

From Adaptation to Effectiveness: A Systematic Review of Climate Adaptation Measures and their Effectiveness in Urban Areas

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Abstract: *Urban climate adaptation has expanded rapidly from risk recognition and planning towards implementation, but the existence of an adaptation measure does not by itself demonstrate that climate risk has been reduced. This systematic theoretical literature review examines how urban climate adaptation measures can be assessed from two connected perspectives: applicability- whether a measure is suitable and implementable under particular risk, spatial, institutional and social conditions—and effectiveness- whether that measure produces measurable, durable and equitable changes in the risk pathway. Recent peer-reviewed evidence supported by selected authoritative reports, is synthesized across urban heat, flooding, nature-based solutions, early warning, infrastructure, planning, governance and community-based adaptation. The review distinguishes adaptation intentions, inputs, implementation, outputs, outcomes and longer-term resilience and proposes an applicability-to-effectiveness pathway: climate risk and vulnerability to adaptation option to applicability and implementation to outputs to outcomes to durable resilience. The evidence indicates that effectiveness is conditional rather than intrinsic. Recent studies also reveal a persistent evaluation problem: indicators are numerous, but many remain output-oriented, lack time-bound targets, or do not adequately capture governance, equity, maladaptation and long-term outcomes. The review therefore argues that adaptation planning should first establish whether an intervention is applicable to the identified risk and local conditions and then evaluate whether it actually delivers the intended outcome. Detailed policy, managerial, social, environmental, financial and monitoring implications are developed, while research gaps are kept focused on longitudinal evidence, attribution, equity, maladaptation and context-sensitive evaluation. The paper contributes a practical theoretical framework for moving urban adaptation research from counting measures towards demonstrating what works, where, for whom and under what conditions.*

Keywords: climate change adaptation; urban resilience; adaptation effectiveness; applicability; adaptation measures; outcomes; equity; maladaptation; monitoring and evaluation; urban climate governance

1. Introduction

Urban areas are increasingly central to climate adaptation because climate hazards interact with dense populations, infrastructure systems, economic activity, ecological processes and uneven social vulnerability. Heatwaves, intense rainfall, flooding, water stress, storms and other climate-related hazards can disrupt essential services and deepen existing inequalities. In response, cities are adopting heat action plans, drainage improvements, early-warning systems, nature-based solutions, resilient infrastructure, land-use measures, building interventions and community programmes. The growth of adaptation action is important, but it creates a more demanding question for research and policy: which measures are actually suitable for particular urban conditions, and which of those measures produce meaningful and lasting risk reduction?

Recent literature increasingly moves towards this outcome-oriented understanding. Puig et al. (2025) emphasize the need to improve the effectiveness of adaptation measures by connecting decision processes with evidence on outcomes. Olazabal et al. (2026), reviewing 137 publications and 901 indicators and metrics, identify fragmentation and limited standardization in urban adaptation measurement. Nghiem et al. (2026), reviewing 161 studies and 1,064 indicators, similarly show that urban resilience assessment is highly quantitative but frequently lacks time-bound targets and sufficient attention to governance and equity.

India provides a particularly relevant context because adaptation is occurring across highly diverse urban and

climatic settings. Recent evidence from 100 Indian Smart Cities shows that compound dry-hot extremes and socioeconomic vulnerability vary substantially across urban regions, reinforcing the need for context-specific assessment rather than direct transfer of adaptation assumptions. This reinforces the need to distinguish the existence of adaptation activity from evidence about applicability and outcomes. (Sahu et al., 2026)

At the international level, the implementation challenge is becoming more visible. UN-Habitat's 2026 assessment of 142 third-generation Nationally Determined Contributions reports that 80% contain well-developed urban content and nearly three-quarters include concrete urban delivery mechanisms. At the same time, UNEP's 2025 Adaptation Gap Report estimates developing-country adaptation finance needs at about US\$310 billion annually by 2035 under modelled costs, or US\$365 billion using extrapolated NDC/NAP needs, while international public adaptation finance flows were US\$26 billion in 2023. The combination of rising urban ambition and constrained finance makes evidence on applicability, effectiveness and durability increasingly important for investment and governance.

2. Review Methodology and Analytical Approach

This paper uses a structured systematic theoretical literature-review approach. The objective is conceptual and evidence synthesis rather than meta-analysis or primary empirical data collection. The review prioritizes peer-reviewed research published during 2024–2026, with particular emphasis on

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2026 publications, and uses selected 2025 and 2024 studies where they provide systematic reviews, meta-analyses, strong empirical evidence or important conceptual contributions. Authoritative reports from UNEP and UN-Habitat are included where they provide current information on adaptation finance, urban delivery and policy implementation.

Source selection was guided by five criteria: direct relevance to urban climate adaptation; explicit discussion of adaptation measures, applicability, implementation, outcomes or effectiveness; methodological transparency; publication in established peer-reviewed journals or authoritative institutional outlets; and relevance to current urban climate governance. Priority was given to literature from major publishers and journals in environmental change, climate risk, urban climate, sustainability and environmental management. The review does not claim a statistical census of all adaptation literature. Instead, it uses a transparent, theory-led selection to connect evidence from different adaptation domains and identify recurring conditions of effectiveness.

The synthesis was organized around four analytical questions. First, what constitutes an adaptation measure and what distinguishes applicability from effectiveness? Second, what outcomes are reasonably expected from different urban adaptation domains? Third, which implementation and contextual conditions explain variation in performance? Fourth, what evidence is required to judge whether benefits persist, are equitably distributed and avoid maladaptation? These questions allow findings from different studies to be compared without assuming that a single indicator or intervention type is universally appropriate.

The review separates five stages of the adaptation pathway: risk diagnosis, adaptation option, applicability and implementation, outputs, and outcomes leading to durable resilience. Inputs such as finance, knowledge, staff, technology and institutional capacity enable implementation. These are treated here as implementation conditions rather than as the primary subject of analysis; outputs include infrastructure, policies, services and trained actors; outcomes refer to changes in the risk pathway, such as reduced exposure, lower losses, improved health protection or greater service continuity; and longer-term impacts concern resilience, well-being and reduced future vulnerability. This distinction prevents visible project completion from being treated as proof of effectiveness.

Applicability is assessed through five practical dimensions: risk fit, technical and spatial feasibility, institutional and financial feasibility, social accessibility and temporal suitability. Effectiveness is assessed through five related

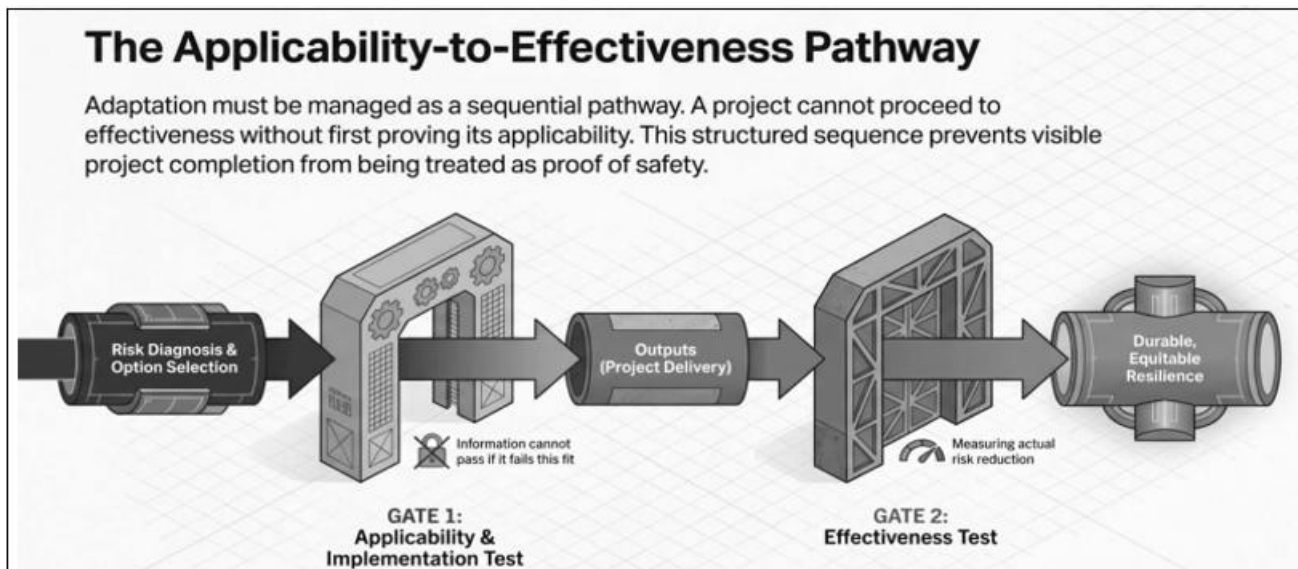
dimensions: reach and uptake, measurable outcomes, durability, distributional consequences and unintended effects. The resulting framework treats effectiveness as conditional. A measure is not considered inherently effective or ineffective across all settings; its performance depends on the interaction between intervention characteristics and local conditions. Recent evidence on climate-adaptive city policies and urban delivery supports this interpretation, showing that policy effects depend on mechanisms, governance capacity, economic structure and context.

3. From Adaptation Measures to Applicability

Applicability is the bridge between a climate-risk diagnosis and the selection of an adaptation measure. It asks whether a response is appropriate to the hazard, feasible within the physical and institutional setting, accessible to intended beneficiaries and sustainable over the relevant time horizon. This step is often implicit in adaptation planning, yet it is crucial because the same measure can produce different results in different cities. Applicability should therefore be treated as a structured assessment rather than an assumption that a measure successful elsewhere can simply be transferred.

Risk fit is the first requirement. Heat interventions, for example, should be selected according to the dominant exposure pathway- outdoor heat, indoor overheating, occupational exposure, energy insecurity or limited access to cooling. Flood interventions similarly depend on whether risk is driven by surface runoff, river overflow, drainage constraints, coastal exposure or development in flood-prone areas. A measure that addresses the wrong mechanism may be technically impressive but poorly applicable. Recent urban heat reviews show the diversity of available responses, from green and blue infrastructure to building and behavioural measures, reinforcing the importance of matching intervention type to local risk.

Technical and spatial feasibility is equally important. Nature-based solutions may require land, ecological conditions, maintenance and sufficient time to generate benefits. Drainage interventions may depend on catchment-scale connectivity rather than a single neighbourhood. Heat measures can interact with building density, shading, ventilation and surface characteristics. A 2026 study of heat adaptation in Grenoble illustrates this conditionality: combined measures produced substantial improvements in thermal exposure, but the magnitude of benefits varied with urban morphology and scenario design. Applicability therefore requires spatial understanding of where and how a measure is expected to work.



Institutional and financial feasibility determines whether a technically suitable option can be delivered and sustained. Responsibilities for urban adaptation are frequently distributed across departments and levels of government. A measure may require planning authority, infrastructure agencies, public health institutions, utilities and community organizations to act together. The recent literature on urban climate delivery emphasizes a 'missing middle' between high-level governance theory and project-level practice: implementation depends on concrete delivery modes and enabling bundles. This suggests that applicability should include governance arrangements, financing, organizational capacity and maintenance from the beginning rather than treating them as post-approval concerns.

Social applicability is also essential. Adaptation measures generate benefits only when people can access and use them. Early warnings require trusted communication and the capacity to act; cooling centres require physical and social accessibility; housing improvements require affordability and tenure-sensitive design; and community-based measures depend on participation and collective capacity. Recent research on everyday urban adaptation shows that adaptation is not limited to formal projects and that social relations and collective action are important but poorly captured by conventional evaluation. Applicability should therefore include the lived conditions that determine whether formal interventions become usable protection. Finally, applicability is temporal. A measure may be suitable for current conditions but become less appropriate as hazards intensify, land use changes or infrastructure ages. Conversely, some interventions may have long lead times but strong long-term benefits. Adaptation planning should therefore consider the timing of benefits, design life, maintenance requirements and future climate conditions. This makes applicability a dynamic concept and creates a direct connection to the later question of effectiveness.

4. What Recent Evidence Shows About Adaptation Effectiveness

Recent evidence across adaptation domains points to a common conclusion: there is no universal hierarchy of

measures. Effectiveness depends on the relationship between the intervention, the risk mechanism and the conditions of implementation. The most useful synthesis is therefore not to declare one measure superior to another, but to identify the outcomes each domain can plausibly influence and the conditions that shape performance.

Urban heat adaptation illustrates the importance of combined measures. Reviews identify green infrastructure, cool roofs, shading, building interventions, urban design and behavioural responses as relevant strategies. Recent modelling in Grenoble found that a combined strategy could reduce median daytime thermal discomfort by approximately 1.9°C and reduce the area in the most severe UTCI exposure category from 4.8% to 0.1%, while also affecting cooling-energy demand. Such results are valuable because they connect intervention portfolios to a measurable outcome, but they also demonstrate that performance is spatially and context dependent.

Nature-based solutions show a similar pattern. A 2025 systematic review examined implementation, contribution and effectiveness across a large body of literature and found that outcomes depend on data-informed planning, stakeholder awareness, resources, institutional conditions and context. A 2024 meta-analysis likewise synthesized evidence on heatwave and flood benefits. The implication is that nature-based solutions should not be evaluated simply by the area planted or number of projects completed. Evaluation should consider the ecological mechanism, maintenance, service delivered, exposure reduced and distribution of benefits.

Urban adaptation policies provide evidence at a larger scale. A 2026 quasi-natural experiment using panel data from 165 Chinese cities found that the Climate-Adaptive City Pilot Policy reduced climate-risk levels, with mechanisms including infrastructure improvement and public environmental awareness and with variation across city types. Another 2026 study using 267 cities found that the same broad policy framework improved urban ecological resilience, again with heterogeneous effects and identifiable mechanisms. These studies demonstrate the value of moving beyond descriptive inventories towards outcome-based

evaluation, while also showing why effectiveness must remain context sensitive.

Community and everyday adaptation broaden the evidence base further. The 2025 review of everyday urban adaptations documented 632 practices from 45 publications and found limited evidence on their cumulative impacts and outcomes. This suggests that formal city plans can underestimate the adaptation system actually operating in neighbourhoods. At the same time, not every coping practice should automatically be classified as effective adaptation: evaluation must still consider whether the practice reduces underlying vulnerability, transfers risk, creates additional burdens or is sustainable over time.

Evidence from India is particularly important for applicability. Recent evidence from Indian Smart Cities shows that climate hazards and vulnerability are unevenly

distributed across cities, with particularly strong compound dry-hot risks in parts of northern, western and central India. The lesson for urban India is that effectiveness cannot be inferred from the presence of technical measures alone. City-level assessment should incorporate institutional capacity, informal settlements, gender, livelihood exposure, access to services and local governance. This also makes a strong case for context-sensitive rather than imported indicator frameworks. (Sahu et al., 2026)

5. Measuring Effectiveness: From Outputs to Outcomes

Measurement is the bridge between adaptation intention and accountability, but current evidence suggests that the problem is not a lack of indicators. Olazabal et al. (2026) identified 901 indicators across

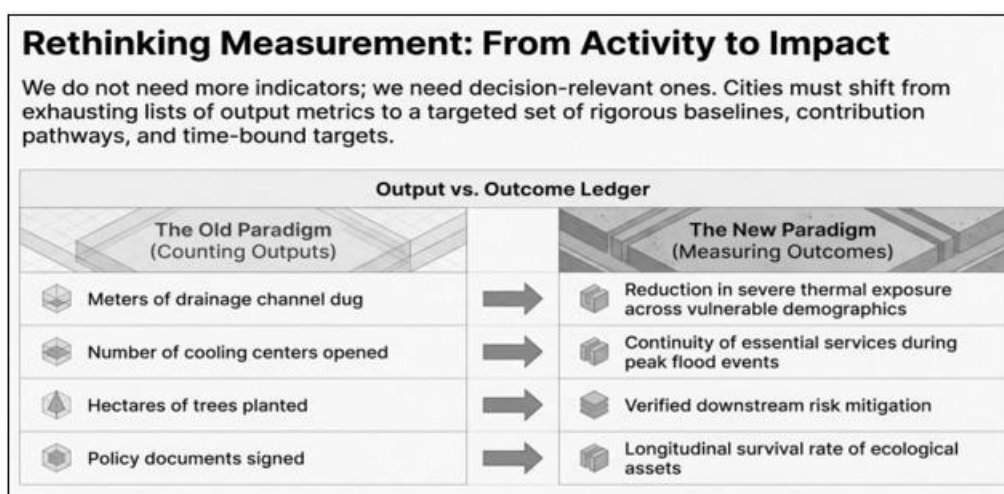


Figure 2: Moving from activity and output counting towards measurable adaptation outcomes.

Source: Author's synthesis based on the reviewed literature

137 publications and found a fragmented methodological landscape. Nghiem et al. (2026) identified 1,064 indicators across 161 studies; 96.6% were quantitative, yet nearly all lacked time-bound targets and only about one-third explicitly addressed climate change. These findings indicate that indicator proliferation can coexist with weak decision relevance. (Olazabal et al., 2026; Nghiem et al., 2026).

A more useful system should distinguish at least four levels of evidence. Inputs show whether resources and capabilities exist. Outputs show whether the intervention was delivered. Outcomes show whether the risk pathway changed. Impacts show whether longer-term resilience, health, economic security or ecological conditions improved. The transition

from outputs to outcomes is the critical evaluative step. A completed drainage channel, planted tree area or issued warning is not itself a risk-reduction outcome.

Attribution is difficult because urban climate outcomes are affected by multiple interventions, socioeconomic change and climate variability. Nevertheless, evaluation can be strengthened through baselines, comparison areas where feasible, repeated measurements, contribution analysis, process tracing and triangulation of quantitative and qualitative evidence. The objective is not to demand perfect causal certainty for every intervention but to make the logic connecting action to outcome explicit and testable.

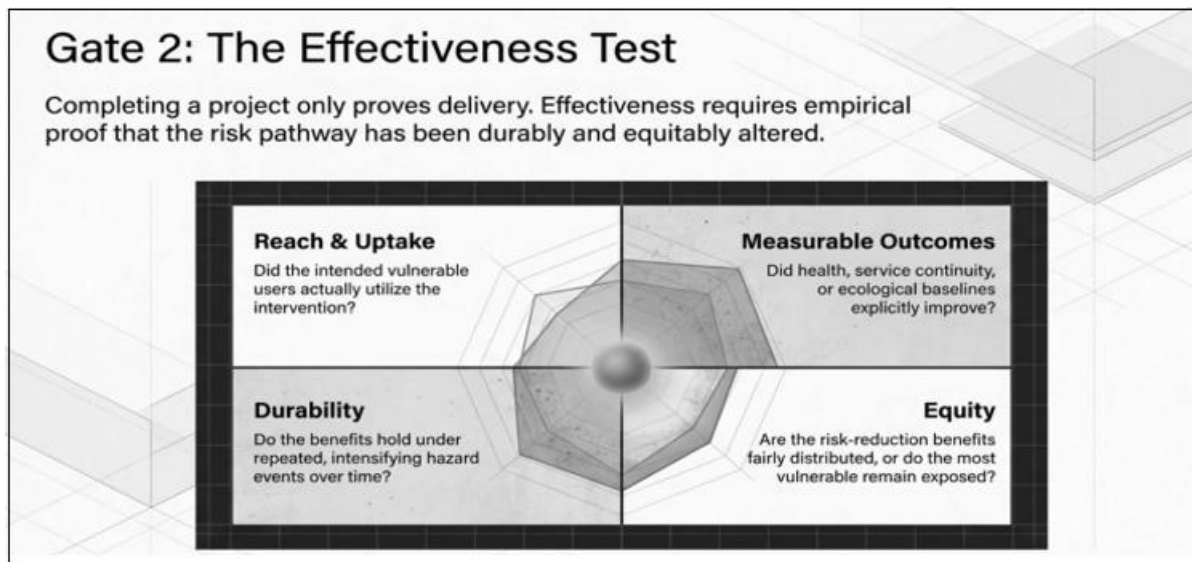


Figure 3: Gate 2: an outcome-oriented effectiveness test beyond project completion. Source: Author's synthesis based on the reviewed literature

Maladaptation must also be evaluated. A measure can reduce one risk while increasing another, shifting risk downstream, increasing energy or water demand, locking in vulnerable development or displacing low-income households. The evaluation boundary should therefore extend beyond the intervention site and immediate project period. This broader perspective is particularly important for infrastructure and land-use measures with long-lived consequences.

6. Cross-Domain Synthesis: What Determines Whether Adaptation Works?

Across the evidence base, the strongest common finding is that adaptation effectiveness is produced by the interaction between a measure and the conditions in which it is deployed. This is visible across heat, flooding, nature-based solutions, governance and community adaptation. A measure can be technically credible but poorly applicable because the required land, finance, institutional authority or maintenance capacity is absent. Conversely, a relatively simple measure can generate substantial benefits when it closely matches the dominant risk pathway and is supported by effective institutions and user uptake. The implication is that urban adaptation research should move away from comparing measures as if they were interchangeable technologies and instead examine the fit between intervention and context.

Recent systematic reviews support this contextual interpretation. Dubou et al. (2026) distinguish absorptive, adaptive and transformative capacities in urban resilience strategies, indicating that adaptation cannot be reduced to a single type of intervention or a single temporal horizon. de Wijn (2026), reviewing 150 studies across high- and low-income contexts, similarly identifies vertical, horizontal and internal governance and contextual conditions as important influences on city-level climate action. These findings strengthen the applicability argument: before an intervention is evaluated for effectiveness, researchers and practitioners need to establish the institutional and contextual conditions under which it can realistically operate.

Governance and institutional continuity provide another explanation for divergent outcomes. Roest et al. (2026) highlight the policy-to-implementation gap in medium-sized cities, while Sudmant et al. (2026) propose climate delivery modes that focus attention on the mechanisms and enabling bundles through which urban climate ambitions become delivery. These contributions complement empirical policy studies by showing that adaptation is not simply a technical choice. Responsibilities, coordination, political support, finance, data and organizational memory determine whether measures can be implemented and sustained. An applicability assessment that ignores these factors may identify a theoretically suitable intervention that cannot be delivered in practice.

The Indian context adds a further lesson about transferability. Recent Indian evidence also shows substantial spatial differences in compound dry-hot exposure and socioeconomic vulnerability across cities. Evidence from Indian Smart Cities also demonstrates that compound dry-hot hazards and vulnerability are unevenly distributed. Together, these findings suggest that international evidence should inform, but not replace, local applicability assessment. An intervention that performs well in a high-income or climatically different city should not be assumed to have the same outcome in Indian cities without examining institutional capacity, settlement form, informal housing, service access and socioeconomic vulnerability. (Sahu et al., 2026)

Finally, applicability and effectiveness should be understood as a learning relationship rather than a one-way sequence. Applicability is assessed before and during implementation, but evidence of effectiveness can reveal that the original assumptions were incomplete. Monitoring may show that a measure reaches fewer people than expected, that benefits decline under extreme events, or that an unintended effect emerges. That evidence should feed back into the next adaptation decision. The practical value of the proposed framework is therefore not only evaluative; it is adaptive. It helps cities decide what to retain, modify, scale, combine or discontinue as evidence accumulates.

7. Applicability, Effectiveness and the Conditions of Success

The above evidence indicates that applicability and effectiveness need to be considered as a two-part process and as interrelated concepts. Applicability deals with whether a measure is a reasonable reaction in a specific context. Effectiveness is the question of whether or not that response will alter the intended risk pathway. This difference is helpful to understand why adaptation failures may happen at different stages: an inappropriate intervention might not work before it is implemented, a well-designed intervention might fail when it is implemented, or a well-designed intervention might fail after it has been implemented, because its risk mechanism was misinterpreted or conditions changed.

The scale of the adaptation finance challenge is illustrated by UNEP's 2025 estimates, which project that developing country adaptations will require US\$310 – 365 billion a year by 2035, while there was only US\$26 billion in international public adaptation finance in 2023. In this context, applicability assessment may be used to prevent unnecessary investments in areas of high risk or too onerous to sustain, and effectiveness assessment may be used to determine if continued investment in a location is warranted based on measurable results.

The message is that evaluation of adaptation should focus on portfolios and interactions where one project does not represent the pathway to the relevant risk. Lastly, effectiveness is dynamic. Both climate hazards and exposure, as well as technology and institutions and social conditions, evolve. What works at one level of hazard may not work at higher levels of hazard. Monitoring and learning are therefore not 'endpoints' but processes by which adaptation is still relevant and possible in the future. This leads to a feedback loop: effectiveness of measures influences further considerations of applicability, and when conditions change, risk considerations call for reassessment of measures.

8. Implications for Urban Climate Management

8.1 Policy and Governance Implications

The policies for urban adaptation should include the risk to be mitigated, the population or property to be protected, the expected results, the timescale and evidence to show progress. Outcome pathways should thus be included in policy documents instead of lists of projects. National and state programs should support cities in implementing the measures through enabling finance, data, standards, and technical support and give cities room to tailor the implementation to local situations. Each of the major adaptation commitments at the city level should include a responsible institution, milestones for implementation, maintenance plans and monitoring. This would further link climate ambition to climate action. (UN-Habitat, 2026; Sudmant et al., 2026).

8.2 Municipal and Managerial Implications

The first concrete step in the practical change for municipal managers is to switch from project-counting dashboards to short dashboards that present outcomes. Tracking baseline

risk, applicability conditions, implementation quality, reach, outcome, durability and equity are useful aspects of a dashboard. Every intervention should have an institutional owner and an appropriate trigger for taking action. Adaptation should also be considered as a portfolio; for example, interventions for heat can be complementary to interventions for water; interventions that reduce flooding can be complementary to interventions that improve housing; and interventions that strengthen transport can also complement interventions focused on health. Maintenance needs are a component of adaptation performance and are not an afterthought.

8.3 Social and Equity Implications

The effectiveness should be measured by the extent of reaching the most exposed and sensitive people in reducing risk. Where relevant, indicators should be broken down by neighbourhood, housing type, income category, occupation, age or other locally relevant indicators of vulnerability. Community knowledge should be seen as evidence about the implementation barriers and outcomes rather than consultation. The examples of everyday adaptation research show that households and communities across the globe are already engaging in a variety of adaptations; formal programmes have the potential to be more successful if they take into account these adaptations and understand the context in which they are constrained. (Alda-Vidal & Olazabal, 2025).

8.4 Environmental and Technical Implications

Technical appraisal should be conducted for the intended climate outcome as well as environmental co-benefits or trade-offs. NbS can have multiple impacts on heat, runoff, biodiversity, amenity and water management and infrastructure can impact on downstream risk or resource use. The system boundaries should then be tailored to the mechanism of intervention for evaluation purposes. Spatial analysis should also account for the urban morphology and ecological conditions - not uniformity at a city level. Studies on heat and NbS corroborate this holistic approach. (Gabeiras et al., 2026; Mosisa et al., 2025).

8.5 Financial and Investment Implications

Adaptation finance to be linked with evidence of performance. The global finance deficit should be taken into account when evaluating project viability, feasibility, risk reduction, maintenance, durability, and distribution of benefits and possible unintended effects. It is not about downplaying adaptation to a strictly monetary cost/benefit analysis. It involves making it explicit that investment decisions are based on a theory of change and a realistic plan for monitoring. Multi-year money should be allocated for maintenance and evaluation—otherwise, benefits can't be proven when measurement is finished with construction. (UNEP, 2025).

8.6 Monitoring, Evaluation and Learning Implications

All major adaptations should start with a baseline and an explicit statement of the change the adaptation will make.

Decisions should be made and the indicators should be chosen to address them, not simply in order to get the most measures. Monitoring should be carried out in the implementation process, following relevant climate events and over longer time periods. When results are not in line with the expectations, evidence should be used to make course corrections. This forms an adaptive management cycle in which evaluating is a management task rather than a reporting task. This change of focus from quantity of indicators to relevance, targets and decision use is supported strongly in the recent literature on indicators. (Olazabal et al., 2026; Nghiem et al., 2026).

9. Research Gaps and Future Directions

There is limited longitudinal evidence on adaptation. Evaluations need to understand whether benefits last longer than project duration and continue in the face of repeated climate-related shocks. Second, attribution in adaptation assessments needs strengthening. Assessments should, where possible, use a more compelling comparison group or contribution approach than just describing changes over time. Third, better outcome-based empirical evidence is needed on equity and maladaptation. Assessments need to look at distributional impacts and risk-shifting, recognizing that inclusion and participation in projects does not necessarily mean that interventions have been equitable and do not result in maladaptation for some. Fourth, evaluations of formal adaptation projects need to better integrate community-level business-as-usual adaptation. There is a need to explore simplified, context-specific sets of indicators with clear targets.

10. Conclusion

This review shows that the central challenge in urban climate adaptation is no longer simply identifying possible measures. The more demanding task is determining whether a measure is applicable to a particular risk and context and, once implemented, whether it produces the intended outcome. Applicability and effectiveness are therefore related but distinct stages. Applicability concerns fit, feasibility, accessibility and temporal suitability; effectiveness concerns demonstrated change in the risk pathway, durability, equity and unintended effects.

The evidence from 2024–2026 demonstrates that adaptation performance is strongly conditional. Heat measures vary with urban morphology and combinations of interventions; nature-based solutions depend on planning, ecological conditions, resources and maintenance; flood interventions depend on system scale and risk transfer; warning systems depend on reach, trust and the capacity to act; and policy interventions depend on institutional mechanisms and governance capacity. Recent empirical studies of climate-adaptive city policies further show that positive effects can coexist with substantial heterogeneity. These findings argue against universal claims that a particular adaptation measure is inherently effective. Instead, effectiveness should be explained through the conditions under which a measure works.

Secondly, it is a conclusion about measurement. There are many indicators in the literature, however the last few reviews

have identified a lack of standardisation, lack of targets over time and limited coverage of governance and equity. But it is not enough to increase the number of indicators. A more effective strategy is to structure a limited number of measures along a logical series of steps in the process of baseline risk to implementation, reach, outcomes and durability. Outputs continue to be useful, but should be considered as proof of delivery, not proof of success. Where possible, attribution should be improved; where it is not, it should be clearly reported.

The third one is about the relevance of applicability prior to investment. UNEP's adaptation finance gap is a measure of resources being limited compared to needs. In these settings, a decision making process is needed that helps determine if an intervention is appropriate to the local hazard, implementable and sustainable, and has the potential to reach target populations and provide a viable way to a risk reduction. Analysis of how urban content has been integrated into national climate plans indicates a growing momentum to link between national and city level commitments in the face of the 2026 assessment by UN-Habitat. What is needed next is for the added ambition to be accompanied by actionable responsibilities, resources, monitoring/learning.

A fourth conclusion that is related to resilience as a learning process is also discussed. Adapting to climate change is not a one-and-done process. Climate hazards are changing, exposure to climate hazards is increasing in cities, institutions change, infrastructure is ageing, and social needs are shifting. Monitoring, evaluation and learning need to be used to inform the selection and redesign of any future measures. The proposed applicability-to-effectiveness framework does this by aligning risk diagnosis, choice of intervention, implementation of intervention, outputs, outcomes and durable resilience, and tests them across the framework with equity, maladaptation, attribution, and uncertainty.

Overall, the review contributes a practical theoretical proposition: urban adaptation should move from a project-centred question—'Has the measure been implemented?'- to a decision-centred sequence-'Is it applicable here, was it implemented as intended, did it reach those at risk, did it change the relevant outcome, did the benefit persist, and did it avoid creating new inequalities or risks?' This shift strengthens the scientific basis of adaptation assessment while remaining usable for urban planning and management. It also provides a basis for future empirical research in which the framework can be tested across cities, hazards and intervention portfolios. The ultimate purpose of adaptation is not the accumulation of projects, indicators or plans, but durable and equitable reduction of climate vulnerability.

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