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EXPLORING HEALTH AND SOCIOECONOMIC IMPLICATIONS OF URBAN REGENERATION AMIDST CLIMATE CHANGE

ABSTRACT

Unlike some temporary disasters, climate change poses a long-term threat, particularly to urban health, affecting both humans and the environment. Urban regeneration offers an opportunity to revitalise cities, promoting urban health and employing strategies that consider future citizen needs and the roles of cities in addressing the climate change challenge. These strategies must address both expected and unforeseen impacts, viewing cities as dynamic entities capable of change. Research has predominantly focused on mitigation strategies to reduce the magnitude of climate change impacts and on adaptation strategies to prepare for them. In cities, green spaces and new materials have been analysed to enhance climatic conditions and human comfort, reflecting the multifaceted relationship between urban health, well-being, and environmental preservation and restoration. Further investigation is expected to increasingly explore the socio-economic dimensions of climate change and urban health. However, it is important not to overlook the essential role of physical actions in addressing urban challenges, avoiding carbon lock-in situations. Community-based adaptation and participatory planning are needed components for an effective climate change counteraction, and inclusive, community-driven approaches address various urban vulnerabilities, promoting equitable health benefits across different population groups. Ultimately, achieving urban health equity requires concerted technical and non-technical thinking, with city regeneration projects focusing on efficient, adaptable physical designs and cohesive social structures.

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1. INTRODUCTION

Over the last two decades, populations worldwide have been confronted with a series of prolonged and overlapping crises, including severe economic downturns, socio-political disruptions, public health emergencies, and escalating climate-related anxieties (Panu, 2020). While certain disasters are temporary and can be mitigated within a relatively short timeframe, climate change represents a chronic and systemic threat whose impacts permeate ecological, social, and economic systems. This is particularly evident in urban contexts, where climate change increasingly undermines both human health and environmental quality (IPCC, 2022). Urban areas, home to more than half of the global population in 2018 and projected to host an even greater share in the coming decades (UN, 2019), function as the epicentres of economic productivity, cultural exchange, and technological innovation. However, they are also concentrated sites of vulnerability. High population density, intensive energy consumption, limited green space, and dependence on complex infrastructure systems render cities highly susceptible to the compounded impacts of climate change, including urban heat island (UHI) effects, flooding, air pollution episodes, and the exacerbation of social inequalities (Nazarian et al., 2022). Urban regeneration, defined here as the integrated process of revitalising urban environments through physical, environmental, social, and economic interventions, presents a critical opportunity to align climate change mitigation and adaptation objectives with the promotion of urban health (UN Habitat, 2021). As a strategic framework, regeneration can transform derelict or underutilised spaces into resilient, inclusive, and health-promoting environments that address both current and future needs. This transformation requires conceptualising cities not as static infrastructures, but as dynamic, adaptive systems capable of continuous renewal in response to environmental, demographic, and technological change (Villalbí & Ventayol, 2016). Historically, climate change-related research has tended to focus on discrete elements of the nexus between environment, health, and urban systems, often privileging the biophysical impacts of climate hazards or the engineering aspects of mitigation measures, while neglecting their broader socio-economic dimensions (Agache et al., 2022). Recent scholarship underscores the necessity of integrating mitigation strategies, which reduce the magnitude of climate impacts (e.g., reducing greenhouse gas emissions), with adaptation strategies, which strengthen resilience to unavoidable climate stresses (Monteiro et al., 2022). The urban context provides a unique platform for such integration, where physical interventions, such as the implementation of green infrastructure, climate-responsive building materials, and sustainable mobility systems, can be complemented by governance reforms, participatory planning, and social equity measures. From a public health perspective, climate-sensitive urban regeneration is increasingly recognised as a means of delivering both direct and indirect health benefits. Direct benefits include reductions in heat-related morbidity and mortality, improved air quality, and enhanced physical and mental well-being through increased access to nature (Frumkin et al., 2017). Indirect benefits encompass the socio-economic co-benefits of regeneration, such as job creation, reduced healthcare costs, and strengthened community cohesion (Herrmann et al., 2018). However, translating these benefits into equitable outcomes remains contingent on deliberate efforts to address structural inequalities in resource access, political representation, and environmental exposure (López-Bueno et al., 2020). The urgency of such integrative approaches is underscored by the lock-in risks inherent in urban development. Without careful planning, investments in carbon-intensive or maladaptive infrastructure can perpetuate environmental degradation and social inequities for decades, constraining the potential for low-carbon transitions (Seto et al., 2016). Conversely, strategically designed regeneration projects can leverage synergies across multiple policy domains, energy efficiency, biodiversity conservation, housing affordability, and public health, to create self-reinforcing cycles of sustainability and well-being (Schmidt & Walz, 2021).

This paper seeks to advance the discourse on urban regeneration by explicitly examining its health and socio-economic implications in the context of climate change. Building upon a systematic literature review and SWOT analysis conducted within a European scope, we identify and synthesise evidence on the strategies, opportunities, and challenges of integrating health promotion and socio-economic resilience into climate-oriented urban regeneration. The analysis foregrounds both physical interventions (e.g., nature-based solutions, sustainable materials, climate-proof infrastructure) and governance mechanisms (e.g., participatory planning, community-based adaptation, policy integration) as dual pillars for achieving urban health equity and climate resilience. By consolidating findings from diverse disciplinary perspectives, urban planning, environmental health, climate science, and socio-economic policy, this study aims to:

- Elucidate the pathways through which urban regeneration can simultaneously deliver health and socio-economic benefits under climate change conditions.
- Highlight the risks of neglecting either technical or social dimensions in regeneration planning, particularly in relation to equity and lock-in effects.
- Propose a conceptual framework for climate-sensitive, health-oriented regeneration that is adaptable to diverse urban contexts.

In doing so, the paper contributes to both the academic literature and the policy discourse on climate change adaptation and mitigation, offering evidence-based recommendations for practitioners, decision-makers, and communities seeking to design urban regeneration projects that are not only climate-resilient but also socially inclusive and health-promoting.

2. CLIMATE CHANGE AND URBAN VULNERABILITY

The impacts of climate change on urban areas are neither uniform nor evenly distributed. Cities concentrate populations, infrastructure, and economic activities, amplifying both exposure to climate-related hazards and the sensitivity of social and ecological systems to such hazards (IPCC, 2022). The urban fabric, characterised by extensive impermeable surfaces, dense built forms, and modified microclimates, often exacerbates climate risks through phenomena such as the urban heat island (UHI) effect, reduced evapotranspiration, and impaired natural drainage (Nazarian et al., 2022). These environmental modifications intersect with socio-economic disparities, producing complex patterns of vulnerability that require integrated and multi-scalar responses.

While the underlying drivers of vulnerability are globally relevant, European cities present specific features that shape climate risk profiles. Temperate and humid subtropical climates dominate much of the continent, with urban areas facing seasonal extremes of heat and precipitation (Kyprianou et al., 2023). Aging infrastructure, high population densities, and historical urban forms can complicate retrofitting for resilience, particularly in heritage districts where conservation requirements may limit the scope of physical modifications (Rosso et al., 2017). Moreover, the continent's policy environment, anchored in binding legal instruments such as the European Climate Law (Regulation (EU) 2021/1119), the Nature Restoration Regulation (Regulation (EU) 2024/1991), and the Regulation on serious cross-border threats to health (Regulation (EU) 2022/2371), offers both opportunities and challenges for coherent, health-sensitive adaptation and mitigation planning (European Parliament, 2021, 2024; Monteiro et al., 2022). These frameworks establish long-term targets for climate-neutrality and ecosystem restoration and strengthen preparedness for climate-related health risks, thereby shaping national and municipal regeneration strategies and resource allocation for urban health equity.

The systematic literature review underpinning this study identifies heat-related hazards as the most intensively studied climate threat in European cities, followed by flooding, air pollution episodes, and droughts (Kyprianou et al., 2023). Heatwaves and UHIs compound thermal stress, particularly in dense city cores where anthropogenic heat emissions, low vegetation cover, and high thermal mass interact, resulting in elevated ambient temperatures (Ketterer & Matzarakis, 2014). This heightened thermal environment increases risks of heat-related illnesses, cardiovascular and respiratory morbidity, and mortality, especially among older adults, children, and individuals with pre-existing health conditions (López-Bueno et al., 2020). Flood risks, both pluvial and fluvial, are also significant in urban areas, where extensive impermeable surfaces accelerate runoff, overwhelm drainage systems, and exacerbate water quality issues (Claessens et al., 2014). Although flood protection measures are present in many European cities, climate change is projected to intensify precipitation extremes, requiring infrastructure upgrades that can be an opportunity to adopt nature-based flood mitigation strategies (Epelde et al., 2022).

Air pollution, driven by both local emissions (e.g., traffic, industry) and transboundary transport of pollutants, interacts with climate variables to influence pollutant dispersion, chemical transformation, and population exposure (Steeneveld et al., 2018). For instance, elevated temperatures can accelerate the formation of ground-level ozone, while stagnant atmospheric conditions during heatwaves can trap pollutants near the surface, compounding respiratory and cardiovascular health risks (Daghistani, 2021).

Urban vulnerability is shaped by three interrelated factors: exposure to climatic hazards, sensitivity of populations and systems, and adaptive capacity to anticipate, cope with, and recover from impacts (Villalbí & Ventayol, 2016).

Exposure is spatially differentiated; low-income and marginalised communities often reside in more hazard-prone areas, such as floodplains, poorly ventilated housing clusters, or neighbourhoods lacking tree cover, due to historical patterns of segregation, disinvestment, and zoning decisions (Appolloni et al., 2020). Sensitivity is influenced by health status, age, occupation, and housing conditions, while adaptive capacity depends on access to resources, information, and institutional support (Herrmann et al., 2018). The evidence suggests that climate change will exacerbate existing urban inequalities, as vulnerable populations tend to have less access to adaptive measures such as air conditioning, flood insurance, or healthcare (Schmidt & Walz, 2021). Moreover, these groups often have limited political representation, constraining their ability to influence planning decisions that affect their resilience (Foshag et al., 2020).

Beyond direct health effects, climate hazards can trigger systemic risks in urban settings. For example, heatwaves can reduce labour productivity, strain energy systems through increased cooling demand, and disrupt transportation networks (Roetzel et al., 2010). Flood events can damage housing, infrastructure, and utilities, displacing residents and undermining local economies (Luber & Prudent, 2009). Such impacts often cascade across sectors, with economic losses feeding back into reduced municipal revenues, constraining the resources available for climate adaptation and social support (Seto et al., 2016). These interdependencies underscore the need to approach urban vulnerability not solely as an environmental or engineering problem but as a multidimensional challenge spanning public health, social policy, economic planning, and environmental governance (Agache et al., 2022). Effective responses require recognising the nexus among climate change, urban health, and socio-economic systems, ensuring that interventions are both technically sound and socially equitable.

In summary, climate change amplifies existing urban vulnerabilities through the interaction of environmental hazards, socio-economic inequalities, and infrastructural constraints. Addressing these challenges demands a systemic approach that integrates physical interventions, social equity considerations, and institutional coordination, a theme that underpins the subsequent analysis of urban regeneration as a health and resilience strategy.

3. GREEN INFRASTRUCTURE, MATERIALS, AND URBAN DESIGN

Green infrastructure, innovative materials, and climate-responsive urban design are central pillars of climate-oriented urban regeneration. These physical interventions simultaneously contribute to mitigation, by reducing greenhouse gas emissions and improving energy efficiency, and adaptation, by enhancing resilience to climatic hazards such as extreme heat, flooding, and air pollution (Kyprianou et al., 2023). Their integration into regeneration projects can deliver direct environmental improvements, substantial health benefits, and significant socio-economic co-benefits.

Nature-based solutions (NBS), including urban forests, street trees, green roofs, vertical gardens, and restored waterways, are among the most frequently studied and implemented strategies in European urban regeneration (Mutani & Todeschi, 2020; Epelde et al., 2022). These interventions mitigate the urban heat island (UHI) effect by providing shade and enhancing evapotranspiration, reducing surface and ambient air temperatures, and consequently lowering the incidence of heat-related illness (Ketterer & Matzarakis, 2014). In addition to thermal regulation, NBSs improve air quality by filtering particulate matter and absorbing gaseous pollutants (Steeneveld et al., 2018), while also contributing to noise reduction, biodiversity enhancement, and stormwater management (Claessens et al., 2014). Parks, community gardens, and green corridors promote physical activity and social interaction, yielding mental health and social cohesion benefits (Mosca et al., 2021; Frumkin et al., 2017). However, the literature also warns of potential risks, such as allergenic plant species, emissions of biogenic volatile organic compounds that can contribute to ozone formation, and maintenance challenges in resource-limited municipalities (Appolloni et al., 2020). Careful species selection, ongoing maintenance planning, and integration with public health monitoring are therefore essential.

Urban design strategies that incorporate green infrastructure often address hydrological resilience alongside thermal comfort. Permeable surfaces, bioswales, and constructed wetlands can attenuate runoff, improve water infiltration, and reduce the risk of pluvial flooding during extreme precipitation events (Epelde et al., 2022). In coastal cities, vegetated buffer zones can also serve as natural flood defences, protecting infrastructure and communities from storm surges (Claessens et al., 2014). These systems deliver multiple co-benefits, from reducing urban water pollution to providing habitat for pollinators and other wildlife, supporting broader ecosystem services. Importantly, hydrological design must anticipate projected climate conditions to avoid under-dimensioning or over-reliance on engineered grey infrastructure (Kyprianou et al., 2023).

Regeneration projects increasingly employ cool materials, reflective coatings, and advanced composites to improve thermal performance and energy efficiency. Cool roofs and solar-reflective pavements reduce absorbed solar radiation, lowering surface and surrounding air temperatures (Middel et al., 2020; Rosso et al., 2017). These interventions can decrease building cooling loads, reduce urban heat stress, and extend infrastructure lifespan by minimising thermal expansion cycles. Building envelope retrofits using high-performance insulation, phase-change materials, and low-carbon construction materials contribute both to mitigation, by reducing operational energy demand, and to adaptation, by improving indoor thermal comfort (Carlucci et al., 2015). However, material interventions must be context-sensitive; for example, applying reflective pavements in areas with high sky view factors may inadvertently increase mean radiant temperature, worsening outdoor thermal comfort (Karakounos et al., 2018).

Urban form, street orientation, aspect ratios, building heights, and spatial distribution of open spaces play a decisive role in microclimate regulation. Regeneration projects that optimise urban geometry can improve natural ventilation, enhance shading, and maximise daylight while preventing excessive heat gain (Ketterer & Matzarakis, 2014). Integrating vegetation within this geometry amplifies these effects, creating shaded, well-ventilated public spaces that encourage outdoor activity and social interaction even during warm periods (Rosso et al., 2022).

The most effective regeneration strategies combine green infrastructure, climate-responsive materials, and optimised urban form into integrated design approaches. For example, a regeneration project might pair street tree planting with reflective pavements and modified building setbacks to enhance both pedestrian comfort and stormwater infiltration (Kyprianou et al., 2023). Such synergies yield multiple co-benefits: reduced heat stress, improved air quality, increased biodiversity, enhanced real estate values, and improved community well-being (Schmidt & Walz, 2021). However, the success of integration depends on long-term maintenance, monitoring, and adaptive management. Without sustained investment and cross-sectoral coordination, initial gains may be lost, and physical assets may degrade prematurely (Foshag et al., 2020).

4. URBAN REGENERATION AS A HEALTH STRATEGY

Urban regeneration, encompassing physical redesign, environmental enhancement, and socio-economic revitalisation, offers a powerful framework for simultaneously addressing the environmental and health challenges posed by climate change. By integrating mitigation and adaptation strategies into regeneration projects, cities can transform hazard-prone, degraded, or underutilised spaces into resilient, inclusive, and health-promoting environments (UN Habitat, 2021).

In the context of climate change, urban regeneration is more than a spatial or architectural exercise; it is a multidimensional process that aligns urban design with public health objectives and environmental sustainability (Villalbí & Ventayol, 2016). The approach recognises cities as dynamic and complex systems capable of adaptation, where interventions at multiple scales (i.e. building, neighbourhood, and city-wide) can generate co-benefits for climate resilience, human well-being, and socio-economic stability (Frumkin et al., 2017). A key insight from the systematic literature review is that regeneration projects often prioritise physical interventions, such as vegetation enhancement, cool materials, and energy-efficient building retrofits, due to their measurable environmental benefits and visibility (Kyprianou et al., 2023). However, the long-term success of such projects depends equally on non-technical dimensions, including community participation, governance integration, and equitable distribution of benefits (Herrmann et al., 2018).

Mitigation strategies embedded in regeneration include urban design and land-use planning that reduce greenhouse gas emissions, promote sustainable mobility, and enhance energy efficiency (Karakounos et al., 2018). Adaptation measures often focus on enhancing urban microclimates, increasing green cover, managing stormwater, and climate-proofing infrastructure (Epelde et al., 2022). Importantly, these strategies are not mutually exclusive; their integration can yield synergistic effects. For instance, green roofs reduce building space cooling loads (mitigation) while also lowering ambient temperatures and improving stormwater retention (adaptation) (Mutani & Todeschi, 2020). Policy-based adaptation measures, such as design guidelines, zoning regulations, and green infrastructure standards, form a strong component of regeneration projects in Europe. These frameworks can institutionalise resilience by embedding climate and health considerations into planning processes, ensuring that regeneration does not inadvertently increase exposure or entrench inequalities.

The health co-benefits of climate-sensitive regeneration are diverse and well-documented. Physical health improvements include reductions in heat-related morbidity and mortality through UHI mitigation (Ketterer & Matzarakis, 2014), better air quality through vegetation and low-emission mobility (Steeneveld et al., 2018), and increased opportunities for physical activity in accessible, walkable neighbourhoods (Rosso et al., 2022). Mental health and well-being benefits arise from improved access to green and blue spaces, which foster relaxation, social interaction, and a sense of place (Mosca et al., 2021). These effects are particularly valuable in urban environments where stress, isolation, and environmental degradation can erode quality of life (Frumkin et al., 2017). Environmental health outcomes, such as enhanced biodiversity, improved soil and water quality, and reduced pollutant loads, also indirectly support human health by improving ecosystem services (Schmidt & Walz, 2021).

One recurrent theme in the literature is the risk of carbon lock-in, situations in which poorly designed regeneration results in long-term reliance on carbon-intensive technologies or maladaptive configurations (Seto et al., 2016). For example, energy-intensive cooling systems introduced to address heatwaves may increase emissions and exacerbate climate change over time if not paired with efficiency measures or renewable energy sources (Roetzel et al., 2010). Regeneration offers the opportunity to break such cycles by prioritising flexible, modular, and low-carbon designs. This requires foresight in planning to anticipate future climate scenarios, demographic changes, and technological advances, ensuring that interventions remain relevant and effective over decades (Kyprianou et al., 2023).

While the physical dimensions of regeneration are often well-advanced, governance integration remains a critical bottleneck. Misalignments between municipal, regional, and national policies can create gaps or redundancies in adaptation and mitigation planning (Foshag et al., 2020). Limited cross-sectoral coordination between urban planners, public health agencies, and environmental departments can further hinder the delivery of co-benefits (Herrmann et al., 2018). Successful regeneration for climate and health depends on multilevel governance that enables knowledge sharing, aligns incentives, and mobilises diverse resources. This governance framework must also institutionalise mechanisms for community engagement, ensuring that residents have a voice in shaping the physical and social environments that affect their health and resilience (López-Bueno et al., 2020).

5. SOCIOECONOMIC IMPLICATIONS OF CLIMATE-ORIENTED URBAN PLANNING

Urban regeneration that integrates climate change adaptation and mitigation is not only an environmental or public health strategy; it is also a socio-economic intervention. The configuration of regeneration projects influences employment, economic growth, real estate dynamics, infrastructure costs, and, critically, the distribution of benefits and burdens across different population groups. As the literature shows, these socio-economic implications are often decisive in determining the political feasibility and long-term sustainability of climate-oriented urban planning (Kyprianou et al., 2023).

A central socio-economic dimension of climate-oriented regeneration is equity, the fair distribution of both the benefits and the costs of urban transformation. The review indicates that climate change impacts, such as heat stress and flooding, disproportionately affect low-income and marginalised communities, who often have less access to adaptive resources, such as air conditioning, insurance, and green space (López-Bueno et al., 2020). Without deliberate safeguards, regeneration can exacerbate these inequalities through green gentrification, where environmental improvements drive up property values and displace vulnerable residents (Ling et al., 2020). The SWOT analysis conducted in Kyprianou et al. (2023) identifies inequalities as a recurrent theme across strengths, weaknesses, opportunities, and threats. While regeneration can reduce vulnerability by improving housing, infrastructure, and access to nature, it can also deepen disparities and enhance gentrification, if benefits accrue disproportionately to already advantaged groups (Kyprianou et al., 2023). Thus, equity-oriented design requires policies such as affordable housing quotas, anti-displacement measures, and targeted investments in underserved neighbourhoods.

Regeneration projects can stimulate local economies through construction, retrofitting, and maintenance activities, generating both short-term jobs and long-term employment in green sectors (UN Habitat, 2021). For example, NBSs, including urban forestry, green roofs, and wetland restoration, require skilled labour for design, installation, and upkeep, creating opportunities for workforce development (Mutani & Todeschi, 2020). Energy efficiency upgrades and the deployment of renewable energy infrastructure in regenerated areas can reduce utility costs for households and businesses, freeing up income for other expenditures and stimulating economic activity (Roetzel et al., 2010). At a systemic level, health improvements from reduced pollution and heat stress can lower public healthcare expenditures, yielding indirect fiscal benefits (Herrmann et al., 2018).

Despite these benefits, the literature emphasises the economic risks of carbon lock-ins, in which urban investments commit cities to costly, carbon-intensive, or unsuitable trajectories. Inadequate regeneration can also generate ongoing maintenance costs that outweigh benefits, particularly if materials or systems degrade faster than expected or require specialised servicing (Daghistani, 2021). Moreover, if climate projections are underestimated during the design stage, regeneration investments may fail to provide adequate protection against future hazards, necessitating costly retrofits or emergency responses (Seto et al., 2016).

Climate-oriented regeneration can enhance urban competitiveness by improving quality of life, environmental performance, and resilience, factors increasingly important for attracting residents, businesses, and tourists (Rosso et al., 2022). Cities that proactively integrate climate adaptation and health promotion into their planning can differentiate themselves in global networks, positioning themselves as innovation hubs in sustainable urbanism (Monteiro et al., 2022). However, this competitive framing must be balanced with inclusivity goals. Regeneration that focuses solely on attracting investment risks, prioritising high-value districts over marginalised areas, thereby undermining city-wide resilience and health equity (Ling et al., 2020).

Governance structures and the degree of community participation in regeneration mediate socioeconomic outcomes. The literature underscores that participatory planning, where citizens, stakeholders, and local organisations are actively involved, enhances social capital, trust in institutions, and collective problem-solving capacity (Foshag et al., 2020). These intangible assets can have long-term socio-economic value, fostering networks that support emergency response, neighbourhood maintenance, and mutual aid during crises. Community-driven approaches also help align regeneration with local needs and preferences, reducing the risk of underutilised or rejected interventions (Frumkin et al., 2017). However, participation must be inclusive and accessible, avoiding *pro forma* consultation that reinforces existing power imbalances (Kyprianou et al., 2023).

6. COMMUNITY PARTICIPATION AND EQUITY

While technological innovation and physical interventions are vital for climate-oriented urban regeneration, the literature repeatedly emphasises that their success ultimately depends on governance structures and the degree to which communities are engaged in the planning, implementation, and stewardship of regeneration projects (Kyprianou et al., 2023). Without inclusive participation, even technically sound projects risk misalignment with local needs, fostering distrust and exacerbating social inequities.

Participatory planning recognises citizens as co-producers of urban space, rather than passive beneficiaries of expert-driven design (Frumkin et al., 2017). By integrating local knowledge, lived experiences, and community priorities into decision-making, cities can develop interventions that are more contextually relevant, socially acceptable, and resilient over time (Foshag et al., 2020). Evidence from the systematic review of Kyprianou et al. (2023) shows that community-driven adaptation measures, such as neighbourhood-based greening initiatives, local cooling centres, and participatory mapping of heat-vulnerable areas, enhance both the effectiveness and equity of climate responses. These initiatives not only address immediate hazards but also strengthen social capital, improving collective capacity to respond to future shocks. Ensuring equity in participation requires proactive measures to involve marginalised groups who are often underrepresented in urban governance processes. Vulnerable populations, including low-income residents, the elderly, migrants, and those in informal housing, may face barriers to participation such as language differences, limited access to information, or competing economic pressures (López-Bueno et al., 2020). To overcome these barriers, regeneration processes must adopt inclusive engagement methods, such as multilingual outreach, accessible meeting formats, childcare provision during consultations, and collaboration with trusted local organisations. Without these measures, participatory processes risk reproducing existing power imbalances and legitimising inequitable outcomes (Herrmann et al., 2018).

Community participation in regeneration yields a range of co-benefits that extend beyond the immediate climate and health objectives. Engagement processes can foster trust between residents and institutions, create opportunities for local employment in project implementation, and encourage behavioural changes, such as energy conservation or active transportation, that further reduce emissions and improve health (Rosso et al., 2022). Moreover, participatory approaches can generate bottom-up innovation, where residents propose solutions that might be overlooked in top-down planning, such as informal cooling strategies, culturally appropriate public space designs, or low-cost retrofitting methods (Foshag et al., 2020).

Multi-level governance is essential for embedding participation and equity into regeneration projects. This involves coordination across municipal, regional, and national levels, as well as collaboration between governmental bodies, non-governmental organisations, academia, and the private sector (Kyprianou et al., 2023). In Europe, these governance arrangements are increasingly informed by “Health in All Policies” approaches that aim to integrate health and equity considerations into decision-making across sectors, including spatial planning, climate mitigation, and adaptation (Green et al., 2021; *Health in All Policies (HiAP) Framework for Country Action*, 2014). At the same time, they interface with EU climate and health legislation, such as the European Climate Law, the Nature Restoration Regulation, and the Regulation on serious cross-border threats to health, ensuring that local regeneration contributes to legally binding climate-neutrality, biodiversity restoration, and health-preparedness objectives (European Parliament, 2021, 2022, 2024). When institutional frameworks mandate participatory processes, through legal requirements, funding conditions, or performance indicators, engagement is more likely to be meaningful and sustained. Furthermore, integrating equity metrics into project evaluation can help ensure that regeneration delivers proportional benefits to disadvantaged communities. These metrics may include measures of health improvements, access to green space, housing affordability, and resilience capacity across different socio-economic groups (López-Bueno et al., 2020).

7. CONCLUSIONS

Climate change presents a persistent and multidimensional threat to urban environments, affecting both human and environmental health while interacting with entrenched socio-economic inequalities. Urban regeneration, when strategically designed and inclusively governed, offers a unique opportunity to align climate change adaptation and mitigation with the promotion of health equity and socio-economic resilience. However, effective regeneration depends on integrating physical interventions, such as green infrastructure, climate-responsive materials, and optimised urban form, with non-technical measures that embed participation, equity, and multi-level governance into planning processes. From an environmental and health perspective, regeneration can directly reduce exposure to hazards such as extreme heat, flooding, and air pollution through interventions like nature-based solutions, permeable surfaces, and advanced building materials. These measures yield co-benefits that extend beyond hazard mitigation, improving mental and physical well-being, enhancing biodiversity, and contributing to climate mitigation through reduced energy consumption. However, the evidence warns that such interventions must be context-specific to avoid unintended consequences, such as reflective pavements increasing mean radiant temperatures in certain configurations. It must be designed to prevent carbon lock-ins that could constrain future adaptation pathways. Socio-economic outcomes are equally significant. Regeneration can deliver economic co-benefits, including job creation, reduced healthcare costs, and enhanced urban competitiveness, but without equity safeguards, it may also contribute to green gentrification and displacement. Targeted policies, such as affordable housing provisions, anti-displacement measures, and equitable distribution of public investments, are necessary to ensure that benefits accrue to vulnerable populations who are most at risk from climate change. Participation emerges as both a principle and a mechanism for ensuring that regeneration addresses local needs and priorities. Inclusive, community-driven planning enhances social capital, builds trust in institutions, and can generate bottom-up innovations that improve project effectiveness. In conclusion, the path toward climate-ready, health-promoting, and socio-economically inclusive cities lies not in isolated technical fixes, but in integrated strategies that view urban regeneration as a dynamic, participatory, and adaptive process. By aligning environmental sustainability with public health and social justice, regeneration can serve as a transformative tool, turning climate challenges into opportunities for building resilient, equitable, and vibrant urban futures.

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