rivers, already impacted by dams on the Subansiri, Ranganadi and Kopili, is difficult to imagine.

Gelling, on the India-China Line of Actual Control (LOAC: an euphemism for border) is the first village to welcome the Tsangpo, which at this point becomes the Siang. It will change its name three more times--to the Brahmaputra, then to Jamuna before uniting with the Ganga in Bangladesh, where the combined flow takes the name Padma, beloved to Bengalis--not least for being home to that sovereign of fish, the silver eelish or hilsa.

Over decades of wandering through these regions, I've come to learn how the river is changing along its course, for better or for worse. On these new journeys, planned for different times this year, I want to explore how it continues to impact the lives of people and communities, ecosystems and livelihoods, incomes and settlement, as well as displacement and migration.

I'm no climatologist, but reading and talking to specialists and learning about the science of climate change has made me wonder how ordinary people--particularly those who have lived along the river's banks for generations--experience these changes. How do they understand it, and how do they plan to cope with the changes that are inevitable?
I know I can't see it all on this one trip, so I came up with a limited travel plan on this leg that was intended to take me to about 10 districts of Assam. I ultimately manage to cover seven districts, travelling over 1,000 km, on roads and on the river. Later, when I am done with this series of stories, I plan to go to the Siang and its fellow rivers in Arunachal Pradesh.

On this journey I sip delicious smoky apong (rice beer) and eat pork curried in pumpkin and garlic in a chang ghar, a home on stilts. These homes are made of bamboo and hay, and accessed via a single, slim log into which small steps, more like notches, are cut to create a 'staircase'.

These homes, typical habitat of the Mishing tribe, are cooled by the breeze from the river which flows through the latticed bamboo doors that are almost always open. The floors are a springy, spongy bamboo weave that further aids air circulation. The homes are usually set some two-and-a-half metres above the land, to protect the family from floods. The bamboo-and-wood huts are built such that they can be easily dismantled and shifted to new settlements when needed, in a way that is impossible for brick and cement homes. This is traditional wisdom at work; over decades and across generations, the Mishing have learned how to co-exist with a turbulent river that can flow placid one day, and swell and flood everything in its path the next.

Beneath the house where I am sipping apong, is a handloom unit used by the women of the house to make the traditional woven cloth of white and bright yellow--a common sight in Mishing homes, and one that contributes to self-sufficiency and also as a source of extra income.

I'll get stuck on river shoals, be caught in a menacing thunderstorm, meet villagers of all ages and conditions of life, use a school toilet and see the working of the Swachh Bharat mission, travel on some of the best highways in the country, and to Bihu songs at public grounds at midnight.

I'll talk with school teachers, farmers, environmentalists, officials, businessmen, contractors, scientists, writers, to try and understand the changes taking place in this ecosystem, and its impact on the people. I visit the site of a major oil blowout, study the frequent weather changes and the uncertainty that it has created among people in the Brahmaputra valley, as well as the new economy and the framework of massive infrastructure, driven by urban growth and built on sand.

I start this journey with a sense of uncertainty, even inadequacy--the river is vast, it is moody, it is constantly changing in character, and no one human, on any one trip, can hope to understand and capture it all.
My journey begins in a slim channel. Our boat catches the fast downstream flow and races headlong into the main stem--and suddenly we are in the midst of a vast expanse of water; there is no sign of the banks on either side, and we are the only vessel in sight.

It is daunting, but there is also a feeling of excitement and freedom as the boat takes me away from the toxicity of cities, from the pollution and the politics, and I feel the crackling energy of the river and the wind on my face, and look out at the far horizon where water and sky merge.

It is good to be with an old friend again.

NOTES :

Chapter 2 : Impermanence, Erosion, Migration On The Brahmaputra

The Brahmaputra, one of the most sediment-laden rivers in the world, is home to a geographical phenomenon--a unique network of an estimated 2,300-plus islands that result from the vast quantities of sand, silt and rock that the river carries along its course, down from the mountains and onto the plain.

The silt and sand accumulate along its flow to form temporary islands. The rocks that tumble along in its course, and the sediment the river carries, give these islands body. Most of these islands are impermanent--literally shifting sands, except for a few very large ones. The biggest of them, Majuli, is the world's largest river island. Even after it has shrunk to a third of its original size, thanks to erosion, it is still vast, spreading over 400 sq km--nearly as large as the capital of Rajasthan, Jaipur. Once you are there, you do not realise that you are on an island in the midst of a mighty river. These temporary islands, locally known as chars or saporis, are in a constant state of flux. The river builds them, and then washes parts of them away--sometimes even an entire small island or shoal disappears--during the periodic floods. The floodwaters carry the silt away only to recreate the islands elsewhere, in an ongoing cycle of land building and destruction.

Since most of these islands are impermanent, their ownership is unclear. They are also extremely fertile--thus, for generations, local communities have settled on these islands as they take shape, living in homes of bamboo and mud, establishing homesteads, raising families and eking out a living through farming and fishing.

When the floods come, people fend for themselves in relief camps, or in temporary shelters along the embankments criss-crossing the flood plains, and even on boats. Once the floods recede, they return to find, at times, that 'their' home island has shifted downstream, sometimes as much as a few kilometres, and that they have to start all over again. This process is cyclical; sometimes they have to go through this process a few times every year, depending on the number of floods and their ferocity. Stress is a constant companion.

These islands are home to nearly a tenth of Assam's population of 35 million, and to a diverse range of communities, including some who live in a national park. Also resident on these chars are many species of wildlife including elephant herds, wild buffalo and feral horses as well as migratory and local birds, while the endangered river dolphins are occasionally sighted in the river and its tributaries.

This space is a universe apart. Buffaloes wallow or swim in the shallows; a fisherman steers his dugout towards our boat and offers us a glowing golden carp--his catch of the day, a whopping one-and-a-half kilos, for Rs 800; an unfinished wooden bridge, with pillars but no top, stands stark against the skyline, silent and accusing. A country boat sputters a careful course through the spaces between the large pillars.

On Kobu sapori in Dhemaji district--one of the better known and older islands on the river--a small group of men from different communities gathers in the local primary school to speak with their visitors.

It has taken us over an hour and a half to get here from the nearest ferry point--which is really nothing more than the bank where boats anchor to take on passengers and goods. The one we hire is a noisy country boat about 20 metres long, with an engine that splutters indignantly when it is turned on, sinks into an occasional coma, and as suddenly comes to life--not the most reassuring form of transport to traverse even a small tributary of the mighty, moody Brahmaputra. But there is very limited choice of transport, and this is what we get.

Eknath Sharma, who says he is 40, was born on Kobu sapori. "Earlier, this island was home to some 10,000 people," says Sharma. "Now barely 1,000 persons live here, although those who have their vote registered here come back to cast their ballot during elections."

I do a quick check later, and find that while his numbers are close to official figures (600), locals say based on a survey by the Accredited Social Health Activist (ASHA) of Kobu Sapori, they are not precise. And that is understandable in a space where time moves at a different pace, and local societies are defined by the seasons and by the river that surrounds them.

Sharma is an unofficial spokesperson for this disparate group of farmers and teachers, all of them with the weather-beaten faces and hardy constitutions of those who live along and on the river, with its myriad uncertainties. Precise or not, Sharma's numbers tell a story of Assam's saporis. It is not about the precarious existence of those who live on the shifting sands but of the many who, unable to cope with the stress of losing homes and land and livestock, are leaving in search of jobs elsewhere.

This jells with our observations. Earlier, as we prepared to board the wooden, rough-hewn country boat that brought us to Kobu, we noticed that an entire family has travelled over on the incoming trip. They're moving, with the tin sheets of their dismantled roofs, the wooden beams, their cooking utensils, gas cylinder, and a trunk-load of clothes. It is a visible sign of the exodus that is all too common along this stretch of the river.

"You see this young man?" Suresh Mukti, Kobu's primary school teacher, points to a youngster on the fringe of the crowd surrounding us. "He has just come from Gujarat; he'll be going back in a month or two." The youngster is part of the incessant flow of unskilled seasonal workers making their way to other parts of the country in search of temporary employment. The villagers say that these migrants send money home, which helps to supplement family incomes.

The last census was carried out in 2011. The latest, which was due in 2021, has been postponed indefinitely with Covid-19 as the cited reason. While there are therefore no verifiable data for the number of migrant workers, professionals and students who move out from the North East and spread out across the rest of the country, the most conservative estimates put the annual outflow in the tens of thousands. Large numbers settle, even temporarily, in large and mid-sized metros across the country, and smaller groups gravitate to small towns in, for example, Maharashtra, Rajasthan and Goa. One recent study placed the number of those who have moved out of the region at about one million in 2001-2011 (the decade of the last census), and said that not less than half of them came back from vulnerable, unskilled jobs in the unorganised sector during the pandemic.

"With active participation from respective state governments, there has been mass return of migrants to their native places," wrote R. Lusome and R. B. Bhagat in 'Migration in Northeast India: Inflows, Outflows and Reverse Flows during Pandemic'. "Migrants from the Northeast are not an exception. More than 138 Shramik Special trains transported nearly 188,000 stranded people to various states of the northeast."

This is not counting those who arranged their own transportation. In all, the study estimates based on newspaper reports, "the number of migrants returning to the northeast during the period of the lockdown is estimated at 512,000. This constitutes about half of the out-migration from the northeast in 2011. This mass return migration to the northeast was unprecedented. About 390,000 migrants returned to Assam alone--a state beleaguered due to immigration politics."

The reasons for out-migration are many: the uncertainty of life along the saporis, the diminishing returns from farms and from fishing, the constant stresses attendant on recurring floods that wipe out the fruits of their labour, the uncertain safety and security situation, the lack of adequate educational facilities, marriage, etc., Lusome and Bhagat say in their study.

What we know is that this out-migration is ongoing; and that those who leave rarely return, except for short visits to the families they have left behind, or during seasonal holidays such as Dussehra, Puja, Bihu, Christmas and New Year, when in any case employment opportunities are limited.

It is all about erosion," says Eknath Sharma. "We can live with floods, but not this kind of deep, constant erosion. Our island is now a fraction of its former size--the river keeps eating away the edges, it takes away our fields and with it, our livelihoods, because fields and fishing are our main sources of income."

A group of us walk in the direction of the local dispensary, which was built a few years earlier--and find that we cannot reach it because a stream has flooded and blocked access. We look around for a dugout to help us cross--but the only one available has been taken away by someone else for other work. The river, we are told, has made a sudden incision into the land on the other side, and the waters are now lapping at the doorstep of the clinic. Caught between the flooded stream and the land-grabbing river, the clinic, which still looks spanking new, stands forlorn, unusable, inaccessible not merely by us, but by the patients who need it.

The story of Kobu is repeated elsewhere. In Lakhimpur, Dhemaji, Tinsukia and Dibrugarh, people are leaving their homes of decades, driven away by the eroding power of the rivers. Some move to government-allotted lands, but this is not always a satisfactory solution--one group, for instance, was given land in a hilly area far from the river, where they could neither farm nor fish and thus found themselves without the means to earn a living. Others sell their land for whatever price they can get, and move to the mainland.

We have reached out to officials for comment on the land allotted for those whose homes are destroyed by the river, and will update the story when we receive a response.

On our way back from Kobu, we get stuck in the shallows. Twice. Each time, the burly boatman--who nurses the engine along and navigates with his rudder--jumps out to push the boat out of the shallows and back into navigable waters. Helping him is a pilot, who is supposed to know the river, its depths and its current surges, like we know the roads of our native city. He uses a long bamboo pole with a dual purpose: it helps to steer the boat, and is also a tool to plumb the depths and detect the silent shallows lying below the surface. This particular pilot isn't very savvy with the river, and repeatedly gets yelled at by the 'captain' of the little boat.

We get free of the shallows only for the engine to promptly fail. We find ourselves drifting, silent and steady, downstream. We have drifted way past the landing point, but there is no help for it--the current takes us for a ride. We all take turns at firing up the engine. Eventually it catches, spluttering into sudden life.

The boatman uses the window of opportunity to quickly steer us to shore--and, as it turns out, lands us next to a bush alive with large red ants. We manage to escape, and walk a couple of kilometres through the bush to reach the designated landing spot. It is not without attendant risk--leeches proliferate, and large piles of dung mark the path taken by elephants. We hurry to reach our destination before sundown.

One of my companions regales us with the story of how, on an earlier trip, he and his team had got delayed getting to a landing point. It was dark, he said, before their vehicle finally headed out of the forest--and then they saw their path blocked by a herd of elephants which started moving towards them. He reversed the vehicle slowly, he told us, for about 500 metres with the elephants still ambling forward; finally, he found another motorable path, and dashed away.
Now there are fewer sightings of elephants, he says--and while I am a little relieved at the lessened risk, I'm also concerned about what the thinning of elephant herds portends.

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Chapter 3: Brahmaputra's Scowling Sky And Economy Of Sand

The scowling sky glowered at us over the sparkling green of the fields and the shining tin roofs of a village hamlet, which reflected a few beams of the sun. We were chugging our way along a stream of the Pagladiya river in Central Assam's Nalbari district, about two hours out of Guwahati, the bustling, overpowering, incredibly fast growing commercial and political capital of Assam--and to a large extent that of the entire northeast.

A storm is coming, I thought to myself, even as the sun came under shadow, the blistering heat under the tarpaulin eased and we breathed in relief.

We had just made it off the boat when the wind hit, squalling and bursting over the island, bending trees and making us scurry, faces covered for protection from the swirling dust, our pace slowed by the sandy track to our destination for the day--a primary school where a health camp was scheduled. A tractor with a trailer of sand driven by a young man in shorts rumbled by us.

We had barely got into the small building at Tilardia, its roof and walls made of tin sheets, when the storm slammed into the island. The children rushed under the desks, a fine exhibition of disaster preparedness, the sheets shuddered in the fierce gale, and water dripped from the roof on new books, the sole teacher at Tilardia L.P. School covered with a plastic sheet; the courtyard, dry a few moments back, turned into puddles of water.

But once the lashing of the rain eased, school resumed with children chanting their lessons. The health camp in a nearby building began smoothly with nurses and community workers as well as the ASHAs (Accredited Social Health Activists) mobilising the community and bringing order to the rush. Most of the attendees were women and children; infants got their first immunisation shots to the accompaniment of surprised painful squalls from the child and the mother's shushing to calm the irked creature. There were pregnancy check-ups and every single person who needed treatment for anaemia (a major problem in rural areas, especially the islands) and other ailments received medication. With quiet efficiency, the nurses checked those who came, entered their names on large registers, before sending them to the single doctor who treated 92 patients in barely two hours. The lab assistant checked blood and urine samples while the pharmacist doled out medicines, yelling out the name of the medication and the patient.

What impressed me hugely here, as in every sapori I had visited, was that the schools had filtration units for drinking water and functioning, clean toilets. I had to use the toilet here at the Tilardia school and did so with a mixture of foreboding and anticipation. I was again pleasantly surprised and much impressed with the high quality of cleanliness. Swachh Bharat in Assam truly has reached this remotest of hamlets, cut off from the mainland by the river, lack of communications and distance.

"I come here every day on my motorbike--the rural roads are very good--and have to take a ferry at one point," said Abdul Rahim, the solitary school teacher. There are 250 students in different classes and sections in Tilardia. "I like my work, it's challenging, I only wish we had more teachers."

As we stepped onto the wet soil track to return to the boat, carefully avoiding puddles, freshly washed paddy fields and vegetable patches on either side greet us. It's then that I see the tractor and its trolley again with its young driver, trundling along. I also see a JCB [backhoe excavator, not necessarily of the eponymous company], its ubiquitous yellow, standing out in bright contrast against the glowing green.

What are these doing here, I wonder, to the village community worker standing nearby. They're building a road in the village. A road? Yes, an earth road for the village so that people can travel more easily. There are just two tractors, I'm told, and this JCB.

The bright yellow is visible long after we have left the island.

In Dibrugarh and Dhemaji, Tinsukia and Lakhimpur as well as Nalbari, at Kukurmara, some 35 km from Guwahati, the wealth, extent, job generation and power of the sand-driven economy is visible. If not JCBs, tractor trolleys, dumpers and small trucks rattle and rumble along small roads and highways in these and, I am sure, in the districts I have not visited, carrying sand and silt drawn from the banks of the river, from designated spots approved by the forest department under whose purview such works lie. But there is also illegal extraction of soil, pebbles and rocks especially from river and stream beds. This in turn endangers people working in these spaces, as they get trapped or dragged into the pits in the river beds.

The soil is taken elsewhere. As sand is the most widely extracted material on earth, after water, it is critical in the construction of almost everything: houses to high rise office buildings, laying of railroads, setting up factories and roads, bridges and airports, markets and even beauty treatment. It is used for construction, for earth works, it's mixed with cement to fuel a new economy, bursting with energy and testosterone.

The silt is good for the home-grown, organic vegetables that are hawked on village roadside and city markets by local farmers and producers. Some of it can be used as a base for roads, as can sand. But some varieties of sand and silt aren't good for construction, don't mix well with concrete and lead to cracked walls and unsafe houses.

Young men are among the owners, drivers and workers here in these smaller townships and villages; the major projects are handled by larger, wealthier players whose connections are vast. The economy of sand is a worldwide phenomenon. In India it plays out in confrontations between those pressing for a green economy based on social capital and others determined to exploit resources. There are casualties too, in several states, with activists, journalists and others caught in the face-offs with accusations often tossed at political leaders, faceless officials from the bureaucracy, forest departments and local contractors.

I'm told that a single truckload can fetch the owner Rs 3,000. "Three truckloads and he's making more money than he would in a formal job," said one informant. That's good going for mid-sized towns where the markets are open and busy, there is a buzz about the harvest festival Bihu in the air and young men call out to each other cheerfully about grabbing a caseload of beer and meeting up at home late. It sounds like any other part of the country--or the world.

But soil excavated wrongly can damage both natural systems, harming the recharge capacity of aquifers, as well as human-designed interventions such as embankments. In Dibrugarh, water engineers are worried about the way private miners have been cutting away at sand stretches along the major embankment that protect part of the city near Maijan Ghat. This could weaken the base of the structure and enable water ingress when floods come.

"They're going about it completely the wrong way," said Kamal Gurung, a local businessman, as he watched trucks growl their way up the Maijan ghat bank to the road with their loads.

Some in Dibrugarh may recall the catastrophic incident of August 1950, when a massive earthquake measuring 8.6 on the Richter scale, flattened the city, ripped valleys apart, demolished hills and sent a high wave of deadly water hurtling through the valley. Parts of Dibrugarh were swallowed by the river, as was Sadiya and other towns and villages upstream. That was why the embankment was built as a fortification against the river to protect Dibrugarh. It is also too often taken for granted that the river at times, especially in high floods, may be flowing above the level of the city--kept at bay by the fortification of the 1950s.

It is that cataclysmic quake that changed the flow and shape of the Brahmaputra, as the seismic event pushed its bed upward, making it shallower. It is a challenge that continues to impact the river, even as sedimentation grows and the water levels get lower.

My friend, the economist and columnist Swaminathan A Aiyar, wrote in the Economic Times in 2013 "... an acute sand shortage has been created by licensing and environmental bottlenecks. So, mafia groups are mining river beds illegally across India. It's easy: one mechanical excavator can extract several truckloads of sand every night."

He added, "Sand helps retain monsoon water in river beds, releasing the water gradually in the dry season. Excessive mining endangers this.
"Central and state governments have detailed environmental rules for extraction, made even tougher by court interventions. Ideally, we should have environmentally safe mining that meets rising construction demand. Instead we have grossly insufficient legal mining, huge illegal mining, sand scarcity for construction, and big illegal profits split between the mafia and politicians."
Swami and I don't agree on some things but he does have a point--the lack of better mining laws that meet rising needs and aspirations. As recently as 2019, not less than 60 million tons of sand were used for urban purposes. As much as 515 million tonnes of sand (15 million in Assam) was consumed across the country in 2017. These figures would only have increased.

The Centre has tried to take steps to tackle the issue. Thus, in 2016, the Union Environment Ministry released the Sustainable Sand Mining Management Guidelines, which aim to "promote scientific mining of sand and encourage environmental friendly management practices". It recommends actions to be taken for sustainable sand extraction, emphasises monitoring and suggests that governments map the district-wise availability of sand.
In 2018, the Ministry of Mines released a 'Sand Mining Framework' to help states frame their sand policies.
According to one account, India is extracting sand faster than it can be replenished naturally. A 2019 UNEP report said that India and China had the most "critical hotspots" where sand extraction was affecting rivers, lakes and coastlines. This is most likely because of the construction boom in both countries, the report said.

Uncontrolled extraction also adversely affects oxygen content in the water, threatening the existence of fish and other species, especially the Gangetic dolphin which is the prime creature of the river and is India's national aquatic animal. Swaminathan Aiyar's thoughts are relevant here: "One alternative is to crush boulders into gravel and sand, but the same environmental problems have hit stone quarrying. This sector is equally characterised by detailed rules and court curbs, a scarcity of gravel and sand, huge illegal mining, and a mafia-politician nexus."

Then come his punch lines: "We have enough outrage at illegal activity. We need more outrage about limitations on legal activity. It sounds progressive to demand environmental impact assessments for sand and rock mining in every deposit, regardless of size. But state governments have neither the money nor expertise. They sorely lack the staff and capacity to implement even existing rules and laws, let alone new ones. Heaping ever more responsibilities on them simply generates cynicism and corruption."
I would say that though this view is important, the state would also need to build capacity on all these fronts, rather than merely being a spectator. In January 2020, the Ministry of Environment, Forest and Climate Change published 'Enforcement and Monitoring Guidelines for Sand Mining', to monitor sand right from the 'identification of sand mineral sources to its dispatch and end-use by consumers and the general public'. But the implementation of these leaves much to be desired, as seen in Assam and other parts of the country.

Meanwhile, trolleys, trucks, dumpers and earth movers trundle across the spanking new, fine slip roads, highways and rural lanes of Assam--and probably other states as well because the northeast is in a frenzy of construction and infrastructure making. A vibrant example is the stunning growth of Guwahati, commercial capital of Assam and the region. The burgeoning city, once a sleepy town, is expanding in every direction, including up. It appears as if every few days, a designer store, spanking new high-end restaurant, apparel store and even mall comes up. There are customers from the city, the state and across the region. People have money and are spending.
Guwahati (it's actually made up of two words--guwa, meaning areca nut, which Assamese and communities across the northeast relish chewing; and haat or market) faces the troubles as do all mid-sized urban bodies which are transitioning into the future--it suffers the aches and aims of a growing city, with unanticipated pressures caused by a surging population. Mumbai, Delhi, Chennai, Bengaluru, Kolkata--all large metros have issues of flooding. But Guwahati faces an additional challenge. When the Brahmaputra is in spate, the water from the channels and drains of this historic city (it was first settled over 1,000 years old) pushes back, instead of heading out into the river, causing more water logging and citizenry woes.
Recent heavy showers threw the bustling city out of gear for hours as commuters struggled with waist-high muddy and discoloured water in some neighbourhoods as drains and roads overflowed. One of the problems is the beels and water bodies of Guwahati, which have acted as storm water reservoirs, have been extensively built up on, despite objections from environmentalists and media. These natural shelters for excess water can no longer play their protective roles. There is periodic desilting and clearing of drains and beels, yet the hills around the city are encroached upon and streams have become clogged with muck.

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Chapter 4: Shifting Sands And Stressed Lives

The Brahmaputra has always been a great sediment carrier--after the Yangtze Kiang in China, it carries more silt and sand than any other river on earth. Thus the alluvial fans of the Brahmaputra, visible through satellite imagery, reach into the Bay of Bengal and build the natural land area of Bangladesh.

But in the past years, the river has become broader and shallower, and its large companions (I don't like to call them tributaries) are also shrinking in depth, volume and width in the winters.

In 2021 the rains came late, and so did the high water. This year, the first wave of torrential rain hit much of Assam and other states as early as February, then again in April, and flooding began with the third spell of heavy rain in May. The unseasonal, untimely flooding forced farmers to rush to their fields, with labourers and members from their communities, to save their rice crops. They brought their harvest onto the roads--the only high land available to them; they dried it on blue tarpaulin sheets and stored it in sacks arrayed on the high ground.

Thousands were displaced; at least 18 persons died, including several in landslides. This drew some attention though public and media focus was riveted on the devastation in the Dima Hasao district, where a newly minted railway line and railway station were overwhelmed by landslides and floods that toppled trains, uprooted tracks, and severed connections with the rest of the country.

The Guwahati High Court reportedly asked the Northeast Frontier Railway, as part of a Public Interest Litigation hearing, why recommendations from a report of the Commissioner of Railway Safety in 2015 were not implemented while constructing the railway line. It is alleged that the new track was poorly designed and built in a hurry, with engineers and contractors not paying due attention to the local geological structure. This resulted in the felling of thousands of trees, whose roots are what bind the soil together, and the indiscriminate gouging of hills, which weakened the slopes and created the conditions for destructive landslides. A top state official says it will take at least six months to get the system in the district back to a semblance of normalcy.

Inter-connected issues resonate elsewhere. In Dibrugarh and Lakhimpur, senior officials blame increased sedimentation in the river on indiscriminate deforestation in the hills of Arunachal Pradesh directly above, which sends rocks and soil cascading down to the river.

This is the fourth and final part of our series, Reflections From A River. Here is the first part, the second part, and the third part of the journeys on the Brahmaputra.

In initial breathless reporting about floods and their aftermath, especially in 'mainland India' and the metro media, there seems to be an established pattern. A burst of stories hits headlines in print, television and social media about the 'unprecedented' downpour, the scale of flooding, the hundreds of thousands of displaced persons, devastation to livestock, property and government infrastructure as well as the notional loss to the economy. Leaders rush to observe the damage from the air (every prime minister has done this in the past 75 years). As the floods recede (there can be three waves of floods), these stories peter out and the media loses interest--until the next year, the next flood. But what happens to the sapori dwellers, to their lives and their livelihoods, once the floodwaters recede? How many think of that and write or broadcast about the painful return home? Many return to find that the land on which they had built their lives has been either obliterated or, in many instances, shifted downstream, or a new island has grown upstream. This often means the following: rebuilding homes, re-growing farms, re-fashioning livelihoods, not once in a lifetime but two and sometimes three times in a single year.

The challenge of flooding in the Brahmaputra valley is exacerbated by the fact that the great river and its companions have turned broader, but shallower. The question is how? And why?

Until recently, there was no trans-Arunachal highway connecting several large valleys in the sprawling state of Arunachal Pradesh, which borders Tibet. Commercial and passenger vehicles were forced to make long, expensive detours into Assam before moving back into Arunachal. Road building is thus regarded as essential for both economic and national security reasons. Yet, the cutting of hill slopes and deforestation that this necessitates means that much of the debris land in the valleys below. It is not clear how much of this is retrieved, or transported elsewhere for construction purposes.

As a result, the carrying capacity of the Brahmaputra and other rivers is diminished by the increasing load of mud and rock and debris, forcing the rivers to dump the silt as they travel onwards, reducing in depth while broadening in girth. Changing weather patterns are creating new challenges for farmers, businesses and administrators. At Guwalbari, a village of 900 members of the Mishing tribal community in Lakhimpur district, Pushpo Pegu gazed at a field of green paddy and rued the loss of last summer's crop. "The rains came too late last year," said Pegu, a health worker in the village, gesturing at his neighbour's shimmering green patch of paddy. "Things are so uncertain; we don't know when to plant and what to plant, because the weather could change anytime and bring rain."

At Guwalbari, which as its name suggests is a place for dairy farming, each home is a light structure of flexible but tough bamboo lattice topped with straw or tin roofs and standing on strong bamboo stilts. It's an indigenous design, perfected over the centuries by this community in Upper Assam to protect them from both floods and, in earlier times, from wild animals.

We climb to Pegu's chang ghar, as such homes are called, via a log with small steps notched into it. Inside, it is cool, dark and airy--a refreshing change to the long boat ride, a trek through fields and the village, and an animated discussion with a group of village women and elders.

We sit on little murhas made from plastic sacking stitched together and placed on the bamboo floor. The seats are comfortable, and the recycling is impressive. The womenfolk serve us the cooling sai apong, freshly brewed rice beer, in broad brass bowls. The apong is followed by bowls of pork in curried pumpkin, laced with garlic and black pepper, a unique and delicious combination.

These are pristine spaces of bewitching beauty, still largely untouched by the scarring power of unplanned development and infrastructure. There are opportunities here--such as for off-circuit tourism for backpackers, environmentalists and researchers--and in other spaces elsewhere, even as the changing weather patterns provoked by climate change create new vulnerabilities and challenges.

I travelled to the Dibru Saikhowa National Park, which sprawls across parts of Dibrugarh and Tinsukia districts and is bordered by the Brahmaputra and Lohit Rivers to the north and the Dibru to the south. We didn't spot any wildlife, as we were travelling during daylight hours. The days, barring dawn and dusk, are too bright and hot for most species--but we did visit a village and forest camp located in the park.

The issues here were the same as in other districts: erosion is eating away at the land, livelihoods and incomes. "We are getting 5 kg of free rice regularly, that's a big help," said Nandanath Regon, a wizened, bare-chested Mishing who lives in the forest village of Laika Pomua.

The 60-year-old is among the Mishing community who had moved here some years back during a large flood, and from the high ground he can see neighbouring houses in retreat from the eroding river, barely a kilometre away. "We will all have to go at some point even if we don't want to," said Regon as he surveyed his banana grove, and the little huts where pigs with their brood were snoring. Chicks scurried about, hustled by a mother hen. The family brought out two beautifully crafted chairs of cane kept for visitors, and served red tea in paper cups. It could have been idyllic, but for the looming menace of the river eating away at the land and creeping ever closer.

Free rice is important, said Lakhinath Ngatey, as he stood by Regon, but "more important now is land where we can settle. The young people are moving out as there is no work here for them." The elders here say that the youth of the village are heading out to Guwahati and beyond.

In Tinsukia, I visited the site of a spectacular blowout of an oil well at Baghjan, near Natun Rongagor village, close to an ecologically sensitive area that includes Maguri Motapung Beel, an internationally renowned bird habitat. The blowout, which took 110 days to cap, was one of India's worst oil disasters and, besides the pollution it spewed into the air, it killed three and displaced nearly 9,000 persons, many of whom stayed in relief camps during the period.

An inquiry report by Assam's Forest Department initially estimated the economic loss at Rs 25,000 crore and a biodiversity loss of 55%, reported East Mojo. Oil India Limited (OIL), a unit of the Indian Oil Corporation, paid Rs 147.92 crore in compensation and relief to over 600 families who were directly impacted.

Anupam Chakravartty, a reporter with the online news site East Mojo, quoted a Supreme Court-mandated inquiry to report that nearly 4 sq km of land impacted by the upsurge was damaged beyond redemption. The report said that the concentration of highly carcinogenic Poly-Aromatic Hydrocarbons (PAHs) in water, soil and sediments of Lohit, Dibru and Maguri-Motapung were significantly higher than those reported in other Indian and global studies on similar accidents. PAHs are highly carcinogenic chemical compounds produced during the incomplete combustion while burning coal, crude oil and gasoline. These compounds can easily bind with organic material leading to large-scale biological degradation of ecosystems impacted by oil spills.

More than 75 hectares had been scorched. Large swathes of rich paddy fields were covered with oil, muck and residue; trees and vegetation for kilometres around were burned and blackened; countless birds, both migratory and local, were roasted alive while a dead river dolphin was washed up.

Migratory birds are returning but in fewer numbers, says Joynal Abedin, a local environmentalist, wildlife specialist and the owner of an eco-resort by the Dangori river. "The local birds seem to be ok, but the problem is there has been no scientific survey," says Abedin, a resident of Guijan town with a deep love for the outdoors and a vast knowledge of the ecosystems of the region, which he willingly shares with anyone who wants to understand.

When I visited the region in May this year, the green sheen was back on the leaves of trees, fields and bushes. The streams appeared clear and clean. I was told, though, that residues from the blowout were affecting replanting efforts, despite the clean-up. Abedin, a large, intense man, says there are still major problems caused by the ecological disaster. Some fish species have disappeared, and silting is also a problem here. Excess silt and sand are harming Maguri beel, the wetland. He rattles off the figures of creatures at risk: "Ninety-eight species of birds, 120 species of fish and 100 species of butterflies."

Chakravarty, the reporter for East Mojo, wrote about failed efforts by farmers to grow crops. The vegetables would turn yellow, wither and die. In one striking case, he cited the experience of Ritu Chandra Moran who was planting tubers. He had dug barely "a few inches" when an "oil slick oozed out of the hole meant for the stout Kosu (taro)".

A major challenge before the many rivers and their dependent communities lies in the downstream impact of upstream interventions such as dams. The giant Subansiri project in Arunachal Pradesh, billed as the largest hydroelectric project in India, is finally approaching completion and is supposed to go on stream in 2023. It was initially scheduled to be finished in 2018, but landslides and other problems required extensive redesign. Local opposition and protests also slowed the process of building.

The Ranganadi dam, on the river of that name in Arunachal, has been functioning since 2001. I travelled to the river from Guijan, in Tinsukia district, and found that it had shrunk to a trickle. As I watched from the bank, a woman walked across much of the empty riverbed with ease while, in the distance, the ubiquitous excavators tossed mud and sand onto a truck waiting on the river bed. Mining is to be done only based on the guidelines put out by the government, with no-mining zones to protect the river. Indiscriminate mining damages the river system, accelerates erosion, causes local habitat disruptions including harming endemic fish and other river-dependent species, harming fishing livelihoods, and adversely impacts access to ground water for neighbouring communities.

I'm not getting into the big dams versus environment debate here--that is complex, and nuanced, and cannot be contained in any single article. But I will, for now, say that all eyes are on the mega dam on the Subansiri. Engineers and officials say that a lot of protective work has been done along the river banks. What we know is how the dam, and therefore the changed flow of the river, will impact downstream communities.

We know this because we have the example of the smaller Ranganadi dam--villages downstream of it are struggling with endemic erosion, damaged fields, falling crop yields, dropping fish catch, and displacement. Keep in mind that the Subansiri is much larger--and therefore the downstream consequences could be much more substantial. But bearing witness will have to wait for a year.

Sumit Sattawan, the young Deputy Commissioner of Lakhimpur, spoke wisely of an issue I had not considered earlier, but which is deeply connected to the larger concerns of changing weather patterns and climate change. He pointed out that communities like the Mishing are accustomed to, and welcome, an abundance of water.

"What populations may have to get cope with is a scarcity of water, they are completely unused to this," said Sattawan, as we sat in the Lakhimpur Circuit House. He saw this as a key challenge "for all of us", to help train people and equip them to manage the transition.

The spells of wet weather and storms underline the relentless challenges rural and urban communities in the region face. Near the town of Jagiroad in Morigaon district, I see villagers on the highway, where they've spread out the grain they've rescued from their fields during the sudden flood. They stir the paddy with their feet, hoping it will dry as the sun beats down. No government official has visited the area to assess damage, one farmer tells me.

Over 150 km away, a boat builder speaks of the changes to the river: "One thing I can tell you," says Ismail Sheik, in the small town of Nagarbera. "In the past five to 10 years, the river has become shallower; navigation is difficult and we don't know why that is--they say there are dams being built in China which are making this happen." The roads and lanes here are messy after days of incessant rain. But the river here, flowing through the sprawling district of Kamrup, is strikingly handsome, as is the countryside.

Beauty is balanced by tragedy. The paddy fields on either side of a superb rural road are deep under water. A group of water buffaloes, their heads sticking out, wallow in the silty water. They seem to be the only ones enjoying themselves. It needs to be emphasised that it is not just one river, or even a network of rivers, that is at stake--it is the entire river basin, which carries the waters of no less than 50 rivers and which, in the heavy rains, swell to what the river scientist Jayanta Bandyopadhyay called 5,000 rivers, as seasonal streams and small rivulets burst into life, in a talk he gave some years back.

These many valleys and the basin embrace, without regard for political boundaries, the entire Ganga-Brahmaputra-Meghna basin which includes the sprawling Tibetan Plateau, Assam and other North Eastern states, Bihar, Uttar Pradesh, West Bengal, and Bangladesh.

More than half a billion people call this region home. While this series highlights the unique problems of the Brahmaputra valley, the issues facing the other parts of these gigantic river systems are equally complex.

As we head to Nagarbera, a rare sight unfolds in the distance: A group of six endangered Greater Adjutant Storks, the great bird that is native to Assam and Myanmar, ponderously walk across the landscape, pausing to plunge their long yellow beaks into the water to grab a bite.

This is a far cry from the garbage dumps near Guwahati, where many of this species cluster, risking pollution and death from toxic waste. One documentary speaks of "the grotesque elegance" of the species, which has two-thirds of its worldwide population located in Assam. Locally known as hargila or bone swallower, the stork has a wing span of two and a half metres, and thin long yellow legs. Purnima Devi Barman, a biologist, has mobilised groups of women in rural communities, known as the Hargila Army, to protect and enable the stork to win the battle for survival, to fight superstition and ignorance.

Such struggles and stories of conservation and protection in the face of aggressive growth mark the canvas of the region. Some, like Debojit Chowdhury at Kukurmara, who has spent many years working to protect the highly endangered Gangetic dolphin, feel that the odds are stacked against them. Chowdhury and the members of local communities here are demanding dolphin protection areas on the Kulsi, a tributary of the Brahmaputra, which flows through the town. Sightings of the shy, beloved national--and state--aquatic animal are frequent here. It frolics despite huge pressures from developers, from factories which have sprung up in the neighbourhood, as well as sand extractors, raising questions in my mind, every day: "How much is too much? What is the balance we need to seek? Can the dolphins and the storks survive this onslaught?"

I don’t know the answers.

Yet, the challenges before the dolphins or xibu and the Bor Tukola, as the stork is affectionately called in Assam, are just a part of the many struggles facing the Brahmaputra, its valley, its ecosystems and the sentient beings that inhabit both river and land.

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To cite this article: Seema Mundoli *et al* 2022 *Environ. Res.: Climate* **1** 015006

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ENVIRONMENTAL RESEARCH
CLIMATE

OPEN ACCESS

RECEIVED
28 February 2022

REVISED
30 May 2022

ACCEPTED FOR PUBLICATION
30 June 2022

PUBLISHED
18 July 2022

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PAPER

Climate change: the missing discourse in the Indian Parliament

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Keywords: democracy, oversight tool, parliamentary questions, climate vulnerability, climate impact, climate mitigation, climate adaptation

Abstract

Parliamentary questions (PQs) are a crucial oversight tool available to parliamentarians in all democracies. In a well-functioning democracy, parliamentary oversight can play an important role in climate change policy, ensuring that climate concerns are represented in national agendas. India is the largest democracy in the world and one of the countries most vulnerable to climate change. Over a 20 year period, from 1999 to 2019, we examine whether parliamentarians used PQs to address climate change issues in India. We asked four questions (a) How often are PQs raised about climate change? (b) Are vulnerable constituency interests being represented in the Parliament? (c) What kinds of questions do parliamentarians ask? and (d) Where do parliamentarians get their information on climate change from? 895 unique PQs related to climate change were raised by 1019 Ministers, forming only a fraction (∼0.3%) of the total PQs asked in parliament during this period, however the number of PQs related to climate change increased over time. PQs were not raised by the states most vulnerable to climate change, nor did they represent the concerns of socially vulnerable groups. The PQs were mostly concerned about the impacts (27.6%) and mitigation (23.4%) of climate change. Impacts on agriculture (38.3%), coastal changes (28.6%), and health (13.4%) were of main interest, along with mitigation issues related to energy (43.6%), agriculture (21.8%), and aviation (9.1%). Despite the significant and growing vulnerability of India to climate change, PQs related to climate change were largely missing. Although they have increased over time, we still find there is substantial room for growth, especially in critical areas of climate justice and adaptation relevant to the Indian context. Raising the level of parliamentary debate on climate change is critical and needs to be foregrounded.

1. Introduction

The climate crisis is one of the biggest challenges facing the earth today, with catastrophic potential impacts on human and natural systems (IPCC 2021). Addressing this challenge requires multi-level governance especially at global, national, sub-national and regional levels. At the global level, climate agreements and treaties negotiate terms for countries to curb emissions (for example, The United Nations Framework Convention on Climate Change 1992, Kyoto Protocol 1997, Paris Agreement 2015). While the efficacy of these treaties and agreements in reducing global emissions are contested, they have been important in keeping climate change issues on the global policy agenda (Kinley *et al* 2021). Equally important is the national level of governance, where the role of the government includes functions, such as creating national climate frameworks, national laws, policies, setting standards for key climate-related sectors, and providing regional funding and support (Eskander and Frankhauser 2020). While the nature of climate change mitigation is predominantly global, impacts are primarily felt at a local scale, and adaptation is often primarily local (di Gregorio *et al* 2019). This makes it imperative for regional and local representation to play a role in the making of climate policies.

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About 44.9% of the world's countries, comprising 49.4% of the world's population, live in democracies, whether full or flawed (Economist Intelligence Unit 2020). Understanding if local and regional nuances of climate change find voice in a parliamentary democracy is an especially important question for contemporary climate policy. The Parliament is considered the central institution of democracy and embodies the will of the people and carries out all their expectations (Holmberg *et al* 2017). It is a legislative organ whose job is to scrutinize the actions of the government (Leston-Bandiera and Thompson 2018). A functioning Parliament can ensure oversight of the representation of relevant climate issues in national government policy and agenda (Fitsilis and de Vrieze 2020). The job of the Parliament to hold the government accountable to its citizens is performed through oversight tools (Pelizzo and Stapenhurst 2013, Bundi 2017). A critical oversight tool is the use of parliamentary questions (PQs), which exists in all parliamentary democracies (Russo and Wiberg 2010). PQs are a crucial instrument for parliamentarians to voice their concerns and represent electoral interests, demand information from the government, and prepare legislative acts (Bailer 2011, Martin 2011). PQs can be used as a metric for the government to gauge public mood and adapt policies and actions accordingly (Sen *et al* 2019). As such, PQs have been used to explore the relationship between media coverage and the Parliament (Datta 2008, van Santen *et al* 2015), parliamentarian concerns related to gender (Bird 2005), tobacco (Varma *et al* 2021), crime and unemployment (Borghetto *et al* 2020), and issues related to science and technology (Haritash and Gupta 2002).

India is considered the world's largest democracy and faces some of the highest climate and disaster risk levels, ranked 29 out of 191 countries (Inform Report 2019). India is particularly vulnerable to climate change due to the geographic size of the country, its diverse climatic conditions, and its large population (Dubash 2012, Mehta *et al* 2019). Further, different sections of society are likely to be impacted differently based on factors such as economic status, social status, gender, and location (Islam and Winkel 2017).

1.1. India and climate change

India adopted the 'National Action Plan on Climate Change' in 2008. Considered the country's flagship climate change legislation, it outlines policies and initiatives directed at mitigation, adaptation, and energy efficiency (Chandel *et al* 2016). Specific missions have also been created to target sectors vulnerable to climate change. India has also established State Action Plans on Climate Change, where each state is expected to tailor an action plan based on its sense of vulnerabilities and opportunities (Jogesh and Paul 2020). Despite state-specific plans, action on climate change at the state level is guided by a strong top–down approach that takes its cues from the central government (Bhardwaj and Khosla 2020). Monitoring climate action in different states and union territories, each with their own unique vulnerabilities is difficult for the center and there may arise situations where pressing issues do not receive the attention they require (Jogesh and Dubash 2015).

1.2. Structure of the Indian Parliament

The Indian Parliament is bicameral in nature, with two houses of representatives—the Lok Sabha (House of the People), which consists of representatives elected directly by the people and the Rajya Sabha (House of the State), whose representatives are elected indirectly (Hewitt and Rai 2010). Though the word is not used explicitly in the Constitution, India has a federal structure of government in which the central government constitutes the highest authority in the country and state governments operate in the periphery, governing the states in the country (Jayal 2007). India consists of 28 states and eight union territories. State governments govern states, while the center directly governs union territories. The Constitution describes a clear division of powers between the center and state (dual polity), in terms of legislative, administrative and financial functions and both the center and state operate supreme, in their respective spheres of governance (Tillin 2019).

1.3. The PQs in India

PQs are asked every morning, during the first hour, when the parliament is in session (Datta 2008). During this period, members of parliament (MP) from different political parties raise questions on all matters relating to administration and government activity, which the government answers through its ministers. In addition to providing a satisfactory answer to questions posed, ministries are also compelled to take into consideration the inputs of MPs into the law-making process, failing which, they could potentially lose the confidence of the house (Datta 2008). In this manner, oversight guarantees that the government is held accountable.

1.4. Research questions

In this study we raised four questions about the role of PQs in India with regard to climate change:

(a) How often are PQs raised about climate change?
(b) Are vulnerable constituency interests being represented in the Parliament? For this question we specifically tested two hypotheses (1) MPs from vulnerable states ask more PQs and (2) women MPs ask more PQs as women constituents are more vulnerable to climate impacts.
(c) What kinds of questions do parliamentarians ask?
(d) And finally, a question of increasing policy relevance for academics—where do parliamentarians get their information on climate change from?

2. Methods

2.1. Data collation

We collated a comprehensive list of PQs related to climate change, asked in the Lok Sabha from 1999 to 2019, using the PQs Data Portal, a repository of PQs from the same period. The PQs Data Portal is a project of the Trivedi Centre for Political Data, led by faculty members from the Ashoka University (Trivedi Centre for Political Data 2021). The dataset which is completely open source is an extremely useful tool to access questions asked in the Lok Sabha, as the data has been cleaned and additional information on the Minister's asking the questions provided. The search tool makes it easy to filter questions based on the area of interest.

PQs were filtered from the database using specific keywords. A long list of 30 keywords related to climate change were initially tested (adaptation, carbon, climate, disaster, drought, extreme, extreme event, forest, fossil fuels, greenhouse, green power, heat, Kyoto, Kyoto Protocol, IPCC, REDD, renewables, sustainable, sustainable development, vulnerability, warm, weather, mitigation, environment, deforestation, biodiversity, pollution, epidemic, methane, and nitrous oxide). Each keyword was tested individually, and the PQs checked manually for relevant results, i.e. PQs that related to climate change such as impacts, mitigation, action, seeking more information, etc. The long-list of keywords was initially created based on what we thought we the most common terms associated with climate change. The long-list was further modified based on the common words that appeared in the PQs about climate change. Through this process, the final short list of keywords was created. Eight keywords were found to yield the most relevant search results—'climate', 'adapt', 'carbon', 'fossil fuel', 'green power', 'IPCC', 'Kyoto' and 'warm'. A total of 1421 PQs were initially obtained. The PQs were then manually checked for relevance, and those not related to climate change or duplicates were removed. The state 'Telangana' was excluded from the analysis as it is a newly created state, which was separated from the state Andhra Pradesh in 2014. There were only four PQs put forth by MPs from Telangana during the study period. The final dataset had 895 questions. The PQs were sorted chronologically (based on the date the PQ was asked). For each PQ, the following additional information was also collected: search term, date, PQ, answer to the PQ, ministry, name of MP, gender of MP, political party, state of MP and constituency of MP.

2.2. Data analysis

Mixed methods (qualitative and quantitative) were used for the analysis. We first describe the quantitative analysis used to answer research questions 1 and 2, and then describe the qualitative analysis for research questions 3 and 4.

2.2.1. Quantitative analysis

To analyze how frequently PQs were raised in parliament, the number of PQs were plotted against the year.

For the second research question, the two hypotheses were tested using generalized linear models (GLM): (a) MPs from vulnerable states ask more PQs and (b) women MPs ask more PQs as women constituents are more vulnerable to climate impacts. The response variable was the number of PQs asked by MPs in parliament, and the explanatory variables were the year the PQ was asked, gender of the MP, climate vulnerability of the state, and the number of sitting MPs from each state. The data were first sorted, cleaned, and then a candidate model set was prepared with 9 models to test the hypotheses.

For this analysis, each MP was treated as a single unit of analysis irrespective of the PQ asked. The number of questions asked by each MP in a year was aggregated. For example, if an MP asked five PQs in 2000, the number of PQs asked was five. The name of the MP, gender, state, and constituency was obtained from PQs Data Portal. In nine instances, either the state or the gender of the MP was not provided in the database. We removed these entries.

Table 1. Description of the variables used in the multiple linear regression models to test the influence of climate vulnerability of the MPs state and MPs gender on the number of questions asked in parliament. PQs = parliamentary questions. MP = Minister of Parliament.

Variable type	Variable name	Measurement	Mean ± SE	Median	Unit
Response variable	No. of PQs asked by MP	Count	1.3 ± 0.02	1	No. of PQs asked in one year
Explanatory variable	Climate vulnerability of state	Continuous	0.5 1 ± 0.002	0.51	Climate vulnerability index
Explanatory variable	Sitting MP's in Parliament	Continuous	35.9 ± 0.58	29	Ministers
Explanatory variable	Year MP asked PQ	Continuous	N/A	N/A	N/A
Explanatory variable	Gender	Categorical	N/A	N/A	N/A

To determine if climate vulnerable groups had representation in parliament, we explored how many PQs were asked based on the background of the MP. Class, caste, and indigenous status of the MP were difficult to obtain, so we restricted this to the gender of the MP.

The climate vulnerability for each state was obtained from Dasgupta *et al* (2020) where relative climate vulnerabilities of the states were assessed through an integrated vulnerability assessment (based on biophysical, socio-economic, and institution and infrastructure-related vulnerability indicators). Vulnerability was conceptualized based on the IPCC-AR5 framework. Climate vulnerability for the union territories was not available. We removed the MP's from union territories who asked questions (17 entries). The final database had 1019 entries after cleaning.

The explanatory variables (the year the PQ was asked, climate vulnerability of the state, and the number of sitting MPs from each state) were scaled before running the models. Table 1 provides details of the variables used in the model. We were unable to obtain information on the MPs who did not ask questions (that is 0 data) as the database did not include this information. Therefore, the models were only run on the MPs who asked questions.

We used GLMs with a negative binomial distribution due to overdispersion of data (Ver Hoef and Boveng 2007) to determine the influence of state climate vulnerability, gender of the MP, sitting MP in each state, and the year on the number of PQs asked by MPs in Parliament.

No interaction was envisioned between the terms. Model selection was undertaken by calculating the Akaike Information Criteria (AIC) (Crawley 2007). All data were analyzed in the statistical software R (R Development Core Team 2021).

2.2.2. Qualitative analysis

For research questions three and four, the analysis was conducted at the level of the PQs. There were a total of 895 PQs. The PQs were qualitatively analyzed using inductive content analysis. Each PQ was treated as a single unit of analysis and was manually coded as follows: 'sector', 'source', 'climate change aspect', 'location', and 'social vulnerability'. The definitions and categories of codes used specifically in this paper are provided in table 2. To check for inter-coder reliability, Kappa scores were calculated for each category. ZJ was the primary coder, and RM and SM were the secondary coders. The secondary coder coded for 50 questions. Kappa scores ranged from 0.80 to 0.95, with a mean of 0.89. These scores indicate there was 64%–84% agreement, which is considered strong (McHugh 2012).

3. Results

3.1. How often are PQs raised about climate change?

A total of 895 unique PQs related to climate change were asked between 1999 and 2020. This is only a very small percentage (∼0.3%) of the total number of PQs asked during the study period. Overall, we found a trend towards more questions on climate change over time, though with some variability. The highest number of questions (104 questions) were asked in 2015, whereas the largest spike in questions was in 2007, where the number of PQs jumped from 8 asked in 2006 to 53 asked in 2007 (figure 1).

3.2. Are vulnerable constituency interests being represented in the Parliament?

MPs from 26 states and five union territories raised PQs in the study period. In total, 1019 MPs asked PQs (in some cases multiple MPs raised the same PQs). MPs that asked the most PQs were from Maharashtra (181), Andhra Pradesh (105), Tamil Nadu (99), Uttar Pradesh (98), and Kerala (69), and the MPs from states

Table 2. The codes and code descriptions that were used to inductively analyze the PQs.

Sl. No.	Code category	Code category description	Code sub-category	Code sub-category description
1	Climate change aspect	The question refers to the impacts, adaptation, or mitigation related to climate change	Impact	Question refers to the impacts of climate change
			Mitigation	Question refers to mitigation efforts to curb climate change
			Adaptation	Question refers to adaptation in response to climate change
			Multiple	Question refers to more than one climate change aspect
			NA	Question does not refer to any of the above categories
2	Sector	The economic sector(s) responsible for/affected by climate change in a particular question	Agriculture	Questions related to the agriculture sector
			Coastal	Questions directed at coastal regions and dealing with sea level rise
			Energy	Questions related to the energy sector
			Health	Questions on the effect of climate change on human health
			Industry	Questions related to the industrial sector
			Water	Questions related to water resources and glaciers
			Aviation	Questions related to the aviation sector
			Livestock	Questions related to the livestock sector
			Multiple	Questions associated with more than one sector
3	Social vulnerability	The question refers to differential impacts of climate change on different sections of society	Gender	Questions relates to differential impacts of climate change based on gender
			Caste	Question refers to differential impacts of climate change based on caste
			Class	Question refers to differential impacts of climate change based on class
			Indigenous people	Question refers to differential impacts of climate change on indigenous people
4	Source	The information sources that the question is based on such as a study, report, or article.	Institute	Questions quotes information from a particular institute
			International agreement	Question quotes information based on an international agreement
			Newspaper article	Question quotes information from a newspaper
			Study	Question quotes information from a study
			Conference	Question quotes information based on the proceedings of a particular conference
			Multiple	Question quotes information from more than one source

that asked the least questions were Mizoram (0), Manipur, Meghalaya, and Punjab (2 each). A total of 92 women MPs asked 117 PQs and 927 men MPs asked 1245 PQs.

The null model (PQs $\sim$ 1), was the best model seperated from the second best model by Delta AIC of 308.9. The null model's outperformance as compared to others in the candidate model set (table 3), indicated there was no evidence for climate vulnerability or gender to have any relationship with the number of PQs asked.

3.3. What kinds of questions do parliamentarians ask?

A total of 635 or 71% of the PQs could be coded with a 'climate change aspect', i.e. they provided enough information for us to categorize them into groups, depending on whether the PQ focused on impacts, mitigation, or adaptation aspects of climate change. Impacts of climate change were mentioned the most (27.6%), followed by mitigation (23.5%). In contrast adaptation received very little attention, being mentioned in just 3.9% of the PQs (table 4).

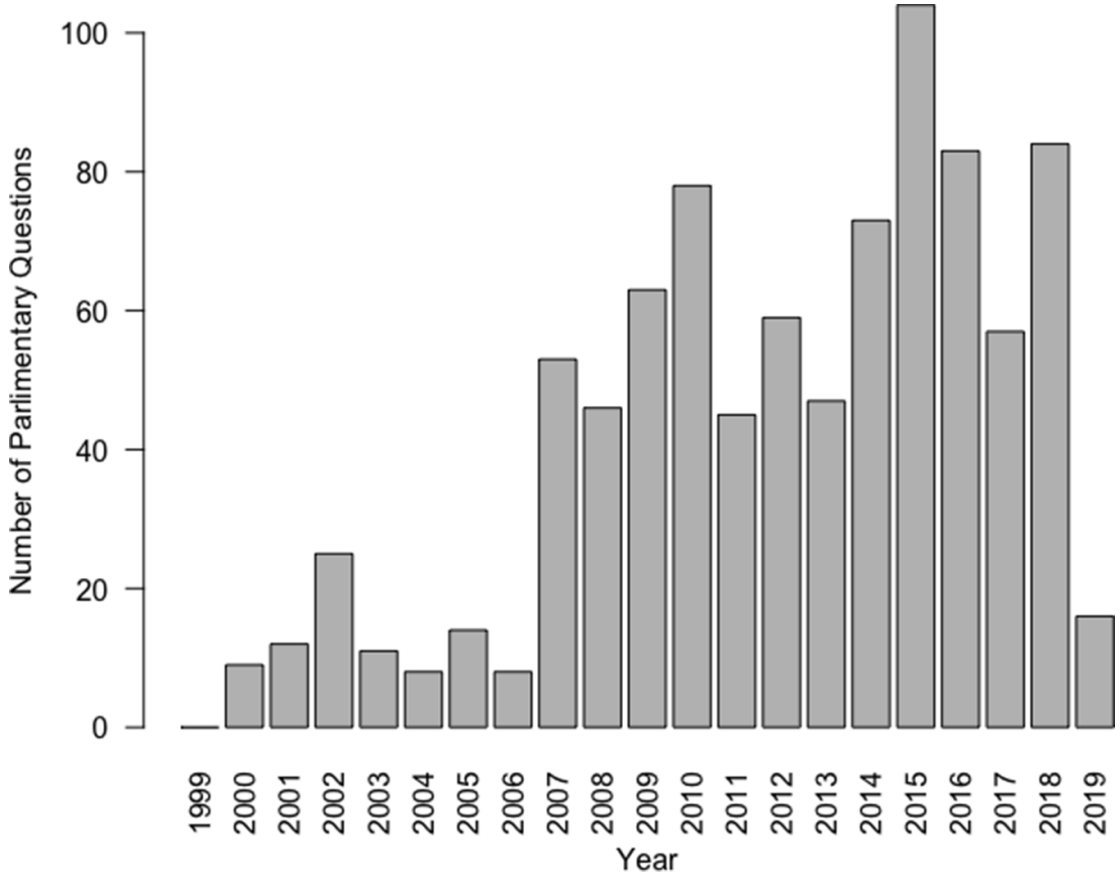

Figure 1. The number of PQs asked by Ministers of Parliament during the parliamentary hour grouped by year (1999–2019).

Table 3. AIC scores of the 9 models prepared to test the two hypotheses (a) MPs from vulnerable states ask more PQs and (b) women MPs ask more PQs as women constituents are more vulnerable to climate impacts.

Model no.	Models	AIC
1	PQ ~ 1	2185.5
2	PQ ~ Year + Vulnerability + MPs in Parliament + Gender	2498.1
3	PQ ~ Year + Gender + Vulnerability	2507.9
4	PQ ~ Year + Vulnerability + MPs in Parliament	2494. 4
5	PQ ~ Gender + Vulnerability + MPs in Parliament	2496.1
6	PQ ~ Year + Gender + MPs in Parliament	2500.5
7	PQ ~ Year + Vulnerability	2504.3
8	PQ ~ Vulnerability + Gender	2505.9
9	PQ ~ Year + Gender	2573.5

The PQs were most concerned about the impacts of climate change on agriculture (38.3%), coastal changes (28.6%), and health (13.4%) (table 5). Questions on agriculture were largely focused on specific crops. Coastal sector impacts were a concern as early as 2007 and persisted into 2018.

The impacts of climate change on the socially or economically vulnerable were represented in 0.007% of the PQs (six PQs). Of these, one PQ asked about the impact of climate change on women, one asked about the impact of climate change on indigenous communities, and four PQs on the economically disadvantaged in the country (two PQs of the impacts of climate change, one PQ on adaptation, and one PQ on the potential unequal distribution of adaptation measures). There were no questions related to differential impacts based on caste.

PQs related to mitigation focused most on energy (43.6%), followed by agriculture (21.8%), and aviation (9.1%), seeking to understand how carbon emissions could be reduced, and the use of new technologies to reduce emissions.

Adaptation, asked in only 21 PQs, focused primarily on agriculture (14 PQS), followed by energy, coastal areas, water, and industry (1 PQ each). Adaptation PQs on agriculture ranged from the use of climate resilient technologies to the need to create awareness among farmers, and specific funds set up for adaptation.

Table 4. Content analysis of the PQs. PQs were coded for sources of climate change information, the aspects of climate change discussed, and mentions of vulnerable communities.

Codes	Sub-categories	Parliamentary questions (%)
Information source	Total	10
	Study	58.9 (% of the total information source)
	Newspaper article	22%
	Conference	11%
	Institute	5.6%
	International agreement	1.1%
	Multiple	1.1%
Climate change aspect	Total	71
	Impact	27.6
	Mitigation	23.5
	Adaptation	3.9
	Multiple	16
Economic and social	Total	0.007
Vulnerability	Economically disadvantaged	4 PQs
	Women	1 PQ
	Indigenous peoples	1 PQ

Table 5. Nature of PQs asked under each economic sector in relation to climate change aspect (impact, mitigation, and adaptation).

	Climate change aspect (%)		
Economic sectors	Impact	Mitigation	Adaptation
Energy	0	43.6	4.8
Agriculture	38.3	21.8	66.7
Coastal	28.6	0	4.8
Health	13.4	1.8	0
Water	7.1	1.8	4.8
Aviation	0	9.1	0
Industry	0	7.3	4.8
Livestock	4.5	1.8	0
Multiple sectors	8	12.7	14.3

The questions also asked for details on measures taken by the government for adaptation in terms investment in green technology, or commitments to through different schemes and funds, sometimes focusing on certain geographically vulnerable areas such as the hilly North–East of India.

3.4. Where do parliamentarians get their information from?

Ministers referred to a source for their information on climate change in only 10%, i.e. 91 questions of the PQs asked (table 4). Studies (60%) were the most cited sources. The most mentioned reports were from IPCC ($n = 8$), the United Nations ($n = 5$) and the World Bank ($n = 4$). The reports referenced included those by academic institutions as well as by civil society organizations, and covered issues of global warming, greenhouse gas emissions and agriculture, as well as health and disease spread, dangers to glaciers, forest cover, and impact on heritage monuments.

Newspaper articles (22%) were the next most cited sources. The Times of India (eight PQs), The Hindustan Times (four PQs) and The Hindu (three PQs) were the newspapers that were quoted the most times in the PQs. The most cited articles were those that reported on an event like a seminar organized or a report release, or drew from a headline in the newspaper. Other quoted sources include specific institutes as sources (five PQs). One PQ drew on an international agreement. Institutions cited as sources included national institutions such as the National Agricultural Research Institute and global institutions such as the Global Forest Resource Association.

4. Discussion

This study largely highlights the missing discourse about climate change from the Indian PQ hour. India is one of the most vulnerable countries to climate change. According to the Global Climate Risk Index, in 2019, India was one of the ten most affected countries due to extreme weather events (Eckstein *et al* 2021). Yet, we found that PQs about climate change were rarely raised in parliament, indicating that this form of

parliamentary oversight is severely under-utilized. On the positive side, the number of PQs on climate change have increased over time, yet with a peak in 2015—after which there is no steady increase.

The number of PQs MP's raised in parliament were neither influenced by the climate vulnerability of their state nor their gender. Among the PQs asked in parliament, MPs were most concerned about the impacts of climate change on agriculture, the coast, and health. PQs on mitigation were focused on energy, agriculture, and aviation sectors. The impacts of climate change on the socially and economically disadvantaged groups of society were rarely mentioned, as were PQs related to adaptation to climate change. MPs received most of their information on climate change from studies and reports, and newspaper articles.

4.1. What influences PQs on climate change in the Indian Parliament?

PQs on climate change in the Indian Parliament seemed largely related to external political events, for example, 2007 saw the sharpest increase in PQs, which was the year that preceded the launch of the National Action Plan on Climate Change. Also, the highest number of questions (104 questions) were asked in 2015—the year that followed the renaming of the 'Ministry of Environment and Forests' to the 'Ministry of Environment Forests and Climate Change' with an accordingly expanded portfolio (Economic Times Bureau 2014).

While country vulnerability to climate change does not seem to have led to an increase in PQs on this topic, state vulnerability also does not seem to be an important driving factor that stimulates questions. Parliamentarians from states with higher climate vulnerability did not ask more PQs, as we might expect. Similarly, neither did gender influence the number of PQs asked. However, because the percentage of women in parliament ranged from only 3% to 11% (in the 2014 term, Ahmed 2018) most of the questions related to climate change were asked by men, probably also accounting for a lack of focus on impacts of climate change on women.

Over the last 20 years there has been a significant rise in extreme weather events (floods, cyclones, heat waves, cold waves) in India which has had severe impacts on human lives and livelihoods (Ray *et al* 2021). However, the spikes in the questions did not correspond to the years that especially severe weather-related disasters occurred. Similarly, the years that states recorded particularly devastating weather events, did not correspond to a rise in PQs on climate change. For example, from 2018, Kerala has been witnessing devastating floods every year, but this has not been captured in the PQs from MPs from Kerala.

The political party of the MP could be potentially influencing PQs. The states where the MPs were from the opposition party could have asked more PQs as seen from other studies on PQs in India (Ojha and Mishra 2010).

It is likely that one of the reasons for the low representation of PQs about climate change in parliament is that climate change does not influence voting behavior. Identity politics, which include religion, is one of the important drivers of voting behavior in India (Gaikwad 2018). This is perhaps in contrast to countries such as the US, and in the EU where civil society action has increased the saliency of the climate action on the political agenda (Nash and Steurer 2021).

However, this was beyond the scope of this study, and future studies could further explore these aspects.

4.2. Impacts of climate change on vulnerable groups

Several studies have shown that climate change will have complex intersecting impacts on different sectors of society, whether on women (Yadav and Lal 2018), children (Dimitrova *et al* 2020), disadvantaged caste (Goodrich *et al* 2019) groups, or the poor. One might expect that parliamentarians from special interest groups—for instance those from indigenous communities, or marginalized caste groups—may ask questions relevant to justice. While we were not able to explore climate issues with respect to other marginalized groups, with respect to gender, women did not ask more PQs than men. However, in total, male MPs asked ten times the number of questions asked by women MPs during our study period. This was largely due to an unequal representation of women in parliament (Ahmed 2018).

Neither did PQs seem especially interested in exploring issues of socio-economic vulnerability and climate justice. In total, only six PQs focused on differential impacts based on economic and social vulnerability, of which most focused on the differential impacts on the economically disadvantaged. This is a staggering gap considering the importance of caste issues on social justice and access to governmental schemes and policies in India (Dunning and Nilekani 2013). This is in sharp contrast to other PQs in India, which often focus on social welfare especially of historically marginalized groups (Ojha and Mishra 2010). The MPs background also influences the PQs they ask, with MPs from historically marginalized groups asking PQs on the impacts on their group (Shankar and Rodriguez 2014). In the case of climate change, it is likely that issues of climate justice and differential impacts on India society are still finding voice in parliament. By failing to specifically recognize that climate change is having and will continue to have

differential impacts on society, the most vulnerable populations will be the most impacted and will have the least access to climate aid (Sultana 2021).

4.3. Climate impacts, mitigation, and adaptation

Unsurprisingly, PQs of climate impacts largely focused on agriculture as it contributes to about 17% of India's GDP, with about 47% of India's workforce engaged in agriculture activities (Gulati *et al* 2018). India's agriculture is especially vulnerable to climate change (Dubey and Sharma 2018)—it is not surprising that this is an area of importance for parliamentarians, whose constituencies are largely rural, with 69% of India still living outside cities in areas were agriculture is of major importance.

Coastal areas were another sector of concern likely because three of the seven largest Indian cities—Mumbai, Chennai and Kolkata—are located on the coast, and therefore especially vulnerable to sea level rise (Khosla and Bhardwaj 2019). Concerns about fishing livelihoods also exist due to an increase in coastal climate disasters over the years (Sarkar and Borah 2018). Apart from health impacts of climate change, other impacts such as mental health issues, or water stress, do not appear to figure on parliamentarians' minds, however—despite their growing importance in the Indian scenario and globally (Mehran *et al* 2017, Obradovich *et al* 2018).

PQs on mitigation seemed to be more techno-managerial in focus, seeking to understand energy and agricultural policies, for instance—part of a larger trend that has been noted by other researchers in South Asia (Stock *et al* 2021).

The lack of focus on adaptation is puzzling especially as it is perhaps one of the most important areas of concern for India in future decades. A similar lack of focus on adaptation has also been demonstrated both in media (Keller *et al* 2020) and research (Vij *et al* 2017). Raising the level of parliamentary debate on adaptation is critical and needs to be foregrounded.

4.4. Sources of climate information

Media can perhaps play a more influential role here. Parliamentarians referred to a source for their information on climate change in 10% questions of the PQs asked. Reports covered in the media, seemed to stimulate PQs, indicating that increased media coverage of climate change issues may help stimulate greater parliamentary discussion of critical climate change issues, and driver greater governmental accountability. Media plays a critical role in shaping and reflecting public opinion, and as such, is known to be an important influencer in shaping political debate (Gavin 2018). The coverage of climate change issues in Indian print media has increased substantially over the past 15 years, with the greatest increase in reportage coming from the area of climate change impacts (Keller *et al* 2020)—this is also where most PQs on climate change tend to focus.

4.5. Limitations of the study

The data retrieval was based on the keywords that we chose based on our prior knowledge which was further refined based on the PQs. It is likely that we might have missed some keywords, which could have provided more PQs. However, we think that this is likely to be a small number and would not influence our findings.

A major limitation of our study was for the MPs, we only included MPs who asked PQs. We do not have data from MPs who did not ask PQs. This is likely to influence the analysis of research question 2, as zero data has not been included. However, this data was very difficult to retrieve and could not be used in the analysis.

In this study we focused on just climate vulnerability of each state and gender as potentially influencing PQs. However, there could be a range of other factors such as political affiliation, major weather or political events, upcoming elections, that could influence PQs. Future studies could perhaps look more closely into the motivations for MPs to ask PQs on climate change.

5. Conclusion

Climate change is one of the biggest game changers facing the world today. India, with its high population density, substantial urban coastal population exposed to climate extreme events, and strong dependence on climate-vulnerable sectors such as agriculture for livelihoods and food security, needs to gear up to cope with a climate emergency that is at its doorstep. In the world's largest democracy, the Indian Parliament plays a critical role in shaping Indian policies on climate change. In functioning democracies like India, PQs are a critical oversight tool that enable parliamentarians to ask questions of legislative and policy importance, and to raise issues relevant to their local constituencies.

Despite the importance of climate change for India's future, we find that PQs on climate change represent a very small fraction of all PQs in India over the past decade. Further, despite the fact that climate impacts are largely local, our findings indicate that MP from the most climate vulnerable states are not asking questions

on climate change. It is surprising to see issues of climate justice, and of differential climate impacts on especially vulnerable constituencies including women, children, and the poor, are almost completely absent from parliamentary discussions.

Our study focused on a few variables, however, to get a deeper understanding of what drives climate discourse in the Indian Parliament, variables such as political party affiliations, and state indicators such as education and health, could be included in future analysis.

In conclusion, we find that PQs on climate change represent a small but could help hold legislature accountable on climate change in India, which is the world's largest democracy, and simultaneously a country especially vulnerable to climate change. We find that the number of PQs on climate issues have increased over time, but there is substantial scope for future growth, especially in critical areas of climate justice, and climate adaptation. Media can potentially play a major influential role in this regard, and this aspect needs to be further explored in future climate policy research.

Data availability statement

The data generated and/or analyzed during the current study are not publicly available for legal/ethical reasons but are available from the corresponding author on reasonable request.

Acknowledgment

The authors would like to thank Dr Koustubh Sharma for useful discussions that helped with the analysis.

Conflict of interest

The authors report that there are no competing interests to declare.

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