The Indian Society for
Ecological Economics (INSEE)

8th Biennial Conference

Urbanization and the Environment

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At the
Indian Institute of Science (IISc)
Bengaluru, India

Sponsors

Indian Council of Social Science Research (ICSSR)
Ms Rohini Nilekani
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Hosts

Department of Management Studies, Indian Institute of Science (IISc)
Ashoka Trust for Research in Ecology and the Environment (ATREE)
National Institute of Advanced Studies (NIAS)

Contents

PROGRAMME

	Sun, 3rd Jan 2016	Mon, 4th Jan 2016	Tue, 5th Jan 2016	Wed, 6th Jan 2016
08:30-09:30		*Registration*		
09:30-11:00		**Inaugural Session**	**Keynote Speeches**	**RTD 5**
11:00-11:30		*Tea/ Coffee*	*Tea/ Coffee*	*Tea/ Coffee*
11:30-13:00		P1 Parallel Sessions (A to E)	P3 Parallel Sessions (A to E)	P5 Parallel Sessions (A to E)
13:00-14:00		*Lunch*	*Lunch*	*Lunch*
14:00-15:30	Field Trip to Jakkur Lake (Optional)	**RTD 1**	**RTD 3**	**RTD 6**
15:30-16:00		*Tea/ Coffee*	*Tea/ Coffee*	*Tea/ Coffee*
16:00-17:30		P2 Parallel Sessions (A to E)	P4 Parallel Sessions (A to E)	**Valedictory Session**
18:00-19:30		**RTD 2**	**RTD 4**	
19:30-20:30	INSEE SAC+LOC Meeting	INSEE Annual General Meeting	Cultural Programme	
20:30-21:30	*Dinner (starting 20:00)*	*Dinner*	*Dinner*	
20:30-22:00	INSEE EC Meeting			

Venue for all plenary sessions (inaugural, keynotes, valedictory and RTDs) is Satish Dhawan Auditorium, IISc

Plenary Talks

Inaugural Address
Sunita Narain

Sustainable cities will be equitable and inclusive cities: How urban growth must be reinvented for sustainability and liveability in our world

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Sunita Narain has been with the Centre for Science and Environment (CSE) since 1982. She is currently the Director General of CSE and Director of the Society for Environmental Communications which publishes the fortnightly magazine, *Down To Earth*.

She is a writer and environmentalist, who uses knowledge for change. In 2005 she was awarded the Padma Shri by the Indian government. She has also received the World Water Prize for work on rainwater harvesting and for its policy influence in building paradigms for community based water management. In 2005, she also chaired the Tiger Task Force at the direction of the Prime Minister, to evolve an action plan for conservation in the country after the loss of tigers in Sariska. She advocated solutions to build a coexistence agenda with local communities so that benefits of conservation could be shared and the future secured. She was a member of the Prime Minister's Council for Climate Change as well as the National Ganga River Basin Authority, chaired by the Prime Minister, set up to implement strategies for cleaning the river.

Dr. Narain began her work in the early 1980s, as a co-researcher with Anil Agarwal, an eminent and committed environmentalist who gave the country its environmental concern and message. In 1985, she co-edited the *State of India's Environment* report, which built an

understanding in the country on why India is so important for the poor. With Anil Agarwal she learnt that environment and development are two sides of the same coin and that for the millions of poor, who live on the margins of subsistence, it a matter of survival. In 1989, learning from the successful initiatives of people to manage their environment, Anil Agarwal and she wrote *Towards Green Villages* advocating local participatory democracy as the key to sustainable development. She has continued to research and write about how environment must become the basis of livelihood security of people in the country. She has also linked issues of local democracy with global democracy, arguing that every human being has an entitlement to the global atmospheric common. In 2012, she has authored the 7th State of India's Environment Reports, *Excreta Matters*, which presents a comprehensive analysis of urban India's water and pollution challenges.

She has devoted time to build the capacities of the CSE so that it can function as an independent and credible institution, influencing public opinion and advocating change. Today, with over 150 full time staff, it is actively engaged in a variety of programmes spanning issues of water management, to rating of industries in terms of the environmental performance and training. CSE is an institution, which believes in the need to use knowledge to bring about change. In other words, it is about "working India's vibrant democracy". The challenge for CSE is to raise concerns and to participate in seeking answers and more importantly, in advocating for the answers to become policy and then practice.

PRESIDENTIAL ADDRESS
SHARACHCHANDRA LELE

Engaging with urban environments: Challenges and opportunities for environmental researchers

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Sharachchandra Lele is a Senior Fellow and Convenor of the Centre for Environment and Development at the Ashoka Trust for Research in Ecology and the Environment (ATREE). He has a B.Tech. from IIT Bombay, an MSc.(Engg.) from IISc Bangalore and a PhD (Energy & Resources) from University of California at Berkeley. He carries out interdisciplinary research on institutional, economic and biophysical aspects of forest and water management, and conceptual issues in sustainability and sustainable development.

Sharad's past research has ranged from estimating environmental costs of large dams, assessing sustainability of forest use by local communities in the Western Ghats, and forest cover change estimation and its impact on hydrological benefits to downstream communities, to long-term impacts of watershed development, viability of biofuel cultivation and state policy on non-timber forest products in central India. He is currently leading an interdisciplinary study of climate change impacts on water management in two urbanizing basins in southern India and the regulation of water pollution in metropolitan Bangalore.

Sharad has published in leading environment and development journals, and has authored a large number of book chapters. He has co-edited two books and co-authored one on Community-Based Natural Resource Management. His latest book was an edited volume titled

"Democratising Forest Governance in India", published by Oxford University Press in 2014.

Sharad is currently an Associate Editor of Ecological Economics, and on the Editorial Boards of Journal of Peasant Studies and Current Opinion in Environmental Sustainability. He is a Founder-Member, four-time Executive Committee member and current President of INSEE. He has also served on the Board of the International Society for Ecological Economics. His focus in this work has been on promoting cross- and inter-disciplinary learning.

Sharad has served on Working Groups of the Planning Commission (2006), the MoEF-MoTA Joint Committee on the Forest Rights Act (2010) and on the Elephant Task Force appointed by the Karnataka High Court (2012). He engages with civil society groups through research-action partnerships and with the wider public through public talks, TV interviews, and popular writing.

Keynote Speech
Barbara Harriss-White

India's indispensable informal waste economy

The first part of this keynote speech affirms the importance of a political ecology approach to urbanization that is grounded in field research. While towns and cities drive political change they break the 'circular metabolism' of natural systems. The 19th century agricultural economist Henry Carey called this relation 'a robbery system'. While the material exchanges of the robbery system may be reconceptualised in abstract terms as those between production and the material conditions for social reproduction, concrete attempts to quantify these material flows have reinforced the value of the 'urban' and the 'rural' as practical analytical categories. But they suffer from two difficulties: i) 'blackboxing' the urban and the rural and ii) omitting the material flows of the unrecorded informal economy. Informal activity is unregulated by the state. It may be outside the ambit of law, or exempted by existing law; regulative law may also be flouted by agents, or deliberately not enforced by the state (in turn due to factors including institutional scarcities resulting from fiscal non-compliance or the accommodations of a criminalised political economy). In India, informality is embedded in the structure of capitalism, not as a simple binary but in complex relations involving labour, family firms, corporates and the state. A paradox emerges where the balance of regulative forces varies locally and requires case-work and field research while the practical policy-making and planning of sustainable infrastructure needs generalizable evidence.

The second part introduces a sector that is under-researched, particularly in terms of the relation between formal and informal activity – waste. All human activity, above all commodity economy, produces waste. It takes gaseous, liquid and solid forms. We look at the generation, handling and social relations of (liquid and solid) waste from industrial production; distribution; consumption and social reproduction in the case of a small South Indian town. We focus on the nature of, and reasons for, the interface between formal and informal activity, and finding the informal indispensable to the formal.

Barbara Harriss-White is Emeritus Professor of Development Studies, Emeritus Fellow of Wolfson College, Oxford University and a Visiting Professor at JNU. She has helped create post graduate programmes in Development Studies, and Contemporary India and directed Queen Elizabeth House, Oxford. Having driven from Cambridge to New Delhi in 1969, she has been able to spend her working life researching and teaching about Indian development through the lenses of agricultural economics, field economics, political economy and development studies. (Co)author and (co)editor of 35 books and over 225 book chapters and journal papers, her work has shown the importance of identity and status categories in the regulation of the capitalist economy (‘*India Working’* 2003); she has also researched the field of agricultural markets as complex and combined arenas of exploitation, inter-sectoral resource extraction, efficiency and dynamic technical change; she has engaged with long term village studies and agrarian change and pioneered a four-decades-long study of a small town in South India (‘*Middle India and Urban-Rural; Development*’ 2015). At the same time, she has explored relations between deprivation, markets, the state and policy processes: in poverty; malnutrition;

gender relations; health and disability; alcohol and household food stress; criminalised destitution; ageing; and social discrimination. In retirement, she investigates the political architecture of (renewable) energy; and waste production in the economy (measuring trade-offs between greenhouse gases, jobs and economic returns in the informal economy (rice); and exploring the social relations of liquid and solid waste in a small town). Elected a Fellow of the UK's Academy of Social Sciences, she won the Edgar Graham prize for originality in Development Studies with her book '*Rural Commercial Capital*' 2008, about agricultural markets in West Bengal.

KEYNOTE SPEECH
SARATH GUTTIKUNDA

Where do we start planning for better air quality in Indian cities?

Air pollution is a complicated issue in India and is most often a symptom of inadequate urban planning. Lack of power supply leads to the use of diesel generator sets; lack of buses to support the public transport demand leads to higher use of personal vehicles; lack of infrastructure to promote walking and cycling leads to more motorised transport; lack of road maintenance and traffic management by allowing on-road parking leads to congestion; lack of a sufficient waste management system leads to garbage being left behind and often burnt in residential areas; and lack of paved or covered roads leads to re-suspension of dust when vehicles are passing by. The fact that air pollution is an externality from multiple sectors means that it needs to be addressed by multiple ministries that are willing to coordinate with one another. Technical solutions alone, like introducing compressed natural gas or changing standards for vehicles and industries, or relocating industries, will not be sufficient to control air pollution in Indian cities. We need a change in the institutional setup in ways that will allow department and ministries to work together. There are multiple sources and only when the government takes the lead to address this seriously, by mandating policies in the context of wider social and economic development, will we have any real change towards improving the quality of air. A start would be informing citizens about the quality of air we breathe, the severity of pollution in the air, and where this pollution is coming from.

Sarath Guttikunda is the Director of an independent research group UrbanEmissions.Info and an adjunct associate professor at the Centre for Climate Studies at the Indian Institute of Technology (Mumbai). His research interests are in studying the impact of emissions at urban, regional, and global scales, using model and survey tools at various complexities. http://www.urbanemissions.info

Valedictory Address
Joan Martinez-Alier

Joan Martinez-Alier is Emeritus Professor at Universitat Autonoma de Barcelona and also at FLACSO, Ecuador. A founding member and former president of the International Society for Ecological Economics, he was a leader of the EJOLT project (www.ejolt.org) between 2011 and 2015 on "environmental justice organizations, liabilities and trade", and is a co-director of the EJAtlas (www.ejatlas.org). He is the author of *Ecological Economics: Energy, Environment and Society* (1990), and *The Environmentalism of the Poor: A Study of Ecological Conflicts and Valuation* (2002), and recently co-edited with Roldan Muradian a *Handbook of Ecological Economics* (Edward Elgar Publ. 2015).

Round Table Discussions

RTD 1

Sustainable Consumption and Production in South Asian Cities: What? How?

Organized by INSEE with support from United Nations Environment Programme (UNEP)

This round table will focus on approaches and initiatives that currently exist to promote more sustainable consumption and production at the city level. Consumption patterns at the city level, and their impact on the environment, depend both on the overall provision of urban services and infrastructure (land use regulation, building design and development, network infrastructures), and on the technological, economic and socio-cultural factors that shape the demand for those services (urban lifestyles). The round table aims to explore both elements, by addressing questions such as:

- How is sustainable consumption and production understood at the city-level?
- What shapes consumption patterns in cities in South Asia, especially in small to medium cities?
- What can individuals, communities, entrepreneurs, planners and governments do to promote sustainable consumption and production?

Sagar Dhara, Cerana Foundation, Hyderabad, India
Atiq Rahman, Bangladesh Centre for Advanced Studies, Dhaka, Bangladesh
Suren Erkman, University of Lausanne, Switzerland *(tbc)*
Madhav Badami, McGill School of Environment & School of Urban Planning, Montreal, Canada *(Moderator)*

RTD 2

From Ecological Economics to Ecology, Economy and Society: Engagements with Interdisciplinarity in Environmental Research

Organized by Ashoka Trust for Research in Ecology and the Environment (ATREE), Bangalore

When INSEE was founded, the idea of environmental research that bridges the natural and social sciences was still a nascent one in the Indian context. INSEE, although founded on the idea of bridging ecology and economics, has consistently sought to push the boundaries and is today poised to launch a journal titled "Ecology, Economy and Society", reflecting a wider understanding of the environmental problem. Others have engaged with the same question (how to analyse environmental problems holistically) in their own ways and own institutional contexts. This panel probes the question of where do we stand today in our understanding of the conceptual, organizational, and pedagogical aspects of interdisciplinarity in environmental research. This panel is not focused on a subtheme of the conference; instead, its focus is more expansive and engages the methodological questions that underpin INSEE's work and approach.

Kanchan Chopra, Professor Emeritus, Former Director, Institute of Economic Growth, University of Delhi; Founding President of INSEE

Desmond McNeill, Head of Research and Director of Research School, Center for Development and the Environment, University of Oslo

Arild Vatn, Professor, Department of International Environment and Development Studies, Norwegian University of Life Sciences (UMB); Former President of European Society for Ecological Economics
Sharachchandra Lele, Senior Fellow & Convenor, Centre for Environment & Development, ATREE, Bangalore *(Moderator)*

RTD 3

Waste-full Cities: Ground-level Challenges and Research Questions

Organized by Centre for Policy Research (CPR), New Delhi

Urban sanitation has come to the fore in the policy space given the call for a Swachh Bharat. A part of public sanitation, viz., solid waste management (SWM) is firmly placed as a municipal obligation, while other aspects, especially dealing with human fecal waste, may be dealt with by other levels of government. As a research topic, it remains relatively under-researched. The thrust of this round table is to highlight ground level challenges in order to pose research questions.

The panelists will discuss formative research on ground realities in different parts of the urban sanitation chain including municipal solid waste, public toilets and waste water management and its intersection with and implications for city governance, economic models of waste and service delivery, public health and environmental pollution. This session will bring together perspectives on different facets of public urban sanitation, and the inter-play with different levels of government and the role of individual and community behavior and responsibility. The issues to be highlighted include:

- The transition of sanitation arrangements from rural to urbanized areas with a focus on the neglect and limited understanding of small cities in urban sanitation policy
- The cognition of and evidence of ground level realities (of waste) shaped by the economics that is used to study waste in urban contexts and the interplay of technical and implementation issues

- Issues surrounding the primacy of state intervention and the need for infrastructure subsidies to provide for improved sanitation verses the arguments favoring the need for behavior change and creating demand by urban communities
- The role of community voice and ownership in governance in producing citywide sanitation outcomes – including processes demonstrating civil society action
- The future of sanitation and the nature of resource recycling and our need to recycle and its policy repercussions

N C Narayanan, Centre for Technology Alternative for Rural Areas, Indian Institute of Technology Bombay
D T V Raghu Rama Swamy, Director and Professor at the School of Infrastructure, RICS School of Built Environment (RICS SBE), Amity University; formally CEO of the Infrastructure Development Corporation (Karnataka) Ltd
Sasanka Velidandla, Chief Executive, CDD Society, Bangalore
Shubhagato Dasgupta, Senior Fellow and Director of the Scaling City Institutions for India (Sci-Fi) Sanitation initiative, CPR, New Delhi *(Moderator)*

RTD 4

Challenges in Urban Water Management

Organized by INSEE with support from Rohini Nilekani

India is undergoing a massive urban transition. By 2031, 600 million people are projected to reside in Indian cities, up from 400 million today. Cities are expected to provide an estimated 70% of new jobs and 70% of the GDP. One of the biggest challenges is to provide water and manage the wastewater generated by burgeoning cities. This policy roundtable will address the critical debates on urban water issues in India that include: infrastructure funding policies and the operation and maintenance of new infrastructure; issues surrounding urban-rural resource transfers and conflicts; equity across and within urban areas and the long-term sustainability of water sources.

S Vishwanath, Director, Biome Environmental Solutions, Bangalore
Hari Sankaran, Vice Chairman and Managing Director, IL&FS, Mumbai
K J Joy, Secretary, Society for Promoting Participative Ecosystem Management (SOPPECOM), Pune
Arvind Shrivastava, Secretary (Budged & Resources), Finance Department, Government of Karntaka (TBC)
Rohini Nilekani, Founder President, Arghyam, Bangalore *(Moderator)*

RTD 5

Resilient Cities and Transformative Adaptation

Organized by Indian Institute for Human Settlements (IIHS), Bangalore

Cities are central to the Indian economic growth trajectory in the decades to come, and are recognised by many as current and future 'engines of economic growth'. It has been reported in the 12th Five Year Plan that the urban share in the country's economic output may have crossed 60 per cent in 2009-10. On the other hand, this growth has come at the cost of social tension over resource allocation across rural and urban residents and significant environmental degradation in urban and peri-urban areas.

At the same time, climate change has emerged as a critical challenge of this century and is posed to intensify existing inequalities. Annual mean temperature in India is projected to increase by more than 3 degrees before the end of this century. There is a growing body of literature that investigates how climate risks intersect with existing vulnerabilities in India's urban centres. Changes in the frequency and intensity of extreme events such as floods and droughts are likely to impact not only agricultural productivity and the sustainability of natural resources; but also urban infrastructure, urban economies and urban livelihoods.

Indians already grapple with multiple challenges – such as gaps in the provision of basic services, safe housing, sustainable livelihoods, deteriorating ecosystems, dysfunctional institutions and unplanned growth. Marginalised and vulnerable populations are more exposed to risks arising from climate change-related

variability such as drought-induced water scarcity and food insecurity, localised floods, and extreme temperature events, as well as environmental and health risks.

IPCC AR5 (Chapter 8 Working Group II and Chapter 12 Working Group III) purports that cities can become sites of transformative adaptation by enhancing economic comparative advantage and reducing risks to enterprises and households. This round table discussion will consider the issues that constrain or enable the uptake of the 'transformation adaptation' agenda in Indian cities. The panelists have consistently worked at the interface of cities, climate change and other risks, including issues of vulnerability and adaptation to climate change.

G K Bhat, Chairman, Taru Leading Edge Pvt Ltd, Ahmedabad
Partha Mukhopadhyay, Senior Fellow, Centre for Policy Research, New Delhi
Sudhir Chella Rajan, Professor, Department of Humanities and Social Science, Indian Institute of Technology Madras
Neha Sami, Consultant-Research, IIHS, Bangalore
Aromar Revi, Director, IIHS, Bangalore *(Moderator)*

RTD 6

Environmental Narratives: Urbanizing Environments and the Media

Organized T V Padma in collaboration with INSEE

India, like most Asian countries, is heading towards a rapid rise in urbanization, which leads to disorganized growth of over-crowded, unmanageable cities, woefully short of basic amenities such as water and sanitation. Besides the long-standing problems of air and water pollution, more recently, global warming is impacting cities with extreme events for example, the Mumbai downpour or Chennai floods. The media plays a critical role in communicating and highlighting concerns about urbanization and environment.

This round table will see four seasoned environment communicators discuss how the media tends to frame news on urbanization and environment. The panelists will address the following key questions.

- How does the media frame and construct urbanization issues in the context of development and environment trade-offs? What are the key issues that media tends to and needs to highlight? Who speaks for the urban development demands and the urbanization-affected people?
- What are the challenges that media faces in covering urbanization-environment issues? Are there additional pressures on media that addressing environment concerns are "blocking development"?
- Has the media has been able to enable changes in policy?
- Are there any biases in coverage – for example, does air pollution receive more coverage than

sewerage; or excitement of technological solutions without further analysis of institutional arrangements to make the technologies work in urban populations?

- Are there successful case studies, or other sources of evidence that the media can use?

Darryl D'Monte, Chairman Emeritus, Forum of Environmental Journalists in India (FEJI) and Founder President, International Federation of Environmental Journalists (IFEJ), Mumbai
Ammu Joseph, Freelance journalist, media analyst and editorial consultant, Bangalore
Ashish Kothari, Founder-member, Kalpavriksh, Pune
Kalpana Sharma, Editorial Consultant, Economic and Political Weekly, and former Deputy Editor, The Hindu, Mumbai
T V Padma, Science journalist, New Delhi (*Moderator)*

Paper Abstracts

P1 A

Urbanization, Industrialization and Climate Change

An Ecologic-Economic Analysis of Urbanization, Energy Consumption, Economic Growth and Environmental Quality in India

Sweety Pandey and Mrutyunjaya Mishra, Department of Economics, Banaras Hindu University, Varanasi
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Developing countries are under the pressure of achieving high growth rate. At the same time, developing economies are expected to overcome a variety of environmental problems such as industrial pollution, urban environmental issues, global warming and others. Therefore, these countries are required to put maximum effort into their policies to overcome environmental issues along with a high growth rate. Various attempts have been made in the literature to analyse the environment–growth nexus. The study attempts to investigate the short run and long run causality issues among CO_2 emissions, urbanization, energy consumption, industrialization and economic growth in India using time series techniques and annual data for the period 1971-2010. The paper presents the facts obtained on the basis of data used and tests conducted for unit root, Johansen co-integration test and causality test based on vector error correction model. The study then proceeds to explain the policy implication of the results found and suggests the policy measures which India can adopt to overcome some of its environmental issues. The important findings that emerge from the investigation are as follows. Firstly, there is bidirectional short run causality between CO_2 emissions and economic growth, which means growth cannot continue without increasing carbon dioxide emission. Moreover, in the long run, economic growth causes carbon emissions. Secondly, urbanization causes CO_2 emissions in the short run as well as long run, which implies that urbanization motivates emissions as it promotes industrialization and more energy consumption. Lastly, there is bidirectional long run causality between economic growth and industrialization. Since, urbanization and economic growth causes carbon

dioxide emission both in the short run and long run; it is advised that urban centres should switch over to less energy-intensive growth. The Government of India should emphasize on reducing CO_2 emissions by promoting more efficient utilization of energy sources and use of more clean energy source so that it may not adversely affect economic growth.

Urbanization and Environmental Performance across Indian States and Union Territories: A Regression Analysis

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India is a large country divided into 29 states and 7 union territories. The extent of urbanization and environmental performance varies across these states and union territories. This study explores a statistical relationship between urbanization and environmental performance by using the cross-sectional data available across these states and union territories. It also explores the impact of development of the industry and services sector on urbanization. The extent of urbanization has been measured by the proportion of people living in urban areas. The development of the industry and services sectors is measured by their combined share in gross state domestic product (GSDP). Environmental performance is measured by the Environmental Performance Index (EPI) and its five constituent indicators recently developed by the Planning Commission of India. The five constituent indicators are air quality, water quality, forests, waste management and climate change. The log-quadratic equations are estimated as the best fit equations to explain the above relationships. It is found that the development of the industry and services sector has a significant positive impact on urbanization. Urbanization increases at an increasing rate with a rise in the share of the industry and service sector in GSDP. Further, it shows inverted U-shaped curves of EPI and its constituent indicators with respect to urbanization; that is, initially, as the level of urbanization increases, environmental performance also improves. Environmental performance deteriorates after a certain level of urbanization. The turning points occur at 25 to 40 per cent of urbanization for different indicators of

environmental performance. The study discusses different aspects of the results obtained.

Impact of Urbanization on Energy Use and CO2 Emissions: A Cross-Country Analysis of Emerging Asian Countries

Bandana Khataniar and Anamika Barua, Department of Humanities and Social Sciences, IIT Guwahati
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The nexus between urbanization, energy use and CO_2 emissions has been a much studied subject in recent times. Urbanization or urban drift is a physical change of land areas which is a result of global change. At this moment, the world population is 6 billion, out of which more than 50% live in urban areas. This rate is increasing every year. Growing urbanization means more consumption. More energy is required to meet this consumption demand, which in turn leads to higher emissions. However, this relationship is not identical in every country as the level of affluence is not the same everywhere. Urbanization is rapid in regions which are in developing stage. Asia is such a region where economic growth is very high as well as urbanization. This study investigates empirically the effects of urbanization on energy use and CO_2 emissions in eight emerging Asian economies during 1980-2010. The countries are China, India, Indonesia, Republic of Korea, Malaysia, Philippines, Singapore and Thailand. The impact is estimated using three panel data estimation models, viz., fixed effects model (FED), least square dummy variable (LSDV) and Arellano-Bond Generalized Method of Moments (GMM). The findings show that urbanization has positive relationship with both CO_2 emission and energy consumption when all the selected countries are considered together. However, the panel data estimations suggest that the impact of urbanization on energy use and emissions varies across the different stages of development. The urbanization elasticity of emissions in the group of high-income countries (Malaysia, Republic of Korea and Singapore) is positive, but in the middle-income group (China, India, Indonesia, Philippines, and Thailand), it is negative. Again with respect to energy consumption, urbanization has positive and significant impact in the high-income countries but negative for middle-income

countries. This means that further urbanization in the high-income group seems to increase rather than to decrease energy consumption. Nonetheless, the investigation is still in progress, and possible solutions to the problems outlined by researchers, are yet to be analysed. The findings may add to existing literature and could be helpful for decision makers.

Investigating Firms' Response towards Environmental Sustainability in the Indian Context

Mousami Prasad, Trupti Mishra and Varadraj Bapat, Shailesh J Mehta School of Management, IIT Bombay
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Environmental management has become critical in present times with rapidly shrinking forests, pollution in water bodies and increasing greenhouse gas levels. With India's target of increasing contribution of the manufacturing sector towards gross domestic production, the thrust on industrialization will stay. The role of corporates assumes importance in this context as they are responsible for environmental degradation on one hand and have access to resources (financial and technological) that can provide solutions; and on the other hand, they are the economic engines of growth and employment. It is therefore important and pertinent to examine how firms are responding to the issue of environmental sustainability. Previous studies on firm practices towards environmental sustainability have yielded mixed results. Some studies argue that corporates are striving for ingenuity in their attempts to reduce their carbon footprint and are proactive in their efforts towards sustainability while other studies are sceptical about their efforts.

This study examines firms' response through both environmental disclosures and environmental performance. Environmental disclosures are measured through quantity scores and quality adjusted scores, calculated using content analysis of annual reports. Environmental performance has been quantified through (a) CO_2 emission intensity where, CO_2 emission of firms has been calculated using IPCC reference approach and (b) resource intensity. Further, the study examines whether the environmental performance (EP) can be

indicated through environmental disclosures (ED) made by the firms in their annual report. Association between performance and disclosure is tested using pair-wise Pearson's and Spearman's rank order correlation. Companies listed under BSE sectoral indices have been selected as the sample, as the companies included in sectoral indices are sectoral leaders and may be treated as large companies.

The average CO_2 coefficient of coal used in Indian industries is estimated as 1.649 (ton CO_2/ton coal), petroleum as 3.101 (ton CO_2/ton oil) and gas as 0.0021 (tons CO_2/cubic metre of natural gas). Overall disclosures, measured by quantity and quality, do not show significant correlation with either of the environmental performance indicators (emission intensity as well as resource intensity). However, in case of better environmental performers, quality of disclosure is negatively associated with resource intensity. As firms reduce their resource intensity, they make higher disclosures, particularly in terms of quality of disclosures. In case of the worst environmental performers, no association between disclosures and performance is observed. Industry classification is found to be positively related to disclosures, indicating that firms from environmentally sensitive industries make higher environmental disclosures.

P1 B

Culture, Consumption and Sustainability of Cities

Economic Sustainability of Urban India: Assessing the Inclusiveness of Household Consumption Expenditure (1983-2012)

Sneha Thapliyal, Centre for Public Policy, IIM Bangalore and Deepak Malghan, Centre for Public Policy and Centre of Excellence for Urban Development, IIM Bangalore
thapliyal.sneha@gmail.com

Urban India has been consistently recording rapid economic growth although the inequality and poverty figures continue to rise as well. As a panacea to such problems of unequitable growth, the Eleventh and Twelfth Five-Year plans have highlighted `inclusive growth' as one of the key pursuits. However, there is little clarity on what precisely can be classified as inclusive growth. This paper proposes that inclusiveness should be assessed on the basis of a normatively defined measure that integrates economic performance as well as distribution of the product of growth. Focusing on the inequality reducing component of growth, we propose that inclusiveness must entail an egalitarian distribution of economic product. Using the welfare measures of Atkinson and Sen, we define equally distributed equivalent consumption (EDEC) as one way to visualize such a desirable distribution. EDEC is the consumption that, if obtained by every individual in the society, would result in the same level of welfare as the actual consumption distribution. EDECs, calculated under assumptions of different types and intensities of inequality aversion, provide counterfactuals to the actual distribution of consumption expenditure (CE). Using these different EDECs, we propose two robust metrics to measure inclusiveness. The first metric, inclusivity index, measures the elasticity of growth rate of these EDECs with respect to the growth rates of real CE to evaluate how inclusive has growth really been. The second metric, exit time to inclusivity, estimates the average time required to achieve an EDEC for the observed rate of growth in CE. We present the analyses using the National Sample Survey's unit-level CE data for urban India from 1983 to 2012.

Vertical (across deciles) and horizontal (across social groups and states) decompositions for these metrics show that growth in the urban sector has been far from inclusive. Lower deciles, backwards social groups (especially Scheduled Tribes) and historically poor performing states continue to benefit the least from India's rapid economic growth. Additionally, it may take as long as a decade of distributionally neutral growth to reach equitable distribution of the product of economic growth. Our findings suggest that a serious reconsideration of existing policies might be required for growth to be sustainable in urban India.

Benchmarking Sustainability of Urban Mobility – An Indicator-based Approach

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More than 50% of the world's population now lives in cities and that figure is set to rise to 75% by 2050. This has resulted in expansion of transportation needs. Urbanization together with increased affordability has given rise to higher daily needs and hence consequential mobility needs. Mobility at a city level can be visualized as trips arising out of various dimensions; most prominent are people, goods and services. People mobility is linked to trips related to work, shopping, leisure, education, etc. Goods/commercial mobility comprises inter or intra city trips for pick-up, dispatching and delivery of goods. The examples of service mobility are online retail trips, food delivery among others which tend to increase with increased urbanization and higher population density. In developing countries where urbanization rates are increasing, the combined effect of high growth coupled with increased mobility and large population is a cause for concern. Increased urbanization has resulted in a chain of interactions among urban sub-systems with implications for sustainability, especially for economic, environmental and social sustainability. In this paper, we have attempted to assess city sustainability through various activities that are generated across the city. Precisely, the city is modelled as an urban system consisting of various subsystems such as residential,

commercial, industrial, employment and mobility. Keeping the mobility subsystem at the centre stage of interaction, other subsystems are considered to interact with it in isolation. Thus, interactions included are between each of the above subsystems and mobility subsystem in the realm of an urban system. The interactions are represented through input, interaction and output phases for each dimension (economic, environmental and social) of sustainability. A given subsystem is considered as a black-box wherein urban inputs enter into the subsystem, bringing about interaction and thereby produce outputs to reflect the contribution of each subsystem towards mobility. Given this conceptual understanding, the present study develops a sustainable urban mobility framework representing the hierarchy of interactions and their visual representation. Indices are constructed at each level to ascertain sustainability levels of each subsystem with respect to each dimension and in each phase. Further sustainability of each subsystem, interaction with mobility subsystem and the overall urban system sustainability are quantified. Sustainability is measured on a scale of 0 to 1, with values closer to 1 indicating that the subsystem/phase/dimension is more sustainable and value closer to zero indicating lower sustainability. This enabled us to develop an Urban Mobility Sustainability Index (UMSI).

Measuring the Sustainability of a Heritage City Varanasi

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Urban growth occurs because of the economic advantage of cities. The environmental status of Indian cities is being discussed as many important Indian cities are in the list of globally most polluted cities. India has the second largest urban system in the world with more than 5,000 cities and majority of them fail even to provide basic requirements of a healthy life. As a city further urbanizes backed by population growth and economic progress, the problem of sustainability gets worst. Thus, in the process of rapid urbanization in India, it is essential to apply the concept of sustainability in policy and planning decisions. No doubt, a state-wise and for mega cities

the comparison of sustainability is evident from the literature but places such as Varanasi with very old human existence and heritage character urgently needs a sustainability analysis. As in its 12th five year plan, the Indian government focuses on the "faster and more inclusive sustainable growth"; it becomes very necessary to achieve the sustainable development of the new emerging cities.

The study investigates if the present pattern of urban development in Varanasi is sustainable. It is an attempt to find ways in which urbanization should take place as per the sustainability requirement. In order to accomplishing the task, a composite urban sustainability index is created for the city and its performance is divided into three broad categories: People, Planet and Profit. These correspond to three dimensions of sustainability – social, environmental and economic and can be described as the triple bottom line. The outcome of the study will contribute to the design of policies, tools and approaches essential for planning to attain the goal of sustainable development and social cohesion of metropolitan regions.

P1 C

Urban Environmental Governance and Technology

Critical Data Practice in Air Pollution Governance: New York, Houston, Philadelphia, Albany, Beijing, Bengaluru

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Air pollution has received escalating attention in recent years, with reports of dramatic air quality problems around the world and growing recognition of health impacts. The World Health Organization has raised air pollution to a new level of concern, releasing new research in 2014 that more than doubled previous estimates of global deaths due to air pollution (with the new estimates attributing one in eight total global deaths to air pollution). The United Nation's sustainable development goals also make air pollution a priority concern, calling for significant improvements in capacity to monitor and evaluate air pollution. In the United States, escalating controversy over ozone standards points to the need for better and more actionable air pollution knowledge, and for new linkages between science and governance. The present research responds to these developments, examining how air pollution research and governance has developed in six cities -- Bengaluru, Beijing, New York City, Albany, Philadelphia and Houston. The research aims to produce a theoretically robust, empirically grounded understanding of distinct environmental health research and governance styles, detailing and categorizing different ways of developing environmental health data, advancing the sciences of environment and health, and directing these toward governance of complex problems. The project extends work in the history and anthropology of science on how "thought styles" shape scientific research to sociocultural analysis of "governance styles." The study extends theorization of governance by addressing how scientific cultures, practices, and infrastructures shape governance processes and outcomes. Findings can be used to improve collaboration between governance regimes (across scale, and between nations), and between governments, scientific bodies

and citizens. In this presentation we will focus on the data infrastructures that have been built and proposed to advance air pollution governance in different settings, describing how approaches to data are shaped by political history and culture. We will also describe how air pollution has provoked the emergence of critical data practices (including an array of citizen science projects) that "push-back" against entrenched ways of thinking about the environment and its problems, and the relationship between science and governance.

Environmental Regulations and Compliance: A Case of Textile Dyes Industry in Ahmedabad

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Environmental regulations have been assuming increasing recognition in designing and organizing industrial production in the highly polluting industries such as textile dyes. The issue is pertinent particularly because textile dyes and chemicals are one of the most polluting industries that account for a fairly large proportion of the industrial base in Ahmedabad that produces over 80 percent of total dyes in the country. Industrial growth in the "golden corridor" distributed over Ahmedabad, Vadodara, Ankleshwar, Vapi and Surat not only causes pollution to the rivers, canals and creeks but also results in overdrafting of ground water without any adequate recharge system. It also causes increasing salinity in the ground water with an alarming level of fluoride in it. The industrial clusters have much higher proportion of sulphur dioxide, nitrogen dioxide and SPM than the standard norms (CSO 1997).

During recent years, Gujarat has been experiencing tremendous pressure from increasing public awareness, public interest litigation, and judicial intervention (Rathi, 2003). This has been recognized by recent studies focusing on chemical industries in the state; the studies have highlighted the urgent need as well as community's response (pressure) to demand for effective pollution control measures to check the grave situation in some of the most hazardous industries in the state. There have been potential threats of closure of the operations which

has forced the small and medium industries located in industrial estates/clusters to join hands and set up combined facilities for waste management. Further, it has been suggested to improve not only the monitoring and regulation system, but also to empower the local communities to ensure their right to a healthy environment and ultimately their survival.

Given this backdrop, the paper seeks to ascertain the dyes industry's behaviour towards environmental regulations and understand the drivers of compliance. Using case studies and in-depth interviews, the paper finds that environmental regulations lack in larger perspectives of environmental protection and cause financial burden to the small firms, although it is the "low-hanging fruit" for the large firms. The small firms suffer not only from the relatively higher cost of compliance but also from other indirect costs involved in the cumbersome procedures of domestic as well as international trade.

Connected Cities, Disconnected Rivers: Analysing Urban Rivers in India

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Rivers have long been cradles of civilization. As Mathew Gandy remarks: "Water is indispensable 'stuff' for maintaining the metabolism, not only of our human bodies, but also of the wider social fabric" (Gandy 2004: 364). As a state subject, rivers have always occupied a contentious place in Indian politics. With increasing urbanization, urban rivers are increasingly stressed. Urbanization has also disconnected urban river watersheds to their floodplains thus creating concomitant problems of flooding. Rising pollution levels in urban and rural water bodies have long been blamed on rampant extraction and increasing pollution. River rejuvenation policies in India have yet to yield concrete results. From the failed Yamuna Action Plan to the cosmetic beautification of the Sabarmati riverfront in Ahmedabad, river rejuvenation policies have specific spatial and policy impacts. Thus far, river rejuvenation policies in urban India have sought to beautify riverfronts and/or provide

24-hour water supply. I argue that this beautification is nothing but a commodification of urban rivers. In envisaging a 'beautiful' riverfront, river rejuvenation policies have often only further obfuscated urban river imaginations.

I argue that river rejuvenation policies in India commodify rivers in specific ways. Beginning with the 73rd and 74th Amendments to the Indian Constitution that introduced local self-governance in India, this paper will examine the ways in which nature has been understood in legal-policy frameworks. Analysing urban river rejuvenation policies in the form of the erstwhile Jawaharlal Nehru National Urban Renewal Mission and the newly launched Atal Mission for Rejuvenation and Transformation, this paper will reflect on the spatial and policy changes that these rejuvenation schemes propose. The specific commodification of rivers and their floodplains along cities is an important topic as burgeoning urbanization is increasingly exerting stress on surface and groundwater sources. Analysing river rejuvenation policies will thus reveal tensions between various actants and social life. In doing so, this paper seeks to further the dialogue on sustainability in urban India.

P1 D
URBAN WATER: FROM SOURCE TO DISPOSAL

Evaluating Consumer's Preference for Wastewater Treatment: A Case Study of Tamil Nadu

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We employ the contingent valuation (CV) method to estimate residents' willingness to participate in wastewater treatment at Chennai. A CV survey was undertaken on 200 randomly selected respondents from all the 15 zones of the Corporation of Chennai. Overall, the results reported in this paper support increased investments to improve the technology of sewage treatment plants (STP)s minimizing water pollution and resolve the scarcity of groundwater in Chennai.

Results of the logistic regression confirmed that the variables – perceived importance by the respondents of controlling water pollution and groundwater contamination, household income, household size, level of education – has significant influence on people's willingness to pay. The results reveal that residents of Chennai are willing to pay significant amounts in terms of higher monthly municipality taxes to ensure that the wastewater treatment facilities is upgraded to enable tertiary treatment.

Coping Strategies and Coping Costs for Accessing Safe Water in Chennai, India

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Households in developing countries face various intangible costs due to scarcity of water. These intangible costs are coping costs which users pay for accessing safe water. This study investigates households' coping costs related to the erratic, unsafe, and inadequate water supply in the city of Chennai,

India. We find that households in Chennai city resort to five main types of coping behaviours: collecting, pumping, treating, storing, and purchasing. Based on the data collected from 423 households, we estimate the components and amount of coping expenditure for water service improvements. We obtain the mean coping costs as Rs. 553 and Rs. 658 per month for piped and non-piped households in this sample, respectively. The variability of these costs is roughly 1 percent of income for the high income households to as high as 15 percent for the low income households. These findings are consistent with previous studies that indicate that poor households have a higher coping cost. Furthermore, we use the multiple regression method, with robust errors, to estimate the determinants of the coping costs. We find that income is positive and significantly related to the coping costs. Families with higher income bear higher coping costs. Higher income households have the financial resources, and therefore tend to spend more on various mechanisms such as storing, purchasing, treatment, etc. Similarly, those households that perceive water contamination as a serious problem have higher coping costs. Those households which are connected to the piped network have lower coping costs. This result can be attributed to the fact that households connected to the piped network have lower opportunity costs in terms of collection time and purchasing water from other sources. Moreover, we study the ward-level effects on the coping costs.

Disposal of Wastewater and the East-bound Growth of the City of Kolkata: A Compatibility Analysis

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Kolkata, home of 4.5 million people is generating 1112 million litres of sewage per day and facing the challenge of managing, disposing and treating wastewater. The 12,500 hectares wide wetland on the eastern fringe of the city, popularly known as the East Kolkata Wetlands (EKW) is serving as a natural sewage treatment plant for more than a century where nearly 78 per cent of city-sewage goes through an intricately designed canal network. This wetland is a designated Ramsar site where livelihood dependence through wise use practices evolved

around sewage-fed fisheries and garbage farming. The sewage treatment process here is a rare example of an inter-twined symbiotic correspondence between two otherwise independent eco-systems related to wastewater treatment and wetland aquaculture.

An aggressive urban expansion in the eastern fringe of the city has led to the unplanned conversion of wetlands into urban settlements. This practice is disturbing the age-old eco-balance and the eco-system-based livelihood by making this sewage-water-pisciculture less profitable. The neighbourhood of the core wetland area is infested with high-rise buildings and institutional establishments creating opportunities for different types of modern vocations for the local people. There is push factor due to reduced profitability of the wastewater fisheries and a pull factor due to emergence of alternative livelihood options through rapid urbanization. These two, taken together lead to a sharp tendency to switch from traditional to modern vocations. If wastewater fishery loses its dominance, the costless treatment of sewage will no longer be viable. Primary survey on the households has been conducted in core areas of the EKW to study their tendency to switch from existing traditional vocations to newly available alternative jobs in terms of different economic, social and demographic factors. If the younger generation is more interested to acquire skills suitable for the modern vocations, then the eco-system balance would be disturbed even without any significant change in the pattern of land-use of the core area. Once this extremely ingenuous tie-up between Kolkata's waste treatment and EKW's livelihood dependence would break, how much will it cost Kolkata for treating wastewater? Are the city authorities aware of this remarkable service provided by the EKW? Should we plan our urbanization with more care, comprehension and integration? Are we planning urban development without paying much heed to eco-compatibility? An assessment of this hidden cost is the primary concern of this paper.

Community-Managed WasteWater Treatment Systems with Techno-economic Assessment

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The paper draws inferences on the effects of rapid urbanization and its dramatic changes in the local environment. The changing scenario places more demands not only on locally available resources such as water but also on local civic agencies. The approach of centralized service provision, especially in case of the Urban Water and Sanitation sector has proved to be expensive, inefficient and non-sustainable in the long run. Urban planners and experts believe that the decision makers need to look beyond the conventional service delivery approach. The National Urban Sanitation Policy-2008 too acknowledges the importance of 'alternatives' in technology, finances and governance in order to achieve the national goal of 100% sanitation.

The alternative to centralized services provisions, i.e. the decentralized interventions (in sewage management) has been tried and tested in different contexts in India. The studies in this area however have been limited to either technical and/or financial assessment. In order to develop comprehensive understanding of sustainability of such interventions, we need to study technical, and financial, management dimensions within a given institutional setting.

With this background, a study was conducted to assess the techno-economic performance of domestic sewage treatment interventions viz. conventional and non-conventional technologies. The analysis focuses on the water and wastewater economics. The study tries to understand the prevalent governance models in decentralized interventions as well. The case study method has been employed to compare the two technologies namely Decentralized Wastewater Treatment Systems (DEWATS) and (modified) Activated Sludge Process (ASP). While DEWATS is a natural system, ASP is electro-mechanical based. About four cases (interventions) have been selected and all are managed by the 'users'. The interventions

studied cater to the populace of different socio-economic profiles.. The details have been provided in Table 1.

Table 1: Details of Decentralized Waste Water Interventions

Case Name	Technology Name	Establishment Type	Population Served	Installed Capacity (KLD)
Vasant Kunj, Delhi	DEWATS	On the drain	1000	35
Chennai	DEWATS	Youth Hostel	60-80	5
Bangalore	(modified) Activated Sludge Process (ASP)	Hotel	222 rooms	100
Bangalore	(modified) Activated Sludge Process (ASP)	Commercial Complex	NA	250

P1 E

Air Pollution, Solid Waste and Human Health

Garbage Management in the Himalayan Hill City Shimla: Concerns for Ecology, Economics and Governance

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The erstwhile summer capital of British India, Shimla is one of the popular hill stations of India. It is the only Class I City in the Indian State of Himachal Pradesh (HP) with a total population of the 1,69,758 persons, excluding the floating tourist population that put an extra burden on waste management. Under Himachal Pradesh Municipal Act 1994, Shimla has adopted the Door-to-Door Garbage Collection Bye-laws in 2006 which state that each household/ commercial establishment/ educational institute/ other institutes will hand over the garbage to the agency authorized by Municipal Corporation (MC) Shimla. Such a garbage collection management is a daunting task in the hilly terrains where most of the localities downside are not connected by the roads and therefore, require much manual labour. Provisions have been made to impose a fine for creating nuisance by littering of garbage. As per MC Shimla's present estimates, the daily waste generation in Shimla City is approximately 86.01 MT. This depicts that waste generation per capita per day is 350 gm/capita/day. The collection of the waste through door–to-door collection and community bins is approximately 70-75 MT. Under such a background, the paper tries to analyse the economics of waste management, concerns of clean environment, and the governance issues especially in terms of convergence and public-private partnership (PPP). An effort is made to analyse the issue in perspective of ecological economics. Certain policy implications also emerge from the results and discussion to benefit the policy at micro and macro levels.

Municipal Solid Waste Management in Kalimpong Town: An Economic Analysis

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Municipal solid waste management has become one of the most urgent problems in the town of Kalimpong, requiring immediate remedial measures. The town is emerging as one of the popular hill towns in the eastern part of India which is undergoing rapid urbanization and population growth, which in turn has led to the emergence of municipal solid waste management as a major problem. The rationale behind selection of the area is to emphasize on the major municipal solid waste generation issues in small towns of a developing nation and to investigate the issues related to municipal solid waste management.

The paper explores public participation regarding the issue of waste management in the study area. A comprehensive economic evaluation regarding the importance of public participation for improved solid waste management services in the study area was made. This study aims to provide inputs on how to improve municipal solid waste management by examining the current scenario of municipal solid waste management in the study area, present cost incurred in its collection and disposal by the municipality, household willingness-to-pay for improved waste management services. Economic prospects of waste management activities like composting and revenue generation through peoples willingness-to-pay have been discussed in this study.

A double bounded dichotomous choice Contingent Valuation Method was used to estimate the households' willingness-to-pay with a sample size of 170 households. Primary data obtained through personal interviews was analyzed using logistic regression. The study concludes that authorities should develop a strong administrative set up and a waste management system taking into consideration various factors that is unique to this region. An intensive education program regarding waste management practice and methods should be undertaken by the municipality to promote solid waste management practices in the town.

Why Urban Waste Continues to Follow the Path of Least Resistance

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This paper explores the movement of municipal waste in the physical space and in the policy space. It investigates why solid waste management rules are being framed by environment ministry, waste policy and strategy by urban development ministry and waste to energy policy by ministry of new and renewable energy. It explores why the proposal for incentivizing biological treatment method for waste remains pending with ministry of chemicals & fertilizers. The paper dwells on the legality, legitimacy and appropriateness of continued dumping and burning of waste as solution and the blind faith in building landfills to the sky. It examines the reasons for promotion of suburban, rural and poorer areas as dumping grounds for urban waste. It explores structural engagement of municipal solid waste which has hazardous waste characteristics.

The papers explores the recommendations on integrated plant nutrient management which has advanced a progressive argument for securing soil nutrients from composts through waste incineration technologies that turn it into pollutants. The paper examines why rules fail to aim at reducing plastic use and encourage zero waste philosophy. It analyses the proposed solid waste rules that applies "to every urban local body, all statutory towns, outgrowths in urban agglomerations as declared by the Registrar General & Census Commissioner of India, notified areas/notified industrial townships, notified area committees, area under Indian railways, defence cantonments, special economic zones in the country and every waste generator." If the idea is to seek sites for landfill and waste processing facilities beyond municipal limits, then this is likely to have grave political implications. It explores these implications.

Based on secondary literature, the paper attempts public health audit of communities living in the vicinity of waste treatment facilities in general and environmental and occupational health audit of formal and informal workers

involved in waste management. It examines the status and role of waste workers who provide invaluable environmental service by ensuring resource and material recovery. The paper cites case studies of misplaced interventions of thermal technologies and market instruments such as carbon trade. It provides case studies to argue for decentralized waste management and treatment facilities. The paper explores the possibility of stopping the movement of municipal waste from one district to another so that waste does not shift to poorer localities by adopting Not In My Back Yard (NIMBY) syndrome.

Impact of Urbanization and Solid Waste on Climate

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As an economy experiences urbanization along with higher GDP growth and corresponding higher levels of consumption, the amount of waste generated increases and the composition of waste changes. The changing consumption pattern in developing countries has been a cause for concern in the developed world on account of the associated GHG emissions.

The waste sector adds to the GHG emissions in the economy mainly through decomposition and methane formation in landfills. However, proper waste management and recycling can reduce the GHG emissions. This paper sought to determine the factors affecting waste generation (including urbanization), that can be established through a quantitative exploration of the available data on waste; and examines what can be expected in terms of waste generation and consequent emissions in the near term and the future, given the expected growth in income and urbanization in India. There appears to be a positive relationship between per capita income of class I cities, their population and the amount of MSW generated in India.

P2 A

Urbanization, Industrialization and Climate Change

Deforestation and Income Growth in South Asia: An Evidence for Environmental Kuznet's Curve

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Deforestation is a significant environmental problem all around the world and there is no exception in the context of South Asia. An array of socio-economic and political factors can influence the rate of deforestation. The major objective of this study is to determine the relationship between deforestation rate and economic growth, population growth, structural transformation, urbanization, and institutional strength in the context of South Asia. For this purpose, we based this study on the concept of environmental Kuznet Curve (EKC). We modelled the deforestation rate as a function of lagged real per capita income, squared and cubic terms of lagged real per capita income to find whether there is an evidence of EKC. The other explanatory variables included in the extended EKC model were, percentage of urban population, percentage of agricultural value added from total GDP, population growth, and institutional strength. We used amalgamated political rights and civil liberties indexes published by the Freedom House as a proxy for institutional strength variable. We obtained the data for all the other variables from World Bank country profiles. The countries included South Asian nations except Maldives and Afghanistan and the period of study was 1990-2011. We included real per capita income variables as centered terms to avoid multicollinearity since, in polynomial regressions multicollinearity can be a problem. Estimated variance inflation factor (VIF) showed that there was no multicollinearity. Due to the heterogeneity between the countries, we used fixed effects model and Hausman specification test showed that the fixed effects model was more appropriate. We estimated a feasible generalized least square regression (FGLS) to check for the robustness of the estimates. Results provided the evidence for an EKC as the lagged real per

capita income variable has a significant positive coefficient and the squared term of the variable has a significant negative coefficient. The cubic term is not significant. Based on the calculations, the first turning point is at 1,871 USD in real terms. The percentage of agricultural value added has a significant positive effect on deforestation. Hence, the structural transformation can be considered as a favourable factor for the forest cover. Similarly, urbanization has a significant positive effect on the deforestation rate. In contrast to the expectations, the institutional strength has a negative effect on the deforestation rate. FGLS estimates are consistent with the fixed effect estimates.

Urbanization, Resource Use and Rise in Entropy: A Case Study of Guwahati City

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Urbanization is a development process that draws on natural resources as input in order to provide goods and services and improve the quality of life in cities. Cities account for 50% of the world population, consume 70% of the global energy, account for 80% of global GDP, and are responsible for 75% of global CO_2 emissions (UNEP). Cities are, thus, engines of growth that rapidly transform energy and matter into goods and services, generating employment and improving living conditions but also producing considerable waste. All resources entering the city are in the form of energy and matter and all waste generated thereafter is also in the form of energy and matter. The Laws of Thermodynamics apply to the economic process where energy and mass transformations take place. The used-up state of matter and energy is a state of high entropy as a result of irreversible thermodynamic processes. Even though reuse, recycle and new technological inventions are looked upon as solutions to waste reduction and reuse, depletion of low entropy resources continues. The paper briefly reviews the various reuse–recycle studies carried out from a thermodynamic point of view. Further, a framework for city as a thermodynamic unit of development based on resource use and recycle has been proposed. The framework is based on the source and sink relationship and looks at the energy–matter

input, transformation and throughput generation. Resource overuse and consequent rise in entropy are key contributors to climate change in the business as usual scenario.

Based on the proposed framework, a case study of Guwahati city has been carried out using two key energy intensive sectors – electricity and transport. Guwahati is a fast emerging metropolis with a population touching 1 million (963,429 as per 2011 census). During the last decade from 2001 to 2011, the population has grown at the rate of 18.96%. Electricity consumption of the city has now touched 1 TWh, which was 0.5 TWh in 2005. There are about 0.8 million on-road vehicles in the city, and growing at a rate of about 0.1 million vehicles per year. The case study attempts to link urban development with energy use, transformation and entropy generation. The results of the present study are considered to be useful in framing appropriate policy interventions for efficient resource use and reuse.

Urbanizing India through Special Economic Zones (SEZs) and its Impact on the Surrounding Environment: Evidence from Mundra, Gujarat, India

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The Special Economic Zones (SEZs) expedites the economic growth through attracting more FDI, promoting exports and increase foreign exchange reserves. One of the main driving factors behind locational choice of SEZ is urbanization, in addition to other factors such as distance to port, airport and availability of cheap unskilled male labour and infrastructure variables. However, the SEZs impact the neighbouring environment adversely. The main objective of this paper is to study the impact of SEZs on the surrounding environment. However, to understand the impact of SEZs on surrounding environment, we conducted a primary study in the neighbouring area of Mundra Port and Special Economic Zone Limited (MPSEZL) of Gujarat. The Mundra Port is situated in the coastal area of Kutch district, which is declared as Critically Vulnerable Coastal Area (CVCA). We surveyed 217 households covering fisherfolk, farmers and cattle grazers to understand

how the local population has been impacted due to the location of SEZs. The results of the survey indicated that the fisherfolk, farmers and cattle grazers are the most affected of all people. Fisherfolk reported that there has been a decrease in fish catch due to SEZs. Although, few basic facilities such as water, toilet and solar light were provided in few bandars such as Juna and Luni by owners of SEZs, the fish catch however, has drastically reduced in the last 3-4 years in those bandars. The farmers have been facing hardships due to acquisition of farming land by the MPSEZL developers at lower than market prices. Besides, the increased salinization due to loss in mangroves has led to decline in agricultural production. Dhrab village which was famous for its date production recorded a drastic reduction in the yield in last 3-4 years. Size and quality of coconut were impacted resulting in loss in revenue. There is pre-seasonal flowering of sorghum (jowar) and pearl millet (bajra), resulting in lower production of sorghum and pearl millet. Many cattle grazers have lost their profession due to increased cost of cattle rearing as the common grazing lands of many villages were taken away by SEZ authorities and as a result the villagers had to work as daily labourers. The study shows that a careful evaluation of the costs and benefits of establishing SEZs is required as the benefits accrue to people outside the region, while the costs are often borne by the local population. There is a need for thorough analysis to understand the real benefits of establishing the SEZs versus the true costs of establishing SEZs.

Benchmarking the Sustainability of Urbanizing India with special reference to Uttar Pradesh

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For the first time in history, more than 50% of the world's population lives in town and cities. The urban population of the world has grown rapidly from 746 million in 1950 to 3.9 billion in 2014. Urban growth occurs because of the economic advantage of cities. The cities of India, the largest democracy and one of the fastest-growing countries in the world, are at the forefront of this change. India has the second largest urban

system in the world with more than 5,000 cities. Being at the epicentre of the furious urbanization is both an advantage and an adversity for India. Thus, in the process of rapid urbanization in India, it is essential to apply the concept of sustainability in policy and planning decisions. However, the criteria for sustainability differ between developed and developing countries. State-wise comparison of sustainability has been done in the studies and there is availability of literature on sustainability of mega cities of India. However, here we are considering an emerging state of India and particularly its emerging cities in comparison with the most developed cities of the country. As in its 12th five year plan, the Indian government focuses on "faster and more inclusive sustainable growth", it becomes necessary to achieve sustainable development of the new emerging cities of a poor but a large and economically important state.

The study investigates if the present pattern of urban development in Uttar Pradesh in the creation of mega cities is sustainable. This has been done by comparing the cities of Uttar Pradesh: Kanpur, Lucknow and Varanasi with mega cities of India (Mumbai, Delhi, Bangalore, Ahmedabad, Chennai, Hyderabad and Kolkata). In order to accomplish the task, sustainable cities index is created for 10 cities and their performance is divided into three broad categories: People, Planet and Profit. These correspond to three dimensions of sustainability – social, environmental and economic and can be described as the triple bottom line. The outcome of the study will contribute to the design of policies, tools and approaches essential for planning to attain the goal of sustainable development and social cohesion of metropolitan regions.

P2 B

Culture, Consumption and Sustainability of Cities

Economics of Urban Ecosystem Services in Bangalore

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Nowadays, more attention is being paid to the relationship between economic activities and the environment. The modern economic system is becoming increasingly complicated; there is market for goods and services but no value of environmental goods and services. In order to deal with these conditions, it is necessary to grasp in detail the essentials of the relationship between human economic activities and the environment. Rapid urbanization poses the question of how to provide a continued flow of ecosystem goods and services without negatively affecting stocks of natural capital within the context of increased pressure and density. Urban areas also provide a range of benefits to sustain and improve human livelihood and quality of life through urban ecosystem services. In the recent past, the value of urban ecosystem is not generally included in economic calculation or proper economic value for ecosystem and their services. The key challenge is that information about decision regarding budget allocations to departments that manage natural assets and the flow of ecosystem goods and services. Conventional economic valuation is restricted to priced goods and services, which represent only a limited subset of ecosystem services. This paper focuses on economic value of ecological services provided by vegetation in urban Bangalore. For this purpose, only two services namely provisioning and cultural services were estimated. Travel cost method was used to evaluate cultural services and a sample size of 200 was taken for the survey. For the cultural services' estimation, Lalbagh Botanical Gardens was chosen and provisioning services were evaluated based on secondary data provided by the Ministry of Horticulture, Karnataka. The paper concludes on a note that urban ecosystem services are very crucial for sustainable well-being of urban dwellers. The policy

implication of the paper is urban planning, budget allocation and municipal service delivery.

Leveraging Culture Towards Sustainability of Cities

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Culture is the backbone of a vibrant society. It is closely related to, among other things, an awareness of one's rights and responsibilities towards safeguarding sustainability of civic amenities in modern cities. By their very nature these are public goods, because they exhibit non-excludability and non-rival consumption. Municipal corporations of cities, in collaboration with citizens' groups, are required to plan for the creation of these facilities. Resources need to be raised for this end. Maintenance of these services requires day-to-day monitoring along with active participation of all stakeholders. Their quality is ensured only when every institution operating within the city limits, both private and public, is empowered to play a constructive role in the continuance of the services.

Educational institutions, government offices, private businesses, citizens' forums, and religious organizations, all need to be compulsorily involved in the creation and preservation of civic amenities. Sanitation & hygiene, efficient & reliable public transport, safety & security, and avenues for ennobling entertainment, are the important aspects of sustainable cities. School education, and health services need to be made accessible to all residents with a sense of human touch, either free of individual charge (from public exchequer) or at affordable prices.

However, what is being seen, in most Indian cities, is that these services and amenities are increasingly being treated as private goods. Most of the aforementioned requirements of sustainable and healthy urban communities are being outsourced to profit-seeking private operators & promoters. Corruption appears to be eroding the delivery mechanisms for most of these amenities. There is a lack of transparency in the working, and finances of each of these services. There is a clear mismatch between what is on paper and what meets the eye in actual practice.

This paper argues that the reason for this is not because resources are unavailable for the different functions. It is because citizens are not empowered to participate in the processes involved. It further makes a case for inculcating a culture of greater involvement in the various aspects of civic societies in our neighbourhood as highlighted by Mahatma Gandhi. It points out that movements such as 'Swatch Bharat' go a long way in creating the awareness that monetary contributions are imperfect substitutes for a sense of personal responsibility, & collective action in supervision of the delivery mechanism.

Modelling Economic Policies for Sustainable Consumption of Natural Resources: A System Dynamics Approach

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This paper presents a System Dynamics model of an economy, comprising renewable natural resources (RNR), local economy and industrial economy. Considering the fact that RNR (forests, ground water and fisheries) form a significant factor of production, in the economic process, high economic growth in the recent decades has caused depletion of renewable resource stocks. This depletion if sustained over a period of time could breach their tipping points and damage their regenerative capacities. This disregard for resource regeneration dynamics poses a systemic threat to the sustenance of economy and all forms of livelihood.

Interactions between the local and industrial economy with RNR in the model are influenced by variables such as economy's dynamic rate of growth, intensity of resource consumption, resource regeneration rates, etc. The model outcomes indicate that a sustained growth in economy could lead to breaching the resource tipping points. This would create a delayed feedback to the economy which would decrease the production flow of goods and services. The impact of such feedback is seemingly invisible, for most part of the simulation time, due to long time delays involved from the declining stock

of resources to the production of goods in the economy. Once the effect of such feedback is felt in form of declining production of goods, the economy would peak and go into decline.

Various model runs show the impact of economic policies on resources and economy. Their outcome forms basis for discussion on how the linkages between economy and renewable resources could be sustained through policy measures. The paper tests the impact of three policy interventions: (1) resource efficiency, (2) resource efficiency and green growth, and (3) localization of economies. The simulation outcomes indicate that resource efficiency and green growth policies are successful in delaying the overshoot and decline of the economy but fail to avoid it. Localization of economies is able to avoid the overshoot and decline of economy throughout the simulation time. This is so because a need-based local economy relying on local means of production using local RNR has an intrinsically slower growth rate. Its close proximity to resource base enables a faster feedback from declining resources to the economy which makes it proactive enough to avoid breaching the resource tipping points. A case for promotion of slow growth, fast feedback local economies is made as a strategy to manage transition towards ecological and economic sustainability.

P2 C
Urban Commons, Institutions and Movements

My Well, Our Water: Can Citizens Become Stewards of Groundwater?

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Bengaluru has grown dramatically in the last decade. The Bengaluru water supply and sewerage board has failed to expand its infrastructure and services to keep pace with this growth. People of Bengaluru, especially those in the peri-urban regions, have adapted to the situation by resorting to groundwater extraction or purchase from tankers as their water source. Many of these urban communities have demonstrated various forms of self-regulation that includes demand management, investments in roof-water harvesting, groundwater recharge and waste water reuse. The city's growth has also meant encroached lakes and disturbed catchments. Along with pollution of the water bodies, this has meant that the lakes of Bengaluru are increasingly under threat. However, citizens have also responded to this and various citizen groups across the city are engaged in protection, revival and maintenance of lakes. These citizens are fighting battles to ensure that lakes are protected. Citizens are also working with the city's governance to revive and maintain them.

It is in the context of these "citizen movements" that a unique initiative in Bengaluru is now exploring if another urban common – groundwater – can be managed by citizens. This initiative is a collaborative effort between Biome Environmental Trust, ACWADAM, Map Unity and Wipro Technologies Pvt. Ltd aiming to achieve urban ground-water sustainability and equity. The initiative aims to engage citizens in an aquifer mapping exercise for the Yamalur watershed located at southeast of the city. Citizens are urged to share the stories of their borewells and open wells with the city. The aggregate of these stories and data is then interpreted through the lens of hydro-geology to arrive at mapping of the watershed's aquifer.

This interpretation is shared with citizens demystifying hydro-geology and informing the citizenry of the important linkages between their water management actions, lakes and groundwater as a common pool resource. The initiative hypothesizes that this process, apart from producing knowledge outputs holds value in itself – to catalyse a citizen self-regulation driven management of groundwater. The initiative also hopes to inform all the water related (but fragmented) institutions of the city – CGWB, Dept Mines & Geology, BWSSB, BBMP, BDA, and KSPCB – with lessons for groundwater governance.

This paper covers how this unique techno-social experiment was conceived and details processes of engagement with citizens, lessons learnt, outputs and outcomes of its first year.

Commons vs. Commodity: Urban Environmentalisms and the Transforming Tale of the East Kolkata Wetlands

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The spurt of research in urban ecology from a social sciences' perspective since the last two or three decades can be explained as an outcome of contemporary urbanization. From an understanding of the commons as a rural artefact, the concept has expanded to include urban spaces and practices; this assumes significant dimension for developing countries including India, where urban growth in the coming decades would primarily take place. To make this further complex, one of the crucial aspects of rapid urbanization in developing world is the emergence of peri-urban interface, where rural and urban features tend to coexist increasingly within cities and beyond their limits. While striving to reinvent themselves as utopias for investors, entrepreneurs and consumers, similar to their counterparts in the 'global South', Indian cities are desperately consuming peri-urban ecological commons that are not only critical to urban economic production and cultural vibrancy but also ecological sustainability of the entire region.

Within this context, the paper traces the transformation of ecological commons in the form of wetlands and garbage dumps

in Kolkata's eastern part (referred to as East Kolkata Wetlands (EKW)) that not only recycles solid waste and effluents, but also produces vegetables, crops and fishes at cheap prices, providing livelihood to poor communities. Using large temporal trajectory and applying political ecology framework, the paper explores strategic transformations of EKW since historic phases. When the British tamed nature's scape and excavated artificial canals facilitating triple purpose of trade, transportation and drainage-sewerage, the eastern sewage-fed EKW emerged as the space for informal, 'untamed' practices by marginal peri-urban communities. Today, it is dwindling in size, resulting in diminishing flows of ecosystem services against poly-centric rapid urban expansion. Unlike emphasizing on the domination/subordination paradigm where ecological commons in urban fringes are perceived as entities functioning both as output and input, produced and required by the city, the case study highlights their mutual linkages and interdependencies that determine the socio-economic and ecological sustainability of the city and its wider environment.

The particular site also offers opportunities to engage in and explore pluralities of urban environmentalism(s) including 'authoritarian', 'bourgeoisie environmentalism' perpetuated by the neoliberal state that aligns well with middle-class aspirations and radical environmentalism (activism) practised by the poor, affected communities, mobilized by grassroots organizations and NGOs, and the complex interactions among these that shape the urban transition of Kolkata.

Fuelwood Dependents of Urban Forests: Odds Favour the Morning Walkers

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Urban commons are at the centre of resource conflicts in the city. Often the conflicts are of access and how multiple user groups value these spaces. Delhi is a unique city with several forest fragments, often referred to as ridge forests, most of which are remnants of Aravali thorn scrub vegetation – native to this region. These forest fragments are often surrounded by

densely populated and yet complex user matrices. While several users recognize these as recreational spaces, others as sites of biodiversity conservation, and yet some others derive vital consumptive uses from these forests. Many of these urban woodlands have been converted into parks over the years that are safe with regulated access and patrolling. We examine the unique case of fuelwood harvesting in the middle of the city. This study is a preliminary attempt to assess the quantum of fuelwood dependence and also explore the profiles of the users to understand the socio-economic context of this practice in Sanjay Van (also known as South-central Ridge). The results indicate that economically poorer households represented highest levels of fuelwood dependence. This is also because of their poor access to alternative sources of energy, especially LPG. Most of these families have been seasonal migrants who service the infrastructure projects in the neighbourhoods. There are also households of long-term residents that consume fuel-wood since it supplements their alternative energy sources. It seems paradoxical that a substantial proportion of urban poor in the neighbourhood utilizes these patches for energy requirements and for public conveniences, while the urban middle class use the same as recreational spaces. Several advocacy groups operating in this area favours conversion of Sanjay Van to a conservancy. As a part of the developmental plans for these green areas, the Delhi Development Authority (DDA) aims to convert several of these into parks while the forest department aims to impose restriction on resource harvest in these urban forests including Sanjay Van. In either of these models, the poor will likely lose access to these woodlands as these commons get appropriated by state agencies and morning-walkers.

The Struggle for Reclaiming the Urban Commons in Delhi

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There is a huge area of land available in the National Capital Territory (NCT) of Delhi called the Gram (or gaon) Sabha land which was historically managed by the villages. This land has been in the past converted to other land uses by the Delhi Development Authority (DDA) (and not the Government of NCT

of Delhi), which has the power decide over its use. Land has been converted for various developmental and other projects. However, in recent years, the Gram Sabhas in some villages have started asserting their right to decide on the use of these lands. The case being discussed in this paper is of Ghummanhera village in south-west Delhi which has fought a successful battle against the Delhi government which wanted the Gram Sabha land of this village to be given away for the purpose of a Treatment, Storage, and Disposal Facility (TSDF) site for hazardous waste. The villagers used various strategies – modern and traditional – such as protests, demonstrations, PIL in the high Court, as well as used the regional-level caste associations (such as the Palam Panchayat of the Jats) to gain traction in the dispute. Likewise, several other villages in this region have refused to provide approval to certain projects being sited in their village. These movements are fast gaining some traction in the rural and peri-urban areas of south-west, west and north-west Delhi, which is turning out to be the new area of urban growth. Can these individual movements or assertions be seen as 'environmental (justice)' movement or simply a reassertion to claim traditional rights over the use of the commons? Or are these simple assertions of the villages to improve their living conditions by allowing only good development projects (such as schools, colleges, bus depots, and stadiums)? Or are these only caste (Jat) movements?? This paper will try to understand these movements by engaging with the literature on environmental and social movements and environmental justice.

P2 D

URBAN WATER: FROM SOURCE TO DISPOSAL

Local Self-governance, Ethnic Division in Slums and Preference for Water Supply Institutions in Kolkata, India

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The paper is based on a primary survey conducted across 23 slums of Kolkata. It comprised both qualitative and qualitative analysis on preference of slum dwellers for alternative water supply institutions. The paper concludes that preference for water supply institution depends on ethnic identity of the slum dwellers, their relative backwardness and deprivation. The paper enunciates the backwardness of Muslims and backward caste community. The deprivation of Hindu general caste is lesser than the other two communities. The Muslim community is more in favour of privatization of water supply for improved delivery as compared to Hindu community. Muslims are less inclined to pay water charges for improved public water supply services. The reasons for such preference of Muslims can be attributed to deprivation at various levels and apathy of councilors in Muslim-dominated regions. The SC and ST community, in spite of being deprived of services, demonstrated their preference for both paid government service and privatization. Benefits such as access to government jobs make them more willing to pay charges for improved public water supply as compared to Muslims. The non-notified slum dwellers, although more deprived and ignored by councilors than notified slum dwellers, are more interested in improvement of existing public system through contribution of water charges. Improvement of water supply through privatization is not possible in non-notified slums due to insecurity of tenure. Notification would entail improvement of basic services in these slums. Dependence on higher level of government service and lack of resource and skills at local levels is also an important hindrance for local planning and delivery of services according to local needs. Hence, local governments should be empowered with more revenue

autonomy and improved capacity to function as self-governing institutions.

Communities would prefer institutions that reduce their risk of exclusion. Risk of exclusion is illustrated by the ignorance (as perceived by citizens) of councilors about water supply conditions in Muslim-dominated regions. This along with derivation of services impels many of them to opt for privatization. Local governments would emerge as institutions of self-governance only when they are able to reduce this risk through demonstrating greater interest in living conditions. Local governments should also work to demonstrate more credible commitment towards the community through communication and redressal of local problems. The paper also suggests that more scientific research is also required for scale neutral water supply technology.

Urbanisation and the Environment

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Water security and water management are important issues that nearly every urban area grapples with, especially in India. As of 2010, only two cities in India – Thiruvanthapuram and Kota received continuous water supply. It has also been observed that the problem of water has become graver in urban and peri-urban areas with its ever increasing population, activities and demands than in rural areas.

Taking the context of Bangalore, this paper will attempt to understand water management with the help of a few case studies in the city. The case studies will help comprehend the broader context of how rapid urbanization and industrialization in Bangalore in the recent years has affected the water system. The case studies will look into the source of water, the process of how water reaches the people, how it is used, treated and where it goes after treatment. We will also understand the stakeholders in this process and their roles. These case studies show examples of how water scarcity has been overcome through efficient water management.

The Twelfth Five Year Plan suggests the need for a participatory management approach for our water as well as aquifer mapping in order to manage groundwater. Through our case studies, we will also explore how organizations – both private and governmental – can join hands with the citizens so that water is used responsibly and also study methods that have been used to make sure that people do not run out of water.

For instance, Rainbow Drive is a community in the Sarjapura region, which does not receive municipal water supply. Completely dependent on groundwater, the people of this community have worked together with organizations such as Biome Environmental Trust to make sure that they use their water wisely and invest in mechanisms that make sure that their groundwater is continuously replenished.

Another example is that of the apartments and villas at TZ Homes in Varathur which had been suffering from acute water shortage. However, community management of rain water, recycling of wastewater and replenishment of groundwater have been the solution to their water woes.

It is necessary for citizens to have a basic understanding of surface water sources and aquifers in order to understand what we are doing to our water resources through continuous exploitation. These case studies help to bring out these aspects, common challenges faced in dealing with these issues and possible solutions to them.

Water Governance in Small Towns: A Comparative Study of Small Towns in Karnataka and Tamil Nadu

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The pattern of urbanization in India includes an explosion of small towns that are also rapidly transiting to mid-size urban centres. Much research on urban water service delivery and governance has been focused on large metropolitan areas, while small and mid-size towns which are much larger in numbers

have received relatively little attention. Water management challenges in small towns in India differ from those in large cities in several ways: absence of dedicated parastatal agency to govern water and manage water supply, lack of economies of scale, limited human and financial resources and high dependence on groundwater with limited or no import of surface water.

We compare three towns of different sizes and resource mix across Karnataka and Tamil Nadu to understand water governance in small towns. We assess the performance of the water supply agency in terms of adequacy, equity, resource and financial sustainability, and democratic accountability. Data were collected through household surveys, field measurements, local government documents and structured and unstructured interviews.

From our analyses, we observe that

a. Towns in Tamil Nadu fared much better than towns in Karnataka in terms of adequacy because of their access to imported water from the reservoir.
b. Problems of inequity were found in all towns, although again inequity seemed lesser in towns of Tamil Nadu.
c. In those towns that are completely dependent on groundwater, questions on resource of sustainability have been the toughest to address. Little attention is paid to the treatment of wastewater and thereby making the water from local sources unusable. State subsidies for 'drought relief' provide perverse incentives to look for the short-term solution of drilling more borewells.
d. In most towns, meeting the cost of water supply is a challenge because of low and fixed monthly charges, limited revenues from other sources, high operation and maintenance costs involved, and non-recovery of billed amounts.
e. Democratic accountability is somewhat higher in Tamil Nadu owing to the governance structure of small towns and administrative culture.

In addition, we note some of the structural, institutional and organizational linkages to the observed difference in

performance of the water supply agencies. We also highlight the need for innovative local/context specific techno-economic approaches and active integration of politics at different scales into the water reform processes.

Potential for and Barriers to Decentralized Wastewater Recycling: Insights from Bangalore, India

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Wastewater reuse is being increasingly considered a quintessential component of sustainable and integrated water resources management. Several thousand water reuse projects with diverse applications (agriculture, toilet flushing, etc.) have been successfully demonstrated around the world, thus making it an important adaptation option for mitigating both water stress and pollution in rapidly growing urban centres, particularly in developing countries. There appears, however, to be a debate between two different approaches: centralized versus decentralized. On paper, the case in favour of decentralization becomes stronger in the context of cities in developing countries, where the infrastructure needed for centralized collection and treatment of sewage has not kept pace with urbanization. However, little is known about the challenges in decentralized wastewater treatment and reuse. The city of Bengaluru is a pioneer in this area. The 'zero-liquid-discharge' order (ZLD) imposed by the Karnataka State Pollution Control Board (KSPCB) requires apartments and commercial buildings above a certain size to not only treat their wastewater but also reuse it. Consequently, on paper, at least 600 and possibly 2000+ apartments have installed wastewater treatment and reuse systems. We present results from a study that sought to analyse the barriers to successful operation of such decentralized systems. Through detailed interviews with residential associations, WWTP operators, KSPCB officials and consultants, we sought to understand the economic, institutional, technical and social factors influencing the extent of both treatment and reuse. Preliminary results indicate that

scale, cost of raw water supply, formal and informal enforcement pressure, clarity on the roles of different governing institutions, and environmental leanings of the resident community are critical requirements for the success of such systems. At the same time, the extreme nature of the ZLD order makes it impossible for even the most well-meaning units to be in full compliance. Reducing the reuse requirement and improving technical support might result in better outcomes on the ground.

P2 E

Rural in the Urban: Agriculture in Cities

Health Cost of Wastewater Irrigation in Urban and Peri-Urban Agriculture: A Study of Varanasi

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Worldwide, the role of wastewater in agriculture has become increasingly important. In the absence of adequate fresh water, wastewater is increasingly being used for irrigation in urban and peri-urban agriculture in the vicinity of the urban areas. Recent surveys across 50 cities in Asia, Africa and Latin America show that wastewater irrigation is a common reality in three-fourths of the cities and its use in agriculture is presently increasing at close to the rate of urban growth in developing countries. In India also, wastewater irrigation is increasingly used for crops such as vegetables, fruits, cereals, flowers and fodder. While the nutrients contained in the wastewater are considered as beneficial to agriculture, the contaminants present in the wastewater pose health risks directly to farmers and farm workers using wastewater without adequate safeguards. This paper quantifies the health risks of wastewater used for irrigation in peri-urban Varanasi where an estimated 200 million litres of untreated human sewage is discharged into the Ganga River daily. This is a cross-sectional study based on both primary and secondary data. A structured household questionnaire was administered to collect primary data among 550 farm households using both wastewater and fresh water for irrigation. It is observed from the primary data that there exists significantly higher morbidity in the wastewater irrigated villages over the freshwater irrigated villages and the cost of illness incurred by the households in wastewater irrigation is substantial. Among the diseases, stomach ailment, intestinal infection, amoebiasis, eye irritation, skin diseases, cough, throat irritation, dysentery, hook worm, pain and aches in body, loss of appetite, typhoid are predominantly dominant among the wastewater households as compared to freshwater households. The morbidity incidence is higher in wastewater irrigation both in

terms of percentage of households and per person incidence of disease. As revealed from the survey, 59.9% of households in wastewater irrigation area reported at least one episode of person sick within three months of the survey against 40.1% in fresh water irrigation. The results point to the recommendation that wastewater treatment should be considered urgent to make the wastewater safe for reuse in irrigation. In addition, there is need for awareness creation among farmers on the risks of wastewater use for irrigation.

Terrace Gardens for Food Security in Urban Households – An Eco-Friendly Model from Kerala, India

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With rapid urbanization, considerable cultivable areas have been converted into modern residential holdings. The recent trend among urban dwellers is to use the available open terrace area for cultivation of vegetables. Residents in urban areas who have now gained a passion for raising crops on their terrace are fervently in search of a model they can replicate. In this context, a model terrace garden was developed for urban households, which besides providing food is environment-friendly and sustainable. The model garden was developed on the terrace of single-storey building with an area of 120 sq. m (3 cents). Based on a survey of 200 households, various crop and subsidiary components were introduced.

The garden comprised vegetables, tuber crops, pulses, spices, fruit crops and medicinal plants. Besides, maize was raised in pots to supply feed to the poultry. The crop residues available after harvest of produce were converted into quality vermicompost in the vermicompost unit maintained on the terrace and recycled to the other crops. Vermiwash was also regularly produced and applied as spray to supply nutrients to the crops. *Azolla pinnata* was constantly recycled as manure to the crops and feed to poultry. All the components can be easily maintained by the family using their spare time. The model has several bioresource cycles arising from recycling of crop residues after composting to all crops; maize to poultry

droppings to crops and azolla unit, azolla to crops and poultry and is thus integrated.

Annually, up to 250 kg safe to eat vegetables was produced from the terrace garden. The economic analysis revealed that during the first year, total annual expenditure was Rs.6451/- out of which Rs.3340/- was the non-recurring cost being the amount incurred towards establishing poultry cage, buying poultry birds, silpaulin sheet for azolla unit, plastic troughs for vermicompost unit and basin and pump for vermiwash unit. The annual recurring cost comes to only Rs.3111/-. The annual gross returns from the model was Rs.14592/-. During the second year, the annual recurring cost was Rs.3000/-. The annual gross returns from the model was Rs.12167/-. Hence, considering the average of the two years, the annual recurring cost was Rs.3056/- and gross returns from the model terrace garden of 3 cents (120 sq. m) was Rs.13380/-.

The widespread growing interest among urban residents to take up cultivation on their terrace for obtaining safe food is a clear indication that the model developed will be socially acceptable. Hence, the developed model is integrated, eco-friendly, sustainable and easily replicable by the average urban residents having free terrace space.

"Grow What You Eat, Eat What You Grow": Organic Terrace Gardening in Bengaluru

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Organic terrace gardening is increasing in popularity among middle and upper-middle class Bengalureans. Through popular fairs, workshops, and a plethora of online groups, urban gardeners are working to build a community and put the "garden" back into the "Garden City". I explore motivations behind the movement to "grow what you eat, eat what you grow" in the context of rising fear of the impact of conventional agricultural practice on human health and the environment. Due to Bengaluru's rapid transformation into "India's IT Capital," the city's relationship with its agricultural communities has changed drastically, resulting in experiences

of precarity all along the food chain. I focus on the urban gardening movement in the city, relaying insights from ethnographic research to argue that growing uncertainty and feelings of distrust surrounding contemporary agricultural production have led to the increasing interest in organic terrace gardening in the city. For many urban gardeners, even certified organic foods have become suspect, so that growing food oneself is the only way to rest assured that it is free from chemicals and other adulterants. This paper explores these feelings of distrust and insecurity in the context of Bengaluru's shifting food system, illuminating how the city's expansion is linked with a growing fear of food safety and environmental sustainability among the urban middle and upper-middle classes. In so doing, I argue that organic terrace gardening is not well-characterized as the "rural in the urban," as it is a distinctly urban experience in a rapidly growing metropolis that motivates individuals toward organic terrace gardening. I conclude with a discussion of the class implications in the current terrace gardening movement, asking questions about the potentials and challenges in generating food safety and security in Bengaluru through organic terrace gardening.

P3 A

Urbanization, Industrialization and Climate Change

Urbanization and Thermal Environment of Guwahati City

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As fallout of urbanization, the urban landscape and energy exchange mechanisms within a city is altered in a manner that cities become relatively warm places to live in. Thus, manifestation of the effects of urbanization on thermal environment of a city can be studied as urban heat island (UHI) effect. It is a phenomenon where surface and atmospheric modifications due to urbanization generally lead to modified thermal climate that is warmer than the surrounding non-urbanized areas. In the recent times, the study of thermal discomfort has found wider acceptance worldwide as the human dimension to the UHI effect. With statistics claiming 61% increase in the number of deaths due to heat stroke across India between 2004 and 2013 (National Crime Records Bureau), there is an urgent need to scientifically assess the current thermal environment of the cities and analyse their preparedness for handling the situation. The present study quantified, for the first time, the effect of the changed thermal regime of Guwahati in terms of Urban Heat Island Intensity (UHII) with *in situ* measurements at various sites within the city. All the three available approaches, ranging from fixed station field measurements to remote sensing and vehicle transect, are used in the study. The effect of the changed thermal regime on the residents of the city was also studied by assessing the thermal discomfort at various sites within the city. Being gateway to the entire north-eastern region of the country, the city has undergone rapid unplanned urbanization in the last decade to become the largest city in the North East region of the country in terms of population. The study not only focuses on assessing the thermal comfort levels prevalent in the city, but also addresses the period of persistence of discomfort.

Willingness to Pay for Green-Rated Buildings in Bangalore

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The construction sector in India occupies the top position in carbon emission with a 24% share of the total direct and indirect emissions. The industry which is rapidly growing at a rate of growth of 10% compared to the world average of 5.2% could hold a huge potential in facilitating the shift to more energy efficient techniques. Demand and absorption of commercial office spaces in Bangalore is a healthy indicator of stable industrial and service sector growth.

There are public and private benefits for green buildings. The private economic benefits of green buildings are reduction in utility bills, water bills, high rental value and improvement in health and productivity conditions of tenant and employees. The public good characteristics prominently describes environmental features such as reduction in emission, controlled use of environmentally hazardous materials, water conservation, preservation of greenery, etc. Market mechanism crucially depends on the flow of information and certification and labelling serves as the 'information provision' and helps in resolving the problem of market failure in the case of such goods with credence characteristics (goods and services where an expert knows more about the quality than a customer need himself/herself are called credence goods.

This study checks how a consumer responds to information provision of different building ratings as per their degree of greenness. It also identifies which green attributes induced them to invest in green office spaces. A total of 104 offices which are working in rented commercial office spaces in East Bangalore participated in the survey from manufacturing and non-manufacturing sectors. A TOBIT model is used and results from the study indicate that electricity bill, annual turnover, rent per square foot of office space are the significant factors that explain the Willingness To Pay for green office spaces in Bangalore city. However, water bills, number of employees, and nearness to commercial centre turned out to be insignificant factors.

Impact of Development of Greenfield Airports on Environment and Urbanization

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Greenfield airports are airports, which are developed on agricultural lands or forest land, either partly or fully. In India, the UPA II government had announced the development of 100 green field airports to give boost to the economic development of the country and improve air connectivity to Tier II and Tier III cities. Greenfield airports play a significant role in accelerating the urbanization of the country though at the same time development of greenfield airports involves the use of agricultural land, deforestation, cutting of hills, diversion of rivers, erosion of sea shores, etc., which have an adverse impact on the environment. However, airports are needed for the development of economy, trade and tourism, urbanization and for cultural and religious integration. In view of this, the study initially investigates the impact of air traffic on environmental degradation using regression analysis and subsequently explores the environmental implications of development of greenfield airports through case studies on Bombay II airport, MOPA airport, Aranmulla airport, Shirdi airport, Kannour airport and Pune Greenfield airport.

Our study suggests that greenfield airports are important from the environment, urbanization and economic development points of view, which will not only help in reducing pollution in the cities but also adopt approaches such as developing plantations in their vicinity so that emission from their activities can be absorbed to some extent. The policy implication of this study will motivate planners and policy makers to introduce policies and change existing policies in favour of the development of greenfield airports.

P3 B

Culture, Consumption and Sustainability of Cities

Urban Energy Poverty in India: A Household-level Analysis

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Energy plays a crucial role in the development of a country. Providing the continuity of energy supply to meet the demands of rapidly growing population and urban aglomarizations is one of the major challenges faced by a developing country such as India. Urban areas with its rapid growing population, economic activities and expectations, exerts immense pressure on the administration for providing services to all. Urban areas in developing countries are characterized by extreme luxurious lifestyles at one end and pathetic living in informal settlements at the other. India's case is no exception.

In this backdrop, it is interesting to analyse household-level energy poverty in urban areas. Unlike the conventional method of single economic poverty line, we use two energy level lines – 'energy sustenance line' and 'energy affluence line'. We do this so as to avoid a situation where people close to an energy poverty line on either side are forced to categorize themselves poor and non-poor though they do not have any significant difference in their energy consumption pattern. Also, a two-line approach does not make poverty line very sensitive where a slight change in poverty leads to millions of the population going in and out of poverty. We determine energy sustenance and energy affluence levels on normative basis following the physical threshold approach. Classifying the activities of the households, we determine the energy fuel basket for sustenance and affluence levels. Then, using NSS (national sample survey) data, we calculate the energy poverty rates for urban areas of different states of India. Following Foster–Greer–Thorbecke (FGT) measure of poverty, we calculate the incidence of energy poverty (number of people below energy poverty line),

the intensity or depth (energy poverty gap index), and severity or distribution (squared energy poverty gap index). We conclude the analyses with comparative pictures from different states in terms of energy poverty and touching on the underlining policies influencing such outcome.

Sustainable Fuel Consumption of Urban Households

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Important fuels that are considered as efficient and sustainable include natural gas (CNG/LNG), propane (LPG), ethanol, methanol, diesel, electric fuel, hydrogen, di-methyl ether (DME), P-series, fuel cell and solar fuels. The Government of India has undertaken various initiatives time to time for the development and promotion of cleaner alternative fuels to control the local as well as global pollutants and thus consequently improving quality of urban environment. These alternative fuels offer a significant potential for reducing harmful emissions from vehicles, and substantially better than conventional fuels both in life cycle emissions and vehicle exhaust emissions. In this backdrop, the objective of this paper is to identify the sustainable fuel consumption pattern of urban households for their mobility service consumption through private cars. A primary sample survey has been conducted on the private mobility services consumption pattern of urban households in India for this purpose in 2013-2014 by the respondent-driven sampling process and total 587 responses were collected. Sixty-eight percent of the total respondents have reported that they are much interested in purchasing a car running on sustainable fuels such as CNG, LPG, etc. Respondents who do not prefer to use energy-efficient equipments have stated that lack of information about the equipment, high initial cost of such equipment, and limited availability of such products in the market are the main reasons behind it. Seventy-three percent of all sample units are also well aware about the energy efficiency and thus intrinsically motivated consumers try to minimize fuel bill by voluntarily switching to new efficient fuel-driven car. Seventy-four percent of the households who have discarded their old car

and purchased a new one, have opted for a fuel-efficient car and 64% among them have reported that they are really saving fuel as they are conscious of fuel saving after purchasing the fuel efficient car. Therefore, a successful sustainable fuel consumption policy/measure can be realized in presence of better management of consumer behaviour by identifying these factors in sustainable fuel consumption pattern. This paper is thus an empirical contribution to the domestic sustainable fuel consumption literature.

Harnessing Social Capital for Sustainable Cities: Community-Based Resource Pooling Transition to Cleaner and Modern Cooking Fuel among the Urban Poor

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A significant percentage of the urban population in India, mostly the poor living in slums still use conventional cooking fuel which have an adverse impact on health as well as environment. A survey on household energy consumption patterns in Hyderabad in 2010 revealed that monthly expenditure of urban poor on firewood or kerosene is as much as the price of liquefied petroleum gas (LPG) cylinder. However, poorer households do not switch to LPG due to the high initial investments for an LPG connection. This paper explored the possibilities of community-based cooperative solutions to deal with the challenge of meeting these upfront investment cost. As a first step, trust games are undertaken in 8 different slums in the city of Hyderabad to understand the trust levels and subsequently a pilot project was initiated to explore the viability of a community-based pooling of financial resources and enable slum households to shift from kerosene and firewood to LPG. Two self-help groups were formed comprising 30 households each in two different slums. The pilot project enabled all the 60 member households to obtain an LPG connection in few months' time.

The results of the pilots suggest that community-based resource pooling can overcome the affordability problem of

urban poor for transition towards cleaner and modern fuels. Importantly, by creating a community-based self-help solution in mobilizing the resources rather than using a conventional subsidy regime, the project is empowering the people to help themselves by using their own social resources. The pilot proved that urban slum dwellers can and are a strong community with well-developed social capital. Also in cities, trust, as a social institution can be an excellent driver for development. This paper reiterates, through this pilot, that it is possible for communities themselves to come up with innovative and sustainable solutions for achieving common development goals. This pilot has tremendous potential for replication in different cities of India as well as other countries elsewhere in the world with a similar LPG marketing mechanism.

P3 C

Urban Environmental Governance and Technology

Re-organizing Urban Space: Towards Sustainable Neighbourhood Transitions

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Urban development during the present decade has been a direct function of the global economic parameters that qualify cities as globally networked centres, amenable to global capital investment. A case in point, are the megacities of India. Kolkata, though called a megacity, falls behind the cities of Mumbai, Bengaluru and New Delhi in terms of landscape transitions that earn accolades for being globally networked, and thus fit to survive. City planners today, are experiencing disconnect between the aims of urban development and the welfare goals set forth by governments. This paper attempts to take a close look at the process of re-organization of space in Kolkata and the essential implications of the same, by examining the neighbourhood as an unit. The study focuses upon the transitions in select neighbourhoods and examines how such transitions affect socio-cultural contexts by creating spaces of consumption instead of creating equitable, liveable neighbourhoods. A neighbourhood-level analysis reveals that that the changes in land use that seem to be directed at urban development, may not always result in creating sustainable urban spaces. Often such developmental projects have been found to create a disconnect and conflict between the older pre-existing social order, cultural ethos and the new emerging socio-cultural parameters. “Gated communities” located in old neighbourhoods have been studied to reveal the nature of conflict. The study proceeds by first mapping the nature of urban transition, based upon which case studies are selected, where interviews and focus group discussions are framed to identify the nature of changes and the citizens’ perceptions of the same. Information has been collected from residents of newly constructed gated communities, but the paper focuses more sharply upon the surrounding pre-existing neighbourhood, to engage in meaningful dialogues with

respondents across different income and social status. The facts that emerge from citizens' perception study cause some concern, primarily because of the increasing gap between the older and newer residents, accentuated by gating of residential spaces, unknown to older neighbourhoods where the rich and poor lived and shared common spaces such as parks, avenues, markets and other facilities. The findings point to a growing sense of despair and it may be concluded that the immediate concerns of urban planners should be to identify how equitable urbanization may be achieved through designing well-integrated neighbourhoods.

Application of Socio-Technical Transition Theory to Understand Urban Sustainability in India

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The paper begins with a research question, why Delhi city has become an entry point of urban transition thinking? It attempts to argue the need to focus on the neglected part of transition studies, regional context of transition. Although this field has attended maturity in the European settings, socio-technical transition theory has been emerging as a new line of research. The existing literature has been mainly confined to the national focus of transition while neglecting the concept of city/spatial location in the transition processes. In this background, Transition theory what so called Multi Level Perspective (MLP) has been applied to explain the experimentation of urban mobility in India. Methodologically, case study has been selected in the Delhi city to understand the historical transition of CNG from Petrol/Diesel in the heart of the city. It argues that the region of Delhi has become a significant spatial location where radical innovation, experimentation and up scaling of CNG technology take place in niche. The case study has found that compressed natural gas (CNG) urban mobility in Delhi city narrates a successful story of urban mobility transition in India and Asia, thereby brining urban solutions of air pollution and climate change in the city, also this case might be significant if will become introduction of possible mobility transition system in India.

Modelling Urban Carrying Capacity and Measuring Quality of Life Using System Dynamics

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India is witnessing massive urbanization not only in large cities but also in small and medium sized towns. As the concentration of population and business of an urban area increases, so do diverse problems and concerns including issues of servicing large number of people within existing resources. Environmental problems, particularly pollution and water scarcity have become more prominent and worrisome in recent times, and are central issues for urban planners and decision makers. This poses a major challenge for policy makers and planners to maintain people's quality of life in a deteriorating environment. To address these complex problems, practical approaches which incorporate the concept of carrying capacity into managing urban development are needed. The urban areas are entities which have great potential of exceeding the local carrying capacity because they require enormous quantity of energy and materials in a relatively small area. Thus, it is prudent to plan the development of cities in line with its local carrying capacity. This paper highlights the dynamic interlinkages between human activities and resources in an urban environment. System Dynamics as a methodology for modelling complex systems is used to understand the process of urbanization (growth in population, business, and construction) and its impact on carrying capacity (water, land, and pollution). It projects possible urbanization scenarios if the current form of growth continues. It also highlights the multiple constraints which may limit urban growth. A composite index (made up of water availability, open space, jobs, and pollution) is used as an indicator to measure the Quality of Life (QoL). Model base runs indicate growth and correction of urbanization in the medium to long run mainly attributable to environment pollution constraints. Even if pollution is cleaned up, other resource constraints (water and open land) become the limiting factors. Reduction in QoL precedes that of population and business in all model runs. This shows that QoL could be used as a lead indicator in planning process. Maintenance of a desired QoL seems to be a far more effective and efficient strategy to avoid an overshoot of carrying capacity.

P3 D

Water for Growing Cities – The Impacts of Urbanization and Climate Change at the Watershed Scale

Rapid urbanization in developing countries poses multiple challenges for the water sector. In analyzing the impacts of urban growth on water resources, many studies have analyzed the direct impacts of water flows between rural to urban areas – both through water supply projects and tanker markets and wastewater return flows. However, cities also transform their hinterlands indirectly by altering land, labor and commodity markets as well as economic activity and access to credit. These factors in turn affect water availability and use and wastewater flows between cities and their hinterland. In addition to the direct impacts of urbanization, there is a concern that global and local climate change may alter the timing and intensity of precipitation and temperatures in and around urban areas with implications for water availability and quality. Understanding the implications of rapid, widespread urbanization thus calls for a multiple-stressor, multiple-concern approach. Drawing on international experiences, this panel will reflect on the broader impacts of urbanization and climate change on land and water resources and the implications for sustainable, equitable resilient water supply.

The Transition from Water Scarcity to Water Pollution in Thippagondanahalli Halli Catchment, India

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By 2050, 450 million more people will reside in Indian cities compared to today. The implications of this massive urban transition for water resources are not fully understood. The policy debate often does not fully reflect the complex nature of human – land and water interactions. The management of Thippagondanahalli (TG Halli) catchment near Bengaluru, India has been a source of policy debate in recent months

following several court rulings. Using a combination of natural and social sciences research approaches, this study evaluates the drivers of change and the implications for goals such as "sustainable and equitable management".

The paper attempts to understand the complex linkages between land, water and people in the TG Halli catchment. It draws on data from a 12-village farm survey to understand drivers of changes in cropping patterns and land uses. The survey data are triangulated against land-use maps derived from satellite imagery. A historical runoff model is used to recreate past inflows into the reservoir. Once the historical model is validated against data, future land-use and population projections are used to model stream flows and sewage inflows into TG Halli reservoir. Various management approaches are evaluated versus multiple normative goals.

Once the main source of water, today the reservoir does not supply any water to Bengaluru city. Inflows into TG Halli have declined sharply since the 1970s. Previous studies suggest that the declining inflows can be linked to the decline in groundwater levels; both because of direct pumping and the expansion of eucalyptus plantations, which decrease groundwater recharge. However, groundwater pumping and eucalyptus expansions have in turn been driven (in part) by underlying drivers such as rising incomes and changing economic opportunities in nearby Bengaluru. On one hand, job opportunities in the city and nearby industrial clusters have made rain-fed farming less lucrative, prompting many farmers to convert their land to eucalyptus plantations and seek work elsewhere. On the other hand, demand for high-value fruits and vegetables have allowed investments in deeper borewells. Thus, the historically declining inflows into TG Halli can be attributed to indirect drivers of urbanization; i.e. via land, labour and commodity markets rather than the actual conversion of land to urban uses. However, in recent years, there are indications of a shift in this trend. There is an increasing inflow of sewage generated by urban settlements within the catchment. In other words, the future fate of TG Halli reservoir is likely to be influenced more by direct drives of urbanization – i.e. actual conversion of land. Any policy on the reservoir must account

for the direct and indirect impacts of urbanization and clarify the goals of management.

Conflicts, Cooperation and Peri-urban Water Security: Towards a Research Agenda for Emerging Indian Cities
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Urbanization processes have created new demands for water; increasingly competition across diverse rural and urban uses is growing. Peri-urbanization processes involve the (re)appropriation of water to alternative uses; they raise new questions for water justice and equity. In a context of increasing climate variability and change, this paper examines the implications of these processes for conflicts and cooperation around water for rapidly growing Indian cities. It presents the elements of a conceptual framework that may be needed to uncover these processes and makes a case for alternative approaches to water governance, to prevent conflict and promote cooperation suited to peri-urban contexts.

Challenges and Opportunities for Urban Water Adaptation Using a Basin Perspective: the Case of Santiago de Chile
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As cities grow, so do their environmental footprints within the basins they are located. Cities consume water and other natural resources to sustain an ever growing population. The fate of these resources suffers from multiple threats, one of them being human extraction. Climate change might affect future water supply for cities. The city of Santiago, located in the Maipo Basin in central Chile, is one of these threatened cities. The main water supply for this city, the Maipo River, is shared by many users (mainly agricultural), and according to recent climate change impact studies streamflow in this river would be reduced due to increase in temperature and reduction in precipitation.
We offer a conceptual model to support this process. The model differentiates between the opportunities within the boundaries

of the city and those that are beyond the city extending to the river basin where the city is located. In the first group of options, we discuss the role that water consumption savings, improvements in distribution, aquifer recharge or reuse of wastewater could have in protecting against excessive extraction and climate change impacts. When we extend the analysis beyond city limits, we find that the portfolio of adaptation options increases to a level that is dependent on the relative location of the city within the basin and in relation to other users. If a city is located closer to the headwater of the basin, the adaptation options are less than in the case when the city is located near the outlet of the basin. In the first case, options are limited to headwater infrastructure building and reoperation and savings-transfers of water from neighbouring users (e.g. irrigation districts also located close to headwaters). In the second case, in addition to those options, the city water supply system could rely on transfers from neighbouring basins, desalination of seawater and use of savings-transfers from a larger set of users.

Using these basin-wide perspectives to assess adaptation options allows the consideration of these benefits but also of some challenges or unexpected impacts associated with the implementation of some of these measures. For example, in the case of the Maipo Basin, an increase in irrigation efficiency and later selling/transfer of saved water to the city of Santiago could be a good adaptation strategy but could also affect users downstream in the basin that were using the "unutilized" water. It is also important to consider that going beyond city limits creates another series of institutional and political challenges for cities that now need to collaborate with different actors and authorities at larger geographic scales, and deal with different and conflicting priorities, needs and dynamics.

Finally, it is important to recognize that although this paper has focused on water supply issues, this basin perspective to analyse climate change adaptation options could also be extended to other types of water-related threats. One clear example is the role that ecosystem preservation close to headwaters could have on preventing floods or erosion and later water quality detriments that could affect the operation of water supply systems for cities and surrounding communities.

P3 E
Urban Ecologies, Biodiversity

Political Ecology of Natural Resource and Its Degradation, Power Relations, Marginalization of Small-Scale Fishing in Mumbai

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Universally, majority of the world's fisheries are small-scale and small-scale fishery sustains the livelihoods of about 200 million people worldwide, nearly 95 per cent of fisheries livelihoods globally. According to Marine Fisheries Census (2010), there are 30 fishing villages, total 9,138 fishing families and 40, 953 populations in greater Mumbai. Process of urbanization and capitalist development in the Indian fishing sector has marginalized or simply wiped out many small-scale fishermen in Mumbai. The repercussions of economic growth are increasingly obvious – displaced communities, over-fishing and decline catch. The fishing industry and fish as natural resource is hijacked by builders (trawler and per cine net owner), which destroy fish species and marine biodiversity in a rapid manner; it affects the coastal ecology. Fishing community has been confronted with an unstoppable barrage of urbanized process and developmental projects, programmes and policies stemming from transnational, national, regional and local conditions. Urbanization has deleterious effect on mangroves and other flora and fauna of the coastal region. Mangroves, forests, salt-tolerant trees and shrubs that grow in the shallow tidal waters of estuaries and coastal areas in tropical regions, form the buffer zone for flood and other natural calamities. It supports to sustain coastal biodiversity. Economic activities such as offshore drilling, aquaculture, and port activities; all affect the coastal ecosystem. The high concentration of people and government in coastal region has produced many economic benefits, including improved transportation links, industrial and urban development, revenue from tourism, and food production, which together affect coastal environment at large. All these activities are governed and controlled by builders and

elites groups in the urban set-up. In case of environmental justice, it is the main concern – who has access to natural resources? Who gets benefitted by all these developmental activities? What type of benefits are they getting? Why not others? How much are the natural resource destructions? All these questions are kept in mind while framing the structure of this paper.

Visitors' Willingness to Pay for Lake Conservation: Evidence from Hyderabad

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Hussain Sagar is a beautiful lake which joins the twin cities of Hyderabad and Secunderabad in India. It was constructed to meet the irrigation needs of old Hyderabad. Later, the lake was converted into a drinking water source. Over many years, this lake has been in news not because of its beauty but pollution. The lake area has shrunk due to encroachments over the years. In addition to this, the lake water is polluted severely due to continuous discharge of untreated domestic sewage and toxic industrial chemicals for several years. The Hyderabad Metropolitan Development Authority is trying to restore the lake. The failure to reduce pollution is partly because of the high cost involved. To find out whether the costs are economically motivated, emphasis must be given to obtain benefits from reduced pollution.

Though number of studies has been conducted to study pollution in the Hussain Sagar Lake, there is not a single study on its impact over the recreational behaviour of visitors. With this background, the specific objective of the paper is to estimate the recreational benefit that may result from controlling water pollution in the lake. A number of recreational studies using Travel Cost Method (TCM) and Contingent Valuation Method (CVM) have been conducted to study how change in water quality changes individual behaviour reflecting improvements in welfare. Here, both revealed and stated preference methods are used to obtain data based on particular quality improvement in and around the lake.

This study surveys a sample of 400 visitors to the Lumbini Park. This park attracts highest number of visitors and also has an access point to the lake. Negative binomial models are used to estimate the value visitors place on recreation. We estimated per trip and per year consumer surplus ranging from INR 780 to INR 2082 for different scenarios. We recommend to the park authorities an increase of entry fee from INR 10 to INR 20. This will increase their revenue earning per year and make it possible to invest the money in lake conservation.

Assessment of Urban Green Space of Bangalore – A Comparative Study

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Urban green spaces, which play a vital role in the health, social framework and economic sustainability of a city require a careful empirical assessment. Ample research shows that trees rejuvenate our mental health and well being by improving air, soil and water quality. This multi-faceted ramification of urban green spaces needs an intricate evaluation approach in an urban policy context. In the current study the combined remote sensing data is employed to investigate green spaces in heterogeneous and challenging urban environments like Bengaluru between 2005 and 2010 using Quick Bird and LISS IV satellite imageries. The main objective of this study is to comparatively evaluate the temporal variation in green spaces across different zones of Bengaluru using NDVI, a key indices for vegetation assessment. Impervious surface ratio (ISR) and Green cover ratio (GCR), the important indexes for estimating the urban heat island phenomenon (Lin et al., 2005; Sun and Lin, 2006) are appraised for both 2005 and 2010 imagery.

Green space showed lot of variations in terms of both quantity and quality between zones in 2005 and 2010 imagery. In terms of area the highest green space in 2005 imagery was observed in Mahadevapura followed by Bommanahalli and Byatarayanapura. The 2010 imagery showed similar pattern in green space distribution. Dasarahalli with high built up spaces showed lowest green spaces followed by East zone in 2005

imagery. But in 2010 imagery, the lowest green space was observed in Dasarahalli followed by west. The West zone showed nearly forty percent decrease in green space between 2005 and 2010 imagery which is the highest and significant among different zones.

The green cover shows rapid depletion from 2005 to 2010 and is more evident in the peripheral zones of the city, where in the rapid expansion of BBMP area and setting up of IT corridors and the ring roads linking different corners of the city have resulted in large scale encroachment of lakes, agricultural fields and barren lands.

The literature on green space of Bengaluru is very scarce and limited there is a lack of reliable data on the availability and determinants of green open space of BBMP. To achieve environmental sustainability, city should increase both its percent green open space and m2 of urban green open space per capita.

Urban Ecology of Delhi: Relationship between Birds and Trees and Their Management

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Cities are generally depicted on the basis of their demographics, socio-economic status, political issues, pollution levels, traffic density, water quality and green cover. In the green cover, lie areas of urban green spaces, which are generally parks, gardens or small woodlands. They could be privately or publically owned. Much development takes place by compromising on green spaces in and around cities, which affects not only the loss of just green cover, but also animal biodiversity. Many of them are not managed properly and have exotic species while some have invasive species such as *Prosopis juliflora* (Vilayati Kikar). With invasive species such as kikar, known to have negative correlation with birds and other exotic tree species growing, architects and landscape designers are now looking to manage these establishments such that they hold native vegetation, attract biodiversity, especially avian and can help in controlling the pollution levels. Albeit few and far

between, the studies correlate bird diversity to the tree diversity, but the basis of the correlation is not established. This study looks into three major urban green spaces in New Delhi and identifies the major native trees suitable for planting in large developments and in urban areas that relate to bird diversity and also evaluate the bird diversity and composition patterns showing relationship of individual trees with various bird species. Birds are important to the ecosystem due to their role as pollinators, plant and animal distributors and biological control agents. From the result, we would conclude the right species of trees to be planted in urban infrastructures which would attract biodiversity. Smart cities' mission launched in India aims to develop models such as walk-to-work and energy saving. Proper urban plantations can provide appropriate solutions.

P4 A

Urbanization, Industrialization and Climate Change; Urban Environmental Governance and Technology

Public Mobility: Enabling Steps for Human-Centered Low-Carbon Societies

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Many countries in Asia are central to the future of a successful climate governance regime. Not least because of their size and being rapidly growing economies, environmental governance in countries such as India will continue to influence the global climate. Simultaneously, and unlike the OECD economies, the prevalent (not only) fossil carbon reality in many parts of Asia (as well as Africa and Latin America) is that of societies living with low and sustainable carbon footprints. This is apparent in high levels of public transport use and non-motorized modes of mobility. That this reality is by default and not design, and that it is under immense pressure given lack of investment and the easy availability of private transport, is a key concern. The challenge for climate governance then is not primarily one of transitioning toward a low-carbon society. Instead, it is one of fostering greater well-being and far greater dignity for citizens within existing widespread low-carbon realities. This focus reorients the climate governance problematic. The existing suite of tools and technological means that populate climate governance, prioritize instrumentalities such as technology transfer, carbon intensity improvement and carbon trading. This rational-choice, techno-economic regime is unable to scrutinize motifs of modernization and progress dominant in the discursive construction of mobility. Nor can it creatively engage and build on notions of human well-being and dignity. It effectively renders pedestrians, bus commuters and street vendors as second-class citizens subject to routine violations of physical safety and personal dignity. Simultaneously, the fleet of private vehicles grows at double-digit rates and their standards of efficiency, power and comfort register remarkable progress, as expected within the transitions narrative. Yet, the

result is hazardous levels of urban air pollution. Building on existing low-carbon realities can help redress this challenge. Such an approach is also imperative given the limited success of instrumental approaches to sustainability in the transport sector of Annex-1 countries. What it needs is a focus on capabilities and fairness to inform governance, in lieu of vague notions of progress and its ecologically modernist material culture of seeking efficient mass consumption and an atomized social milieu.

Introducing Cycling as a Tool for Smart Urban Growth (A Study of Khulna Metropolitan Area)

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This research explores how bicycling can ensure smart urban growth, thereby improving cycling conditions, increasing modal share and ensuring people participation. Khulna metropolitan area, in Bangladesh which serves as a case study is located in the southern part of the country. It is now an upcoming densely populated city and has a current estimated population of around 3.6 million. Almost 80% of road traffic is by non-motorized modes (NMT). Around two-thirds of households have no personal transport, 26% have bicycles, and 7% have motor cycles and only 1.5% own cars.. To maintain this increasing population in the city in a constructive manner and keep its services feasible, a smart growth policy is badly needed. The goal is to introduce cycling for achieving smart urban growth; and the experience of cycling in Khulna may be an ideal example for green transportation system, principally in a developing country. Environmental, social and economical aspects have been considered to construct the linkage between cycling and smart growth. Mainly based on primary data and using software (Excel, SPSS, and Corel-draw etc.), maximum analysis has been completed. From the analysis, it is clear that maximum trips in Khulna can be conducted within 30 minutes and 4 km, which is the major positive condition to adopt cycling. Majority of the advanced groups of people in this city want to adopt cycling to avoid the increasing pressure from motorized vehicles. From this perspective, i.e. the scope and opportunities of cycling, it is clear that Khulna will be a perfect

city to adopt cycling. So, if the government and local government take proper initiatives and work collaboratively to adopt cycling; then the transportation system of Khulna can be possibly free from congestion.

Promoting Cycling for Sustainable Cities

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Sustainable transport is one of the key pillars of sustainable cities. Cities in India face common transport challenges such as growing energy consumption, rising carbon emissions and increasing environmental footprint. Encouraging cycling as a mode of transport in Indian cities presents a mitigation option to address the above issues. Given the positive social and environmental benefits of cycling, encouraging higher cycle ownership and cycle use are extremely desirable to promote sustainability in cities. However, data suggests that cycle ownership and use of cycles is steadily declining in most of the Indian cities. For instance, Delhi has witnessed a decline of more than 30% in its cycling mode share in the last five decades. Transport plan and policy-making process have primarily focused on motorized modes and attention to non-motorized modes has been limited. With the launch of Smart cities initiative and AMRUT scheme, Indian cities have an opportunity to prioritize and encourage use of cycles as a mode of transport and reduce dependence of cities on automobiles.

The paper aims to highlight current state of cycle ownership and cycle use in Indian cities. It also examines reasons for declining trends in cycling in Indian cities. Factors such as inadequate cycling infrastructure, lack of investment on non-motorized modes, lack of maintenance of existing infrastructure, etc. would be discussed based on evidence from different Indian cities. The paper also undertakes a detailed analysis of various initiatives taken up to promote cycling in different cities, for instance, bicycle sharing systems, developing dedicated cycling infrastructure, etc. Based on the findings, the paper makes recommendations for promoting cycling in Indian cities.

P4 B

Culture, Consumption and Sustainability of Cities

Urbanization and the Environment

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Guwahati, in the state of Assam is the largest city of Northeast India, which serves as a gateway to other parts of the region. In the last decade, the urbanization pattern of Guwahati has challenged the dominant notion of northeast India being a peripheral and marginal region. The city is growing in every possible direction, with real estate being the major engine. The possibility of opening up of trade with Southeast Asian countries has made Guwahati an attractive destination for investments. Hence along with capital, there is also an influx of labour, which in turn has led to a struggle over the environmental resources of Guwahati. Guwahati is ecologically gifted as it is situated on the banks of river Brahmaputra and has 18 hills within the city limits. Despite being so, Guwahati faces several environmental issues annually such as artificial flood, landslide, human animal conflict, etc which take toll on average 10 human lives per year.

The blame for such issues is mainly directed at the hill settlements inhabited by migrants from different parts of Assam. The high living cost in the main city area and lack of planning for the migrant population, has made the settlements on the hills inevitable. Such spaces in the urban sphere have become a bone of contention between the settlers and the state as some of the hills belong to the reserve forest category. Several grass root level organizations have come forward in support of the land ownership of the settlers. In contrast to this scenario, realtors are developing the hills in other parts of the city which are being offered at a high market price for the well-to-do citizens. Intrusion of environmental spaces by human activities has led to frequent leopard attacks in the human inhabited areas. While the state authorities had taken up eviction initiative with marginal success, it certainly does not offer a

long-term solution keeping in the mind the livelihood of poor migrants and the fragile environment of Guwahati.

The paper attempts to explore the various legal and environmental implications of the issue and presents the challenges which are faced by third world developing cities in the neo-liberal economic structure. The paper would take into account the narratives of the hill settlers, including their journey to the city and their way up to the hills.

Understanding Adaptation Decisions in Urban Fishing Communities

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Climate change as well as urbanization can adversely impact city-dwelling natural resource dependent communities. The Kolis are the native fisherfolk of Mumbai whose primary source of livelihood is fishing. The community needs to adapt to various changes, such as change in fish catch and extreme events, to sustain their livelihood. These changes are results of multiple stressors, many of which are by-products of urbanisation. Understanding the impacts and drivers of adaptation to change is essential to facilitate sound policy making for such marginalized communities. Availability and implementation of adaptation strategies can be facilitated by ownership or having access to different kinds of capitals or assets: physical, natural, human, financial, cultural and social. Urbanisation can aid as well as hamper the accessibility of these different capitals to a community. The literature suggests that better access to technology, education, health facilities and greater availability of diversification opportunities in urban areas might help communities to adapt and cope with changes. On the other hand, urbanization might weaken cultural and social capital through forced displacement of marginalized traditional communities. Urban governance can also play a major role in building a milieu conducive for adaptation. All

these determining factors of adaptation are not independent and might influence each other. Taking cue from the literature, the present study has attempted to identify the adaptation choices and assess the influence of different factors on adaptation decisions in the fishing community of Mumbai. It is observed, from the Marine Fisheries Census 2010, that the population of Mumbai's fishing community is declining, indicating migration to neighboring areas or abandonment of the profession. Mumbai's fishing population is choosing to quit rather than to significantly intensify or diversify their efforts. A pilot survey was conducted and a logistic regression model was employed to analyze the determinants of intensification adaptation decisions in the fishing community of Mumbai. Preliminary findings suggest that availability of social networks and subsidies are important for adaptation through intensification. The approach of the study can be useful for understanding decision-making in the community. This can subsequently facilitate crafting of livelihood interventions that can assist the community to adapt to multiple changes.

A Cultural Paradigm for Sustainable Development of Cities

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Indian cities are growing at a decadal rate of 31.76% (2001-2011), demographically. Urban areas in India house 377 million people and are expected to accommodate 590 million people by 2030. The extent of transformation yet to take place, especially in Tier II Cities such as Jalandhar, Chandigarh, Pondicherry, Mangalore and Udaipur provides an opportune window for us to support these cities mature in a sustainable manner. The launch of key concepts by our National Government such as Skill India, Clean India and Digital India supported with urban development schemes such as Smart Cities, AMRUT (Atal Mission for Rejuvenation and Urban Transformation) and HRIDAY (Heritage City Development and Augmentation Yojana) are all aimed at aligning our cities with a sustainably conscious development model. It is however critical to deliver this change such that it reflects the inherent

growth principles of the region and its community in order to sustain this transformation in the future.

Evolving around the concept of *Centrality*, it is our hypothesis that every segment of the society has a critical role to play in every stage of urban development. In parallel, different segments of a city keep evolving at every stage of urban development making the development model of a city dynamic and lifelike. The paper analyses these different stages of urbanism, as described below and develops a framework for analysis upon application of Physical, Social, Cultural, Economic and Environmental assets, to nurture a culture of sustainable urbanism.

Stage 1, Childhood: Growth - developing the foundation of a city by providing infrastructure and services hence forming the basis for serving as a nucleus of opportunities in the future.
Stage 2, Adolescence: Consumption-penetration of awareness activities towards an efficient and sensitive urban lifestyle by studying consumption habits of a city and subsequent waste generated
Stage 3, Youth: Change and Innovation - exploring opportunities for innovation using traditional skills and wisdom; allowing for adaptation to a progressive lifestyle while strengthening cultural roots
Stage 4, Middle Age: Economic Impact - market interventions in all sectors of planning and development; cities contribute to ~60% of GDP (likely to grow up to 70% by 2030; Coupled with conscious consumption habits (Stage 2) and innovations in lifestyle (Stage 3), market forces can suitably pave way for green growth.
Stage 5, Old Age: Leadership-sustaining the culture of sustainable urbanization; requires dynamic policy frameworks, which are liberal yet forceful for the desired impact

The above framework derives a set of indicators which provide a roadmap for sustainable development of diverse cities. Consequently, a distinct set of recommendations are prescribed for each stage of urbanization, giving clear signals to every segment of the community to contribute as a whole.

P4 C
Urban-Rural Environmental and Resource Linkages

Capabilities as Justice: Analysing the Acceptability of Payments for Ecosystem Services (PES) through 'Social Multi-Criteria Evaluation'

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'Payments for ecosystem services' (PES) is rapidly becoming a popular governance intervention within natural resource management to align land-use stewardship to conserve critical ecosystem services while simultaneously improving human well-being through the provision of incentives. This has been particularly true in bridging effective water resource management between urban and rural settings. Considerable evidence indicates that complex socio-ecological systems are characterized by substantial uncertainties as well as diverse and conflicting values both spatially and temporally. The market logic of commodifying ecological relationships according to the purely utilitarian values of individuals greatly simplifies this complexity and may result in reinforcing pre-existing inequities. As such, conceiving PES as a social contract built upon the incorporation of technical knowledge and participatory deliberation rather than market principles alone better reflects dynamic socio-ecological systems. This paper introduces two novel components for refining the legitimacy of PES in water resource management. A case study of the Sundarijal catchment located within the Kathmandu Valley of Nepal is considered, where PES has been proposed to improve the quality of water to downstream urban beneficiaries through a transfer of incentives to upstream farmers located within the Shivapuri-Nagarjun National Park.

Firstly, we broaden consideration of human well-being in PES beyond income effects by considering justice as the freedom or capability to 'do and be' whatever is desired. In this manner, 'payment' for ecological land-use stewardship is characterized as the set of incentives necessary which aids in overcoming obstacles determined through individual and collective

perspectives. Secondly, this paper applies social multi-criteria evaluation (SMCE) as a decision-support framework to determine the acceptability and payment vehicle of PES within a set of alternative policy considerations for a complex ecosystem management decision. Through both technical and social evaluations of different management options against a set of criteria, we highlight the legitimacy that different PES designs may have for improving water quality and capabilities for well-being. This research is thus novel in three respects. From a conceptual perspective, we employ Amartya Sen's capabilities approach to critically question the desirability of PES interventions; from a methodological perspective, we incorporate the capabilities approach with SMCE to unravel how alternative management considerations address functioning sets, and finally from an empirical perspective, we operationalize this combination for analysing PES feasibility.

Flood Damage and Level of Urbanization: A District-Level Panel Data Investigation in Bihar, India

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Urbanization, both a driver and consequence of economic growth, can play a vital role in radiating both the benefits of development to rural economy as well as expose rural areas to disasters. The quantity and quality of urbanization in a disaster-exposed zone can be a governance issue and important policy concern. With this motivation, the key objective of this paper is to examine the role of urbanization in determining the vulnerability of flood hazard in Bihar, in conjunction with other socio-economic factors while taking into account both geospatial and temporal settings. Bihar, located in eastern India, while recording considerable increase in growth, has maintained sluggish growth in urbanization in the last two decades. The level of urbanization in Bihar is quite low compared to the national average, with relative asymmetry in urbanization levels and growth among the districts. We have used the conventional risk-hazard model to understand the role of urbanization in vulnerability by using 12 years longitudinal data of all the districts. Defining risk as the expected loss of

lives resulting from the interaction between natural or human induced hazards and existing vulnerability conditions, we used count panel data regression model. Besides the role of urbanization, we investigated the role of physical, climatic, and socio-economic factors in determining the vulnerability. Notably, we use Digital Elevation Model (DEM) to overlay the survey of India map to estimate the point as well as average elevation and slope of each district under ArcGIS framework. As most of northern Bihar's districts are recurrently flooded by rivers originating from Nepal before their confluence with the river Ganges, we incorporate various spatial dummies to incorporate spatial and hydro-meteorological factors under GIS modelling. The results show that rainfall, water levels and discharge significantly and positively explain the loss of lives. In contrast, a percentage of forest and district domestic product exhibited significant negative relationship. The result shows that exposure to vulnerability increases in areas with high rainfall and geographically surrounded by areas with significantly high rainfall in its neighbourhood and upper catchment. Further, higher level of vegetation is likely to save significant number of lives. The district domestic product has a negative and significant relation showing that the adaptive capacity of the population increases with higher income. However, our study found level of urbanization showing an insignificant relation highlighting the fact that at the macro scale, level of urbanization does not play a significant role in increasing the vulnerability to flood damage.

Urban Growth and Access to Coastal/Marine Resources along the Coastal Karnataka

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Coastal and marine ecosystems are the backbone of fisheries economy as it supports livelihoods of approximately 2 million directly and indirectly. India is endowed with a coastline of over 8,118 km, continental shelf of 0.5 million square km and exclusive economic zone (EEZ) of 2.02 million square km. Urbanization, industrialization and modern fishing methods are threatening the sustainable livelihoods of fishermen

communities. Indian coasts are undergoing changes in geo-physical and socioeconomic characteristics, due to increased competition by different stakeholder groups with varying levels of economic and social powers. The regulations governing coastal physical space such as coastal regulation zone notification 2011 and other environmental regulations although tries to minimize the developmental activities within 500 meter zone, there is ample scope for undermining the claims of physical space (open space, coastal commons, beach space and wetlands) by the traditional coastal communities for their livelihood. The Karnataka coast represents a case of competition and conflicts among unequal stakeholders leading to physical changes in land use and land cover affecting the traditional communities. There are 144 marine fishing villages, 96 landing centres and 30,713 households with substantial percentage of fishers dependent upon small-scale fishing operations in open water bodies including the sea, rivers and creeks, as well as in fish trading, processing and related activities. With the setting up of thermal power plants (UPCL, Padubidri, Udupi district), special economic zones (MSEZ, Mangalore), ports and harbours (New Mangalore port), tourism resorts and hotels (Gokarna) and shrimp aqua farms (Kumta), the Karnataka coast has undergone tremendous change in its capacity to provide ecosystem services and also livelihood to traditional communities. The traditional fishers are also experiencing restriction and loss of access to fishing grounds due to the recent industrial deep sea fishing policy of the state and promotion of various mariculture enterprises along the coast supported by the state-sponsored fisheries research and development activities. The alienation of small-scale fishers with the industrial development drive has left them marginalized. This study focuses on the impact of coastal land use/land cover changes on the livelihood of the traditional fishers, governance of coastal and marine fishing spaces.

The Effect of Infrastructural Facilities Development on Efficiency of Primary Educational Institutions in Urban Areas

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The government of Bangladesh is spending an outsized part of the primary education budget on developing the infrastructural facilities of primary educational institutions. As urban primary educational institutions are more accessible than the rural ones, the development of the infrastructural facilities is rapid in urban areas compared to the rural areas. In this paper, the effect of infrastructural facilities on the efficiency of primary education institutions is evaluated by using Stochastic Frontier Production Model with random effect and inefficiency effect models. Efficiency is measured with infrastructural and without infrastructural facilities among the institutions located in urban and rural areas. The result show that the efficiency of primary institutions with infrastructural facilities in urban areas (93%) is better than institutions without infrastructural facilities (45%). Moreover, in absence of infrastructural facilities, the efficiency of both urban and rural institutions decreases significantly. This study also describes the significance of variables included in the infrastructural facilities on primary education efficiency. Hence, this study assesses how the elements of urbanization are affecting the basic or primary education efficiency in Bangladesh.

P4 D

Regulating Industrial Water Pollution through Standards and Targets: Insights from India and China

In rapidly growing economies such as China and India, industrial water pollution poses a major environmental challenge. In both countries, various efforts have been made to address this challenge: passage of acts, setting up of regulators, and implementation of pollution reduction programmes through various means. This set of papers explores some conceptual issues in the regulation of industrial water pollution, especially in an urbanizing context. Together, these papers hope to provide insights into principles and practices used in the regulation of industrial water pollution.

Rethinking Irrigation Water Quality Standards in the Context of Urban Streams

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Most Indian cities lack basic wastewater treatment infrastructure, resulting in urban rivers receiving sizeable portion of the domestic and industrial sewage. The water from these rivers is often used by downstream farmers for irrigation purposes thereby posing a risk to human health. The Central Pollution Control Board of India (CPCB) has clearly laid out the water quality standards for different uses of river water, including irrigation. In addition, CPCB has also specified the effluent standards for discharge in surface water, public sewers, oceans and reuse standards for irrigation purposes. However, there are several gaps within and discrepancies between these prescribed standards. We illustrate these problems using examples from the Vrishabhavathy river in the city of Bengaluru, the capital of Karnataka state.

The Vrishabhavathy receives partially treated industrial and domestic wastewater from the western portion of Bengaluru

city. This water is mainly used by farmers in downstream villages for agricultural purposes. We present data on the chemical and biological quality of the Vrishabhavathy river. We then compare these values with the standards set for irrigation water. We identify the following issues:

a) Gaps: Though the levels of toxic heavy metals and faecal coliforms are dangerously high posing significant risk to farmers as well as urban consumers of the food grown by the farmers, the river is classified as 'fit for irrigation' as per CPCB standards. Water meets the irrigation water quality standards set by CPCB, because CPCB assumes 'natural river flow' when setting this standard, whereas flows in urban streams are often dominated by partially treated domestic and industrial effluents.
b) Discrepancies: The standards set for effluent reuse for irrigation are completely different from those set for irrigation use of surface water. The effluents reuse standards comprises eight parameters including heavy metals such as arsenic and cyanide. However, surface water used for irrigation should only comply with water quality criteria comprising four water quality parameters that do not include heavy metals. Rivers that carry partially treated sewage from cities to downstream farming regions fall through the cracks: they are neither conventionally understood rivers nor conventionally defined effluents.

Our analysis calls for re-examination of the irrigation water quality standards so as to ensure health & well–being of farmers & urban consumers and make the effluent discharge standards consistent and compatible with irrigation water quality standards for downstream use.

State Planning and Water Pollution Control in China: Is It Sufficient to Improve China's Water Quality?

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China has heavily relied on state planning in tackling its severe industrial water pollution. At the centre of the state planning

process are the overall five-year plans (FYPs) for social and economic development. Following the release of the general FYPs, the Ministry of Environmental Protection (MEP) develops its own environmental FYPs. The concept of total emission control was initially proposed during the 8th FYP (1991–1995) and has been translated into numerical reduction targets since the 9th FYP. These targets were largely aspirational until the 11th FYP when they became binding agreements with provincial governors and managers of major state-owned enterprises. This presentation reviews the setting, allocation, and implementation of water pollution reduction targets with a focus on the mandatory reduction targets during the 11th and 12th FYP. It also analyses the pros and cons of using mandatory numerical targets in controlling China's industrial water pollution. The challenges in reconciling water pollution control targets to be established in the 13th FYP (2016-2020) and the national "Action Plans of Water Pollution Prevention and Control" issued in 2015 will also be discussed.

Tirupur's Journey and the Impact of 'Zero' Coming into Fashion

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The demand for textiles is increasing globally and most production occurs in countries characterized by low minimum salaries and poor environmental law enforcement, but also freshwater scarcity. During the early 90s, exports from Tirupur, Tamil Nadu, exploded and the town became an important generator of employment, wealth and polluting effluents. Since then, the town and its surroundings are deeply integrated into a global production network that feeds domestic as well as international retail chains. Today, its textile sector involves thousands of small and medium-sized units and more than 500,000 workers. However, the non-biodegradable, chiefly untreated discharges from the hosiery industry started to prevent the use of local water resources for both irrigation and drinking purposes already in the late 80s.

Authorities and courts have for long been facing increasingly difficult water allocation decisions, and reached out for new effluent treatment technologies and methods of enforcement. The industry's severe impact on the Noyyal River and local aquifers has been subject to repeated court reviews. Policy measures on Common Effluent Treatment Plants (CETP) did not quite succeed in creating a sustainable path of growth. In 2006, the Madras High Court for the first time explicitly ruled that a treatment system regarded as the best practice, Zero Liquid Discharge (ZLD), was to be implemented. Following a contempt petition, the Court in 2011 directed the closing of over 700 dyeing and bleaching units.

Save for some state-of-the-art units, many dyeing and bleaching industrialists have remained reluctant to adopting new techniques, some preferring to dispose of effluents along the eastern coast through a hundreds of kilometres long pipeline. In the aftermath of the 2011 closing order, many resorted to outsourcing the dyeing to units located outside the region – with ensuing workers' layoffs and generally reduced growth.

ZLD was developed in the USA some 40 years back along with advances in membrane filtration and reverse osmosis. Further refined for use in the textile industry during the 80s, courts and authorities began stipulating its use for the Indian fashion manufacturing around a decade later. Today, the feasibility seems a matter of energy access for evaporation more than one of closing the water cycle.

This paper reviews ZLD as part of a larger study on Tirupur's industrial revolution of the last 25 years; applying transition theory to analyse the development from a multi-level and multi-scalar perspective and investigate the interlinked places, processes, institutions and actors.

P4 E

Air Pollution, Solid Waste and Human Health

Potential Greenhouse Gas Emission Reduction from Municipal Solid Waste to Energy in Kathmandu Valley Nepal

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Solid waste treatment is one of the major environmental problems faced by many municipalities of Nepal. The Kathmandu Valley, which includes the capital metropolitan city along with one sub-metropolitan city and three other municipalities, has been a national economic and employment centre. Rapid urbanization and a complex pattern of settlement with a high population density cause a day-by-day increasing waste generation. Therefore, conversion of municipal solid waste into energy is promising as it helps to reduce greenhouse gas emission into the atmosphere and it provides cost-effective, efficient and sustainable energy services in developing countries.

This paper explores conversion of municipal solid waste into energy; thereby capturing landfill gas to generate electricity as well as to determine greenhouse gas (GHG) emission reduction and its potential benefit to the socio-economical and environmental aspects. Landfill gas, mainly methane is created by anaerobic decomposition of municipal solid waste in the landfills. The decay of organic waste produces gas consisting of approximately 50% methane. When untapped and unmanaged, this gas can is released into the atmosphere, which poses a threat to the environment and human health. Nepal is a developing country and the amount of municipal solid waste generated (0.45kg/capita-day having 70% of organic content) is on the increase due to a continuing significant increase in population. Prevailing practices of waste treatment are riverbank dumping, open dumping and disposal of waste in landfill site without methane recovery facility. As a result, significant amount of GHG (95462 tCH_4 from 5711,599 tons of deposited waste in 20 years from five municipalities of Nepal) is

being released into the atmosphere. Besides such emission, it can have significant adverse impact on public health and environment.

Similarly, this study reveals environmental benefits such as GHG emission reduction of 46.1% (44087 tCH_4) by capturing landfill gas to generate electricity (94.1Gwh) and increasing the aesthetic quality of environment by avoiding release of offensive smell to local environment. Also, the study explains the economic benefit (Internal Rate of Return (IRR) 18% and payback period 13 years) of country by developing methane recovery from landfill site project as a clean development mechanism (CDM) project. Furthermore, the study emphasizes that energy generation from local resources ensures environmental sustainability as the solid waste is not only a local resource but also known as discard resource and could have significant importance by meeting the energy needs and energy security of a country as well as mitigating adverse climate change effects.

Transformation of Waste into Energy in the Pabna Municipality Area of Bangladesh: An Economic Valuation

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Waste is a part of the natural environment but it is becoming a serious issue in many municipality areas. Similar to other municipality areas, Pabna has been experiencing rapid population and economic growth which led to unprecedented levels of consumption and consequently, waste generation. Pabna is facing waste management crisis. Conditions and resources for waste management are severely strained in this city. As societies become more affluent and urbanized, communities become more congested and waste composition becomes more complex which make it problematic to continue dumping because it now leads to negative impacts on human health and environment. As a common scenario of waste mismanagement and negative environmental impacts from the landfilling by waste in Pabna city, it is essential to reduce GHGs

emissions from landfilling and development of renewable energy supplies that are drivers for alternative waste management strategies. This study sets its objectives to assess the perceptions and preferences for waste management in Pabna, evaluate differences between landfilling and waste-to-energy (WTE) in terms of economic and environmental costs and benefits and explore the range in parameters that support the feasibility of WTE. This study carried out both the secondary data and household interviews (n = 301), followed by a structured questionnaire and used the First Order Decay Model, cost–benefit analysis and sensitivity analysis to generate empirically supported assessment. Provision of tipping fees, waste tax, willingness to pay for waste collection and electricity bill for using electricity generated from the waste can help to improve the transformation of waste into energy project in the Pabna city.

This study considers specific and relevant ways to transform waste into energy to generate empirically supported explanations, identified negative impacts of open dumping of waste and formation of waste policy in the Pabna city of Bangladesh. The findings of this study will provide a robust basis for policy makers, planners, researchers, government and development partners for further research, project implementation of transformation of waste into energy, develop specified policies to lessen the emission of GHGs, building a resilient and sustainable waste management and establish a low carbon society.

Strategic Management of Household Waste and Local Government: A Cross-Country Analysis

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Attempts to manage urban solid waste in the past decades have concentrated on designing of the first best instruments for waste reduction at source and/or diverting waste from landfills. However, in reality the policy options adopted by the local bodies often show considerable spatial variation and deviation from these first-best options. This difference arises not only in terms of the variants of Pay As You Throw schemes but in terms

of recycling arrangements for non-biodegradable waste as well as treatment options for organic waste. In this paper we account for this policy heterogeneity by locating the waste management practices adopted by different municipal authorities in an integrated strategic framework. Our study also attempts to identify the influence of social, economic and demographic factors in this regard using cross-country case studies.

We envisage the waste management strategy of the local bodies as one of sharing different responsibilities with the household along different stages of the process viz., collection, processing and disposal through effective bargaining. The crucial issue is the division of treatment cost between the household and the local civic authority. In fact, depending on the growth of market in municipal services both the household as well as the local body may decide to outsource part of these processing activities to the external agents and an institutional arrangement of public-private-partnership may evolve. The prospect of this new institutional arrangement crucially depends on the feasibility of decomposition of the municipal services into different specific sub-services where market can be allowed to specialize in each sub-service to reap the advantage of scale economy. The part of the holistic municipal service, which cannot be delegated in this way, has to be retained in the hand of the local body in the form of a pure public service (good).

We use country wise data base on waste management regulations as well as the country case studies to identify the variations in the sharing arrangements between households and the municipalities in urban areas of low-income, middle-income and high-income countries. The variations in policy choices are explained in terms of the access to the state of the art waste management technology, the socio-economic factors influencing the level of development, degree of urbanization, demographic concentration and last but not the least, the climatic condition.

P5 A

Urbanization, Industrialization and Climate Change

Dengue, Weather and Household Coping Strategies in Delhi

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Similar to most of the cities in the world, Delhi is also vulnerable to health impacts of climate change. Among the climate-sensitive infectious diseases, the vector-borne disease dengue is most prevalent in Delhi and occurs regularly. This generates the need for designing adaptive strategies to address the future incidence of dengue. Development of adaptive capacity by institutions requires correct and well-evaluated information on the coping strategies or immediate, short-term response by the households. This study makes an effort to determine the relationship between weather and dengue incidence and evaluate coping strategies adopted by the households of Delhi. The impact of weather on dengue incidence is modelled using Poisson regression model with subsequent prediction of the probability of dengue incidence in different months of a year. Data of dengue incidence and weather variables during January 2008 to May 2013 has been used. Coping strategies adopted by the households in response to the incidence is evaluated for the impact of weather and other determinants using a probit model. Responses received from 559 households surveyed from the last week of January to first week of March 2014, across different zones and categories of colonies in which dengue is most prevalent, has been used in the analysis. The survey aimed at eliciting information on coping strategies adopted by households, socio-economic and demographic status, surrounding environment, awareness level and interventions.

Findings of the analysis reveal a strong association between lagged weather variables and dengue incidence confirming weather sensitivity of dengue incidence in Delhi. Further results of the probit regression for coping strategies revealed that the household decision to adopt coping strategies was

positively and significantly influenced by the weather, per capita income, awareness and inspection by civic bodies. Fogging, typically a reactive measure carried out only after the cases have been reported, had no significant effect on coping strategies. With increasing awareness level, households adopt coping strategies more specific to dengue. Expenditure on repellents varied depending on months in which used and timing of usage. The study provides inputs for the timings, location and type of intervention required to build the adaptive capacity by institutions.

Flood-Induced Economic Loss and Damage to the Textile Industry in Surat City, India

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Indian coastal cities are susceptible to climate-induced rapid and slow-onset disasters such as cyclonic storms, floods and sea-level rise, all while existing urbanization challenges amplify vulnerability. Enhancing a city's resilience capacity is, therefore, a pertinent issue for policy makers when there are plans to redevelop several of India's cities into 'climate smart' cities – this needs a comprehensive city-wide loss and damage assessment. For empirical purposes, this study attempts a loss and damage assessment of Surat city, an industrial hub for both textile and diamond industries, in western India to floods. Interviews of 145 owners of textile weaving units were completed, including focus group discussions and shared learning dialogues. The advantage is that this study estimates indirect loss and damage and considers compensation as a positive externality – mostly ignored by the disaster assessment agencies in India. This study finds five conclusions: (i) all the sample units were severely affected by floods which occurred in 2006, and on average, these units took 49 days to return to normal, (ii) most of the labourers out-migrated during the post-flood scenario, and hence, shortage of labour was reported as a major issue, (iii) the mean loss and damage of an unit was approximately INR 1.51 million where INR 0.98 million was

towards direct losses, INR 1 million was towards indirect losses and compensation accounted for INR 0.47 million (at 2013 price) – this urges the need for indirect losses to be factored into the disaster's impact cost assessment, (iv) all the surveyed units are unable to access insurance as the companies are reluctant to insure those industries located in the risk-prone areas, and (v) weaving units' risk perception about potential impacts from future floods is moderate, which may lead to lack of investment in planned adaptation measures. In doing so, one can assess the city's resilience capacity to future disasters, and such an initiative could be an eye opener to policy makers, so that this can be replicated in other cities.

Urbanization and Resilience in Coastal Ecosystem Based Economy

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Coastal ecosystems have important ecological, social and economic functions contributing to welfare of the communities. The wide variety of economic activities, which prevails along the coasts, has either direct or indirect connectivity with the coastal ecosystems through provisioning of a diverse range of goods and services. However, these systems are permanently under pressure due to natural and anthropogenic threats. Often, it gets exacerbated by rapid urbanization process of the coastal economy. In this context, how to build resilience of coastal communities is a major research question. Resilience can be realized through reduction of vulnerability and risks and implementation of proper adaptive measures. Adaptation can be through reduction of risk and vulnerability, or building adaptive capacity. Adaptation requires adequate information on risks and vulnerabilities in order to identify needs and appropriate adaptation options. Adaptation options can be implemented either to modify the drivers or exposure and vulnerability or both. The types of governance structures, their specific roles and degree of interconnectedness become vital for enabling the system to adapt and thereby making it more resilient. This paper discusses these challenges with a case

study of Digha-Sankarpur-Mandarmoni coastal belt of West Bengal. This coastal region is characterized by high population density, considerable shift in the pattern of economic activities over the last few decades, high degree of dependence on the coastal ecosystem services along with extraction of resources. In the last few decades, this region has experienced rapid shift of economy from major traditional activities of agriculture and fisheries to the booming tourism sector along with expanding fisheries sector supplemented by use of modern technologies.

Will India's "Smart" Cities Be Resilient to Climate Change?

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India's "Smart Cities" programme emphasizes the role of cities as engines of economic growth. It envisions cities that are economically competitive, attract investment, provide infrastructure, and generate revenues. However, will such cities be resilient to climate change? Or could such urban development lead to inequitable access to natural resources and services, reduced resilience and maladaptation, and technological lock-in into high carbon pathways?

This paper addresses this question through a multi-dimensional framework of urban vulnerability to climate change. Based on secondary data for 160 Indian cities, we apply an indicator-based approach and multivariate statistical analysis to explore relative vulnerability to climate change at the city scale. The choice of indicators takes cognizance of unique features of cities such as economic connectedness, market dependence, resource footprint, and occupational diversity. The paper also examines how the relative vulnerability of Indian cities has changed between 2001 and 2011. Simulation techniques are used to unpack the trade-offs between economic competitiveness and environmental sustainability.

We show that various factors moderate the relationship between assets and vulnerability, and highlight the importance of ecological capital, social capital, and economic diversification. The analysis indicates that to be climate resilient, the "smart cities" of the future need more than high aggregate levels of wealth or assets: cities with diversified economic opportunities will be better equipped to adapt to the new risks posed by climate change. This supports earlier research showing that cities heavily relying on a single resource or exported commodity have low potential to adapt while economic diversification facilitates knowledge transfers and fosters innovation. The results also caution against urban planning and infrastructure creation that are devoid of ecological considerations. In many cities, for instance, due to the encroachment of drains, streams, and lakebeds, heavy rainfall events (which are projected to increase due to climate change) frequently lead to traffic disruption, loss of work hours, water logging of homes, and increased risk of water-borne diseases.

P5 B

Culture, Consumption and Sustainability of Cities; Air Pollution, Solid Waste and Human Health

E-waste Mitigation and Management in India: Synthesis of Stakeholders' Perspectives

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The estimated global production of e-waste is at about 41.8 million tonne in 2014 which is projected to touch 50 million tonne in 2018. It is projected that India will be among the largest producers of e-waste in coming days. E-waste management in India is intricate, given the nature of stakeholders and their competing interests. This necessitates a deeper understanding of stakeholder dynamics for devising effective e-waste management and mitigation strategies.

Stakeholders are "persons or groups with legitimate interests in procedural and/or substantive aspects" of any activity. Accordingly, we identify five stakeholders/ stakeholder groups for the e-waste scenario:

1. Government authorities (government departments, regulatory bodies, local and national authorities, Public Sector Undertakings)
2. Private Sector (suppliers, manufacturers, vendors, formal recyclers, bulk consumers)
3. Consumers (individuals and households)
4. Informal sector (repairers, resellers, scrap dealers, collectors, processers, dismantlers)
5. Civil society groups

We then classify each stakeholder as either "affecting" or "affecting and affected" or "affected". The classification is guided by degree, temporality, and directness of the impact of each stakeholder on the current e-waste scenario and vice-versa. The informal sector is classified as the most *affecting and affected* stakeholder and all others as *affecting* stakeholders.

We make a case for active and open participation of informal sector in mainstream e-waste management, with arguments from the stakeholder theory. From the instrumental viewpoint, we argue that activities of informal sector can potentially translate to significant economic and environmental benefits. Further, the participation of informal sector as a legitimate stakeholder is normatively justified, keeping in with the idea of environmental justice. Based on instrumental and normative justifications, we suggest that mainstreaming of informal sector is not only environmentally just, but also socially responsible and economically efficient.

Finally, we suggest directions in terms of future roles of stakeholders towards e-waste mitigation and management. Firstly, we believe there is need for more studies to document and quantify the economic and environmental contributions of the informal sector. Secondly, the Government and private sector need to recognize the informal sector as a legitimate stakeholder entitled to participate in mainstream e-waste management activities. Mainstreaming would include formalization of informal units, facilitated by Government and civil society groups; and funded— in part or fully— by the private sector and consumers. Thirdly, we emphasize on co-operation between (formalized) informal units and formal recyclers as opposed to competition.

Predicting Ecologically Conscious Consumer Behaviour among Indian Urban Consumers: Application of Theory of Planned Behaviour

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The rapid economic growth in the past years have witnessed increasing consumers' consumption worldwide causing environmental deterioration through over-consumption and utilization of natural resources. It is anticipated that if the current trend of economic growth, urbanization, and

irresponsible consumption pattern continues, the environmental degradation would worsen with the consequences of global warming, depletion of stratospheric ozone layer, pollution of sea and rivers, noise and light pollutions, acid rain and desertification. Many studies explored that urbanization is today emerging as a significant influence on ecologically conscious consumer behaviour. Since consumers themselves are major contributors to environmental degradation and pollution, consumers need to be ecologically more conscious and responsible in their consumption behaviour. However, despite the continued growth of environmental movement all over the world, it has yet to make its impact on the consumers of many countries including some developed ones. As one of the leading emerging countries, India is experiencing rapid economic growth with urbanization and changes in consumption pattern that are claimed to contribute to environmental deterioration. As a result, it is vital to explore the antecedents of ecologically conscious consumer behaviour of Indian urban consumers in order to better design marketing and other policy strategies to promote pro-environmental consumer behaviour. This study is a pilot phase that collected data from a sample of 114 respondents residing in New Delhi, Hyderabad, Kolkata, and Chennai. Using the Theory of Planned Behaviour (TPB) as a theoretical framework, this study finds that consumers' attitude towards environment and perceived effectiveness positively influence behavioural intention which in turn positively affect ecologically conscious consumer behaviour in the context of Indian urban consumers. As a pilot study, this study does not suggest any policy guidelines. However, the final phase of the study would recommend possible policy implications suggesting on what aspects of ecological behaviours marketers and other concerned policy makers need to focus on educating and persuading Indian consumers to engage them in ecologically conscious consumer behaviour.

Policy Instruments for Electronic Waste Management under Extended Producer Responsibility Framework: A Review and Lessons for India's e-Waste Rules

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The end-of-life disposal of electrical and electronic equipment (EEE) (or e-waste) is turning out to be a major urban environmental problem, particularly in emerging economies such as China and India, which are among the fastest growing markets for EEE. Extended producer responsibility (EPR), in which the producers are made responsible for the end-of-life disposal of EEE, is a widely used approach to manage e-waste, both in developed as well as developing countries. Within the EPR framework, a range of policy instruments such as mandatory take back, recycling rate targets, and deposit-refund systems are adopted by various countries to ensure environmentally safe disposal of e-waste.

India's e-waste (Management and Handling) Rules, 2011, which came into effect in May 2012, use EPR framework for e-waste management, which is currently dominated by informal markets. Under these rules, the producers of EEE must provide facilities (i.e., waste collection centres) for consumers to return the products after their useful life and ensure that the collected e-waste is channelled through formally registered recycling and/or dismantling centres. The Ministry of Environment and Forests has recently proposed amendments to the 2011 Rules and one of the main new provisions is the introduction of deposit–refund system to be implemented by the producers.

We review the theoretical literature on policy instruments within the EPR framework to first show that the simple mandatory take back provision in the 2011 Rules does not provide incentives to either the producers or the consumers to ensure safe collection and disposal of e-waste. Subsequently, we analyse the incentive effects of other policy instruments compatible with the EPR framework. We then draw on the empirical literature on implementation of various policy instruments to draw implications for EPR policy design and implementation in India.

P5 C

Smart Cities, but for Whom? The Loss of the Commons and Urban Vulnerability

'Commons' evoke a rural imagery, but common property resources (CPRs) in cities contribute significantly to livelihoods and wellbeing of millions of urban residents. These urban CPRs range from lakes, rivers, parks, groves, remnant forest patches and avenue trees. In coastal cities they include ecosystems like mangroves and salt pans. Urban ecosystems provide a range of ecosystem services categorized as provisioning, regulating, supporting and cultural services that are critical for human wellbeing and the resilience of the most vulnerable.

Among these, the regulating, supporting and cultural ecosystem services receive consideration in urban planning, including air quality, regulation of climate, and open spaces for recreation. Scant attention is paid to provisioning services that includes subsistence use for food, fodder, fuelwood and medicine, or the support of traditional livelihoods like grazing, fishing and agriculture. These provisioning services of commons, accessed primarily by urban poor and migrants, are critical for survival of these marginalized groups in the city environment.

However, growth of cities, both unplanned and non-inclusive, has brought about a transformation of urban CPRs, undermining the provisioning ecosystem services they provide. Urban CPRs are either viewed as prime real estate or alternately prioritized for recreation. While the former contributes to development induced displacement, an all too familiar occurrence in cities today; the latter smacks of bourgeoisie environmentalism, again an increasing trend.

Cities are undoubtedly nodes for economic growth, as recognized by the vision for the much talked about 'smart cities'. However, in achieving these goals, what is being ignored is both a practical approach that addresses issues of environmental sustainability and an empathetic approach that undermines equity.

This panel will draw on the work done by scholars on urban commons to present a critical analysis of the trends in transformation of urban CPRs. The objective is to generate a wider debate on alternatives to the current model of urbanization and urban CPR utilization that not only emphasize a model of urban growth where the commons takes center stage: a model that is socially inclusive and environmentally sustainable.

Land, Water and Power: The Demise of Common Property Resources in Peri-urban Gurgaon, India

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This paper describes how urbanization processes and urban expansion intersect with social and power relations to reduce the access of periurban communities to common property resources (CPRs). Unequal power structures mean that certain groups are deprived of access to village CPRs. Processes of urban expansion further reduce access to CPRs, as the latter are acquired to support urban expansion. Though rural–urban transformations are characterized by the emergence of new sources of irrigation such as wastewater, not all are able to benefit from them. The acquisition of common property grazing lands to support the drinking water needs of the city affects the livelihood of livestock dependent population, that shift to casual labor. This also translates into a shift from grazing, the domain of men in the household, to stall-feeding, the domain of women, and thereby creating additional responsibilities for women in natural resource collection. The demise of CPRs such as village ponds with the increased pressure on groundwater resources increase the drudgery of women and marginalized groups in accessing water. This paper highlights four key features of depleting CPRs in periurban Gurgaon: (1) urbanization processes reduce the access of periurban communities to common property resources; (2) unequal power structures cause deprivation of access to village CPRs to certain communities; (3) demise of CPRs leads to transformation of gender relations; (4) alternative models of urbanization are prerequisite for the protection of commons.

Commons That Provide: Multiple Uses and Vulnerabilities of Bengaluru's Urban Commons

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India is rapidly urbanizing, and its cities are seen as the main contributors to economic growth and employment generation. The 'smart cities' model with a focus on high quality infrastructure, and information and communication technology, is being extensively promoted. But the model pays little attention to environment sustainability. Cities are dependent on its ecosystems such parks, remnant forests, wetlands and lakes for a range of ecosystem services. These ecosystems are also urban commons that support provisioning services critical for traditional livelihoods and subsistence use of urban residents from different socio-economic backgrounds. However, the emphasis of planners and policy makers has been to conserve urban ecosystems for recreation, conservation and aesthetic purposes. This paper draws on research conducted over a decade (and continuing currently) in urban and peri-urban Bengaluru. Commons that includes lakes, gunda thopes (wooded groves) and open spaces in slums were studied to understand the dependence on them especially by urban poor and migrant workers. Lakes in Bengaluru support livelihoods of agriculturists, grazers, fishers, dhobis and brick makers. Lakes are a source of water for household use and most dependent on them are migrant workers who often have no alternate water sources to meet their daily needs. The land around lakes and gunda thopes are used to source fuelwood and fodder, while fruits from trees in thopes are consumed by surrounding residents. Different varieties of green leafy vegetables are collected from the lake bed contributing to household diet. Open spaces in slums are also used to grow a variety of vegetables, spices and medicinal plants that are included in daily meals. Thus, the livelihoods, food security, health and well-being of impoverished urban groups are especially linked to the range of provisioning services of these urban commons. However, urbanization has placed immense pressure on these spaces. The conflicting imagination of uses

of these commons that prioritizes one kind of use over another has also raised concerns of equitable access. Commons are being converted to public spaces or enclosed and gated, with limitations placed on the extraction of water, fodder, fuelwood, fish and fruits, thereby alienating traditional and vulnerable users. The paper argues for a different envisioning of the environment and planning process that prioritizes provisioning ecosystem services of urban commons to meet the dual goals of ecological sustainability and social justice.

New Claims on the Coastal Commons: Contestation, Marginalization of Fishers and Fisher Spaces, and Environmental Degradation in the Mumbai Metropolitan Region

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This paper draws from an ongoing project that seeks to understand the various ways in which new geographies of law as well as their willful violations and amendments result in contestations over the coastal commons in the Mumbai metropolitan region. India's coasts are undergoing a momentous process of socio-economic change that involves many new and competing claims on space and resources. This is accompanied by the development of new governance arrangements based on spatial zonation, which have now become the subject of intense societal debate. The fishing population of India has especially been worst affected, and they have responded both institutionally and organizationally to the set of new claims that are being imposed. The new coastal claims exacerbate the diverse pressures on fisher livelihoods and survival as well as coastal commons that are already under severe stress due to coastal erosion, changing tidal patterns, loss of biodiversity, and ecological degradation, in a context of competition and conflict over fishing grounds involving fishers from other parts of Maharashtra and India, as well as global commercial fisheries. Amidst these vulnerabilities and insecurities, environmental legislation such as the Coastal Zone Regulation Act and its various amendments have played multiple and often contradictory roles in redefining access to

and the use of coastal resources. From a sociological perspective, the role of the state, inequalities related to class, caste, and livelihoods, economic growth imperatives, and environmental transformations are seen to impact the coastal commons and create new contestations even as older conflicts remain unresolved.

Coastal fishing villages and related commons in the Mumbai region are facing a double jeopardy from conservation interests and development imperatives – with fishers being marginalized and alienated from their work places and residential areas because of conservation needs and development projects. An attempt to understand these contestations raises a number of research questions which are currently being studied. What are the different types of resources under stress from new coastal claims and developments? What are the new claims both internal and external to coastal zones and fishing communities? How have coastal commons been conceptualized and governed locally, and in what way have their legal status assisted the successful claims to these areas and resources? What is the role of environmental legislation, their violation, amendments, and the state's failure to implement these laws, in environmental degradation, and marginalization of resource dependent groups? This paper will elaborate some of these questions prior to carrying out more field research to respond to such questions empirically and theoretically.

P5 D
Urban Water: from Source to Disposal

Patterns and Drivers of Household's Water Consumption in Coimbatore

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Coimbatore similar to many other rapidly expanding cities in India is characterised by inadequate water supply. Households meet their water requirement by accessing multiple sources – both formal and informal. The poor water supply situation is largely caused by combination of low-level equilibrium trap in the domestic water sector and the lack of perennial water sources available to the city.

However, there is little information on the various water sources and the actual quantity of water use at household level in Coimbatore, which might be used to improve allocation and management. We examined the patterns of water sources used and the drivers of water use among households in Coimbatore. A household's decision about which source(s) to use and how much water to draw from each source depends on both supply side and the demand side factors. On the demand side, the socio-economic status of the households and their existing water infrastructure (overhead tanks and sumps) will drive the choice of source mix. On the supply side, it is location of the households (high water supply areas vs. low water supply areas), which will determine their choice of source mix.

A primary survey was conducted among 579 households in 10 out of 100 wards after an extensive pilot survey. The survey was designed to gather data on households' socio-economic characteristics, various sources of water used, the cost of accessing water, and the quantity of water drawn from each source. A major challenge in such surveys that of quantifying water use from non-metered sources. To address this, metering experiments were also conducted; first, to measure the actual quantity of water supply for households which are non-metered

and second, to measure the litres per minute (LPM) of water extracted from borewells. This data will be used to match the data from the primary survey.

Preliminary results suggest that households with access to in-house water service connections consume significantly more water than those households that depend only on public sources (public standpipes and public water tankers). Although in-house connections are found to be the most commonly used water source in the study area overall, the low-economic class households were the dominant users of standpipes and the high-economic class households were the dominant users of borewell. Finally, the economic class of the household and in-house infrastructure seem to drive the choice of water source more than its geographical location.

Fetching Pails of Water: Examining Households Choice of Drinking Water Sources in Urban India

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Extending universal coverage of safe drinking water for the bourgeoning urban population is one of the major development challenges in India. The NSS 69th Round documents that though 95 percent of the urban population in India uses improved source of drinking water, there are significant variations in the ease of access. In fact, 47 percent of the urban inhabitants are yet to receive individual pipe water connection and almost one-quarter of the urban population does not have any drinking water source within their premises. However, allocating time/resource to fetch quality water from a distant source would involve tightening of time-income budget constraint for the household and can lead to offsetting changes that may outweigh the benefits from improved source. Similarly, social and economic factors such as awareness and income level might constrain individual efforts to connect to the piped water network. Current policy dialogues in India advocates supply side measures such as minimizing transmission leakages for ensuring increased availability of potable water. However, without having informed guesses

about the factors that influence access to drinking water sources, it might be difficult to gauge the effectiveness of such policy measures. We attempt to model the choice of drinking water source in urban India using a nationally representative data of 14,796 urban households from Indian Human Development Survey (2005).

We estimate a Multinomial Logit Model of choice of water source for the subsample of households without any drinking water source in their premise to assess the relative probability of choosing ground water sources and uncovered sources of water over piped water. To account for the opportunity cost of fetching water, we use several measures of time as explanatory variables viz., time to reach the nearest source, waiting time at the source as well as normalized measures of household income and assets. We also construct an index of media exposure at the household level to capture the influence of awareness level on source choice. Next, we estimate a PROBIT model for the full sample to analyse the determinants of getting connected to piped water network. As water supply is provided by local government institutions, we expect households' social connectivity to be a crucial determinant of access to publicly provided water connection. To this end, we include an index of political and social network as other explanatory variables to account for the possibility of elite capture after controlling for endogeneity bias.

Drinking Water in Urban India: A Study of Deficiency, Quality and Some Social Implications

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Although India is on track to meet the target on reducing the percentage of people without sustainable access to safe drinking water, it is still struggling to keep pace with population growth and ever-accelerating urbanization. It has been reported that 95% of Indian households have access to improved source of water (NFHS-3); but it does not ensure access to safe drinking water. It is also reported that 50.7% of urban households have access to piped water supply at their premises but access in non-slum and slum areas is 62.2% and 18.5%,

respectively. Sanitation and wastewater services, which lag way behind water access in policy priority as well as delivery, also add to the problem. Against this backdrop, this intends to assess the status of the drinking water supply in urban India; keeping in mind the related problems of reliability of the source, quality of water and the measures adopted by the people and the state to overcome such problems. The paper discusses the past trend and the present status of the availability of drinking water across the states in urban India. The command of the users over the sources and their perenniality and sufficiency are also discussed. Lastly, issues such as water usage and water quality particularly related health problems are analysed. The data used in this paper are taken from various NSS and NFHS reports. Among other urban infrastructure, water holds a very special place. In cities today, large infrastructure and considerable investment are required to transport, treat and distribute water. At the same time, in contrast to the highly capital-intensive water industry, local resources are available and can be used by all. Such technical and economic aspects which are strongly embedded in social and cultural dimensions and cannot be treated in isolation are often ignored while designing delivery services.

There is no doubt that water and sustainable development are inextricably linked. Once viewed as an infinite and bountiful resource, water today defines human, social and economic development. Therefore, water requirements for the increasing urban population need to be assessed. Accordingly, effective water management strategies should be devised and necessary reforms for implementation of such strategies should be undertaken.

Sustainability of Urban Water Supply and Sanitation in Dryland Areas – Case Study of Indore City

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The attainment of financial, environmental and social sustainability of urban service provision is a problematical project nowadays. Given the huge investments that are being made in the improvement of urban infrastructure and services

it is of the utmost importance that these investments are made to bring about the greatest good of the greatest number in a sustainable manner. Within urban infrastructure the supply of water and its disposal after use has become very important because water has to be brought from distant sources and the wastewater needs to be treated before being discharged into natural water bodies or rivers both of which are very costly propositions. In dryland areas which are physically water scarce and constitute some 70 percent of the country, the problem becomes even more acute as the costs associated with setting up and running water supply and sanitation services go up exponentially. Thus, there is a need to study in depth the financial, environmental and social aspects of water supply and sanitation infrastructure and services in big cities in the dryland areas. The situation is particularly problematical in this regard in Indore which is the largest city of Madhya Pradesh. The city is situated on the dry Malwa Plateau which is naturally water scarce, similar to most parts of western, northwestern, central and peninsular India. This paper critically reviews the financial, environmental and social sustainability of urban water supply and sanitation infrastructure and services in the city of Indore based on an analysis of the municipal corporation budgets and water supply and sanitation data. Finally, after discussing various successful decentralised alternatives both global and local, suggestions are made for a more equitable and sustainable water management system for Indore.

P5 E

Urban-Rural Environmental and Resource Linkages

Changing Dynamics of Water Negotiation in Midhill Towns of Nepal: A Case from Dhulikhel

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Nepal hill towns face unprecedented water scarcity due to rapid population growth and escalating demands of water for domestic and industrial uses. Traditional local sources are proving inadequate to meet these growing needs. Water has been sourced to towns through negotiated agreements between downstream town users and upstream communities, such as at Dhulikhel, the case we examine in this paper. However, agreements have gradually become a source of conflict between upstream and downstream communities. Earlier agreements are being critically questioned by upstream communities as a result of growing water scarcity and uneven development between the up- and down-stream, with upstream communities demanding revisions that take into account changing social, economic and political contexts of communities.

The Dhulikhel Drinking Water Supply Project, which is widely perceived as one of the most successful community-governed drinking water projects in the mid hills towns of Nepal, is considered herein for the empirical case in this paper. Our ongoing study explores the multiple factors that have placed under strain the original 1992 arrangement for water resources. These include changes in national political landscapes, clashing water values, misinterpretation of water rights and deteriorating public trust in local institutions. In this present context, past arrangements have been questioned and no new criteria have been agreed for negotiating between upstream and downstream communities, and as a result, the sustainability of water supply is jeopardised. This paper analyses and outlines possible negotiation pathways to settle

water-based disputes based on empirical field data and literature review.

Waterscape: Urban & Rural Reconfigured

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In the wake of rapid changes which characterize world demographics, easily observed in terms of emerging cities among the third world countries such as India, urbanization poses new challenges on the availability of shrinking resources such as water. Water shortages, competing demands, anomalies in distribution, etc., are some of the issues which have been perplexing the planners and technocrats in many growing cities across the global south. These invariably result in contestations and conflicts around the much precious blue gold. Water transfer emerges as a solution where huge volumes of water are diverted from the hinterlands to the booming urban centres. Such transfers are emblematic of the dichotomy between the city and village which engulfs the development narrative. However, interactions and linkages between the urban and rural become crucial as they are a continuum rather than discreet spaces. Spatial configurations of the urban and rural boundaries collapse as the area witnesses implicit and explicit relationships which evolve due to such dependence and exchange in a newly configured waterscape. Deploying the idea of waterscapes, this paper argues that the socio-natural relations are established and evolve through the register of water transfer in the city and its hinterland. This paper using qualitative methods further illustrates that it is through the everyday politics of water supply embedded in the connections, relationships, and processes which leads to challenges within a dynamic waterscape as in the case of Udaipur (Rajasthan, India). Indeed it is productive to examine the idea of evolving urbanism which stretches beyond the given limits of urban boundary through these linkages. Examining the case of urbanizing Udaipur (Rajasthan), this paper aims to elucidate that the waterscape is constantly being made and remade through the circulation of water across seemingly separate urban and rural terrain. Indeed in this waterscape, many local factors reshape the city and demonstrate the newer geographies

of the urban centres where larger political economy of production and consumption of water become the propellers of further urbanization.

Issues and Implications of Water Diversion from Rural to Urban Areas: A Case Study

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Water diversion from rural surface water resources to urban cities is prevalent all over the world. One such case is the Chennai Water Augmentation Project I (also known as the New Veeranam Project). The project was implemented in 2004 and since then, around 180 MLD of water has been diverted from Veeranam irrigation tank to Chennai city to fulfil increasing drinking water demand due to rapid urbanisation. Although it is necessary to give priority to drinking water demand in urban areas, it is also important to look at the opportunity costs of water diversion. Veeranam tank provides various ecosystem services such as water for irrigation, fisheries production, ground water recharging, recreational services and allied agricultural activities (livestock production, duck rearing, etc.). Due to the poor performance of the government in managing the tank, various ecological issues such as siltation, encroachment in the catchment area, and water pollution occur, leading to the deterioration of water resource in the long run. The state government forbids local communities to access enough water for irrigation so as to transfer water to Chennai city. This leads to economic losses for households that depend on the Veeranam tank for various income earning opportunities. This paper analyses the ecological and economic issues pertaining to water diversion from Veeranam tank to Chennai city. Further, this paper argues whether market based instrument i.e. Payment for Ecosystem Services (PES) Scheme can be a viable strategy to eliminate the economic losses faced by the tank's stakeholders and simultaneously overcome the ecological losses of the tank.

Impact of Technology, Population and Urbanization on Cropland Expansion: Panel Data Evidence from Post-Green Revolution in Andhra Pradesh

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A key challenge for sustainable development is how future population can be fed healthily and sustainably. Feeding a rapidly expanding population with increasing industrialization and urbanization driven affluence will require a sustainable increase in production of agricultural commodities. Increasing demand of land for urbanization and food production may lead to the degradation of natural and social environment unless technology helps to spare land for alternative activities such as industrialization and urbanization. Technological intervention in agriculture has not only increased per hectare production (yield) (land saving) but it has also reduced fallow period to increase effective supply of land (land augmentation). This study assesses the evidence that land saving and land augmenting aspects of green revolution technology have spared land from agriculture at sub-national scale. We investigate the impact of change in combined energy yield of major crops and cropping intensity on agricultural expansion defined as annual change in cropland area for 20 districts of Andhra Pradesh over the period 1970-2009. We develop a variant of I = PAT equation, an extensively used tool in environmental economics, which states that change in demand for land for agricultural operations is an outcome of change in population, per capita affluence and technology. This variant is used to derive a functional form for econometric application. Second objective of the study is to examine impact of urbanization on cropland expansion in order to understand interconnection between technology and urbanization to drive land-use change.

Photography Exhibition

Living at the Margins of Bengaluru's Lakes: Untold Stories of Change, Loss and Hope

This photography exhibition has evolved from a research study about the use of ecosystem services by residents of low-income settlements located at urban lakes. The study was conducted between May and November 2015 by Marthe Derkzen from VU University Amsterdam in collaboration with Harini Nagendra and Seema Mundoli from Azim Premji University in Bengaluru. The photographs tell the stories of those living at the margins of Bengaluru's lakes: in low income settlements that include former villages, migrant clusters, and settlements that are a few decades old. While those at the margins of lakes are often blamed for the degradation of these lake ecosystems, they are also preserving and often increasing native biodiversity and open space – something quite uncommon in a modern metropolis like Bengaluru. This photo exhibition tells their untold stories, narrating their experiences of loss, hope and stories of change.

The photographs have been taken by Arati Kumar-Rao, Marthe Derkzen and Anoop Bhaskar. This initiative is supported by Azim Premji University, USAID, Ashoka Trust for Research in Ecology and the Environment (ATREE), and VU University Amsterdam.

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