NATURE BASED SOLUTIONS AS A TOOL FOR HEAT WAVE MANAGEMENT AND IMPROVING PUBLIC HEALTH IN CITIES

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Abstract

Presently, there exist more than thirty heat action plans across various cities, states, and regions of India, focusing mainly on heat prevention, preparedness, and mitigation measures. Heat action plans concentrate on coordination among different stakeholders, particularly government agencies involved in responding to extreme heat events. However, they do not offer much practical guidance for actual on-the-ground action during such events. Contemporary international discourse on the subject, therefore, increasingly emphasizes the need to incorporate nature based solutions, underscoring the need to attend to questions of adaptation as integral to managing heat waves during extreme heat events. Against this backdrop, this paper focuses on integration and mainstreaming of nature based solutions in urban planning for managing heat waves and improvising public health. Drawing on on-going research in the city of Chennai, we identify vulnerabilities, impacts, and adaptations resulting from extreme heat. Combining an array of methods, that include household surveys, key informant semi-structured ethnographic interviews, shared learning dialogues with different stakeholders, architectural and photographic documentation and observational analysis of the houses, we derive three principles to develop more effective nature based solutions to deal heat wave management. We argue that knowledge and practices of nature based solutions are 1) best understood with a focus on the community-scale, 2) socially distributed and propagated through a variety of mechanisms, and 3) strongly gendered, with the implication that women can be crucially important in ensuring effectiveness of various heat-related interventions. While the ways in which these strategies manifest and the tools and methods necessary to implement them may vary significantly across different locations, we suggest that nature based solutions are essential starting points for managing heat waves and improvising public health. This research has an implication for integration of nature based solutions in urban planning thereby help urban planners and policymakers to best engage in urban heat governance. As such, nature based solutions figure as an important policy response, in achieving heat governance and heat justice by recognizing the local geographies and their concerns.

Key words: Heat wave management, public health, nature based solutions, urban planning, governance.

1. Introduction - Background and Context

Globally, rapid urbanization and increasing temperatures have positioned urban settlements and their experiences of severe heat waves and heat stress in the built environment, as a major concern for contemporary urban climate change researcher. According to Climate Impact Lab's 2019 report, the global rate of heat-related mortality is predicted to reach 85 per 100,000 people by 2100, with lower-income groups expected to experience rates of over 100 per 100,000 people. Following this, the Global Climate Risk Index 2021 ranked South Asian nations as

among the most vulnerable to the effects of climate change worldwide (Raparthi, K. 2014). With five straight years of the highest temperatures between 2015 and 2019, India was positioned seventh on the list, making it particularly vulnerable to the negative effects of excessive heat (Hass et, al., 2021).

In response to this, across the globe, and in South Asia and India in particular, intergovernmental agency action, preparedness, and community outreach for heat related awareness and mitigation actions in the form of comprehensive heat plans to combat heat waves were established. In India, the National Disaster Management Authority took the initiative to establish guidelines and build capacities of the states, cities, and districts to follow a national framework for formulating heat action plans and implementing them. By the year 2018, more than thirty, “one size fits all” heat action plans across various cities, states, and regions of India, focusing on heat prevention, preparedness, and mitigation measures, with inter-agency coordination among various stakeholders were formulated to deal with the scorching heat (Kotharkar, R., 2022).

Contemporary international discourse on the subject increasingly emphasizes the need to develop proactive nature based solutions by prioritizing the city's most vulnerable neighbourhoods. Incorporating this approach, few Indian cities (Rajkot and Bhubaneswar) have developed climate adaptive action plans by undertaking a comprehensive climate profiling of the city, identifying the most vulnerable wards in the city, comprehending the socioeconomic circumstances of those who live in these heat vulnerable areas and recommended short, medium and long term strategies to overcome the heat wave impacts (Markandeya, 2021). However, in-depth review of these action plans highlights their inability in offering practical guidance for actual on-the-ground action during such events. Against this backdrop, our research contributes to the existing research on climate adaptive action plans, providing foundational insights for formulating the need for and designing nature based solutions especially for urban settlements (Dubash, 2019).

In this research, we attend to questions of locally-oriented, innovative and affordable adaptation measures across various levels (neighbourhood, household and individual) as integral to urban planning. We present findings from our ongoing research in the city of Chennai. Our analysis of the settlement identifies 1) distinct thermal vulnerabilities that these settlements exhibit, partly due to the usage of cheap and locally available resources for constructing houses, 2) impacts of heat waves rising due to unreliable urban infrastructures, including those of water, electricity, sanitation, and waste-management and 3) indigenous, locally oriented, gender specific adaptation measures that result from extreme heat in such context. A key insight that we build further on, is that grounded indigenous knowledge alongside human centric and place centric innovative heat adaptation practices, ensure to be a significant component for the design of locally adaptive nature based solutions for urban settlements.

Our research is structured in a holistic manner, articulating a range of socio-economic, spatial, and culturally localized, everyday heat adaptation strategies through which socially marginalized groups in southern cities deal and cope with extreme urban heat. In the next section, we engage in thought provoking questions related to how, why and to what extent

individuals, communities and built environment autonomously and incrementally adapt/respond to heat waves. Following this, the next section titled as methodology section, outlines the method and the data sets comprising of spatial data, weather data, as well as qualitative data gathered through remote sensing, field measurements, and an array of methods that include household surveys, key informant interviews, and shared learning dialogues with different stakeholders, that were incorporated while undertaking this study. Later, the discussion section analyses the settlement across the neighbourhood, individual and household levels, generating in-depth understanding of on-ground in action adaptation strategies; opening news pathways which we refer to as design principles for the design of more effective locally adaptive nature based solutions that are apparently oblivious among state heat action plans to deal with the negative impacts of urban heat (Raparthi, K. 2015).

2. Climate Change and Heat Waves

According to the Intergovernmental Panel on Climate Change (IPCC), twenty-first century urban areas are expected to experience an increase in the severity and frequency of extreme heat events, when compared to the past and will intensify further due to human-induced climate change. This is especially true in the context of rapidly urbanizing south Asian nations, particularly India, having experienced consistently 3–8 Celsius degrees above average temperature, reaching as much high as 44 Celsius degrees, in the month of March 2022— the highest ever since records began 122 years ago. Also, extreme heat episodes contribute to below-average rainfall in the region, with India receiving 71% less rainfall than usual for the month of March 2022 (Bakshs et al., 2018). Therefore, as climate change and global warming continue intense heat waves referred to as extremely high surface air temperatures lasting for several days will become more and more common, causing serious and massive consequences in the past, present and will worsen in the future across the globe.

Effects of heat waves are very complex, multifaceted, and multidimensional, impacting human health and well-being, economic security, built environment, infrastructure, and social interactions and the ecosystem. They also exhibit cross-scale phenomena across many facets of society, posing a serious threat to human life if not addressed (Navas et al,. 2022). With regards to preventing and reducing exposure to heat waves, and dealing with an array of heat wave effects at different scales, calls for comprehensive solutions that enable and sustain a collaborative top-down and bottom-up approach (Raparthi, K. 2016a, 2016b). Against this backdrop, many urban climate change researchers have proposed a two pronged approach consisting of heat wave mitigation and adaptation techniques, deployed at various scales and institutional levels with a common and novel agenda of addressing the ill effects of heat waves. Heat wave mitigation primarily aims at alleviating the causes and the impacts of heat waves including strategies such as increasing the green cover in a city to reduce urban heat island effect, or implementing cool roofs to provide comfort. On the other hand, heat wave adaptation comprising of an array of institutional, technological, institutional, infrastructure, and institutional responses predominantly striving to adapt to the effects of heat waves either by limiting exposure, offering additional protection to the inhabitants or creating awareness to extreme heat waves is regarded as a successful strategy to address the effects of heat waves (Bakhsh et al., 2018).

3. Heat Action Plans

With an intention to respond to the growing heat waves globally, across South Asian nations and particularly in India, heat action plans were developed, serving as a guide to manage and minimize the negative impacts of extreme heat. According to Kotharkar (2021, p. 9), approximately 47 countries across the globe have incorporated heat action plans or heat response plans or heat wave action plans, all exhibiting similar content with an ultimate aim of responding to heat by, — identifying and alerting specific risk vulnerable populations from heat related illness, providing local heat morbidity and mortality related information, relying on early warning system, equipping themselves for timely action across the national/state and local level (Mahadevia, 2019).

In India, the first ever Heat Action Plan was developed for the city of Ahmedabad located in the western part of the country during the year 2014, as a response to the record breaking heat temperature and increased heat mortality deaths reported in the city. This HAP was considered as the first of its kind in South Asia, developed based on a situated understanding of the city, including but not limited to a range of interventions — early warning systems, building capacity, public awareness for preparedness, alongside a series of significant methods for identifying vulnerable populations, estimation of heat related mortalities and morbidities and population projections. In-line with the Ahmedabad HAP, alongside considerations of mandates from the National Disaster Management Authority (NDMA), more than 30 HAPs across various cities in India were successfully developed till date.

As a result of replicating Ahmedabad HAP to other cities, apart from exhibiting common institutional elements pertaining to the implementation, coordination, and assessment of initiatives across spatial scales, the HAPs also share a wide array of long term heat wave mitigation and response strategies (such as — increasing the green cover in a city to reduce urban heat island effect, or implementing cool roofs to provide comfort), alongside a generalized list of “Heat waves DO’s and DON'Ts”. As such, most of the global south HAPs, neither reflect the intensely contentious nature of local geographies, spatial temporal context that configure and shape the ground realities of life, nor the urban socio-political and economic dynamics that constitute a particular space. Against this backdrop, international discourses emphasize three rudimentary propositions for increasing HAPs effectiveness: 1) be place-specific—capturing the varying complexities, 2) respond across various scales—city, neighbourhood and household level (NRDC International 2020, p: 9) and 3) adaptive in nature—acknowledging social networks and everyday practices (Parnell, 2016). This emerging need for locally adaptive nature based solutions deeply contested within the existing socio-urban politics happens to be the vantage point for our research.

4. Nature based solutions as a Response to Management of Urban Heat Waves

Nature-based solution is an emerging concept that integrates various ecosystem services and management strategies to address the societal challenges related to climate change, water security, well -being of human health, quality of life. The benefits and multifunctional aspects of nature-based solutions towards reducing urban heat island effects and tackling heat

inequities with regard to the three aspects of climate change vulnerability is highlighted. First aspect relates to exposure and highlights the extent of a community, region or resource exposure to the vulnerability. The second is sensitivity and relates to the degree to which community, region or resource is either responsive or affected to the effect. The third dimension is the adaptive capacity. It highlights the ability of the community, region or resource to either innovate or adjust to the changing conditions (Raparthi, K. 2020a, 2020b).

Recent research on nature based solutions highlight its ability of reducing urban heat island effects and tackling heat inequities. For instance by promoting urban greening, expanded park space expanding green space, by planting street trees, have the ability to reduce air and surface temperatures. Green roofs can help reduce temperatures, among other benefits. By increasing urban green spaces and practising nature based urban agricultural practises the impacts of heat waves can be controlled and water flow can be regulated. By planting trees, also tends to engage building owners and communities to retrofit buildings by applying green practices, such as using of green walls that have an ability to moderate indoor temperatures. These practices can also be applied to vacant and underused spaces in communities by converting them into cooling centres to reduce heat stress. Accordingly, the adaptive capacity of nature based solutions is highlighted by the ability to respond to urban heat and by empowering marginalized groups to support common-pool resource management institutions and implement local adaptive strategies such as home gardening and developing green roofs (Raparthi, K 2022). Moreover, urban green spaces, bio retention areas, green infrastructure and carrying out locally led greening initiatives have the ability to enhance the extent of social interaction, cohesion building and thereby contribute positively to the social, physical wellbeing and quality of life (Jennings & Bamkole, 2019).

A vital objective of nature based solutions is to design indoor living conditions that are responsive to and regulate the micro-climate to ensure thermally comfortable and habitable conditions, by using locally available resources as building materials. Traditional houses were successful in doing this without air conditioners or other insensitive mechanical means of ventilation. Informal architecture thrived on passive, nature-based ventilation design and local materials which were innately resilient to the micro-climate of the region. Houses of mud with small punctures or latticework openings in Rajasthan, houses of stone in North India, houses of bricks and wood with large windows in South India in addition to thick-walled houses in hotter regions and thin-walled structures in coastal regions, supported meeting cooling needs without air conditioners. In this regard, architecture is a vital tool to address this issue given that 30 percent of global GHG emissions are contributed by the construction industry (Raparthi, K 2021a, 2021b, 2021c).

A few other fundamental architectural design principles that can be incorporated for similar architecture-supported heat adaptation and mitigation include appropriate building orientation and micro-climate aspects i.e. the distance between buildings, the open space quality between surrounding buildings, the direction of openings, shading over ventilation, insulation, presence of trees and greens and the right walling material. It is evident that while solutions exist there is a lack of action to ensure that heat stress is addressed substantially by the mind ful incorporation of building design fundamentals in collaboration with inhabitants as part of

constructing new structures and even retrofitting old ones. There is therefore a need and potential for HAPs to espouse these perspectives too.

Working on heat wave adaptation research and policy (Wolf et al,. 2010; Bakhsh, 2018; — alongside many other scholars as we do, advocate that effective adaptive initiatives do not necessarily need to correspond to an array of long and short term measures as it is at present, but rather realize that humans are intertwined with external threats, social landscapes of inequity, and communal resources (Raparthi, K. 2018). Thereby emphasize the need for a localized and people-centred approach to adaptation (Dreyfus 2015) in responses to heat risks that capitalize on local and social capital so as to build adaptive capacities (IPCC 2014). The community based approach is considered the only means of responding to risk for a significant part of households living in informal urban areas (IPCC 2014, p.563) Hence, for these reasons, adaptation processes and initiatives must focus on understanding through various techniques how heat affects various aspects of the community (Kinney et al., 2008).

At an overarching level, the HAP framework focuses on Establishing early warning systems and inter-agency coordination, Capacity building/training programs for healthcare professionals, Public awareness and community outreach and Collaboration with non-government and civil society. Most of the state HAPs framework reflects cautionary and responsive mechanisms with reactive and adaptive connotations and often fail to take active steps towards addressing vital aspects of the built environment which have a colossal impact on heat stress conditions.

5. Discussions

Based on the above, we offer four propositions to orient thermal governance in informal settlements:

1. Vulnerabilities to heat are locally produced at the intersection of different material, socio-political, and climatological factors. Insights from our field research highlight that the inability to afford thermally resistant materials and uneven access to key service infrastructures arising due to lack of land tenure rights render inhabitants of informal settlements particularly vulnerable to the impacts of extreme heat. Any attempt to mitigate thermal vulnerabilities must therefore begin from an understanding of ways in which these are produced in specific times and places.

2. There already exist an array of strategies through which individuals and communities adapt to rising temperatures. These are not substitutes for the provision of more formalized infrastructures that will help mitigate the impacts of extreme heat, but can nonetheless offer ways to develop cooling infrastructures that are locally grounded and less energy intensive. A plethora of makeshift arrangements, including modified dietary, clothing, and other behavioural patterns, use of cooling paints and other such housing adaptations, and creative use of the evaporative cooling techniques, can be readily witnessed in such spaces.

3. Adaptation is a social practice. Especially in the context of informal settlements, we witness that knowledge and skills for adaptation are distributed across the community and propagated through a variety of mechanisms. There is also an array of interdependencies

through which access to cooling is secured, e.g. interdependencies that are necessary to secure access to water. Community, thus, can be an important source of resilience in coping with extreme heat.

4. The appropriate scale of thermal governance cannot be known a priori but rather emerges from empirical attention to the specificities of place. Socio-spatial scales such as those of neighbourhood or community, rather than that of the entire city, might be better suited for such purposes.

6. Conclusions

Most of the cities in India often lose their green spaces to accommodate urban sprawl and infrastructure development, thereby provide housing for the increasing population growth. This advocates for a paradigm shift in planning cities. Planners need to consider the importance of natural open spaces as integral part of the master planning, development planning process rather than considering them as casualties for urban development. Accordingly, development plans must take into account the economic and social benefits of the city's natural resources and weigh the benefits against the costs that are involved in letting these natural resource spaces to be encroached by urban development.

Urban planners need to delineate significant amount of green open spaces, marshlands, lakes to remain un-built and un-encroached. Thereby integrate the protection of these spaces into the city development. There is a need for effective regulation of land use plans to protect, retrieve and rejuvenate open green spaces and water bodies. City planners need to reconsider the importance of nature based solutions and encourage investments in open green spaces, empower local communities in the process. Thereby centre nature based solutions in the long term planning process for resilient infrastructure and sustainable urban planning.

Finally, we conclude our research by drawing on theories of "southern urbanisms" (Bhan, 2019; Simone, 2020) and demonstrate the conceptualization of the existing HAPs in a manner similar to the Northern logics, lacking the much evident and contested nature of urban socio-politics and spatio-temporal contexts around which the everyday life of urban global south revolves. Thereby, reinforcing the need for much on-ground action oriented research to design as well as assess the effectiveness of nature based solutions.

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