Seven principles of strong climate change planning

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Abstract

As greenhouse gas emissions and climate change impacts increase worldwide, there is an urgent need for communities, and consequently urban planners, to simultaneously mitigate and adapt to climate change. We synthesize recent research to examine whether the field of planning is adequately addressing climate change. We conclude that while there has been progress in recent years, it is insufficient given the scope of the climate change challenge and the myriad ways that climate impacts negatively affect communities. We argue for seven principles of strong climate change planning: 1) clear goals; 2) diverse strategies; 3) public participation; 4) coordination across actors, sectors, and plans; 5) processes for implementation and monitoring; 6) techniques to address uncertainty. For each of these principles we discuss the current state of research and practice.

Keywords: Climate change; mitigation; adaptation; resilience; planning

Communities are not adequately planning for climate change. Global carbon emissions continue to rise (Le Quéré et al., 2018), even as alarming studies point to Greenland ice sheets melting at accelerating rates (Bevis et al., 2019), warming ocean temperatures (Cheng, Abraham, Hausfather, & Trenberth, 2019), mass extinctions (IPBES, 2019), and mounting climate and weather-related disaster costs (NOAA NCEI, 2018). The latest Intergovernmental Panel on Climate Change (IPCC) report argues that climate change is already affecting human and natural systems and limiting global temperature increases to 1.5 degrees Celsius would reduce risks but also require rapid, unprecedented "transitions in energy, land, urban and infrastructure (including transport and buildings), and industrial systems" (IPCC, 2018). Practicing planners and planning scholars have a role to play in these transitions and in helping communities prepare for climate change impacts (IPCC, 2014a). An important first step is to create strong climate change plans. In this paper, we discuss what that entails. We begin with an overview of climate planning, determining that while planners are engaging with climate change in research and practice, planning can still improve. We then propose seven principles for strong climate plans: including ambitious, yet attainable goals, diverse strategies, meaningful public participation and justice, coordination across actors, sectors, and plans, specific processes for implementation and monitoring, and strategies that address uncertainty. We conclude with a few promising developments that may facilitate more effective climate change planning.

The current status of climate change planning

The international planning community has not ignored climate change. Discussions of global climate change in this journal date back to 1990 (Titus, 1990). Initially, planners focused on climate change mitigation, or reducing greenhouse gas (GHG) emissions and increasing GHG

sinks. The *Cities for Climate Protection* program, led by the international organization ICLEI, provided an early framework for climate mitigation: conduct a baseline GHG emissions inventory, adopt emissions reduction targets, develop a climate action plan (CAP), implement actions, and monitor progress. Cities proved to be important climate mitigation innovators (Anguelovski & Carmin, 2011; Bulkeley, 2010) with many developing CAPs (c.f. Bassett & Shandas, 2010; Boswell, Greve, & Seale, 2010). This suggests a central role for planners in reducing GHGs, however, planning departments and professionals were rarely the main authors of CAPs (Bassett & Shandas, 2010).

Recently, the focus has broadened from mitigation to adaptation planning. Adaptation is "the process of adjustment to actual or expected climate and its effects" (IPCC, 2014b). Some cities now develop adaptation plans before mitigation plans (CAPs) (Reckien et al., 2018). A global assessment of 401 cities found that 18% were engaged in adaptation planning and cities furthest along were large cities in the global North (Araos et al., 2016). A study of 885 European cities found that 66% had a mitigation plan and 26% had an adaptation plan (Reckien et al., 2018). In the U.S., approximately 50 cities and counties have adopted stand-alone adaptation plans since 2007 (Woodruff & Stults, 2016). This growth should be applauded, but given that by 2035 more than 150 communities on the U.S. east and gulf coasts alone face chronic inundation from sea level rise (Spanger-Siegfried et al., 2017), it is insufficient.

Climate change planning is now increasingly embedded within a broader resilience agenda (Davoudi et al., 2012; Meerow & Mitchell, 2017). This is driven in part by international organizations. For example, one of the United Nations' Sustainable Development Goals is to make "cities inclusive, safe, resilient and sustainable" (Sharifi & Yamagata, 2018). The Rockefeller Foundation's *100 Resilient Cities* initiative has also been influential, supporting

cities worldwide in hiring a chief resilience officer and developing a resilience plan (Rockefeller Foundation, 2018). While climate action plans focus on mitigating GHGs and adaptation plans on preparing for the impacts of climate change, resilience plans seek to enhance communities' ability to cope with a variety of shocks and stresses – everything from earthquakes, to extreme weather, to racial inequity. Resilience plans' broader systems approach addresses certain weaknesses of climate change planning, but comes at the expense of other planning elements (van den Berg & Keenan, 2019; Woodruff, Meerow, Stults, & Wilkins, 2018). We briefly reflect on these trends, but future research should further examine these trade-offs and the implications of this resilience shift.

Even where communities develop climate mitigation, adaptation, or resilience plans, they are often lacking in ambition or quality. In an early assessment of 170 city CAPs across the U.S., Wheeler (2008) found that CAPs lacked sufficiently ambitious targets, monitoring, and failed to address adaptation. A study of 200 European cities similarly showed that while 65% of cities had a mitigation plan, their actions were insufficient to achieve GHG reduction targets and adaptation strategies were less common and concrete (Reckien et al., 2014). Adaptation plans can also be improved, particularly in terms of implementation processes (Woodruff & Stults, 2016; Baker et al., 2012; Preston et al., 2011). Resilience plans have been critiqued for providing few truly new strategies to help cities prepare for future risks (van den Berg & Keenan, 2019).

According to the American Planning Association (APA), the goal of planning is to "maximize the health, safety, and economic well-being of all people living in our communities." (APA, 2019). The APA also has an official policy recognizing that climate change "will almost certainly prove to be one of the most important planning challenges of the 21st century" (APA, 2011). We therefore believe that planners need to work with communities to ensure they are

producing high quality climate change plans. Practicing planners undoubtedly face many political pressures and constraints in climate change planning (Mitchell & Graham, 2017). Numerous studies have examined the barriers to climate change planning (Hamin, Gurran, & Emlinger, 2014; IPCC, 2014a; Moser & Ekstrom, 2010), but fewer outline what quality climate change planning entails.

We argue for seven key principles of strong climate change planning (Table 1). These are derived from the broader plan quality literature (Berke & Godschalk, 2009; Lyles & Stevens, 2014) and have been applied to evaluate climate and resilience plans (Woodruff et al., 2018; Woodruff & Stults, 2016). Here we reflect on the current state of knowledge and practice for each principle. We draw on planning literature from the last ten years and our own research on climate change adaptation and resilience planning, which is admittedly U.S. focused. While this does limit generalizability, research suggests that cities in higher-income countries like the US are the most engaged in climate change planning (Araos et al., 2016).

Table 1 about here

Set ambitious, yet attainable goals

Tackling climate change requires setting ambitious goals for reducing GHG emissions and preparing for climate change impacts. Plans should have a clear purpose, vision for the future, well-defined outcomes, and measurable objectives to achieve goals (Baker et al., 2012; Woodruff & Stults, 2016). As noted, the primary goal of climate change planning has expanded from mitigation to include adaptation. While CAPs may not set sufficiently ambitious GHG reduction targets, these mitigation plans at least have a measurable goal: reduced GHG emissions (Wheeler 2008; Reckien et al. 2014). In comparison, the goals and outcomes for adaptation

planning are difficult to define. As such, adaptation plans often lack specific goals (Woodruff and Stults 2016). Vogel et al. (2016) provide one vision of successful climate change adaptation based on lessons learned from multiple successful cities. Resilience plans tend to better define goals and objectives than climate adaptation plans and also helpfully recognize the connections between climate change and other challenges, such as aging infrastructure and systemic inequities (Woodruff et al., 2018). For example, Boston's resilience plan recognizes the need to address systemic racism to improve disaster outcomes and economic growth.

Provide a strong fact base using the best available data

To combat climate change, cities need data on current conditions, future projections, and modeled impacts (Baker et al., 2012). For mitigation planning, this entails a detailed GHG inventory, for adaptation planning the fact base usually consists of vulnerability assessments (Bassett & Shandas, 2010; IPCC, 2014a). Numerous resources provide guidance on conducting these assessments. One analysis of online adaptation resources found over 1000 related to vulnerability assessment (Nordgren, Stults, & Meerow, 2016). Plans should explain how data were collected or analyzed as well as break down emissions and vulnerability by sector and population. Vulnerability assessments should identify projected climate change impacts on the water system, natural system, built environment, economic system, public health, cultural assets, and public services. Generally, resilience plans appear weaker in terms of their fact base than climate change adaptation plans, often lacking basic climate projections or vulnerability assessments, although resilience plans better acknowledge the underlying drivers of human vulnerability (Woodruff et al., 2018).

Outline diverse strategies to achieve goals

Given the simultaneous need to mitigate and adapt, strong climate change planning will require many different strategies. These should include efforts to change planning processes, policies and design standards, land use, physical infrastructure, green infrastructure, individual behavior, education, capacity building, technology, and research (Stults & Woodruff, 2016). It is critical to rank identified strategies and attempt to calculate the costs of both implementation and inaction (Berke & Godschalk, 2009). Identifying co-benefits associated with actions – including adaptation and mitigation win-wins – is also important for broadening support, particularly in the global South, where mitigation is a lower priority than adaptation (Ayers & Huq, 2009). Green infrastructure is an increasingly popular climate change strategy worldwide, in part because of its numerous co-benefits (Kabisch et al., 2016).

Engage the public and foster justice in all planning processes

Planners generally agree on the importance of broad participation in planning processes (Burby, 2003). This same principle applies to climate change planning, yet there is room to improve procedural equity, or fair participation in decision-making (Schrock, Bassett, & Green, 2015; van den Berg & Keenan, 2019). Research suggests that CAP and adaptation planning processes are dominated by elites and technocrats (Bassett & Shandas, 2010; Haverkamp, 2017). Because of the perceived urgency for climate investments, Long and Rice (2018) point out that cities may further relegate equity concerns. Woodruff et al. (2018) found that resilience plans did a better job outlining the public engagement processes than adaptation plans, but rarely described steps taken to include marginalized communities. Stronger climate change planning should recognize and seek to address injustices and employ different participatory approaches to ensure that all

local populations can shape the framing of the climate challenge, plan development, and implementation and monitoring (c.f. Blue, Rosol, & Fast (2019) for guidance on participation parity in climate planning). The plan should outline these engagement processes and their outcomes (e.g. who participated; Woodruff & Stults, 2016).

Coordinate efforts to address climate change across actors, sectors, and plans

Concerns that climate change planning will detract from efforts to foster social justice point to the inescapable planning challenge: negotiating conflicting priorities. If anything, climate change is complicating the conflicts between economy, environment, and equity that Campbell sketched out two decades ago (Berke, 2016; Campbell, 1996). For example, cities may want to avoid new construction in flood-prone areas, but they face housing affordability and development pressures. Cities have limited resources and therefore need to coordinate efforts. Planners can use the *Plan Integration for Resilience Scorecard* to identify inconsistencies across a city's network of plans that stem from conflicting priorities and may increase vulnerability (Berke et al., 2015; Berke, Malecha, Yu, Lee, & Masterson, 2018).

One way to reduce inconsistencies is to integrate climate change into other planning efforts and seek win-win strategies. Yet incorporating future climate projections or risks into hazard mitigation, for example, is still relatively uncommon (Stults, 2017). This represents a missed opportunity, because integrating adaptation into other planning efforts – or mainstreaming – can help highlight the consequences of climate change for different sectors and the need to consider climate change in all decision-making (Woodruff, 2018). Boston's comprehensive plan, Imagine Boston 2030, provides a good example of mainstreaming. Climate change is discussed throughout the plan and projected sea level rise mapped on future land uses.

While the plan still proposes investment and development in sea level rise risk areas, incorporating climate considerations into the plan demonstrates the imperative for regulatory and protection measures in those areas.

Whether climate change is addressed in stand-alone plans or mainstreamed, it cuts across traditional sectors and jurisdictional scales, requiring collaboration. Strong climate change planning requires broad internal support within the city organization and diverse representatives from local universities, different levels of government, the private sector, nongovernmental organizations, and neighboring jurisdictions (Innes, 1996). Yet a study of 350 cities worldwide suggests that many relevant municipal agencies are only marginally involved in climate change planning (Aylett, 2015). The growing focus on resilience may be helpful in this regard, as resilience planning supposedly facilitates collaboration and breaks down siloes (Goldstein et al., 2018; Sharifi & Yamagata, 2018).

Include a clear process for implementation and monitoring

A major implementation gap remains in climate change planning. Many climate mitigation and adaptation plans exist, but few are put into practice and monitored, or even outline clear steps for doing so (Moser, Coffee, & Seville, 2017; Woodruff & Stults, 2016). One study in the United Kingdom found that while over 80 percent of local governments had conducted climate risk assessments by 2010, less than 40 percent had a plan for addressing them, none of which had been implemented (Porter, Demeritt, & Dessai, 2015). Correspondingly, many resources focus on the early planning phases, with fewer for implementation and monitoring (Nordgren et al., 2016). To facilitate implementation, plans should have a clear timeline, funding source, and responsible organization for each strategy. Research suggests that mainstreaming climate change

into other sectors or plans increases adoption, so even if a stand-alone climate change plan is being developed, it should be linked to other planning efforts (Vogel et al., 2016; Smit & Wandel, 2006).

Access to funding and finance have been persistent challenges to implementation (Shi, Chu, & Carmin, 2015; Hinkel et al., 2018). But some cities are creatively applying existing financing instruments to fund adaptation projects. For example, San Francisco is proposing a general obligation bond and a special tax on waterfront property to begin fortifying the 3-mile seawall that protects its iconic waterfront area (Seawall Finance Work Group, 2017). Cities may also consider resilience fees or insurance-based fees, which provide a new revenue stream while also creating a market signal for developers to avoid high-risk areas or to invest in risk reduction (Levy & Hurst 2018).

It is critical to monitor plans' implementation and evaluate outcomes. Plans should outline the method of evaluation, responsible parties, and requirements for reporting and updating. This is relatively straightforward with climate change mitigation, which focuses on reducing GHG emissions. Indicators and metrics for evaluating adaptation are much more contested and clearly an avenue for future research (Arnott, Moser, & Goodrich, 2016).

It is important to monitor who is being affected by climate change planning. Most climate justice discussions have focused on the inherent injustice of global climate change; namely that the people and countries most impacted are not the primary contributors of GHG emissions (Bulkeley, Edwards, & Fuller, 2014). Recent studies have also pointed to justice issues inherent to local climate change planning. First, there may be inequities between cities in terms of their capacity and resources to plan for climate change. Studies find that city size and wealth are predictors of whether they will plan for climate change (Shi, Chu, & Debats, 2015). Within

cities, climate change – like other disasters – will have disproportionate impacts on vulnerable communities including children, the disabled, and the elderly. These and other marginalized groups tend to live in more vulnerable areas, have less resilient housing, access to fewer resources to deal with disasters, and limited options for evacuation or relocation (Shi et al., 2016). These inequalities may be exacerbated by adaptation investments. Anguelovski et al. (2016) document a number of international examples of adaptation planning having negative justice implications, which they group into acts of commission –whereby efforts displace poor communities – and acts of omission, or instances where investments prioritize wealthier communities. Adaption investments may also lead to climate gentrification, where perceived climate vulnerability (either because of geography or protective infrastructure) make safer parts of a community more attractive, driving up real estate prices and either displacing or excluding low income populations. Evidence from Miami suggests that this may already be happening, with higher elevation properties appreciating more (Keenan, Hill, & Gumber, 2018). This highlights the importance for planners to examine the consequences of adaptation strategies for disadvantaged populations and couple adaptation strategies with housing policies that protect existing neighborhoods (Levy & Herst 2018).

Address climate change uncertainty

Numerous uncertainties, from scientists' imperfect understanding of physical climate processes to unknown future GHG emissions and political responses, make climate change planning difficult (Stults & Larsen, 2018). Many of planners' responsibilities entail managing uncertainty, so planners are equipped to address climate uncertainty (Berke & Lyles 2013). Plans should identify sources of uncertainties and consider different scenarios reflecting the range of

possibilities. One promising strategy is adaptive management, a flexible, iterative governance approach whereby adjustments are regularly made based on new information learned through system monitoring (Tompkins & Adger, 2004). Another is to prioritize no- or low-regret strategies that would be beneficial regardless of future climate impacts (Preston, Westaway, & Yuen, 2011). When evaluating different scenarios, it is useful to prioritize robust strategies that are effective across a range of possible climate futures (Lempert, 2000). At a minimum, plans should acknowledge the need for strategies that account for uncertainty. Yet a recent assessment of 44 U.S. adaptation plans found none use of scenario planning or robust strategies (Stults & Larsen, 2018)**,** and resilience plans were even worse in addressing uncertainty (Woodruff et al., 2018).

Seeds of good climate change planning

While communities and planners are still not doing enough to plan for climate change, there is some cause for optimism. We end here by highlighting a few promising "seeds" for climate change planning (Bennett et al., 2016). First, surveys show that the public is increasingly concerned about climate change. (Leiserowitz et al., 2018; Poushter & Huang, 2019). Second, communities worldwide are increasingly developing climate change mitigation, adaptation, and resilience plans and exploring novel approaches (Reckien et al., 2018; Woodruff & Stults, 2016). Third, planners have a wealth of resources for climate change planning at their fingertips, from the APA, the American Society of Adaptation Professionals, the Urban Sustainability Directors Network, EcoAdapt, and more. One effort to catalogue adaptation-related tools found over 3500 resources from over eighty organizations, which is promising, but also makes it challenging for practitioners to locate what they need (Nordgren et al., 2016). There is a clear need to document,

curate, and share climate change planning successes to inform practice and increase support (Moser et al., 2017).

Planners' ability to think long-term, handle uncertainty, integrate across systems, and bring together diverse actors aligns well with skillsets required for climate action (Berke & Lyles, 2013; Crane & Landis, 2010; Mitchell & Graham, 2017). Indeed, adaptation plans prepared by planners demonstrate stronger goals, strategies, implementation and monitoring, and coordination than plans prepared by other actors (Woodruff and Stults 2016). Urban planners must continue to work towards better climate change planning, and we believe that focusing on the seven principles discussed in this paper is a good way to start.

References

Anguelovski, I., & Carmin, J. (2011). Something borrowed, everything new: innovation and institutionalization in urban climate governance. *Current Opinion in Environmental Sustainability*, *3*(3), 169–175. https://doi.org/10.1016/j.cosust.2010.12.017

Anguelovski, I., Shi, L., Chu, E., Gallagher, D., Goh, K., Lamb, Z., … Teicher, H. (2016). Towards Critical Studies of Climate Adaptation Planning: Uncovering the Equity Impacts of Urban Land Use Planning. *Journal of Planning Education and Research, 36(3),* 333-348. https://doi.org/10.1177/0739456X16645166

APA. (2011). *American Planning Association Policy Guide on Planning & Climate Change*. Retrieved from https://www.planning.org/policy/guides/adopted/climatechange.htm

Araos, M., Berrang-Ford, L., Ford, J. D., Austin, S. E., Biesbroek, R., & Lesnikowski, A. (2016). Climate change adaptation planning in large cities: A systematic global assessment.

Environmental Science and Policy, *66*, 375–382. https://doi.org/10.1016/j.envsci.2016.06.009

Arnott, J. C., Moser, S. C., & Goodrich, K. A. (2016). Evaluation that counts: A review of climate change adaptation indicators & metrics using lessons from effective evaluation and science-practice interaction. *Environmental Science & Policy*, *66*, 383–392. https://doi.org/10.1016/j.envsci.2016.06.017

Ayers, J. M., & Huq, S. (2009). The value of linking mitigation and adaptation: a case study of Bangladesh. *Environmental Management*, *43*(5), 753–764. https://doi.org/10.1007/s00267-008-9223-2

Aylett, A. (2015). Institutionalizing the urban governance of climate change adaptation: Results of an international survey. *Urban Climate*, *14*, 4–16. https://doi.org/10.1016/j.uclim.2015.06.005

Baker, I., Peterson, A., Brown, G., & McAlpine, C. (2012). Local government response to the impacts of climate change: An evaluation of local climate adaptation plans. *Landscape and Urban Planning*, *107*(2), 127–136. https://doi.org/10.1016/j.landurbplan.2012.05.009

Bassett, E., & Shandas, V. (2010). Innovation and climate action planning: Perspectives from municipal plans. *Journal of the American Planning Association*, *76*(4), 435–450. https://doi.org/10.1080/01944363.2010.509703

Bennett, E. M., Solan, M., Biggs, R., McPhearson, T., Norström, A. V., Olsson, P., … Xu, J. (2016). Bright spots: seeds of a good Anthropocene. *Frontiers in Ecology and the Environment*, *14*(8), 441–448. https://doi.org/10.1002/fee.1309

Berke, P., & Godschalk, D. (2009). Searching for the Good Plan: A Meta-Analysis of Plan Quality Studies. *Journal of Planning Literature*, *23*(3), 227–240. https://doi.org/10.1177/0885412208327014

Berke, P. R., Malecha, M. L., Yu, S., Lee, J., & Masterson, J. H. (2019). Plan integration for resilience scorecard: evaluating networks of plans in six US coastal cities. *Journal of Environmental Planning and Management*, 62(5), 901-920. https://doi.org/10.1080/09640568.2018.1453354

Berke, Philip. (2016). Twenty Years After Campbell's Vision: Have We Achieved More Sustainable Cities? *Journal of the American Planning Association*, *82*(4), 380–382. https://doi.org/10.1080/01944363.2016.1214539

Berke, Philip, & Lyles, W. (2013). Planning in the Age of Uncertainty Public Risks and the Challenges to Climate-Change Adaptation: A Proposed Framework for Planning in the Age of Uncertainty. *Cityscape*, *15*(1), 181–208.

Berke, Philip, Newman, G., Lee, J., Combs, T., Kolosna, C., & Salvesen, D. (2015). Evaluation of Networks of Plans and Vulnerability to Hazards and Climate Change: A Resilience Scorecard. *Journal of the American Planning Association*, *81*(4), 287–302. https://doi.org/10.1080/01944363.2015.1093954

Bevis, M., Harig, C., Khan, S. A., Brown, A., Simons, F. J., Willis, M., … Nylen, T. (2019). Accelerating changes in ice mass within Greenland, and the ice sheet's sensitivity to atmospheric forcing. *Proceedings of the National Academies of Sciences*, 1–6. https://doi.org/10.1073/pnas.1806562116

Blue, G., Rosol, M., & Fast, V. (2019). Justice as Parity of Participation. *Journal of the American Planning Association*, 1–14. https://doi.org/10.1080/01944363.2019.1619476

Boswell, M. R., Greve, A. I., & Seale, T. L. (2010). An assessment of the link between greenhouse gas emissions inventories and climate action plans. *Journal of the American Planning Association*, *76*(4), 451–462. https://doi.org/10.1080/01944363.2010.503313

Bulkeley, H. (2010). Cities and the Governing of Climate Change. *Annual Review of Environment and Resources*, *35*(1), 229–253. https://doi.org/10.1146/annurev-environ-072809-101747

Bulkeley, H., Edwards, G. A. S., & Fuller, S. (2014). Contesting climate justice in the city: Examining politics and practice in urban climate change experiments. *Global Environmental Change*, *25*, 31–40. https://doi.org/10.1016/j.gloenvcha.2014.01.009

Burby, R. J. (2003). Making plans that matter: Citizen involvement and government action. *Journal of the American Planning Association*, *69*(1), 33–49. https://doi.org/10.1080/01944360308976292

Campbell, S. (1996). Green Cities, Growing Cities, Just Cities?: Urban Planning and the Contradictions of Sustainable Development. *Journal of the American Planning Association*, *62*(3), 296–312. https://doi.org/10.1080/01944369608975696

Cheng, L., Abraham, J., Hausfather, Z., & Trenberth, K. E. (2019). How fast are the oceans warming? *Science*, *363*(6423), 128–129. https://doi.org/10.1126/science.aav7619

Crane, R., & Landis, J. (2010). Introduction to the special issue: Planning for climate change:

Assessing progress and challenges. *Journal of the American Planning Association*, *76*(4), 389–401. https://doi.org/10.1080/01944363.2010.512036

Davoudi, S., Shaw, K., Haider, L. J., Quinlan, A. E., Peterson, G. D., Wilkinson, C., … Porter, L. (2012). Resilience: A Bridging Concept or a Dead End? "Reframing" Resilience: Challenges for Planning Theory and Practice Interacting Traps: Resilience Assessment of a Pasture Management System in Northern Afghanistan Urban Resilience: What Does it Mean in Planni. *Planning Theory & Practice*, *13*(2), 299–333. https://doi.org/10.1080/14649357.2012.677124

Goldstein, B. E., Chase, C., Frankel-Goldwater, L., Osborne-Gowey, J., Risien, J., & Schweizer, S. (2018). *Transformative Learning Networks: Guidelines and Insights for Netweavers* (No. 2018–01). Boulder, CO. https://doi.org/10.5663/aps.v1i1.10138

Hamin, E. M., Gurran, N., & Emlinger, A. M. (2014). Barriers to municipal climate adaptation: Examples from coastal massachusetts smaller cities and towns. *Journal of the American Planning Association*, *80*(2), 110–122. https://doi.org/10.1080/01944363.2014.949590

Haverkamp, J. A. R. (2017). Politics, values, and reflexivity: The case of adaptation to climate change in Hampton Roads, Virginia. *Environment and Planning A*, *49*(11), 2673–2692. https://doi.org/10.1177/0308518X17707525

Innes, J. E. (1996). Planning through consensus building: A new view of the comprehensive planning ideal. *Journal of the American Planning Association*, *62*(4), 460-472. https://doi.org/10.1080/01944369608975712

IPBES. (2019). *Global assessment report on biodiversity and ecosystem services of the*

Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. (E. S. Brondizio, J. Settele, S. Díaz, & H. T. Ngo, Eds.). Bonn, Germany: IPBES Secretariat. Retrieved from https://www.ipbes.net/global-assessment-biodiversity-ecosystem-services

IPCC. (2014a). Adaptation Planning and Implementation. In C. B. Field, V. R. Barros, D. J. Dokken, K. J. Mach, M. D. Mastrandrea, T. E. Bilir, … L. L. White (Eds.), *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (pp. 869–898). Cambridge: Cambridge University Press.

IPCC. (2014b). Annex II: Glossary. In K. J. Mach, S. Planton, & C. von Stechow (Eds.), *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (pp. 117–130). Geneva, Switzerland: IPCC.

IPCC. (2018). *Global warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change,*. (V. Masson-Delmotte, P. Zhai, H. O. Pörtner, D. Roberts, J. Skea, P. R. Shukla, … T. W. P. Z, Eds.). Geneva, Switzerland.

Kabisch, N., Frantzeskaki, N., Pauleit, S., Naumann, S., Davis, M., Artmann, M., … Bonn, A. (2016). Nature-based solutions to climate change mitigation and adaptation in urban areas - perspectives on indicators, knowledge gaps, barriers and opportunities for action. *Ecology and Society*, *21*(2). https://doi.org/10.5751/ES-08373-210239

Keenan, J. M., Hill, T., & Gumber, A. (2018). Climate gentrification: from theory to empiricism in Miami-Dade County, Florida. *Environmental Research Letters*, *13*, 054001.

Le Quéré, C., Andrew, R. M., Friedlingstein, P., Sitch, S., Hauck, J., Pongratz, J., … Zheng, B. (2018). Global Carbon Budget 2018. *Earth Syst. Sci. Data*, *10*, 2141–2194. https://doi.org/10.5194/essd-10-2141-2018

Leiserowitz, A., Maibach, E., Rosenthal, S., Kotcher, J., Ballew, M., Goldberg, M., & Gustafson, A. (2018). *Climate Change in the American Mind*. New Haven, CT.

Lempert, R. J. (2000). Robust strategies for abating climate change. *Climatic Change*, *45*, 387–401. https://doi.org/10.1023/A:1005698407365

Levy, David L., & Herst, Rebecca. (2018). *Financing Climate Resilience: Mobilizing Resources and Incentives to Protect Boston from Climate Risks*. Sustainable Solutions Lab, University of Massachusetts Boston, Boston, MA. Retrieved from https://www.greenribboncommission.org/wp-content/uploads/2018/04/Financing-Climate-Resilience-April-2018.pdf

Lyles, W., & Stevens, M. (2014). Plan Quality Evaluation 1994-2012: Growth and Contributions, Limitations, and New Directions. *Journal of Planning Education and Research*, *34*(4), 433–450. https://doi.org/10.1177/0739456X14549752

Meerow, S., & Mitchell, C. L. (2017). Weathering the storm: The politics of urban climate change adaptation planning. *Environment and Planning A*. *49*(11), 2619-2627. https://doi.org/10.1177/0308518X17735225

Mitchell, C. L., & Graham, A. (2017). Evidence-Based Advocacy for Municipal Climate Change Action. *Journal of Planning Education and Research*, 1-13. https://doi.org/10.1177/0739456X17740939

Moser, S. C., Coffee, J., & Seville, A. (2017). *Rising to the Challenge, Together: A Review and critical assessment of the state of the US climate adaptation field*. The Kresge Foundation. https://kresge.org/sites/default/files/library/rising_to_the_challenge_together_linked_0.pdf

Moser, S. C., & Ekstrom, J. A. (2010). A framework to diagnose barriers to climate change adaptation. *Proceedings of the National Academy of Sciences of the United States of America*, *107*(51), 22026–22031. https://doi.org/10.1073/pnas.1007887107/-/DCSupplemental.www.pnas.org/cgi/doi/10.1073/pnas.1007887107

NOAA National Centers for Environmental Information (NCEI). (2018). U.S. Billion-Dollar Weather and Climate Disasters. https://www.ncdc.noaa.gov/billions/

Nordgren, J., Stults, M., & Meerow, S. (2016). Supporting local climate change adaptation : Where we are and where we need to go. *Environmental Science and Policy*, *66*(2016), 344–352. https://doi.org/10.1016/j.envsci.2016.05.006

Porter, J. J., Demeritt, D., & Dessai, S. (2015). The right stuff? Informing adaptation to climate change in British Local Government. *Global Environmental Change*, *35*, 411–422. https://doi.org/10.1016/j.gloenvcha.2015.10.004

Poushter, J., & Huang, C. (2019, February 10). Climate change still seen as the top global threat, but cyberattacks a rising concern. *PEW Research Center*. Retrieved from https://www.pewresearch.org/global/2019/02/10/climate-change-still-seen-as-the-top-

global-threat-but-cyberattacks-a-rising-concern/

Preston, B. L., Westaway, R. M., & Yuen, E. J. (2011). Climate adaptation planning in practice: an evaluation of adaptation plans from three developed nations. *Mitigation and Adaptation Strategies for Global Change*, *16*(4), 407–438. https://doi.org/10.1007/s11027-010-9270-x

Reckien, D., Flacke, J., Dawson, R. J., Heidrich, O., Olazabal, M., Foley, A., … Pietrapertosa, F. (2014). Climate change response in Europe: What's the reality? Analysis of adaptation and mitigation plans from 200 urban areas in 11 countries. *Climatic Change*, *122*(1–2), 331–340. https://doi.org/10.1007/s10584-013-0989-8

Reckien, Diana, Salvia, M., Heidrich, O., Marco, J., Pietrapertosa, F., Gregorio-hurtado, S. De, … Dawson, R. (2018). How are cities planning to respond to climate change ? Assessment of local climate plans from 885 cities in the EU-28 ska Lorencov a. *Journal of Cleaner Production*, *191*, 207–219. https://doi.org/10.1016/j.jclepro.2018.03.220

Rockefeller Foundation. (2018). What is urban resilience? Retrieved from http://www.100resilientcities.org/resources/#section-1

Schrock, G., Bassett, E. M., & Green, J. (2015). Pursuing Equity and Justice in a Changing Climate: Assessing Equity in Local Climate and Sustainability Plans in U.S. Cities. *Journal of Planning Education and Research*, *35*(3), 282–295. https://doi.org/10.1177/0739456X15580022

Seawall Finance Work Group. (2017). *Fortifying San Francisco's Great Sewall: Strategies for Funding the Seawall Resiliency Project*. San Francisco, CA.

Sharifi, A., & Yamagata, Y. (2018). Resilience-Oriented Urban Planning. In *Resilience-Oriented Urban Planning* (pp. 3–27). Lecture Notes in Energy 65, Springer. https://doi.org/10.1007/978-3-319-75798-8_1

Shi, L., Chu, E., & Debats, J. (2015). Explaining Progress in Climate Adaptation Planning Across 156 U.S. Municipalities. *Journal of the American Planning Association*, *81*(3), 191–201. https://doi.org/10.1080/01944363.2015.1074526

Smit, B., & Wandel, J. (2006). Adaptation, adaptive capacity and vulnerability. *Global Environmental Change*, *16*(3), 282–292. https://doi.org/10.1016/j.gloenvcha.2006.03.008

Spanger-Siegfried, E., Dahl, K., Caldas, A., Udvardy, S., Cleetus, R., Worth, P., & Hammer, N. (2017). *When Rising Seas Hit Home: Hard Choices Ahead for Hundreds of US Coastal Communities*. Retrieved from https://www.ucsusa.org/RisingSeasHitHome

Stults, M. (2017). Integrating climate change into hazard mitigation planning: Opportunities and examples in practice. *Climate Risk Management*, *17*, 21–34. https://doi.org/10.1016/j.crm.2017.06.004

Stults, M., & Larsen, L. (2018). Tackling Uncertainty in US Local Climate Adaptation Planning. *Journal of Planning Education and Research*. https://doi.org/10.1177/0739456X18769134

Stults, M., & Woodruff, S. C. (2016). Looking under the hood of local adaptation plans: shedding light on the actions prioritized to build local resilience to climate change. *Mitigation and Adaptation Strategies for Global Change*, 1–31. https://doi.org/10.1007/s11027-016-9725-9

Titus, J. G. (1990). Strategies for adapting to the greenhouse effect. *Journal of the American Planning Association*, *56*(3), 311–323. https://doi.org/10.1080/01944369008975775

Tompkins, E. L., & Adger, W. N. (2004). Does Adaptive Management of Natural Resources Enhance Resilience to Climate Change?, *Ecology and Society*, *9*(2): 10. http://www.ecologyandsociety.org/vol9/iss2/art10/

van den Berg, H. J., & Keenan, J. M. (2019). Dynamic vulnerability in the pursuit of just adaptation processes: A Boston case study. *Environmental Science and Policy*, *94*, 90–100. https://doi.org/10.1016/j.envsci.2018.12.015

Vogel, J., Carney, K. M., Smith, J. B., Herrick, C., Stults, M., O'Grady, M., … Giangola, L. (2016). *Climate Adaptation: The State of Practice in U.S. Communities*. Retrieved from https://kresge.org/sites/default/files/library/climate-adaptation-the-state-of-practice-in-us-communities-full-report.pdf

Wheeler, S. M. (2008). State and Municipal Climate Change Plans. *Journal of the American Planning Association*, *74*(4), 481–496. https://doi.org/Yes

Woodruff, S. C. (2018). Coordinating Plans for Climate Adaptation. *Journal of Planning Education and Research*, 1–13. https://doi.org/10.1177/0739456X18810131

Woodruff, S. C., Meerow, S., Stults, M., & Wilkins, C. (2018). Adaptation to Resilience Planning: Alternative Pathways to Prepare for Climate Change. *Journal of Planning Education and Research*, 0739456X1880105. https://doi.org/10.1177/0739456X18801057

Woodruff, S. C., & Stults, M. (2016). Numerous strategies but limited implementation guidance

in US local adaptation plans. *Nature Climate Change*, *6*(8), 796–802. https://doi.org/10.1038/nclimate3012