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# Supporting local climate change adaptation: Where we are and where we need to go

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### ABSTRACT

Local governments are on the front line of efforts to address climate-related impacts. Recognizing this, there is a growing movement to develop and deliver tools, resources, and services to support local communities' climate adaptation initiatives. There is, however, limited understanding of what specific types of resources exist and how well these resources match the needs of local practitioners. To bring clarity to these questions, we: 1) assessed the current landscape of climate-adaptation resources and services; 2) surveyed community practitioners to learn how well these resources align with their needs; and 3) convened leading service providers and local practitioners to identify strategic opportunities for moving the adaptation field forward. Findings demonstrate that existing services and resources are meeting the early phases of local adaptation efforts such as conducting vulnerability assessments and creating adaptation plans, but are failing to meet the needs associated with implementing, monitoring, and evaluating adaptation activities. Additionally, a lack of funding and staff time to support adaptation, as well as inaccessible resource formats are barriers impeding local climate adaptation efforts. The mismatch between the types and formats of services being provided and the needs of local governments means that more work is needed to ensure that climate adaptation resources are responsive to the existing and future needs of local governments. Moreover, our research finds that there is a strong and growing need to organize and streamline the climate adaptation resource and service landscape so that practitioners can easily, effectively, and efficiently access the resources they need to build more resilient local communities.

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## 1. Introduction

Local governments undertake a wide array of activities in the course of fulfilling their responsibilities to ensure the health, safety, and general welfare of their citizenry (Allan and Bryant, 2012; Norton, 2011). From sanitation services to the provision of emergency response and land use planning, local governments provide numerous services that make life in our local communities desirable (Amundsen, 2013; Homsy and Warner, 2015; Laukkonen et al., 2009). Over the last few decades, however, the ability of local governments to provide these services in a cost-effective and efficient manner has been challenged by factors such as the Great Recession, changing economic profiles, and the downsizing of staff.

In addition to economic impacts, local governments must also contend with the impacts associated with a changing climate (Hunt and Watkiss, 2011; Wamsler et al., 2013). From drought to heat waves, flooding, and vector-borne diseases, the impacts of climate change have and will continue to be felt most acutely at the local level (Bierbaum et al., 2013). Since most decisions in the U.S. about land use, infrastructure, hazard mitigation, and water resources are made at the local level, it is imperative that local communities find ways to integrate climate considerations into their planning and management activities (Berke et al., 2015; Betsill, 2001).

Unfortunately, most local governments lack the in-house capacity or expertise needed to engage with the added complexity associated with climate change (Bierbaum et al., 2013). Moreover, recent economic hardships have led to reductions in the basic resources (financial and human capital) that local governments have to undertake their work precisely at a time when issues such as climate change are creating new challenges and demands (Zimmerman and Faris, 2011).

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Given these circumstances, local governments are turning to external agents for assistance with understanding local climate impacts, devising plans to prepare for future impacts, and acquiring the public and political support needed to embrace climate action (Hughes, 2015). A rapidly growing number of information hubs, publications, tools, training materials, and consulting services have been developed to meet growing demands for climate-related resources. To-date, however, the content and quality of these resources have not been assessed, cataloged, or evaluated, and there is little understanding of whether these resources are meeting the needs of local practitioners.

This paper strives to fill these voids by answering three questions: 1) what types of services and resources currently exist to support local climate-adaptation activities; 2) how well do these resources align with the needs of local practitioners; and 3) what is needed to move local climate adaptation activities forward?

### 1.1. The local adaptation landscape

The global climate is changing (Intergovernmental Panel on Climate Change, 2014). Impacts associated with these changes are felt most acutely at the local level (Baker et al., 2012; Bierbaum et al., 2014). In light of this, a number of communities are beginning to prepare for current and projected future climatic changes (Thayer et al., 2013). To support and track their efforts, the adaptation community created a five-step climate adaptation process that includes: 1) identifying and assessing vulnerabilities/risks; 2) planning; 3) implementing strategies; 4) monitoring and evaluating; and 5) revising and sharing lessons learned (Bierbaum et al., 2014; Intergovernmental Panel on Climate Change, 2014; Moser and Ekstrom, 2010) (Fig. 1).

In recent years, a number of surveys and case studies have been developed to assess how local communities are progressing through the adaptation process. A survey conducted by Brody et al. (2010) looking at both efforts to reduce greenhouse gas emissions (mitigation) and prepare for climate impacts (adaptation) at the sub-national level found that decision-makers across sectors have low to extremely low concern about climate change. This translated into little to no climate action in their sample ( $n=579$ ). In a more focused analysis of local climate plans, Wheeler (2008) found that communities are planning to mitigate climate change across multiple sectors, but plans contain virtually no strategies aimed at adapting. Bassett and Shandas (2010) found

similar results, noting that virtually no plan in their sample “contained any notable discussion of strategies for adapting to climate change” (p. 440).

More recently, Carmin et al. (2012) conducted a global study of local communities’ adaptation initiatives, 156 of which were in the U.S. The sample included local government members ofICLEI-Local Governments for Sustainability, a membership association of local communities focused on climate and sustainability. Sixty percent of their U.S. respondents were somewhere within the adaptation cycle, with 24% just beginning to initiate their adaptation process, 27% in the vulnerability analysis or planning stages, and 9% in the implementation stage (Carmin et al., 2012; Shi et al., 2015). These results suggest that while adaptation action in the U.S. is still nascent, a growing number of communities are initiating efforts to prepare for climate-related impacts (Carmin et al., 2012; Hansen et al., 2013; Hughes, 2015).

In an attempt to compile a more holistic snapshot of local adaptation initiatives, Hughes (2015) conducted a meta-analysis of U.S. cities’ adaptation efforts by analyzing 54 pieces of peer-reviewed literature, government reports, white papers, and non-governmental organization reports. The author found that “urban adaptation planning is primarily framed as, and motivated by, the need to protect valuable assets and reduce the city’s vulnerability” (p. 23). Berrang-Ford et al. (2011) found similar results through their search of English-language peer-reviewed literature, noting that most of the literature focuses on local vulnerability assessments, not on adaptation actions.

In a report providing detailed case studies of 18 U.S. communities, Abt Associates (2016) found that early adaptation actors are similarly focused on vulnerability reduction, emphasizing the reduction in exposure<sup>1</sup> and sensitivity.<sup>2</sup> The researchers also concluded that existing adaptation initiatives often fail to address issues related to the unequal distribution of climate impacts, pointing to equity concerns (Abt Associates, 2016); a result mirrored by Hughes (2015), Aylett (2015), and Schrock et al. (2015).

### 1.2. Barriers and constraints to local adaptation activity

In addition to understanding where local communities are in the adaptation process, a significant body of literature focuses on understanding why communities do or do not take climate action. This literature generally concentrates on factors that enable or constrain local government climate adaptation activities. Political leadership, previous disaster experience, and membership in climate-oriented organizations have all been shown to impact whether a community acts on climate change or not (Tang et al., 2010; Woodruff and Stults, 2016).

Barriers impeding or slowing climate adaptation action commonly include: difficulty in understanding climate science (Bassett and Shandas, 2010; Fünfgeld, 2010), lack of staffing capacity (Aylett, 2015; Shi et al., 2015; Thayer et al., 2013), limited financial resources (Angelovski and Carmin, 2011; Hunt and Watkiss, 2011) and lack of leadership (Amundsen et al., 2010; Bedsworth and Hanak, 2013; Bulkeley, 2010; Measham et al., 2011; Moser, 2009). More recently, practitioners have cited the sheer volume of adaptation-related services and resources as an impediment to their adaptation efforts (Lawrence et al., 2013; Stults et al., 2015).

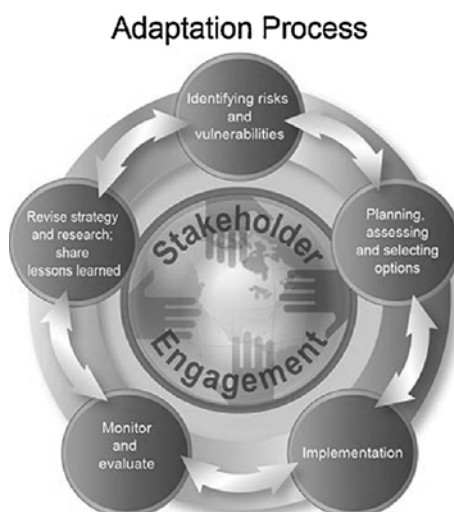


Fig. 1. Basic Adaptation Process Cycle per the 2014 U.S. National Climate Assessment.

<sup>1</sup> Exposure is defined by the Intergovernmental Panel on Climate Change (2014) as “the presence of people, livelihoods, etc., in places that could be adversely affected by changing climate conditions”.

<sup>2</sup> Sensitivity is defined by the Intergovernmental Panel on Climate Change (2014) as “the degree to which a system or species is affected by climate variability or change”.

The common barriers identified in these studies suggest an increased understanding of the causes of inaction. The question remains, what can be done to address these challenges? Many nonprofit organizations, academic institutions, and higher branches of government are working to resolve these barriers by developing services such as trainings, case studies, and customized climate downscaling services. What is not understood, however, is if, and how, existing resources are meeting local practitioner needs. If not, what can be done to make existing resources more useful and usable for local practitioners? Given the rate at which the climate adaptation field is growing, it is essential for the positive growth of the field to understand: 1) what is already available; 2) how useful existing resources are in supporting the goals of practitioners; and 3) what resource gaps still exist.

## 2. Methods

The project consisted of three phases: 1) mapping climate adaptation services and resources; 2) surveying local government practitioners; and 3) convening climate-adaptation service providers and local government stakeholders.

### 2.1. Phase I: mapping climate adaptation services and resources

Using researcher knowledge, expert elicitation, and an online search, we created a list of organizations producing locally relevant climate adaptation resources and services. Our focus was on nonprofit and boundary organizations (Cash et al., 2006; Engle and Lemos, 2010) as well as those organizations creating resources that are applicable to a variety of local communities (i.e., place-based organizations were excluded). This list was validated with the project's advisory committee, composed of seven adaptation thought-leaders, and three select local government representatives prominently working on climate adaptation. Recommended additions were integrated into the organizational list, which resulted in 85 unique organizations (see Supplementary material).

We then developed a codebook of information to be captured from each of the adaptation-resources available from the 85 organizations. This codebook (see Supplementary material) was developed in partnership with local government representatives to ensure that the material captured during coding was relevant to and structured in a way that is reflective of how local government staff look for resources. The codebook was pre-tested by all researchers on five organizations not included in our final sample, to ensure consistency in coding. This resulted in modest revisions to the codebook. The final codebook was then used to code and categorize all of the publicly available resources and services provided by the 85 organizations.

After coding an organization's climate adaptation resources, we sent the completed results to each organization for review. Each organization was asked to ensure that: 1) all organizationally relevant climate adaptation resources were captured, and 2) all resources were classified appropriately. All suggested additions and revisions were addressed. Once completed, we created a database of all resources available from the 85 organizations. This database was analyzed to determine the types of adaptation-related resources available, the sectors supported by each resource, the phase of the adaptation process supported by each resource, and the climate impact being addressed by each resource.

### 2.2. Phase II: surveying local government practitioners

In the spring of 2014, we conducted an online survey of local practitioners to assess the types of climate resilience services being used, the types of resources and services needed, and the preferred

format for resources. We conducted three rounds of pilot testing and revisions both with survey experts at the University of Michigan's Institute for Social Research and with local government staff in Ann Arbor, MI; Flagstaff, AZ; and Cambridge, MA. The survey instrument was built using the online software Qualtrics.

The final survey consisted of 24 questions (23 multiple-choice and 1 open answer); seven of which were included in this analysis (See Supplementary material). The survey was jointly administered through three nonprofit local government membership associations: ICLEI-Local Governments for Sustainability (ICLEI), the Urban Sustainability Directors Network (USDN), and the National League of Cities (NLC). All three organizations sent the survey to their full membership lists. The survey ran from March 27, 2014 through May 6, 2014. Bi-weekly reminders were sent by ICLEI, USDN, and NLC encouraging their members to complete the survey. In addition, three \$1000 scholarships to attend the 2015 National Adaptation Forum in St. Louis, MO were randomly awarded to individuals that completed the survey. Final survey results were statistically analyzed for themes and trends.

### 2.3. Phase III: convening local government climate-adaptation service providers and local government stakeholders

The final phase of the project included a two-day meeting of 53 individuals from 48 organizations. Attendees came from: 1) organizations that provide local climate adaptation services and resources; 2) local governments; or 3) the research team (see Supplementary Material). Climate-adaptation resource providers were intentionally over-represented in order to maintain the meeting's focus on local adaptation services and resources as well as to foster relationship building amongst members of the provider community.

The meeting was held in May 2014 at the Garrison Institute in Garrison, NY. Four objectives guided the workshop:

1. Develop a shared understanding of the types of resources available for local and regional climate adaptation practitioners;
2. Identify opportunities to address key gaps in support of local and regional adaptation initiatives;
3. Prioritize areas for investment and/or action; and
4. Foster relationships among meeting participants.

The workshop agenda was crafted to enable multi-way engagement between the researchers, service providers, and local government representatives. Prior to arriving onsite, participants were provided a brief summary of the results from Phases I and II. The workshop also began with two 15-min presentations on Phase I and II findings. Throughout the remainder of the workshop, facilitated discussions were used to glean insights from participants about the state of the adaptation field. The workshop concluded with a series of brainstorming sessions and a large plenary focused on needed next steps to advance the local climate adaptation field.

## 3. Results

### 3.1. Phase I: mapping climate adaptation services and resources

3565 discrete climate adaptation-related services or tools were identified between the 85 organizations analyzed. All resources were coded based on type, phase of the planning process they support, and impact they seek to address. In cases where a resource was applicable to more than one planning phase or impact, all relevant categories were included in the coding. In cases where a resource was applicable to all categories (i.e., all phases of the planning process), the resource was coded as 'generic.' Table 1

**Table 1**  
Total Number and Percentage of Resources By Type.

Type of Resource	Total Number Coded	Percentage
Fact Sheet	639	17.6%
Best Practice/Case Study	605	16.6%
Scientific Report/Data Source	579	15.9%
Webinar	357	9.8%
Library	333	9.1%
Project in the Field	232	6.4%
Talking Points	216	5.9%
Planning Guide	172	4.7%
Tools	169	4.6%
Trainings/Workshops	121	3.3%
Newsletter	51	1.4%
Network	45	1.2%
Blog	39	1.1%
Curriculum	20	0.6%
Grants	17	0.5%
Pledge/Political Activism	18	0.5%
Consulting	15	0.4%
Clearinghouse	8	0.2%
Monitoring and Evaluation	6	0.2%

denotes the total number and percentage of resources available by “type”. The most common type of resources found were fact sheets (17.6%), best practices/case studies (16.6%), and scientific reports and data sources (15.9%) (Stults et al., 2015). The least common types were monitoring and evaluation resources (0.2%) and adaptation clearinghouses (0.2%).

Most of the available resources support the early phases of adaptation planning (vulnerability assessments – 29.5% and adaptation planning – 26.7%, respectively) (Table 2). Minimal resources were found that support the later phases of the adaptation process such as implementation (13.6%), financing adaptation (5.5%), and monitoring and evaluating adaptation efforts (5.8%).

The majority of resources coded (54.5%) did not focus on addressing any specific climate impact (Table 3). Of those that did, stormwater and flooding related resources (20.9%) and resources supporting communities in preparing for sea level rise or coastal erosion (13.6%) were the most common. The least common climate impacts targeted in existing resources are extreme heat (4%) and forest fires (4.3%).

### 3.2. Phase II: surveying local government practitioners

Approximately 1200 individuals received the link to complete the practitioner survey. Nearly one quarter, or 291 respondents, completed at least 75% of all questions and were, therefore, included in our analysis. The exact number of individuals that received the survey is unknown because we did not have access to the membership lists fromICLEI, NLC, and USDN. Instead, these three organizations sent the survey link directly to their membership.

**Table 2**  
Total Number and Percentage of Resources Available by Phase of the Planning Process.

Phase of the Planning Process	Total Number Coded Resources	Percentage of Total Resources
Vulnerability Assessment	1016	29.5%
Adaptation Planning	918	26.7%
Building Community Support	704	20.5%
Generic	648	18.8%
Implementation	468	13.6%
Building Internal Support	367	10.7%
Law/Policy Changes	241	7.0%
Monitoring and Evaluation	199	5.8%
Financing	189	5.5%
Setting Goals	106	3.1%

Of the 291 respondents, 52.5% (153) indicated that their community was gathering information on climate impacts or collecting information on how to plan for climate change. The same percentage (52.5%) indicated that their community was actively implementing actions that have adaptation value (as defined by the respondent) (Fig. 2). The smallest number of respondents (16%) indicated that they were actively monitoring and evaluating adaptation-related activities (Fig. 2). These results are similar to those found by Carmin et al. (2012).

Primary motivators for adaptation activity included political leadership (42%), knowledge of projected future climate impacts (31%) and community support for adaptation activity (25%) (Fig. 3). The least common motivator was available funding, with less than 10% of respondents (29) selecting this option. The two climate impacts noted as being of significant concern were stormwater runoff (158 responses) and localized flooding (153 responses). Stormwater runoff was noted as being a significant or moderate concern for all survey responses (81% selected this option), regardless of physical location. Impacts noted as being of least concern were emergence of new diseases (20 responses), land subsidence (27 responses), and saltwater intrusion (32 responses).

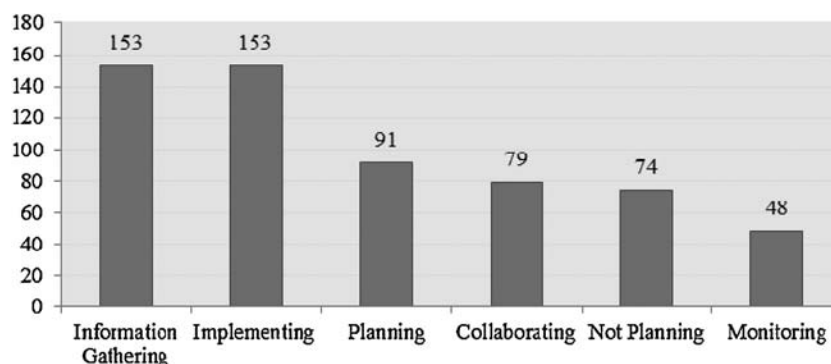
Similar to previous studies (Eisenack et al., 2014; Measham et al., 2011; Moser and Ekstrom, 2010) the most common barrier identified was lack of funding (157 respondents). Other major challenges included lack of staff time to support adaptation (53%) and challenges associated with implementing adaptation actions (46%) (Fig. 4). Respondents pointed to the following as being only a minor challenge or no challenge to their climate adaptation efforts: learning from other communities working on adaptation (148 responses); obtaining information about how to plan for climate change (136 responses); and obtaining scientific data on projected climate impacts (134 responses). The lack of stakeholder emphasis on “obtaining scientific data on projected climate impacts” is in contrast with the refrain in the scientific literature, which dedicates considerable focus on the need for creating better, more detailed climate information and, more recently, to the need to develop tools to effectively translate that information to support decision-making (e.g., Hamin et al., 2014; Moser and Ekstrom, 2012).

With respect to resource format, over 80% of respondents indicated using best practices or case studies frequently to occasionally (Fig. 5). Other resources used frequently or occasionally include: conversations with peers (75.6%); scientific reports or articles (72.2%); and newsletters (68.7%). The least-used resources include scientific reports (63% of respondents indicated using rarely to never), trainings or workshops (58% of respondents indicated using rarely to never), and online clearinghouses of adaptation-related material (51% of respondents indicated using rarely to never).

Survey respondents were also asked about the extent to which various resources would help them move forward with climate adaptation action. The top three options selected as significant or

**Table 3**  
 Total Number and Percentage of Resources Available to Support Specific Climate Impacts.

Climate Impact	Total Number Resources Coded	Percentage of Total Resources
Generic	1874	54.5%
Stormwater/Flooding	720	20.9%
Sea Level/Coastal Erosion	469	13.6%
Drought	327	9.5%
Ecosystem Changes	231	6.7%
Extreme Heat	138	4.0%
Forest Fires	147	4.3%



**Fig. 2.** Where Respondents are in the Adaptation Process.

moderately helpful were: guidance on identifying financial support (84%); sample climate-adaptation related policies, ordinances, and codes (83.6%); and information on potential adaptation strategies (83%). The preferred format for desired resources was websites (80% of respondents), followed by case studies or fact sheets (62% of respondents), and regional or annual conferences (62% of respondents) (Fig. 6). The least desirable formats included email listserv digests (21% of respondents), blog posts (8% of respondents), and social media such as Facebook and Twitter (8% of respondents).

**3.3. Phase III: convening local government climate-adaptation service providers and local government stakeholders**

We convened fifty-three representatives from forty-eight organizations at the Garrison Institute in upstate New York in May 2014 to explore findings from Phase I and II. Participants were drawn from nonprofit organizations, academia, private consulting firms, federal agencies, and local governments (see Supplementary materials). Over the course of the two-day workshop, participants identified a series of priorities to advance the current adaptation landscape while also accelerating the development of next generation adaptation-support resources and services. Consensus was reached regarding these areas for investment. Foremost among the recommendations was the development of mechanisms and strategies that help practitioners connect more quickly and easily with the resources and information they need.

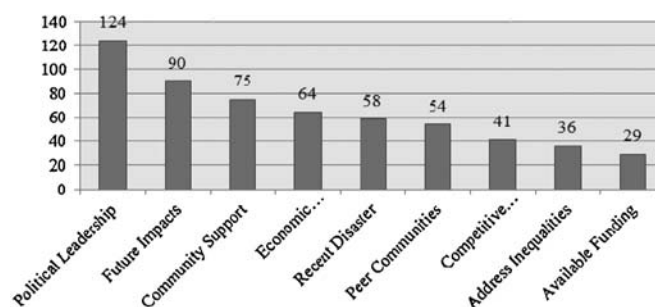
Collectively, participants identified six main categories of adaptation-related needs.

**3.3.1. Navigational needs**

While many resources are available to support climate adaptation initiatives, practitioners struggle to find the resources that are the most useful given their specific needs. This need was often framed as uncertainty about which tools or resources to use based on local needs. Interestingly, the use of uncertainty in

regards to navigating the climate landscape is rarely discussed in the peer-reviewed literature, which mostly focuses on uncertainty associated with future climate conditions (e.g., climate modeling uncertainty and impact projection uncertainty) (e.g., Abunnasr et al., 2013; Hallegatte, 2009; Mearns and Norton, 2010). Participants felt this source of uncertainty warranted the creation of “on-ramps” to help practitioners find the resources they require in an efficient, effective, and timely manner. A streamlined “service bureau”, a centralized repository of adaptation resources, or regional adaptation call centers were some ideas offered to address this need. This barrier was by far the most commonly discussed challenge facing local practitioners and was repeatedly cited as limiting the speed of local adaptation activities.

Another navigational challenge is ensuring that the utility of existing resources is evaluated. Currently, climate services and resources are not rated or ranked, leaving practitioners with no way of judging which resource to use and when. This challenge was framed by one practitioner as leaving them with “no discernable way of knowing what’s valuable or effective versus what’s unproven and ineffective”. Participants discussed creating a standard or rating system that would help practitioners determine which resources to use based on their specific needs.



**Fig. 3.** Motivations for Action.

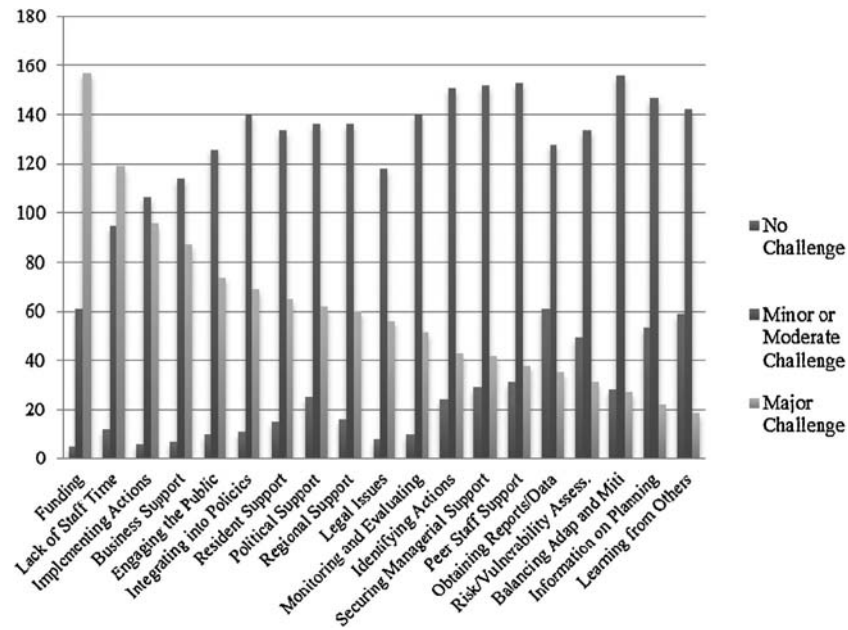


Fig. 4. Barriers to Adaptation Action.

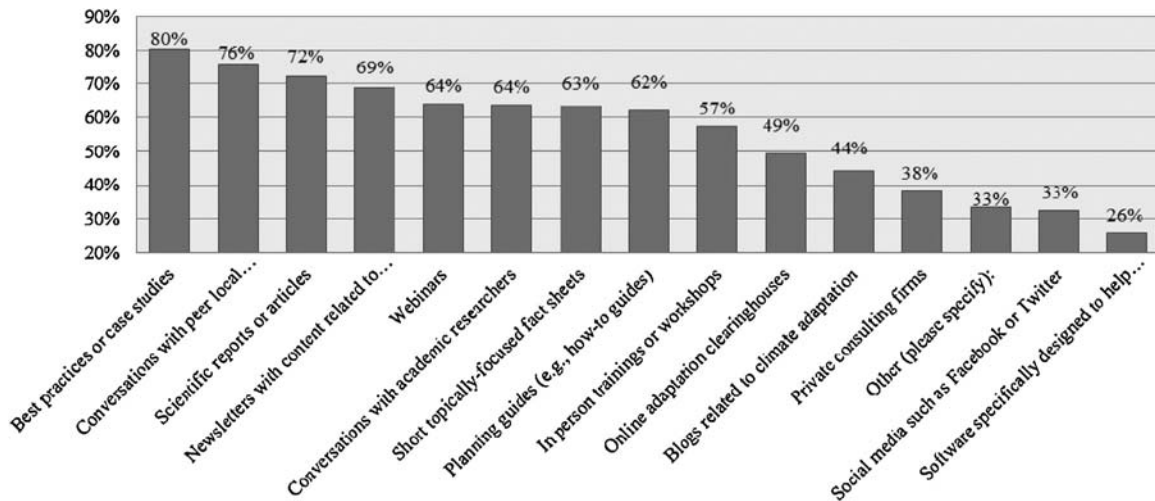


Fig. 5. Resources Used Frequently or Occasionally.

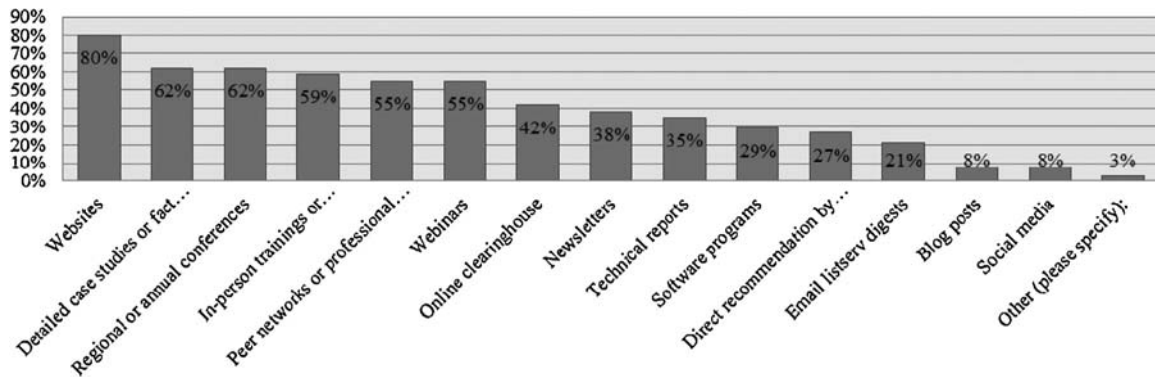


Fig. 6. Desired Format for Resources.

### 3.3.2. Structural needs

This gap pertains to translating existing resources and creating new resources with local practitioners. Specifically, many existing generic resources must be contextualized in order to be useful to specific places. Moreover, since most practitioners are approaching adaptation on an issue-by-issue basis (e.g., heat island mitigation, stormwater management), sector-specific resources need to be available to support these initiatives. Workshop participants suggested that resource providers balance the benefits of providing generic resources with the reality that practitioners are approaching adaptation in a more targeted fashion. This means that more sector-specific resources are needed, although tools and techniques that allow for working across silos are also valuable so long as they can be tailored to specific locations.

Additionally, participants emphasized the dearth of resources available to support both goal setting and monitoring and evaluating. These two areas were deemed important for laying the foundation for what a community hopes to achieve and measuring progress towards that vision. Participants speculated that the disproportionate number of resources focused on supporting early-stage adaptation initiatives as opposed to the later phases of the adaptation process is due to the need for specificity in the later phases compared to generalizability in the early phases.

Participants also highlighted the need to train and engage more private sector companies in climate adaptation. Since many local communities engage with consulting companies to advance their water, energy, hazard mitigation, or public infrastructure initiatives, it is imperative that these organizations have the knowledge required to integrate climate change into their initiatives.

### 3.3.3. Jurisdictional/political needs

Participants highlighted that regulations and laws at regional, state, and federal levels can and often do impede local efforts to prepare for climate change. To address this, participants called for more work to identify regulations and laws that are impeding local adaptation initiatives and collaboration in finding strategies for overcoming these barriers. This also includes finding ways to motivate or incentivize more local action through federal and state policy and regulatory drivers.

In addition, participants pointed to the need for more and better resourced regional, cross-jurisdictional governance structures. Many climate impacts, including sea level rise and flooding, are best dealt with on a regional basis, yet existing governance structures limit trans-boundary action.

### 3.3.4. Financial needs

While acknowledging the broader reality – that more funding is needed to prepare for climate impacts – participants focused on how to leverage existing funding streams as opposed to creating new ones. Participants emphasized that a great deal of money is currently being spent on traditional (non-adaptive or maladaptive) development. Finding ways to leverage these funds by incorporating climate-sensitivities or more sustainable, adaptive practices is strongly recommended.

Participants pointed to the need to work with federal agencies to support development of regulatory drivers to ensure that all federal funding requires communities to consider future climate conditions. This would guarantee that existing funds are being used to finance adaptive strategies instead of strategies that will ultimately place more people and infrastructure in harm's way.

Participants also raised the issue of supporting smaller communities with financial and staffing capacity so that they could prepare for climate change. Most of the local climate adaptation actors profiled to-date are from large, well-resourced communities (Hughes, 2015). As the impetus for climate action

becomes more pronounced, it will be essential to find mechanisms for supporting small and medium-sized communities in their adaptation efforts.

### 3.3.5. Technical needs

This category of need focused on technical and analytical gaps in the field. Specifically, participants identified the need for detailed information regarding the economic impacts of climate change and assistance in using that information to make a financial case for why climate action is warranted. Also identified was technical assistance with scenario planning and statistical and dynamical downscaling of climate models. Importantly though, participants noted that there is already a bounty of scientific information available. Instead of investing in the creation of more information, participants called for a central, easily accessible clearinghouse to store existing information, supported by technical assistance to help find and translate the information for use.

Participants also placed great emphasis on the need for specific policy tools, model ordinances, and bylaws to help accelerate the transition from planning into action. It was noted that, while there are plenty of examples and guidance materials available, there is little in the way of transferable models of resilience-focused ordinances and regulatory language.

### 3.3.6. Social needs

The final category of needs pertain to social issues, particularly tools and resources focused on vulnerable populations. The research combined with participant observation indicates that there is a significant lack of resources focused on climate change and social justice, equity, and vulnerable populations. This gap should be remedied systemically by bringing the perspectives and priorities from these communities into mainstream climate conversations.

Participants also noted the paucity of resources targeting health-related impacts. Given that health issues resonate with individuals from all walks of life and political backgrounds (Leiserowitz et al., 2012), there is a clear need to utilize health as a platform for climate action. This need also includes the development of techniques to engage the public health community, including mental health professionals, in climate-related dialogues.

## 4. Conclusion

This research finds that a significant number of resources and services are available to support local and regional climate adaptation efforts. In some cases, these resources are meeting the immediate needs of practitioners. In other cases there are glaring omissions that need to be addressed. For example, research shows that a large percentage of the resources available are 'generic' in the sense that they are not specifically focused on a geographical region, sector, or phase of the adaptation planning process. Generic resources are often easier to create and have wide potential application across a variety of municipalities. However, generic resources are not able to meet the particular needs of cities that are looking for targeted services and resources.

Even when specific resources do exist, they are heavily focused on supporting the early phases of the adaptation process, including conducting a vulnerability assessment or creating a climate adaptation plan. The dearth in resources supporting the later phases of the adaptation process could eventually stymie or seriously delay local adaptation action. Some participants identified this gap as already slowing down adaptation activity. It may be that the proliferation of resources focused on the early phases of the adaptation process is reflective of the young age of the adaptation field. Regardless, the question of how to advance the

field to the next stage of development is one that requires further inquiry, including work to actualize many of the recommendations identified by workshop participants in Section 3.3.

Our results also show that the sector-specific resources that exist do a decent job of supporting stormwater management and flooding issues, which are the most common areas of concern from local practitioners in our survey. However, the abundance of resources related to sea level rise and coastal erosion does not match the demand for these types of resources. Moreover, the dearth of resources focused on vulnerable populations and health-related issues are voids that local practitioners want addressed.

Additional gaps identified through this research include few resources focused on financing adaptation or making a financial case for why adaptation is needed, and a glaring lack of model ordinances and codes. These two topics were repeatedly identified as gaps by practitioners.

On the positive, our research finds that many categories of existing resources are highly desirable and being used by practitioners, especially case studies and best practices guides. There was a mismatch, however, in the format being used to convey these materials. Practitioners expressed a preference for web-based resources (which many resources are), but noted that they want resources to be succinct and interactive. They also desire the dissemination of information through face-to-face convenings (e.g., conferences, workshops, trainings, professional network meetings) and other personal modes of communication. This finding aligns with other results that show that conversations with peers, academics, and with members of peer-networks are important resources being used by local practitioners (Berke et al., 2011; Hughes, 2015). Unfortunately, few of the existing resources are currently in or easily translatable to these formats.

Given the findings from the three phases of our research, we have identified nine strategies we believe are imperative to moving the local adaptation field forward. Taken together, these recommendations have value in that they represent the perspectives of leading service providers, practitioners, and adaptation thought leaders from across the U.S.

- 1) Develop a centralized web platform to ease access to local-climate adaptation resources. The platform should be designed with local end-users to ensure it is useful, useable, and understandable. All existing and new resources should be accessible from the platform. Financing to support maintenance of the platform will be essential.
- 2) Create a centralized adaptation “extension service” or “help desk” to improve two-way communication between providers and practitioners. This could include a “concierge” service to facilitate practitioner access to, and use of, appropriate resources as well as the solicitation of user review of existing resources. These reviews should be compiled to create an external resource ranking or rating system.
- 3) Incentivize or initiate the development of regional collaboratives of local governments, nonprofits, and other stakeholders to promote multi-jurisdictional cooperation on adaptation-related issues.
- 4) Ensure that end-users are continually engaged in the design, development, testing, and revision of resources. Make particular efforts to ensure that disadvantaged communities and their representatives are systemically engaged in such processes.
- 5) Engage professional societies and their membership, including those from public health, social justice, public works, etc. in climate adaptation activities.
- 6) Develop new resources focused on filling key gaps needed to aid in the implementation of adaptation actions. Areas for initial investment should include resources for: 1) financing

- adaptation; 2) making a financial case for why adaptation is needed; and 3) model adaptation ordinances and regulations.
- 7) Create methodologies for measuring progress in adaptation. Ensure that these methodologies cover multiple contexts, sectors, and scales and can be tailored to local contexts.
- 8) Invest in peer-to-peer learning and networking for practitioners, service providers, and adaptation professionals. This includes supporting large national convenings as well as smaller regional meetings, online networking, and other mediums.
- 9) Work with U.S. federal agencies such as FEMA, EPA, DOT, and HUD to ensure they incorporate climate considerations in their grant review and investment decisions, thereby avoiding maladaptive activities.

In short, our results suggest that the climate adaptation field is growing rapidly and will likely continue to grow as the impetus for climate action becomes more pronounced. In order to ensure that the field grows in a manner that is reflective of the need of local communities, it is essential that we coalesce around strengths while seeking to improve our weaknesses. This research has identified some key strengths of the current field as well as some strategic opportunities to move forward. It is our hope that others will continue to build upon this work, thereby helping the adaptation field continually reflect on where it has been and where it needs to go.

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#### Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at <http://dx.doi.org/10.1016/j.envsci.2016.05.006>.

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