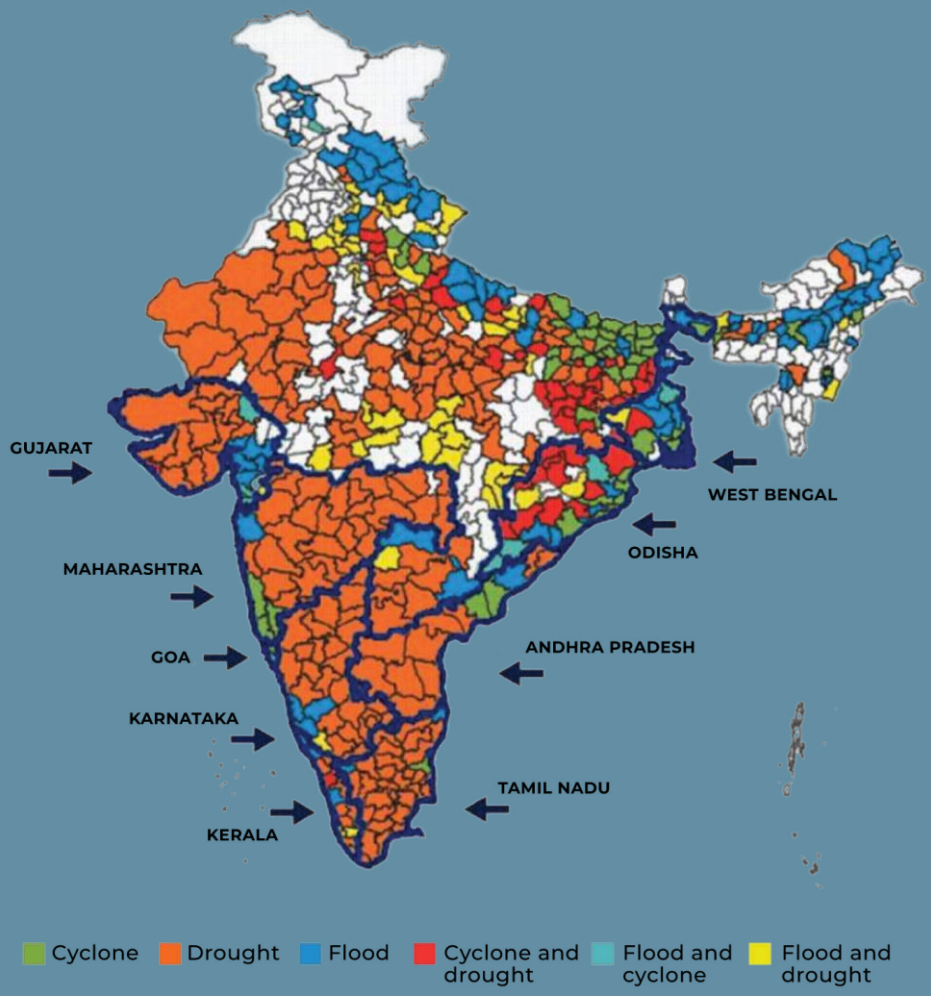
REPORT:

Climate Resilient Urban Sustainable Habitats (CRUSH) Workshop

Dept. of Electrical Engineering,
Indian Institute of Technology (IIT) Delhi

Image Source: Mapping India's Climate Vulnerability, CEEW 2021



UofT INDIA FOUNDATION

July 5th, 2024

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INTRODUCTION

Climate Resilient Urban Sustainable Habitats (CRUSH) in the Indian context

Over 70% of the world's population is expected to live in cities by 2050. India is on a similar trajectory, with its urban population experiencing a six-fold increase since 1951. The Indian Census estimated 350 million people inhabiting peri-urban areas along India's plains, coasts, hills, and deserts in 2021. With this number expected to only increase, Indian landscapes will be rendered increasingly vulnerable to climate stressors and hazards. These developments will in turn impact livelihoods and wellbeing of communities within these ecosystems. Thus, sustainable solutions are critical toward ensuring safety and security of communities as well as the ecosystems that house them.

At the University of Toronto India Foundation (UTIF), we recognized a need to initiate conversations around sustainable habitats and facilitated a dialogue among a trans-disciplinary community of researchers, architects, urban planners, and entrepreneurs to highlight best practices and approaches backed by experience and research. Dr. Karan Singh (Head - School of Cities, India) highlighted the role of The University of Toronto's (U of T) School of Cities' (SoC) program in Canada toward mobilizing expertise; actioning knowledge; marshaling data and ideas; and transforming them into instruments of change.

In line with U of T's endeavors to bridge gaps between evidence and practice, UTIF convened a day-long Climate Resilient Urban Sustainable Housing (CRUSH) Workshop in partnership with SoC; Indian Institute of Technology, Delhi (IIT-D); and Tata Trusts Housing on July 5, 2024, at the Department of Electrical Engineering, IIT-D, Hauz Kaus. This workshop aimed to foster dialogue and knowledge exchange between researchers; urban planners; civil society-, social sector- and government representatives and explore solutions for sustainable, climate-change resilient habitats.

The CRUSH workshop featured speakers from diverse regions with experience in conducting research- and devising implementation approaches for sustainable urban housing. The workshop aimed for our speakers to navigate sustainability from policy- and planning-; financing-; construction-; and livelihood generation for livelihood generation perspectives within the Indian context. The workshop also aimed to provide insights into data- and technology- based monitoring approaches for climate shocks and disaster response grounded in community-involvement.
UTIF envisaged this workshop to build a bridge between U of T academicians and an incredible ecosystem of researchers, scholars, civil society actors, and NGOs in India to solve these problems with a long-term vision of delivering engineering -and technology-based solutions. This workshop aimed to be a catalyst that initiates a dialogue on promoting a climate-change resilient future for India.

SETTING THE STAGE...

Keynote Address

Prof. Debolina Kundu, Director (Additional Charge) - National Institute of Urban Affairs

"By addressing urban planning with a focus on climate adaptation, cities can transform their vulnerabilities into strengths, creating resilient urban environments that can withstand and mitigate the impacts of climate change."

Speaker Bio: Dr. Debolina Kundu is Director (Additional Charge) - National Institute of Urban Affairs (NIUA), and Country Investigator - India for the GCRF Centre for Sustainable Healthy and Learning Cities and Neighborhoods. She is a member of various committees formed by central and state governments, including the Fifth Delhi Finance Commission. She is the chief editor of journals - Environment and Urbanisation, Asia (SAGE) and NIUA. She was a Co-Chair of the Task Force on LiFE, Resilience, and Values for Wellbeing under the G20 Think Tank initiative. She has over 25 years of experience in development studies and has consulted with organisations across the world on urbanization, migration, urban development policies, municipal finance, social protection, governance, and exclusion.

Prof. Debolina Kundu's keynote address provided a comprehensive overview of contemporary urbanization in India; the critical need for climate-resilient urban planning; and various initiatives undertaken by NIUA to address these challenges.

Prof. Kundu touched upon India's rapid urbanization, noting that 50% Indian population will inhabit cities by 2047. Cities contribute to around 70% of the national Gross Domestic Product (GDP) and are slated to play a key role in India's goal of becoming a 5 trillion-dollar economy by 2028. She nuanced the interplay between rapid urbanization; the stress caused by consumption–production loop on ecosystems; and the impact of climate change on heightening vulnerabilities of an ecosystem. She emphasized that safeguarding natural ecosystems ravaged by urbanization can improve health and wellbeing of habitats and nurture a habitat's resilience to climate shocks.

Prof. Kundu recommended environment-centered approaches that factor in the diversity observed in each region. She shared initiatives undertaken by NIUA in collaboration with community-level stakeholders; local government bodies; and civil-society organisations:

- Initiating the Climate Smart Cities Assessment Framework, implemented by NIUA, which focuses on urban planning, green cover, biodiversity, energy efficiency, mobility, air quality, water management, and waste management. The framework helps cities translate data into informed decision-making.

- Parvatmanthan (Churning Mountains)- a collaborative platform for inclusive and climate-resilient sanitation solutions for representatives from the Indian Himalayan Region

- River City Alliance: A partnership that advocates integrating rivers and water bodies into urban planning by creating urban river management plans and sustainable water management practices.

- The Master Plan for Delhi 2041, supported by NIUA, advocates a green-blue factor for building plan approval; wastewater treatment and reuse; renewable energy, and improving pedestrian and cycling infrastructure.

- Development of an urban river management framework, flood vulnerability assessments and climate action plans for cities

Dr. Kundu's emphasis on symbiotic associations of integrated planning; proactive climate resilience; and collaborative efforts with sustainable urban habitats contextualized the workshop and UTIF's overarching aim of this endeavor.

I. INDIAN HILL REGION

A structural engineer's standpoint on sustainable development in the hills: Challenges and opportunities in Mandi and Kangra, Himachal Pradesh

Dr. Kaustav Sarkar (Associate Professor, School of Environmental Engineering, IIT Mandi)

Speaker Bio: Dr. Kaustav Sarkar holds a Ph.D. from IIT-D. He is an Associate Professor at the School of Civil and Environmental Engineering, IIT Mandi, and has over a decade of experience in developing and delivering courses related to materials, design, and computational aspects of structural engineering for under- and post-graduate students. His primary research interests are durability design of structures and sustainable concrete production. His work has contributed substantially toward mapping exposure severity; facilitating sustainable design; and managing steel and concrete structures in India.

In his presentation, Dr. Sarkar outlined structural and environmental challenges unique to hilly regions of Himachal Pradesh. He emphasized the damage inflicted on infrastructure due to the confluence of natural hazards (like floods, cloudbursts, earthquakes and others); changing population trends; and lack of awareness of building principles amongst local communities. He emphasized the association between unsafe/improper construction practices and heightened risks rendered to public infrastructure when faced with climate shocks.

Dr. Sarkar discussed the role of awareness, planning, and technology to mitigate these challenges. He presented the case of the Kotropi landslide which occurred in 2017 but was indicated as potential threat by satellite imaging data since 2001. He shared IIT Mandi's work in harnessing technology to deploy early warning systems (low-cost solar sensors embedded in soil that measure soil movement and rainfall) that notify residents of potential climate shocks via SMS-, light-, and buzzer alerts.

A multi-pronged approach to sustainable, inclusive and climate-resilient urbanization: People's Science Institute's work in the Indian Himalayan Region in Uttarakhand

Lead Speaker: Dr. Debashish Sen (Director, People's Science Institute, Dehradun)
Ms. Shristi Mahar (People's Science Institute, Dehradun)

"Building climate resilience requires identifying vulnerable areas, conducting participatory risk assessments, implementing context-specific interventions, establishing appropriate institutional systems, and ensuring proper monitoring. Convergence and capacity building of local urban bodies are crucial for effective implementation."

Speaker Bio: Dr. Debashish Sen is Director of People's Science Institute (PSI), Dehradun, a non-profit research and development organisation. He holds a Bachelor of Technology Degree in Agricultural Engineering from Allahabad Agricultural Institute, India and a PhD from the Wageningen University, The Netherlands. He has been actively involved in watershed-based livelihood development programs; promotion of agro-ecological practices; and participatory groundwater management in the Himalayan and Bundelkhand regions of India. He has authored over 50 papers and articles on issues related to natural resources management, participatory watershed development, mountain-appropriate technologies, traditional water sources, and drought management.

Characteristics of Indian Himalayan Region (IHR)

Fragility

Inaccessibility

Marginality

The misery is exacerbated due to:

Urbanization

Climate Change

"CRUSH", Indian Institute of Technology (IIT) Delhi, New Delhi, July 5, 2024

Dr. Debashish Sen and Ms. Srishti Mahar of the People's Science Institute (PSI) discussed the impact of climate change and urban development in the context of the Indian Himalayan Region (IHR), and Uttarakhand. Uttarakhand is the most rapidly urbanizing Himalayan state in terms of population and number of towns. Residents—especially the urban poor—experience routine water shortages (stressors: drying springs, reduced river flows, and falling groundwater); infrastructure loss (stressors: landslides, flash floods, and waterlogging); and reduced agricultural yields (stressors: erratic rainfall, irregular winter rains) which have contributed to increased health issues and loss of livelihood among inhabitants.

Additional Farm & Off Farm Livelihood Interventions

Bee Keeping

Sewing & Knitting

Community based Tourism

S. No.	Activity (Households)	Additional Value (Rs.)	Avg. Income /HH (Rs.)
1	Production of vegetable, spices, pulses (1070)	29,13,050	2,722
2	Bee keeping (38)	52,465	1,380
3	Sewing & Knitting (223)	3,96,580	1,778
4	Homestay (17)	2,25,000	13,235
	Total	53,56,695	

"CRUSH", Indian Institute of Technology (IIT) Delhi, New Delhi, July 5, 2024

PSI's multi-pronged interventions aim to protect the environment with involvement of local inhabitants within IHR. Their interventions include engineering-based solutions to rejuvenate drying springs; vegetative and social measures; and rainwater harvesting via environmental- (ponds) and community-centered (house roofs) approaches. PSI has also identified income-generation/agrarian livelihood alternatives such as tourism and apiculture for IHR inhabitants.

Dr. Sen's talk highlighted the stakes held by local communities in fostering sustainable climate change action and emphasized the importance of community-centered participatory approaches in building a community's resilience to climate shocks.

Participatory Risk Assessment

Water User Group's Training

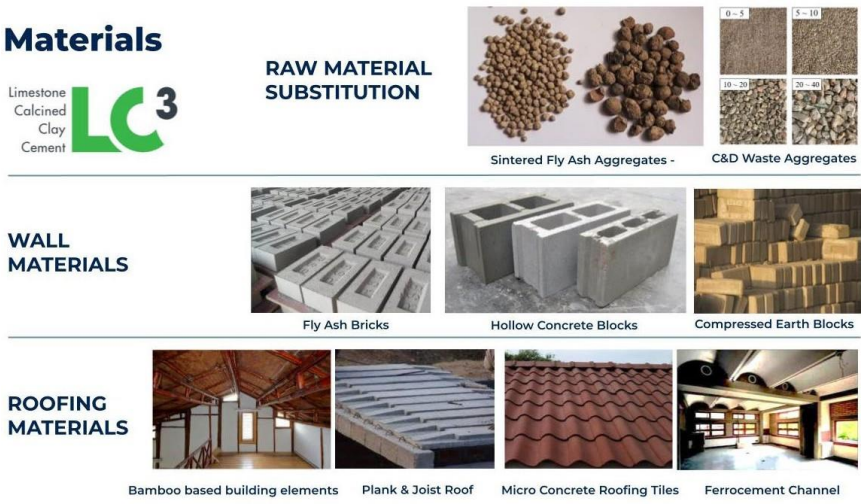
II. THE COASTAL REGION

Transforming the built environment with climate resilient materials, technologies and practices: Development Alternative's work in sustainable habitats

Mr. Mohak Gupta, Assistant Program Director, Development Alternatives

Speaker Bio: Mr. Mohak Gupta studied architecture at Sushant School of Art and Architecture and is an urban development professional with experience in applying sustainability principles to urban space management and resource governance. He is an Accredited Professional with the Indian Green Building Council. He is also a Member of the Bureau of Indian Standards Planning and Housing Sectional Committee (CED 51) and the 'Global Circular Economy Roadmap' on Consumption by Chatham House. He currently works on conducting action-based policy research and providing planning support for transitioning to low-carbon pathways; developing inclusive green economies; integrating concepts of climate resilience; circularity, and resource efficiency across sectors.

Mr. Mohak Gupta presented strategies to align habitat development in coastal regions with sustainability from a climate-change centered lens. Mr. Gupta highlighted the increasing vulnerabilities of human settlements in coastal regions to climate shocks and ecosystem degradation. Informal settlements— often constructed in flood-prone and geologically unstable areas—are further impacted by high residential density and overcrowding.



He presented Development Alternative's work spanning 3 years toward rebuilding 900 houses across three villages struck by a tsunami in 2008 in Tamil Nadu as a best-practice model. Under this project, Development Alternative adapted a multi-focused approach that combined technology-based interventions with community-focused capacity building and participatory consultative processes with the community. These approaches were implemented via planning exercises and led the team to develop master plans for implementation at the regional- and village level. Their strategies facilitated sustainable water management for each building and community spaces/ green areas for the settlements in Tamil Nadu; these were constructed using environment-friendly and economical materials such as fly-ash blocks.

In Odisha, the team engaged decentralized service banks services- and production banks that oversaw technical expertise and training hubs for artisans and local professionals. These centers utilized local expertise for construction and production. In summary, Mr. Gupta's talk focused on a combination approach that was community-centered; utilized sustainable construction options; and adopted a strategic approach to policy and finance for building climate resilience.

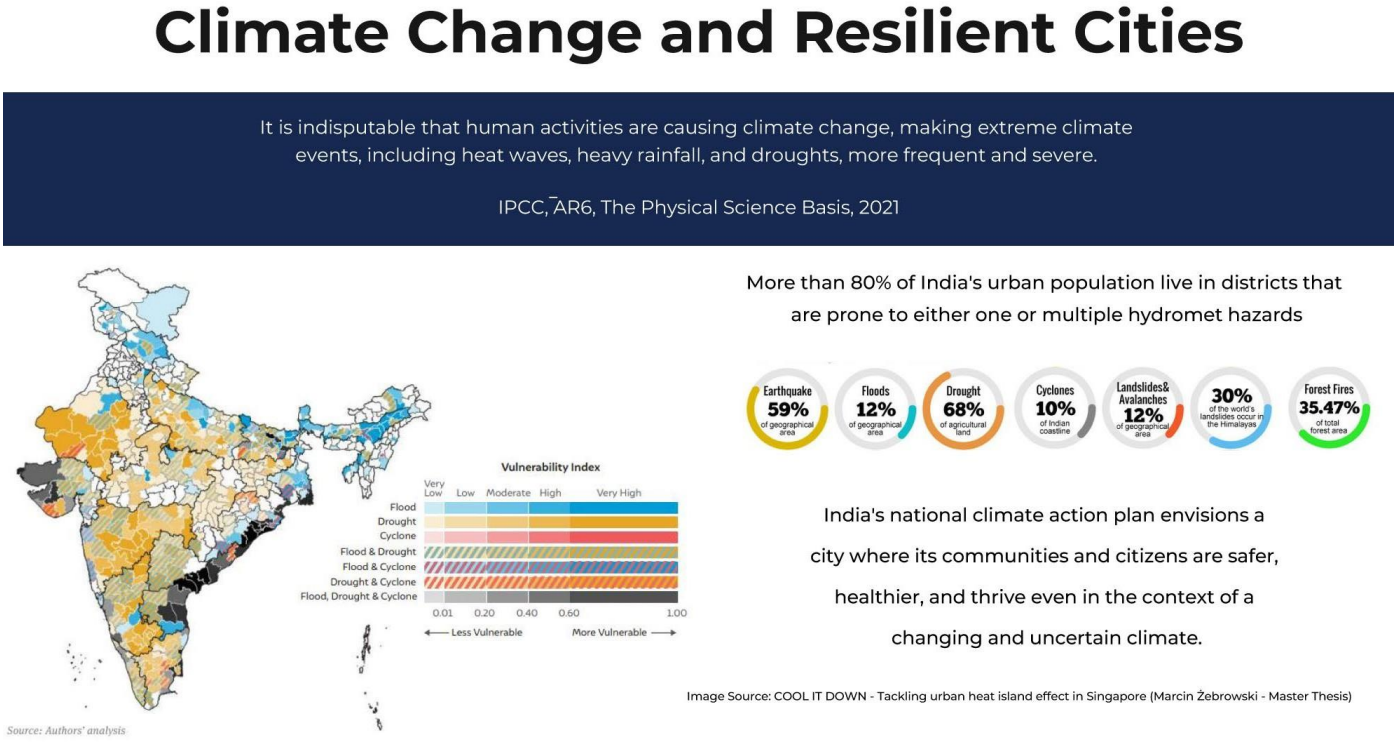
Multi-directional impacts of climate change on Indian cities: Aga Khan Agency for Habitats' green infrastructure solutions in India's coastal areas

Madhukar Sanap, Head - Emergency Management and Development Programs, Aga Khan Agency for Habitat

"India has the largest coastline of 7500 kilometers, and almost all of the states are coming under the high-risk area, and every year the coastal area is getting affected by some other type of disaster…"

Speaker Bio: Madhukar Sanap leads Emergency Management and Developmental Programs at Aga Khan Agency for Habitat India. As a social anthropologist, his expertise includes policy, finance, and government relations. Madhukar has presented research at conferences, significantly contributing to climate action, disaster risk reduction and sustainability domains. He excels in climate action, disaster risk reduction, and environmental sustainability, collaborating with governments and humanitarian organisations. Madhukar is pivotal in humanitarian networks, designing disaster programs and coastal restoration initiatives. He has responded to disasters, offering support and long-term recovery solutions.

Mr. Madhukar Sanap highlighted Aga Khan Agency for Habitat's experiences, challenges, and innovative strategies for fostering sustainable urban habitats along the country's coastal areas, while ensuring the resilience and well-being of communities. While Aga Khan Agency for Habitats traditionally worked in disaster management, they have pivoted to an adaptive, multidimensional approach to climate resilience as a response to the effects of rising sea levels, extreme climate events and coastal erosion. Their in-house GPS team conducts comprehensive hazard assessments in over 300 villages and cities, and they also encourage surface and groundwater management through check dams, contour bunding, and other structures.



Within coastal regions, Aga Khan Agency for Habitat works closely with local community groups; government agencies; civil society organisations to promote nature-based solutions like the plantation of native mangrove species for carbon sequestration; storm surge mitigation; preventing saline water intrusion into agricultural areas; and reducing soil erosion and landslide risks. A notable example is Enviroshala School Resilience Program that engages young students in climate change action.

Mr. Sanap emphasized the importance of community involvement, green infrastructure, and a strategic approach to policy and finance for building climate resilience.

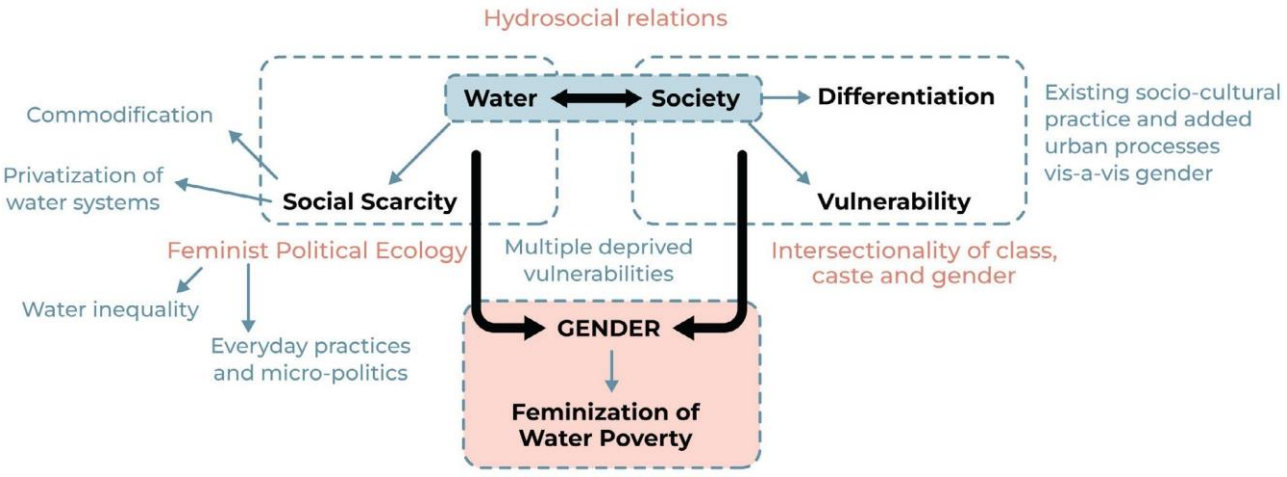
Gender and Climate Change Action

Manjula Bharathy - Professor Centre for Urban Policy and Governance The School of Habitat Studies, TISS, Mumbai

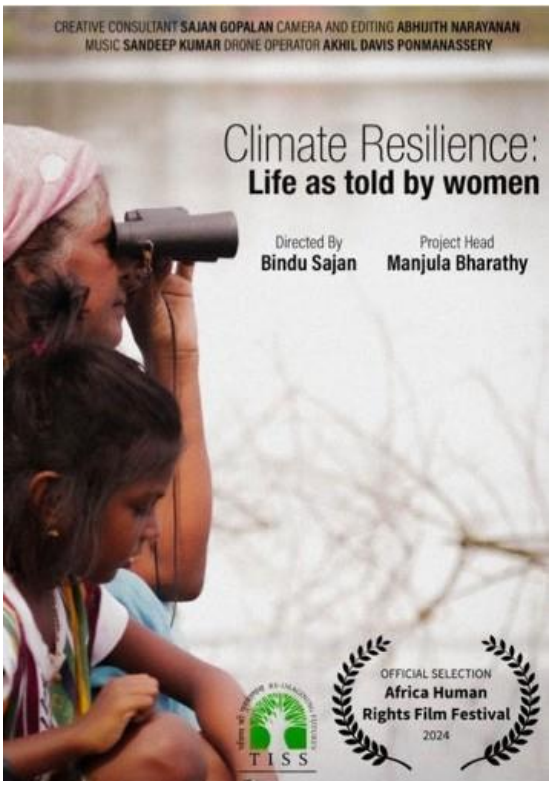
Speaker Bio: Dr. Manjula Bharathy is Professor and former Dean at School of Habitat Studies, Tata Institute of Social Sciences, Mumbai. She was a Fulbright Research Scholar in Gender Studies at University of Rutgers, USA and was the Chief Operating Officer, Kudumbashree Mission; Member Central Advisory Committee on Panchayati Raj, Government of India; and Member of Expert Committee on Decentralized Planning for the Sixth Scheduled Areas, Government of India. Her areas of research include democratic decentralization; climate change: social vulnerability; local governance; and gender and micro- credit programs. Ms. Bharathy is also an award-winning documentary filmmaker.

Dr. Manjula Bharathy's presentation provided a critical perspective on the intersection of gender and climate change, highlighting perspectives from feminist political ecology to emphasize the inter-connections between gender relations; power networks; and climate change. She drew on work on building community resilience to climate-change induced high tide flooding in coastal communities in Kerala.

Dr. Bharathy's research documented the impact of high tides in a marginalized coastal community in Vypin island area, Kerala. The area, disconnected from the mainland, lacked access to essential services, including healthcare, transportation, and food.



Biodiversity loss; climate change; and unequal social structures exacerbated gender-centric inequality. Dr. Manjula's team engaged Feminist Political Ecology (FPE) as an approach to understand the associations between human-environmental change and conflict by critically examining the influence of uneven power relations on resource access, governance, and control across multiple scales.



The observations and findings from this approach led to novel interventions such as Coastal Video Volunteers Network, which engages women from impacted communities to make small videos documenting their experiences to facilitate gender-inclusive discourses on climate change in the public sphere. A vital learning from Dr. Manjula's work was highlighting the invisibility that women experienced in negotiation and dialogue as well as disproportionate burden of vector-borne diseases. This in turn adversely affected maternal health.

In summary, Dr. Manjula's work with communities drew on a knowledge-power-justice framework to redefine knowledge production in a local context and create community-driven interventions that drive critical analysis of power, agency, and gender. Her work also highlighted intersectional ties between gender, climate change, and gender-specific health outcomes

III. DRY AND ARID REGIONS

Cities taking charge: C-40 Cities' global network of cities lays down plan for climate adaptation and resilience
Kanupriya Kaikeya - Senior Manager, Engagement and Communications for South and West Asia, C-40 Cities
Speaker Bio: Ms. Kanupriya Kaikeya is Senior Manager, Engagement and Communications for South and West Asia. With a decade's experience, she supports the design and delivery of strategic climate action initiatives for C40 in the region along with engaging with partners and identifying communication opportunities and approaches.

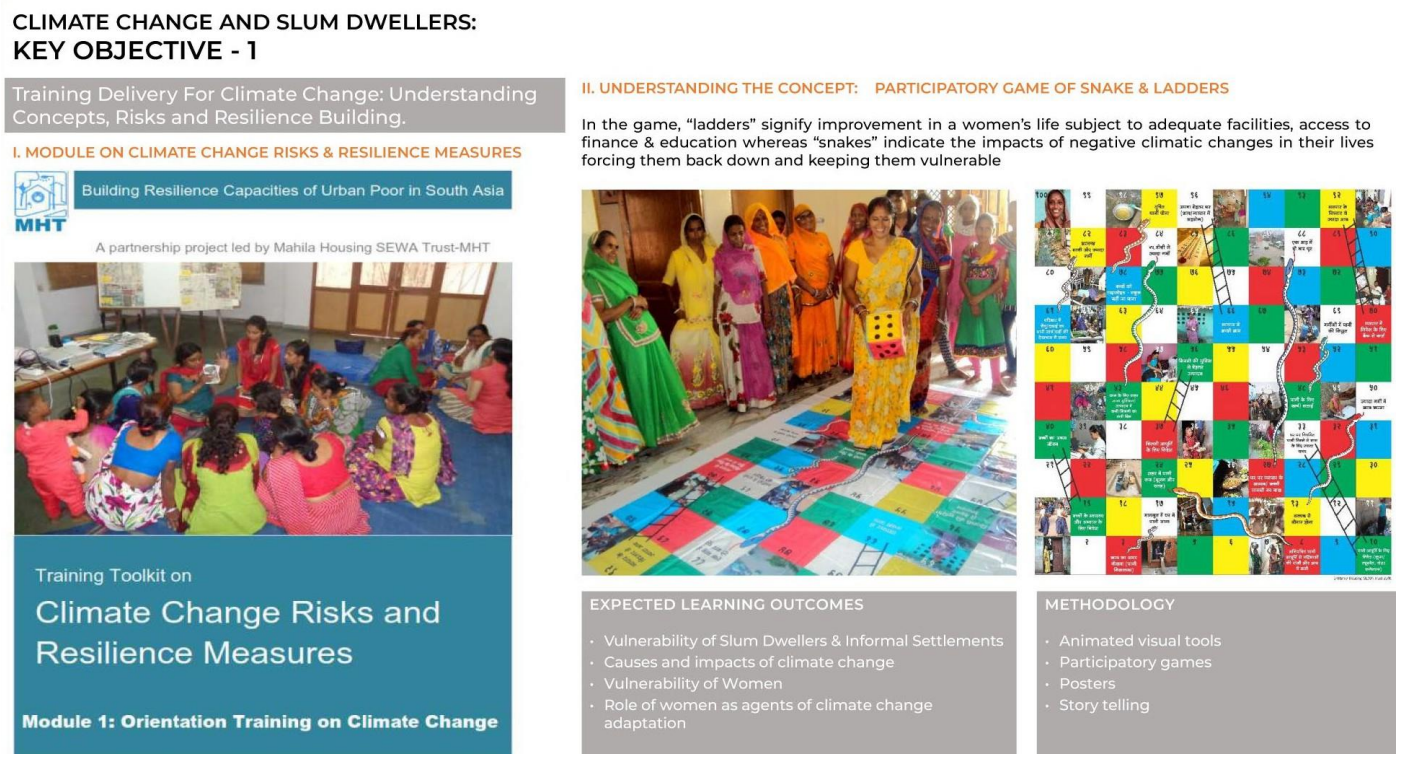
Ms. Kanupriya Kaikeya's presentation highlighted the critical role of cities in addressing climate change via strategic, localized actions to build resilience against extreme heat. She discussed the impact of climate change on cities; drivers of growth and development; and their risks and vulnerabilities.

She introduced the work of C40 Cities, a network of nearly one hundred world-leading cities committed to driving impactful, large-scale climate action through political will and leadership. C-40 Cities' network engages city-level in driving swift and planned change for their city residents. She presented Ahmedabad, a C40 City member, as a case study. Ahmedabad was the first city in the Global South to devise a heat action plan in 2014. Their plan includes strategic mitigation and adaptation measures such as a seven-day temperature forecast that sends data-backed weather forecasts to the Ahmedabad Municipal Corporation and surrounding areas. The information is utilized to strengthen networking between government agencies; health officials; hospitals; emergency responders; and community leaders to mitigate climate-centered emergencies and facilitating disaster response.

Climate solutions in the built environment in arid urban India: Mahila Housing Trust
Bhavna Maheriya - Senior Manager, Program Manager, Mahila Housing Trust (MHT)
Speaker Bio: Ms. Bhavana Maheriya is an Electrical Engineer who has over twenty years of Energy and Community development experience. She has designed, managed and evaluated renewable/ efficient energy program for MHT. She has previously managed a Grid Electrification Program in partnership with the private sector (Ahmedabad Electricity Company) which has enabled legal electrification on all poor households in Ahmedabad and was showcased as a worldwide best practice by USAID. She has experience in a range of community energy programs including grid electrification, renewable energy, and energy

auditing and developing efficient energy entrepreneurs. She also has conducted evaluations and assessment for community energy programs across states of India.

Ms. Bhavna Maheriya's presentation showcased innovative and practical solutions implemented by Mahila Housing Trust (MHT) to address climate change challenges in slum settlements with provisions for support in mitigating climate shocks (like tsunamis and earthquakes) and stressors (such as heat stress; water scarcity; water inundation; and vector-borne diseases). Their climate projects aim to train women; pilot and validate technology solutions within communities; design financial products for community adoption of these technologies; and influence policy through partnerships.



MHT has adopted a systems-thinking approach to facilitate understanding of climate change; its root causes and interconnections; and hone surveillance mechanisms led by women from impacted communities. They've strengthened capacities by using interactive gamified- and picture-based tools such puzzles; loop diagrams; quadrants; and board games (such as snake-n-ladder). Further, residents were trained to utilize community-based surveillance toolkits to capture real-time data on water quality; surveillance of vector-borne infections; and weather situations in their area. MHT's technological solutions include modular roofs made from recycled coconut husks and solar-reflective white paint for temperature regulation in dwellings and fiber sheets for home roofs that provide air lite ventilation.

Proposed Cooling Station Design

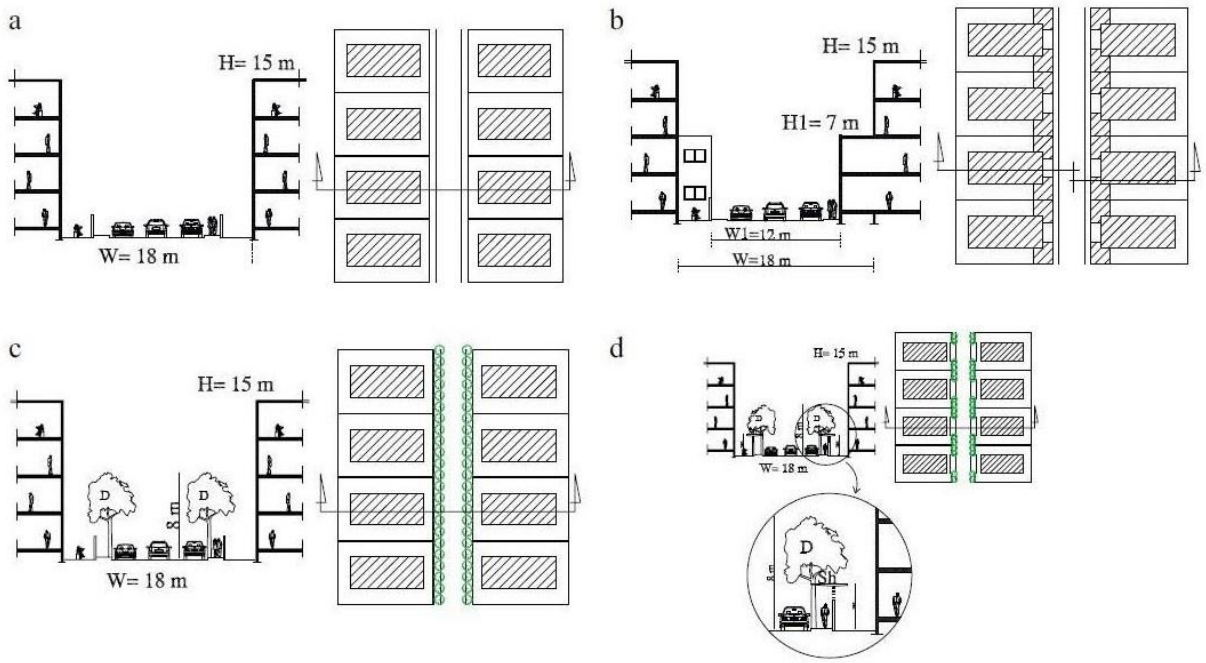
Heat mitigation strategies for sustainable desert cities in arid zones: A comparative view of Jodhpur, India and Arizona, USA

Dr. Shreya Bannerjee - Assistant Professor, Sustainable Urban Planning, IIT Jodhpur

"When developing resilience, people, the economy, the natural environment, and infrastructure must all come together. That's how we achieve resilience against disasters like heat waves, floods, droughts, or landslides."

Speaker Bio: Dr. Shreya Banerjee is an Assistant Professor of Sustainable Urban Planning at the Indian Institute of Technology Jodhpur. She holds a PhD in Urban Climatology and a Masters in City Planning from IIT Kharagpur. She has developed urban design strategies for heat-responsive housing and explored nature-based solutions for urban cooling in Singapore., Dr. Bannerjee was awarded a Building Energy Efficiency Higher and Advanced Network (BHAVAN) fellowship from IUSSTF in 2019 for a research visit at Arizona State University. Dr. Bannerjee works at the intersection of climate resilience; heat mitigation, and adaptation strategies; public health, and informal settlements.

Dr. Shreya Bannerjee presented examples of creating sustainable habitats in hot-arid desert cities through a human biometeorology based multi-dimensional framework. Her talk compared arid regions in Phoenix, Arizona and Jodhpur, Rajasthan from perspectives of space planning and utilization; materials choice; and socio-economic factors. Dr. Banerjee discussed different metrics to quantify heat, including mean radiant temperature, and physiologically equivalent temperature (PET). She integrated insights from human biometeorology and highlighted the utility of this approach in planning climate resilient urban habitats.



Source: Yahia MW & Johansson E, Landscape and Urban Planning (2014); 125, 1–16

She illustrated these principles with data from Maricopa County, Arizona, that compared heat-related mortality between indoor- and outdoor spaces, underscoring the need for comfortable outdoor spaces to reduce indoor energy consumption. In addition, she shared findings from a study in Phoenix, Arizona where increasing tree canopy and implementing cool roofs contributed to temperature reduction. She highlighted structural- and design- modifications in traditional architecture of Jodhpur's historic areas (thick walls, interconnected structures; and lime plaster with light indigo paint) which facilitated cooler indoor temperatures.

In summary, her discussion on urban thermal performance and human biometeorology emphasized the importance of integrated and context-specific structural approaches to building resilience in arid regions.

ROADMAP FOR CLIMATE CHANGE RESILIENCE

The speakers advocated for a multi-pronged and intersectional approach that involves impacted communities; academia; government bodies; entrepreneurs; and independent climate action groups. They further identified the following key gaps/challenges across regions:

- Limited research-informed/data-driven approaches for fostering climate change resilience
- Limited availability of knowledge material and lack of structured plans for disseminating available knowledge on climate action knowledge among vulnerable and impacted communities
- Limited avenues for engaging private entrepreneurs in climate change action
- Region-specific approach in planning and design toward building climate change resilience
- Disproportionate allocation of planning and implementation resources
- Top-down planning lacking in community-led participatory approaches

Call to Action:

The following were some of the identified areas of focus for future work and research:

- Developing data-backed systems/interventions to monitor regional climate changes that lead to the development of early warning systems
- Context-specific resilience building interventions for economically disenfranchised- and other communities especially vulnerable to climate shocks
- Strategies to strengthen knowledge transfer among policy makers and implementors

CONCLUDING NOTE

Our speakers outlined the multidimensional impacts of climate change on India's emerging urban and peri-urban areas. As climate stressors and hazards—such as extreme heat, cyclones, floods and landslides—increase in frequency and intensity, their effect is reflected in the quality of air as well as access to safe water and inhabitable land available to communities. Thus, it is vital that climate action in regions be approached with strategies best suited to address stressors unique to the regions.

Hill Regions

- Technology-based interventions can help mitigate structural and environmental challenges in hill regions, and provide innovative solutions that support sustainable urban development.
- Soil and water conservation efforts can help rejuvenate the natural environment in parallel with agroecological measures that reduce human consumption of natural resources and empower communities to draw on natural resources in a sustainable manner.

Coastal Regions

- Master planning can foster disaster preparedness; create resilient settlements; and strengthen local competencies to reduce long-term climate change risks.
- Long-term mitigation programs can help urban areas create green infrastructure; drive conservation efforts; build accessible community interventions; and strengthen capacities for disaster management
- Integrating gender justice with climate justice allows us to center experiences of marginalised and vulnerable communities and improve overall health and mortality. A communitarian, participative perspective can aid local governance and contribute to community-level resilience in the face of climate shocks and disasters.

Dry and Arid regions

- City-level local leadership can address climate risks by creating policy and driving action via climate action plans, land-use planning, and zoning. These action plans direct healthcare and financial information and use governments' infrastructural resources for mitigating climate shocks.
- Combining technology solutions with financial sustainability options strengthens resilience of vulnerable communities to adverse climate events by facilitating access to interventions. Capacity building and community involvement ensures that urban climates remain climate-resilient in the long term.
- Human biometeorology can aid in site planning, urban morphology, and the generation of nature-based solutions in optimizing thermal comfort. Communities, the economy, the natural environment and infrastructure must all be considered when planning for long-term climate resilience in urban habitats

Integrated urban planning can help us take a long-term view of human habitats, planning for climate-resilient habitats while mitigating the impact of rapid urbanization on the environment. We can harness data and technology to generate appropriate risk assessments, generate strategies for land, water and waste management by terrain, choose sustainable materials, plan disaster response efforts, conserve the natural environment we occupy.

FUTURE READING...

Peer-reviewed papers:

AlKhaled, S., Coseo, P., Brazel, A., Cheng, C., & Sailor, D. (2020). Between aspiration and actuality: A systematic review of morphological heat mitigation strategies in hot urban deserts. Urban Climate, 31, 100570. https://doi.org/10.1016/j.uclim.2019.100570

Middel, A., Häb, K., Brazel, A. J., Martin, C. A., & Guhathakurta, S. (2014). Impact of urban form and design on mid-afternoon microclimate in Phoenix Local Climate Zones. Landscape and Urban Planning, 122, 16–28. https://doi.org/10.1016/j.landurbplan.2013.11.004

Middel, A., Chhetri, N., & Quay, R. (2015). Urban forestry and cool roofs: Assessment of heat mitigation strategies in Phoenix residential neighborhoods. Urban Forestry & Urban Greening, 14(1), 178–186 https://doi.org/10.1016/j.ufug.2014.09.010

Santos Nouri A, Matzarakis A (2019). The Maturing Interdisciplinary Relationship between Human Biometeorological Aspects and Local Adaptation Processes: An Encompassing Overview. Climate; 7(12):134. https://doi.org/10.3390/cli7120134

Schneider, F. A., Ortiz, J. C., Vanos, J. K., Sailor, D. J., & Middel, A. (2023). Evidence-based guidance on reflective pavement for urban heat mitigation in Arizona. Nature Communications, 14(1). https://doi.org/10.1038/s41467-023-36972-5

V. Kelly Turner, Ariane Middel, Jennifer Vanos. (2023). Shade is an essential solution for hotter cities, Nature 619 (7971):694–697 https://doi.org/10.1038/d41586-023-02311-3

Venhari, A. A., Tenpierik, M., & Taleghani, M. (2019). The role of sky view factor and urban street greenery in human thermal comfort and heat stress in a desert climate. Journal of Arid Environments, 166, 68–76. https://doi.org/10.1016/j.jaridenv.2019.04.009

Yahia, M. W., & Johansson, E. (2014). Landscape interventions in improving thermal comfort in the hot dry city of Damascus, Syria—The example of residential spaces with detached buildings. Landscape and Urban Planning, 125, 1–16. https://doi.org/10.1016/j.landurbplan.2014.01.014

Knowledge reserves:

A comprehensive list of reading material on climate shock resilience and preparedness; fostering community-based participatory action in climate change solutions; strengthening capacities of workforces involved in climate change response; and equity in climate shock response can be accessed from Development Alternatives portal:

Mahila Housing Trust maintains a knowledge hub for grass-root, and community led initiatives featuring research, toolkits, and other knowledge products on habitat development, climate change resilience, and participatory governance with gender as its lens. These can be accessed from their portal.

People's Science Institute's portal can be accessed for diverse research studies on climate action in mountain habitats and for studies conducted across India for pollution and industrial waste management.

About C40 Cities: C40 is a global network of nearly 100 mayors of the world's leading cities that are united in action to confront the climate crisis.

ACKNOWLEDGEMENTS

UTIF and SoC would like to thank IIT-D, our collaborators and venue partners, for hosting the CRUSH workshop. We would like to thank all our speakers for their valuable insights and for their larger work toward fostering climate resilience. We extend our heartfelt gratitude to the Office of Vice President International, U of T, for their support in planning the CRUSH workshop. This endeavor was supported by our funding agency TATA Trust, and we are grateful for their continued support and their larger commitment to making a difference. We would like to thank Comms Ninja, our documentation partner, for their support in writing this report.

Co-organizers

Partners

Documentation Partner