Part III: Reworlding the Planet - Concepts for Survival and Solidarity
Chapter 2

INFRASTRUCTURE OF SURVIVAL: RESILIENT DESIGN IN THE AGE OF CLIMATE CHANGE

[1] Dr. Dhavamanidoss Sakthidoss, Associate Professor, Sethu Institute of Technology, Virudhungar, Tamilnadu, India - 626115

INTRODUCTION

The 21st century has ushered in an era of unprecedented environmental challenges, with climate change emerging as one of the most pressing threats to human survival and ecological stability (Baettig et al., 2007). Rising global temperatures, intensified natural disasters, sea-level rise, and shifting weather patterns are no longer distant projections, but lived realities across the globe. From floods that devastate urban infrastructure to heatwaves that cripple public health systems, the impact of climate change is deeply intertwined with the built environment. Traditional models of infrastructuredesigned for predictability, linear growth, and environmental stabilityare increasingly inadequate in the face of accelerating uncertainty.

The concept of *resilient infrastructure* has gained traction across disciplines such as urban planning, architecture, civil engineering, and environmental science (Yilmaz et al., 2021). Resilient design emphasizes adaptability, redundancy, flexibility, and long-term sustainability, shifting focus from efficiency and expansion to durability and survival. It also recognizes that infrastructure is not merely physical or technical; it is social, economic, and political, shaped by who builds it, who benefits from it, and who is left vulnerable in times of crisis. This background sets the stage for critical rethinking of the conceptualization and development of infrastructure (Rao, 2023). As climate change continues to expose the fragilities of existing systems, there is a growing need to imagine and implement infrastructural forms that not only withstand disasters, but also foster social equity, ecological harmony, and long-term resilience. The "infrastructure of survival" thus emerges as a vital framework for navigating an increasingly volatile future.

This chapter explores the concept of survival infrastructure as a critical response to the escalating climate crisis (Maruf et al., 2024). Although conventional approaches to infrastructure have prioritized growth, development, and economic efficiency, they often overlook the complex vulnerabilities that climate change has exposed, particularly in marginalized and climate-sensitive regions. The purpose of this chapter is to investigate the limitations of traditional infrastructure

paradigms and highlight the need for a transformative shift toward resilience-based design principles.

By situating infrastructure within the broader context of environmental uncertainty, this chapter aims to examine how resilient design can serve not only as a technological solution, but also as a socio-political imperative (Luan et al., 2021). It explores how infrastructure can be reimagined to anticipate disruption, enable recovery, and promote inclusive well-being, especially in communities disproportionately affected by climate change.

This chapter draws on interdisciplinary insights from environmental studies, political ecology, urban planning, and sustainability science (Mancebo, 2017). It highlights both global innovations and grassroots practices that exemplify resilient designs, offering a comparative perspective on how different societies respond to shared climate challenges. Ultimately, the chapter aims to contribute to a more nuanced and critical understanding of what it means to build survival in a rapidly changing world.

CONCEPTUAL CLARIFICATION

The term "Infrastructure of Survival" refers to the essential systems, structures, and networks that enable human and ecological communities to endure, adapt to, and recover from environmental shocks and socio-political disruptions - particularly in the context of climate change (Eichsteller et al., 2022). This concept blends physical infrastructure (such as housing, water systems, and energy grids) with social infrastructure (such as community networks, governance systems, and indigenous knowledge), emphasizing their role in sustaining life amid increasing precarity.

The origins of the term can be traced to discourses in resilience theory, urban planning, and environmental justice, gaining traction as climate change has moved from a scientific concern to a socio-political reality (Loo, 2023). Following early 21st-century disasters such as Hurricane Katrina, the 2010 Haiti earthquake, and more recently, global heatwaves and floods, scholars and policymakers have recognized the inadequacy of conventional development paradigms. Infrastructure was no longer just about economic growth or efficiency; it had to be about survival, especially for marginalized communities most at risk. This framing also draws on the work of thinkers, such as Achille Mbembe's necropolitics, Judith Butler's notion of precarious life, and Anna Tsing's multispecies survival in the Anthropocene, which collectively question whose survival is prioritized and under what systems (Deutscher, 2017). The "infrastructure of survival" thus emerges as a critical lens to rethink design and development not just as technical solutions, but as ethical, political, and ecological commitments to sustaining life in a damaged world.

The idea of infrastructure as a tool for survival has evolved considerably over the past few decades (Neligan & Rajakulendran, 2022). Traditionally, infrastructure refers to large-scale technical systems, such as roads, bridges, and electricity grids, designed to support economic productivity. This modernist view, rooted in 19th- and 20th-century development agendas, prioritized durability and expansion, often with little regard for environmental limits or social equity. However, the turn of the 21st century has marked a significant shift. With the increasing frequency of climate-induced disasters, the limits of conventional infrastructure have become starkly visible. Scholars from urban studies, disaster management, and critical geography have begun to interrogate who is

protected and who is exposed (Raju & Jeffrey, 2017). This led to a reframing of infrastructure, not merely as a matter of engineering but also as a matter of social and ecological resilience.

The key milestones in this evolution include the following.

1. Resilience Turn: Influenced by the work of the Resilience Alliance and popularized by UN frameworks such as the Sendai Framework for Disaster Risk Reduction (2015), resilience came to mean the capacity to "bounce back" or adapt. However, critics have pointed out that resilience is often glossed over structural inequality.
2. Intersection with Climate Justice: The concept began incorporating ideas from climate-justice movements, emphasizing that adaptation must address historical and spatial inequalities. This raises questions like: Who designs infrastructure? Who benefits? Who bears the cost?
3. Community-Centered and Indigenous Models: The evolution also saw an expansion from centralized, state-led models to decentralized and community-led initiatives. In many Global South contexts, informal settlements and indigenous communities created vernacular "infrastructures of survival' that defined formal planning yet offered high resilience.
4. Multispecies and Posthuman Turns: Recent developments have extended this idea beyond humans. Scholars such as Donna Haraway and Anna Tsing emphasize how infrastructure must support the interdependent survivalof humans, animals, plants, and ecologies.

This conceptual shift has implications for design, governance and ethics. It challenges technocratic and market-driven infrastructure models and demands multiple participatory and adaptive approaches (Rossouw, 2019). In its evolved form, the infrastructure of survival is a dynamic and relational constructresponsive to ecological thresholds, cultural specificities, and political struggles.

To fully understand the "infrastructure of survival," it is important to clarify its relation to and distinction from adjacent concepts, such as resilient infrastructure, sustainable development, disaster risk reduction (DRR), and social infrastructure (Burns & Machado Des Johansson, 2017). Resilient infrastructure is often used in policy and engineering contexts to denote systems capable of withstanding and recovering from shocks (Besigomwe, 2025). While it overlaps with the infrastructure of survival, the latter expands the scope beyond engineering resilience to include political economy, lived experiences, and cultural survival. It is as much about power and justice as it is about material robustness.

Sustainable development provides a long-term vision that aims to meet the needs of the present without compromising future generations (Emina, 2021). However, it has been criticized for being vague and sometimes complicit in greenwashing. In contrast, the infrastructure of survival emphasizes urgent, grounded responses to present existential threats, especially for vulnerable populations, and does not assume continuity unless it is actively fought for. Disaster Risk Reduction (DRR) is a technical field concerned with minimizing exposure to hazards (Catindig et al., 2020). It plays a vital role in the broader discussion but often lacks critical engagement with structural inequalities. The infrastructure of survival integrates DRR but pushes it further, questioning the systemic causes of vulnerability and the politics of aid, planning, and insurance.

Social infrastructure, as explored by scholars such as Eric Klinenberg, highlights the role of spaces such as libraries, parks, and community centers in fostering resilience and social ties (Latham & Layton, 2019). This is an essential component of the survival infrastructure, which takes a more holistic view, integrating both social and ecological systems into its core. Finally, the infrastructure for survival is distinct because of its ethical and ontological emphases. It foregrounds the politics of care, the right to shelter and life, and the necessity of coexistence in a fragile world. It refuses to separate design from justice, resilience from resistance, or survival from transformation.

THEORETICAL FOUNDATIONS

The idea of "Infrastructure of Survival" draws upon several foundational theories that connect resilience, systems thinking, ecological design, and sociotechnical adaptation (Wallis-Lage & Erdal, 2021). At its core, this concept seeks to explore how built environments and public systems can be reimagined not merely for efficiency or growth but also for survival, continuity, and adaptability amid escalating climate risks. Resilience Theory is central to this inquiry. Originating in the ecological sciences, particularly from the work of C.S. Holling 's(1973) resilience theory has evolved to include socio-ecological systems (SES) (Greene, 2017). Resilience refers to the capacity of systemms to absorb disturbances, adapt to change, and retain core functions. In urban planning and infrastructure design, this theory supports the creation of decentralized, modular, and adaptive structures that can withstand climate shocks, ranging from rising sea levels to extreme heat waves and supply chain collapse. Infrastructure is not static, but dynamic, requiring capacity for both resistance and transformation.

Systems Theory, particularly when applied to complex adaptive systems, provides a complementary lens (Onik, 2019). Infrastructure, comprising energy grids, water systems, housing, and transportation, is part of a vast, interlinked sociotechnical ecosystem. System theory highlights interdependencies, feedback loops, and tipping points. It promotes holistic design approaches in which vulnerability in one domain (e.g., transportation) may cascade into failures elsewhere (e.g., healthcare delivery). Therefore, building for survival requires planning across networks, not silos.

Degrowth and post-development theories also undergird the critique of conventional infrastructure (O'Kane, 2020). These frameworks challenge the growth-centric model, which has historically guided development, leading to exploitative resource extraction, exclusionary urbanization, and socio-ecological vulnerabilities. In this context, survival infrastructure prioritizes sufficiency, equity, and low-carbon transitions over economic expansion. It seeks to redefine progress in community well-being, ecological restoration, and cultural sustainability. Further, Feminist Political Ecology contributes a critical dimension by emphasizing how gender, power, and inequality shape access to infrastructure and vulnerability to climate impact (Elmhirst, 2015). Infrastructure, often assumed to be neutral, reflects and reproduces sociopolitical hierarchies. The concept of "infrastructure of care" - community kitchens, water collectives, or informal networks of support - repositions marginalized actors as agents of resilience. This theory insists on democratizing design and valuing everyday labor survival.

Finally, Design Justice and Critical Infrastructure Studies examine who designs, decides, and benefits (Sutton, 2021). They foreground participatory processes, historical marginalization, and the politics of (in)visibility in infrastructure. These theories align with the idea that survival infrastructure must not only function technically but also serve justice, especially for frontline communities that bear the brunt of climate change. While core theories emphasize resilience, equity, and systems thinking, several other theoretical perspectives either complement or complicate the survival infrastructure framework. Technological Determinism, for instance, presents a contrasting view (Dafoe, 2015). It frames technology as the primary driver of societal change, often suggesting that smarter, more efficient infrastructure (e.g., AI-powered grids, smart cities, and green architecture) will solve climate challenges. While such innovation is essential, this perspective risks depoliticizing design by ignoring structural inequalities, land dispossession, or sociocultural dislocation. It also tends to prioritize capital-intensive solutions that may marginalize poorer or rural communities. While it may complement resilience thinking in terms of innovation, it often competes with ecological or justice-based approaches.

Modernist Planning Paradigms that favor centralized, top-down infrastructure development may also stand in tension with a survival-centered design (Gaganelis et al., 2019). Modernist ideals have historically led to the displacement of communities, ecological degradation, and a homogenized vision of urbanism. By contrast, survival infrastructure promotes decentralization, redundancy, and local knowledge. However, these paradigms may be reconciled through adaptive planning strategies that blend centralized resource management with local control. Green growth and sustainable development discourse offers a more nuanced complement (Kuhn, 2016). These frameworks attempt to harmonize economic development with ecological sustainability. While they align with some aspects of the survival infrastructure, particularly in promoting low-carbon technologies and climate adaptation, they often remain tied to neoliberal economic assumptions. Critics argue that they co-opt environmental language without addressing root causes such as extractivism or inequality. Therefore, they provide valuable tools but require critical adaptation within the survival lens.

Actor-Network Theory (ANT) and Science and Technology Studies (STS) offer valuable insights into the co-construction of infrastructure, society, and nature (Cressman, 2018). They view infrastructure not as a neutral background, but as active participants in shaping behaviors, possibilities, and futures. These perspectives enrich the discussion by illustrating how values, norms, and power dynamics become embedded in material systemsfrom dams and roads to data centers and disaster shelters. Finally, Indigenous Epistemologies bring forward complementary worldviews grounded in reciprocity, place-based knowledge, and kinship with the more-than-human world (Parkinson, 2023). These perspectives challenge anthropocentric, techno-scientific assumptions, and offer radically different models of survival based on stewardship, communalism, and interdependence.

In summary, the theoretical landscape was plural and contested. While some perspectives advance the goals of survival infrastructure, others require critical interrogation or selective integration to avoid reinforcing the existing hierarchies or unsustainable trajectories. The selected theoretical lens - anchored in resilience theory, systems thinking, political ecology, and design justice - is appropriate for the concept of “Infrastructure of Survival” because it addresses the multidimensional crises posed by climate change (Chester et al., 2018). This lens captures not only

the technical and material dimensions of infrastructure but also its social, ecological, and political entanglements.

First, resilience and systems theories are crucial because they offer tools to understand infrastructure embedded in dynamic, nonlinear systems (Joss & Keleher, 2011). Climate change is not a single event, but a condition of ongoing unpredictability. Thus, we need infrastructure that can flex, adapt, and recover the qualities best addressed through adaptive systems thinking. Second, feminist political ecology and post-development theory ensure that the concept does not remain technocratic (Elmhirst, 2015). These perspectives foreground everyday survival strategies, care work, and the lived experiences of marginalized groups. They critique dominant models that privilege urban, male-centric, or elite definitions of infrastructure, thereby expanding the framework to include informal, decentralized, and communal survival systems.

Design justice and critical infrastructure studies offer a normative framework (Autio, 2017). They ask: Who decides what constitutes infrastructure? Who benefits from or is excluded? This orientation ensures that the infrastructure of survival is not only functional but also participatory and inclusive. In the age of climate apartheid, where infrastructure can become a site of exclusion (as seen in gated resilience, climate-proof enclaves, or extractive megaprojects), justice must be a central design principle. In conclusion, this theoretical lens was selected because it is interdisciplinary, critical, and future-oriented. It integrates material, social, and ethical dimensions of infrastructure, making it suitable for ensuring sustainable and equitable survival in an increasingly unstable world.

DEBATES, GAPS, AND THEORETICAL CHALLENGES

The discourse on resilient infrastructure in the context of climate change is riddled with inherent tensions that reflect deeper ideological, political, and technological divides (Onuoha et al., 2022). One central controversy concerns the balance between technocratic and community-led adaptations. Resilience is often framed through high-tech, data-driven models that emphasize robust engineering solutions, such as sea walls, smart grids, and flood-proof buildings. On the other hand, critics argue that such approaches marginalize local knowledge, indigenous practices, and social equity concerns by centralizing expertise in elite institutions and technocracies. Another tension exists between "build back better" narratives and de-growth or adaptive retreat strategies (Harris, 2016). While development agencies and governments often advocate resilient reconstruction as a means of economic revitalization, this perspective may conflict with the ecological realities. For example, rebuilding in flood-prone or wildfire-susceptible regions may reinforce unsustainable patterns of habitation, raising questions regarding the long-term viability of such infrastructural commitments. Opponents argue for an adaptive retreat - strategically withdrawing from vulnerable zones - as a more ecologically sound and socially just response, even if politically unpopular.

A third controversy revolves around the privatization of resilience (Lindsey et al., 2016). Increasingly, resilience infrastructure is tied to public-private partnerships (PPPs), insurance markets, and green bonds. While these mechanisms inject much-needed capital into climate adaptation, they often prioritize profit-making and risk transfer over collective safety. Critics warn that this could lead to a form of “resilience apartheid,” where wealthy communities have access to

cutting-edge infrastructure, while marginalized populations remain exposed to environmental hazards. Finally, there are epistemological tensions regarding what counts as "infrastructure" and "resilience." Should these terms be limited to physical systems (roads, water supply, buildings) or should they include social infrastructure such as care systems, education, and informal networks that often determine survival during crises? The absence of a unified definition complicates policy design and academic inquiry, contributing to fragmented responses to climate change.

A range of critical perspectives have emerged to challenge mainstream narratives and assumptions surrounding resilient infrastructure (Musonda et al., 2023). Postcolonial and feminist scholars have pointed out that dominant frameworks often reproduce historical imbalances in power. For instance, infrastructural planning in the Global South frequently adopts northern models of resilience that are ill-suited to local socio-cultural contexts. This imposition not only undermines local sovereignty, but also leads to infrastructural solutions that fail to serve the most vulnerable. From a political ecology standpoint, scholars emphasize that infrastructural vulnerability is not merely a function of physical exposure to climate risks, but is deeply shaped by socio-economic and political structures (Jeganathan et al., 2021). In this view, resilience is not just an engineering challenge, but a justice issue. Who is protected and who bears the burden of adaptation are the central political questions. The uneven geography of climate resilience, where elite urban zones receive sophisticated protection while rural or informal settlements are neglected, reveals the embedded inequalities of infrastructural governance.

Decolonial critiques further challenge epistemic frameworks that underpin infrastructure discourse (Colpani, 2022). They argue that indigenous ontologies of land, water, and time are often ignored in the planning processes. For example, the indigenous concept of "living with water," practiced in many riverine and coastal cultures, contrasts with the dominant logic of controlling water through barriers and diversion. Recognizing such knowledge systems opens pathways to pluralistic and inclusive models of resilience.

Scholars critique the overly static and linear conceptualizations of resilience from a systems theory and critical urbanism perspective (Stern et al., 2023). Infrastructure is often treated as a fixed asset rather than a dynamic socio-technical process that evolves in relation to environmental and social change. This neglects the temporal dimension of resilience (how infrastructure adapts, ages, and sometimes fails) and calls for greater attention to flexibility, redundancy, and repair. Moreover, intersectional critiques highlight how infrastructural failures are disproportionately borne by marginalized groups, particularly women, the elderly, people with disabilities, and the economically disenfranchised (Lv*, 2024). Critical resilience studies thus argue for shifting the focus from "bounce back" to "bounce forward" strategies that not only restore but transform existing conditions of vulnerability.

Despite the growing interest in Resilient Infrastructure, several significant gaps persist in academic and policy literature ("Resilient Infrastructure," 2022). First, integrated frameworks that bridge technical resilience with social and ecological dimensions are lacking. Most existing models remain siloed - either overly focused on physical design and engineering or, conversely, narrowly concerned with social resilience without adequately addressing infrastructural needs. Interdisciplinary synthesis remains underdeveloped, leaving researchers and policymakers with no comprehensive tools for holistic climate adaptation. Second, while the literature acknowledges the

importance of community participation, there is limited exploration of how local knowledge systems can meaningfully inform infrastructural design (Makhfud & Mursyidah, 2024). Participatory approaches are often tokenistic, and community engagement is reduced to consultation, rather than co-creation. More empirical work is needed on the mechanisms of collaborative governance, particularly in marginalized or indigenous contexts, where trust and historical injustices shape perceptions of risk and resilience.

A third major gap concerns long-term sustainability and life cycle planning (Kaur et al., 2022). Much of the resilience discourse centers on immediate responses to extreme events, such as floods, droughts, and hurricanes, while neglecting slow-onset changes, such as sea-level rise, soil degradation, or heat stress. Consequently, infrastructure is often reactive rather than anticipatory. The lack of long-duration data and modeling tools also hampers efforts to assess future resilience under compound and cascading risks. Additionally, insufficient attention has been paid to the political economy of resilience financing (Bianchi & Labory, 2018). How resilience projects are funded, how they control financial flows, and how resources are distributed remain underexplored. This is especially relevant in the context of global south cities, where debt, donor priorities, and capital market pressures shape adaptation pathways in ways that may undermine equity. Finally, there is a conceptual void in defining the success of resilient infrastructure. Should success be measured entirely in terms of reduced disaster losses, enhanced equity, ecological restoration, or something else? The absence of shared indicators leads to fragmented evaluations and makes cross-context learning more difficult.

APPLICATION OR ILLUSTRATION

The eastern coast of India, particularly Odisha, has long been vulnerable to tropical cyclones because of its geographical location along the Bay of Bengal (Jana et al., 2021). In 1999, a super cyclone struck Odisha, causing catastrophic damage and exposing the fragile nature of existing infrastructure. Over 10,000 people died and millions were displaced. This tragedy marked a turning point in India's approach to climate-resilient infrastructure. In the following two decades, Odisha emerged as a model for cyclone-resilient planning (Das et al., 2024). The state implemented a multi-tiered disaster management strategy that integrated robust infrastructure, early warning systems, community preparedness, and policy reform. Central to this was the construction of cyclone-resilient houses and shelters.

The Odisha State Disaster Management Authority (OSDMA), in collaboration with international donors and NGOs, launched the owner-driven reconstruction collaboration (ODRC) project (Handlin, 2015). The initiative focused on building over 30,000 cyclone-resistant houses using locally available materials, elevated plinth levels, and wind-resistant roofs. These houses are equipped to withstand wind speeds up to 300 km/h and are strategically located to minimize exposure to storm surges and flooding. Importantly, the designs included climate-sensitive features, such as rainwater harvesting and natural ventilation, adapting both to emergencies and long-term sustainability. A distinguishing aspect of this model is community involvement (Hiryanto et al., 2021). The locals were trained in resilient construction techniques and employed in rebuilding efforts, fostering a sense of ownership, and ensuring the transfer of knowledge. This participatory approach led to broader resilience beyond infrastructure; communities became active agents in risk reduction, enhancing both adaptive capacity and social cohesion.

The ecosystem was further strengthened by multipurpose cyclone shelters (Morgera, 2017). These structures serve as schools or community centers during normal times and are transformed into shelters during emergencies. Equipped with solar panels, sanitation facilities, and food storage, they demonstrate the principle of dual-use infrastructure, maximizing utility while ensuring preparedness. When Cyclone Fani struck in 2019, despite its high intensity (Category 4), the death toll was remarkably low (less than 100), thanks largely to the resilient infrastructure, proactive evacuation, and early warning systems (Ansar et al., 2020). The shelters and homes built after 1999 remained intact, underscoring the success of resilient designs in protecting lives and livelihoods. This case demonstrates the Infrastructure of Survival in action, not as isolated engineering achievements, but as integrated systems shaped by local needs, ecological context, and social dynamics (Chiovaro & Paxton, 2020). This shows that climate-resilient design is not only a technical question but also a political and cultural one. Odisha's experience illustrates how investing in resilience upfront pays dividends, both in saving lives and in reducing long-term economic losses.

The Odisha case offers a rich field of theoretical reflection on Resilient Infrastructure as an adaptive system ("Resilient Infrastructure," 2022). It moves beyond the conventional understanding of infrastructure as fixed physical assets to a more dynamic conceptualization, aligning with theories of socio-ecological resilience and infrastructural governance. Resilience in this context is not merely about bouncing back from shocks but also about transforming the socio-technical systems that produce vulnerability in the first place (Ngoma et al., 2023). This aligns with C.S. Holling's adaptive cycle highlights the phases of growth, collapse, reorganization, and renewal within ecological systems - a useful lens for understanding how Odisha's catastrophic cyclone led to systemic transformation.

The participatory rebuilding approach resonates with Amartya Sen's capabilities approach, emphasizing not only material survival, but also the ability of individuals and communities to shape their own future (Macleod, 2014). Involving local populations in reconstruction not only addresses immediate structural vulnerabilities, but also cultivates adaptive capacity, enhancing resilience from within. From an infrastructural governance perspective, the Odisha case exemplifies what Brian Larkin calls "infrastructure as a cultural system." Resilient infrastructure here is not just material but symbolic; it reshapes community identity, builds trust in the state, and transforms public expectations about safety, preparedness, and entitlement (Adam et al., 2022).

Moreover, the case brings into relief the ethics of care embedded in infrastructural choices (Odollo & Ochieng, 2019). Resilient design is not value-neutral; it reflects decisions about which lives are prioritized, what futures are imagined, and how resources are allocated. Odisha's focus on inclusive design - integrating women, children, and marginalized groups in shelters and planning - illustrates infrastructure as an ethical project. Thus, the theoretical reflection reinforces the central claim of this chapter that the infrastructure of survival is not simply a matter of technical efficiency or cost-benefit calculus. It is a relational, political, and ecological undertaking rooted in the everyday realities of risk and deeper structures of inequality and hope that shape our future on a warming planet.

CONTRIBUTION AND INNOVATION

Infrastructure has long been tied to conventional metrics of efficiency, productivity, and economic development (Zhang, 2024). However, in the age of climate change, these traditional frameworks are becoming increasingly inadequate. This chapter proposes a transformative shift in understanding infrastructure, not merely as physical assets such as roads, bridges, and buildings, but as dynamic systems of survival, adaptation, and social equity. The new insight offered here is the reconceptualization of infrastructure as *"resilient ecosystems of care and continuity* embedded within ecological, social, and cultural landscapes.

This perspective foregrounds climate resilience not only as technical robustness or disaster resistance but also as the capacity to sustain life and dignity in the face of systemic shocks, whether environmental, social, or political (São José, 2016). For example, decentralized water-harvesting systems, green public spaces, and low-carbon housing are not just sustainable technologies; they are socio-political choices that reflect the values of inclusivity, ecological responsibility, and intergenerational justice. Moreover, this chapter critiques the prevailing model of resilience that often reinforces top-down, technocratic responses, and is frequently blind to local contexts and vulnerable populations (Levy, 2022). Instead, it advances a bottom-up understanding of resilience that emphasizes participatory design, traditional knowledge systems, and place-based adaptation. The argument is that the future of survival infrastructure lies not in megaprojects alone, but in distributed, flexible, and human-centered systems that prioritize adaptability over permanence.

This shift also challenges the artificial separation between built and natural environments (Hoffman & Jennings, 2015). In the Anthropocene, urban and rural landscapes were deeply entangled with ecological processes. Therefore, resilient designs must integrate ecological regeneration, social cohesion, and cultural memory as foundational principles. Infrastructure must no longer be seen as neutral; it is inherently political, shaping who survives, thrives, and remains excluded in a rapidly changing world. By offering this reconceptualization, this chapter contributes a critical intervention to climate discourse, urging scholars, practitioners, and policymakers to move beyond resilience as mere recovery, and toward resilience as radical transformation.

Based on this new understanding, the chapter proposes an integrated framework of "Survival-Centered Resilient Design" (SCRD) that synthesizes ecological thinking, social justice, and adaptive architecture into a cohesive infrastructure paradigm (Cuervo, 2016). The SCRD model was grounded into four interlinked pillars.

1. Ecological Embeddedness: Infrastructure must be designed in tandem with local ecosystems. Nature-based solutions such as urban wetlands, living shorelines, and regenerative agriculture should be integral and not auxiliary.
2. Social Resilience: Infrastructure should protect and empower the most vulnerable people. Design must include informal settlements, indigenous communities, and frontline workers, recognizing their roles as co-creators of knowledge and resilience.
3. Decentralization and Flexibility: Rigid, centralized models must give way to modular, decentralized systems that can adapt to diverse geographies and evolving risks. Microgrids, local food networks, and mobile health clinics exemplify these systems.

4. Cultural Continuity and Knowledge Integration: Traditional ecological knowledge and community memory must be respected and integrated into future planning. Resilience is not only material; it is symbolic, lived, and culturally specific.

Together, these pillars advocate for a paradigm shift from extractive infrastructure to regenerative systems, reactive to anticipatory planning, and expert-driven blueprints to community-rooted collaborations.

This proposition contributes to both a theoretical and a practical toolset for navigating an uncertain future climate (Bhandari, 2024). It is not merely about surviving disasters but also about **reframing infrastructure as a lifeline for flourishing amid disruption**. In doing so, it invites interdisciplinary engagement and policy innovation that bridges architecture, environmental studies, public health, and political sciences.

IMPLICATIONS AND FUTURE DIRECTIONS

The concept of "infrastructure of survival' compels a rethinking of infrastructure beyond its conventional association with development and economic progress (Sampelalong & Sukartini, 2020). It reframes infrastructure as a socio-political and ecological construct that embodies the capacity of societies to endure and adapt to environmental disruption. This theoretical shift challenges the dominant paradigms in urban planning, architectural design, and climate adaptation, which have often prioritized efficiency, scalability, and capital investment over resilience, equity, and ecological embeddedness. Resilient design, in this context, is not merely about constructing climate-proof structures but about creating adaptive systems - social, spatial, and ecological - that sustain life under conditions of uncertainty (Hezavehi et al., 2020). This requires engaging with interdisciplinary theories, such as political ecology, critical infrastructure studies, and feminist and decolonial approaches to design, which foreground questions of power, marginalization, and justice. Therefore, the notion of infrastructure must be expanded to include soft systems, such as community networks, local knowledge, and governance frameworks, that co-evolve with hard systems to ensure survivability.

This perspective also challenges the anthropocentric orientation of design thinking by integrating multispecies and more-than-human perspectives (Dashper & Buchmann, 2019). These theoretical implications extend to ethics and epistemology. What counts as the knowledge of building resilience? Who decides what is worth preserving or rebuilding? By foregrounding survival, this discussion has shifted from technological optimism to ecological humility and ethical responsibility. This reorientation invites a relational, situated, and long-term view of infrastructure, re-embedding it within the ecological limits of the planet and the social fabrics of vulnerable communities. Finally, this chapter proposes a theoretical framework in which infrastructure becomes a site of care, resistance, and imagination for an alternative future.

The reframing of infrastructure as a survival imperative opens several avenues for interdisciplinary research (Dalton et al., 2022). First, there is a pressing need for empirical studies that map the lived experiences of communities navigating infrastructural breakdowns, particularly in the climate-vulnerable regions of the Global South. Ethnographic work can uncover how informal, indigenous, or community-driven practices contribute to everyday resilience and how these practices might

inform policy and design. Second, computational and systems modeling can be applied to simulate the performance of resilient infrastructures under varying climate stressors by integrating social variables, such as inequality, migration, and governance (Manrique et al., 2022). Third, transdisciplinary collaboration between engineers, urban ecologists, social scientists, and designers is crucial for developing hybrid models of adaptive infrastructure that blend technological and ecological logic.

For practitioners, urban planners, architects, policymakers, and community organizers, the insights from this chapter underscore the need for participatory and inclusive design processes (Konou et al., 2023). Infrastructure cannot be viewed merely as a technical fix; it must be understood as a socio-political intervention. Building resilience requires centering on the voices of marginalized communities, co-producing knowledge, and foregrounding local adaptability over standardized solutions. Climate-resilient infrastructure must also be anticipated, rather than reactive. Practices such as climate-responsive architecture, decentralized energy systems, nature-based solutions, and community-centered disaster planning are practical applications of the theoretical shift outlined here (Jena, 2021). Importantly, the implementation of resilient design must align with broader frameworks of climate justice, ensuring that the infrastructures of survival do not reproduce existing inequalities but instead lay the groundwork for more equitable and sustainable futures.

Conclusion

In an age of escalating climate change and environmental uncertainty, the notion of *infrastructure* must evolve beyond the traditional lens of physical development and economic utility (Sari et al., 2023). This chapter has argued that infrastructure today must be understood as the foundation for survival - as systems that enable societies not only to function under normal conditions but also to endure, adapt, and transform in the face of climate-related disruptions. From flood-resilient housing and decentralized energy grids to green urban planning and indigenous knowledge systems, this chapter highlighted a diverse array of approaches that foreground resilience, inclusivity, and long-term sustainability. At the heart of this rethinking lies a critique of conventional development paradigms that prioritize extractive growth and linear planning models, often at the cost of ecological degradation and social vulnerability (Wang et al., 2021). Instead, this chapter advocates for a paradigm shift that integrates ecological sensitivity, participatory governance, and social equity into the design and purpose of infrastructure. It positions resilience not as a passive capacity to 'bounce back' but as an active, forward-looking strategy that redefines how communities live, work, and prepare for a rapidly changing world.

The chapter has also emphasized the need to reframe resilience through a pluralistic lens, drawing from environmental science, political ecology, indigenous studies, and postcolonial urbanism (Ren, 2020). By doing so, it underscores that resilient design cannot be imposed top-down, but must emerge from local contexts, cultural practices, and knowledge ecologies that have long adapted to environmental uncertainty. Furthermore, the infrastructure for survival is political. Decisions about where, how, and for whom infrastructure is built are deeply tied to power, access, and justice (Monea, 2023). This chapter has highlighted how climate-resilient infrastructure must be designed with a recognition of the intersecting vulnerabilities of the urban poor, marginalized communities, and those excluded from planning processes. Thus, resilience is not merely technical or ecological; it is also related to social inclusion, rights, and governance.

In summary, this chapter contributes to the emerging discourse on climate-resilient futures by offering a holistic and interdisciplinary perspective on infrastructure. It calls for a transformative approach in which design is adaptive, sustainability is systemic, and survival is central. The "infrastructure of survival" is not merely a response to a crisis but a proactive reimagination of how we inhabit the planet. As climate challenges intensify, so too must our commitment to build systems that are not only robust and regenerative, but also just and humane.

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