Climate Change and Cities

Second Assessment Report of the Urban Climate Change Research Network

SUMMARY FOR CITY LEADERS

ARC3.2

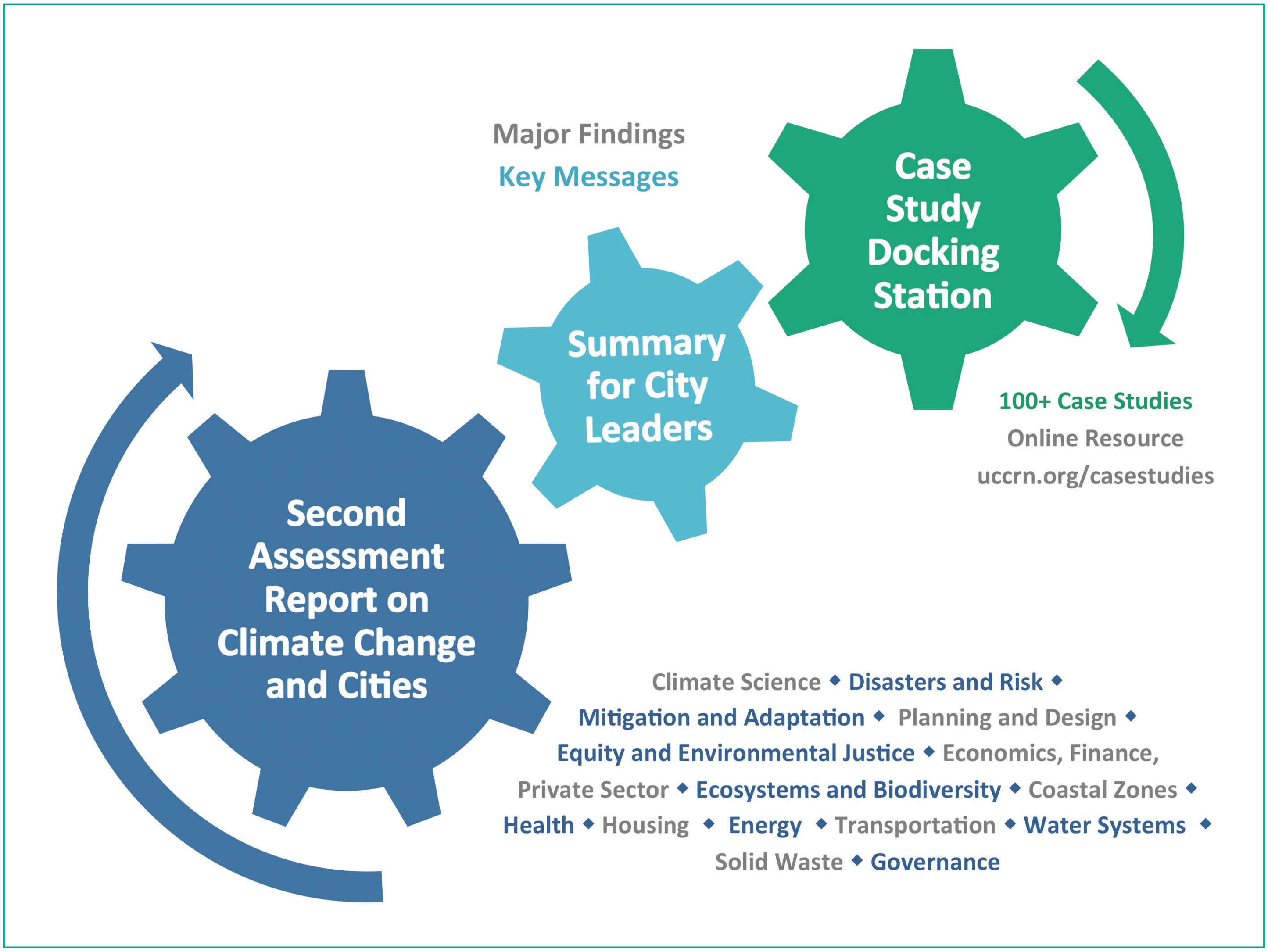

Figure 1: *Components of the Second Assessment Report on Climate Change and Cities (ARC3.2) and their interactions.*

ARC3.2 Summary for City Leaders
Urban Climate Change Research Network
Second UCCRN Assessment Report on Climate Change and Cities

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Cover photo: Rio de Janeiro by Somayya Ali Ibrahim

ARC3.2
SUMMARY FOR CITY LEADERS

This is the *Summary for City Leaders* of the Urban Climate Change Research Network (UCCRN) *Second Assessment Report on Climate Change and Cities* (ARC3.2) (Figure 1). UCCRN is dedicated to providing the information that city leaders—from government, the private sector, non-governmental organizations, and the community—need in order to assess current and future risks, make choices that enhance resilience to climate change and climate extremes, and take actions to reduce greenhouse gas emissions.

ARC3.2 presents a broad synthesis of the latest scientific research on climate change and cities[1]. Mitigation and adaptation climate actions of 100 cities are documented throughout the 16 chapters, as well as online through the ARC3.2 Case Study Docking Station (www.uccrn.org/casestudies). Pathways to Urban Transformation, Major Findings, and Key Messages are highlighted here in the *ARC3.2 Summary for City Leaders*. These sections lay out what cities need to do achieve their potential as leaders of climate change solutions. UCCRN Regional Hubs in Europe, Latin America, Africa, Australia and Asia will share ARC3.2 findings with local city leaders and researchers.

The *ARC3.2 Summary for City Leaders* synthesizes Major Findings and Key Messages on urban climate science, disasters and risks, urban planning and design, mitigation and adaptation, equity and environmental justice, economics and finance, the private sector, urban ecosystems, urban coastal zones, public health, housing and informal settlements, energy, water, transportation, solid waste, and governance. These were based on climate trends and future projections for 100 cities around the world.

Climate Change and Cities

The international climate science research community has concluded that human activities are changing the Earth's climate in ways that increase risk to cities. This conclusion is based on many different types of evidence, including the Earth's climate history, observations of changes in the recent historical climate record, emerging new patterns of climate extremes, and global climate models. Cities and their citizens already have begun to experience the effects of climate change. Understanding and anticipating these changes will help cities prepare for a more sustainable future. This means making cities more resilient to climate-related disasters and managing long-term climate risks in ways that protect people and encourage prosperity. It also means improving cities' abilities to reduce greenhouse gas emissions.

While projections for future climate change are most often defined globally, it is becoming increasingly important to assess how the changing climate will impact cities. The risks are not the same everywhere. For example, sea level rise will affect the massive zones of urbanization clustered along the world's tidal coastlines and most significantly those cities in places where the land is already subsiding. In response to the wide range of risks facing cities and the role that cities play as home to more than half of the world's population, urban leaders are joining forces with multiple groups including city networks and climate scientists. They are assessing conditions within their cities in order to take science-based actions that increase resilience and reduce greenhouse gas emissions, thus limiting the rate of climate change and the magnitude of its impacts.

In September 2015, the United Nations endorsed the new Sustainable Development Goal 11, which is to "Make cities and human settlements inclusive, safe, resilient and sustainable." This new sustainability goal cannot be met without explicitly recognizing climate change as a key component. Likewise, effective responses to climate change cannot proceed without understanding the larger context of sustainability. As ARC3.2 demonstrates, actions take to reduce greenhouse gas emissions and increase resilience can also enhance the quality of life and social equity.

1. Cities are defined here in the broad sense to be urban areas, including metropolitan and suburban regions.

Pathways to Urban Transformation

Hyderabad, India | Cairo, Egypt | Paris, France | Phnom Penh, Cambodia | New York, USA | Rio de Janeiro, Brazil

As is now widely recognized, cities can be the main implementers of climate resiliency, adaptation, and mitigation. However, the critical question that ARC3.2 addresses is under what circumstances this advantage can be realized. Cities may not be able to address the challenges and fulfill their climate change leadership potential without transformation.

ARC3.2 synthesizes a large body of studies and city experiences and finds that transformation is essential in order for cities to excel in their role as climate-change leaders. As cities mitigate the causes of climate change and adapt to new climate conditions, profound changes will be required in urban energy, transportation, water use, land use, ecosystems, growth patterns, consumption, and lifestyles. New systems for urban sustainability will need to emerge that encompass more cooperative and integrated urban-rural, peri-urban, and metropolitan regional linkages.

Five pathways to urban transformation emerge throughout ARC3.2. These pathways provide a foundational framework for the successful development and implementation of climate action. Cities that are making progress in transformative climate change actions are following many or all of these pathways. The pathways can guide the way for the hundreds of cities–large and small/low, middle, and high income–throughout the world to play a significant role in climate change action. Cities that do not follow these pathways may have greater difficulty realizing their potential as centers for climate change solutions. The pathways are:

Pathway 1: Disaster risk reduction and climate change adaptation are the cornerstones of resilient cities. Integrating these activities into urban development policies requires a new, systems-oriented, multi-timescale approach to risk assessments and planning that accounts for emerging conditions within specific, more vulnerable communities and sectors, as well as across entire metropolitan areas.

Pathway 2: Actions that reduce greenhouse gas emissions while increasing resilience are a win-win. Integrating mitigation and adaptation deserves high priority in urban planning, urban design, and urban architecture. A portfolio of approaches is available, including engineering solutions, ecosystem-based adaptation, policies, and social programs. Taking the local context of each city into account is necessary in order to choose actions that result in the greatest benefits.

Pathway 3: Risk assessments and climate action plans co-generated with the full range of stakeholders and scientists are most effective. Processes that are inclusive, transparent, participatory, multi-sectoral, multi-jurisdictional, and interdisciplinary are the most robust because they enhance relevance, flexibility, and legitimacy.

Pathway 4: Needs of the most disadvantaged and vulnerable citizens should be addressed in climate change planning and action. The urban poor, the elderly, women, minority, recent immigrants and otherwise marginal populations most often face the greatest risks due to climate change. Fostering greater equity and justice within climate action increases a city's capacity to respond to climate change and improves human wellbeing, social capital, and related opportunities for sustainable social and economic development.

Pathway 5: Advancing city creditworthiness, developing robust city institutions, and participating in city networks enable climate action. Access to both municipal and outside financial resources is necessary in order to fund climate change solutions. Sound urban climate governance requires longer planning horizons, effective implementation mechanisms and coordination. Connecting with national and international capacity-building networks helps to advance the strength and success of city-level climate planning and implementation.

A final word on timing: Cities need to start immediately to develop and implement climate action. The world is entering into the greatest period of urbanization in human history, as well as a period of rapidly changing climate. Getting started now will help avoid locking-in counterproductive long-lived investments and infrastructure systems, and ensure cities' potential for the transformation necessary to lead on climate change.

Climate Observations and Projections for 100 ARC3.2 Cities

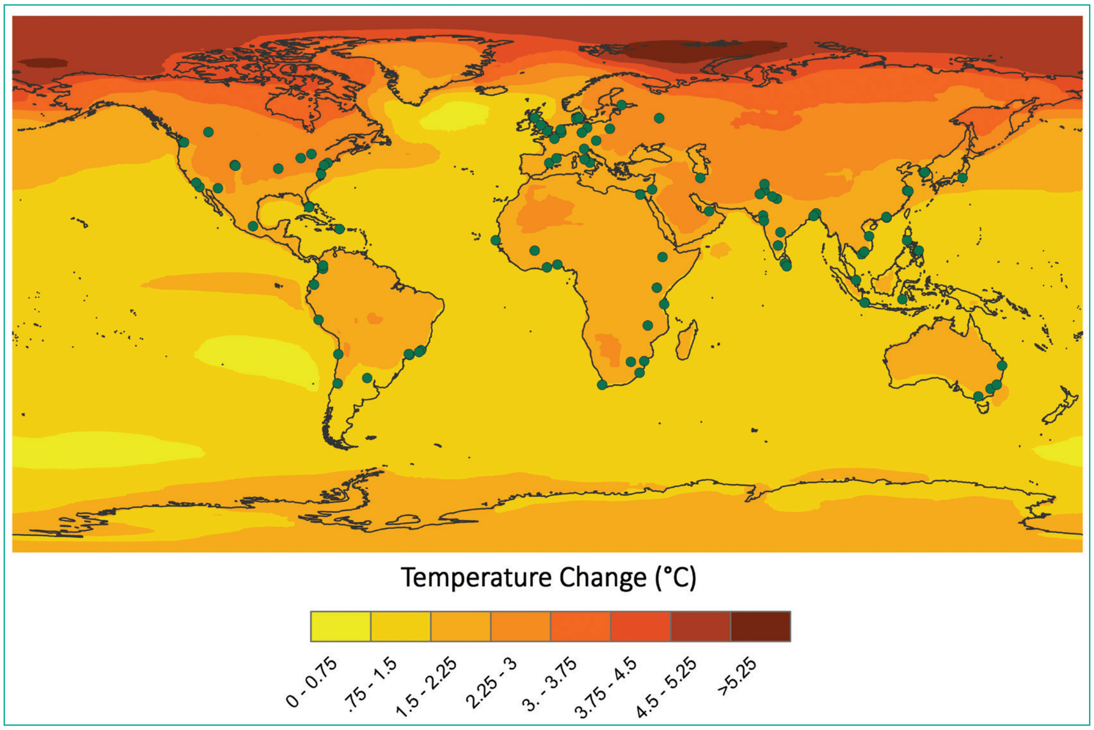


Figure 2: *Projected temperature change in the 2050s and ARC3.2 Cities. Temperature change projection is mean of 35 global climate models (GCMs) and one representative concentration pathway (RCP4.5). Colors represent mean annual temperature change for a mid-range scenario (RCP 4.5), from CMIP5 models (2040-2069 average minus 1971-2000 average).*

- Temperatures are already rising in cities around the world due to both climate change and the urban heat island effect. Mean annual temperatures in 39 ARC3.2 cities have increased at a rate of 0.12 to 0.45°C per decade over the 1961 to 2010 time period. [1]
- Mean annual temperatures in the 100 ARC3.2 cities around the world are projected to increase by 0.7 to 1.5°C by the 2020s, 1.3 to 3.0°C by the 2050s, and 1.7 to 4.9°C by the 2080s (Figure 2). [2]
- Mean annual precipitation in the 100 ARC3.2 cities around the world is projected to change by -7 to +10% by the 2020s, -9 to +15% by the 2050s, and -11 to +21% by the 2080s.
- Sea level in the 52 ARC3.2 coastal cities is projected to rise 4 to 19 cm by the 2020s; 15 to 60 cm by the 2050s, and 22 to 124 cm by the 2080s. [3]

1. Of the 100 ARC3.2 cities, 45 had temperature data available for the 1961 to 2010 time period. For each of these 45 cities, the trend was computed over the given time period. For the trends, 39 cities saw significant (at the 99% significance level) warming. Data are from the NASA GISS GISTEMP dataset.

2. Temperature and precipitation projections are based on 35 global climate models and 2 representative concentration pathways (RCP4.5 and RCP 8.5). Timeslices are 30-year periods centered around the given decade (e.g., the 2050s is the period from 2040 to 2069). Projections are relative to the 1971 to 2000 base period. For each of the 100 cities, the low estimate (10th percentile) and high estimate (90th percentile) was calculated. The range of values presented is the average across all 100 cities.

3. Sea level rise projections are based on a 4-component approach that includes both global and local factors. The model-based components are from 24 global climate models and 2 representative concentration pathways (RCP 4.5 and RCP 8.5). Timeslices are 10-year periods centered around the given decade (e.g., the 2080s is the period from 2080 to 2089). Projections are relative to the 2000 to 2004 base period. For each of the 52 cities, the low estimate (10th percentile) and high estimate (90th percentile) was calculated. The range of values presented is the average across all 52 cities.

What Cities Can Expect

Jakarta. Photo by Somayya Ali Ibrahim.

People and communities everywhere are reporting weather events and patterns that seem unfamiliar. Such changes will continue to unfold over the coming decades and, depending on which choices people make, possibly for centuries. But the various changes will not occur at the same rates in all cities of the world, nor will they all occur gradually or at consistent rates of change.

Climate scientists have concluded that, while some of these changes will take place over many decades, even centuries, there is also a risk of crossing thresholds in the climate system that cause some rapid, irreversible changes to occur. One example would be melting of the Greenland and West Antarctic ice sheet, which would lead to very high and potentially rapid rates of sea level rise.

MAJOR FINDINGS

- Urbanization tends to be associated with elevated surface and air temperature, a condition referred to as the *urban heat island*. Urban centers and cities are often several degrees warmer than surrounding areas due to presence of heat absorbing materials, reduced evaporative cooling caused by lack of vegetation, and production of waste heat.
- Some climate extremes will be exacerbated under changing climate conditions. Extreme events in many cities include heat waves, droughts, heavy downpours, and coastal flooding, are projected to increase in frequency and intensity.
- The warming climate combined with the urban heat island effect will exacerbate air pollution in cities.
- Cities around the world have always been affected by major, naturally occurring variations in climate conditions including the El Niño Southern Oscillation, North Atlantic Oscillation, and the Pacific Decadal Oscillation. These oscillations occur over years or decades. How climate change will influence these recurring patterns in the future is not fully understood.

KEY MESSAGES

Human-caused climate change presents significant risks to cities beyond the familiar risks caused by natural variations in climate and seasonal weather patterns. Both types of risk require sustained attention from city governments in order to improve urban resilience. One of the foundations for effective adaptation planning is to co-develop plans with stakeholders and scientists who can provide urban-scale information about climate risks—both current risks and projections of future changes in extreme events.

Weather and climate forecasts of daily, weekly, and seasonal patterns and extreme events are already widely used at international, national, and regional scales. These forecasts demonstrate the value of climate science information that is communicated clearly and in a timely way. Climate change projections perform the same functions on longer timescales. These efforts now need to be carried out on the city scale.

Within cities, various neighborhoods experience different microclimates. Therefore, urban monitoring networks are needed to address the unique challenges facing various microclimates and the range impacts of extreme climate effects at neighborhood scales. The observations collected through such urban monitoring networks can be used as a key component of a citywide climate indicators and monitoring system that enables decision-makers to understand the variety of climate risks across the city landscape.

Managing Disasters in a Changing Climate

Figure 3: *Damaged homes in New York City as a result of Hurricane Sandy, November 2012. Photo by Somayya Ali Ibrahim.*

Globally, the impacts of climate-related disasters are increasing. The impacts of climate-related disasters may be exacerbated in cities due to interactions of climate change with urban infrastructure systems, growing urban populations, and economic activities (Figure 3). As the majority of the world's population is currently living in cities–and this share is projected to increase in the coming decades, cities–need to focus more on climate-related disasters such as heat waves, floods, and droughts.

In a changing climate, a new decision-making framework is needed in order to fully manage emerging and increasing risks. This involves a paradigm shift away from impact assessments that focus on single climate hazards based on past events. The new paradigm requires integrated, system-based risk assessments that incorporate current and future hazards throughout entire metropolitan regions.

MAJOR FINDINGS

- The number of and severity of weather and climate-related disasters is projected to increase in the next decades; as most of the world's population live in urban areas, cities require specific attention on risk reduction and resilience building.
- The vulnerability of cities to climate-related disasters is shaped by cultural, demographic and economic characteristics of residents, local governments' institutional capacity, the built environment, the provision of ecosystem services, and human-induced stresses such as resource exploitation and environmental degradation such as removal of natural storm buffers, pollution, over-use of water, and the urban heat island effect.
- Integrating climate change adaptation with disaster risk reduction involves overcoming a number of barriers: such as adding climate resilience to a city's development vision; understanding of the hazards, vulnerabilities, and attendant risks; closing gaps in coordination between various administrative and sectoral levels of management; and development of implementation and compliance strategies and financial capacity.
- Strategies for improving resilience and managing risks in cities include the integration of disaster risk reduction with climate change adaptation; urban and land-use planning and innovative urban design; financial instruments and public-private partnerships; management and enhancement of ecosystem services; building strong institutions and developing community capabilities; and resilient post-disaster recovery and rebuilding.

KEY MESSAGES

Disaster risk reduction and climate change adaptation are the cornerstones of making cities resilient to a changing climate. Integrating these activities with a city's development vision requires a new, systems-oriented approach to risk assessments and planning. Moreover, since past events cannot inform decision-makers about emerging and increasing climate risks, systems-based risk assessments must incorporate knowledge about current conditions and future projections across entire metropolitan regions.

A paradigm shift of this magnitude will require decision-makers and stakeholders to increase the capacity of communities and institutions to coordinate, strategize, and implement risk-reduction plans and disaster responses. This is why promoting multi-level, multi-sectoral, and multi-stakeholder integration is so important.

Integrating Mitigation and Adaptation as Win-Win Actions

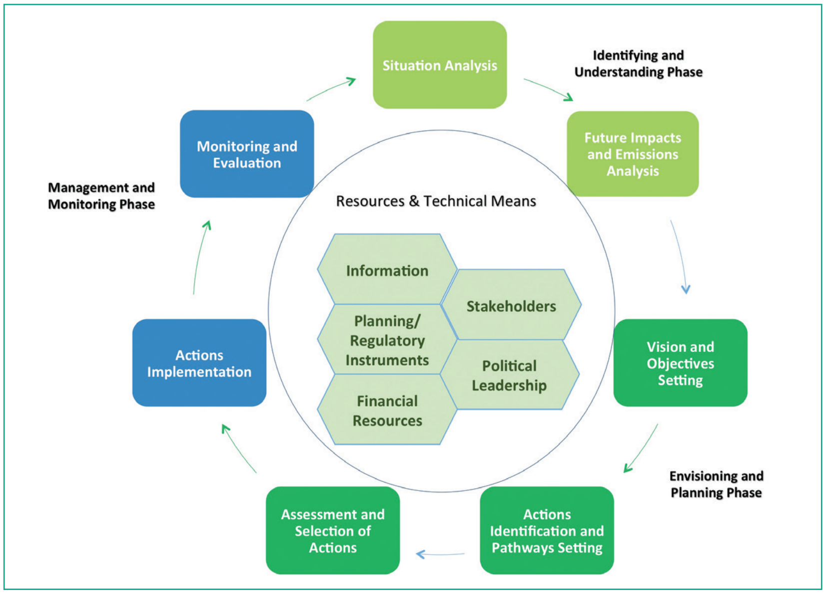


Figure 4: *Main resources and technical means that can be used by cities in their planning cycle for integrating mitigation and adaptation.*

Urban planners and decision-makers need to integrate efforts to mitigate the causes of climate change (mitigation) and adapt to changing climatic conditions (adaptation). Actions that promote both goals provide win-win solutions. In some cases, however, decision-makers have to negotiate trade-offs and minimize conflicts between competing objectives.

A better understanding of mitigation and adaptation synergies can reveal greater opportunities for urban areas. For example, strategies that reduce the urban heat island effect, improve air quality, increase resource efficiency in the built environment and energy systems, and enhance carbon storage related to land use and urban forestry are likely to contribute to greenhouse gas emissions reduction while improving a city's resilience. The selection of specific adaptation and mitigation measures should be made in the context of other sustainable development goals by taking current resources and technical means of the city, plus needs of citizens, into account.

MAJOR FINDINGS

- Mitigation and adaptation policies have different goals and opportunities for implementation. However, many drivers of mitigation and adaptation are common, and solutions can be interrelated. Evidence shows that broad-scale, holistic analysis and proactive planning can strengthen synergies, improve cost-effectiveness, avoid conflicts and help manage trade-offs.
- Accurate diagnosis of climate risks and the vulnerabilities of urban populations and territory are essential. Likewise, cities need transparent and meaningful greenhouse gas emissions inventories and emission reduction pathways in order to prepare mitigation actions.
- Contextual conditions determine a city's challenges, as well as its capacity to integrate and implement adaptation and mitigation strategies. These include the environmental and physical setting, the capacities and organization of institutions and governance, economic and financial conditions, and socio-cultural characteristics.
- Integrated planning requires holistic, systems-based analysis that takes into account the quantitative and qualitative costs and benefits of integration compared to stand-alone adaptation and mitigation policies (Figure 4). Analysis should be explicitly framed within local priorities and provide the foundation for evidence-based decision support tools.

KEY MESSAGES

Integrating mitigation and adaptation can help avoid locking a city into counterproductive infrastructure and policies. Therefore, city governments should develop and implement climate action plans early in their administrative terms. These plans should be based on scientific evidence and should integrate mitigation and adaptation across multiple sectors and levels of governance. Plans should clarify short, medium and long-term goals, implementation opportunities, budgets, and concrete measures for assessing progress.

Integrated city climate action plans should include a variety of mitigation actions—those involving energy, transport, waste management, and water policies, and more—with adaptation actions—those involving infrastructure, natural resources, health, and consumption policies, among others—in synergistic ways. Because of the comprehensive scope, it is important to clarify the roles and responsibilities of key actors in planning and implementation. Interactions among the actors must be coordinated during each phase of the process.

Once priorities and goals have been identified, municipal governments should connect with federal legislation, national programs, and, in the case of low-income cities, with international donors in order to match actions and foster helpful alliances and financial support.

Embedding Climate Change in Urban Planning and Design

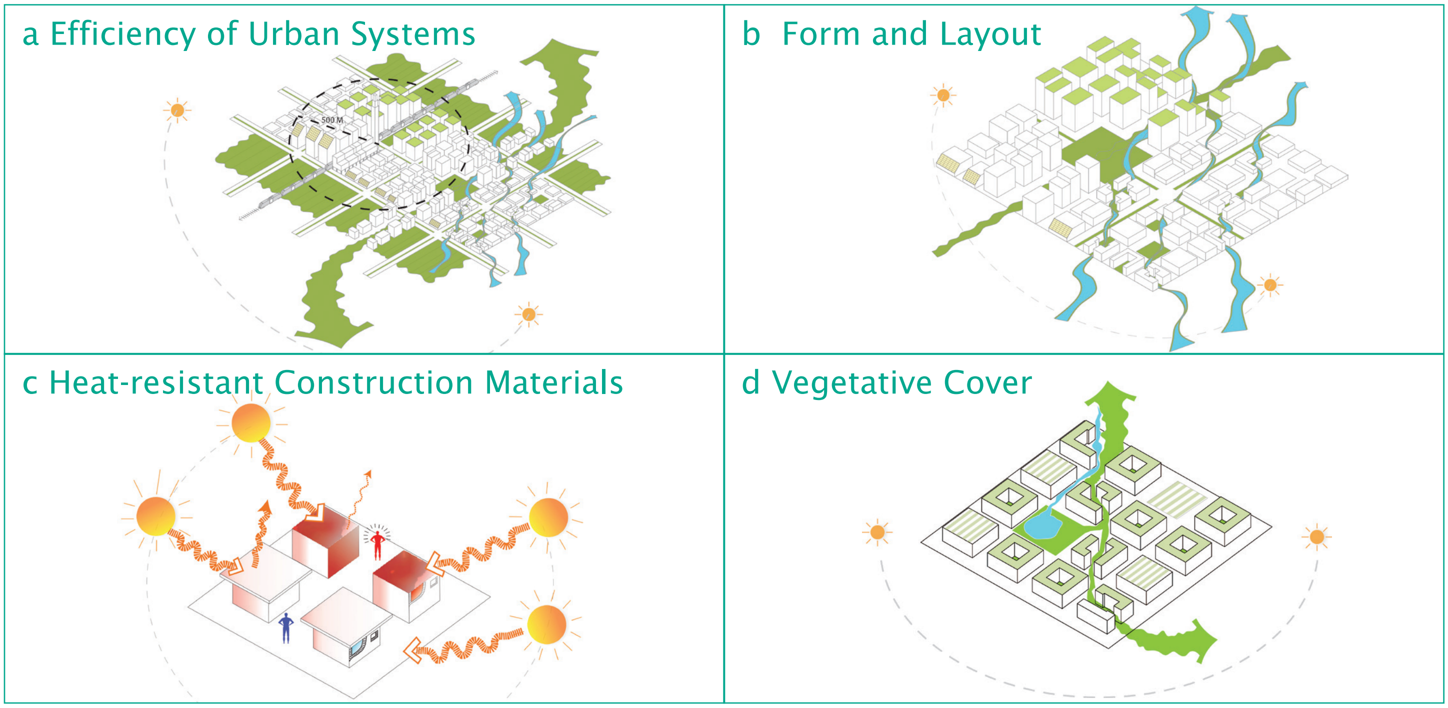


Figure 5: *Main strategies used by urban planners and designers to facilitate integrated mitigation and adaptation in cities: (a) reducing waste heat and greenhouse gas emissions through energy efficiency, transit access, and walkability; (b) modifying form and layout of buildings and urban districts; (c) use of heat-resistant construction materials and reflective surface coatings; and (d) increasing vegetative cover. Source: Urban Climate Lab, Graduate Program in Urban & Regional Design, New York Institute of Technology, 2015.*

Urban planning and urban design have a critical role to play in the global response to climate change. Actions that simultaneously reduce greenhouse gas emissions and build resilience to climate risks should be prioritized at all urban scales—metropolitan region, city, district/neighborhood, block, and building. This needs to be done in ways that are responsive to and appropriate for local conditions.

MAJOR FINDINGS

Urban planners and designers have a portfolio of climate change strategies that guide decisions on urban form and function (Figure 5).

- Urban waste heat and greenhouse gas emissions from infrastructure—including buildings, transportation, and industry – can be reduced through improvements in the efficiency of urban systems.
- Modifying the form and layout of buildings and urban districts can provide cooling and ventilation that reduce energy use and allow citizens to cope with higher temperatures and more intense runoff.
- Selecting construction materials and reflective coatings can improve building performance by managing heat exchange at the surface.
- Increasing the vegetative cover in a city can simultaneously lower outdoor temperatures, building cooling demand, runoff, and pollution, while sequestering carbon.

KEY MESSAGES

Climate change mitigation and adaptation strategies should form a core element in urban planning and design taking into account local conditions. Decisions on urban form have long-term (>50 years) consequences and affect the city's capacity to reduce greenhouse gas emissions and to respond to climate hazards. Investing in mitigation strategies that yield concurrent adaptive benefits should be prioritized.

Urban planning and design should incorporate long-range strategies for climate change that reach across physical scales, jurisdictions, and electoral timeframes. These activities need to deliver a higher quality of life for urban citizens as the key performance outcome.

Equity and Climate Resilience

Cities are characterized by the large diversity of socio-economic groups living in close proximity. Diversity is often accompanied by stratification based on class, caste, gender, profession, race, ethnicity, age, and ability. This gives rise to social categories that, in turn, affect the ability of individuals and various groups to endure climate stresses and minimize climate risks.

Differences between strata often lead to discrimination based on group membership. Poorer people and ethnic and racial minorities tend to live in more hazard-prone, vulnerable and crowded parts of cities. These circumstances increase their susceptibility to the impacts of climate change and reduce their capacity to adapt and withstand extreme events.

MAJOR FINDINGS

- Differential vulnerability of urban residents to climate change is driven by four factors: (1) differing levels of physical exposure; (2) urban development processes that have created a range of built-in risks, such access to critical infrastructure and urban services; (3) social characteristics that influence the allocation of resources for adaptation; and (4) access to power, institutions, and governance (Figure 6).
- Climate change amplifies vulnerability and hampers adaptive capacity, especially for the poor, women, the elderly, children, and ethnic minorities. These people often lack power and access to resources, adequate urban services, and functioning infrastructure. Gender inequality is particularly pervasive in cities, contributing to differential consequences of climate changes.
- While some extreme climate events, such as droughts, can undermine everyone's resource base and adaptive capacity, including better-off groups in cities; as climate extremes become more frequent and intense, this can increase the scale and depth of urban poverty overall.
- Mobilizing resources to improve equity and environmental justice under changing climatic conditions requires (1) participation by impacted communities and the involvement of civil society; (2) non-traditional sources of finance, including partnerships with the private sector; and (3) adherence to the principle of transparency in spending, monitoring, and evaluation.

KEY MESSAGES

Urban climate policies should include equity and environmental justice as primary long-term goals. They foster human wellbeing, social capital, and sustainable social and economic development, all of which increase a city's capacity to respond to climate change. Access to land situated in non-vulnerable locations, security of tenure, and access to basic services and risk-reducing infrastructure are particularly important.

Cities need to promote and share a science-informed policymaking process that integrates multiple stakeholder interests and avoids inflexible, top-down solutions. This can be accomplished by participatory processes that incorporate community members' views about resilience objectives and feasibility.

Over time, climate change policies and programs need to be evaluated and adjusted in order to ensure that sustainably, resilience, and equity goals are achieved. Budgetary transparency, equitable resource allocation schemes, monitoring, and periodic evaluation are essential to ensure that funds reach target groups and result in equitable resilience outcomes.

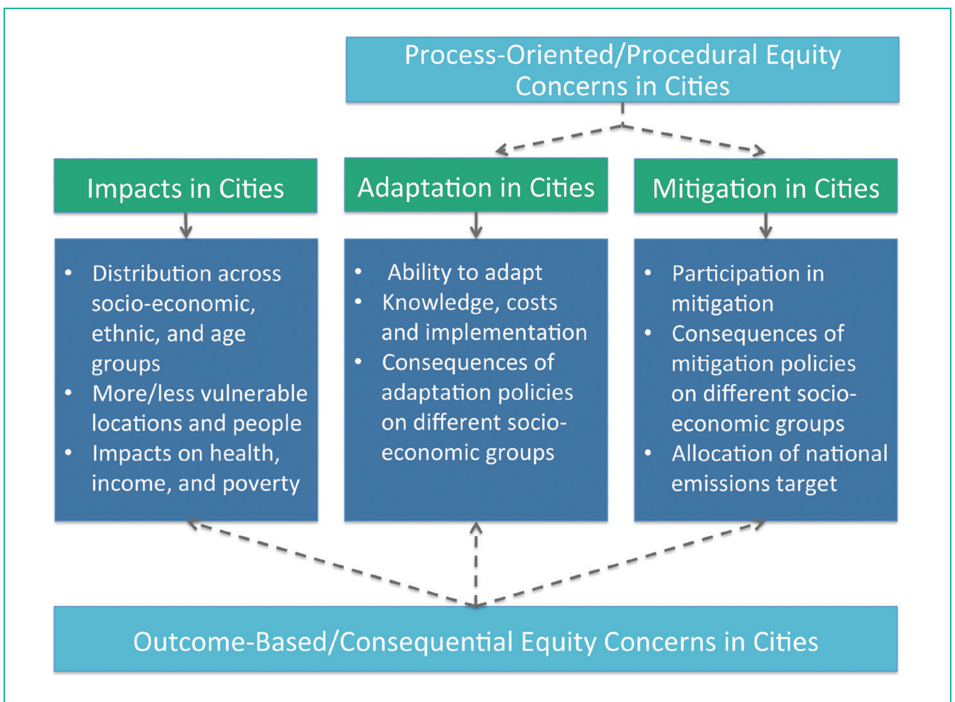


Figure 6: *Equity dimensions relevant to climate change impacts, adaptation, and mitigation in cities: outcome-based, distributive or consequential equity; and process-oriented or procedural equity. Source: Metz, 2000.*

Financing Climate Change Solutions in Cities

Since cities are the locus of large and rapid socioeconomic development around the world, economic factors will continue to shape urban responses to climate change. To exploit response opportunities, promote synergies between actions, and reduce conflicts, socio-economic development must be integrated with climate change planning and policies.

Public sector finance can facilitate action, and public resources can be used to generate investment by the private sector (Figure 7). But private sector contributions to mitigation and adaptation should extend beyond financial investment. The private sector should also provide process and product innovation, capacity building, and institutional leadership.

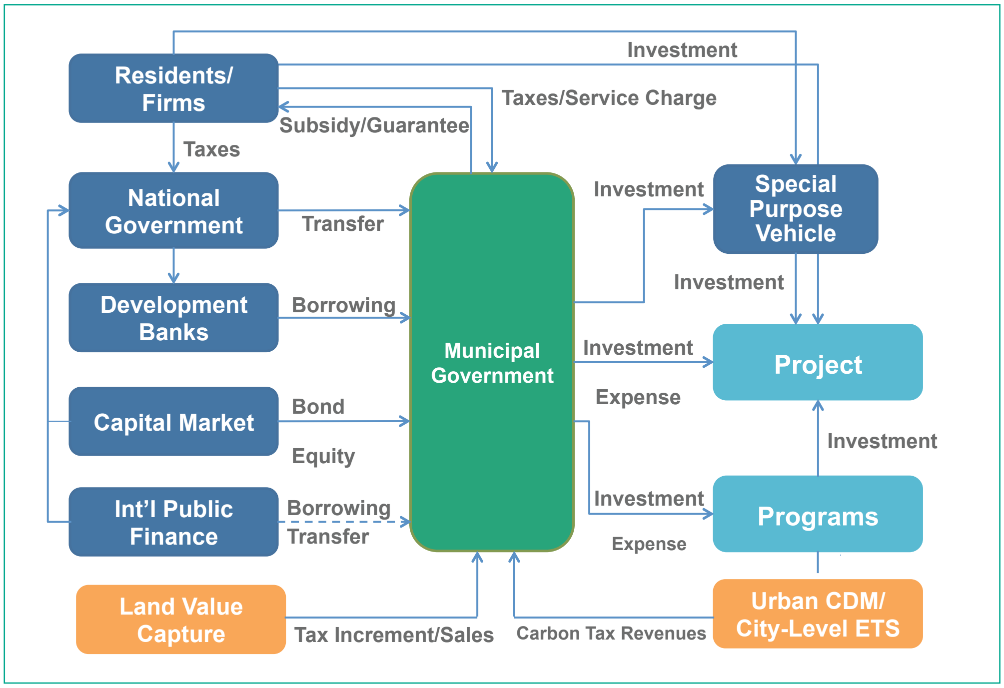


Figure 7: *Opportunities of climate finance for municipalities.*

MAJOR FINDINGS

- Implementing climate change mitigation and adaptation actions in cities can help solve other city-level development challenges, such as major infrastructure deficits. Assessments show that meeting increasing demand will require more than a doubling of annual capital investment in physical infrastructure to over $20 trillion by 2025, mostly in emerging economies. Estimates of global economic costs from urban flooding due to climate change are approximately $1 trillion a year.

- Cities cannot fund climate change responses on their own. Multiple funding sources are needed to deliver the large infrastructure financing that is essential to low-carbon development and climate risk management in cities. Estimates of annual cost of climate change adaptation range between $80-100 billion, of which about 80% will be borne in urbanized areas.

- Public-private partnerships are necessary for effective action. Partnerships should be tailored to the local conditions in order to create institutional and market catalysts for participation.

- Regulatory frameworks should be integrated across city, regional, and national levels in order to provide incentives for the private sector to participate in making cities less carbon-intensive and more climate-resilient. The framework needs to incorporate mandates for local public action along with incentives for private participation and investment in reducing business contributions to emissions.

- Enhancing credit worthiness and building the financial capacity of cities are essential to tapping the full spectrum of resources and raising funds for climate action.

KEY MESSAGES

Financial policies must enable local governments to initiate actions that will minimize the costs of climate impacts. For example, the cost of inaction will be very high for cities located along coastlines and inland waterways due to rising sea levels and increasing risks of flooding.

Climate-related policies should also provide cities with local economic development benefits as cities shift to new infrastructure systems associated with low-carbon development.

Networks of cities play a crucial role in accelerating the diffusion of good ideas and best practices to other cities, both domestically and internationally. Therefore, cities that initiate actions that lead to domestic and international implementation of nationwide climate change programs should be rewarded.

Urban Ecology in a Changing Climate

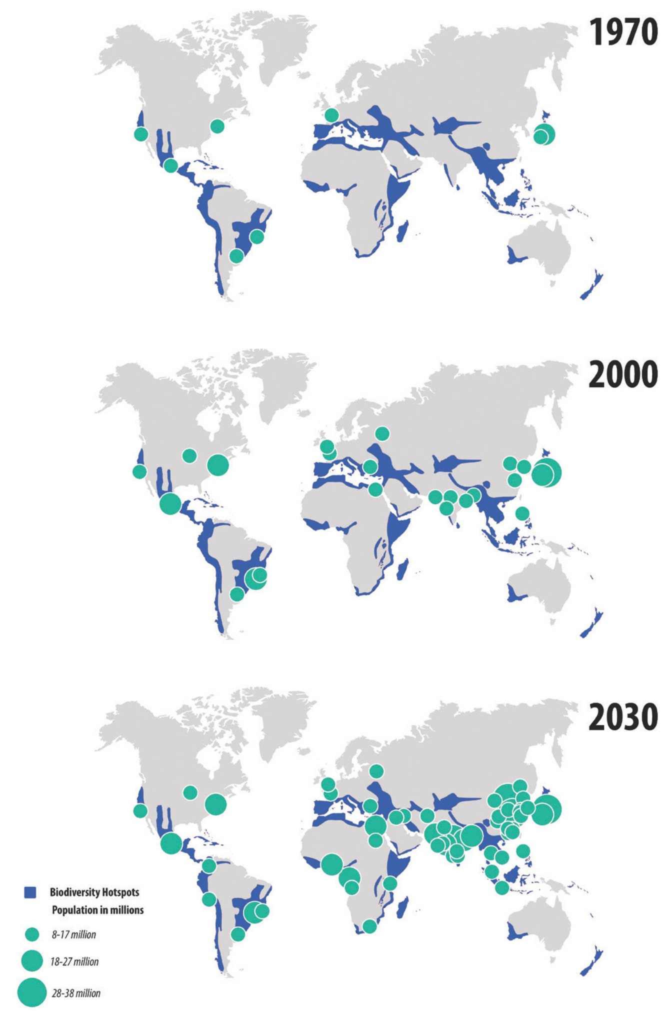


Figure 8: *Urban areas (green) with large populations in 1970, 2000 and 2030 (projected), as examples of urban expansion in global biodiversity hotspots (blue).*

MAJOR FINDINGS

- Urban species and ecosystems are already being affected by climate change.
- Urban ecosystems are rich in biodiversity and provide critical natural capital for climate adaptation and mitigation.
- Climate change and urbanization are likely to increase the vulnerability of biodiversity hotspots, urban species, and critical ecosystem services (Figure 8).
- Investing in urban ecosystems and green infrastructure can provide cost-effective, nature-based solutions for adapting to climate change while also creating opportunities to increase social equity, green economies, and sustainable urban development.
- Enhancing urban ecosystems and green infrastructure investment has multiple co-benefits, including improving quality of life, human health, and social wellbeing.

Almost all of the impacts of climate change have direct or indirect consequences for urban ecosystems, biodiversity, and the critical ecosystem services they provide for human health and wellbeing in cities. These impacts are already occurring in urban ecosystems and their constituent living organisms.

Urban ecosystems and biodiversity have an important and expanding role in helping cities adapt to the changing climate. Harnessing urban biodiversity and ecosystems as adaptation and mitigation solutions will help achieve more resilient, sustainable, and livable outcomes.

Conserving, restoring, and expanding urban ecosystems under mounting climatic and non-climatic urban development pressures will require improved urban and regional planning, policy, governance, and multi-sectoral cooperation.

KEY MESSAGES

Cities should follow a long-term systems approach to ecosystem-based climate adaptation. Such an approach explicitly recognizes the role of critical urban and peri-urban ecosystem services and manages them in order to provide a sustained supply of over time horizons of twenty, fifty, and one hundred years. Ecosystem-based planning strengthens the linkages between urban, peri-urban, and rural ecosystems through planning and management at both urban and regional scales.

The economic benefits of urban biodiversity and ecosystem services should be quantified so that they can be integrated into climate-related urban planning and decision-making. These benefits should incorporate both monetary and non-monetary values of biodiversity and ecosystem services, such as improvements to public health and social equity.

Cities on the Coast: Sea Level Rise, Storms, and Flooding

Coastal cities have lived with extreme climate events since the onset of urbanization, but climatic change and rapid urban development are amplifying the challenge of managing risks. Some coastal cities are already experiencing losses during extreme events related to sea level rise. Meanwhile, urban expansion and changes and intensification in land use put growing pressure on sensitive coastal environments through pollution and habitat loss.

The concentration of people, infrastructure, economic activity, and ecology within the coastal zone merits specific consideration of hazards exacerbated by a changing climate. Major coastal cities often locate valuable assets along the waterfront or within the 100-year flood zone, including port facilities, transport and utilities infrastructure, schools, hospitals, and other long-lived structures. These assets are potentially at risk for both short-term flooding and permanent inundation.

MAJOR FINDINGS

- Coastal cities are already exposed to storm surges, erosion, and saltwater intrusion (Figure 9). Climate change and sea level rise will likely exacerbate these hazards. Assessments show that the value of assets at risk in large port cities is estimated to exceeded $3.0 trillion USD (5% of Gross World Product) in 2005.

- Expansion of coastal cities is expected to continue over the 21st century, with over half the global population living in cities in the coastal zone by mid-21st century. Annual coastal flood losses could reach $71 billion by 2100.

- Climate-induced changes will affect marine ecosystems, aquifers used for urban water supplies, the built environment, transportation, and economic activities, particularly following extreme storm events. Critical infrastructure and precariously built housing in flood zones are vulnerable.

- Increasing shoreline protection can be accomplished by either building defensive structures or by adopting more natural solutions, such as preserving and restoring wetlands or building dunes. Modifying structures and lifestyles to "live with water" and maintain higher resiliency are key adaptive measures.

KEY MESSAGES

Coastal cities must be keenly aware of the rates of local and global sea level rise and future sea level rise projections, as well as emerging science that might indicate more rapid rates of (or potentially slower rates) of sea level rise.

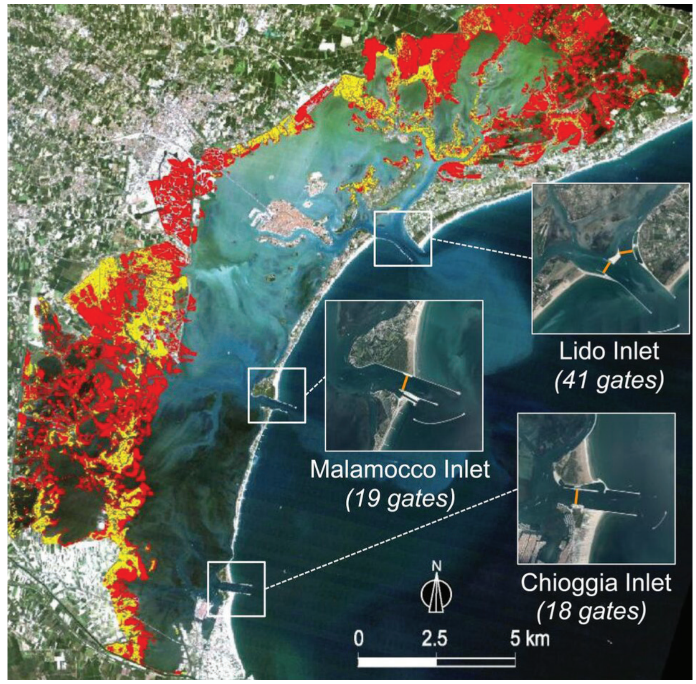


Figure 9: *The MOSE project for the defense of the City of Venice from high tides. Yellow, marsh areas surviving at the beginning of the 21st century; red, marshes that have disappeared over the course of the 20th century. Source: Modified from Consorzio Venezia Nuova - Servizio Informativo.*

An adaptive approach to coastal management will maintain flexibility to accommodate changing conditions over time. This involves implementing adaptation measures with co-benefits for the built environment, ecosystems, and human systems. An adaptive strategy requires monitoring changing conditions and refining measures as more up-to-date information becomes available.

Simple, less costly measures can be implemented in the short term, while assessing future projects. Land-use planning for sustainable infrastructure development in low-lying coastal areas should be an important priority. Further, cities need to consider transformative adaptation, such as large-scale relocation of people and infrastructure with accompanying restoration of coastal ecosystems.

Delivering integrated and adaptive responses will require robust coordination and cooperation on coastal management issues. This must be fostered among all levels of local, regional, and national governing agencies, and include engagement with other stakeholders.

Managing Threats to Human Health

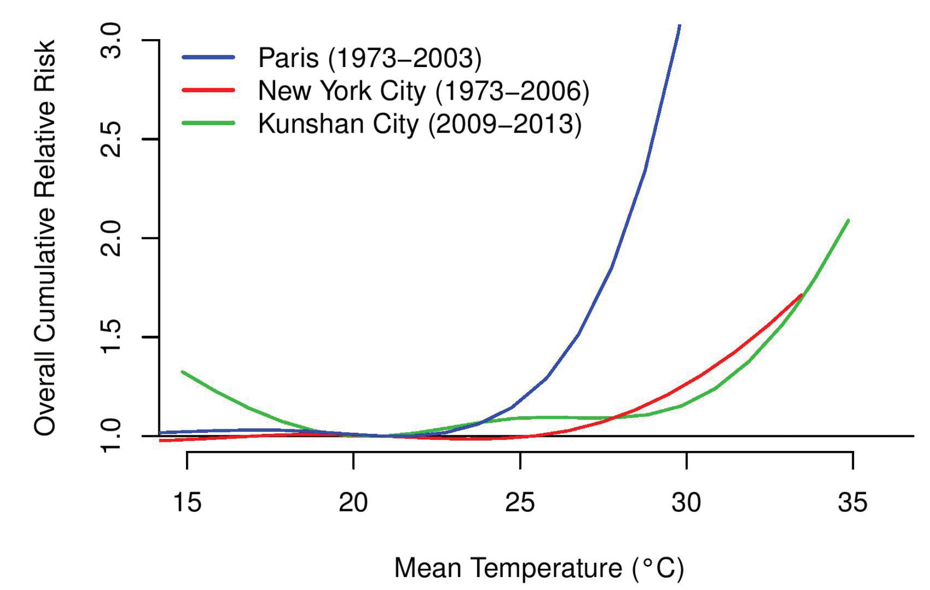


Figure 10: *Overall cumulative heat-mortality relationships in Paris (France), New York City (USA), and Kunshan City (China).*

Climate change and extreme events are increasing risks of disease and injury in many cities. Urban health systems have an important role to play in preparing for these exacerbated risks. Climate risk information and early warning systems for adverse health outcomes are needed to enable interventions. An increasing number of cities are engaging with health adaptation planning, but health departments of all cities need to be prepared.

MAJOR FINDINGS

- Storms, floods, heat extremes, and landslides are among the most important weather-related health hazards in cities (Figure 10). Climate change will increase the risks of morbidity and mortality in urban areas due to greater frequency of weather extremes. Children, the elderly, the sick, and the poor in urban areas are particularly vulnerable to extreme climate events.

- Some chronic health conditions (e.g., respiratory and heat-related illnesses) and infectious diseases will be exacerbated by climate change. These conditions and diseases are often prevalent in urban areas.

- The public's health in cities is highly sensitive to the ways in which climate extremes disrupt buildings, transportation, waste management, water supply and drainage systems, electricity, and fuel supplies. Making urban infrastructure more resilient will lead to better health outcomes, both during and following climate events.

- Health impacts in cities can be reduced by adopting "low-regret" adaptation strategies in the health system, and throughout other sectors, such as water resources, wastewater and sanitation, environmental protection, and urban planning.

- Actions aimed primarily at reducing greenhouse gas emissions in cities can also bring immediate local health benefits and reduced costs to the health system through a range of pathways, including reduced air pollution, improved access to green space, and opportunities for active transportation on foot or bicycle.

KEY MESSAGES

In the near term, improving basic public health and health care services; developing and implementing early warning systems; and training citizens' groups in disaster preparedness, recovery, and resilience are effective adaptation measures.

The public health sector, municipal governments, and the climate change community should work together to integrate health as a key goal in the policies, plans and programs of all city sectors.

Connections between climate change and health should be made clear to public health practitioners, city planners, policy-makers, and to the general public.

Housing and Low-Income Communities

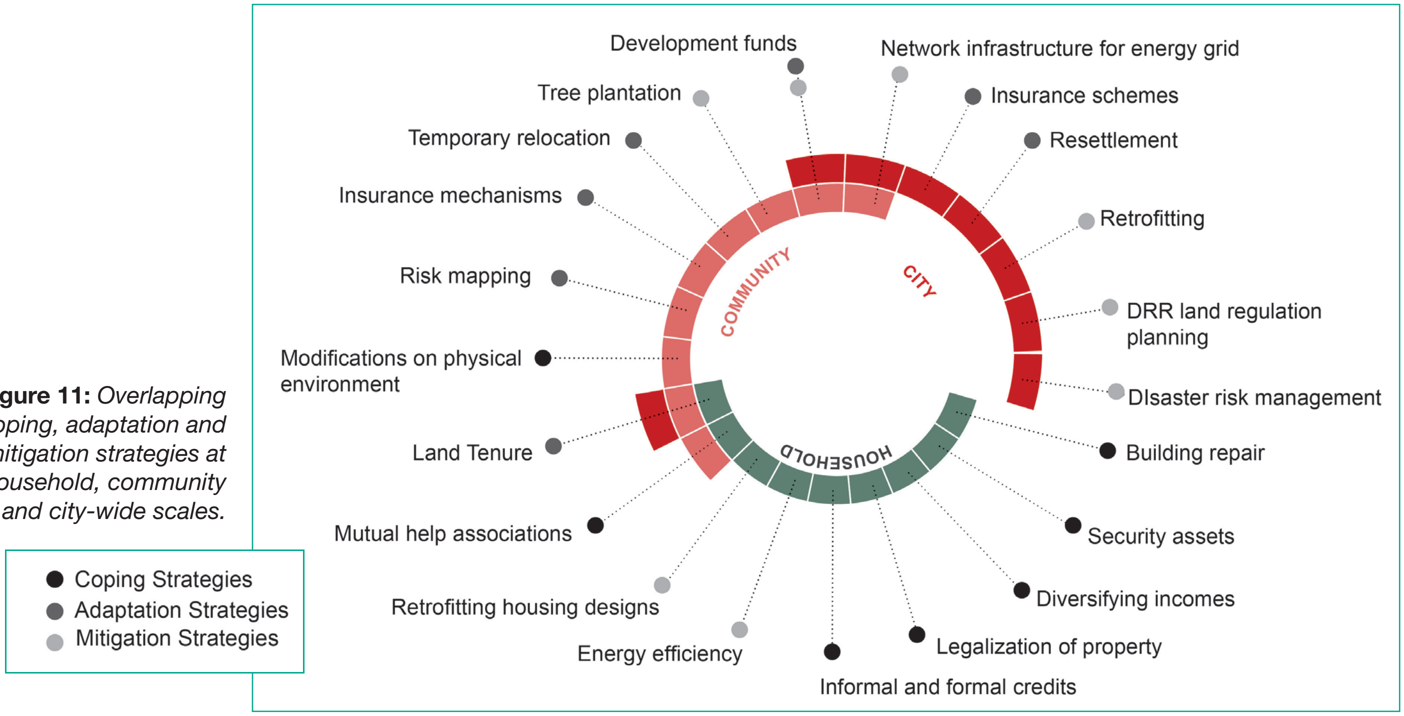


Figure 11: *Overlapping coping, adaptation and mitigation strategies at household, community and city-wide scales.*

Addressing vulnerability and exposure in the urban housing sector can contribute to the wellbeing of residents. This is especially true in informal settlements, where extreme climate events present the greatest risks. Understanding the impacts of mitigation and adaptation strategies on the housing sector will help decision-makers make choices that improve quality of life and close development and equity gaps in cities (Figure 11).

MAJOR FINDINGS

- The effects of hazards, people's exposure, and their vulnerability collectively determine levels of risk. Risks are associated with specific social and physical geographies within each city. Mapping risks and developing early warning systems—especially for informal settlements—can provide information that decision-makers and stakeholders need to reduce vulnerability.
- Developed countries account for the majority of the world's energy demand related to buildings. Incentives and other measures are enabling large-scale investments in mass-retrofitting programs in higher-income cities.
- Housing construction in low- and middle-income countries is focused on meeting demand for over 500 million more people by 2050. Efficient, cost-effective, and adaptive building technologies can avoid locking in carbon-intensive and non-resilient options.
- Access to safe and secure land is a key measure for reducing risk in cities. Groups that are already disadvantaged in regard to housing and land tenure are especially vulnerable to climate.
- Among informal settlements, successful adaptation depends upon addressing needs for climate-related expertise, resources, and risk-reducing infrastructure.

KEY MESSAGES

City managers should work with the informal sector to improve safety in relation to climate extremes. Informal economic activities are often highly vulnerable to climate impacts, yet they are crucial to economies in low- and middle-income cities. Therefore, costs to the urban poor and their communities—both direct and indirect—should be included in loss and damage assessments in order to accurately reflect the full range of impacts on the most vulnerable urban residents and the city as a whole.

Widespread implementation of flood and property insurance in informal settlements can help reduce their high reliance on third-party subsidies and, hence, enhance their climate change resilience. This requires efforts to overcome the lack of insurance organization, and limited demand for insurance within these communities.

Retrofits to housing that improve resilience create co-benefits, such as more dignified housing, improvements to health, and enhanced quality of public spaces. Meanwhile, mitigating greenhouse gas emissions in the housing sector can create local jobs in production, operations, and maintenance, especially in low-income countries and informal settlements.

Energy Transformations in Cities

Demands on urban energy supply are projected to grow exponentially due to the growth trends in urbanization and the size of cities, industrialization, technological advancement, and wealth. Increasing energy requirements are associated with rising demands for vital services including electricity, water supply, transportation, buildings, communication, food, health, and parks and recreation.

With climate change, the urban energy sector is facing three major challenges. The first is to meet the rising demand for energy in rapidly urbanizing countries without locking into high carbon-intensive fuel such as coal. The second is to build resilient urban energy systems that can withstand and recover from the impacts of increasing extreme climate events. The third is to provide cities in low-income countries with modern energy systems while replacing traditional fuel sources such as biomass.

MAJOR FINDINGS

- Urbanization has clear links to energy consumption in low-income countries. Urban areas in high-income countries generally use less energy per capita than non-urban areas due to the economies of scale associated with higher density.
- Current trends in global urbanization and energy consumption show increasing use of fossil fuels, including coal, particularly in rapidly urbanizing parts of the world.
- Key challenges facing the urban energy supply sector include reducing environmental impacts, such as air pollution, the urban heat island effect, and greenhouse gas emissions; providing equal access to energy; and ensuring energy security and resilience in a changing climate.
- While numerous examples of energy-related mitigation policies exist across the globe, less attention has been given to adaptation policies. Research suggests that radical changes in the energy supply sector, customer behavior, and the built environment are needed to meet the key challenges.
- Scenario research that analyzes energy options requires more integrated assessment of the synergies and tradeoffs in meeting multiple goals: reducing greenhouse gases, increasing equity in energy access, and improving energy security.

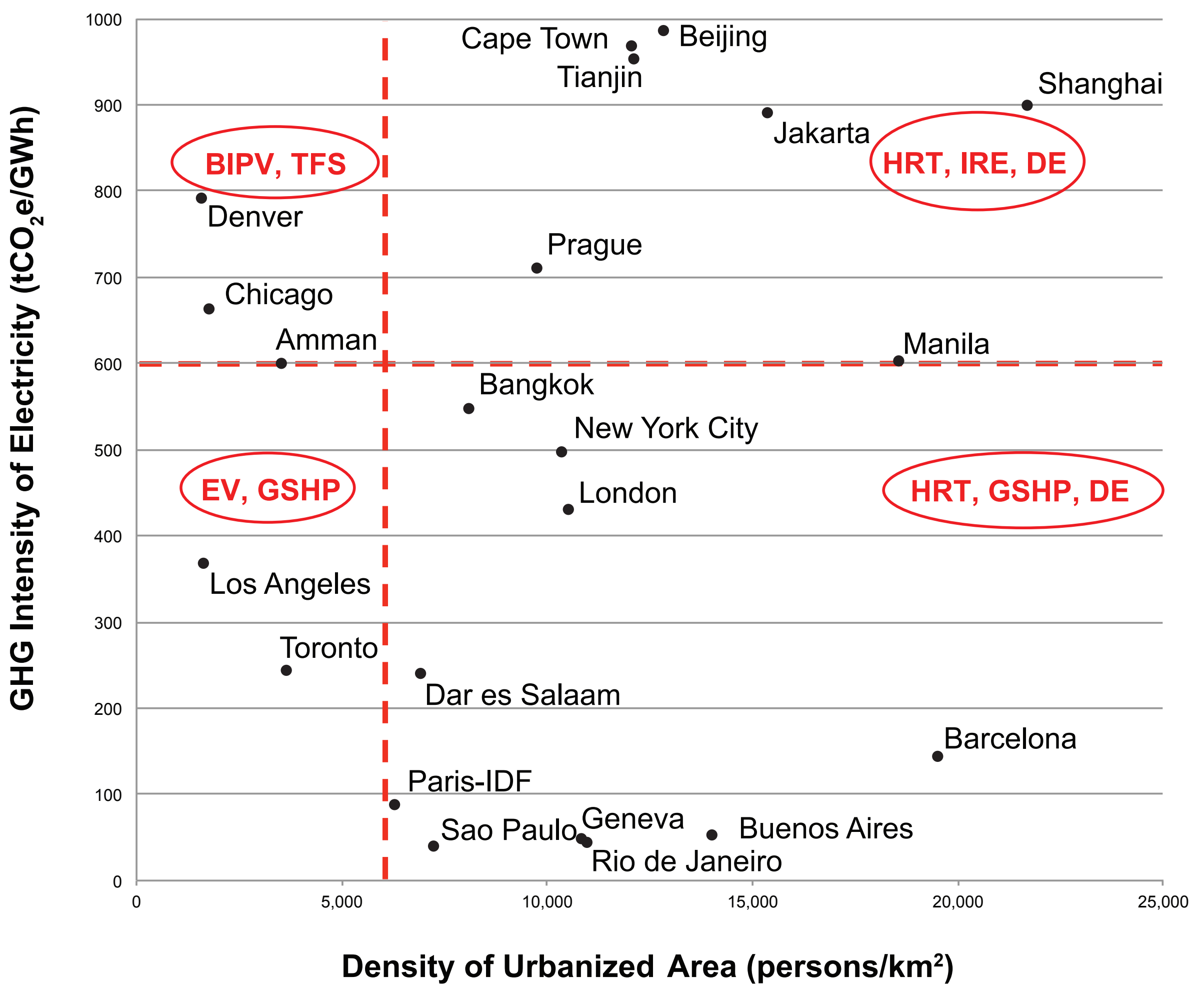
KEY MESSAGES

In the coming decades, rapid population growth, urbanization, and climate change will impose intensifying stresses on existing and not-yet-built energy infrastructure. The rising demand for energy services—e.g., mobility, water and space heating, refrigeration, air conditioning, communications, lighting, and construction—in an era of enhanced climate variation poses significant challenges for all cities.

Depending on the type, intensity, duration, and predictability of climate impacts on natural, social, and built and technological systems, threats to the urban energy supply sector will vary from city to city. Local jurisdictions need to evaluate vulnerability and improve resilience to multiple climate impacts and extreme weather events.

Yet future low-carbon transitions may also differ from previous energy transitions because future transitions may be motivated more by changes in governance and environmental concerns than by the socio-economic and behavioral demands of the past. Unfortunately, the governance of urban energy supply varies dramatically across nations and sometimes within nations, making universal recommendations for institutions and policies difficult, if not impossible. Given that energy sector institutions and activities have varying boundaries and jurisdictions, there is a need for stakeholder engagement across the matrix of institutions to cope with future challenges in both the short and long term.

In order to achieve global greenhouse gas emission reductions through the modification of energy use at the urban scale, it is critical to develop an urban registry that has a typology of cities and indicators for both energy use and greenhouse gas emissions (Figure 12). This will help cities benchmark and compare their accomplishments and better understand the mitigation potential of cities worldwide.



BIPV	Building Integrated Photovoltaics
DE	District Energy
EV	Electric Vehicles
GSHP	Ground Source Heat Pumps
HRT	Heavy Rapid Transit
IRE	Import Renewable Electricity
TFS	Transportation Fuel Substitution

Figure 12: *Low-carbon infrastructure strategies tailored to different cities based on urban population density and average GHG intensity of existing electricity supply. Source: Adapted from Kennedy et al., 2014.*

Transport as Climate Challenge and Solution

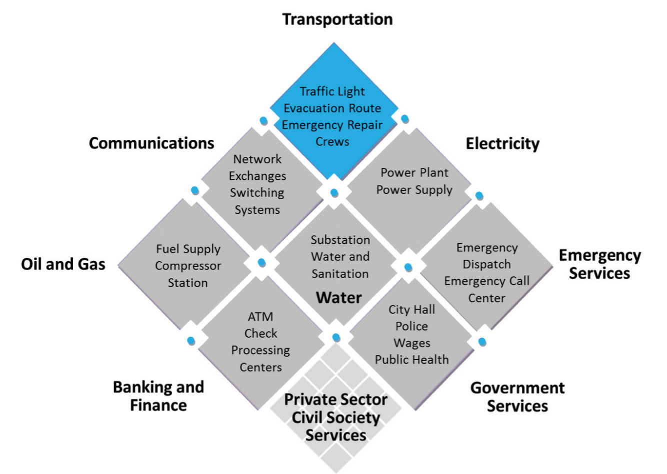


Figure 13: *Urban transport's interconnectivity with other urban systems Source: Adapted from Melillo et al., 2014.*

Urban transport systems are major emitters of greenhouse gases and are essential to developing resilience to climate impacts. At the same time cities need to move forward quickly to adopt a new paradigm that ensures access to clean, safe, and affordable mobility for all.

In middle-income countries, rising incomes are spurring demand for low-cost vehicles and, together with rapid and sprawling urbanization and segregated land use, are posing unprecedented challenges to sustainable development while contributing to climate change.

Expanded climate-related financing mechanisms are being developed at national and international levels such as the Green Climate Fund. Local policymakers should prepare the institutional capacity and policy frameworks needed to access financing for low-carbon and resilient transport.

MAJOR FINDINGS

- Cities account for over 70 percent of greenhouse gas emissions with a significant proportion due to urban transport choices. The transport sector directly accounted for nearly 30% of total end-use energy-related CO_2 emissions. Of these, direct emissions from urban transport account for 40%.
- Urban transport emissions are growing at two to three percent annually. The majority of emissions from urban transport is from higher-income countries. In contrast, 90% of the growth in emissions is from transport systems in lower-income countries.
- Climate-related shocks to urban transportation have economy-wide impacts, beyond disruptions to the movement of people and goods. The interdependencies between transportation and other economic, social, and environmental sectors can lead to citywide impacts (Figure 13).
- Integrating climate risk reduction into transport planning and management is necessary in spatial planning and land use regulations. Accounting for these vulnerabilities in transport decisions can ensure that residential and economic activities are concentrated in low-risk zones.
- Low-carbon transport systems yield co-benefits that can reduce implementation costs, yet policymakers often need more than a good economic case to capture potential savings.
- Integrated low-carbon transport strategies—Avoid-Shift-Improve—involve avoiding travel through improved mixed land use planning and other measures; shifting passengers to more efficient modes through provision of high-quality, high-capacity mass transit systems; and improving vehicle design and propulsion technologies to reduce fuel use.
- Designing and implementing risk-reduction solutions and mitigation strategies require supportive policy and public-private investments. Key ingredients include employing market-based mechanisms; promoting information and communication technologies; building synergies across land use and transport planning; and refining regulations to encourage mass transit and non-motorized modes.

KEY MESSAGES

Co-benefits such as improved public health, better air quality, reduced congestion, mass transit development, and sustainable infrastructure can make low-carbon transport more affordable and sustainable, and can yield significant urban development advantages. For many transport policymakers, co-benefits are primary entry points for reducing greenhouse gas emissions. At the same time, policymakers should find innovative ways to price the externalities—the unattributed costs—of carbon-based fuels.

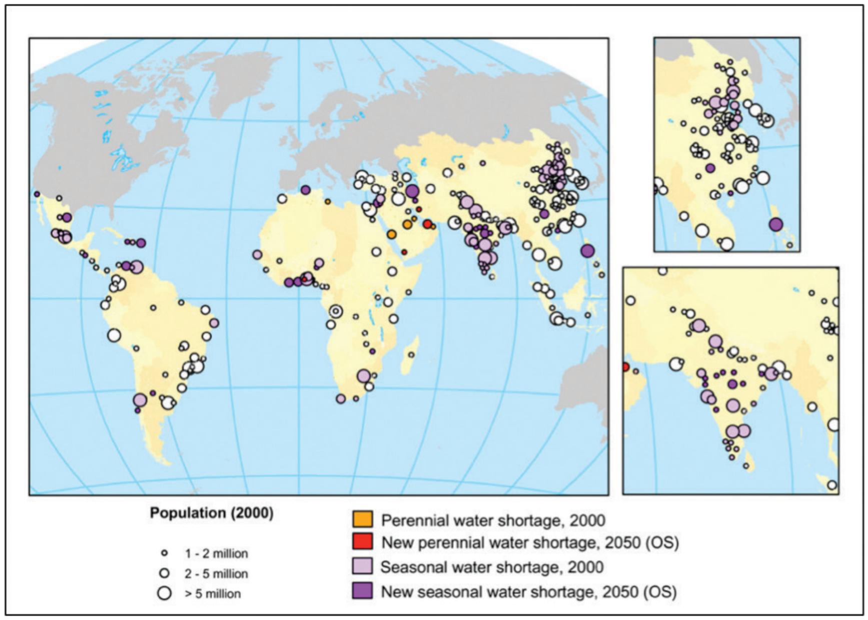
The interdependencies between transport and other urban sectors mean that disruptions to transport can have citywide impacts. To minimize disruptions due to these interdependencies, policymakers should take a systems approach to risk management that explicitly addresses the interconnectedness between climate, transport, and other relevant urban sectors.

Low-carbon transport should also be socially inclusive, as social equity can improve a city's resilience to climate change impacts. Automobile-focused urban transport systems fail to provide mobility for significant segments of urban populations. Women, the elderly, the poor, non-drivers, and disadvantaged people need urban transport systems that go beyond enabling mobility to fostering social mobility as well.

Sustaining Water Security

In regard to climate change, water is both a resource and a hazard. As a resource, good quality water is basic to the wellbeing of the ever-increasing number of people living in cities. Water is also critical for many economic activities, including peri-urban agriculture, food and beverage production, and industry. However, excess precipitation or drought can lead to hazards ranging from increased concentrations of pollutants—with negative health consequences, a lack of adequate water flow for sewerage, and flood-related damage to physical assets.

Projected deficits in the future of urban water supplies will likely have a major impact on both water availability and costs. Decisions taken now will have an important influence on future water supply for industry, domestic use, and agriculture.



Robert I. McDonald et al. PNAS 2011;108:6312-6317

Figure 14: *Distribution of large cities (>1 million population in 2000) and their water shortage status in 2000 and 2050. Gray areas are outside the study area.*

MAJOR FINDINGS

- The impacts of climate change put additional pressure on existing urban water systems and can lead to negative impacts for human health and wellbeing, economies, and the environment (Figure 14). Such impacts include increased frequency of extreme weather events leading to large volumes of storm water runoff, rising sea levels, and changes in surface water and groundwater.
- A lack of urban water security, particularly in lower-income countries, is an ongoing challenge. Many cities struggle to deliver even basic services to their residents, especially those living in informal settlements. As cities grow, demand and competition for limited water resources will increase, and climate changes are very likely to make these pressures worse in many urban areas.
- Water security challenges extend to peri-urban areas as well, where pressure on resources is acute, and where there are often overlapping governance and administrative regimes.
- Governance systems have largely failed to adequately address the challenges that climate change poses to urban water security. Failure is often driven by a lack of coherent and responsive policy, limited technical capacity to plan for adaptation, limited resources to invest in projects, lack of coordination, and low levels of political will and public interest.

KEY MESSAGES

Adaptation strategies for urban water resources will be unique to each city, since they depend heavily on local conditions. Understanding the local context is essential to adapting water systems in ways that address both current and future climate risks.

Acting now can minimize negative impacts in the long term. Master planning should anticipate projected changes over a timeframe of more than fifty years. Yet, in the context of an uncertain future, finance and investment should focus on low-regret options that promote both water security and economic development, and policies should be flexible and responsive to changes and new information that come to light over time.

Many different public and private stakeholders influence the management of water, wastewater, storm water, and sanitation. For example, land use decisions have long lasting consequences for drainage, infrastructure planning, and energy costs related to water supply and treatment. Therefore, adapting to the changing climate requires effective governance, and coordination and collaboration among a variety of stakeholders and communities.

Cities should capture co-benefits in water management whenever possible. Cities might benefit from low-carbon energy production and improved health with wastewater treatment. Investment strategies should include the application of life-cycle analysis to water supply, treatment, and drainage; use of anaerobic reactors to improve the balance between energy conservation and wastewater treatment; elimination of high-energy options, such as inter-basin transfers of water wherever alternative sources are available; and recovering biogas produced by wastewater.

Managing and Utilizing Solid Waste

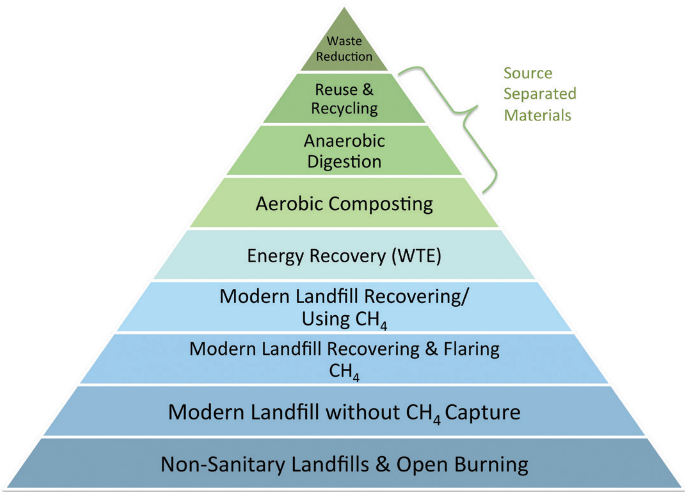


Figure 15: *The hierarchy of sustainable solid waste management. Source: Kaufman and Themelis, 2010.*

Municipal solid waste management is inextricably linked to increasing urbanization, development, and climate change. The municipal authority's ability to improve solid waste management also provides large opportunities to mitigate climate change and generate co-benefits, such as improved public health and local environmental conservation.

Driven by urban population growth, rising rates of waste generation will severely strain existing municipal solid waste infrastructure in low and middle-income countries. In most of these countries, the challenge is focused on effective waste collection and improving waste treatment systems to reduce greenhouse gas emissions. In contrast, high-income countries can improve waste recovery through reuse and recycling, and promote upstream interventions to prevent waste at the source.

Because stakeholder involvement, economic interventions, and institutional capacity are all important for enhancing the solid waste management, integrated approaches involving multiple technical, environmental, social, and economic efforts will be necessary.

MAJOR FINDINGS

- Globally, solid waste generation was about 1.3 billion tons in 2010. Due to population growth and rising standards of living worldwide, waste generation is likely to increase significantly by 2100. A large majority of this increase will come from cities in low- and middle-income countries, where per capita waste generation is expected to grow.
- Up to three to five percent of global greenhouse gas emissions come from improper waste management. The majority of these emissions are methane—a gas with high greenhouse potential—that is produced in landfills. Landfills, therefore, present significant opportunities to reduce greenhouse gas emissions in high- and middle-income countries.
- Even though waste generation increases with affluence and urbanization, greenhouse gas emissions from municipal waste systems are lower in more affluent cities. In European and North American cities, greenhouse gas emissions from waste sector account for 2–4 percent of the total urban emissions. These shares are smaller than in African and South American cities, where emissions from waste sector are 4–9 percent of the total urban emissions. This is because more affluent cities tend to have the necessary infrastructure to reduce methane emissions from municipal solid waste
- In low- and middle-income countries, solid waste management represents 3–15 percent of city budgets, with 80–90 percent of the funds spent on waste collection. Even so, collection coverage ranges from only 25–75 percent. The primary means of waste disposal is open dumping, which severely compromises public health.
- Landfill gas-to-energy is an economical technique for reducing greenhouse gas emissions from the solid sector. This approach provides high potential to reduce emissions at a cost of less than US$10/tCO2-eq. However, gas-to-energy technology can be employed only at properly maintained landfills and managed dumpsites, and social aspects of deployment need to be considered.

KEY MESSAGES

Reducing greenhouse gas emissions in the waste sector can improve public health; improve quality of life; and reduce local pollution in the air, water, and land while providing livelihood opportunities to the urban poor. Cities should exploit the low-hanging fruit for achieving emissions reduction goals by using existing technologies to reduce methane emissions from landfills. In low-and middle-income countries, the best opportunities involve increasing the rates of waste collection, building and maintaining sanitary landfills, recovering materials and energy by increasing recycling rates, and adopting waste-to-energy technologies. Resource managers in all cities should consider options such as reduce, re-use, recycle, and energy recovery in the waste management hierarchy.

Urban Governance for a Changing Climate

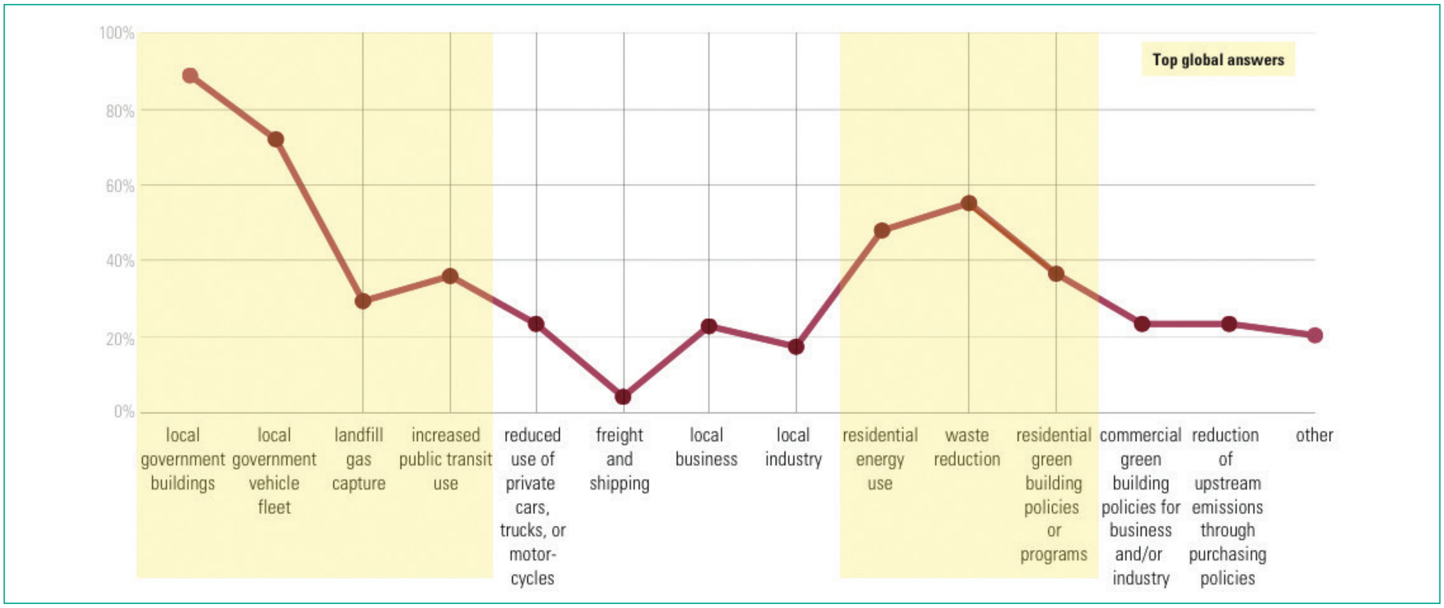


Figure 16: *Mitigation interventions and uptake by cities resulting in measurable emission reductions. Source: Aylett, 2014.*

Greenhouse gas emissions and climate risks in cities are not only local government concerns. They challenge a range of actors across jurisdictions to create coalitions for climate governance. Urban climate change governance occurs within a broader socio-economic and political context, with actors and institutions at a multitude of scales shaping the effectiveness of urban-scale interventions. These interventions may be particularly powerful if they are integrated with co-benefits related to other development priorities, creating urban systems (both built and institutional) that are able to withstand, adapt to, and recover from climate-related hazards.

Collaborative, equitable, and informed decision-making is needed in order to enable transformative responses to climate change, as well as fundamental changes in energy and land-use regimes, growth ethos, production and consumption, lifestyles, and worldviews. Leadership, legal frameworks, public participation mechanisms, information sharing, and financial resources all work to shape the form and effectiveness of urban climate change governance.

MAJOR FINDINGS

- While jurisdiction over many dimensions of climate change adaptation and mitigation resides at the national level, along with the relevant technical and financial capacities, comprehensive national climate change policy is still lacking in most countries. Despite this deficiency, municipal, state, and provincial governmental and non-governmental actors are taking action to address climate change (Figure 16).
- Urban climate change governance consists not only of decisions made by government actors, but also by non-governmental and civil society actors in the city. Participatory processes that engage these interests around a common aim hold the greatest potential to create legitimate, effective response strategies.
- Governance challenges often contribute to gaps between the climate commitments that cities make and the effectiveness of their actions.
- Governance capacity to respond to climate change varies widely within and between low- and high-income cities, creating a profile of different needs and opportunities on a city-by-city basis.
- The challenge of coordinating across the governmental and non-governmental sectors, jurisdictions, and actors that is necessary for transformative urban climate change policies is often not met. Smaller scale, incremental actions controlled by local jurisdictions, single institutions, or private and community actors tend to dominate city-level actions
- Scientific information is necessary for creating a strong foundation for effective urban climate change governance, but governance is needed to apply it. Scientific information needs to be co-generated in order for it to be applied effectively and meet the needs and address the concerns of the range of urban stakeholders.

Urban Governance for a Changing Climate (continued)

KEY MESSAGES

While climate change mitigation and adaptation have become a pressing issue for cities, governance challenges have led to policy responses that are mostly incremental and fragmented. Many cities are integrating mitigation and adaptation, but fewer are embarking on the more transformative strategies required to trigger a fundamental change towards sustainable and climate-resilient urban development pathways.

The drivers, dynamics, and consequences of climate change cut across jurisdictional boundaries and require collaborative governance across governmental and non-governmental sectors, actors, administrative boundaries, and jurisdictions. Although there is no single governance solution to climate change, longer planning timescales, coordination and participation among multiple actors, and flexible, adaptive governance arrangements may lead to more effective urban climate governance.

Urban climate change governance should incorporate principles of justice in order that inequities in cities are not reproduced. Therefore, justice in urban climate change governance requires that vulnerable groups are represented in adaptation and mitigation planning processes; priority framing and setting recognize the particular needs of vulnerable groups; and actions taken to respond to climate change enhance the rights and assets of vulnerable groups.

Rio de Janeiro. Photo by Somayya Ali Ibrahim.

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ARC3.2 CASE STUDIES

The ARC3.2 Case Study Docking Station presents over 100 examples of what cities are doing about climate change on the ground, across a diverse set of urban challenges and opportunities. They are included in the ARC3.2 volume and incorporated into an online website, (www.uccrn.org/casestudies), a searchable database that allows exploration and examination. The ARC3.2 Case Study Docking Station is designed to inform research and practice on climate change and cities by contributing to scientifically valid comparisons across a range of social, biophysical, cultural, economic, and political factors.

UCCRN Case Study Docking Station Team: Martin Lehmann, David C. Major, Patrick A. Driscoll, Somayya Ali Ibrahim, Wim Debucquoy, Jovana Milić, Samuel Schlecht, Megi Zhamo, Jonah Garnick, Stephen Solecki, Annel Hernandez

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UCCRN Regional Hubs

UCCRN Regional Hubs are being established in Europe, Latin America, Africa, Australia, and Asia. The Hubs promote enhanced opportunities for urban climate change adaptation and mitigation knowledge and information transfer, both within and across cities, by engaging in on-going dialogue between scholars, experts, urban decision-makers, and stakeholders.

The UCCRN European Hub was launched in Paris in July 2015, in partnership with the Centre National de la Recherche Scientifique, University Pierre et Marie Curie, and l'Atelier International du Grand Paris. Co-Directors are Dr. Chantal Pacteau and Dr. Luc Abbadie.

The UCCRN Latin American Hub was launched in Rio de Janeiro in October 2015, with Instituto Oswaldo Cruz at FIOCRUZ, Universidade Federal do Rio de Janeiro, and the City of Rio de Janeiro. Co-Directors are Dr. Martha Barata and Dr. Emilio La Rovere.

The UCCRN is in discussion to establish Regional Hubs in Durban, Melbourne/Sydney/Canberra, Bangkok, Aalborg, São Paulo, and others.

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URBAN CLIMATE CHANGE RESEARCH NETWORK

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