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Local climate change adaptation plans in the US and France: Comparison and lessons learned in 2007-2017

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ABSTRACT

As the number of local climate adaptation plans has rapidly grown during the past ten years in response to increasing threats of climate change, cities and various organizations offer new insights on climate adaptation planning methods rooted in their countries' planning cultures. To facilitate monitoring, knowledge sharing, and cross-border comparison of climate adaptation plans, we have developed a uniform system of 24 indicators, integrating the key aspects of plans' structure and organization; content and scientific basis; and plan development and coordination process. We examine here 36 examples of local climate change adaptation plans of small and mid-sized urban communities in France and the United States and reflect on the experiences they offer to future planning. Driven by different methodological guidelines, French and U.S. plans demonstrate different strong points, offering useful insights for future planning. Yet, they appear to share similar shortcomings on both sides of the Atlantic. The key findings include the need for clearer planning toolkits for local governments, engagement of diverse stakeholders, attention to equity, and higher level of integration of plans across multiple sectors and scales. Citizens' groups, academia, and the private sector should play a more active role in the development and implementation of adaptation plans.

1. Introduction

Over 54% of the world's population lives in urban settlements and this number is expected to increase to 66% by 2050 (UN Habitat, 2016). In the European Union (EU) and the United States (U.S.), the proportion of urban population is higher, with over 75% of Europeans and 82% of Americans living in cities and towns (EEA, 2017; U.S. Census Bureau, 2017). Urban areas account for between 60 and 80% of energy consumption and generate as much as 70% of the human-induced greenhouse gas emissions primarily through the consumption of fossil fuels for energy supply and transportation (UN Habitat, 2016). Being important engines of economic development, cultural and technological exchange, and financial, intellectual and political assets, cities lead climate change mitigation, adaptation, and resiliency planning efforts around the world (Lindseth, 2004; Preston et al., 2011; Reckien et al., 2015).

Scholarly literature on local climate adaptation planning is still emerging and most research has been dedicated to the experience of larger high-capacity cities (Anguelovski et al., 2016; Araos et al., 2016; Arnott et al., 2016; Olazabal et al., 2019), especially through the efforts of C40 Cities Climate Leadership (https://www.c40.org/) and 100 Resilient Cities (http://www.100resilientcities.org/) networks. Although the number of local climate adaptation plans developed by communities of all sizes and scales continues to

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grow in response to increasing threats of climate change (Reckien et al., 2018; Woodruff et al., 2018), less attention has been given to the experience of small and mid-sized towns and cities, both in the U.S. and France, and worldwide. Smaller cities typically have fewer internal resources for building their adaptive capacity (LeFranc-Morin, 2019). They also appear to have fewer opportunities for peer learning, being less engaged in global and regional adaptation networks (Woodruff, 2018).

Climate change adaptation planning seeks to adjust human-environmental systems in response to actual or expected climatic stimuli to minimize their harms or exploit beneficial opportunities (IPCC, 2007). To achieve a higher level of understanding and international collaboration as it exists today in the realm of greenhouse gases (GHG) mitigation planning, more research is necessary to inform and guide future planning efforts. Despite significant growth in the number of local adaptation plans during the past decade in many countries, monitoring of climate adaptation plans and adaptation planning processes has been very limited. Local communities can offer diverse insights based on their unique experiences and inspired by their national planning cultures. However, in the context of diverse approaches to the climate adaptation planning process, the lack of comparable methodological frameworks may be hindering knowledge sharing and the rapid transfer of successful practices. In the absence of a comprehensive system of widely accepted criteria, climate adaptation plans are likely to inherit the same gaps that are present in the guidelines that were used to create them. To facilitate knowledge sharing, monitoring, and comparison of climate adaptation plans, there is a growing need for a more uniform, comprehensive assessment framework transcending scales, economic sectors, and international borders. To address this challenge, we propose here an integrated independent evaluation instrument, based on the synthesis of recommendations gleaned from guidelines of national and international agencies and scholarly literature published in English and French.

France and the U.S. provide particularly interesting case studies for our assessment due to the significant differences in their environmental planning cultures and their history of national climate policies. In France, the top-down national and the European Union (EU) regulations have guided local climate policy and adaptation planning from the start (Gallezot et al., 2010; Bertrand, 2013; Reckien et al., 2014; Richard, 2016). On the contrary, in the U.S., climate adaptation efforts have been predominantly driven bottom-up by state, local, and tribal initiatives (Bierbaum et al., 2013; Vogel et al., 2016; Woodruff, 2018). On a more personal note, our focus on France and the U.S. stems from the realities of our location, languages, and experiences.

Our research has three interrelated goals:

1) To offer a comprehensive, yet flexible and simple, uniform system of indicators to facilitate monitoring, comparison, and knowledge transfer of local climate adaptation planning across the national and institutional borders;
2) To learn from the experience of the first-generation[1] climate adaptation plans developed by small and medium-sized urban communities (between 5000 and 300,000 people) in France and the U.S.;
3) To identify the key factors contributing to an effective climate adaptation planning process at the local scale in the context of diverse national and regional planning cultures.
4) The paper consists of six sections, including introduction, historical context of climate adaptation planning in the U.S. and France, methodology, results, discussion, and conclusions.

2. Historical context of this study

International and national climate policies have been developing since the 1990s, shortly after the release of the first report of the IPCC (IPCC, 1990), followed by the IPCC Technical Guidelines for Assessing Climate Change Impacts and Adaptations (IPCC, 1994). With a few exceptions of climate-related policies pioneered in the late-80s to early-90s, the first generation of city-level climate plans goes back to the mid-to-late 1990s (Wheeler, 2008). In 1993, the International Council on Local Environmental Initiatives (ICLEI), later renamed Local Governments for Sustainability, initiated the Cities for Climate Protection (CCP) program. The CCP provided technical assistance to cities worldwide with climate action planning, focusing chiefly on mitigation and much less on adaptation strategies.

The municipal climate planning efforts in the U.S. and internationally have been further advanced by the Sierra Club's Cool Cities campaign, the Center for Climate Strategies, and C40 Cities Climate Leadership Group, all created in 2004–2005 (Table 1). The U.S. Conference of Mayors' Climate Protection Agreement was also launched in 2005 (Wheeler, 2008), as a landmark pledge by mayors from all across the country to take local action to reduce carbon emissions from city operation and by the community at large, consistent with the goals of the Kyoto Protocol. More than 1060 mayors signed the agreement, mostly representing large U.S. cities. Two years later, the ICLEI Climate Resilient Communities program was launched in 2007, offering technical assistance and methodology to local jurisdictions worldwide to assess their vulnerabilities and prepare their communities for the impacts and costs associated with projected global climate change. Keene, NH was the first community in the U.S. to adopt this new five-step program in 2007. During the same year, the Covenant of Mayors – a European co-operation movement involving local and regional authorities – launched its Mayors Adapt initiative and the European Union adopted the “Adapting to climate change in Europe” green paper (EC, 2007). The latter was followed in 2009 by the EU white paper “Adapting to climate change: Towards a European Framework for Action,” setting out concrete actions, including mainstreaming in the EU policy areas (EC, 2009).

In the following decade, the local governments and their international networks, such as ICLEI, Global Covenant of Mayors for Climate and Energy (a merged initiative between the Compact of Mayors and Covenant of Mayors), C40 Cities, and 100 Resilient Cities(100 RC), have continued playing a very important role in shaping regional, national and global climate change policies.

[1] Plans developed for the first time.

Table 1
Major historical milestones of climate change mitigation and adaptation planning in the U.S., France, and globally.

Year launched	United States	France	International/European
1990s	The U.S. Environmental Protection Agency starts an annual inventory of GHG emissions (1990); First National Communication on Climate Change of the U.S. (1995).	First National Communication on Climate Change of France (1995).	IPCC First Report (1990); UNFCCC is adopted (1992); The ICLEI Cities for Climate Protection (CCP) (1993); IPCC Technical Guidelines on Assessing Climate Impacts and Adaptations (1994); UNFCCC enters in force (1994).
2000s	First National Climate Assessment (2000); Center for Climate Strategies is established (2004); the Sierra Club's Cool Cities campaign starts (2005); The U.S. Conference of Mayors' Climate Protection Agreement (2007). Interagency Climate Change Adaptation Task Force (ICCATF) (2009); Interagency Adaptation Science Workgroup (2009); Interagency Crosscutting Group on Climate Change and Human Health (2009).	The National Observatory of Global Warming Effects – (Observatoire national sur les effets du réchauffement climatique (ONERC)) (2001) is established; ONERC First Report on Climate Adaptation (2005); National Adaptation Strategy (2006).	The European Climate Change Program starts (ECCP) (2000); C40 Cities Climate Leadership is established (2005); Adapting to Climate Change in Europe Green Paper (2007); Adapting to climate change: Towards a European Framework for Action White Paper (2009); The ICLEI Climate Resilient Communities (CRC) Program (2010).
2010s	National Global Change Research Plan (2012–2021) (2012); Executive Order 13653 (Preparing the United States for the Impacts of Climate Change) (2013)[a]	First National Plan on Adaptation to Climate Change (NPACC I) (2011); The Law Grenelle 2 (2010); The Law on Energy Transition for Green Growth (2016); Second National Plan on Adaptation to Climate Change (NPACC II) (2018).	The EU Strategy on adaptation to climate change (2013); 100 Resilient Cities (100RC) (2013); Covenant of Mayors "Mayors Adapt" initiative (2014); Evaluation of the EU strategy on adaptation to climate change (2018).

[a] Revoked by Executive Order 13783 in 2017.

France presented its first national adaptation strategy in 2006, marking the beginning of the government's focus on adaptation. In 2011, a more detailed National Plan for Adaptation to Climate Change (NPACC) was issued, offering a set of 84 actions expressed in 242 measures (Ministère de l'écologie, du développement durable, des transports et du logement, 2011). Although adaptation options were not formally prioritized in the NPACC, "grey" (e.g. more water-efficient irrigation) and "soft" measures (e.g. heat-wave management plans) were identified as the main types of adaptation options. These actions were identified and assessed using participatory processes and cost-benefit assessment (EEA, 2014). Following the COP21, France decided to initiate a review process for the NPACC (Ministère de l'environnement, de l'énergie et de la mer, 2016). Climate planning became compulsory in France in 2012 by the Loi Grenelle 2[2] through the adoption of the compulsory Territorial Climate and Energy Plans (PCETs) required for urban areas with a population over 50,000. The Law on Energy Transition for Green Growth[3] added two years later the "Air" dimension in climate planning, through the adoption of Territorial Climate, Air, and Energy Plans (Plans Climat, Aire, Energie Territorial – PCAETs), required by the end of 2016. Despite the absence of binding directives on adaptation, these formal injunctions to "think" about the effects of climate change announce the generalization of regional reflections on adaptation (Richard, 2014). Consequently, these plans, though primarily aimed towards climate change mitigation, have also to address the adaptation objectives.

These key milestones of French climate adaptation policies reflect the broader context of the EU climate policy development. In 2013, the European Commission adopted an EU strategy on adaptation to climate change which aimed to make Europe more climate-resilient (EC, 2013), followed by its evaluation in 2016–2018. By 2017, 26 countries within the European Economic Area (EEA) have adopted national adaptation strategies (compared to 7 in 2008 and 20 in 2014), and 20 countries have developed action plans to define the adaptation actions they would implement, some already being under the first revision. 23 EEA countries have recently completed their national climate change risk or vulnerability assessments. Nine of them, including France, have also completed or established protocols for monitoring their national climate adaptation plans (European Climate Adaptation Platform 2017).

Contrary to France, climate change mitigation and adaptation planning policies in the U.S. are neither compulsory nor binding, and their presence and level of coordination vary greatly across states and jurisdictions. The U.S. federal climate policy made a very significant leap forward between 2009 and 2016. Some of the key federal initiatives of President Obama's administration include the creation of the U.S. Interagency Climate Change Adaptation Task Force (ICCATF); the development of three cross-cutting national adaptation strategies focused on integrating federal, state, local and tribal efforts on adaptation in key sectors; the new decadal National Global Change Research Plan (2012 – 2021); and the Adaptation Science Workgroup inside the U.S. Global Change Research

[2] French Law of 12 July 2010 on the National Commitment for the Environment (Loi n°2010–788 du 12 juillet 2010 portant engagement national pour l'environnement)

[3] French Law of August 17, 2015 on the Energy Transition for Green Growth (Loi n°2015–992 du 17 août 2015 relative à la transition énergétique pour la croissance verte)

Program (USGCRP) (Bierbaum et al., 2013; Hansen et al., 2013; EPA, 2014). A detailed comprehensive review of climate change adaptation history and achievements in the U.S. before 2012 can be found in the seminal review by Bierbaum et al., 2013. Despite the deregulatory climate policies of the U.S. federal government since 2017,[4] climate adaptation initiatives have continued to grow across the nation, driven by the state, local and tribal efforts (Adler, 2018; Arroyo, 2017; GCC AC, 2019).

3. Methodology

3.1. Case studies

Our study is based on the analysis of 36 local first-generation climate adaptation planning documents developed by small and mid-sized urban communities, as well as related auxiliary documents (Addendum 1). Metadata for the dataset developed through this study is available in da Cunha and Lioubimtseva, 2020

The selection of adaptation plans in both countries was driven by the following criteria:

- Local, community-level scale (e.g. city, town or group of adjacent urban communities that may include suburban and peri-urban areas covered in a plan);
- Focused on climate change adaptation (either stand-alone or together with climate change mitigation plan);
- Multi-issue (addresses more than one issue associated with threats and impacts of climate change (e.g. flooding, forest fires, health, etc.) or more than one sector;
- Dedicated to a community with a total population between 5000 and 300 000 people;
- Published and listed in the national databases;
- Information was available on how each plan was developed at the time of this study.

Documents that have been eliminated from this review are climate action plans that do not address climate change adaptations, regional plans, single-issue plans (e.g. a green infrastructure plan, a sea-level rise adaptation plan), “initiatives” – documents providing information about local projects or initiatives not published as a climate adaptation plan or adaptation planning report, unpublished climate adaptation plans, and drafts under review. We have excluded single-issue adaptation documents as incomplete by default (failing to anticipate plural impacts of climate change). Because the literature on the differences between adaptation and resiliency plans is still extremely unsettled (Woodruff et al., 2018), a resiliency plan is included in this sample based on its content and adaptation planning language.

We deliberately focus on small and mid-sized urban communities, as opposed to much better studied large cities. The vast majority of cities in the U.S., France, and worldwide are urban areas with a population under 300,000, and they provide a home for a very large part of the urban population in both countries (OECD, 2019; Lefranc-Morin, 2019). Most of the existing climate adaptation literature to date focuses on large cities, such as New York, Paris, San Francisco, London, Tokyo, etc., especially through the efforts of C40 Cities Climate Leadership. Large cities in developed countries have significant resources for climate adaptation planning and often benefit from the presence of research institutions, conferences, think tanks, and other national and international organizations. Smaller cities, on the other hand, face their unique set of challenges: they typically have significantly less resources and are less likely to be engaged in the national and international networks. Considering that definitions of “small and mid-sized” cities vary in different countries and classifications (Hansen, 1988; The City of Rochester, 2002; EEA, 2017; OECD, 2019), we chose to define our areas of interest as urban communities with a population between 5000 and 300,000 people.

Our selection of plans was guided by the goal to obtain a sample of adaptation plans of small and mid-sized cities, reflective, as much as possible, of diverse climatic conditions of both countries, to test the proposed methodology, rather than to provide an exhaustive review. We used online databases, ADEME for France and the GCC AC and other databases for the U.S., as a departure point to identify communities with existing climate adaptation plans and to obtain contact information and websites of local agencies in charge of the plans. Google searches of cities' official websites were used to locate the plans and additional documents (e.g. annexes, presentations, related planning documents, and information about planning meetings). If no plan was available on the city's official website, we reached out to the city administration officers via email for additional information. Population numbers were obtained from the national censuses websites (U.S. Census Bureau, 2018; INSEE, 2018). Our sample is relatively small and is limited to plans that are documented in the national databases and published on their cities' official websites, including information on how and by whom each plan was developed (da Cunha and Lioubimtseva, in press).

In France, climate adaptation planning is fully integrated into the ongoing required climate plans (PCETs and PCAETs), which are developed by the local governments at the scale of individual urban communities or agglomerations. The French term “*communauté*” reflects levels of administrative divisions of adjacent settlements that may include towns, cities, suburban, and peri-urban areas. Depending on the form of local governance, such urban places may include *communautés d'agglomérations*, *communautés urbaines,* and *communautés des communes* (for more information, see Addendum 2). In most cases, they have in their prerogatives land-use planning and climate change mitigation and adaptation planning combined. The GIS-based searchable online database of the ADEME includes metadata about 527 PCETs/PCAETs (http://observatoire.pcet-ademe.fr/). It provides easily accessible information about the

[4] The Columbia Law School Sabin Center for Climate Change Law (http://columbiaclimatelaw.com/) provides the most up-to-date information on the state of climate change mitigation and adaptation regulations, deregulatory actions, and climate change litigation in the United States.

municipality and key milestones of climate preparedness planning (such as completion of the local assessment of the GHG emissions, vulnerability diagnostics, and implementation stages of their climate mitigation and adaptation planning process), and other related information, such as commitment to Agenda 21. At the time of this study (May 2018), 75 PCET/PCAETs of urban areas meeting our selection criteria had reported engagement in climate adaptation planning[5] in the ADEME PCET/PCAET database (ADEME, 2018). Further examination of the completion of adaptation plans has allowed us to narrow down to 16 finalized PCET/PCAETs of 18 cities (Fig. 1A). Note that the number of plans is different from the number of their communities because PCAET "Ouest 06" is a joint climate adaptation plan by three adjacent small cities: Sophia Antipolis, Pays de Grasse and Canne Pays de Lérins. In this particular case, the population cutoff applies to each city, and not the combined population of the three. Another exceptional case is the adaptation plan of Saint-Etienne Métropole: the PCAET covers an ensemble of suburban and rural communities around its main mid-sized city of Saint Etienne with a total population of the metropolitan area over 300,000. It is included in the analysis based on the population size of the City of Saint Etienne, covered in the document, rather than the entire metropolitan area. The selection of plans includes case studies from all climate zones and diverse geographic regions of France, such as the Atlantic and Mediterranean coasts, the Alps, Massif Central, and Martinique.

In the U.S., there is no federal database for reporting municipal climate change mitigation and adaptation planning efforts. The GCC AC (https://www.adaptationclearinghouse.org/) provides the most up-to-date information about the progress of state and local adaptation planning to climate change. At least 112 local climate adaptation planning initiatives and related documents by various local entities (including city, village, county, parish, tribal, watershed, and regional initiatives) were reported by the GCC AC by May 2018. With a few exceptions, the vast majority of the local plans belong to cities situated in states with existing climate adaptation plans, and almost one-third of all documents reported by the GCC AC (34 plans) were in the State of California. To provide this geographic breadth and some balance of case studies from different regions and states, we limited the number of plans from California to five cities located in different parts of this vast state (north, center, and south with two distinctively different climate types). For the rest of the U.S., the selection was driven by the accessibility of adaptation plans meeting our selection criteria and, as much as possible, the maximum possible diversity of regions and climatic conditions of their locations. The sample captures the majority of climate types and geographic regions of the U.S., including coastal areas, the Rockies, the Great Lakes, and Alaska. Not all documents listed in the GCC AC database are relevant for this study (e.g. initiatives, vulnerability studies, single-issue plans not addressing climate change). In addition to the GCC AC database, we used websites of ICLEI USA (icleiusa.org), Local Model Forest Policy Program Climate Solutions University (http://www.mfpp.org/climate-solutions-university), and Environmental Protection Agency Climate Change Adaptation Resource Center (https://www.epa.gov/arc-x), independent reports (Hansen et al., 2013; Headwater Economics, 2012; Steinhoff et al., 2015; Vogel et al., 2016), and scholarly reviews (Bierbaum et al., 2013; Lysák and Bugge-Henriksen, 2016; Shi et al., 2015; Woodruff and Stults, 2016; Woodruff, 2018; Woodruff et al., 2018) to identify cities meeting our selection criteria. Based on these sources, we assembled a non-exhaustive sample of 20 plans meeting our selection criteria (Fig. 1B).

3.2. Comparative evaluation framework

A vast number of guiding instruments and tools for community adaptation planning has emerged during the past decade by national and international organizations, e.g. (Brown et al., 2011; EC, 2013; EPA, 2014; International Bank for Reconstruction and Development and World Bank 2011; Ministère de l'écologie, du développement durable, des transports et du logement, 2011; Nottingham Declaration on Climate Change, 2009; ONERC, 2016; Snover et al., 2007). These documents offer diverse conceptual frameworks and sometimes emphasize very different criteria and steps necessary in the adaptation planning process. While such a diversity of available tools reflects the growing recognition of the importance of climate change adaptation planning, it also makes it difficult to compare climate adaptation plans developed within different national and organizational frameworks. Some guidelines focus primarily on the preconditions for successful adaptation planning, such as "political support, operational knowledge, and scientific expertise and competency" (International Bank for Reconstruction and Development and World Bank, 2011); others prioritize their content, e.g. "integration, best available climate science, vulnerability and risk assessment, ecosystem-based approach" (EPA, 2014; IPCC, 2012), while finally, the third address primarily the planning process and its procedural steps, emphasizing the importance of scoping, objective setting, organizational process, and defining expected outcomes, decisions and actions (Brown et al., 2011; Snover et al., 2007).

Such growing diversity of methodological approaches by various organizations is also reflected in the growing number of scholarly publications, offering different evaluation frameworks and metrics for developing a comprehensive adaptation plan (Adger et al., 2005; Arnott et al., 2016; Doria et al., 2009; Füssel, 2007; Gagnon-Lebrun and Agrawala, 2006; Lesnikowski et al., 2015; Preston et al., 2011; Smit and Wandel, 2006; Woodruff and Stults, 2016). Climate change adaptation approaches and theories draw on diverse concepts and terminology including risk, resilience, impacts, vulnerability, and hazard (Brown et al., 2011), and findings from different adaptation management and adaptation planning studies are not always directly comparable. A systematic approach to monitoring and evaluation for climate change adaptation is still emerging. Earlier guideline instruments seem to focus more on problem scoping and goal setting (e.g. Snover et al., 2007) and emphasize general plan evaluation criteria (Bauer, 1997). More recent documents recognize that goal setting is only the first step of the planning process, preparing a foundation for adaptation decision-making involving optimization and resilience building, e.g. (Matyas and Pelling, 2015).

[5] Plans with completed vulnerability assessment for purposes of adaptation planning (Volet "*Adaptation au changement climatique*").

While intuitively, one might assume that a conceptually "correct," good-quality adaptation plan should automatically translate into successful implementation (Laurian et al., 2010) leading to a reduction of vulnerability, there is not yet enough evidence to back this assumption. Because climate adaptation planning has such a short history, longer-term monitoring of climate plans, their implementation, reevaluation, and consequent revisions would be necessary to answer this question. Considering that the publication dates of adaptation plans examined in our study ranged from 2007 to 2017, it would be impossible at this time to predict or evaluate their success defined in terms of reduction of human vulnerability. A much longer monitoring study would be necessary to evaluate the implementation of climate adaptation plans and their future iterations. Therefore, this current analysis focuses on the merits and challenges of adaptation planning documents, based on their content, completeness, and information about the process of their development. Our emphasis is on comparison of adaptation plans, rather than the outcomes of the planning process, that in most cases are still unknown.

Despite the diversity of theoretical frameworks and still emerging terminology, we see a growing consensus in scholarly and technical literature that a complete local climate adaptation plan should follow several common general guiding principles summarized in Table 2:

We have further isolated 24 measurable criteria informed by these guiding principles that can be represented as three dimensions of the plans' overall quality: *structure, content, and process* (Table 3). The criteria are not weighted, and there is a different number of criteria in each group based on the assumption that all criteria are equally important in their group and overall.

Ranking of each criteria of adaptation planning quality was based on a 0–4 scale, where a score lower than 1 (0–0.99) is defined as "lacking" from 1 to 1.99 - "mentioned" from 2 to 2.99 - "present" from 3 to 3.99 - "explained" and 4 – "clearly explained with examples." The same 0 to 4 ranking scale is used for the total values defined as "poor" if below 1, "fair" between 1 and 1.99, "good" between 2 and 2.99, "very good" for 3 to 3.99, and 4 is "excellent." The resulting dataset comprises quality scores for all 36 cities based on 24 criteria, each ranked on a 0 to 4 scale.

Data analysis included three iterations: first, each author read each adaptation plan and associated supporting documents separately and ranked the quality of plans for each of the 24 criteria. All scores were entered in the Excel spreadsheet and explained through referencing of the plans. Next, we compared the scores to identify areas of disagreements and the justification for each score.

Fig. 1. A Case studies in France.
Fig. 1B Case studies in the United States.

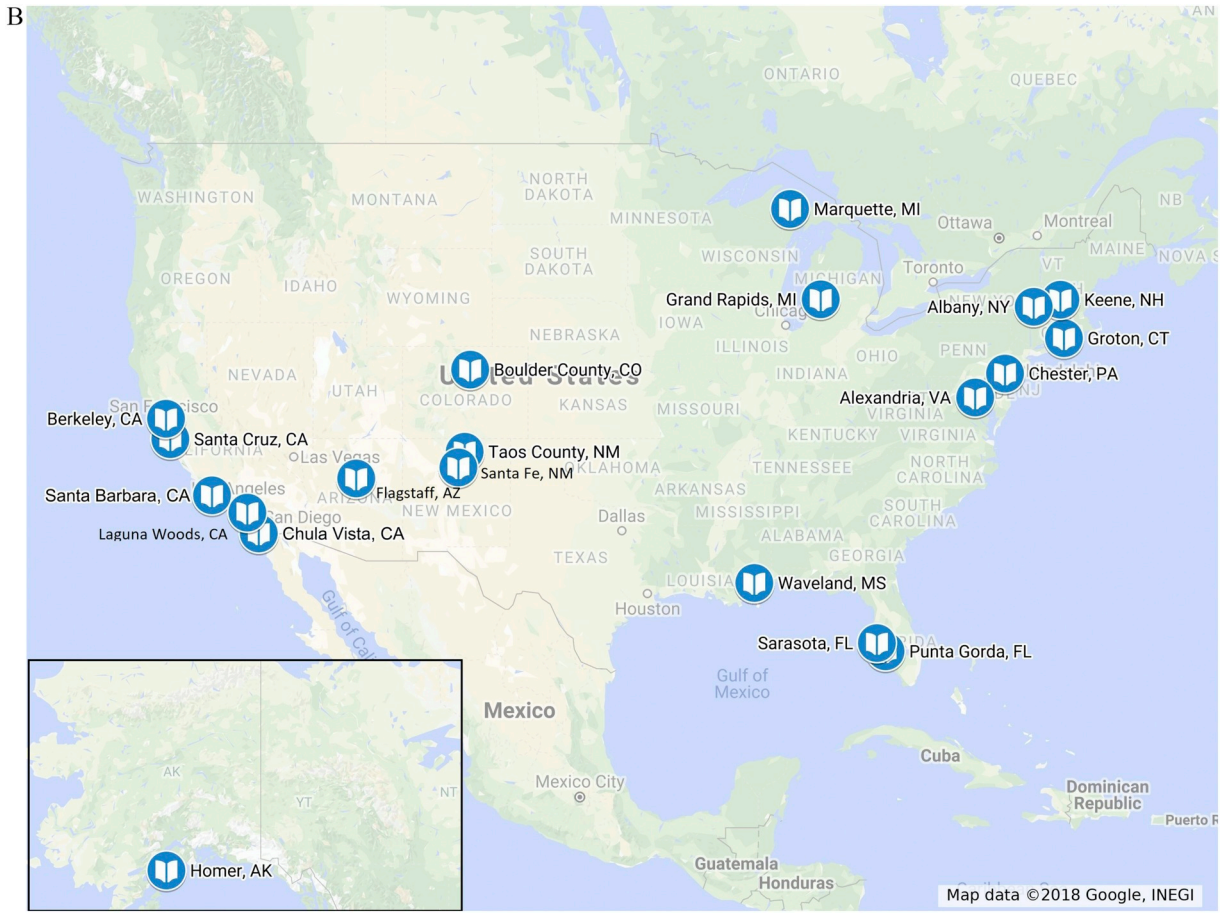


Fig. 1. (*continued*)

Table 2
Guiding principles of climate adaptation planning based on the literature.

	Guiding principle	References
a)	Clear goal setting and decision-making process driven by SMART (specific, measurable, achievable, results-oriented, time-bound) objectives.	Adger et al., 2005; Brown et al., 2011; Füssel, 2007; International Bank for Reconstruction and Development and World Bank 2011; Nottingham Declaration on Climate Change, 2009.
b)	Context-specific assessment of climate change impacts, vulnerabilities, risks, and uncertainties, informed by the best available science.	Adger et al., 2005; Brown et al., 2011; EEA, 2014, 2016; Gagnon-Lebrun and Agrawala, 2006; IPCC, 2012; ONERC, 2011, 2016; Smit and Wandel, 2006; Snover et al., 2007; EPA, 2014.
c)	Reliance on political will, support, and engagement of diverse stakeholders, including civil society, governmental agencies, and the private sector.	Brown et al., 2011; Füssel, 2007; Gagnon-Lebrun and Agrawala, 2006; International Bank for Reconstruction and Development and World Bank 2011; Nottingham Declaration on Climate Change, 2009; ONERC, 2016; Smit and Wandel, 2006; Snover et al., 2007.
d)	Coordination and balance with climate change mitigation planning, disaster management, land use planning, and sustainability planning.	Brown et al., 2011; EPA, 2014; Gagnon-Lebrun and Agrawala, 2006; IPCC, 2012; Nottingham Declaration on Climate Change, 2009; ONERC, 2011; Snover et al., 2007.
e)	Flexibility and ability to cope with uncertainties and complexities of climatic and non-climatic changes.	Adger et al., 2005; Brown et al., 2011; EEA, 2016; EPA, 2014; Füssel, 2007; Matyas and Pelling, 2015; Smit and Wandel, 2006; Woodruff and Stults, 2016
f)	Integration across multiple sectors and scales.	Adger et al., 2005; EEA, 2016; EPA, 2014; Füssel, 2007; ONERC, 2011, 2016; Wamsler and Pauleit, 2016.
g)	Continuous monitoring and assessment, leading to iterative planning.	Brown et al., 2011; EEA, 2016; EPA, 2014; ONERC, 2011, 2016; Snover et al., 2007; Woodruff, S.C., Stults, M., 2016.

Table 3
Criteria of climate adaptation plans assessment.

Group I: Readability and structure of climate adaptation plans. Refers to the overall readability and clarity of the plan, its logical organization, and the presence of the core structural elements, such as budget, implementation and evaluation plans. Informed by the guiding principles a and g.	1. Clarity, readability, and logical structure 2. Time-bound achievable objectives 3. Inclusion of a plan for implementation 4. Inclusion of a plan for budgeting 5. Inclusion of a plan for evaluation 6. Use of measurable performance indicators
Group II: Quality of the plan content and scientific basis for adaptation planning. Refers to the quality of the content, including the scientific basis for adaptation planning, including but not limited to climate change scenarios, flexibility in face of uncertainties, and integration with other local planning activities. Informed by the guiding principles b, e, and f.	7. Informed by climate trends and scenarios 8. Informed by climate change impact analysis 9. Informed by vulnerability analysis to climate change 10. Consideration of the current and future risks and opportunities 11. Consideration of social equity and justice 12. Actions addressing continuity of public services[a] 13. Actions including ecosystem-based approaches 14. Flexibility and recognition of uncertainties 15. Consideration of non-climatic challenges 16. Place-based focus 17. Integration across multiple societal sectors 18. Integration across multiple geographic scales
Group III: Plan development process, inclusivity, and coordination. Refers to the available information on plan development, participatory process, expected roles of stakeholders in implementation, and coordination with other related planning activities. Informed by guiding principles c and d.	19. Role of civil society in the implementation 20. Role of the private sector in the implementation 21. Participatory planning process 22. Coordination with disaster-management plan 23. Coordination with GHG mitigation plan 24. Awareness of other local adaptation plans

[a] E.g. education, health care, public safety, environmental protection, postal services, emergency services (police, paramedics, firefighters), social services, justice, law enforcement, etc.

The second round of in-depth readings focused on plans and criteria with differently ranked scores, information rechecking, and clarification of any missed points. The final round of reading and discussion produced the reconciled scores which were used for further analysis.

4. Results

4.1. Overall quality of climate adaptation plans

At the first glance, the average quality of all plans examined in this study appears to be “good” (2.56), ranging from “fair” (1.17) to “very good” (3.48). On average, French plans show a slightly higher overall average quality score compared to the U.S. plans (2.63 vs. 2.50), with a more extreme quality range (1.17–3.29 vs. 1.63–3.48) and higher dispersion (SD 0.63 vs. 0.45) respectively (Table 4).

Table 4
Quality of climate adaptation plans.

All plans			
Quality	Average	Range	SD
Overall	2.56	1.17–3.48	0.54
Group I	2.27	1.00–3.83	0.73
Group II	2.71	0.58–3.67	0.70
Group III	2.55	0.83–3.67	0.72
French plans			
Quality	Average	Range	SD
Overall	2.63	1.17–3.29	0.63
Group I	2.43	1.50–3.50	0.56
Group II	2.61	0.58–3.67	0.86
Group III	2.85	1.17–3.67	0.61
U.S. plans			
Quality	Average	Range	SD
Overall	2.50	1.63–3.48	0.45
Group I	2.14	1.00–3.83	0.83
Group II	2.78	1.67–3.42	0.53
Group III	2.29	0.83–3.33	0.70

Table 5
Representation of strength in the top nine plans (score group ≥3).

Adaptation Plan	Group I	Group II	Group III
CA du Niortais	3.17	3.23	2.83
CA Var Esterel Méditerranée (CAVEM)	2.67	3.23	3.33
Grand Nancy	3.5	3.08	3
Le Grand Chalon	2.33	3.38	3.33
Laguna Woods, CA	3.5	3.15	3.17
Ouest06 (CASA, CAPG, CAPL)	2.33	3.31	3.33
Perpignan Méditerranée Métropole	3.17	2.69	3.67
Punta Gorda, FL	3.83	3.17	3.33
Saint-Etienne Métropole	3	3.08	3.17

In Group I (readability and structure), the French plans demonstrate higher scores and less variability compared to the U.S. plans. They also have significantly higher (2.78 vs. 2.29) and more consistent scores in Group III, based on information about the plan development process, inclusivity, and coordination. These findings seem to be consistent with more uniform national methodological requirements reflected in the structure of French plans. The U.S. plans, on the other hand, appear to be stronger, on average (2.78), based on their content and quality of scientific data (Group II), ranging from 1.67 to 3.42.

However, there is much more variability among the cities with respect to each group of criteria. Only two U.S. and seven French plans show "very good" scores based on all criteria. One U.S. plan and three French have scored "fair." No plan appeared to be "excellent" or "poor." At a finer resolution, there are ten U.S. and six French plans with a total score below 2 in at least one group of criteria. Hence, U.S. plans have greater stronger and weaker points, deviating from their average ratings. The ratings of French plans appear to be more uniform with more consistent high or low scores across all criteria. They appear to be either good or not, based on the majority of criteria, with much less variability among the criteria (Table 5).

4.2. Strengths and challenges of the plans

Despite the major differences between the two countries' planning cultures and climate policies, American and French adaptation plans have many strengths and challenges in common (Fig. 2). The criteria that appear to have the highest average scores *in both countries* are 1 ("overall clarity and logical structure") (3.16 in the U.S. and 3.25 in France) and 16 ("place-based focus") (3.79 in the U.S. and 3.94 in France). Other criteria with relatively high average scores in both countries (2.44–2.88 for France and 2.84–3.37 for U.S.) include clear goal setting (2), implementation planning (3), consideration of climate change trends and scenarios (7), climate impact analysis (8), and vulnerability analysis (9). Results show equally high average scores for criteria (17) ("integration of adaptation planning across multiple sectors") (2.79 U.S. vs. 3.00 France) and (18) ("integration across scales") (3.47 U.S. vs. 3.19 France).

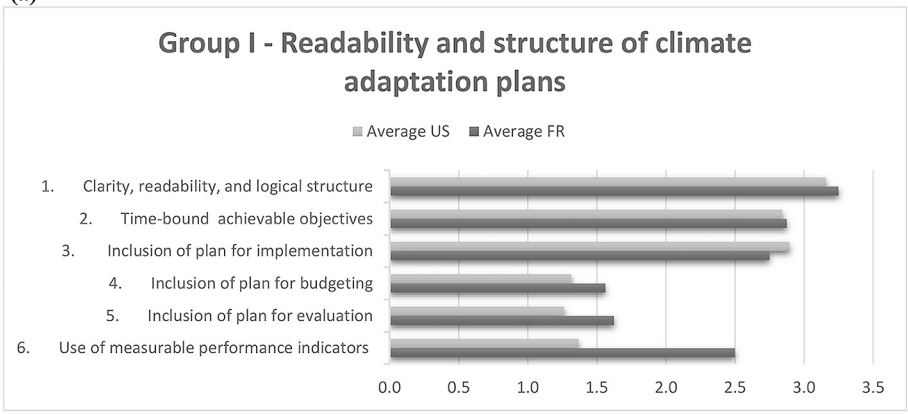
The lowest scores, *common for both countries* (1.26–1.32 for U.S. and 1.56–1.63 for France), include a shortage of information about budget planning (4) and evaluation planning (5). Many plans are still mere declarations of intent, with no published budget, unclear implementation plan, and no follow-up evaluation reporting process. Even though many French PCETs/PCAETs have finalized their budgets, they predominantly address mitigation actions budget only or, occasionally, mixed adaptation-mitigation objectives.

Little or no articulation of strategies to address social and environmental equity and justice (11) appears to be another *common challenge* of plan development process in both countries (1.69 in France and 1.47 in the U.S.). In France, social equity and justice are addressed in poverty reduction schemes (e.g. Multiannual Plan Against Poverty and for Social Inclusion (République française, 2013) and omitted in climate adaptation plans, except for one aspect of social equity: fuel poverty program. A very small number of American plans, such as Santa Fe, NM, Grand Rapids, MI, Punta Gorda, FL, and Laguna Woods, CA acknowledge the higher burden of climate change on poorer communities and the need of specific actions to address it.

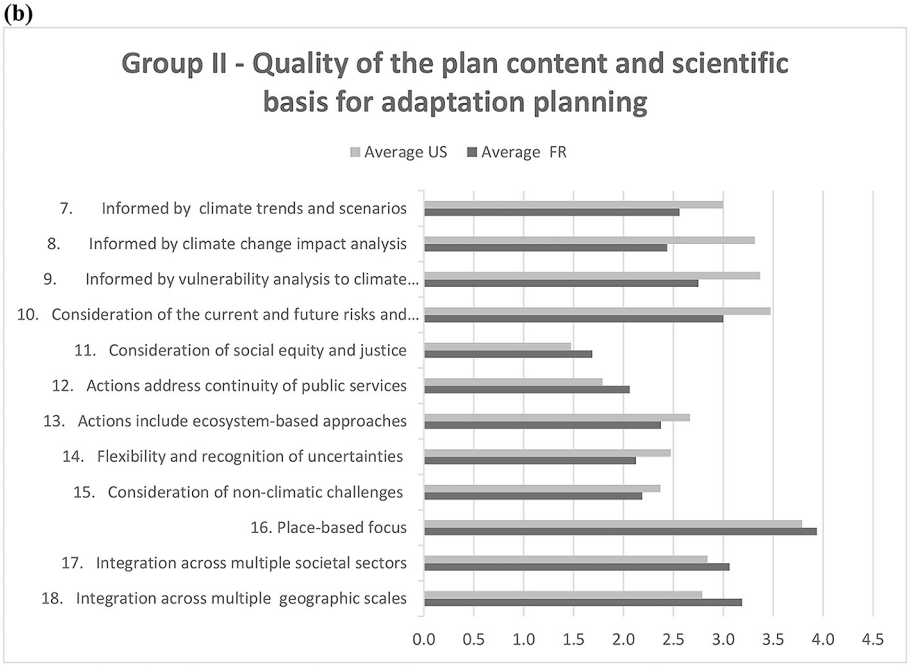
Nevertheless, we found several contrasting points comparing adaptation plans of French and U.S. communities. French adaptation plans appear to be markedly ahead of the U.S. plans in terms of their inclusion of measurable performance indicators (6). Some examples of specific measurable indicators found in French plans include numerical targets for green and blue infrastructure, air quality, water quality, public health (e.g. allergies), first aid response facilities, and creating neighborhood solidarity networks for mutual assistance. On the other hand, seven out of the 20 U.S. plans examined here used no measurable indicators at all (score 0) and only one plan demonstrated fully explained measurable performance indicators (Punta Gorda, FL - score 4). Those U.S. plans, who do use indicators, use a wide range of different approaches that are hard to compare.

On the other hand, American climate adaptation plans consistently demonstrate higher average scores in Group II for the analysis of climate trends and scenarios (7), climate change impacts (8), vulnerability analysis (9), consideration of the current and future risks (10), ecosystem-based climate adaptations strategies (13), and consideration of non-climatic challenges. French plans generally

(a)



(b)



(c)

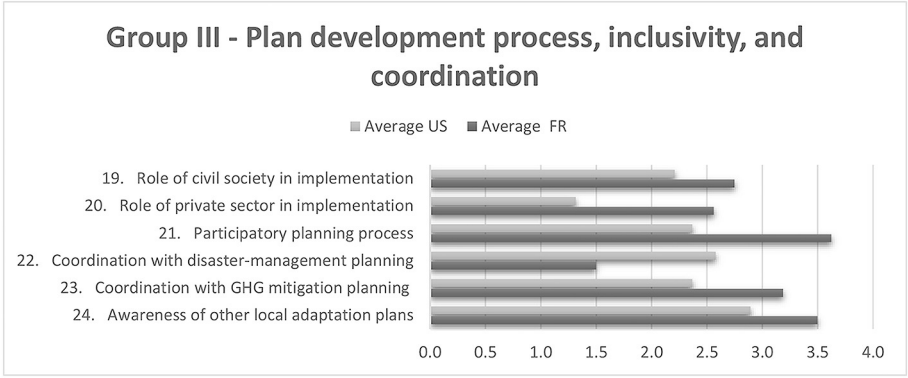


Fig. 2. Variability of individual criteria of plans' quality: a) Group I – structure and organization of adaptation plans; b) Group II - Quality of the plan content and scientific basis for adaptation planning; c) Group III - Plan development process, inclusivity, and coordination.

demonstrate slightly lower but still relatively good scores for these criteria, with a much wider disparity depending on the cities.

French plans typically show significantly better scores, compared to the U.S. plans, in many criteria in Group III, such as "engagement of civil society and citizens" (19), "engagement of local enterprises" (20), "implementation of participatory process and inclusivity" (21), "coordination with the GHG mitigation planning" (23), and "awareness of other local adaptation plans" (24). Nevertheless, no plan makes an explicit reference to other plans, and therefore it is not clear if municipalities are fully aware of the existing best practices and truly reference other cities' experiences.

5. Discussion

Our study aims to develop a uniform system of indicators to facilitate cross-national comparison and monitoring of local climate adaptation plans. Such analysis is necessary to identify and share the strengths and best practices of climate adaptation planning emerging in diverse national contexts and cultures. The proposed system of 24 indicators reveals important insights about climate adaptation plans of small and mid-sized urban communities in France and the U.S. and the lessons they offer. In a way, some of our findings are not quite surprising: climate adaptation plans reflect national and state policies and follow the guidelines of their umbrella organizations and omit aspects that are not explicitly required. The important lesson is that the most effective way to improve existing and especially future adaptation plans is to improve and update the guidelines first.

French plans are more homogeneous in their content and format than American plans, due to planning at the national and the EU levels, relayed by the ADEME and its methodologies. For example, almost all French plans used measurable indicators and three plans received the top scores in this area (Grand Nancy, Cherbourg-en-Cotentin, and Montrevel-en-Bresse). This is in striking contrast with the U.S. plans: seven out of the 20 U.S. plans examined here used no measurable indicators, and only one plan (Punta Gorda) demonstrated fully explained, measurable performance indicators. The most articulated adaptation actions and their indicators are linked to the management of municipalities concerning the improvement of public buildings and the sensitization of municipal agents to better integrate adaptation in local activities, land-use planning, and urban development (e.g. in Agglomeration Community Center Martinique and Perpignan Méditerranée Métropole). Some cities, such as Grand Nancy, for example, have already developed and applied quantitative indicators specific to the proposed adaptation measures. Higher scores of French plans related to the use of quantitative metrics and higher level of coordination and integration through the planning process are explainable by the long-standing history of planning practices in France (Bertrand, 2013; Richard, 2016). Land-use planning activities at various scales, from inter-communal to cross-border urban development planning,[6] are rooted in intercommunal cooperation and integration of sectorial planning (urban and suburban transportation plans, green plans, forestry plans, watershed plans, etc.)

Another lesson to learn from the ADEME framework is the implementation of participatory processes for defining the issues, strategies, and actions, well demonstrated in all French plans. The presence of participatory processes in the construction of PCETs/PCAETs can be linked to the history of community participation in policy making in France (Bertrand, 2013). Since the 1990s, France has responded to contests (anti-nuclear struggles, territorial zoning and development projects contestations, etc.) by the institutionalization of citizen participation through voluntarist policies of consultation with the community (e.g., Bouchardeau and Barnier Laws[7]). The ADEME climate planning methodology suggests that municipalities should conduct a co-construction process to define climate mitigation and adaptation actions to be taken (ADEME, 2016, pp.10–11). Beyond participation in discussions of and contribution to the plans' content, the involvement of local actors – citizens, businesses and associations – in the implementation of adaptation actions is assumed to contribute to the overall good quality of adaptation plans (Richard, 2014). Citizen and business involvement in the implementation of adaptation actions takes other forms, such as signing a community climate charter, creation of dedicated clubs (e.g. Grand Chalon Energy Club, PCET Ouest06 Business Club, Var Esterel Méditerranée Partners Committee), and sponsoring workshops (Perpignan Mediterranean Métropole, Communauté Urbaine de Dunkerque). Another interesting example is the participation of neighborhood associations, encouraging the participation of the residents in the climate adaptation planning and furthering it at the neighborhood scale (e.g. in Brest Métropole).

Cross-sectoral and cross-scale integration appears to be much more challenging in the U.S., where numerous climate adaptation initiatives have been championed by various groups at different times, and are occasionally hindered by conflicting partisan agendas and complexity of interactions among the local, tribal, state, and federal agencies (Vogel et al., 2016). The level of participation of both citizens' groups and the private sector in the development of U.S. plans appears to be much weaker as well. Although minimal engagement of the private sector in climate planning process in the U.S. might appear counterintuitive, it is consistent with the idea that government regulations and incentives are necessary to engage the private sector in joint adaptation actions (Mendelsohn, 2000). Although the U.S. EPA Climate Leadership Award played an important role in 2012–2016 in recognizing and incentivizing exemplary corporate, organizational, and individual leadership in response to climate change, it was discontinued in 2018 along with the EPA's sponsorship of the Climate Leadership Conference (EPA, 2018).

In this more fragmented landscape of the U.S. adaptation plans, driven by multiple forces and scales, and in the absence of federal climate adaptation policy, state policies appear to be crucial for supporting local plans (Arroyo, 2017). For example, the State of

[6] The PCAET of CU de Dunkerque explained the functioning of the intercommunal cooperation and sectorial planning at different scales (Communauté Urbaine de Dunkerque, 2015).

[7] The Bouchardeau Law mandates public inquiry when developments are likely to affect the environment (Loi n°83-630 du 12 juillet 1983). The Barnier Law broadens the participation of the public and associations in all major projects by creating the National Commission of Public Debate (CNDP) (Loi n° 95-101 du 2 février 1995)

California addresses adaptation to climate change through the California Climate Adaptation Strategy (California Natural Resources Agency, 2009, 2014, 2018), and California Adaptation Planning Guide (California Natural Resources Agency, 2012), providing a decision-making framework intended for use by local and regional stakeholders. The state also produced four major assessments of local and statewide vulnerabilities to climate change in 2006, 2009, 2012, and 2018 (California Environmental Protection Agency) and developed Cal-Adapt – a web-based tool, which enables city and county planners, government agencies, and the public to identify potential climate change risks in specific areas throughout California. Benefiting from the state climate policies, Californian cities lead the nation in terms of the number of local plans and their quality and coordination.

As a whole, U.S. plans consistently demonstrate higher scores for several content-related criteria, showing more in-depth analysis of scientific climate data and modeling scenarios, and higher quality assessment of climate impacts, risks, vulnerabilities, and flexibility facing uncertainties of climate change scenarios. We attribute these strengths to partnerships of the local governmental and non-profit organizations with academia, more common in the U.S. than in France. Twelve out of the 20 U.S. plans examined here involved collaboration with local university professors and scientists and at least half of them have received funding dedicated to partnerships with the local universities from research programs sponsored by federal agencies, such as NOAA, FEMA, and EPA. Although U.S. plans generally contain more information about climate change scenarios and their uncertainties, tremendous variability of methodologies makes them harder to compare at compatible spatial and temporal scales. For example, the plan of Boulder, CO includes a 22-page detailed analysis of the county's historical climatology and a range of climate change scenarios using a set of regional projections downscaled from 16 General Circulation Models (GCM) and four scenarios derived from Regional Climate Models. The City of Grand Rapids, MI worked with one of the authors of this study using the MAGICC-SCENGEN 5.3.2 model to construct regional climate change projections based on multi-model means from 20 GCMs from the CMIP3/AR4 archive and historical climatology. Plans of Flagstaff, AZ and Keene, NH used bibliographic analysis of climate change projections from the IPCC and other scholarly publications. The plan of Marquette, MI examined historical temperature and precipitation trends and did not use any climate change scenarios.

There is more uniformity of how French plans approach climate change scenarios and impacts. The majority of them provide much less detailed (typically between 0.5 and 2 pages), generalized assessment of historical temperature and precipitation trends and, in some plans, a brief interpretation of GCM climate change scenarios, based on the IPCC and Meteo France reports. Contrary to many U.S. adaptation plans, French plans typically do not include any site-specific research or downscaling of climate modeling scenarios or extensive analysis of scholarly literature.

Similar differences are noticeable in the assessment of human vulnerability to climate change. Once again, the U.S. plans demonstrate a wider range of approaches and levels of detail in this area. In some older U.S. plans, (e.g. Boulder, CO, and Taos, NM) thematic areas of vulnerability (e.g. health, water, ecosystems, etc.) are deduced from the impacts projected by climate change scenarios. Plans of Flagstaff, AZ, Sarasota, FL, Chula Vista, CA, and Grand Rapids, MI based their vulnerability assessments on opinions of experts through interviews and bibliographic research. Some other cities, e.g. Keene, NH, Punta Gorda, FL, Marquette, MI, and Groton, CT invited their residents to identify local vulnerabilities to climate change through residents' workshops involving discussions with experts and other stakeholders.

In France, assessment of human vulnerability to climate change is a required prerequisite for the construction of PCETs/PCAETs. It is typically based on an evaluation of current and projected climatic conditions and sometimes includes the historical perspective. For example, the Plan of Communities of Vallée de Chamonix-Mont-Blanc highlights the impacts of climate change on the region's culture and environment over the past 75 years. When considering the future, the majority of plans extrapolate impacts of projected climate change on their geographic area based on the regional or national climate change scenarios. For example, the plan of Communauté d'Agglomération du Niortais used regional climate change scenarios from Météo France for their theme-based (water, biodiversity, health, and natural risks) and sector-based (agriculture, energy sector, construction and development, insurance and mutual insurance, transport, and tourism) vulnerability analysis.

Unfortunately, the majority of adaptation plans, both in the U.S. and in France, limit human vulnerability assessments to the most obvious dimension, such as physical exposure to climate impacts, e.g. flooding or heat waves based on location and infrastructure. The majority of plans in both countries largely ignore social and economic determinants of sensitivity and adaptive capacity of the population, such as age, gender, income, wellness, mobility, access to health care, education, insurance, transportation and so on. Yet, these factors are essential for understanding and assessing human vulnerability (Polsky et al., 2007). If cities fail to address equity consideration in their vulnerability assessments, climate adaptation plans can produce maladaptive outcomes by protecting more affluent and economically valuable areas over low-income and minority neighborhoods (Anguelovski et al., 2016).

The inclusion of ecosystem-based climate adaptation strategies through the development of green and blue infrastructure is another strong point of American adaptation plans, which is consistent with the U.S. EPA recommendations (U.S. EPA, 2014). Some examples of ecosystem-based strategies in U.S. plans include urban afforestation and wildfire management measures (Santa Fe, NM and Flagstaff, AZ); flood risk management through river valley restoration and floodplain ecosystem management (Grand Rapids, MI and Santa Fe, NM); restoration of coastal ecosystems (Punta Gorda, FL); green infrastructure development, such as green roofs, green walls, rain gardens, and bioswales (Grand Rapids, MI; Laguna Woods, CA), and many others. In French climate plans, ecosystem-based adaptation strategies are mostly limited to the preservation of green spaces in urban areas. The only exception found here was the plan of Chamonix-Mont-Blanc, a mountain resort area, relying on ecotourism and alpine skiing.

Our assessment reveals that despite very different planning cultures and national climate change policies, many aspects of climate adaptation plans on both sides of the Atlantic share strikingly similar strengths and challenges. The experiences of cities whose plans received “very good” scores (≥ 3), both overall and in each group of criteria (Grand Nancy, Saint-Etienne Métropole, Punta Gorda, FL, and Laguna Woods, CA) provide useful insights on the local community factors and characteristics contributing to successful

climate adaptation planning. We identify here three major factors of success: a) diversity of stakeholders, b) history of environmentalism, and c) broader territorial context.

In both countries, the plans with highest scores demonstrate development through active and meaningful engagement and participation of diverse stakeholders, such as local policy-makers, various civic organizations, business and non-profit sectors, schools and youth organizations, and academia. In all plans with the highest scores, we found evidence of genuine collaboration and active involvement of citizens. Residents of these cities had opportunities to participate in the planning process through public meetings, attend experts' presentations about climate change, and offer their input and feedback. In contrast, all plans in our sample, produced by external entities, with minimal or no engagement of citizens, have received relatively low- quality scores. Interestingly, all plans developed by external private contractors demonstrated the lowest quality, based on the majority of criteria. To reveal the role of participatory planning we recomputed the total quality scores excluding the three criteria that address participation (19, 20 and 21). When ranked with and without these three criteria, the best plans retained the highest total scores. Comparison of the plans' overall ranking and their ranking based on the average of criteria addressing participation indicate that the best plans were developed with active participation and engagement of stakeholders.

This finding is consistent with other studies documenting the advantages of collaborative climate planning actively engaging diverse stakeholders (e.g., Doria et al., 2009; Wiseman et al., 2010; Richard, 2016). However, it is important to keep in mind that high participation and engagement alone do not automatically lead to good quality plans. In our sample, among the 16 plans (11 in France and 5 in the U.S.) with a score 3 or higher ("very good") for the participation criteria, eight plans have an overall score between 2 and 3 based on all other criteria ("good") and one is below 2.

Our second observation is that all plans obtaining the highest scores belong to municipalities with an existing culture of interest in climate and environmental issues and voluntary climate actions. For example, Grand Nancy, Saint-Etienne Métropole, Laguna Woods, CA and Punta Gorda, FL, all have a long-standing history of voluntary climate, energy and environmental planning, before development of their climate adaptation plans. The plan of Saint-Etienne Métropole, published in 2011, is among the oldest in France, and the city had already many elements of climate change mitigation and adaptation planning in place, way before they became legally required. Laguna Woods published its Climate Protection Action Plan in 2009 and its Local Hazard Mitigation Plan in 2012, which provided a strong foundation for the Climate Adaptation Plan, published in 2014. The PCAET of Grand Nancy refers to over 30 years of voluntary climate change mitigation activities by the city, years before climate planning in France became a requirement (Grand Nancy, 2014, p.7). Punta Gorda and Charlotte County in Southwestern Florida have a long history of local hazard mitigation planning and concerns about sea-level rise issues, addressed in earlier documents (Beever et al., 2009; Charlotte County Local Mitigation Strategy Work Group, 2015).

All cities with top quality plans appear to be actively involved in a broader-scale territorial climate planning beyond their plan. For example, the PCAET of Saint-Etienne Métropole provides numerous references regarding its coordination with climate mitigation and adaptation planning by the Rhône-Alpes region (Saint-Etienne Métropole, 2011, p.9, 14, 24). The PCAET of Grand Nancy, likewise, demonstrates strong integration with the plan of the Lorraine region and the voluntary Regional Network of the PCAETs of Lorraine (Grand Nancy, 2014, p. 36). All cities participating in the regional network in Lorraine engage in the regular exchange of information and hold regular meetings three times a year to discuss and share their experiences. The City of Laguna Woods developed its plan following the California Adaptation Planning Guide (2012), jointly developed by the California Governor's Office of Emergency Services (Cal OES) and the California Natural Resources Agency (CNRA) and Cal-Adapt. The City of Punta Gorda has been a part of the larger Southwest Florida Regional Planning Council.

The results of this study also reveal six major shortcomings, evident in climate adaptation plans of both countries:

a) Lack of continuity and learning from prior experiences;
b) Lack of collaboration and sharing of knowledge among cities;
c) Insufficient diversity of stakeholders participating in the plan development process;
d) Insufficient integration across the economic sector, scale, and planning initiatives;
e) Neglect of sensitivity and adaptive capacity in assessment of human vulnerability;
f) Insufficient attention to environmental equity and justice.

Chronologically our selection of plans spans over the past ten years, with the oldest plans dating back to 2007 in the U.S. and 2011 in France. Although we initially expected that the quality of plans would gradually improve as the time goes, the reality is more complex. While the later plans have possibly benefited from familiarization with the existing best practices and awareness of earlier documents, we have not found enough evidence that more recent plans demonstrate much better quality than their predecessors. More research is necessary to understand why municipalities do not tap enough into each other's experiences, feedback and data from other plans, at least not explicitly. What are the roles of regional agencies, municipalities, and academia in this knowledge transfer? Unfortunately, for the majority of the older plans, we also found very limited evidence of them being periodically reevaluated and revised. If indeed some plans have remained unrevised for 5–10 years, are they still relevant and what new directions has local adaptation planning taken since their adoption? To what extent the existing plans have been implemented and what lessons have been learned from this? More research is necessary to assess if and how climate adaptation plans evolve through implementation and reevaluation. To be relevant, they need to become constantly evolving and living documents, reflective of the growing knowledge about changing vulnerabilities and adaptation strategies of their communities.

The involvement of diverse stakeholders, including branches of the local government, universities, industry, non-profit organizations, and neighborhood associations, representing diverse social, economic, and cultural groups of the population, appear to be

essential for successful climate adaptation planning (Keskitalo et al., 2016). Yet, very few cities appear to do it well. We found that collaboration with academia remains very limited in France, while in the U.S. the main challenge is to intensify the involvement of the private sector in community adaptation planning. Citizens' involvement through community education and citizens' science initiatives could also offer more opportunities for involvement of local public museums, nature centers, botanical gardens, aquaria, and other organizations. Climate change is an excellent example of a global issue relevant to everyone, leaving large numbers of concerned citizens eager to participate in finding solutions, yet disappointed by the lack of opportunities to be involved in meaningful ways.

Integration, both vertically across the scale, and horizontally among various economic sectors, actors, and planning departments and initiatives, is another major challenge in both countries but especially in the U.S. There is an urgent need in state and national policies to encourage and facilitate integration of related initiatives in city and regional planning, climate change mitigation and adaptation planning, transportation planning, sustainability planning, and strategic planning at various levels. Last but not the least, such integrated planning initiatives must be informed by deeper analysis of all three dimensions of human vulnerability (exposure, sensitivity, and adaptive capacity), and tackle not only environmental but also social and economic aspects of climate preparedness. Explicit attention should be given to the eradication of homelessness, poverty reduction, urban food security, affordable health care, multimodal transportation, public safety, and continuity of public services.

Before concluding, we would like to highlight that our study has several limitations. The 24 criteria of the plans quality assessment are not weighted and there is an assumption that all criteria are equal. This decision is arbitrary and more research is needed to evaluate the relative weight of various factors. All criteria used in our study come directly from the scholarly literature and the guidelines of national and international agencies. Some of these criteria would be better evaluated and understood if they could be further deconstructed to more specific components. For example, although many plans include or are based on “vulnerability analysis to climate change,” vulnerability is a very complex concept composed of physical, social, and economic variables. If the vulnerability is not scoped as a composite of multiple factors of exposure, sensitivity and adaptive capacity, adaptation strategies can be discriminatory towards some neighborhoods or population groups and lead to a shift of vulnerability to other areas (Anguelovski et al., 2016). Poorer neighborhoods could be gentrified through the development of green infrastructure or the needs of older people or minorities can be overlooked. In our study, we found that the majority of plans understand “vulnerability” solely as “physical exposure” and rarely consider factors such as population age, race, education, and income. Therefore, deconstructing vulnerability assessment as three more specific criteria, such as “assessment of exposure,” “assessment of sensitivity,” and “assessment of adaptive capacity” could be more informative for defining balanced adaptation strategies.

Some criteria in the proposed framework might partially overlap depending on their interpretation by the plans' authors. For example, criteria “informed by climate impacts analysis” and “informed by vulnerability to climate change” appear to overlap in some adaptation plans, when assumptions about future vulnerabilities (mainly exposures) are deduced from the projected impacts of climate change informed by the scenarios of global and regional climate models.

A number of our criteria, such as “clarity, readability and structure” or “awareness of other local adaptation plans” are very subjective. Our interpretation and scoring of criteria are also quite subjective, especially because the assessment of the plans was informed by our screening of the plans and related documents, and did not involve any input from the city officials or residents.

Last but not least, our study is based on a small sample of climate adaptation plans in just two countries. This is a pilot project, offering a potential framework of indicators for monitoring adaptation plans, and our preliminary results are not intended for statistical inferences at this stage. Our research sample is intentionally focused solely on cities with a population below 300,000 people, currently underrepresented in the literature. As the number of small and mid-sized cities embracing climate adaptation planning continues to grow, a broader study, involving more cities and countries, is needed to grow understanding of their successes, limitations, and transferability of methodological approaches.

6. Conclusions

Climate adaptation planning is still an emerging interdisciplinary field and the effectiveness of existing adaptation plans would be fully tested by time, as communities continue experiencing more impacts of climate change. To our knowledge, this is the first study offering a comparative analysis of European/French and U.S. climate adaptation plans. It offers a comprehensive independent system for monitoring climate adaptation plans, integrating three groups of indicators: structural and organizational quality, quality of the content and scientific data, and the quality of plan development process. This is also one of the very first attempts to harmonize recommendations and frameworks by various national and international organizations, as they apply to small and mid-sized cities. Despite many limitations of the proposed framework (e.g. no weighting and potential overlapping and/or correlations of some criteria), it offers a much needed operational instrument to cities and scholars worldwide to improve the process of development, implementation, evaluation, and reporting of their existing or future plans. Such cross-national and cross-institutional comparison is necessary to reveal more objectively the strengths and challenges of existing climate adaptation plans, which are difficult to capture otherwise, and to inform and improve the development of future plans by cities (especially small and mid-sized cities) and guidelines of their umbrella organizations. Case studies used in this study (see also da Cunha and Lioubimtseva, in press) provide useful examples of local plans and their strengths to inform future adaptation planning efforts.

Several recommendations may be drawn based on the experiences of small and mid-sized cities examined in our pilot study:

- There is a need for more systematic international, national, and subnational monitoring of adaptation planning. Learning from the best practices, inspiring success stories, and place-based community knowledge and experience is essential for improving the

quality of the current and future plans. An international database of adaptation plans could provide a useful resource for peer-learning from communities of comparable size, facing similar issues all over the world.

- Cities (and especially resource-strapped small cities) urgently need user-friendly high-quality climate change data and scenarios at a relevant spatial and temporal resolution. Visualization and information tools, similar to Cal-Adapt in California, should become available in every country or state through collaboration of the local universities, climate scientists, and governmental entities.
- Climate preparedness is an important task for the entire community, no matter how small it is. There is a need to create and support policies promoting integration of climate adaptation planning in schools, colleges, and universities as well as in public and private institutions in a way that is similar to how we currently integrate emergency planning.
- In our sample of cities, vulnerability assessments in climate adaptation plans remain largely limited to the interpretation of physical exposure to predicted climate impacts. There is a major gap in addressing the sensitivity and adaptive capacity of the population to climate change in the majority of existing plans. Conscious inclusion of the social and environmental justice and equity considerations in assessments of human vulnerability are crucial for successful adaptation planning. Future research is necessary to continue refining the proposed indicators and monitoring implementation and revisions of climate adaptation plans.
- Climate adaptation is a dynamic process of policy adjustments, rather than a constant state. Therefore, the monitoring of adaptation plans is a long-term journey following the evolution of adaptation plans through their continuous iterative re-evaluation and revision. To assess if an adaptations plan works, a detailed vulnerability assessment is necessary both before and after the implementation of a plan.

This study is a starting point of a long-term multi-year international study of adaptation planning in small and mid-sized cities. Our future plans include long-term in situ observations of plans implementation, expanding the database of adaptation plans to a larger number of cities internationally, and exploring how the role of community engagement and diversity of stakeholders influence considerations of equity in adaptation planning.

Declaration of Competing Interest

None.

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