Loughborough University

This item was submitted to Loughborough's Research Repository by the author.
Items in Figshare are protected by copyright, with all rights reserved, unless otherwise indicated.

Interpreting sustainability and resilience in the built environment

PLEASE CITE THE PUBLISHED VERSION

https://doi.org/10.1108/IJDRBE-07-2021-0076

PUBLISHER

Emerald Publishing Limited

VERSION

AM (Accepted Manuscript)

PUBLISHER STATEMENT

This paper was accepted for publication in the journal International Journal of Disaster Resilience in the Built Environment and the definitive published version is available at https://doi.org/10.1108/IJDRBE-07-2021-0076. This author accepted manuscript is deposited under a Creative Commons Attribution Non-commercial 4.0 International (CC BY-NC) licence. This means that anyone may distribute, adapt, and build upon the work for non-commercial purposes, subject to full attribution. If you wish to use this manuscript for commercial purposes, please contact permissions@emerald.com.

LICENCE

CC BY-NC 4.0

REPOSITORY RECORD

Marlow, Elisabeth C, Ksenia Chmutina, and Andrew Dainty. 2022. “Interpreting Sustainability and Resilience in the Built Environment”. Loughborough University. https://hdl.handle.net/2134/18858656.v1.

Accepted for the International Journal of Disaster Resilience in the Built Environment

Interpreting sustainability and resilience in the built environment

Elisabeth C Marlow, Ksenia Chmutina, Andrew R.J Dainty

elisabeth_green@hotmail.com; K.Chmutina@lboro.a.cuk; A.Dainty@mmu.ac.uk

School of Architecture, Building and Civil Engineering, Loughborough University, LE11 3TU, UK; Manchester Metropolitan University, Manchester, M15 6BH, UK

Keywords: Measurement; Interpretations; sustainability; resilience; city; case study

Abstract

Purpose: Conceptual interpretations of sustainability and resilience are widening with discursive use and altering the relationship and understanding of both concepts. By using three city case studies in the USA, this paper considers which conceptual interpretations are operational and what is being measured in the context of city policy, municipal planning and built environment practice. With increasing pressures of urbanisation, it is imperative to consider which conceptual interpretations of resilience and sustainability are being measured in frameworks for the built environment if Risk-Informed Sustainable Development across multiple sectors is to be delivered.

Design/methodology/approach: Three case studies with semi-structured interviews have been thematically analysed to explore how sustainability and resilience have been operationalised at policy, planning and practice levels.

Findings: City policies, municipal planning and practitioners are working with different interpretations. Collectively Risk Informed Sustainable Development is not formally recognised. Policies recognise GHG reductions and natural hazard events; planning guidance stipulates Environmental Impact Assessments based on legal requirements; and practitioners consider passive-survivability and systematic thinking. Across the sectors, the Leadership in Environmental and Energy Assessment Method provides a common foundation but is used with varying requirements.

Practical implications: Decision-makers should incorporate risk-informed sustainable development, update codes of practice and legal requirements leading to exemplary practice becoming normalised.

Social implications: Passive-survivability should be affordable and adopt risk-informed sustainable development principles.

Originality: Three US city case studies with data collected from interviews have been analysed simultaneously at policy, planning and practice levels. Interrelated implications have been outlined on how to improve decision-making of sustainability and resilience across sectors.

1. Introduction

Many interpretations of the concepts of sustainability and resilience are being used in multiple contexts. Such malleability, whilst seen as useful by some (Chmutina at al., 2016), also generates conflicts in decision-making, particularly as policy shifts occur (Vale, 2014; UNDRR, 2019; Marlow, 2020). The concept of sustainability is clearly defined and outlined in the Brundtland report (1987), and this definition is largely accepted, although some variations appear occasionally (Shirazi and Keivani, 2017). There is however no agreed definition of resilience as a concept although, as will be demonstrated later in this paper, in city context the definitions are largely focussed on Disaster Risk Reduction (DRR) (Wisner, 2020). Both concepts could

be integrated in the built environment (BE) (Achour *et al.*, 2015) but there needs to be a multidisciplinary approach with incentives for policy and practice to progress towards better decision-making. More recently both concepts have generated new agendas and further interpretations of these concepts, which are creating decision-making conflicts between policy and practice (Achour *et al.*, 2015; Chmutina, Meding and Bosher, 2019; Wang *et al.*, 2020). Global practice is at a critical juncture in creating a legacy for the built environment, as many institutions or cities have declared "climate emergency" (Borders, 2020; Shendruk, 2020). The 2019 Global Assessment Report (GAR) outlines that the way forward for both concepts is through Risk Informed Sustainable Development (UNDRR, 2019) – however the operationalisation of this has not yet happened as decisions about risk (i.e. resilience) and decisions about development (i.e. sustainability) are not yet integrated (Chmutina et al., 2021). This paper aims to examine how sustainability and resilience in the built environment (BE) have been interpreted by decision-makers in a city context, it shows how the interpretations of the two concepts differ at different levels of policy and practice, and which have been operationalised in order to reconcile policy and practice.

City context is important to evaluate because 60% of the global population by 2050 will live in cities (United Nations, Department of Economics and Social Affairs, Population Division, 2019); ten global cities are already generating a quarter of the global carbon emissions (Santander and Garai-Olaun, 2016; Moran, 2018); and cities are at increasing risk from hazards and threats (UNDRR, 2020). Given the long term environmental consequences faced by humanity in the BE (For Cities by Cities, 2019), it is important to unify interpretations, goals and targets that are offered in sustainability and resilience discourses between policy, municipal planning and built environment professionals (Achour *et al.*, 2015; Fainstein, 2018; Talen, Wheeler and Anselin, 2018).

Decision-making about sustainability and resilience in cities has particularly been influenced by the C40 Cities (C40) and 100 Resilient Cities (100RC) because these programs have established governance networks and supported the development of strategies for member cities (C40 Cities, 2016). The C40 framework was established in 2005 by city decision makers; now 96 cities across the world support each other with monitoring and evaluating their sustainability performance. For these cities, sustainability means, *"large cities taking action to address climate change by developing and implementing policies and programs that generate measurable reductions in both greenhouse gas emissions and climate risks"* (C40 Cities, 2019).

In 2013, the 100RC initiative was launched for city decision-makers to compete for funding to make their city able to cope with shocks and stresses from hazard events. A city resilience index was created for cities to assess their resilience by using goals and indicators, and then develop actions, the index report defines resilience as "*City resilience describes the capacity of cities to function, so that the people living and working in cities – particularly the poor and vulnerable – survive and thrive no matter what stresses or shocks they encounter*" (The Rockefeller Foundation and Arup, 2015, p. 11). By 2016, there were 63 cities participating however, the programme abruptly closed in 2019 (Berkowitz, 2019).

By adopting the C40 and 100RC frameworks, both sustainability and resilience have become 'measurable', with a myriad of goals and indicators introduced to aid this; 'what' is being 'measured' in city frameworks could have significant long term consequences for communities, city planning and building design and generate more risks and vulnerabilities for the BE (Talen, 2003; Chmutina *et al.*, 2021). The measurement of goals tends to articulate a hierarchy of decisions and demonstrate progression towards a target (Saaty, 2008), but when considering how both concepts are being measured there is no common method. Recently, the International Labour Organization has launched codes of practice on measuring resilience and sustainability in cities (British Standards Institution, 2018, 2019) but many measurement frameworks already exist (Schipper and Langston, 2015). GAR 2019 (UNDRR, 2019) outlines that conceptual fractures have been generated by nuances in how sustainability and resilience have been interpreted and that measurement can restrict better outcomes. As cities generate their own policies (Chicago Council on Global Affairs, 2018; U20, 2018; The City of New York, 2019b), it is critical to examine the shifts in sustainability and resilience and the impact of how they are currently used in decision-making as they provide targets for future development (Santander and Garai-Olaun, 2016; de Blasio, 2018b; Emanuel, 2019b; Walsh, 2019a; Marlow, 2020).

For six decades, many political negotiations have led to the international agreements of the Rio Earth Charter, Kyoto Protocol, the Paris Agreement, and the latest Glasgow Agreement, and established global targets to protect the environment and reduce Green House Gas (GHG) emissions (Sands, 1992; United Nations, 1998; Falkner, 2016; UNFCCC, 2021). In the USA, leading environmentalists created a movement for the creation of Environmental Laws such as 1971 National Environmental Protection Act (NEPA) and in 1992, practitioners formed the US Green Building Council (USGBC), which still have a legacy today (Hays, 1982; EPA, 2019).

Initially in tandem with Brundtland, sustainable built environment principles were recognised by the Hannover Principles (McDonough and Braungart, 1992), but within a decade policy makers created further, more specific social, environmental and economic goals in order to demonstrate how sustainability can be measured and targets met (Elkington, 2004). With sustainability being a critical issue for the BE, a multitude of measurement frameworks was created across multiple scales such as: urban eco-footprinting (Wackernagel and Rees, 1995), Environmental Impact Statements (EIS) (APA 2019), Strategic Environmental Assessments (UNECE, 2003), and World Green Building Council (WGBC, 2017) frameworks including an internationally recognised Leadership in Environmental and Energy Design (LEED) assessment method (Marjaba and Chidiac, 2016). Municipal planning follows the guidance stipulated by law - in the US representation is provided by the American Planning Association (APA), which has launched guidance on climate change and hazard management but APA policy is not an NEPA requirement and may not have filtered into city policies (APA, 2019).

The concept of resilience has been shaped by global policy makers with the Hyogo Framework (Folke *et al.*, 2002; United Nations, 2005) and its successor, Sendai Framework for Disaster Risk Reduction (SFDRR) (United Nations, 2005; UNISDR, 2015). The SFDRR defines resilience as "*the need for improved understanding of disaster risk in all its dimensions of exposure, vulnerability and hazard characteristics; the strengthening of disaster risk governance*" (UNISDR 2015, p.4). Recognising measurement of resilience as a concept in the decision-making of the BE is complex as many frameworks exist that have been created between since 2010 (Schipper and Langston, 2015). With so many frameworks, it has become debatable whether resilience should be measured at all (Carpenter *et al.*, 2001; Levine, 2014; Cheek and Chmutina, 2021) and recognising which frameworks have been adopted by practice is important. As risks and recovery costs increase for cities, many seek to quantify resilience (Barkham *et al.*, 2014; World Bank Group, 2019), but, what conceptual differences have been created and what are the impacts in policy and practice (Cities and Regions in the UNFCCC Process, 2021)?

2. Research design

An initial systematic literature review (Bryman and Bell, 2015) of academic publications, sustainability and resilience policy at global and city level documents, urban or city scale measurement frameworks used in policy and practice (Marlow, 2020) (in English) created a multitude of definitions and meanings; to further examine how sustainability and resilience are interpreted and measured, three research methods were combined: case studies, thematic analysis, and semi-structured interviews (Dubois and Gadde, 2002; Yin, 2003; Braun and Clarke, 2006). Three case studies were considered to provide comparative analysis and validation (Eisenhardt, 1989). The city scale of the BE has been considered because it provides boundary constraints for decision-makers. The criteria for the case studies were involvement with C40 and 100RC, WGBC registered assessment methods, city strategies for sustainability and resilience, and working parameters such as time zones, same country and language. Considering these parameters, three cities were selected from a list of 196 cities worldwide, – New York City (NYC), Chicago, and Boston[1]. The case studies were then constructed (Yin, 2003) to analyse the themes of: how sustainability and resilience have been interpreted and measured at three decision-making levels: city policy, municipal planning, and design and planning practice. Semi-structured interview questions were created to corroborate with the city literature, and pilot tested with a peer group (Yin, 2003). To examine the differences and similarities in the interpretation of the concepts between policy and practice, a purposive sampling approach was adopted

[1] For the full list and the detailed case study protocol see Marlow, 2020.

towards the identification of decision-making stakeholders (Bryman and Bell, 2015). A total of 19 online semi-structured interviews (8 in NYC, 6 in Chicago and 5 in Boston) were carried out. The interviews were conducted with policy makers and practitioners with expert knowledge of sustainability and resilience- in the BE, including policy developers, attorneys, local governance, clients, urban planners, architects, structural and civil engineers, and specialist consultants [1]. An NVivo coding framework was developed to analyse the themes of conceptual interpretations such as systems thinking, hazards, carbon, environmental and social factors, and which measurement frameworks have been operationalised. Corroboration between policy and practice required the researcher to employ abductive reasoning (Dubois and Gadde, 2002) so that connections were constructed across sectors between how the themes have been interpretated and operationalised. The case study findings are outlined in the following sections.

3. Interpretations and measurements in city case studies

Three USA case study cities recognised that policies and codes of practice are in a state of flux when considering sustainability and resilience; the differences are generating decision-making tensions. In summary, city policies have stratified the concepts towards tangible components of carbon reduction and emergency response to natural hazards which do not fully reflect Brundtland Report or SFDRR. The interviewed BE practitioners recognised different knowledge by using term of 'passive-survivability', meaning that the BE must cope without electricity, water and food for several days after a hazard occurs, or even function sustainably to cope with climate change (Baniassadi *et al.*, 2019); this term thus embraces both sustainability and resilience. Practitioners' interview responses also reflect understanding of a mutual systematic relationship of both concepts. Recognised in the municipal planning processes were the use of Environmental Impact Assessments as stipulated by the 1970 National Environmental Protection Act (EPA, 2019), but how the legal requirements have been applied in planning processes varies in each city. Practitioners found these stipulations to be out of date. Regarding the measurement of both concepts, the LEED framework was mostly recognised in decision-making, but practice considered that no framework fits the specific needs. What is clear is that planning and design processes, are yet to fully inform the measurement frameworks and practitioners are ahead of policies. In the following sections, each case study provides context on how sustainability and resilience have been interpreted and measured in policy and practice.

3.1 NYC case study

A political shift occurred towards sustainability in 2007, with the joining of C40 cities, the launch of the NYC Green Infrastructure plan and PlaNYC 2030 (Bloomberg, 2007a, 2007b). Sustainability policies were implemented in the following five years, however the impacts of the Storm Sand changed the policy trajectory towards resilience, with the launches of: "One NYC built to last" (de Blasio, 2012), "One NYC rebuilding the city" (Goldstein, Peterson and Zarrilli, 2014), and "One NYC - the plan for a strong and just city (The City of New York, 2015). Today, One NYC is a umbrella policy for sustainability and resilience, which tracks progress by using indicators for both concepts (de Blasio, 2018a).

One NYC policy has adopted this definition of sustainability which reflects understanding of Brundtland: "*… the activities we undertake today will not compromise the present generation's or future generations' ability to meet their own needs. It is grounded in the recognition that people, economic development, and the environment are interconnected, and for any to thrive, all must thrive together*" (The City of New York, 2015, p. 162). The interpretation of resilience resonates with coping with emergencies: "*…the ability of people, the places where they live, and our infrastructure systems—such as transportation and energy—to withstand a stress or shock event, to recover, and emerge even stronger."* (The City of New York, 2015, p. 217). Neither interpretation fully recognises the mutually supportive relationship or a systematic approach to disaster risk reduction that goes beyond just being able to cope with emergency responses.

When considering how both concepts have been measured, differences become clear. The One NYC sustainability and resilience interpretations are labelled Vision 3 and 4, respectively. Tables I and II list the One NYC indicator and target descriptions for each Vision. However, the city policy has also participated in

100RC (2019), which identifies 18 shocks and stresses for the city but these are not fully recognised in the One NYC Indicators (de Blasio, 2018a).

Table I One NYC Sustainability Measurement Goals (The City of New York, 2015, p. 161)

Vision 3 Indicator Group	Description of Target
1. 80x50	Reduce NYC's GHG by 80% by 2050
2. Zero Waste	Zero Waste to landfill by 2030
3. Air Quality	Best Air Quality amongst US cities by 2030
4. Brownfields	Address contaminated land and convert it to safe and beneficial to low-income communities
5. Water Management	To mitigate flooding and provide high quality water services
6. Parks & Natural Resources	All New Yorkers to benefit from useful, accessiblek and beautiful open space

Table II One NYC Resilience Measurement Goals (The City of New York, 2015, p. 215)

Vision 4 Indicator Group	Description of Target
1. Neighborhoods	Every city neighborhood will be safer by strengthening community, social, and economic resilience
2. Buildings	The city's buildings will be upgraded against changing climate impacts
3. Infrastructure	Infrastructure systems across the region will adapt to maintain continued services
4. Coastal Defence	NYC's coastal defenses will be strengthened against flooding and sea level rise

Although addressing sustainability visions in a strategic document is valuable, the measurement indicators reflect that sustainability means a reduction of carbon, waste, air pollution, and flooding – i.e., the environmental concerns; not necessarily a social-ecological systems response that will enhance the future legacy of the city. Resilience indicators reflect an understanding of coping with a hazard event or climate change, and ensuring infrastructure works in emergency scenarios; but the wider scale issues of ecosystem restoration and adaptation are not present. Both concepts have been stratified towards tangible components of carbon reduction (not all the GHG) and emergency response, and how these ideas get incorporated into municipal planning appear to be restricted.

The City Environmental Quality Review (CEQR) adopted the EIS process that has been stipulated by NEPA (EPA, 2019), The CEQR however has a notable absence of green building standards and definitions of sustainability and resilience; NEPA has also not been reviewed since 1991 (NYC Planning, 2014; The White House, 2019). Recently, the NYC Mayors Office of Environmental Coordination (2020) recognised policy as out of date and has redefined the term 'Environment' as "*the physical conditions which will be affected by a proposed action, including land, air, water, minerals, flora, fauna, noise, objects of historic or aesthetic significance, existing patterns of population concentration, distribution, or growth, and existing community or neighborhood character*" (Thomson Reuters, 2021). From this position, it would appear that city policies are in a state of flux, and it is not clear how municipal practice can make effective decisions towards a more resilient and sustainable built environment.

Measurement indicators of sustainability and resilience are not outlined by the NYC Department of Building or represented in the existing 2014 codes of practice (NYC Buildings, 2019). However, what does exist are local laws that enact energy conservation and climate change to address out of date municipal laws (NPCC, 2015; NYC Mayors Office of Sustainability, 2019). Despite considerable efforts by city governances, the municipal codes are also constantly changing and generating nuances between both concepts (NPCC, 2015; NYC Mayors Office of Environmental Coordination, 2020).

The importance of the role of the BE practice has been recognised by the acknowledgement of the NYC Urban Green Council (NYC UGC), which operationalises the LEED Framework and has been supporting governance to make better decisions. NYC UGC knowledge has created the carbon reduction '80x50' roadmap (NYC Urban Green Council, 2018). NYC UGC has also created a Green Task Force and a Climate Resilience Task Force which are advocating policy and new climate projections (NYC UGC, 2019; Rosenzweig and Solecki, 2019). A recent city charter has been developed in consultation with NYC communities, however it remains to be established which interpretation of both concepts will feedback into city policies (The City of New York, 2019a).

3.2 Chicago case study

Chicago's Climate Change Action Plan, introduced 2008 by Mayor Richard J Daley, defined sustainability and provides goals towards carbon reduction. Daley's plan was revised in 2015 to become 'Sustainable Chicago Action Plan' (SCAP) (Emanuel, 2015a) which defines sustainability with seven themes: Economic Development and Job creation, Energy efficiency and clean energy, Transportation options, Water and Wastewater, Parks, Open Space and Healthy Food, Waste and Recycling, and Climate Change. The policy interpretation of sustainability steers towards carbon reduction and energy: "*By tapping into energy efficiency as a resource, we will meet the energy demands of a growing city, invest in our infrastructure, save money, and reduce our environmental impact. Through energy saving retrofits for our businesses, residences, and government buildings to, and investments in renewable energy sources, Chicago will improve citywide efficiency by 5 percent, and create at least an additional 20 MW of renewable energy*." (Emanuel, 2015a, p. 4). After its publication, SCAP was very quickly revised as a part of the Sustainable Chicago 2015: Action Agenda 2012-2015 Highlights and Look Ahead (Emanuel, 2015b), which expands on the seven core themes and provides 24 goals with actions. Resilience has been recognised as Goal 24 "*protect the city and its residents by preparing for changes in the climate";* its actions are: "*Prepare for the human impacts of climate change by supporting people with information and services, such as cooling centers. Prepare the natural environment for climate impacts and maintain biodiversity. Prepare the infrastructure for climate change by reducing the urban heat island effect, managing flooding from high intensity storm events, and strengthening resilience to extreme weather*." (Emanuel, 2015b, p. 24).

Interpretations and measurements continued to evolve as the city appointed a Chief Resilience Officer and the launch of 'Resilient Chicago' (100RC, 2016). The Resilient Chicago report defined resilience as "*the ability of its individuals, institutions, businesses, and systems within the community to survive, adapt, and grow despite the chronic, stresses or acute shocks it experiences. A truly resilient city is not only expected to perform well in good times but also recover expediently after challenges*." (Emanuel, 2019b, p. 9). The resilience agenda addressed four critical areas: Reducing disparities between Chicago's neighbourhoods; Addressing the root causes of crime and violence; Ensuring the provision of critical infrastructure; and, Promoting engaged, prepared, and cohesive communities (Emanuel, 2019b, p. 7). From the work with the city's stakeholders, 12 goals and 50 actions were identified (100RC, 2019a) but 14 shocks and stresses were adopted by city governance (Emanuel, 2019b, p. 8). Finally, Resilient Chicago resolves that sustainability and resilience policies should align (Emanuel, 2019b) and both concepts become mutually recognised with this definition: "*Resilient Chicago presents a vision for the city – one where residents, neighborhoods, institutions, and government agencies are successfully connected to each other in the pursuit of economic opportunity, safety, equity, and sustainability. The strategy also describes a number of actions that will benefit residents, in particular those most vulnerable*." (Emanuel, 2019b, p. 140). However, a recent press release identified that Resilient Chicago will become 'One Chicago' (Emanuel, 2019a), and this strategy could be subjected to further political shifts.

Understanding how sustainability and resilience have been interpreted in municipal planning and practice is difficult because there are many decision-making conflicts due to different political and zoning jurisdictions and all municipal codes are currently being reviewed (Emanuel, 2017; Frydland, 2019). What is recognisable is that Chicago has a USGBC profile as it has become a LEED Platinum city (USGBC, 2019), whereas understanding of how both concepts are being measured has been recognised by Chicago's Metropolitan Agency, a regional planning agency with the "*On to 2050*" (CMAP, 2019). The city's Planning and Sustainability Bureau has mobilised the Chicago Sustainable Development Policy and provides a handbook for communities and open space (City of Chicago, 2017, 2019a, 2019b). When reviewing city's guidance, it is unclear how the city's environmental compliance needs are being met because the ownership of the decisions between the Planning Department and Department of Buildings are subject to political shifts (City of Chicago, 2020). Approaches to sustainability and resilience are difficult to evaluate as the planning process refers to Green Permitting (Department of Buildings, 2012). Green Permitting points towards EIS requirements and the LEED framework but these requirements are not clearly outlined in the Sustainable Development Policy, so the guidance itself is disrupted.

3.3 Boston case study

Mayor Walsh created the 2014 Climate Action Plan (Walsh *et al.*, 2014) that defines sustainability and resilience for the city. The definition aligns with international agreements but also social behaviour relating to DDR. From the outset both concepts have been merged and defined by nine themes: State of Climate, Cross cutting themes, Boston's Carbon footprint, Implementation and next steps, Neighbourhoods, Large Buildings and Institutions, Transportation, Climate preparedness, and 80% GHG by 2050. Boston has weighted sustainable development towards reducing GHG emissions concerned with energy consumption and transportation (25% reduction by 2020 and 80% by 2050). However, city governance also wants to prepare Boston for the Impacts of Climate Change and sets out the following priorities (Walsh *et al*. 2014, p. 7): "*Work with regional and state agencies, and surrounding communities to align and accelerate regional preparedness planning. Incorporate climate preparedness into existing local planning and community engagement efforts. Ensure public- and private-sector developments and major capital projects are prepared for expected climate change over their projected life".*

Resilient Boston (Martin, 2015) further recognises the exposure of Boston being a coastal city, as well as its social vulnerabilities that include racial and financial inequalities. Recognised risks are in relation to flooding, subsidence to water ingression, warmer weather and Nor'easter storms. Walsh *et al.* (2014, p. 69) outline the coordination climate preparedness efforts across city, state and federal levels for buildings, transportation, land-use and natural systems, energy, water infrastructure, and emergency management. Resilient Boston defines sustainability as "*Consisting of reliable and effective structures and procedures to survive over time (including leadership, capacity, and funding streams)*" (Walsh, 2017, p. 138). Resilient Boston defines resilience as: "*the capacity of individuals, communities, institutions, businesses, and systems within a city to survive, adapt, and thrive—no matter what kinds of chronic stresses and acute shocks they experience.*" (Walsh, 2017, p. 9).

Resilience measurement is recognised by four long-term visionary goals with 23 associated initiatives. Most critically, Goal 4 defines three components of resilience as: "*Goal 4.1 Develop a redundant and reliable public transportation network to provide equitable accessibility for all Bostonians; Goal 4.2: Prepare for the impacts of climate change and other threats, while accelerating sustainable infrastructure, environment, and communities; Goal 4.3: Improve the collaboration of partners working in Boston communities to address climate change and other emergencies*." (100 Resilient Cities & Walsh 2017, pp.106–130). Boston's 100RC profile identified 20 shocks and stresses (100 Resilient Cities, 2018). Beyond these city strategies, the Mayor has recently launched Climate Ready Boston and maintained a policy called Carbon Free Boston (Walsh, 2016, 2019a). Mayor Walsh 'Jan 29, 2019' speech on Climate Change, discusses all Boston's policies, but there is a focus on the Boston's Climate Action Plan (Walsh, 2019b).

Boston Planning Development Agency (BPDA) interprets sustainability and resilience in Article 80 and 37 (BPDA, 1996, 2017). Article 80 (BPDA, 1996) prescribes a development review process that outlines LEED Silver and compliance with the Building Code CM780 (Office of Public Safety and Inspections, 2018) as a mandatory requirement for new developments. Article 37 (BPDA, 2017) outlines the green building and climate resilience guidelines which stipulates a compliance process towards new large developments and LEED standards (BPDA, 2018).

Whilst this suggests a unified approach towards green building frameworks with the E+ building performance program (Walsh *et al.*, 2014), many scales of development are not subjected to the same performance criteria - but this situation is changing. Recently the city has launched resilient design criteria for the Harbor District development and provided detailed specifications (Boston Public Works Department, 2018).

3.4 Interpretation of Resilience and Sustainability in cities by practitioners

Across three cities, 19 practitioners were interviewed about decision-making of sustainability and resilience to understand their conceptual interpretation of the concepts and their measurements– and whether it aligns with city policy definitions. Sustainability has been mostly considered as an umbrella term or reaffirmation of the Brundtland definition. Resilience was interpreted mostly as a systems approach, which included a focus on 1) capacity building of systems, 2) response to hazards, and 3) rate of response (recovery). Some professionals were aware of the vulnerabilities and their root causes, e.g., social inequalities, that have been created and must be addressed to provide *passive-survivability* in the system. Recognised by practitioners is a broader understanding of both concepts, and the differences between the policy and municipal planning matter because practitioners are limited in implementing better changes that work on a systematic scale. Practitioners outlined that the project scope of works is a limiting factor because measurable targets are prioritised (such as carbon reduction through building services) rather than delivering sustainability and resilience outcomes.

When considering measurement, the interviewees discussed the frameworks operationalised in their decision-making practice. The most recognised framework was LEED with 14 responses, which was followed by other frameworks with 10 responses. Notable frameworks that are being utilised by practitioners are: LEED, Passivhaus [2] and LEED- RELi which operationalise sustainability and efficiency of systems to be able to operate “off-grid” (Wilson, 2006, 2018). New sources have been recognised by practice (American Institute Architects, 2020; Moody’s, 2020; WELL, 2020), however, more city frameworks are being mobilised (Brown, Abdallah and Townsley, 2017). What practitioners indicate is that these known frameworks have developed habitual responses to energy and GHG, so biases have been created which neglect aspects of sustainability and resilience. This has created a tension with policy because in the municipal codes the LEED framework is optional; or at a low performance level, so this has led to practitioners creating other performance frameworks that suit their needs.

4. Implications for research, policy and practice

This paper has demonstrated that built environment practitioners have a different understanding of sustainability and resilience from what is currently being used in city policies and municipal planning. The core ideals of sustainability corroborate with the Brundtland Report (1987); resilience is malleable and this is understood by practitioners. As differences in understanding are created between sectors and disciplines, the concepts have become theoretically stratified (Wang *et al.*, 2020) and biases towards the quantifiable targets emerge in decision-making frameworks, which do not reflect the broader definitions of sustainability and resilience (Wisner, 2020). Similarly, adjusting how scope of works outline project outcomes would facilitate practitioners to employ systematic approaches and make real changes to the built environment.

Many practitioners point out that policy and guidance is out of date, so more coherency between policy, municipal planning and BE disciplines is still required (Marlow, 2020). Practitioners are using the term passive-survivability, but this term is not used in policy or municipal codes. This is the crux of decision-making conflict for research, policy and practitioners: the policy and codes are the rulebook - but the rulebook is not aligned with the way that sustainability or resilience are understood and operationalised in practice. Making

better decisions would require both policy and practice to use the same terms such as passive-survivability in codes of practice.

Actions can be taken in cities. The case studies all recognised that when policy developers work with practitioners' progressive actions have been created, as seen with NYC UGC developing the Blueprint for Efficiency Policy. Where US Green Building Council LEED chapters have started to be integrated into policy development, it should be noted that the existing LEED framework does provide a mutual platform for policy and municipal planners. However, to move forward beyond existing policy targets, LEED best practice standards need to be operationalised (with all credits being targeted) and high performance standards (such as Gold or Platinum), to be mandatory across decision-making for the BE (Garde, 2009; Smith, 2015; Champagne and Aktas, 2016). Further to policy outlining better LEED performance standards, the adoption of the LEED- RELi framework would help with making revisions to municipal policy and codes because the mandatory credits reflect the understanding of passive-survivability (Wilson, 2018). LEED also needs to be used with caution, Chicago has adopted the LEED Framework in most of its practice and policy, but has become subjected to biases towards carbon reduction rather than a more holistic sustainability approach and faces decision-making challenges due to political jurisdiction across municipal areas (Chicago Council on Global Affairs, 2018; USGBC, 2019).

Evaluating the city case studies shows that creating a real legacy of a more sustainable and resilient BE requires national and local laws to be concurrently revised to reflect global targets and best practice knowledge that is contextually appropriate as well as a better theoretical understanding of sustainability and resilience (Peters and Tanner, 2016; UNDRR, 2019; Cities and Regions in the UNFCCC Process, 2021). Supportive actions recognised from this research are that multidisciplinary approaches need to expand to transdisciplinary decision-making, as it leads to better public awareness and commitment to making city transformation (Chicago Council on Global Affairs, 2018). Further to this, city policies need moderating beyond existing C40 and 100RC frameworks to ensure that the broader concept of sustainability and resilience are addressed because many social- environmental issues still need to be prioritised with the systems approach (Meadows, 2008). As revisions are made to city strategies, municipal planning must address the out-of-date codes and even evaluate national environmental laws because all practitioners need better policy and scope of works to deliver transformational targets.

As the decision-making process gets more involved and with so many measurement frameworks in existence, more unification is required between theory, policy, municipal planning and BE practice to reduce tensions in decision-making that can endure political shifts. With the UNDRR declaring Risk Informed Sustainable Development (UNDRR, 2019), progressive actions still need to be taken towards both resilience and sustainability across boundaries so that decision-making conflicts generated by differences in interpretations and measurement in the built environment can be reduced.

References

100 Resilient Cities (2016) *Officer, Mayor Emanuel names Aaron Koch Chief resilience*, *1*. Available at: https://www.100resilientcities.org/mayor-emanuel-names-aaron-koch-chief-resilience-officer/ (Accessed: 6 May 2019).

100 Resilient Cities (2018) *Boston*. Available at: http://www.100resilientcities.org/cities/boston/ (Accessed: 1 March 2018).

100 Resilient Cities (2019a) *Chicago*. Available at: https://www.100resilientcities.org/cities/chicago/ (Accessed: 9 September 2019).

100 Resilient Cities (2019b) *New York City*. Available at: https://www.100resilientcities.org/cities/new-york-city/ (Accessed: 9 September 2019).

Achour, N. *et al.* (2015) 'Integration of resilience and sustainability: from theory to application', *International*

Journal of Disaster Resilience in the Built Environment, 6(3), pp. 347–362. doi: 10.1108/IJDRBE-05-2013-0016.

American Institute Architects (2020) *AIA 2030 Design Data Exchange*. Available at: https://2030ddx.aia.org/helps/sustainability-action-plan (Accessed: 7 July 2020).

American Planning Association (2019) *APA Policy Guides*. Available at: https://planning.org/policy/guides/ (Accessed: 24 July 2021).

Baniassadi, A. *et al.* (2019) 'Passive survivability of buildings under changing urban climates across eight US cities', *Environmental Research Letters*, 14(7), p. 074028. doi: 10.1088/1748-9326/ab28ba.

Barkham, R. *et al.* (2014) *Resilient Cities: A Grosvenor Research Report*. London: Grosvenor.

Berkowitz, M. (2019) *An update from 100 Resilient Cities*. Available at: https://www.100resilientcities.org/update-from-100rc/ (Accessed: 27 July 2019).

de Blasio, B. (2012) *One City New York City's Built to Last*. NYC. Available at: http://webcache.googleusercontent.com/search?q=cache:8chHSnKqm_UJ:www.nyc.gov/html/builttolast/assets/downloads/pdf/OneCity.pdf+&cd=1&hl=en&ct=clnk&gl=uk (Accessed: 5 November 2019).

de Blasio, B. (2018a) *One NYC Indicators 2018*. Available at: https://onenyc.cityofnewyork.us/wp-content/uploads/2018/04/OneNYC_2018_Progress_Indicators-1.pdf. (Accessed: 19 March 2019).

de Blasio, B. (2018b) *OneNYC Progress Report 2018*. NYC. Available at: https://onenyc.cityofnewyork.us/wp-content/uploads/2019/04/OneNYC-Progress-Report-2018.pd (Accessed: 19 March 2019).

Bloomberg (2007a) *NYC Green Infrastructure Plan*. NYC. Available at: https://www1.nyc.gov/assets/dep/downloads/pdf/water/stormwater/green-infrastructure/nyc-green-infrastructure-plan-2010.pdf (Accessed: 19 March 2019).

Bloomberg (2007b) *PlaNYC: A Greener, Greater New York*. NYC. Available at: www.nyc.gov/html/planyc/downloads/pdf/publications/full_report_2007.pdf (Accessed: 19 March 2019).

Borders, E. without (2020) *Engineers declare climate emergency*. Available at: https://www.ewb-uk.org/engineers- declare-climate-emergency/ (Accessed: 20 January 2020).

Boston Public Works Department (2018) *Climate Resilient Design Standards & Guidelines for Protection of Public Rights-of-way*. City of Boston. Available at: https://www.boston.gov/sites/default/files/imce-uploads/2018-10/climate_resilient_design_standards_and_guidelines_for_protection_of_public_rights-of-way_no_appendices.pdf (Accessed: 7 June 2019).

BPDA (1996) *Article 80*. City of Boston. Available at: http://www.bostonplans.org/projects/development-review/what-is-article-80 (Accessed: 31 January 2019).

BPDA (2017) *Boston Zoning Code Article 37 Green Buildings and Climate Resiliency Review Procedures and Submittal Requirements*. City of Boston. Available at: http://www.bostonplans.org/planning/planning-initiatives/article-37-green-building-guidelines (Accessed: 12 January 2019).

BPDA (2018) *Large Project Review*. City of Boston. Available at: http://www.bostonplans.org/projects/development-review/large-projects (Accessed: 2 February 2019).

Braun, V. and Clarke, V. (2006) 'Using thematic analysis in psychology', *Qualitative Research in Psychology*, 3(2), pp. 77–101. doi: 10.1191/1478088706qp063oa.

British Standards Institution (2018) 'BS ISO 37120 : 2018 BSI Standards Publication Sustainable cities and communities — Indicators for city services and quality of life'. London: BSI Standards Limited.

British Standards Institution (2019) 'BS ISO 37123 : 2019 BSI Standards Publication Sustainable cities and communities — Indicators for resilient cities'. London: BSI Standards Limited.

Brown, H., Abdallah, S. and Townsley, R. (2017) *Understanding local needs for wellbeing data measures and indicators*. Available at: https://whatworkswellbeing.org/product/local-authority-wellbeing-indicator-sets-and-

guidance-only/.

Brundtland, G. (1987) *Report of the World Commissionon Environment and Development: Our common future*. Oxford: Oxford University Press.

Bryman, A. and Bell, E. (2015) *Business Research Methods*. 4th edn. Oxford: Oxford University Press.

C40 Cities (2016) *Benefits of Climate Action, Piloting a global approach to measurement*. Available at: https://drive.google.com/file/d/0B1VfKggXc6qOQ2syT1FsQTkwRm8/view (Accessed: 22 May 2017).

C40 Cities (2019) *About C40*. Available at: https://www.c40.org/history (Accessed: 25 March 2019).

Carpenter, S. *et al.* (2001) 'From Metaphor to Measurement: Resilience of What to What?', *Ecosystems*, 4(8), pp. 765–781. doi: 10.1007/s10021-001-0045-9.

Champagne, C. L. and Aktas, C. B. (2016) 'Assessing the Resilience of LEED Certified Green Buildings', *Procedia Engineering*, 145, pp. 380–387. doi: 10.1016/j.proeng.2016.04.095.

Cheek, W. W. and Chmutina, K. (2021) '"Building Back Better" is Neoliberal Post-Disaster Reconstruction.', *Disasters*, p. disa.12502. doi: 10.1111/disa.12502.

Chicago Council on Global Affairs (2018) *The Chicago Climate Charter : North American Cities Taking Action on Climate*. City of Chicago. Available at: https://www.thechicagocouncil.org/sites/default/files/repot_chicago-climate-charter_20181220.pdf (Accessed: 8 April 2019).

Chmutina, K., von Meding, J., Sandoval, V., Boyland, M., Forino, G., Cheek, W., Williams, D.A., Gonzalez-Muzzio, C., Tomassi, I., Páez, H., Marchezini, V. (2021) 'What we measure matters: the case of the missing development data in Sendai Framework for Disaster Risk Reduction monitoring', *International Journal of Disaster Risk Science*. doi: 10.1007/s13753-021-00382-2.

Chmutina, K. *et al.* (2021) *Cities Standardised indicators for ' resilient cities ': The folly of devising a technical solution to a political problem*.

Chmutina, K., Meding, J. Von and Bosher, L. (2019) *Language Matters: Dangers of the 'Natural Disaster' Misnomer*, *Global Assessment Report on Disaster Risk Reduction (GAR 2019)*. UNDRR. Available at: https://www.preventionweb.net/files/65974_f410finalkseniachmutinalanguagematt.pdf (Accessed: 14 November 2019).

Cities and Regions in the UNFCCC Process (2021) *COP26: Streamlining subnational advocacy into four focus areas for Glasgow and beyond*. Available at: https://www.cities-and-regions.org/cop26/.

City of Chicago (2017) *Chicago Sustainable Development Policy Handbook*. Available at: https://www.cityofchicago.org/city/en/depts/dcd/supp_info/sustainable_development/chicago-sustainable-development-policy-handbook0.html (Accessed: 15 March 2018).

City of Chicago (2019a) *Environment and Sustainability*. Available at: https://www.chicago.gov/city/en/progs/env.html (Accessed: 6 May 2019).

City of Chicago (2019b) *Open Space and Sustainability Plans*. Available at: https://www.chicago.gov/city/en/depts/dcd/provdrs/planning_and_policydivision/svcs/open-space-and-sustainability-plans.html (Accessed: 4 April 2019).

City of Chicago (2020) *Chicago Construction Codes*. Available at: https://www.chicago.gov/city/en/depts/bldgs/provdrs/bldg_code/svcs/chicago_buildingcodeonline.html (Accessed: 27 June 2020).

CMAP (2019) *ON TO 2050 INDICATORS: Appendix*. Available at: https://www.cmap.illinois.gov/documents/10180/905585/FINAL+Indicators+Appendix.pdf/ae234d88-74c0-7a94-f70d-ea350c999810 (Accessed: 8 April 2019).

Department of Buildings (2012) *Green Permit Process 1*. City of Chicago. Available at: https://www.chicago.gov/content/dam/city/depts/bldgs/general/GreenPermit/110112Green_Permit_Flow_Chart.pdf. (Accessed: 2 April 2020).

Dubois, A. and Gadde, L. E. (2002) 'Systematic combining: An abductive approach to case research', *Journal of Business Research*, 55(7), pp. 553–560. doi: 10.1016/S0148-2963(00)00195-8.

Eisenhardt, K. M. (1989) 'Building Theories from Case Study Research.', *Academy of Management Review*, 14(4), pp. 532–550. doi: 10.5465/AMR.1989.4308385.

Emanuel, R. (2015a) *Sustainable Chicago 2015: Action Agenda*. Available at: https://www.chicago.gov/content/dam/city/progs/env/SustainableChicago2015.pdf (Accessed: 8 April 2019).

Emanuel, R. (2015b) *Sustainable Chicago 2015: Action Agenda 2012-2015 Highlights and Look Ahead*. Available at: https://www.cityofchicago.org/content/dam/city/progs/env/Sustainable_Chicago_2012-2015_Highlights.pdf (Accessed: 15 March 2018).

Emanuel, R. (2017) *Guide to permits*. Chicago: Department of Buildings. Available at: https://www.chicago.gov/city/en/depts/bldgs/provdrs/permits.html (Accessed: 8 April 2019).

Emanuel, R. (2019a) *Press Release 'Resilient Chicago'*. Available at: https://www.chicago.gov/city/en/depts/mayor/press_room/press_releases/2019/february/ResilientChicago.html (Accessed: 8 April 2019).

Emanuel, R. (2019b) *Resilient Chicago: A plan for Inclusive Growth and a Connected City*. Chicago: 100 Resilient Cities and City of Chicago. Available at: https://resilient.chicago.gov/download/Resilient Chicago.pdf.

EPA (2019) *Laws and Regulations*. Available at: https://www.epa.gov/laws-regulations/summary-executive-order-12866-regulatory-planning-and-review (Accessed: 20 April 2019).

Fainstein, S. S. (2018) 'Resilience and justice: planning for New York City', *Urban Geography*, 39(8), pp. 1268–1275. doi: 10.1080/02723638.2018.1448571.

Falkner, R. (2016) 'The Paris Agreement and the new logic of international climate politics', *International Affairs*, 92(5), pp. 1107–1125. Available at: https://static1.squarespace.com/static/538a0f32e4b0e9ab915750a1/t/57d3dfc646c3c43b079d1c59/1473503175245/Falkner_2016_TheParisAgreement.pdf.

Folke, C. *et al.* (2002) 'Resilience and Sustainable Development: Building Adaptive Capacity in a World of Transformations', *AMBIO: A Journal of the Human Environment*, 31(5), pp. 437–440. doi: 10.1579/0044-7447-31.5.437.

For Cities by Cities (2019) *Key Takeaways for City Decision Makers from the IPCC 1.5°C Report and Summary for Urban Policymakers*. Available at: https://c40-production-images.s3.amazonaws.com/other_uploads/images/2327_For_cities_by_cities_v18_(1).original.pdf?1567192456 (Accessed: 5 November 2019).

Frydland, J. (2019) *Modernizing Chicago's Construction Codes: Phase 2 Ordinance Spring 2019*. City of Chicago. Available at: https://www.chicago.gov/content/dam/city/depts/bldgs/general/CodeModernization/Combined SUBSTITUTE.pdf.

Gaillard, J. C. and Jigyasu, R. (2016) 'Measurement and evidence: whose resilience for whom?', *Resilience Development Initiative*, 11(1), p. 15. doi: 10.1111/j.1467-629X.1980.tb00220.x.

Garde, A. (2009) 'Sustainable by design?: Insights from U.S. LEED-ND Pilot Projects', *Journal of the American Planning Association*, 75(4), pp. 424–440. doi: 10.1080/01944360903148174.

Goldstein, W., Peterson, A. and Zarrilli, D. A. (2014) *One City, Rebuilding Together: A Report on the City of New York's Response to Hurricane Sandy and the Path Forward*. Available at: http://www1.nyc.gov/assets/home/downloads/pdf/reports/2014/sandy_041714.pdf (Accessed: 5 March 2018).

Hays, S. P. (1982) 'From Coservation to Environmental Politics in The United States Since World War Two', *Environmental Review*, 6(2), pp. 14–41. doi: 10.2307/3984153.

Levine, S. (2014) *Assessing resilience: why quantification misses the point*, *HPG Working Paper*. London: Overseas Development Institute. Available at: http://www.odi.org/sites/odi.org.uk/files/odi-assets/publications-

opinion-files/9049.pdf.

Lewis, S. W. and Abdallah, S. (2016) *Happy City Index 2016 Report*. Available at: https://www.centreforthrivingplaces.org//wp-content/uploads/2016/10/Happy-City-Index-2016-Report-FINAL.pdf (Accessed: 17 June 2018).

Marjaba, G. E. and Chidiac, S. E. (2016) 'Sustainability and resiliency metrics for buildings – Critical review', *Building and Environment*, 101(May), pp. 116–125. doi: 10.1016/j.buildenv.2016.03.002.

Marlow, E. C. (2020) *Investigating the interplay of sustainability and resilience of the built environment*. Loughborough University. Available at: https://repository.lboro.ac.uk/articles/thesis/Investigating_the_interplay_of_sustainability_and_resilience_of_the_built_environment/12962438/1?file=24693269.

Martin, S. A. (2015) 'A framework to understand the relationship between social factors that reduce resilience in cities: Application to the City of Boston', *International Journal of Disaster Risk Reduction*, 12(June), pp. 53–80. doi: 10.1016/j.ijdrr.2014.12.001.

McDonough, W. and Braungart, M. (1992) *The Hannover Principles: Design for Sustainability*. Charlottesville, VA: William McDonough & Partners. Available at: https://mcdonough.com/wp-content/uploads/2013/03/Hannover-Principles-1992.pdf.

Meadows, D. H. (2008) *Thinking in Systems: A primer*. Edited by D. Wright. White River Junction, Vermont: Chelsea Green Publishing.

Moody's (2020) *Moody's ESG and Climate Risk*. Available at: https://esg.moodys.io/ (Accessed: 7 July 2020).

Moran, D. et al (2018) 'Carbon footprints of 13 000 cities', *Environmental Research Letters*, 13(064041).

NPCC (2015) 'New york city panel on climate change 2015 report conclusions and recommendations', *Annals of the New York Academy of Sciences*, 1336(1), pp. 107–108. doi: 10.1111/nyas.12592.

NYC Buildings (2019) *2014 Construction Code*. Available at: https://www1.nyc.gov/assets/buildings/apps/pdf_viewer/viewer.html?file=2014CC_BC_Chapter_2_Definitions.pdf&section=conscode_2014 (Accessed: 9 July 2019).

NYC Mayors Office of Environmental Coordination (2020) *CEQR Laws and Regulations*. Available at: https://www1.nyc.gov/site/oec/environmental-quality-review/ceqr-laws-regulations.page#resources (Accessed: 25 June 2019).

NYC Mayors Office of Sustainability (2019) *Laws and Regulations: Buildings & Energy*. Available at: https://www1.nyc.gov/site/sustainability/regulations/buildings-energy.page (Accessed: 19 March 2019).

NYC Planning (2014) *City Environmental Quality Review Technical Manual*. New York: NYC Mayor's Office of Environmental Coordination.

NYC Urban Green Council (2018) *Blueprint for Efficiency*. New York: Urban Green Council.

NYC Urban Green Council (2019) *Strategies*. Available at: https://www.urbangreencouncil.org/content/initiatives/advance-sustainable-building-policy (Accessed: 2 April 2019).

Office of Public Safety and Inspections (2018) *Ninth Edition of the MA State Building Code 780*. Available at: https://www.mass.gov/service-details/ninth-edition-of-the-ma-state-building-code (Accessed: 13 January 2021).

Passivhaus Trust (2019) *What is Passivhaus?* Available at: http://passivhaustrust.org.uk/what_is_passivhaus.php#2 (Accessed: 19 July 2019).

Peters, K. and Tanner, T. (2016) *Resilience across the post-2015 frameworks: how to create greater coherence*, *ODI Working Paper*. London: Overseas Development Institute. Available at: https://www.odi.org/sites/odi.org.uk/files/resource-documents/11006.pdf.

Richard J Daley (2008) *Chicago Climate Action Plan*. Chicago. Available at: https://www.chicago.gov/content/dam/city/progs/env/CCAP/CCAP.pdf (Accessed: 8 April 2019).

Rosenzweig, C. and Solecki, W. (2019) 'New York City Panel on Climate Change 2019 Report Executive Summary', *Annals of the New York Academy of Sciences*, 1439(1), pp. 11–21. doi: 10.1111/nyas.14008.

Saaty, T. L. (2008) 'Decision making with the analytic hierarchy process - International Journal of Services Sciences - Volume 1, Number 1/2008 - Inderscience Publishers', *International Journal of Services Sciences*. doi: 10.1504/IJSSci.2008.01759.

Sands, P. (1992) 'The United Nations Framework Convention on Climate Change', *Review of European Community and International Environmental Law*, 1(3), pp. 270–277. doi: 10.1111/j.1467-9388.1992.tb00046.x.

Santander, A. A. and Garai-Olaun, A. A. (2016) 'Urban Planning and Sustainable Development in The 21st Century, Conceptual and Management Issues', *IOP Conference Series: Earth and Environmental Science*, 44(3), pp. 1–6. doi: 10.1088/1755-1315/44/3/032005.

Schipper, E. L. F. and Langston, L. (2015) *A comparative overview of resilience measurement frameworks analysing indicators and approaches*, *Working Paper 422*. London: Overseas Development Institute. doi: 10.13140/RG.2.1.2430.0882.

Shendruk, A. (2020) *Which cities have declared climate emergenices*. Available at: https://qz.com/1786781/which-cities- have-declared-climate-emergencies/ (Accessed: 3 February 2020).

Shirazi, M. R. and Keivani, R. (2017) 'Critical reflections on the theory and practice of social sustainability in the built environment – a meta-analysis', *Local Environment*, 22(12), pp. 1526–1545. doi: 10.1080/13549839.2017.1379476.

Smith, R. M. (2015) 'Planning for urban sustainability: the geography of LEED ® –Neighborhood Development ™ (LEED ® –ND ™) projects in the United States', *International Journal of Urban Sustainable Development*, 7(1), pp. 15–32. doi: 10.1080/19463138.2014.971802.

Talen, E. (2003) 'Measuring urbanism: Issues in smart growth research', *Journal of Urban Design*, 8(3), pp. 195–215. doi: 10.1080/1357480032000155141.

Talen, E., Wheeler, S. M. and Anselin, L. (2018) 'The social context of U.S. built landscapes', *Landscape and Urban Planning*, 177(February), pp. 266–280. doi: 10.1016/j.landurbplan.2018.03.005.

The City of New York (2015) *OneNYC: The Plan for a Strong and Just City*. New York. Available at: http://www.nyc.gov/html/onenyc/downloads/pdf/publications/OneNYC.pdf (Accessed: 19 July 2019).

The City of New York (2019a) *Final Report of the 2018 New York City Charter Revision Commission*. Available at: https://www1.nyc.gov/assets/charter/downloads/pdf/final-report-20180904.pdf (Accessed: 25 October 2019).

The City of New York (2019b) *NYC Charter*. Available at: https://nyc-charter.readthedocs.io/en/latest/ (Accessed: 3 April 2020).

The Rockefeller Foundation and Arup (2015) *CITY RESILIENCE INDEX*. London.

The White House (2019) *The Clinton-Gore Administration, A record of progress*. Available at: https://clintonwhitehouse5.archives.gov/WH/Accomplishments/eightye ars-08.html (Accessed: 26 June 2019).

Thomson Reuters (2021) *New York Consolidated Laws, Envrionmental Conservation Law - ENV § 8-0105. Definitions*. Available at: https://codes.findlaw.com/ny/environmental-conservation-law/env-sect-8-0105.html (Accessed: 28 February 2021).

U20 (2018) *U20 cities call on the G20 to prioritize an urban perspective in tackling global issues: An official communiqué from Urban 20 (U20)*. Available at: http://www.metro.tokyo.jp/tosei/hodohappyo/press/2018/10/31/documents/10_01.pdf (Accessed: 10 October 2019).

UNDRR (2019) *Global Assessment Report on Disaster Risk Reduction 2019*. Geneva: UNDDR. doi: 10.18356/f4ae4888-en.

UNDRR (2020) *Human Cost of Disasters*. Gen. doi: 10.18356/79b92774-en.

UNECE (2003) 'Protocol on Strategic Environmental Assessment To the Convention on Environmental Impact Assessment', *Organization for Economic Cooperation and Development*, pp. 3–14.

UNFCCC (2021) *COP 26 Outcomes*. Available at: https://ukcop26.org/the-conference/cop26-outcomes/ (Accessed: 22 November 2021).

UNISDR (2015) 'Sendai Framework for Disaster Risk Reduction 2015 - 2030', in *Third World Conference on Disaster Risk Reduction, Sendai, Japan, 14-18 March 2015.* Geneva: United Nations, pp. 1–25. doi: A/CONF.224/CRP.1.

United Nations, Department of Economics and Social Affairs, Population Division (2019) *World Urbanization Prospects: The 2018 Revision (ST/ESA/SER.A/420)*, *Demographic Research*. New York: United Nations. Available at: https://population.un.org/wup/Publications/Files/WUP2018-Report.pdf.

United Nations (1998) 'Kyoto Protocol to the United Nations Framework Convention on Climate Change', *Review of European Community & International Environmental Law*, 7(2), pp. 214–217. doi: 10.1111/1467-9388.00150.

United Nations (2005) *Report of the World Conference on Disaster Reduction, Kobe, Hyogo, Japan, 18 - 22 January 2005*. Available at: http://www.unisdr.org/2005/wcdr/intergover/official-doc/L-docs/Final-report-conference.pdf (Accessed: 16 September 2019).

USGBC (2019) *Mayor Emanuel Announces Chicago Achieved LEED for Cities Platinum Certification*. Available at: https://www.usgbc.org/articles/mayor-emanuel-announces-chicago-achieved-leed-cities-platinum-certification (Accessed: 20 April 2019).

Vale, L. J. (2014) 'The politics of resilient cities: whose resilience and whose city?', *Building Research & Information*, 42(2), pp. 191–201. doi: 10.1080/09613218.2014.850602.

Wackernagel, M. and Rees, W. E. (1995) *Our Ecological Footprint*. Gabriola Island, B.C: New Society Publisher.

Walsh, M. J. *et al.* (2014) *Greenovate Boston 2014 Climate Action Plan Update*, *City of Boston*. City of Boston. Available at: https://www.cityofboston.gov/eeos/pdfs/Greenovate Boston 2014 CAP Update_Full.pdf (Accessed: 24 January 2019).

Walsh, M. J. (2016) *Climate Ready Boston*, *City of Boston*. City of Boston. Available at: https://www.boston.gov/sites/default/files/embed/2/20161207_climate_ready_boston_digital2.pdf (Accessed: 24 January 2019).

Walsh, M. J. (2017) *Resilient Boston- An Equitable and Connected City*. City of Boston. Available at: https://www.boston.gov/sites/default/files/document-file-07-2017/resilient_boston_digital.pdf.

Walsh, M. J. (2019a) *Carbon Free Boston*, *City of Boston*. Available at: https://www.boston.gov/news/boston-launches-new-initiative-achieve-climate-goals (Accessed: 24 January 2019).

Walsh, M. J. (2019b) *Major Speech Chamber of Commerce*, *City of Boston*. Available at: https://www.boston.gov/news/mayor-walshs-2018-remarks-greater-boston-chamber-commerce (Accessed: 31 January 2019).

Wang, Y. *et al.* (2020) 'Conceiving resilience: Lexical shifts and proximal meanings in the human-centered natural and built environment literature from 1990 to 2018', *Developments in the Built Environment*, 1(100003), p. 100003. doi: 10.1016/j.dibe.2019.100003.

WELL (2020) *WELL Health-Safety Rating*. Available at: https://www.wellcertified.com/health-safety (Accessed: 7 July 2020).

Wilson, A. (2006) *Passive Survivability: A New Design Criteron for Buildings*. Available at:

www.buildinggreen.com/feature/passive-survivability-new-design-criterion-buildings (Accessed: 28 June 2020).

Wilson, A. (2018) *LEED pilot credits on resilient design adopted*. Available at: https://www.usgbc.org/articles/leed-pilot-credits-resilient-design-adopted (Accessed: 28 June 2020).

Wisner, B. (2020) 'Five Years Beyond Sendai—Can We Get Beyond Frameworks?', *International Journal of Disaster Risk Science*, 11(2), pp. 239–249. doi: 10.1007/s13753-020-00263-0.

World Bank Group (2019) *Building Urban Resilience: An Evaluation of the World Bank Group's Evolving Experience (2007-17)*. Washington DC: World Bank: Independent Evaluation Group.

World Green Building Council (2017) *Our Green Building Councils*. Available at: http://worldgbc.org/our-green-building-councils.

Yin, R. K. (2003) *Case Study Research, Design and Methods*. 3rd edn. Thousand Oaks, California: SAGE Publications Ltd.

[1] Ethical approval has been received by following procedures.
[2] PassivHaus Framework (Passivhaus Trust, 2019)