Urban Planning
2025 • Volume 10 • Article 9509
https://doi.org/10.17645/up.9509

cogitatio

ARTICLE

Open Access Journal

help Them help Themselves: A Toolkit to Facilitate Transformative Community-Based Climate Change Adaptation

Subhashree Nath [1,2]

[1] Faculty of Environmental Sciences, TU Dresden, Germany
[2] Leibniz Institute of Ecological Urban and Regional Development (IOER), Germany

Correspondence: Subhashree Nath (s.nath@ioer.de)

Submitted: 30 October 2024 **Accepted:** 28 January 2025 **Published:** 30 April 2025

Issue: This article is part of the issue "Co-Creation With Emerging Technologies to Address Climate Challenges in Cities" edited by Cesar Casiano Flores (University of Twente), A. Paula Rodriguez Müller (European Commission, Joint Research Centre), and Evrim Tan (University of Munster), fully open access at https://doi.org/10.17645/up.i439

Abstract

Inclusive, co-created strategies are crucial for climate adaptation in vulnerable communities, as they empower local stakeholders to actively participate in decision-making, tailoring responses to specific needs. However, tools that facilitate this collaborative approach are scarce and often inaccessible to under-resourced groups. This article introduces help Them help Themselves (hThT), a web-based tool designed for transformative community-based climate change adaptation (TCbA), which enhances co-creation in adaptation planning. Derived through a combined literature review and key informant interviews, hThT integrates local climate data to offer community-specific, actionable adaptation recommendations. A novel voting feature within the tool allows community members to evaluate proposed measures directly via mobile devices, ensuring broader participation—particularly among women and marginalised groups, who are often restricted by socio-cultural norms and existing power relations. Further, hThT incorporates a reflexive questionnaire that supports facilitators in maintaining inclusive, transparent, and accountable adaptation processes, offering a structured approach to co-creation. Serving as a boundary object, hThT enables shared understanding and collaborative decision-making across diverse groups, bridging governance gaps that commonly impede adaptive planning. Leveraging advances in ICT, hThT aims to enhance the accessibility and usability of climate information, fostering representative decision-making in adaptation planning. By embedding hThT into broader adaptation frameworks, these efforts become more effective and scalable across varied communities, offering a realistic, participatory model for adapting to the uncertainties of climate change.

Keywords

climate change; co-creating adaptation; collective decision-making; community-based adaptation; transformative adaptation; under-resourced communities; web-based tools

1. Introduction

Transformative community-based climate change adaptation (TCbA) is a proactive, co-created approach that empowers under-resourced communities and marginalised groups to adapt to climate change by addressing the root causes that make them more vulnerable than others (Nath, 2024). It leverages the potential of strategic, collective action to address structural inequalities (Ensor et al., 2018). TCbA focuses on communities such as residents of informal settlements in the Global South and shrinking cities in the Global North, who often lack government support due to limited resources, political will, or conflicting priorities. TCbA builds on the established and practiced concept of community-based adaptation (CbA; see Dodman & Mitlin, 2013; Huq & Reid, 2007; Rashid & Khan, 2013; Roy, 2018; Shammin et al., 2021) and emphasises the need to reframe adaptation decision-making by centring it around those most affected, enabling them to actively shape their own strategies along with government and private actors (Nath, 2024). In essence, TCbA aims to facilitate co-created adaptation plans through collective decision-making, ensuring representative participation of all affected groups.

However, in practice, collective decision-making, representative participation, and co-creation face numerous challenges. Historically, decision-making power has been concentrated in the hands of a few, entangled in administrative bureaucracy and information gatekeeping. Gender norms restricting women's mobility often result in their exclusion from collective decision-making processes (Karim & Thiel, 2017). Co-creation, where affected communities and public and private actors collaborate to solve issues like climate adaptation by sharing knowledge and resources (Hofstad et al., 2022), struggles with the challenge of achieving a common understanding and agreement on solutions. Therefore, reframing adaptation decision-making requires interventions that enhance collective decision-making, encourage participation, and foster co-creation. Systemic interventions are needed, particularly by targeting leverage points (Abson et al., 2017). Nath (2024) identified three such leverage points for mobilising TCbA, recognising "changing the structure of information flow" as the most accessible, driven by advances in digitalisation and ICTs. Emerging strategies include the use of web-based digital tools like adaptation option platforms and smartphone apps that enable civic engagement (Karali & Mattern, 2017; Palutikof, Street, et al., 2019b; Street et al., 2019). However, reviews of existing adaptation web-tools (Brzoska et al., 2022; Cavan et al., 2021; Palutikof, Street, et al., 2019b; Shabajee et al., 2014, etc.) show that most are narrowly focused, user-unfriendly, or require specialized expertise. Additionally, these tools primarily provide information on climate change impacts and adaptation without explicitly facilitating participation or consensus-building. In addition, their limited visibility on common search engines like Google or app platforms like Play Store and Apple Store further restricts their usage and the dissemination of their benefits to local communities, particularly those with already limited access to resources such as information, finances, human capital, or government support.

This article proposes a toolkit consisting of a reflexive questionnaire and a web-based decision-support tool: Help Them help Themselves (hThT). Accessible via web browser, mobile app, or as a plugin for existing civic engagement apps, hThT collects local climate data, translates it into actionable insights, and provides tailored adaptation recommendations. These recommendations are based on biophysical simulations of the measures on the built environment and cost-benefit analyses for the affected community, offering a common reference for decision-making. Therefore, acting as a boundary object (Star & Griesemer, 1989), hThT facilitates consensus-building among stakeholders—community members, community-based

organizations (CBOs), NGOs/NPOs, municipal officers, and funding agencies. It also proposes a feature novel to adaptation facilitation tools: Each household can access information and vote on adaptation measures via mobile phone, increasing representative participation, which is often limited by power relations and socio-cultural norms (Nath, 2022; Regmi et al., 2016; Reid et al., 2009). Additionally, hThT integrates a reflexive questionnaire (Nath, 2024) to assist facilitators in ensuring an inclusive, transparent, and accountable adaptation process.

The next sections discuss the concept behind hThT, its development process, policy, the governance environment required for the uptake of hThT, and other digital tools that facilitate co-created adaptation.

2. hThT: Using Information as a Resource to Empower Under-Resourced Communities

The current structure of information flow in climate adaptation positions researchers and scientists as the extractors and interpreters of climate data (i.e., the producers, as defined by Lemos et al., 2012). This high-level data is often translated into information and knowledge accessible mostly to experts in adaptation, mitigation, policy, and development agencies. However, information becomes truly usable only when deployed by users in decision-making processes (Lemos et al., 2012, p. 791). Moreover, the data and knowledge produced often cover larger spatial and longer temporal scales that are useful for local action (see, e.g., Wetzel & Mäs, 2022). Adaptation actions are context- and place-specific, affecting specific sets of stakeholders and thus, requiring a knowledge base tailored to local settings (Few et al., 2007).

As a result, despite the apparent abundance of climate information, locally relevant, comprehensible data for non-experts remain scarce. This has been a recurrent barrier to adaptation (Archie et al., 2014; Nath, 2022). On the other hand, advances in digitalisation and access to ICT offer significant potential for general internet users, whether via computers or smartphones, to access vast amounts of information on climate change, its impacts, and possible solutions (Zulkafli et al., 2017). However, to fully harness this information, users must possess "information fluency"—the ability to understand and leverage technology for optimal outcomes (Park, 2017). It is argued that hThT can enable this information fluency by distilling relevant climate information into actionable insights for community members. This is an essential step towards democratisation of information, promoting the inclusion of marginalised groups in selecting problems and their solutions (Buytaert et al., 2014).

Further, in the context of climate adaptation planning, decision-making power has historically been top-down, with central or state governing bodies and funding agencies, often from industrialised nations, holding the power. Meanwhile, those who contributed the least to, and are most affected by, climate change— under-resourced and marginalised groups in emerging countries—often have no voice in this adaptation planning. This imbalance between adaptation decision-makers and beneficiaries frequently results in maladaptation (Schipper, 2020). However, it is argued that meaningful participation can be both a means to address this imbalance and an end, enabling beneficiaries to take a more active role in the process. This can be achieved through greater access to and understanding of adaptation information (Sheppard et al., 2015), facilitated by digital technology (Tappert et al., 2024; United Nations, 2023). Digital information technology, as a boundary object, can be used to break knowledge barriers and facilitate mutual learning in a polycontextual environment, while creating new practice knowledge (Forgues et al., 2010). The internet, as an open and decentralised technology, provides opportunities to create and deliver knowledge through web-based support for users with diverse needs across scales (Zulkafli et al., 2017).

The proposed web tool, hThT, seeks to empower under-resourced communities by using information as a resource to enable informed decisions on adaptation planning and implementation, while also developing their political capabilities. The capacity to access information shifts power from the powerful to the powerless (Park, 2017, p. 166), making it a crucial skill for reframing decision-making processes. Political capabilities here refer to the "political power to shape adaptation decisions" and pursue transformative outcomes, or at the very least, apply enough political pressure to challenge unjust decision-making processes (Holland, 2017, p. 397). One way to exert such power is through co-creating shared systems of learning by doing, which can be put into practice (Giddens, 1984; Newell & Proust, 2017, as cited in Colloff et al., 2021, p. 164). hThT aims to provide this system via a web-tool that both informs users about adaptation measures and facilitates decision-making through mobile-based voting. This is combined with the reflexive questionnaire (Nath, 2024) to ensure an equitable decision-making process from inception to implementation.

hThT focuses on facilitating the continuous process of adaptation, not just the outcome, since as climate change progresses, more unknown than known consequences will emerge (Schipper, 2020). Therefore, hThT doesn't aim to provide only one-off solutions but to facilitate communities in preparing for these uncertainties by developing their capacities to self-organise and use relevant climate information to adapt. This also informs hThT's definition of successful adaptation, which is not about determining when a community is considered adapted but about ensuring the development of adaptive capacity within the community. This is achievable only when the community is equipped with the necessary tools to adapt to evolving conditions, relying on key skills such as digital and information literacy, self-organisation, and the ability to assert political agency. This also includes continuous and deliberate efforts to address structural issues. The hThT reflexive questionnaire aims to facilitate these deliberate efforts through a list of diagnostic questions for each step of the adaptation process that ensures all relevant actors and stakeholders are cognisant of the need to create an inclusive strategy that respects the needs of all groups (Nath, 2024). Figure 1 shows the use of the hThT tool set along a typical (T)CbA process.

The characteristics of the web-tool are based on a two-step methodology (see Figure 2): a literature scan of existing digital and web-based adaptation tools aimed at non-experts, and insights gathered through interviews with key informants.

2.1. Characteristics Derived From Literature

The following are key insights from relevant literature on decision-support frameworks (e.g., Denzer et al., 2011; Leitch et al., 2019; Palutikof, Leitch, et al., 2019; Street et al., 2019; Zulkafli et al., 2017) and digital tools (e.g., Brzoska et al., 2022; Cavan et al., 2021; Deas, 2015; Fisher et al., 2018; Palutikof, Street, et al., 2019a, 2019b; Shabajee et al., 2014), especially those facilitating adaptation decisions, to inform the development of hThT:

1. Socio-cultural context: Tools must consider the socio-cultural context of their end users, including capabilities, time, and resources, to ensure accessibility and effectiveness (Palutikof, Street, et al., 2019a). Socio-cultural norms may influence tool adoption, and tool design should be mindful of potential barriers for specific groups, such as gender-based constraints, "accounting for its historical embeddedness in social practice" (Wolfram & Vogel, 2012, p. 326). Understanding the perspective of the targeted end-users and contextualising information provided based on the socio-cultural context

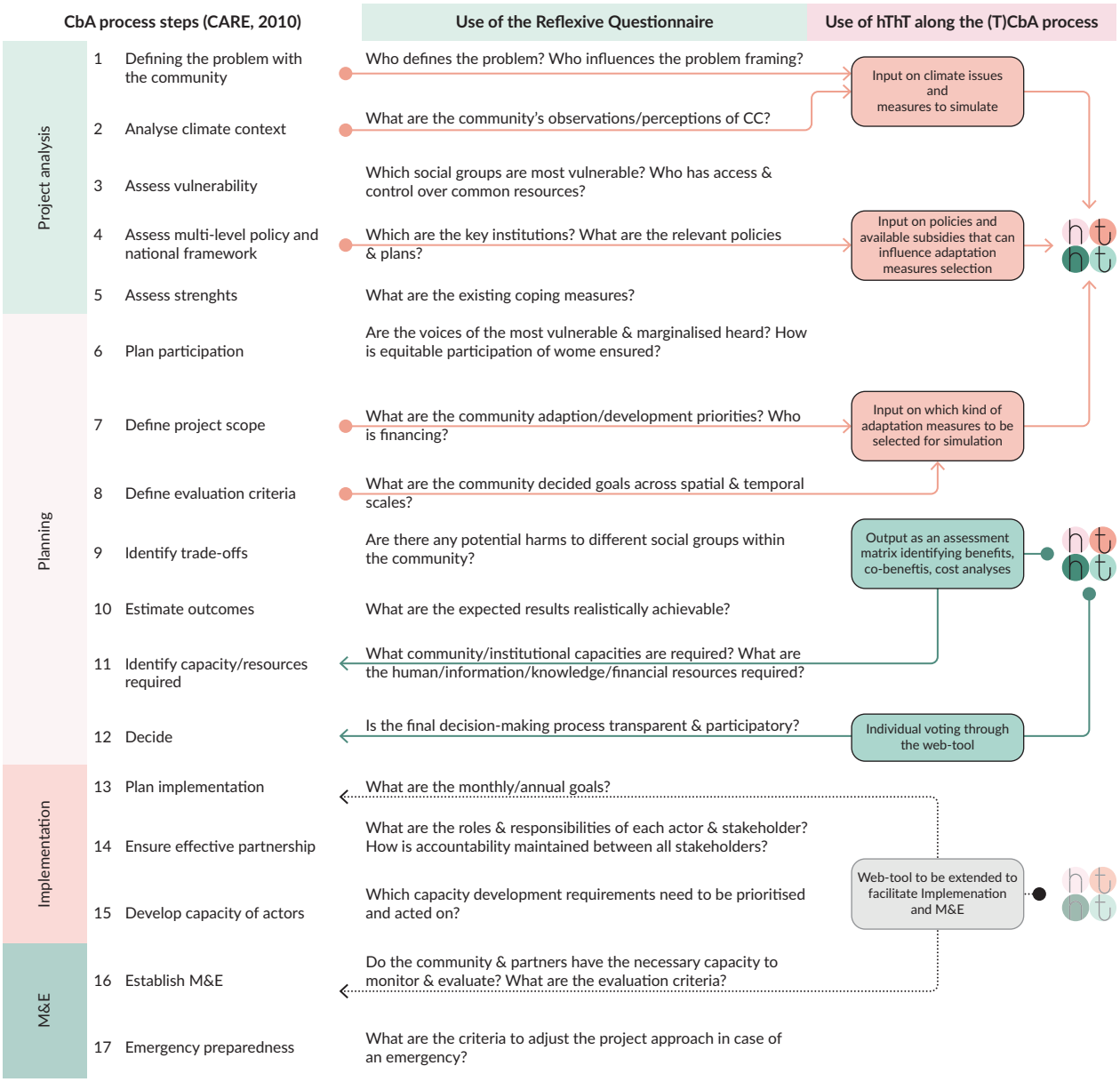


Figure 1. Using hThT web-app and reflexive questionnaire along the (T)CbA adaptation process. Note: The use of hThT in the implementation and M&E phase is envisioned and not described in this article. Sources: Reflexive questionnaire adapted from Nath (2022, 2024); (T)CbA cycle adapted from CARE (2010).

of the tool is crucial for both implementation and evaluation of impact (Brzoska et al., 2022; Street et al., 2019).

2. Defined spatial and temporal scale: Tools must be tailored to the appropriate scale for action-takers (e.g., individual or community), providing micro-level or neighbourhood-specific information (Brzoska et al., 2022; Palutikof, Leitch, et al., 2019). Adaptation measures should be implementable at the relevant scale, and the tool should address local knowledge, trade-offs, and varying granularity of information and expertise(Fisher et al., 2018).
3. Ease of use and actionable outputs: For non-expert users, it is helpful to have comprehensive outputs and actionable information that resonates with their needs (Deas, 2015), especially monetary values, in

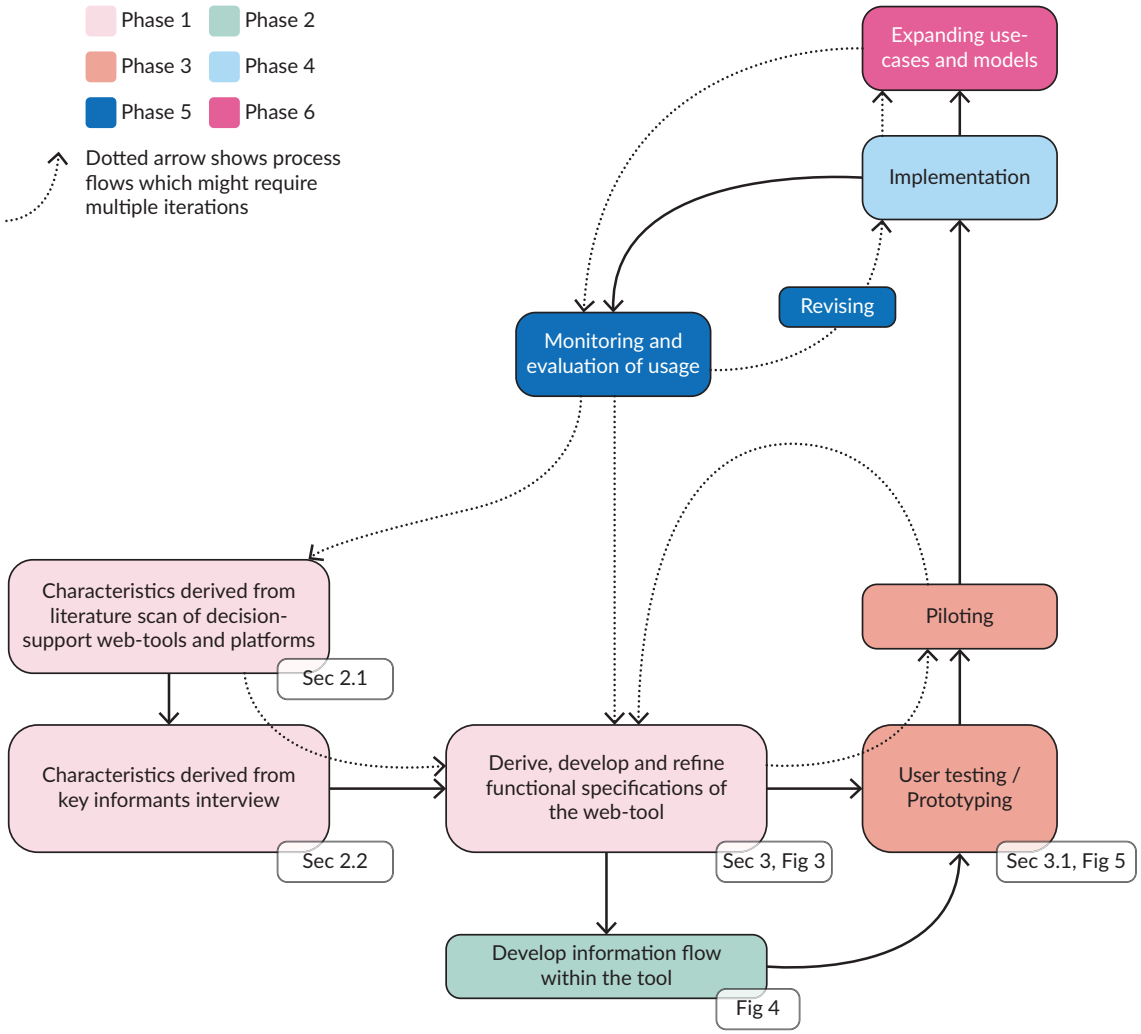


Figure 2. hThT web-tool development process. Notes: Various phases of development are represented in this process; this article is limited to the first part of phase 3—user-testing/prototyping.

order to convince funders (Brzoska et al., 2022), and gather consensus among the local action-takers. Tools requiring minimal input data and offering easy navigation increase usability (Brzoska et al., 2022; Cavan et al., 2021; Deas, 2015; Wetzel & Mäs, 2022). This should be complemented with simple language and user-friendly interfaces (Haße & Kind, 2019; Palutikof, Street, et al., 2019b).

4. Multiplicity and flexibility of use: Tools should define clear user groups (Cavan et al., 2021; Denzer et al., 2011) and be designed for diverse needs and decision-makers (Zulkafli et al., 2017), addressing climate impact as one of many stressors (Lemos et al., 2012). Using open-source data, modular designs, and the ability to update models help address the one-size-fits-all challenge (Brzoska et al., 2022; Palutikof, Street, et al., 2019b).
5. Evaluate adaptation options and trade-offs: Tools must help users evaluate adaptation options, link them to impacts, and assess trade-offs and co-benefits (Stratus Consulting Inc., 1999, as cited in Cavan et al., 2021).
6. Facilitate participation and consensus building: Tools should promote engagement and participation (Haße & Kind, 2019), particularly among marginalised groups within a community. This may require strategies such as focused group discussions rather than open forums (Rosengren et al., 2020).

7. Institutionalisation: Adaptation tools need rhetorical force—users must trust the information and recognise its authority, which comes when the tool is institutionalised within policy and multi-level decision-making (Deas, 2015). The credibility of the tool relies on expert validation and state endorsement (Palutikof, Leitch, et al., 2019). Ownership by a recognised institution further strengthens uptake; however, civic intimacy between citizens and the institute also influences uptake (Praharaj et al., 2017).
8. Inter-organisational application: For effective implementation and securing funding, the tool must facilitate inter-organisational data exchange, such as between municipal departments (Wetzel & Mäs, 2022).
9. Integration in existing workflows: Tools are more likely to be adopted when they complement existing knowledge and routines (Fisher et al., 2018). Information that adds value to current processes is more usable and easier to integrate.
10. Maintenance and serviceability: Continuous guidance and support are crucial during both development and application (Street et al., 2019). Identifying communities of practice and boundary organisations helps users navigate the tool and avoid adoption barriers (Fisher et al., 2018; Kalafatis et al., 2015; Palutikof, Street, et al., 2019a). Regular updates are necessary to maintain user trust.

2.2. Characteristics Derived From Key Informant Interviews

Building on the insights from the literature review, key informant interviews (KIIs) were conducted to gather user perspectives. The KII approach allows researchers to understand how target communities—here, the users of the web-tool hThT—experience and perceive the tool, providing insight into a broader range of end uses and useful features (Cossham & Johanson, 2019). While a grounded co-creation process is argued for developing web-tools due to the limited feasibility of the current research, a KII approach is used for "practical insider knowledge and are interviewed as surrogates for a wider circle of players" (Bogner et al., 2009, p. 2).

Interviewees were identified from potential user groups, including community members, researchers, practitioners in CbA, NGOs/NPOs working with under-resourced communities, and government officials.

Community members were interviewed from a test case site in an informal settlement in South-West Delhi. This was also accompanied by a survey of their neighbourhood-built environment in December 2023. Two individuals, who chose to remain anonymous, shared their perceptions on the need for adaptation, their experiences with government-managed mobile apps for citizen engagement (e.g., Swacchata-MoHUA, MCD app), and their thoughts on integrating grievance redressal with adaptation planning in a web-tool.

Researchers and practitioners provided insights into the barriers they faced in implementing community-based interventions, their experience with community participation, and their feedback on the potential usability of a web-tool. Interviewees included Sushila Pandit, a researcher at the Global Challenges Doctoral Centre, University of Kent, and Richard Taylor, Senior Research Fellow at the Stockholm Environment Institute, London. Pandit has over a decade of experience in climate change through her work with national and international organisations like CARE, Practical Action, and Mercy Corps. Taylor specialises in climate adaptation tools and decision-making processes.

In the NGO/NPO category, the director, Renu Khosla, and Barsha Poricha of the Delhi-based CURE were interviewed. CURE works with informal and low-income urban communities to develop solutions that integrate them into city development processes, including web-based applications for collecting and integrating community data.

One practitioner, Preeti Prada Panigrahi, an urban social policy strategist who, at the time of the interview, was leading the slum upgrading project JAGA Mission in Odisha, and a retired government official, Pradeep Kumar Khandelwal of the East Delhi Municipal Corporation, also provided valuable insights.

Three key themes were identified to guide the interviews and analysis: Climate adaptation awareness in the communities involved; participation in decision-making—whether present or absent and to what level; and feedback on the envisioned web-tool. Interviews were conducted either in person or via video, lasting between 45 and 60 minutes each. The interview guide can be found in the Supplementary File 1.

The following key requirements were extracted from the interviews:

1. Ownership and serviceability: To ensure widespread adoption and legitimacy, interviewees stressed that the tool should be centrally owned by the government, allowing for cross-state and municipal use. This echoes findings from the literature (points 8 and 10 in Section 2.1). Central ownership ensures long-term reliability, updates, and support—balancing top-down control with bottom-up use.
2. Avoiding an "app graveyard": While apps like the Swacchhata Platform (https://www.swachh.city) have been successful, there is concern about creating an "app graveyard" of abandoned platforms. Panigrahi suggested a modular approach, integrating climate services into existing civic engagement platforms to avoid overwhelming users with competing apps.
3. Identifying champions: Considering the socio-cultural context of application, identifying community champions—such as young people—was recommended for promoting tool uptake. These champions could be trained to use the tool and then help raise awareness within their communities.
4. Orientation and sensitisation: To address digital literacy challenges, periodic workshops were recommended. Trained champions could autonomously run these sessions. Additionally, the tool's user interface should remain simple and free of jargon to ensure accessibility.

2.3. Features of the hThT Web-Tool

Figure 3 presents a matrix linking requirements derived from the literature and KIIs with the features of hThT, assessed at varying confidence levels (low, medium, high). It illustrates how these features operationalise the characteristics of TCbA. For instance, the proposed hThT architecture meets the requirement of "evaluating options, trade-offs, and co-benefits" with high confidence, as it enables the collection and translation of climate science into actionable insights, displayed in an assessment matrix of co-benefits and trade-offs (see also Figure 5, screen (g)). By providing climate-informed decision support, it empowers communities, granting them agency for adaptation action and fostering learning (TCbA characteristics 2 and 5; see Figure 3). Additionally, simulating the effects of selected measures on local environments aids consensus-building (TCbA characteristic 4). While rooted locally, science-backed decisions enhance community voices across administrative levels, facilitating greater representation (TCbA characteristic 3). Other requirements, such as "addressing socio-cultural context," are collectively met with medium

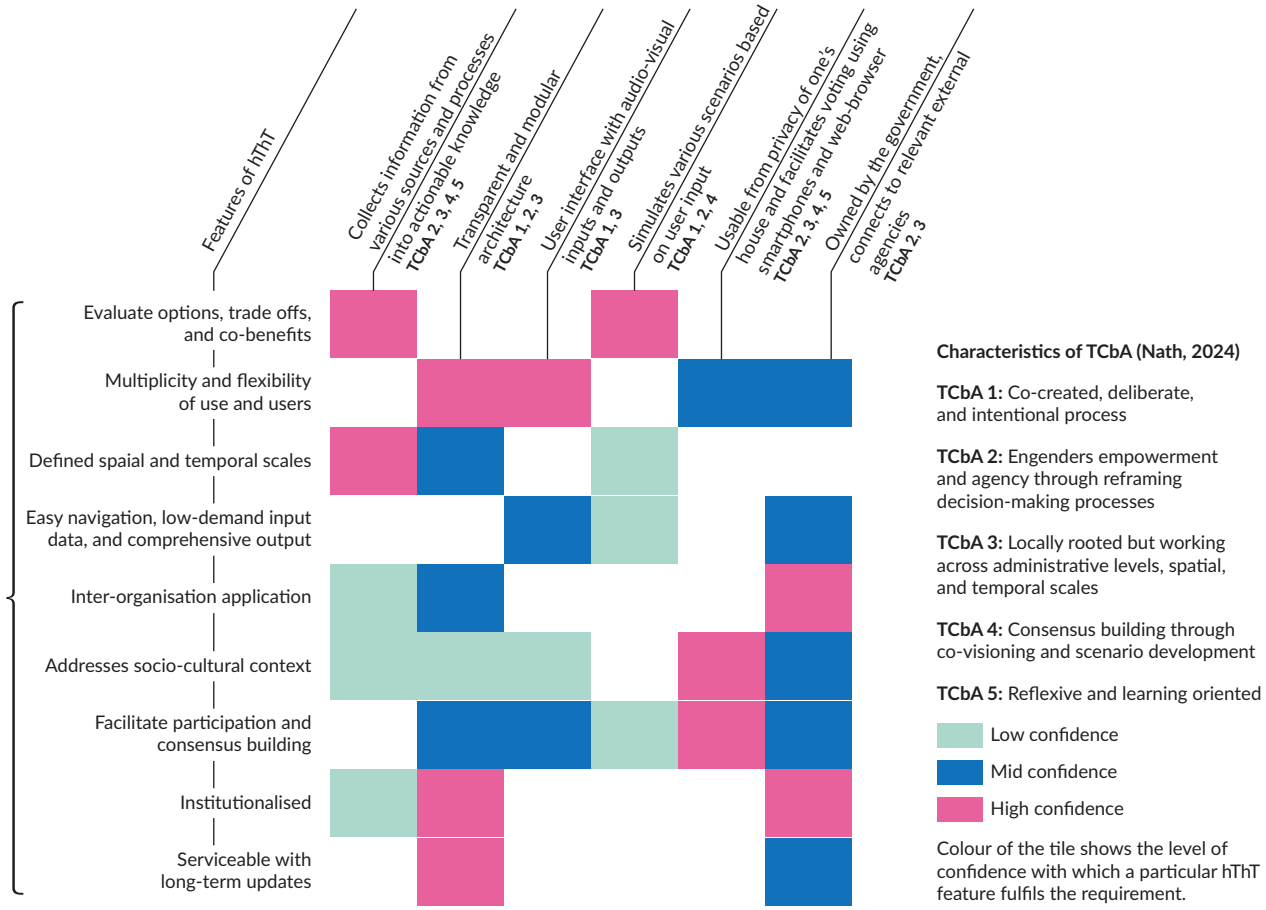


Figure 3. Features of hThT web-tool. Source: Nath (2024).

confidence. In addressing norms and power dynamics in decision-making, the tool introduces a high-confidence, novel feature for voting on adaptation measures based on the assessment matrix, also meeting the requirement of "facilitating participation and consensus building." This feature, "usable from the privacy of one's home via smartphones or web-browsers," further empowers community members (TCbA characteristic 2) by enabling equitable participation in decision-making, regardless of gender or socio-economic background.

As discussed in Section 2.1, some of these features build on the characteristics conceptualised and/or implemented in tools like the one conceptualised by Brzoska et al. (2022), who emphasised the need to include microclimatic simulations and develop a tool that can support non-scientific communities, such as planners, but also private users. hThT also furthers the feature of modularity, designing for multiple uses and enabling participation, as suggested by Haße and Kind (2019), while updating the Klimalotse (climate navigator) tool for use in public institutions and their decision-making processes. However, hThT distinguishes itself from these and other existing tools, such as CoastAdapt (Leitch et al., 2019) or STAR tools (Cavan et al., 2021), through its focus on being comprehensible and accessible to non-experts, particularly private users, and by advancing the use of online voting to ensure representative and meaningful participation. In addition, conceiving hThT both as a plug-in and a stand-alone tool is a novel feature.

3. hThT Web-Tool: Information Architecture

The hThT web-tool has been envisioned as a co-created web-tool, i.e., while an institution may own or host the tool to legitimise it (point 7 in Section 2.1), its development and evolution are deeply influenced by ongoing input and contributions from the community it serves. Therefore, the proposed information architecture uses an open design approach. An open design is defined as "the state of a design project where both the process and the sources of its output are accessible and reusable by anyone for any purpose" (Boisseau et al., 2018, p. 17). This approach also allows the design to be freely shared, collaborated on, or prototyped by communities or individuals.

Its overall architecture comprises a front-end user interface and a set of back-end tools or analytical modules, like data sets for location and 3D model data or adaptation measures; connected via a centralized system for data storage, definition, and delivery (see Figure 4, point (a)). This architecture allows hThT to have a modular development of solutions tailored to specific locations and adaptation challenges. Different components can be modified to fit the adaptation needs of specific neighbourhoods (Figure 4, point (b)). For instance, based on the climatic region and geographic location of the neighbourhood, issues like heat, drought, or flooding can be added or removed, and the recommend adaptation measures updated. Similarly, simulations and software can be adjusted based on the geophysical phenomenon and the level of detail required for the task. Different software applications (like ENVI-Met, IDA-ICE, etc.) for varying relevance and accuracy of 3D model development and subsequent simulation—for example, outdoor thermal comfort, stormwater run-off analysis, indoor thermal comfort, etc.—can be easily plugged in and independently developed. The modularity of these components also allows for updates with new information and as adaptation science progresses. It is envisioned that with such a modular design based on the principles of open design, the tool will be adopted by communities of practice, like researchers and practitioners working on local adaptation, ensuring its maintenance over time.

Additionally, hThT can be integrated with other citizen engagement tools or used as a standalone web tool. The granularity of information and its delivery method are flexible, catering to different user needs. More detailed information, for example, simulation details, can be accessed by experts for verification and replication (Figure 4, point (c)), while community decision-makers can choose to directly see actionable information, like the assessment matrix (see Figure 5, screen (g)).

The tool is both demand- and feedback-driven, providing new information based on community-identified needs. For example, communities can request the development of neighbourhood models for specific adaptation measures (see Figure 4, point (a), and Figure 5, screen (c)). This flexibility allows hThT to expand its geographic coverage as new neighbourhoods require assessment. Additionally, the front-end interface and language can be customised for different user groups—whether residents of an informal settlement (e.g., the test case in India) or a municipal officer in a small under-resourced municipality, for example, in peri-urban Germany. To accommodate varying levels of digital literacy, the interface includes explanatory visuals and audio input/output options, ensuring inclusivity in co-creating adaptation plans.

The front-end displays results in the form of assessment matrices, voting options, and visualisations accessible via smartphones, laptops, or citizen engagement apps (see Figure 4, point (d)). The option for e-voting minimises the influence of powerful community members, which often skews physical group voting

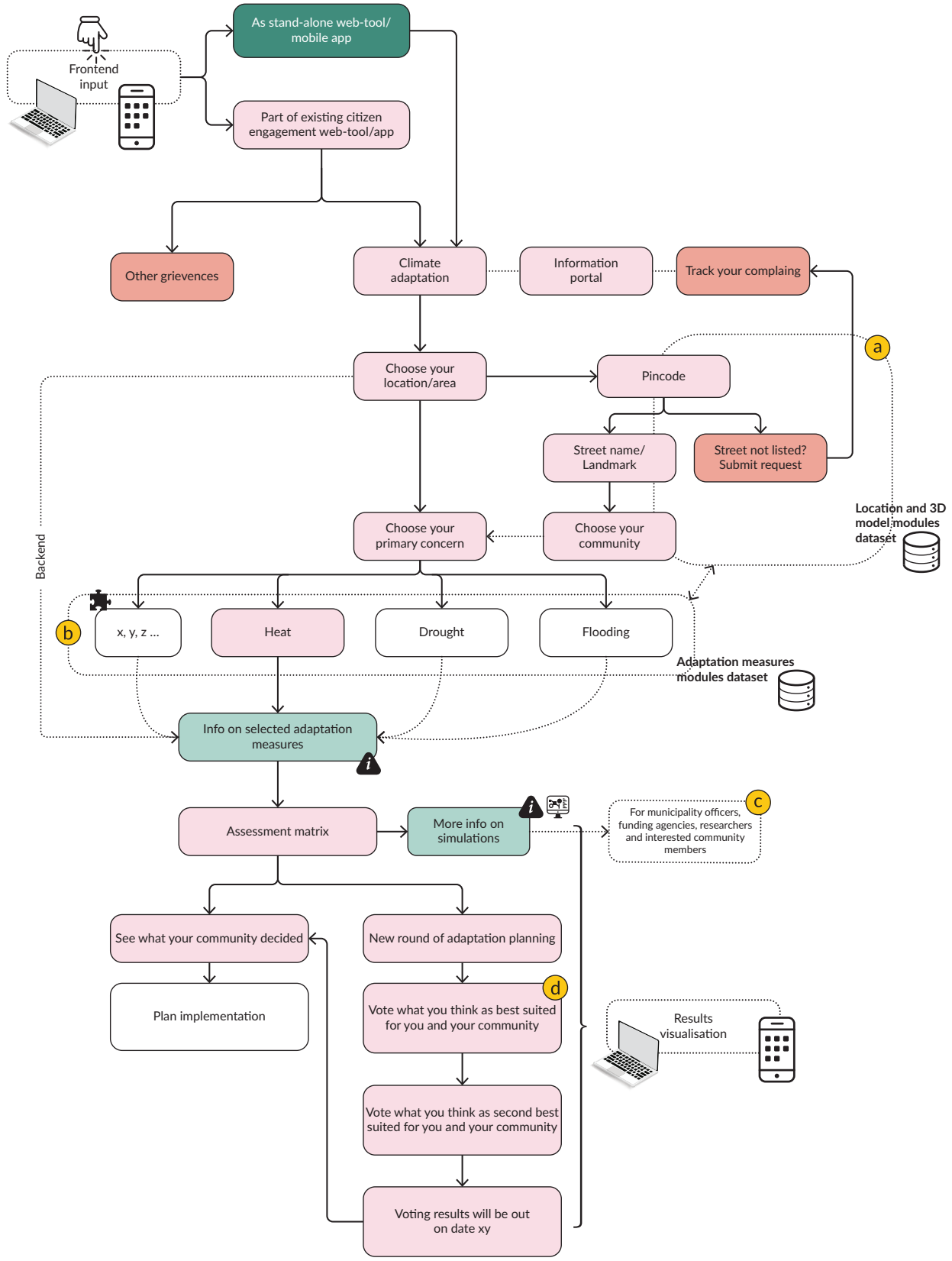


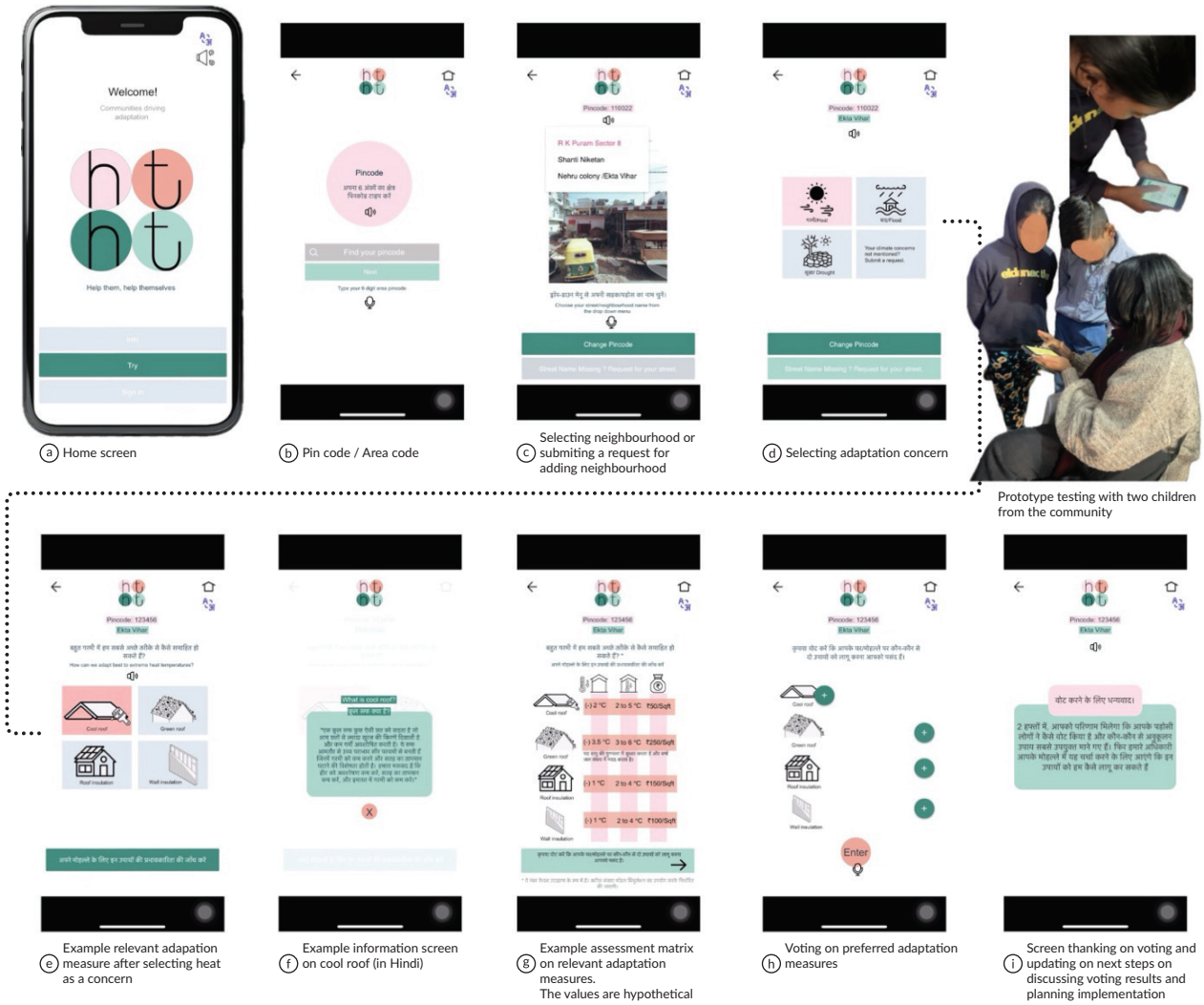
Figure 4. hThT web-tool information architecture. Key points are highlighted: Point (a) highlights the analytic modules; point (b) the flexible adaptation modules; point (c) leads to extra information on simulation details, like model boundary conditions, etc.; point (d) highlights the voting feature.

results. E-voting also enables participation from groups who might otherwise be excluded due to socio-economic norms, allowing them to vote from home.

3.1. Prototyping hThT in an Informal Settlement in Delhi, India

To evaluate the usability and comprehensibility of the tool, a mobile app prototype was developed using a trial version of the web-based prototyping software Proto.io (https://proto.io). The user interface was designed to be simple, requiring minimal input from users (see point 2 in Section 2.1), with information on possible adaptation measures available in the local language and with audio output options at each step. The prototype focused on heat adaptation, with the assessment matrix showing hypothetical values of improvement in outdoor and indoor thermal comfort, and the cost per sq. ft. of applying this measure (see Figure 5, screen (g)).

The prototype mobile app was shown to the community, who had been consulted as key informants during the initial development. Their feedback was mixed. They found the user interface usable after an initial explanation,



(a) Home screen
(b) Pin code / Area code
(c) Selecting neighbourhood or submiting a request for adding neighbourhood
(d) Selecting adaptation concern
(e) Example relevant adapation measure after selecting heat as a concern
(f) Example information screen on cool roof (in Hindi)
(g) Example assessment matrix on relevant adaptation measures. The values are hypothetical
(h) Voting on preferred adaptation measures
(i) Screen thanking on voting and updating on next steps on discussing voting results and planning implementation

Figure 5. hThT Smart Phone App Prototype.

but they suggested integrating voice input, as many community members were non-readers and relied on visuals and audio. The prototype only included voice output. However, when asked if they would use the app if made available via smartphone app stores, the community responded: "Come back in a few weeks. We can't think of these things when we have just received an eviction notice." This reaction was not entirely unexpected, as climate change is just one of many challenges the community faces and is often not their top priority (Lemos et al., 2012; Reid et al., 2009, p. 13).

While there were precedents that suggested this eviction notice would not be acted on, the fear persists and deprioritised adaptation concerns. Due to time constraints, the community was not consulted again, raising important questions about the usability of such adaptation tools. Specifically, when can these tools intervene in informal settlements? How do these contexts change? What policy and governance environments are needed for the uptake of hThT and other adaptation tools? The next sections explore these questions.

4. Points of Intervention: When and Where Is hThT Applicable?

The hThT tool set, including the web-tool and the reflexive questionnaire, was developed in response to the need for a practical solution to mobilise TCbA. TCbA offers alternative pathways to address the multidimensional challenges faced by under-resourced communities (Nath, 2024, p. 5). These challenges vary depending on whether the community is resource-deprived, as in informal settlements, or resource-scarce, as in shrinking cities.

To understand how hThT can facilitate adaptation in informal settlements, it is crucial to consider the typical lifecycle of such settlements, which progresses from informal land occupation without basic services to becoming a formal settlement recognised and supported by state authorities (Du Plessis et al., 2016). Several steps are taken along this continuum, as outlined in Figure 6, which shows the common trajectory of informal settlements in India (referred to as slums). hThT can intervene at two key stages. The first is after the settlement has been officially recognised as a "slum" and as it continues to grow. During this phase, hThT can be employed by the community, facilitated by NGOs and CBOs, to adapt to climate stressors, often by securing essential services. For instance, securing a regular water supply, while a basic necessity, is crucial for coping with heat. Similarly, green roofs can help harness rainwater and improve thermal comfort. hThT, through its location-specific simulation of current and adapted conditions, along with cost-benefit analyses, provides evidence to demand funding and support for implementing these measures. Most adaptation measures at this stage will be limited to short-term, low-cost options due to the absence of tenure rights and the ongoing threat of eviction. The second possible intervention point is to co-create a climate-resilient slum upgrading plan, involving the community, state authorities, and public or private funding and implementing agencies. This intervention is crucial, as most slum upgrading plans do not currently incorporate climate resilience and tend to involve only tokenistic participation (Satterthwaite et al., 2020). By combining the hThT questionnaire and web tool, the process allows for reflexive and inclusive participation and provides a platform for individuals to vote on their preferred adaptation and upgrading measures. In resource-scarce shrinking cities, depopulation and consequent economic decline have reduced municipal budgets and capacities for climate adaptation. This often leads to a lack of urgency and political will to address climate-induced stressors. Concurrently, there is a trend in European Union countries toward civil service reform and decentralisation of public tasks. Citizens are increasingly expected to take on roles that were

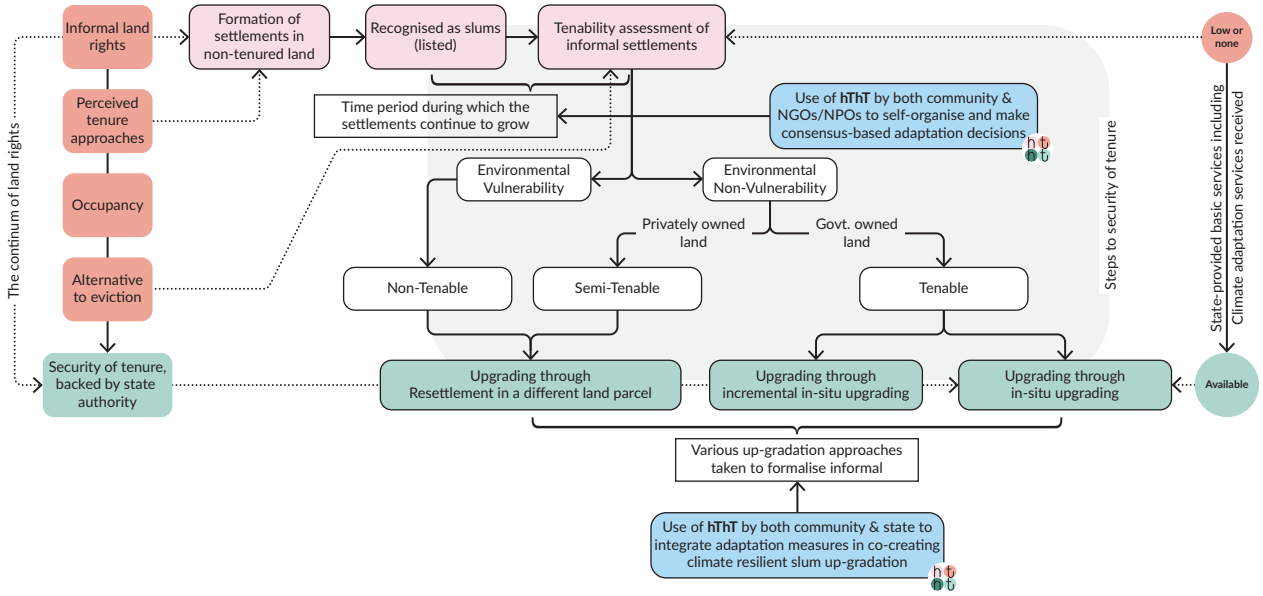


Figure 6. Typical intervention points in an informal settlement.

previously public services, and in turn, are more interested in being involved (Korthagen et al., 2018). This creates an entry point for hThT to act as a transparent platform for co-creating adaptation strategies and sharing responsibilities among citizens and private and public actors.

By providing tailored simulations of relevant adaptation measures, using locally specific climate data, hThT enhances trust in the proposed solutions without adding capacity burdens. hThT can also provide information on relevant funding policies to support the implementation of these measures. The lack of updated information on which funding measures can be used for implementation and the lack of capacity to identify viable solutions are two key issues raised by municipal officers in the German states of Saxony, Saxony-Anhalt, and Thuringia (Höhle et al., 2022). Furthermore, hThT's participatory framework, user-friendly interface, and options for audio input, output, and multiple languages ensure that even those with limited digital literacy can engage. This broadens participation, making decision-making more inclusive and equitable.

However, these interventions for co-creating adaptation strategies can only succeed if complementary policy and governance structures are in place, as discussed in the next section.

5. Required Environment for the Uptake of hThT

The uptake of hThT and other digital technologies for facilitating co-creation of adaptation planning and implementation strategies relies first on public policies and governance structures, and secondly on public awareness and readiness to participate in these processes. Coherence between climate policies and policies on e-governance, devolution of power to the local level, digitalisation, participation (offline and digital), and funding is crucial. Casiano Flores and Crompvoets (2020) emphasise the lack of coherence between various governance elements that leads to policy failures. Gaps in policy integration lead to poor coordination between institutions and involved actors across administrative levels, resulting in ineffective partnerships

and unsustainable community-driven projects (Piggott-McKellar et al., 2019). Coherence (or the lack of it) is among five key qualities of governance that can be assessed to determine whether the current governance structure is supportive or restrictive of the uptake of hThT and other adaptation tools (Casiano Flores & Crompvoets, 2020).

While most adaptation action occurs at the local level, policies are often discussed at the national and state levels. For instance, a recent scholarly appraisal of climate adaptation policies and governance in India did not mention any local-level adaptation planning (Pandey et al., 2024). Without a commitment to integrating locally led adaptation planning into national policy, along with dedicated resources at the local level, funding for adaptation will continue to support top-down, centralised activities that struggle to address the needs of vulnerable communities (Remling & Veitayaki, 2016, as cited in Nath, 2022). This leads to a lack of reliable, long-term financing needed to maintain tools like hThT, operating at the local level.

In India, existing policies on decentralisation, such as the 73rd Constitutional Amendment Act and state finance commissions, along with the National e-Governance Plan (Ministry of Communications, 2006) and National Policy on Information Technology (Ministry of Communications, 2012), theoretically provide a strong foundation for hThT uptake. However, in practice, local governing bodies' power remains "residual" and depends heavily on political will (Mohapatra, 2012). A decade later, Mohapatra (2022) reports that the devolution of functions and functionaries has not yet been fully implemented, leaving local self-governing bodies financially dependent on state governments. Additionally, resources must be allocated for capacity building at the local level. Based on observations from municipalities in East Germany, Tafel et al. (2024) argue that without adequate resources, even municipalities with high awareness and motivation fail to actualise adaptation. These capacities can range from human resources and knowledge of relevant funding policies to integrating digital technologies, such as web-tools, into established workflows.

The uptake of hThT and similar tools facilitating community-based adaptation is also vulnerable to path dependence, which may act as a barrier to institutional change by locking them into specific patterns of thinking and decision-making. Such path dependence reduces their ability to adequately or meaningfully respond to evolving problems like climate change and may make them reluctant to respond to the emergence of new imperatives (Matthews et al., 2015).

On the other hand, public engagement also remains a challenge, despite growing awareness. In India, this is particularly due to the stratified and complex socio-economic and political context, power imbalances, and the inadequacy of decentralised governance structures. These factors complicate access to the information needed for civic decision-making (Menon & Hartz-Karp, 2019). In urban areas, however, growing public discontent with government decision-making has led to increased interest in community participation and partnership in civic decision-making (Menon et al., 2021). Citizens have expressed a readiness for partnerships, third-party facilitation, and support from civic advocacy groups (Menon et al., 2021). A similar trend is observed in European countries, where citizens are increasingly eager to participate in decision-making. However, challenges persist in this context as well. Participatory and e-participative projects provide personal value for participants and enhance community capacity but often lack direct or indirect political impact (Korthagen et al., 2018). For example, Swedish municipalities have noted a disconnection between citizen participation and climate adaptation in policy documents, which can discourage future civic involvement (Glaas et al., 2022).

Civic involvement is also influenced by who owns e-engagement platforms and web-tools, with those assigned prominent roles in local government being more widely used (Kumar et al., 2013). Civic intimacy also influences the uptake of these tools and platforms. While abilities and digital skills are important influencers, citizens' awareness and interest play a larger role (Praharaj et al., 2017). Further, to create a supportive environment for the uptake of hThT there must be clear pathways showing how local civic participation outcomes are translated into policies at different levels. Mees et al. (2019) argue that the increased responsibilities placed on citizens also affect government roles. While government involvement may not decrease, its role must evolve from a regulatory and directive approach to one that is more collaborative and adaptive, enabling and supporting community-led initiatives that are self-managed by citizens.

6. Conclusion and Outlook

This article proposed a toolkit to mobilise TCbA. The toolkit comprises a web-tool to facilitate co-creation of adaptation strategies and a set of diagnostic questions designed to assist on-ground facilitators in being reflexive about the socio-cultural context in which adaptation planning and implementation will take place. The information architecture of the proposed web-tool, which follows an open-design approach, is presented along with a smartphone app prototype. The web-tool, accessible by smartphones or computer web browsers is designed to facilitate the co-creation of adaptation strategies by ensuring representative and meaningful participation of community members of all genders, ages, and socio-economic backgrounds in the decision-making process. It can be a stand-alone app or integrated into other citizen engagement apps. Findings from KIIs and existing literature highlight the critical need to embed the toolkit directly within the TCbA process, ensuring it is contextualised rather than viewed as a universal solution. Effective adaptation requires not only the provision of digital tools but also a holistic framework that integrates these tools into established community practices and governance structures. Further, the hThT platform has the potential to serve as a boundary object, capable of bridging organisations and stakeholders from different communities of practice, while enhancing communication across policy domains and governance levels involved in climate adaptation.

The integration of climate services within a digital public services model, as part of the recent UN's Digital Public Infrastructure approach (United Nations, 2023), underscores the broader potential of digital adaptation tools. Developing monitoring and evaluation features, real-time collaboration, and expert support options could expand hThT's capacity as an adaptive governance resource, ultimately enhancing the co-creation of strategies. However, the toolkit's effectiveness will rely on evolving it to support the consolidation of individual decisions into coherent, community-driven actions—a complex process that, as noted, cannot be simplified into input-output models (Biesbroek et al., 2015). Therefore, a notable limitation of the proposed toolkit is the challenge of consolidating individual perspectives into collective decision-making. The process of moving from personalized preferences to collective action remains intricate, influenced by socio-political dynamics and imbalances in decision-making power. The hThT toolkit, while advancing accessibility and inclusivity, is not positioned as a comprehensive solution to all public decision-making complexities. While the toolkit incorporates a reflexive questionnaire to engage with these internal dynamics, more extensive, ongoing community engagement remains crucial. Adapting the toolkit to diverse socio-political contexts remains a challenge. While hThT's modular design and multiplicity of uses render it conceptually adaptable, its practical uptake and efficacy will ultimately depend on the specific realities of different settings. For instance, the rapid and unplanned urbanisation of cities in the Global South

contrasts sharply with the challenges of shrinking cities in the Global North, highlighting the need for tailored implementation strategies.

Overall, hThT offers a foundation for collaborative adaptation, yet future work must prioritise frameworks that accommodate community needs through iterative co-design, continuous improvement, and, ultimately, empowerment in adaptive governance.

Acknowledgments

This research would not have been possible without the generous contributions of time and feedback from the community members who supported me during the fieldwork and participated in the interviews. I am deeply grateful to the key informants for their invaluable insights: Sushila Pandit, Richard Taylor, Renu Khosla, Barsha Poricha, and Pradeep Kumar Khandelwal.

Funding

This research was supported by the funding received from Dresden Leibniz Graduate School—a joint interdisciplinary facility of the Leibniz Institute of Ecological Urban and Regional Development (IOER) and TU Dresden. Publication of this article in open access was made possible through the institutional membership agreement between the University of TU Dresden and Cogitatio Press.

Conflict of Interests

The author declares no conflict of interests.

Data Availability

Appendix 1 provides details on the interview guidelines. Additional data and materials not included in the appendix are available upon request.

Supplementary Material

Supplementary material for this article is available online in the format provided by the author (unedited).

References

Abson, D., Fischer, J., Leventon, J., Newig, J., Schomerus, T., Vilsmaier, U., von Wehrden, H., Abernethy, P., Ives, C., Jager, N., & Lang, D. (2017). Leverage points for sustainability transformation. *AMBIO A Journal of the Human Environment*, *46*, 30–39. https://doi.org/10.1007/s13280-016-0800-y

Archie, K. M., Dilling, L., Milford, J. B., & Pampel, F. C. (2014). Unpacking the 'information barrier': Comparing perspectives on information as a barrier to climate change adaptation in the interior mountain West. *Journal of Environmental Management*, *133*, 397–410. https://doi.org/10.1016/j.jenvman.2013.12.015

Biesbroek, R., Dupuis, J., Jordan, A., Wellstead, A., Howlett, M., Cairney, P., Rayner, J., & Davidson, D. (2015). Opening up the black box of adaptation decision-making. *Nature Climate Change*, *5*(6), Article 6. https://doi.org/10.1038/nclimate2615

Bogner, A., Littig, B., & Menz, W. (Eds.). (2009). *Interviewing experts*. Palgrave Macmillan.

Boisseau, É., Omhover, J.-F., & Bouchard, C. (2018). Open-design: A state of the art review. *Design Science*, *4*, Article 3. https://doi.org/10.1017/dsj.2017.25

Brzoska, P., Fügener, T., Moderow, U., Schünemann, C., Westermann, J., Grunewald, K., Maul, L., & Barr, A. (2022). Towards a web tool for assessing the impact of climate change adaptation measures on heat stress at urban site level. *One Ecosystem*, *7*, Article 85559. https://doi.org/10.3897/oneeco.7.e85559

Buytaert, W., Zulkafli, Z., Grainger, S., Acosta, L., Alemie, T. C., Bastiaensen, J., De Bièvre, B., Bhusal, J., Clark, J., Dewulf, A., Foggin, M., Hannah, D. M., Hergarten, C., Isaeva, A., Karpouzoglou, T., Pandeya, B., Paudel, D., Sharma, K., Steenhuis, T., . . . Zhumanova, M. (2014). Citizen science in hydrology and water resources: Opportunities for knowledge generation, ecosystem service management, and sustainable development. *Frontiers in Earth Science*, *2*. https://doi.org/10.3389/feart.2014.00026

CARE. (2010). *Community based adaptation toolkit*. https://www.betterevaluation.org/en/resources/climate_change_adaptation/community_adaptation_toolkit

Casiano Flores, C., & Crompvoets, J. (2020). Assessing the governance context support for creating a pluvial flood risk map with climate change scenarios: The Flemish subnational case. *International Journal of Geo-Information*, *9*, Article 460. https://doi.org/10.3390/ijgi9070460

Cavan, G., Butlin, T., Gill, S., Kingston, R., & Lindley, S. (2021). Web-GIS tools for climate change adaptation planning in cities. In W. Leal Filho (Ed.), *Handbook of climate change adaptation* (pp. 1–27). Springer. https://doi.org/10.1007/978-3-642-40455-9_106-1

Colloff, M., Gorddard, R., Abel, N., Locatelli, B., Wyborn, C., Butler, J., Lavorel, S., van Kerkhoff, L., Meharg, S., Munera, C., Enora, B., Fedele, G., Wise, R., & Dunlop, M. (2021). Adapting transformation and transforming adaptation to climate change using a pathways approach. *Environmental Science & Policy*, *124*, 163–174. https://doi.org/10.1016/j.envsci.2021.06.014

Cossham, A., & Johanson, G. (2019). The benefits and limitations of using key informants in library and information studies research. *Proceedings of RAILS—Research Applications Information and Library Studies*, *24*. https://informationr.net/ir/24-3/rails/rails1805.html

Deas, M. (2015). *Cal-Adapt and the usability of climate adaptation tools* [Doctoral dissertation]. MIT. https://dspace.mit.edu/handle/1721.1/99075

Denzer, R., Schlobinski, S., & Gidhagen, L. (2011). A decision support system for urban climate change adaptation. In IEEE (Eds.), *2011 44th Hawaii International Conference on System Sciences*. https://doi.org/10.1109/HICSS.2011.8

Dodman, D., & Mitlin, D. (2013). Challenges for community-based adaptation: Discovering the potential for transformation. *Journal of International Development*, *25*(5), 640–659. https://doi.org/10.1002/jid.1772

Du Plessis, J., Augustinus, C., Barry, M., Lemmen, C., & Royston, L. (2016, March 14–18). *The continuum of land rights approach to tenure security: Consolidating advances in theory and practice* [Paper presentation]. 2016 World Bank Conference on Land and Poverty, Washington, DC, USA. https://www.researchgate.net/publication/303697119

Ensor, J. E., Park, S. E., Attwood, S. J., Kaminski, A. M., & Johnson, J. E. (2018). Can community-based adaptation increase resilience? *Climate and Development*, *10*(2), 134–151. https://doi.org/10.1080/17565529.2016.1223595

Few, R., Brown, K., & Tompkins, E. L. (2007). Public participation and climate change adaptation: Avoiding the illusion of inclusion. *Climate Policy*, *7*(1), 46–59. https://doi.org/10.1080/14693062.2007.9685637

Fisher, S., Dodman, D., Van Epp, M., & Garside, B. (2018). The usability of climate information in sub-national planning in India, Kenya and Uganda: The role of social learning and intermediary organisations. *Climatic Change*, *151*(2), 219–245. https://doi.org/10.1007/s10584-018-2291-2

Forgues, D., Koskela, L., & Lejeune, A. (2010). Information technology as boundary object for transformational learning. *Journal of Information Technology in Construction*, *14*(6), 48–58. http://www.itcon.org/paper/2009/06

Glaas, E., Hjerpe, M., Wihlborg, E., & Storbjörk, S. (2022). Disentangling municipal capacities for citizen participation in transformative climate adaptation. *Environmental Policy and Governance*, *32*(3), 179–191. https://urn.kb.se/resolve?urn=urn:nbn:se:liu:diva-183912

Haße, C., & Kind, C. (2019). Updating an existing online adaptation support tool: Insights from an evaluation. *Climatic Change*, *153*(4), 559–567. https://doi.org/10.1007/s10584-018-2166-6

Hofstad, H., Sørensen, E., Torfing, J., & Vedeld, T. (2022). Designing and leading collaborative urban climate governance: Comparative experiences of co-creation from Copenhagen and Oslo. *Environmental Policy and Governance*, *32*(3), 203–216. https://doi.org/10.1002/eet.1984

Höhle, J., Zorn, A., Pluntke, T., Neumann, T., Schäfer, S., & Struve, S. (2022). *Kommunen im Kontext klimatischer Verndерungen und extremer Wetterereignisse: Ergebnis-se einer Kommunenbefragung*. TU Dresden. https://klimakonform.uw.tu-dresden.de/images/pdf/KlimaKonform_Broschuere_Kommunenbefragung_2022-04-22.pdf

Holland, B. (2017). Procedural justice in local climate adaptation: Political capabilities and transformational change. *Environmental Politics*, *26*(3), 391–412. https://doi.org/10.1080/09644016.2017.1287625

Huq, S., & Reid, H. (2007). *Community-based adaptation: A vital approach to the threat climate change poses to the poor*. IIED. https://www.iied.org/17005iied

Kalafatis, S. E., Lemos, M. C., Lo, Y.-J., & Frank, K. A. (2015). Increasing information usability for climate adaptation: The role of knowledge networks and communities of practice. *Global Environmental Change*, *32*, 30–39. https://doi.org/10.1016/j.gloenvcha.2015.02.007

Karali, E., & Mattern, K. (2017). Communicating climate change adaptation information using web-based platforms. *Advances in Science and Research*, *14*, 241–245. https://doi.org/10.5194/asr-14-241-2017

Karim, M. R., & Thiel, A. (2017). Role of community based local institution for climate change adaptation in the Teesta riverine area of Bangladesh. *Climate Risk Management*, *17*, 92–103. https://doi.org/10.1016/j.crm.2017.06.002

Korthagen, I., van Keulen, I., Hennen, L., Aichholzer, G., Rose, G., Lindner, R., Goos, K., & Nielsen, R. Ø. (2018). *Prospects for e-democracy in Europe* (No. IP/G/STOA/FWC/2013-001/LOT 8/C4). European Parliamentary Research Service. https://search.issuelab.org/resource/prospects-for-e-democracy-in-europe.html

Kumar, P., Kumar, D., & Kumar, N. (2013). ICT in local self governance: A study of rural India. *International Journal of Computer Applications*, *83*(6), 31–36. https://doi.org/10.5120/14453-2714

Leitch, A. M., Palutikof, J. P., Rissik, D., Boulter, S. L., Tonmoy, F. N., Webb, S., Vidaurre, A. C. P., & Campbell, M. C. (2019). Co-development of a climate change decision support framework through engagement with stakeholders. *Climatic Change*, *153*(4), 587–605. https://doi.org/10.1007/s10584-019-02401-0

Lemos, M. C., Kirchhoff, C. J., & Ramprasad, V. (2012). Narrowing the climate information usability gap. *Nature Climate Change*, *2*(11), Article 11. https://doi.org/10.1038/nclimate1614

Matthews, T., Lo, A. Y., & Byrne, J. A. (2015). Reconceptualizing green infrastructure for climate change adaptation: Barriers to adoption and drivers for uptake by spatial planners. *Landscape and Urban Planning*, *138*, 155–163. https://doi.org/10.1016/j.landurbplan.2015.02.010

Mees, H. L. P., Uittenbroek, C. J., Hegger, D. L. T., & Driessen, P. P. J. (2019). From citizen participation to government participation: An exploration of the roles of local governments in community initiatives for climate change adaptation in the Netherlands. *Environmental Policy and Governance*, *29*(3), 198–208. https://doi.org/10.1002/eet.1847

Menon, S., & Hartz-Karp, J. (2019). Institutional innovations in public participation for improved local governance and urban sustainability in India. *Sustainable Earth*, *2*(1), Article 6. https://doi.org/10.1186/s42055-019-0013-x

Menon, S., Hartz-Karp, J., & Marinova, D. (2021). Can deliberative democracy work in urban India? *Urban Science*, *5*(2), Article 2. https://doi.org/10.3390/urbansci5020039

Ministry of Communications. (2006). *NeGP focuses on e-Delivery*. https://www.pib.gov.in/newsite/PrintRelease.aspx?relid=68736

Ministry of Communications. (2012). *Cabinet approves National Policy on Information Technology 2012*. https://pib.gov.in/newsite/PrintRelease.aspx?relid=87875

Mohapatra, B. P. (2012). Local self governing institutions and fiscal decentralisation in India: Form to function. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.2193836

Mohapatra, B. P. (2022). State finance commissions and devolution of funds to Panchayati Raj Institutions in Odisha: A critique. *Review of Development and Change*, *27*(1), 61–82. https://doi.org/10.1177/09722661221087979

Nath, S. (2022, December 13). *The role of structured decision-making in community-based adaptation: A systematic scoping review* [Paper presentation]. 28th Annual Conference, of the International Sustainable Development Research Society Stockholm, Sweden. https://doi.org/10.5281/zenodo.7681489

Nath, S. (2024). Mobilising transformative community-based climate change adaptation. *Urban Transformations*, *6*(1), Article 1. https://doi.org/10.1186/s42854-023-00059-7

Palutikof, J. P., Leitch, A. M., Rissik, D., Boulter, S. L., Campbell, M. J., Perez Vidaurre, A. C., Webb, S., & Tonmoy, F. N. (2019). Overcoming knowledge barriers to adaptation using a decision support framework. *Climatic Change*, *153*(4), 607–624. https://doi.org/10.1007/s10584-018-2177-3

Palutikof, J. P., Street, R. B., & Gardiner, E. P. (2019a). Looking to the future: Guidelines for decision support as adaptation practice matures. *Climatic Change*, *153*(4), 643–655. https://doi.org/10.1007/s10584-019-02404-x

Palutikof, J. P., Street, R., & Gardiner, E. (2019b). Decision support platforms for climate change adaptation: An overview and introduction. *Climatic Change*, *153*. https://doi.org/10.1007/s10584-019-02445-2

Pandey, V. K., Anshu, & Sharma, K. K. (2024). Climate change adaptation policies and governance: A critical appraisal. In K. K. Sharma, S. Sharma, V. K. Pandey, & R. Singh (Eds.), *Climate change and human adaptation in India: Sustainability and public policy* (pp. 199–206). Springer Nature. https://doi.org/10.1007/978-3-031-55821-4_14

Park, S. (2017). Information is power. In S. Park (Ed.), *Digital capital* (pp. 161–183). Palgrave Macmillan. https://doi.org/10.1057/978-1-137-59332-0_8

Piggott-McKellar, A. E., McNamara, K. E., Nunn, P. D., & Watson, J. E. M. (2019). What are the barriers to successful community-based climate change adaptation? A review of grey literature. *Local Environment*, *24*(4), 374–390. https://doi.org/10.1080/13549839.2019.1580688

Praharaj, S., Han, J. H., & Hawken, S. (2017). Innovative civic engagement and digital urban infrastructure: Lessons from 100 Smart Cities Mission in India. *Procedia Engineering*, *180*, 1423–1432. https://doi.org/10.1016/j.proeng.2017.04.305

Rashid, A. K. M. M., & Khan, M. R. (2013). Community based adaptation: Theory and practice. In R. Shaw, F. Mallick, & A. Islam (Eds.), *Climate change adaptation actions in Bangladesh* (pp. 341–362). Springer Japan. https://doi.org/10.1007/978-4-431-54249-0_18

Regmi, B. R., Star, C., & Leal Filho, W. (2016). An overview of the opportunities and challenges of promoting climate change adaptation at the local level: A case study from a community adaptation planning in Nepal. *Climatic Change*, *138*(3/4), 537–550. https://doi.org/10.1007/s10584-016-1765-3

Reid, H., Alam, M., Berger, R., Cannon, T., Huq, S., & Milligan, A. (Eds.). (2009). *Community-based adaptation to climate change: An overview* (Vol. 60). https://www.iied.org/g02608

Rosengren, L. M., Raymond, C. M., Sell, M., & Vihinen, H. (2020). Identifying leverage points for strengthening adaptive capacity to climate change. *Ecosystems and People*, *16*(1), 427–444. https://doi.org/10.1080/26395916.2020.1857439

Roy, R. (2018). *Evaluating the suitability of community-based adaptation: A case study of Bangladesh*. https://doi.org/10.1007/978-3-319-69838-0_3

Satterthwaite, D., Archer, D., Colenbrander, S., Dodman, D., Hardoy, J., Mitlin, D., & Patel, S. (2020). Building resilience to climate change in informal settlements. *One Earth*, *2*(2), 143–156. https://doi.org/10.1016/j.oneear.2020.02.002

Schipper, L. (2020). Maladaptation: When adaptation to climate change goes very wrong. *One Earth*, *3*, 409–414. https://doi.org/10.1016/j.oneear.2020.09.014

Shabajee, P., Fairbrother, M., Dewsbury, J.-D., & Preist, C. (2014). ICT 4 Climate change adaptation: Systemic and generative perspectives & tools. In *2nd International Conference on ICT for Sustainability 2014 (ICT4S2014)* (pp. 248–257). Atlantis Press. https://doi.org/10.2991/ict4s-14.2014.30

Shammin, M., Wang, A., & Sosland, M. (2021). *A survey of community-based adaptation in developing countries*. In A. K. E. Haque, P. Mukhopadhyay, M. Nepal, & M. R. Shammin (Eds.), Climate change and community resilience (pp. 31–47). Springer. https://doi.org/10.1007/978-981-16-0680-9_3

Sheppard, A., Burgess, S., & Croft, N. (2015). Information is power: Public disclosure of information in the planning decision-making process. *Planning Practice & Research*, *30*(4), 443–456. https://doi.org/10.1080/02697459.2015.1045225

Star, S. L., & Griesemer, J. R. (1989). Institutional ecology, 'translations' and boundary objects: Amateurs and professionals in Berkeley's Museum of Vertebrate Zoology, 1907–39. *Social Studies of Science*, *19*(3), 387–420. https://doi.org/10.1177/030631289019003001

Street, R. B., Pringle, P., Lourenço, T. C., & Nicolletti, M. (2019). Transferability of decision-support tools. *Climatic Change*, *153*(4), 523–538. https://doi.org/10.1007/s10584-018-2263-6

Tafel, J., Zorn, A., & Schäfer, S. (2024). Klimapolitisches Engagement auf kommunaler Ebene in Deutschland—Entwicklung eines Index zu Bewusstsein, Konzeption und Durchführung von Klimaschutz und Klimawandelanpassung. *Raumforschung und Raumordnung | Spatial Research and Planning*, *82*(3), Article 3. https://doi.org/10.14512/rur.2225

Tappert, S., Mehan, A., Tuominen, P., & Varga, Z. (2024). Citizen participation, digital agency, and urban development. *Urban Planning*, *9*, Article 7810. https://doi.org/10.17645/up.7810

United Nations. (2023). *A global digital compact—An open, free and secure digital future for all: Our common agenda Policy Brief 5*. https://doi.org/10.18356/27082245-28

Wetzel, S., & Mäs, S. (2022). *Development of a framework for decision support in the context of climate adaptation*. Gesellschaft für Informatik e.V. https://dl.gi.de/handle/20.500.12116/39394

Wolfram, M., & Vogel, R. (2012). Governance and design of urban infostructures. *Raumforschung Und Raumordnung*, *70*. https://doi.org/10.1007/s13147-012-0169-8

Zulkafli, Z., Perez, K., Vitolo, C., Buytaert, W., Karpouzoglou, T., Dewulf, A., De Bièvre, B., Clark, J., Hannah, D. M., & Shaheed, S. (2017). User-driven design of decision support systems for polycentric environmental resources management. *Environmental Modelling & Software*, *88*, 58–73. https://doi.org/10.1016/j.envsoft.2016.10.012

About the Author

Subhashree Nath is currently a PhD researcher at the Leibniz Institute of Ecological Urban and Regional Development and TU Dresden. Her work focuses on bridging the gap between community and scientific knowledge on liveability and climate resilience. She develops community engagement tools to make scientific insights more accessible. Her interests include community-driven climate adaptation using ICT, decolonial theories for just adaptation, and methodologies like fuzzy cognitive mapping and system dynamics to analyse power dynamics in community-driven adaptation and development.