

Commissioned Paper 1

Towards a Novel Assessment Framework for Cities and Climate Change

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The IPCC has expressed interest in learning about assessment frameworks that have particular relevance for cities and climate change. In response, the goals of this commissioned paper of the IPCC Conference on Cities and Climate Change Scientific Steering Committee are to:

- 1 Review past assessments, especially those related to cities and urban areas.
- 2 Identify needs of user communities.
- 3 Develop ideas for alternative novel assessment frameworks and procedures.

1. REVIEW OF PAST ASSESSMENTS

Many major climate assessments have been conducted in recent years at global, national, and regional scales. Some of these cover a wide range of topics, while others focus on a particular area such as oceans or biodiversity. Assessments that explicitly consider climate change and urban areas include those of the IPCC AR5 (including components of Working Groups II and III), the Urban Climate Change Research Network (UCCRN), and the World Bank.

For assessments to be successful, they must be salient, credible and legitimate (Cash et al., 2002). In order for an assessment to be salient, the research being considered must be relevant to the intended audience. Therefore user knowledge needs should be explicitly solicited and answered. Use of peer-reviewed research and vetting of authors helps to create credibility, while the inclusion of scientists from a range of geographies and development status (i.e., low, moderate and high-income settings) builds legitimacy and ensures fairness when creating an assessment. By looking at how these assessments were created and at who created them, we can determine if they are credible and legitimate. By looking at the relationship between the assessment's creators and stakeholders, we can see if the assessments are also salient.

Here we compare several important assessments that have explicitly considered cities and urban areas. Comparisons are made regarding their framework, organization, process, outcomes,

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impacts, challenges, limitations, and utility. The following questions were posed about the engagement of the assessments with stakeholders and scientific literature, the process by which they were carried out, and their governance structure:

- What is the scale of the assessment including geographical, sectoral, and systemic extents?
- What topics does the assessment cover, and how are topics selected? What topics were not included?
- What is the relationship between the authors and the stakeholders? Is there a knowledge co-generation process embedded in the assessment methodology?
- Is there a benchmarking function? And if so, is there a consistent methodology for each assessment iteration?
- How were the authors and other participants chosen?
- Does the report deal only with peer-reviewed sources or does it also include gray literature? How is gray literature defined?
- Is the assessment peer-reviewed? Is there a public review process?
- How many rounds of review does the assessment go through before public release?
- Is the assessment approved, and if so, by whom? Is there a formal process of approval?
- How is it funded?
- What is the governance structure of the assessment?
- How are issues of scientific uncertainty, likelihood, and probability incorporated?
- How are science-based conflicts dealt with?

A. IPCC The Fifth Assessment Report (AR5), Working Group II, Chapter 8 and Working Group III, Chapter 12 (2014)

Within the IPCC Fifth Assessment Report, Chapter 8 of Working Group II examines Urban Areas (Revi et al. 2014). This chapter focuses on the potential impacts of climate change on urban centers, populations, and enterprises, initiatives taken to adapt to climate change, and suggested institutional and governance changes that could improve adaptation to climate change. The authors recognize that urban areas range in size – from several thousand inhabitants to several million – and in definition, depending on boundary-setting and national urban policy. There is generally a lack of international agreement in definition of an urban center. Indicators both within and between these urban areas are analyzed throughout the chapter.

Chapter 12 of Working Group III of AR5 also has an explicit urban focus (Seto et al. 2014). The chapter assesses the connection between human settlement growth, infrastructure development and spatial planning, and conditions of GHG emissions and climate mitigation. The intense current level of urbanization and expansion of urban areas are reviewed and the key links between urbanization and GHG emissions are identified.

The IPCC Assessment Reports are funded by national contributions via the United Nations Environment Programme and the World Meteorological Organization and focus on a wide range of topics related to climate change at global and regional scales (IPCC 2013; IPCC 2014a; IPCC 2014b). Assessments are conducted in 7-year cycles. The topics of the assessment are assigned to

three different working groups. The IPCC Working Group I (WG I) assesses the physical scientific aspects of the climate system and climate change. Working Group II (WG II) assesses the vulnerability of socio-economic and natural systems to climate change, negative and positive consequences of climate change, and options for adaptation. It also takes into consideration the inter-relationships among vulnerability, adaptation and sustainable development. Working Group III (WG III) assesses options for mitigating climate change through limiting or preventing greenhouse gas emissions and enhancing activities that remove them from the atmosphere. The IPCC, first established in 1988, utilizes its assessment process to create, compile, and then provide in layman's terms information on climate change to its stakeholders, which are primarily governments, the UN Framework Convention on Climate Change, and non-governmental organizations (NGOs) around the globe.

There is no standard assessment methodology for the IPCC, since the methods are updated as the assessment cycles progress in order to keep up with current research. Authors are selected based on their expertise after a call to governments and IPCC observer organizations for nominations and the submission of detailed CVs. The composition of author teams aims to reflect a range of scientific, technical, and socio-economic views and backgrounds. A comprehensive assessment requires author teams to include a diverse set of authors from different regions and from developed and developing countries to ensure that reports are not biased towards the perspective of any one country or group of countries and that questions of importance to particular regions are not overlooked. The IPCC assessments are developed through multiple rounds of drafting and review. As the culmination of an assessment's development, IPCC member governments endorse the report. The endorsement process is based on interactions between those who will use the report – the governments – and those who write it – the scientists.

The IPCC assessment materials consist of peer-reviewed literature; reports from governments, industry and research institutions; publications by international and other organizations, and conference proceedings. Information about certain experiences and practices in mitigation and adaptation activities in particular may be found in sources other than traditional scientific and technical journals. Such materials may utilize a wide range of quality-assurance mechanisms, including but not limited to formal peer review. Expert reviewers and governments are invited at different stages to comment on the scientific, technical and socio-economic assessment and the overall balance of the drafts. The review process includes wide participation, with hundreds of reviewers critiquing the accuracy and completeness of the scientific assessment contained in the drafts.

Key points related to the IPCC for urban assessments:

- 1) Benchmarking function
- 2) Rigorous review process
- 3) Endorsement by national governments
- 4) Limited focus on cities
- 5) Working Group structure siloes mitigation and adaptation responses

B. Urban Climate Change Research Network (UCCRN) First and Second Assessment Reports on Climate Change and Cities; ARC3.1 (2011) and ARC3.2 (2018)

The goal of the Urban Climate Research Network (UCCRN) Assessment Reports on Climate Change and Cities (ARC3) is to help cities develop effective and efficient climate change mitigation and adaptation policies and programs. By so doing, UCCRN is developing a model of within- and across-city interactions that is multidimensional, i.e., with multiple interactions of horizontal knowledge-sharing from developing to developed cities and vice versa. The UCCRN works simultaneously by knowledge-sharing among small to mid-sized to large to megacities. Free-flowing multidimensional interactions are essential for optimally enhancing science-based climate change response capacities.

Authors defined the topics covered in the first ARC3 (Rosenzweig et al. 2011) based on surveys of city officials and sustainability officers and with the help of the ARC3 Steering Group. ARC3.2 topics were updated based on surveys and on input from several scoping sessions held at large urban climate change conferences around the world where suggestions for topics were solicited.

This process resulted in ARC3 coverage of a broad range of urban climate change topics. These include risk-framing, key urban sectors, and cross-cutting issues. Chapters relate to assessment of urban vulnerability and key climate hazards, mitigation and adaptation responses in urban sectors, and the roles of land use planning and governance in responding to climate change challenges. The second iteration of ARC3, ARC3.2 (Rosenzweig et al. 2018) has double the number of chapters with updated material on certain topics and added chapters on new topics. New topics included in ARC3.2 are Urban Planning and Design; Environmental Equity and Justice; Economics, Finance and the Private Sector; Urban Ecology and Biodiversity; Urban Coastal Zones; Housing and Informal Settlements; and Urban Solid Waste.

Authors are selected from the over 750 members of the UCCRN based on expertise in the topics that arise from stakeholder interactions and surveys. ARC3 uses both peer-reviewed and gray literature; the latter is important since much cutting-edge work on climate change and cities is reported by cities themselves or by city network groups such as C40, ICLEI, and UCLG.

The assessment itself is peer reviewed. ARC3.2 underwent three rounds of rigorous peer-review with each chapter being peer-reviewed by scholars who are subject experts. The reviewers also include stakeholders from major organizations that fund urban and climate change projects, such as the World Bank, UN-Habitat, and UN Environment Programme. City practitioners and policy-makers also review the ARC3 chapters.

In addition to the ARC3.2 assessment, UCCRN has developed a Case Study Docking Station where over 115 case studies, shared throughout the book, can be easily accessed by researchers, practitioners, and policy-makers. The Case Studies display empirical evidence on city efforts on mitigation and adaptation to climate change and address challenges and opportunities for urban areas. These Case Studies address issues that cities face in regard to climate change in social, biophysical, cultural, economic, and political contexts. The Case Study Docking Station is innovative in the research, findings, and related outcomes, which are presented by practitioners

and researchers from the cities themselves. With its searchable database based on key words, the ARC3 Case Study Docking Station provides opportunities for users to extract information based on a process in which there are multiple entry points for the more than 115 studies.

Stakeholder consultations proceed throughout the ARC3 writing process, allowing for flexibility as the assessment is developed. Based on these interactions, ARC3 is structured to communicate to a range of groups important for urban decision-making. These stakeholders include urban practitioners, civil society groups, scholars and city leadership groups. The ARC3.2 *Summary for City Leaders* was released at the Mayors Summit held at the Paris City Hall during COP21 in 2015.

Key UCCRN ARC3 points for effective urban assessments:

- 1) Free-flowing multidimensional stakeholder-scientist interactions essential for optimally enhancing science-based climate change response capacities in cities.
- 2) Benchmarking and updating process highly useful to ensure relevance in on-going assessment process.
- 3) Adaptation and mitigation considered in intertwined approach.
- 4) Case Study Docking Station provides peer-to-peer knowledge sharing.

C. New York State ClimAID Assessment (2011, 2014)

The ClimAID assessment provides information on climate change impacts and adaptation for New York State. The assessment covers the topics of climate risks, vulnerabilities, and adaptation strategies for eight sectors: water resources, coastal zones, ecosystems, agriculture, energy, transportation, telecommunications, and public health. Observed climate trends and future climate projections were developed for seven regions across the state.

To ensure that the information provided by ClimAID was relevant to the climate-related decisions made by practitioners, stakeholder interactions were a key part of the process. Working with the New York State Research and Development Authority (NYSERDA) and the Project Advisory Committee, the sector leaders identified relevant stakeholders from the public sphere (e.g., state and local agencies), nonprofit organizations (e.g., non-governmental community and environmental groups), private-sector entities (e.g., businesses), and academic institutions for each of the sectors, and organized an on-going series of stakeholder interactions. There is a consistent methodology for each iteration of this assessment. As with the original ClimAID assessment in 2011, the 2014 edition provided updated climate risk projections for the seven regions in order to facilitate the ongoing study of the impacts of climate change and how NYS can adapt.

The ClimAID report was prepared by Columbia University, the City University of New York, and Cornell University in the course of performing work contracted for and sponsored by NYSERDA. The authors were chosen by the co-principal investigators and were vetted by New York State officials. The volume was peer-reviewed and included peer-reviewed gray literature on consideration via a case-by-case basis.

Key ClimAID points for effective urban assessments:

- 1) Close and frequent interactions between researchers and stakeholders
- 2) Development of a demand-driven assessment process where the goals, objectives, and specific outcomes were derived from stakeholder interactions.
- 3) Integrated nodal structure of analysis as opposed to linear climate science model projection output driving the process.
- 4) Line-of-sight linkages to other parallel assessment processes at municipal and national scales.

D. World Bank Report – Cities and Climate: Responding to an Urgent Agenda (2011)

The World Bank's 5th Urban Research Symposium on Cities and Climate Change: Responding to an Urgent Agenda, held in Marseille in June 2009, sought to highlight how climate change and urbanization are converging to create one of the greatest challenges of our time. The assessment responded to the recognition that climate change mitigation and adaptation in cities had emerged as a new theme on the global agenda, creating a strong desire among governments, the private sector, and the academic community worldwide to learn from experiences and good practice examples.

The symposium and its accompanying publication made an important contribution to the growing body of knowledge and practice in the area of cities and climate change (Hoornweg et al. 2011). During the three-day symposium, approximately 200 papers were presented to more than 700 participants representing more than 70 countries. As co-organizers, the authors found it very rewarding to have such an audience and to share the wide range of topics discussed, from indicators and measurement to institutions and governance. The publication comprises an edited selection of the papers submitted to the symposium. The entire collection of symposium papers is available as an online resource for interested readers.

Key World Bank Urban Research Symposium points for effective urban assessments:

- 1) Comprehensive integrated and global approach to assessment topic.
- 2) Interactions between research and stakeholder communities from local, national, and international interest groups.
- 3) Extensive post-event information and data hosting online.

2. IDENTIFICATION OF KNOWLEDGE NEEDS OF USER COMMUNITIES

The multiple user communities associated with climate change and cities assessments have a variety of knowledge needs (Table 1). Researchers need to have cutting-edge understanding of the science, identified areas of potential critical unknowns, and associated methodologies to investigate them. For example, recent assessments of sea level rise projections have accelerated the research community to investigate the long tails of the projections and the prospects for high-end, rapid ice melt scenarios. Practitioners need to have actionable, consensus-focused,

evidence-based science to implement in mitigation and adaptation actions. While there is general interest by practitioners in the full range of risks, often they are most interested in cutting-edge projections, information, and data on those conditions with the highest likelihoods and greatest certainty that will affect their cities. City decision-makers need concrete examples of what other cities are doing and how they are and are not being effective. Policy-makers need context and guidance to frame overall directives for cities to follow, not only within the domain of climate change but also with its likely interactions with the complex socio-ecological urban system.

Crucial elements of assessments are those areas in which the knowledge needs of the communities overlap and where they diverge. It is also important to recognize that these domains will shift over time as issues emerge. For example, urban ecology and urban ecosystem services issues within climate assessments were fringe topics in the early 2010s, while today they have moved toward the center of stakeholder interest.

Table 1. Interests and Knowledge Needs of Researchers, Practitioners and Policy-Makers

Researchers	Practitioners	Policy-Makers
Stakeholder-driven agendas	Evidence-based science	Policy options
State-of-the-science methods	Examples from peers	Links to national and international agencies
Focus on emergent elements	Focus on consensus elements	Focus on urban system linkages

3. ALTERNATIVE NOVEL ASSESSMENT FRAMEWORKS AND PROCEDURES

Most fundamentally, city-climate change assessments need to recognize the unique characteristics of cities. As currently constituted, the IPCC structure is not conducive to assessing multifaceted urban systems. In particular, the separation in the IPCC between Impacts, Adaptation, and Vulnerability in Working Group II and Mitigation in Working Group III sets up a silo-ed approach that can actively hold back the development and implementation of effective urban climate change solutions. A range of alternative assessment frameworks and procedures need to be integrated to develop a novel approach for the IPCC to interact within its assessment process moving forward. Key perspectives on this novel approach are emerging.

First, the use of an urban systems approach is essential for assessing climate risks and impacts, as well as adaptation and mitigation opportunities and challenges. Urban systems operate in a variety of ways including simple linear and complex non-linear interactions and responses. Urban system sectors often involve relatively well understood, linearly structured engineering systems but are embedded in complex interdependencies with other sectors, as well as socio-ecological systems with non-linear structures. The systems approach to urban assessments provides a framework for understanding the role of the significant stresses that climate change poses on the operation of urban sectors. This approach facilitates the development of resilience and mitigation metrics, early-warning signals of potential system crises, and pending system tipping points.

The role of technology in the structure, metabolism, and management of cities is profound, and must be taken into account in the ongoing urban and climate change assessment process. The operation and potential failure of the technological systems of cities have important implications for the resilience of urban areas and for their ability to implement the mega-mitigation actions required to achieve the 1.5C temperature target (Solecki et al., 2018). Climate extremes in urban contexts reveal the potential for catastrophic collapse resulting from large-scale disturbances and cascading interdependent system failures.

Equity, environmental justice, formality, and informality must also be critical elements explicitly taken into account in on-going urban assessments. Low-income and low-status groups are the most vulnerable people in urban settings, as they tend to inhabit higher-risk areas prone to flooding and over-heating. Gender must also be critically taken into account. Informal urban systems need to be considered, and mitigation efforts need to be analyzed for their unintended consequences in regard to marginalized urban populations as well.

Finally, planning and governance are key dimensions of cities as socio-ecological systems. Urban climate change governance is a set of formal and informal rules, rule-making systems, and actor networks at all levels (from local to global), both in and outside of government that are established to steer toward mitigation and adapting to climate change (Biermann et al., 2009). Urban climate change governance occurs within the broad context of urban systems, with actors and institutions at a multitude of scales and with a broad spectrum of interests and concerns shaping the effectiveness of intervention.

Urban Climate Spectrum-Nexus Assessment Protocol

Future urban-based climate assessments need to incorporate the range of dimensions described above. These dimensions are relevant to climate change assessments generally and conditions found in city settings, specifically. These dimensions include a range of *spectrum-nexus* considerations that involve both the range of conditions to be assessed and how the interaction and synergies of the conditions will be evaluated. The collective assemblage of these represents the foundation for an advanced urban climate assessment protocol. The relevance of the spectrum-nexus dimensions needs to be considered when defining specific assessment goals and outcomes (Table 2). Collectively, these dimensions illustrate that a salient, credible and legitimate assessment cannot be considered as simply a single assessment, but rather should explicitly define and respond to multiple sets of users.

Table 2. Spectrum-nexus dimensions for urban climate change assessments

ASSESSMENT DIMENSIONS	CONCEPTUAL RANGE	TYPICAL FOCUS OF EXISTING ASSESSMENTS	PREFERRED PRIMARY OPERATIONAL RANGE
<i>Time</i>	Distant Past to Distant Future	Present – 30-80 future	100 years past – 100 years future

<i>Spatial Scale</i>	Household to Global Connections	Municipal	City District to Metropolitan Region
<i>Type of Knowledge</i>	Local – Expert	Expert	Local; local interpreted by experts; Expert
<i>Weather – Climate Data</i>	Everyday Weather to Climate Extremes	Annual Trends to Known Extremes	Seasonal to Known Extremes; Increasingly Practitioner-Policy-Maker Driven
<i>Climate-Urbanization Nexus</i>	Climate-Urban Systems as Separate to Fully Integrated	Climate Systems Act Upon Urban Systems – Impacts	Climate System interacting with Integrated Urban Social, Infrastructure, and Ecological Systems
<i>Urban System</i>	Individual Sector Analysis to Integrative Systems Analysis	Multiple, Single Sector Analysis – e.g. water, energy, etc.	Individual and Integrated Systems illustrate Flow and Cascading Connections
<i>Informal-Formal Nexus</i>	Completely Informal to Completely Formal	Formal Systems and Networks	Recommend Practitioner-Policy-Maker Defined
<i>Confidence</i>	Very High Confidence to Very Low Confidence	Rarely Applied in City Level Assessments	Very High Confidence to Very Low Confidence
<i>Likelihood</i>	Virtually Certain – Exceptionally Unlikely	Very Likely to Very Unlikely	Very Likely – Exceptionally Unlikely

RECOMMENDATIONS

Arising from the review undertaken by this commissioned paper, there are two key activities that will enable progress: novel urban assessment and city science partnerships.

Moving Forward on Novel Urban Assessments

In order for city assessments to be salient, credible, and legitimate, they must be tailored to multiple sets of stakeholders and their needs. The assessment process needs to acknowledge that there are multifaceted needs and interpretations of each assessment based on the different user communities. An innovative assessment process needs to simultaneously assess the needs and

interest area of each user group, the separateness of each group, the overlaps between the groups, the interactions between groups' interests, and the boundary movements of the groups' interest.

The integration of social, ecological, and technological systems in cities provide transformative avenues leading to urban climate adaptation and mitigation. This must be the goal in the next stage of urban climate change assessment. Adaptation and mitigation must be liberated from the predominant silo-ed approaches that have resulted in individualized city approaches to adaptation and mitigation that are extremely limited. Thus, there is a strong need for inter-related approaches to adaptation and mitigation so that these synergistic approaches can minimize unanticipated conflict and avoid lock-in (Urge-Vorsatz et al., 2018).

Given these complexities, it does not necessarily follow that the IPCC itself should take on the mantle of developing and conducting on-going urban climate change assessments. It has very usefully committed to producing a *Special Report on Climate Change and Cities* in the AR7 cycle. We recommend that the IPCC create an alliance with the Urban Climate Change Research Network to provide the on-going benchmarking function of on-going assessment, and that the results of the UCCRN *Third Assessment Report on Climate Change and Cities (ARC3.3)* projected to be completed in time for the *IPCC Special Report on Cities* in order to provide a major input to the planned Special Report.

Science-Policy Linkages and the Role of City Science Partnerships

Promoting effective science-policy and scientist-policymaker-practitioner interaction is a recurring challenge in climate assessment work. Participating individuals often talk at or past one another without really talking to one another. Science-policy, scientist-policy-maker interaction easily can be described as something that needs continual dialogue and engagement. Many points of potential tension and misunderstanding exist and as a result those involved need to constantly talk not only about the content of the conversation but also its context and their own positionality. Like other contentious issues, science-policy linkage discussions simply are never fully settled or resolved but need continual attention and dialogue because the opportunity for failure is always present.

The need for ongoing partnership of cities-focused science bodies or panels to respond to these challenges in cities throughout the world is clear. Modalities of such panels will differ according to local urban contexts, but ensuring that the knowledge base for climate action is available to all cities is essential. An example in a high-income city is the New York Panel on Climate Change, which has served the City of New York as an "independent" science body that directly responds to city science queries and requirements for a decade. The discussion and debate between city officials and panel members typically is cordial but can get contentious and very difficult even as the objective interpretation of the science is maintained. The City "uses" the panel in complex ways and the boundary between the two is fluid and at times porous but is always present. Overall, the panel process has been successful and other cities (and those not as rich in resources) have started to emulate the model.

That said, there is a clear opportunity to push ahead with even a more ambitious proposal that in some ways has already started to form via UCCRN and other city networks. A network of city-science panel partnerships should be created that distributes and shares cutting-edge city relevant

climate science and lessons learned on adaptation and mitigation. UCCRN embodies this spirit via a horizontal network of city practitioner-city based scientist partnerships and Regional Hubs – this process can be greatly extended.

Specific Recommendations:

- 1) Solicit and respond to user needs in an ongoing process throughout assessment.
- 2) Follow an urban systems approach, including sector interdependencies, technology, and governance.
- 3) Consider adaptation and mitigation in an intertwined way to encourage synergies and avoid trade-offs and lock-in.
- 4) Found assessment on explicit principles of equity and environmental justice, formality and informality.
- 5) Link to already in-place ongoing, benchmarked process provided by UCCRN ARC3 to provide input into the IPCC Special Report on Climate Change and Cities in the AR7 cycle.

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