

**Summary:** Cities in both the United States and Europe are experiencing floods, heat waves, droughts, and other effects of climate change. At the same time, cities are constantly updating their built and natural environment in a way that supports the adaptive planning needed to respond to changes in climate, including exacerbation by growing populations and aging infrastructure. Local land use and infrastructure planning provide the framework for new stormwater systems, buildings, parks, and public spaces. Smart growth approaches that consider where and how cities develop, as well as green infrastructure systems for managing stormwater, can prepare for greater fluctuations in weather conditions. Importantly, these approaches are also capable of producing additional community benefits. This brief looks at the adaptive planning policies and practices that the European cities of Rotterdam, Barcelona, and Lyon are instituting to combat the effects of climate change. The local approaches these cities are developing provide examples of innovations that U.S. cities can look to when implementing their own local climate action plans.

## Building Climate Change Adaptation with Smart Growth and Green Infrastructure: Adaptive Planning Policies from Rotterdam, Lyon, and Barcelona

by Abby Hall

### Introduction: Why Cities Must Adapt to Climate Change

Climate change is happening and communities are already seeing the impacts in the form of heat waves, floods, droughts, and other extreme weather disasters that impact public health, natural ecosystems, and overall economic well-being. Even if emissions of greenhouse gases were immediately curbed, global changes in climate are certain to continue for some time.<sup>1</sup> Extensive research identifies the direct impacts that climate change will have on different regions and on various elements of society and economies in the United States.<sup>2</sup> Large and small communities across the country must start to identify ways they can adapt, defined as “adjustment in natural or human systems to a new or changing environment that exploits beneficial opportunities or moderates negative effects.”<sup>3</sup>

Climate change adaptation will be a local and regional issue rather than a national issue for the United States because of the regional variability of risks. Unlike smaller European countries such as The Netherlands, where there is the single predominant risk

of flooding, the United States will see great regional difference in the types of climate change impacts, from sea level rise on the coasts to drought in the West and flooding in the Midwest. In smaller European countries, therefore, a national adaptation strategy that coordinates agencies, funding, and programs around a common climate change risk can be an effective tool. In the United States, on the other hand, the federal government can provide overall support in the form of funding and removal of programmatic barriers, as well as technical assistance, but the solutions will need to be regionally and locally developed. Regional climate science should be used to develop risk assessments that are locally scaled, and regional climate scientists are often best prepared to discuss regional impacts and appropriate solutions.

Climate change will have an acute impact on cities because of the concentration of population in urban areas. Climate change risks for cities include:

- Extreme heat, heat waves, and air quality problems, due in part to heat-trapping landscapes like roofs and paved surfaces.

# Policy Brief

- Flooding from increased intensity and frequency of storms.
- More periods of drought and water scarcity.
- Sea level rise.

The impacts of these risks to basic city functions and responsibilities include:

- Increased costs for repairing and maintaining infrastructure because of flooding, land subsidence, and erosion. Some infrastructure may become unusable because of sea-level rise.
- Public health problems related to heat waves, poor air quality, extreme weather, or an increased vulnerability to disease.
- Threats to buildings and transportation infrastructure.

City governments are well-positioned to start adapting to climate change risks immediately because cities continually update, repair, and invest in the built environment. Development decisions about where to build and, more importantly for climate change, where not to build, are made every day and can have effects for many decades to come.<sup>4</sup> Not only is planning the right process for adapting to climate change, it is imperative for cities to consider the future effects of climate change with every development decision and investment. Since no federal land use planning policy exists in the United States, meaningful, government-level action on climate change adaptation is most likely to begin at the local level.

Land use planning is necessarily a flexible and changing process, and effective responses to climate change effects require adaptability over space and time. Moreover, in the United States as well as abroad, the era of single-issue investments is coming to an end as tight city and state

Development decisions about where to build and, more importantly for climate change, where not to build, are made every day.

budgets necessitate the identification of multiple benefits from each investment. For these reasons, land use planning is increasingly focused on approaches that confer a range of benefits while also having flexible designs that can alter with a changing climate, such as green infrastructure for managing stormwater with natural systems.

This policy brief analyses the preventative solutions that Rotterdam, Barcelona, and Lyon are using to address the climate change threats of heat waves and the water-related impacts of increased precipitation and sea level rise, including flooding, stormwater management challenges, and drought. Rotterdam has an overarching adaptation plan called Rotterdam Climate Proof that addresses many climate change risks with a five-year timeline of goals that are being adopted as official municipal policies. Lyon is introducing small green spaces and water features, as well as expanding its tree plan to create many small, accessible spaces that will help cool dense neighborhoods threatened by heat island effects. Barcelona is retrofitting existing public parks and creating new public green spaces that can help deal with flooding and heat island effects, as well as engaging the general public to help develop effective adaptation policies with near-term benefits.

## Urban Planning Is the Right Process for Adaptation

Municipal level land use planning provides the right context to plan for climate adaptation. Cities are constantly changing and land use planning is the process by which citizens, governments, and the private sector decide where and how development will occur. In addition, cities regularly update and maintain infrastructure such as water pipes, roads, public transit, and utilities. Cities in Europe are very built out, and urban cores in the United States are taking a greater share of construction permits than undeveloped areas,<sup>5</sup> leading to regular redevelopment of older and existing neighborhoods in many cities on both sides of the Atlantic. City planning departments also regularly use future population projections to make decisions regarding infrastructure upgrades and redevelopment projects, whether for housing, retail, or commercial needs. Since climate change data is similarly based on future projections that rely on ranges rather than specific fixed numbers, city planning departments can be an important partner in the effort to respond to climate change because of their experi-

# Policy Brief

ence in planning for the future and their history of using adaptable models to guide these plans.

Planning processes include decisions about locations for new growth and redevelopment and provide an important opportunity to consider both vulnerable areas that should be avoided and protected zones that are appropriate for growth. Cities can pair maps and information about growth areas with risk and vulnerability assessments to decide the best places for new investments. Comprehensive land use plans help determine community design and development density, setting priorities for infrastructure and capital facilities investments, developing policies for land use in floodplains and other high risk areas, and protecting critical natural resources. In the United States, land use is primarily a locally dictated process, but state and federal programs can influence and support local land use decisions. In particular, federal programs for disaster planning and recovery, such as the Federal Emergency Management Agency's (FEMA) Hazard Mitigation Assistance programs,<sup>6</sup> have the potential to support local efforts to plan with consideration for climate change. Altogether, there are a number of planning tools, policies, and funding streams that drive decisions about where and how a community will grow and change.

Adaptive planning solutions can be integrated into comprehensive land use plans, capital improvement plans, zoning and building codes, improved flood maps, and incentives for development and conservation. The process of incorporating climate change considerations into local planning is iterative. Early steps include using best-available climate science to develop vulnerability assessments, and then layering this information with future land use plans. Next steps will require improving local climate change scenarios by properly downscaling national datasets, as well as translating climate change data into a format that is readily usable by land use planners, emergency managers,

**Effective planning for adaptation to climate change will require an overall approach that is anticipatory and flexible.**

and other local decision-makers and staff. Effective planning for adaptation to climate change will require an overall approach that is anticipatory and flexible and relies on the use of future conditions data to make predictions about the range of impacts rather than simply reacting after natural hazards occur. Such a flexible approach allows for best available data to impact and refine plans and investments to better respond to changing conditions.

## Case Studies

### *Lyon, France*

Lyon is located at the confluence of the Rhône and Saone rivers in east central France. It is the second largest region in France after Paris and is home to a metropolitan population of close to 2 million people. The city faces increasing public health threats caused by heat waves and contributing heat island effects. Though temperatures are predicted to increase across all months, the greatest temperature increases are likely to come in the summer months. More drastic rainfall decreases in summer will exacerbate these temperature increases, creating a dual problem for the Lyon region.

Though no large-scale adaptation projects are underway, Lyon is taking an adaptive approach to its overall planning by bringing climate change considerations into ongoing infrastructure projects and plans. In particular, Lyon's 2030 comprehensive plan, known as SCOT, outlines steps for increasing green spaces, reducing impervious surfaces, and considering the role of green space in dense urban areas.<sup>7</sup> Most of Lyon's adaptation projects are happening through small-scale open space improvements, including tree planting and using green infrastructure techniques that will simultaneously manage stormwater runoff, mitigate heat island effects, and restore groundwater systems to mitigate drought conditions.

Regional planning is built into the government structure of the metro region, which is overseen by a decision-making agency known as Grand Lyon. This regional planning approach supports transit-oriented development concentrated close to the City of Lyon, the employment center of the region. Compact development near a variety of transportation options can help community members access necessary services during disasters, such as cooling centers during heat waves. Grand Lyon has large networks of natural corridors, but these open spaces are not enough

# Policy Brief

to mitigate heat impacts because they are too removed from population centers. The important lesson that both city staff and Grand Lyon staff highlighted is that highly impervious, densely developed urban areas need smaller scale green spaces to break up heat-trapping surfaces such as roads and rooftops. Even large parks may not contribute the valuable cooling impacts that smaller, linear green spaces can introduce throughout cities.<sup>8</sup> In addition, the cost of building new, large parks is prohibitive. Including small-scale green spaces along roadways or within redevelopment sites is thus also more cost-effective.

The City of Lyon is starting to develop a climate plan that links planning and investments for water, land use, roads, and green spaces. Trees are an important component of this plan and Lyon's efforts to cool the city. Trees offer greater shade, increase the city's albedo (the fraction of solar energy reflected from the Earth back into space), and help with heat absorption at night. Trees can also cool the surrounding environment as rainwater is both evaporated off of leaves and soil space and transpired as trees take up water and release it back into the atmosphere. Lyon's planners and arborists consider streets to be a prime location for planting new trees because of their prevalence in urban areas and their contribution to mitigating heat island effect. Streets are a major source of heat-trapping surfaces, and trees can help to limit the heat uptake of these spaces. To this end, arborists are doing research to better understand the species of trees that can withstand both increasing temperatures in summer and the cooler winter conditions. Additionally, trees have to be able to survive the sometimes harsh conditions of the urban environment, where utilities, streets, and buildings compete with canopy space above ground and root space below ground. By highlighting the multiple benefits of trees, city planners are starting to include new tree planting and maintenance guidelines in a new citywide tree charter anticipated to be completed in 2011. Grand Lyon's trees and landscapes department is based within the roads and public spaces department, which increases the likelihood for project implementation that links topics that have historically been planned for separately, such as trees, roads, and water management.

One specific project called La Confluence provides a model for how to integrate climate change into infrastructure and land use planning. Lyon Confluence is a large, 150-hectare peninsula redevelopment project that reflects the goals

of Lyon's commitment to climate change adaptation. This former industrial rail yard sits at the confluence of Lyon's two major rivers and includes new housing, commercial, retail, and park uses. The design connects new development to the existing street grid and introduces what are called transverts, or greenways, in both existing neighborhoods and new portions of the peninsula. The early phases of the project are complete and were not explicitly designed to confront heat island effects, but the flexible planning approach will allow future phases, set to be completed by 2015, to more directly link natural and built areas. Project developers will evaluate progress every two years to see if goals were reached. If environmental performance goals have not been met, project managers will analyze what improvements or changes may be necessary. Project developers work closely with Grand Lyon and city of Lyon staff to ensure the transfer of knowledge and lessons learned. Lyon Confluence provides a strong example for how cities can find opportunities for climate adaptation within ongoing investments and developments.

## *Barcelona, Spain*

Located on the Mediterranean coast and at the mouths of the Llobregat and Besòs rivers, Barcelona's biggest challenges for adapting to climate change will be related to sea level rise. The city is already experiencing saltwater intrusion that is limiting the ability to use groundwater reserves for drinking water and irrigation. An additional climate change risk includes reduced precipitation, which leads to both drought and temperature increases. Barcelona has experienced a nearly five degrees centigrade increase in annual mean temperature, due in large part to reductions in precipitation.<sup>9</sup>

Barcelona's environment department, MediAmbient, is taking individual actions that adapt to climate change, but the city lacks a comprehensive strategy for assessing vulnerabilities to climate change and developing long-term city-wide responses. Barcelona's leaders lack a sense of urgency that climate change poses an immediate threat to the city, in part because there have been no major disasters related to climate change, such as floods that damage property or heat waves that increase hospital visits. However, small-scale efforts are underway to add more trees to limit stormwater overflows and provide shade for cooling, to increase density in already developed areas to prevent the loss of additional natural spaces, and to link green corridors in the city to

# Policy Brief

create a system of multifunctional open spaces.<sup>10</sup> Members of the Municipal Environmental and Sustainability Council work with the relevant city agencies to link climate goals with updates of existing plans and ordinances, but individual agencies are primarily focused on their individual sectors and do not have a common set of goals to guide joint investments, policies, or incentives. Without a cohesive plan for the different types of infrastructure in the city, individual agency efforts will not achieve large scale, cohesive action to prepare the city for climate change. In addition, if the environmental and social goals are not supported by economic goals and cost-benefit analyses, new investments will be difficult to justify.<sup>11</sup>

The Barcelona case study is instructive in that it reveals the benefits of positive citizen engagement in climate change adaptation planning. Citizens have been successful at developing an action plan for adapting to climate change, where signatories commit to take action. First established in 2002, Barcelona's Agenda 21 Commitment to Sustainability responded to the international Agenda 21 plan for action to encourage environmentally sustainable development at the global, national, and local levels.<sup>12</sup> Barcelona's Agenda 21 Commitment to Sustainability outlined a broad participatory process in which thousands of citizens and hundreds of stakeholder groups collaborated in a transparent adaptation planning process.<sup>13</sup> The newest iteration of the citizens' commitment is the Barcelona School Agenda 21 Program, known by the Spanish acronym PA21E, which focuses on the role of schools and is funded by the Barcelona City Council, the Municipal Institute for Education, the Agbar Foundation, and UN-HABITAT.<sup>14</sup> PA21E engages students and teachers to identify climate change concerns and undertake local projects within their schools, such as energy and water efficiency upgrades, waste prevention, composting, and the creation of green courtyards and gardens. The program has expanded from 69 to 326 participating schools, and shows the power of civic engagement to expand awareness and action to adapt to climate change. The city government may not have its own internal adaptation plan, but citizens and other organizations are taking collective action to address the ways to mitigate climate change and respond to its likely risks.

Barcelona is a large and very densely developed city with many historic buildings. Large events, such as the 1992 Olympics and Forum 2004, pushed large investments

Without a cohesive plan for the different types of infrastructure in the city, individual agency efforts will not achieve large scale, cohesive action to prepare the city for climate change.

into the city and spurred redevelopment of several neighborhoods, including the Port Olympic, Poble Nou, and Diagonal Mar. More recently, a large project known as 22@ achieves many climate change co-benefits through improved infrastructure design, including energy efficiency improvements, water recycling, and green roofs and walls. The 22@Barcelona project was developed as an "innovation district" for the city where pilot projects, innovation, and new technologies are encouraged within both the buildings' office spaces and within the public realm of this 220-hectare redevelopment site. The Barcelona city council passed new regulations to transform this site from primarily industrial uses and low-income neighborhoods to new office space, subsidized housing, and green spaces, all with the intention of updating the city's image and improving a physical space through flexible city design that meets current and future needs.<sup>15</sup> The original designs for redeveloping this large industrial area included enough density for district heating and cooling, shared electricity distribution, pneumatic waste disposal, and smart traffic management systems. However, the project receives criticism, including from community groups and academics, for the loss of effective public spaces and truly affordable housing.<sup>16,17</sup> There are several industrial areas at the outskirts of the city, such as Marina Zona Franca, which were slated for redevelopment, but this project and others like it are stalled due to the current economic recession.

Barcelona's future redevelopment plans de-emphasize large events and focus on small projects that will regenerate neighborhoods and provide benefits for residents and everyday users, as opposed to tourists and visitors. For

# Policy Brief

example, the city is developing a new green strategic plan and biodiversity plan that will focus on the value of street trees for creating urban corridors with nodes at small parks within key neighborhood gathering spots.<sup>18</sup> As redevelopment projects continue, the city has the potential to incorporate better information about risks from sea level rise to improve the long-term adaptability of new investments. In the near-term, the city government could focus on regularly scheduled maintenance, upgrades, and new infrastructure investments to increase resilience to continuing threats from climate change.

## *Rotterdam, The Netherlands*

Rotterdam, located within the Rhine Delta and the site of Europe's largest port, self-identifies as a testing ground for climate adaptation strategies, especially for mitigating sea level rise and floods in delta cities. Rotterdam is considered one of the most vulnerable European cities, and certainly the most vulnerable Dutch city, to the threat of extreme flooding from storm surges and sea level rise. Its place at the mouth of the Rhine also poses threats from river flooding associated with increased precipitation. Climate adaptation in Rotterdam receives political support at all levels, from national government agencies to local elected officials. This consensus allows for climate considerations across all departments and infrastructure types and enables innovative projects and widespread policy changes.

The City of Rotterdam is designated as a hotspot location for the national Knowledge for Climate program, a strong public-private partnership that links science and policy to support research and action on climate change adaptation. Through Knowledge for Climate, scientists work directly with the national government, provinces, cities, and the infamously powerful water boards to include consideration of climate science in planning and infrastructure investment decisions. Rotterdam will receive large investments totaling over €10 billion over the next ten years to improve land use and infrastructure planning to protect people, property, and the function of the port while improving the quality of life for Rotterdam residents.<sup>19</sup>

Strong national funding and policy support provides the context for Rotterdam's ambitious and action-oriented adaptation plan, which lays out a goal of becoming climate-proof by 2025. Most goals within the overarching adaptation plan, called Rotterdam Climate Proof, have a

The success of Rotterdam's adaptation plan is its integration of climate planning across disciplines and into the standard operating procedures of all city departments.

five-year timeline to be incorporated as municipal policies. Rotterdam Climate Proof includes five themes that fold into a city-wide adaptation strategy: watershed planning; accessibility and transportation; building location and type; green infrastructure for water; and public space and quality of life. The success of Rotterdam's adaptation plan is its integration of climate planning across disciplines and into the standard operating procedures of all city departments.

Rotterdam is making major investments in two neighborhoods that are appropriate locations for new development. Stadshavens (translated to Port City) is a 1,600 hectare former industrial port that the city is taking over for new housing, commercial areas, and tech-industry developments. Flexibility is included in building designs to consider future changes in river levels and impacts of sea level rise. Kop van Zuid is a redeveloping neighborhood on higher ground that is preparing for the rise in water by rethinking the role and flexibility of traditional building design. First floors of new or renovated buildings have removable features, sturdier materials, and large doors that can easily take on water in high rain periods. The larger Stadshavens redevelopment and regular updates to the Kop van Zuid neighborhood provide examples of urban core projects that can be designed and implemented with vulnerabilities in mind, while small-scale improvements to older, more stable neighborhoods support incremental changes that introduce green infrastructure into public parks, along streets, and even in the form of green roofs on private properties.

## **Major Takeaways**

### *Sense of Urgency Matters*

The evidence from all the cities visited revealed that a key to effective adaptation is the ability to appropriately convey

# Policy Brief

risk and the need to plan with that risk in mind. One of the common questions decision-makers and elected officials ask is how and when to start investing in protective measures. Even though there is indisputable scientific evidence that the global climate is changing, the data and models about what the real impacts will be are still imperfect. For example, there are ranges for how high the sea level will rise, rain storms are getting bigger and happening more often, and cities are getting hotter. But predictions of exact degrees of temperature, feet of sea level rise, inches of rain, or frequencies of storm don't exist.

This lack of precise information about climate change effects and subsequent risks highlights the division between what scientists can confidently claim and the need to take preventative action based on the information that is available. On both sides of the Atlantic, politicians, planners, and other decision-makers have a hard time developing projects and making investments based on imprecise information. Global climate change models project future climate changes at a relatively large scale, providing average changes across entire regions. These projections do not provide enough detail to identify what the impacts will be in certain states, counties, or local communities. Because future climate changes are based on the amount of greenhouse gases that are emitted in the future, scientists do not yet know what the magnitude or severity of climate changes will be decades from now. Global climate models deal with this uncertainty by presenting projections of future climate change based on different scenarios of future greenhouse gas emissions. To understand future projections of climate change at a more local level, global climate model data needs to be translated to a finer spatial scale. This process is called "downscaling" and will provide the necessary level of detail to determine future projections of climate change at county and local levels. Many politicians and planners are calling for scientists to help them understand broader likelihoods of risk so that they can begin to implement protective solutions before it is too late to properly prepare for impacts.

While current models may not give decision-makers exact details about risks and vulnerabilities, cities are adapting to climate change as insurance against threats to human safety and economic security. In both Lyon and Rotterdam, the loss of life due to preventable natural disasters in the past provides a strong motive for governments to take action

that will protect their citizens. In addition to the loss of life, the economic and societal consequences stemming from damage to buildings, private properties, and infrastructure provides a further impetus for acting swiftly. In Rotterdam and Lyon, decisions are made in the near term to prevent damage in the long term. Several decision-makers in both cities were acutely aware of the need to act immediately in order to stave off damage that could occur if no actions were taken in advance. These decision-makers approach adaptation in terms of the time cities have left to make investments that will prevent the earliest possible date of serious damage. They ask, "What is the worst thing that can happen and what is the latest moment we can act to prevent it?" Elected officials and planners in Rotterdam, Lyon, and Barcelona are using risk-based approaches to plan for the most likely, highest consequence impacts.

The Dutch government and elected officials in Rotterdam are motivated to take action on climate change because of a historic flood and the need to protect The Port of Rotterdam. The Netherlands experienced a devastating flood of the North Sea in 1953, when many seawalls and dikes collapsed, resulting in over 1,800 deaths.<sup>20</sup> This catastrophic flood instilled a sense of threat in citizens and policymakers that flood risks are real, can cause extreme damage, and should be prevented at all costs. This historical experience is a major driver for the Dutch investment of nearly €5 billion<sup>21</sup> to build the Delta Works projects, which involve a massive system of dams, storm surge barriers, sluices, dikes, and levees that combine to protect Dutch lands from flooding while maintaining port functions.<sup>22</sup>

The Dutch government continues to invest large amounts of money to further protect its citizens from new flood risks associated with climate change.<sup>23</sup>

Economic dependency on the Port of Rotterdam is another source of motivation for investing billions in preventing future floods. The Port of Rotterdam is the largest seaport in Europe and the economic engine of The Netherlands. The city is advertising to international companies and other countries that it is taking steps to protect investments in the port and associated infrastructure. The Delta Works project is designed to fully protect Rotterdam from storm surges in the North Sea that might only occur for a 1 in 10,000-year storm. As a point of comparison, the U.S. National Flood Insurance Program uses the 100-year flood, which

# Policy Brief

## Elected officials and planners in Rotterdam, Lyon, and Barcelona are using risk-based approaches to plan for the most likely, highest consequence impacts.

represents a one percent likelihood of flooding in any given year, as the standard for floodplain management and to determine the need for flood insurance.<sup>24</sup> Dutch citizens pay high taxes and have high expectations of the government to spend those funds to protect the public good. In The Netherlands, it is easy for the federal government to undertake such a massive effort because flooding is the largest natural threat to the country; 59 percent of the land is susceptible to it.<sup>25</sup> In the United States, there is less public consensus about the role of government, greater variation in natural disaster threats, and considerably less agreement on the reality of climate change.<sup>26</sup>

Similarly, Lyon's motivation for action on climate change adaptation also stems from the 2003 heat waves that caused over 14,000 deaths across France and an 80 percent increase in mortality in Lyon.<sup>27</sup> The serious loss of life in Lyon has created a public health motivation to reduce temperatures in the city. A key lesson from Lyon is an expressed need to prioritize investments in action instead of studies and risk assessments. When asked whether the city was doing research on temperature increases in different neighborhoods to make decisions about where to place new trees, the staff person in charge of developing Lyon's new tree charter responded by saying that by the time they complete research on specific areas and impacts, they could have trees halfway to maturity, working to mitigate the negative impacts of urban heat island effect.<sup>28</sup> Research requires considerable time and resources, and cities such as Lyon are choosing instead to invest in actions that will more quickly start to alleviate climate change impacts.

Barcelona is a bit different from Rotterdam and Lyon; the city is not investing as much in adaptation because of the coinciding forces of the economic recession and a lack of

awareness about the impending threats of sea level rise and drought. With a national unemployment rate at over 20 percent, political leadership has other near-term concerns that are prioritized before climate adaptation needs.<sup>29</sup> Although scientists and some policymakers are aware of the risks, there is not currently enough of a sense of urgency around climate change risks to drive political decisions and investments toward climate change adaptation in Barcelona.

### *Adaptation Solutions Should Have Community, Economic, and Environmental Benefits*

At the same time that urgency drives decisions, local leaders are finding it important to tie climate change actions to near-term benefits that can be seen and felt by citizens today, not just for protection against future risks. Additional benefits may include economic development, community aesthetics, improved walkability, stormwater infrastructure savings, and wildlife habitat. In the United States in particular, city leaders must justify investments in infrastructure and new development as having economic development potential for the long-term fiscal health of the community and even the larger region. Cities have the opportunity to align a broad range of goals to ensure maximum investment and long-term support for adaptation policies. Project planning can build in "no regrets" approaches that achieve immediate goals of planners, politicians, and citizens: economic development, community livability, and environmental performance. No regrets adaptation measures refer to actions a community can take that provide benefits even if climate change impacts are not as severe as predicted. Green infrastructure approaches are one example of no regrets solutions, because trees or green roofs can improve water quality, provide more walkable streets, and lower energy consumption in buildings.<sup>30</sup>

In Rotterdam, providing a high quality of life for residents and visitors is as important as protecting them from floods. Current investments in adaptation must demonstrate other immediate benefits to the overall quality of the city in order to continue attracting new residents. Rotterdam's Water Squares are spaces in dense urban areas designed for public uses during dry periods, but with the capacity and structure to store rain water during heavy storms. Water Squares are dry for the majority of the year and serve as parks with seating, play areas for kids, and even sports fields. But the topography, materials, and engineering of Water Squares allow them to take on water during storms while also

# Policy Brief

retaining some of the public uses. For smaller storms, the Water Squares collect water in pools and fountains, and during large storms the entire space may be submerged with large volumes of water, thereby protecting surrounding properties from flooding.

In Lyon, the Confluence project, which began in 1999 and now has two of three phases completed, provides an example of flexible planning that addresses changing goals and infrastructure needs. Confluence was not planned with the consideration of climate change in mind, but as the project has developed over time, the project leaders have incorporated adaptive approaches to now-known effects of climate change.<sup>31</sup> The pattern of redevelopment was planned to bring water from the Rhone and Saone rivers to work as public amenities in the inner areas between offices and housing. At the same time, a series of small, linear parks were designed to allow for quick access from most buildings on the peninsula, as opposed to a single, large park that might be farther from some sites. Today, both the linear green spaces and water features are identified as having cooling impacts against urban heat island effect, because of their greater distribution around the city. The decision to identify new benefits and goals for these already planned park designs allows these investments to be maintained and supported in the future.

Barcelona's history of urban development has prioritized the role of public spaces in the fabric of the city. Residents and visitors recognize the high value of well-designed public spaces, from the larger and more famous sites such as La Rambla or Park Guell to the smaller neighborhood plazas and seating areas tucked down the alleys of Barri Gotic.

City leaders must justify investments in infrastructure and new development as having economic development potential for the long-term fiscal health of the community.

Investments in adaptation do not match the pace seen in Rotterdam or Lyon, but current green infrastructure projects to better manage stormwater are focused on publicly owned lands to either improve existing parks or establish new public open spaces. Future adaptation planning will have to address the high priority role of public spaces in the land use of Barcelona.

## *Effective Adaptation Requires Planners, Scientists, Engineers, and Politicians*

Effective adaptation efforts in Rotterdam, Lyon, and Barcelona take an integrated approach to link climate change risks to one another and to existing goals of city agencies. All three cities provide examples of cross-agency cooperation that leads to thoughtful solutions to climate change risks. In Lyon, a partnership between the Grand Lyon planning department and the landscape office is leading to a new regional tree plan to mitigate heat island effects and limit flooding from stormwater. In the early 2000s, Rotterdam began to broaden water infrastructure planning, such that flooding concerns are now integrated with stormwater, waste water, and drinking water management. Water and spatial planning staff within the city now work together to consider how land use changes will impact water infrastructure systems. In Barcelona, different city agencies have begun to address adaptation by integrating planning for public green spaces, water management, and roadway planning. However, there is not enough integration with economic benefits and social issues, which limits the effective integration into agency action plans and formal policies. A variety of experts, including civil engineers, economists, water managers, land use planners, and landscape architects, have to work together to simultaneously plan for flood risk, stormwater management needs, and city planning.

Adaptation also requires communication between scientists and policymakers. Climate change data needs to be formatted to prioritize accessibility and usability by local planners. In The Netherlands, the Knowledge for Climate program provides an excellent model for how climate scientists work directly with local policymakers to integrate climate scenarios into planning at the smaller scale of city planning. The Dutch National Program on Climate Adaptation and Spatial Planning<sup>32</sup> also provides a good example of interagency and interdisciplinary coordination. The signatories to the national adaptation strategy and policy paper

# Policy Brief

convey the range of expertise that should be included in planning for adaptation:

- Ministry of Housing, Spatial Planning, and the Environment (VROM)
- Ministry of Transport, Public Works, and Water Management (V & W)
- Ministry of Agriculture
- Nature and Food Quality (LNV)
- Ministry of Economic Affairs (EZ)
- Association of Provincial Authorities (IPO)
- Association of Netherlands Municipalities (VNG)
- Association of Water Boards (UvW)

Barcelona's MediAmbient, the city's environmental agency, is creating mechanisms for typically-divided offices to work together on common issues. The agency has recently reorganized its basic functions to focus on four areas: water, green spaces, energy, and waste management. The city's water department formerly separated different water functions in the city, but now the water section integrates planning and maintenance for fountains, waste, drinking water, and stormwater.<sup>33</sup> However, a group of green building experts referred to the broader difficulty of integrating expertise and traditional disciplines into a single project.<sup>34</sup> Some fields, whether engineering, planning, or architecture, can be territorial about the timing and roles in project development, which can make it difficult to plan and design buildings as whole systems or to consider mechanisms to link natural and built water infrastructure systems.

The most effective and efficient solutions to climate risks are designed when academics, governments, business stakeholders, and the public collaborate on potential solutions. Governments have the opportunity to structure permitting processes in ways that require integrated planning and design. Academics can work more closely with governments, citizens, and the private sector to ask the most pressing research questions and ensure that studies are designed to produce applied results with data and tools that are usable for practitioners. And if politicians can speak to the ways that a single investment will meet multiple needs, adaptation is more likely to receive funding and be implemented in the near term.

## *Effective Adaptation Requires Public Participation and Outreach*

Climate change adaptation will be most effective if acted upon locally, especially in the United States, which is large and geographically diverse. People who live and work in communities targeted for climate adaptation projects must have a major seat at the table as decisions are made about how to adapt. The smart growth movement in the United States has recognized the importance of civic engagement and emphasizes the need to encourage community and stakeholder collaboration in development decisions and to create a transparent process.<sup>35</sup> Citizen participation can be time-consuming, frustrating, and expensive, but encouraging community and stakeholder collaboration can lead to creative, speedy resolution of development issues and greater community understanding of the importance of good planning and investment. Smart growth plans and policies developed without strong citizen involvement will, at best, not have staying power; at worst, they will be used to create unhealthy, undesirable communities. When people feel left out of important decisions, they will be less likely to become engaged when tough decisions need to be made.

Outreach and public participation workshops should be tailored to the local vulnerabilities and goal-setting for adaptation approaches. This type of public engagement requires time and input from city staff, but can establish common goals, plans that address those goals, and steps that are more likely to be implemented with widespread support and sense of ownership.<sup>36</sup>

Encouraging community and stakeholder collaboration can lead to creative, speedy resolution of development issues and greater community understanding of the importance of good planning and investment.

# Policy Brief

For example, in Rotterdam, the first Water Squares pilots were located in a neighborhood that was not engaged in the design and had concerns about safety. The neighbors spoke out against the Water Squares, forcing the city to locate early pilots elsewhere. The city now prioritizes public involvement before making decisions about the location and design of new Water Squares.<sup>37</sup> In the United States, community engagement will be even more important because of skepticism around climate change. Involving the community early and often in the planning process can improve public support, and often leads to innovative strategies that fit the unique needs of each community. Barcelona provides another example of how to create a clear role for the public to engage in adaptation planning. Through the Agenda 21 planning process, the City of Barcelona empowered a group of committed citizens and stakeholders to help write the first adaptation plan. Community expertise can be included as central to the process of identifying adaptation projects and building feedback into their long-term success. Public participation and outreach will help cities identify projects that are more likely to have near-term benefits to the community and economy and long-term potential for success.

## Conclusion

A major difference between these three European cities and the U.S. experience is that national rules often drive local land use in Europe. Municipalities in The Netherlands, France, and Spain are required to meet national and European Union-level land use and environmental regulations that often support climate change adaptation through better land use planning. And in the case of The Netherlands, the national government is providing direct, substantial funding and other resources to support regional and local research, planning, and implementation for climate change adaptation. In the United States, the federal government has little role in state and city preparation for the impacts of climate change. Despite recent efforts to integrate adaptation planning into all federal agencies,<sup>38</sup> the United States is far from having a cohesive vision for how to adapt to the wide range of climate change risks facing the nation. There are some examples of federal funding and programs that can be used to support local adaptation, but other programs and agency statutes also stand as barriers to adaptive land use planning and infrastructure investments. However, many cities and individual states are nonetheless developing

innovative adaptive solutions by bringing together experts from various fields, including climate science, emergency management, engineering, land use, public health, water resources, and transportation. For example, large U.S. cities like Chicago<sup>39</sup> and New York<sup>40</sup> and smaller cities such as Keene, New Hampshire,<sup>41</sup> have outlined near-term and long-range strategies to deal with local climate change impacts. This indicates that in both Europe and the United States, cities are the testing ground for climate change adaptation, offering an example to state and federal governments about the possibilities for adaptation policies and approaches.

## Endnotes

<sup>1</sup> "Adapting to the Impacts of Climate Change, Report in Brief," National Research Council of the National Academies (2011): [http://dels.nas.edu/resources/static-assets/materials-based-on-reports/reports-in-brief/Adapting\\_Report\\_Brief\\_final.pdf](http://dels.nas.edu/resources/static-assets/materials-based-on-reports/reports-in-brief/Adapting_Report_Brief_final.pdf)

<sup>2</sup> "Global Climate Change Impacts in the United States," United States Global Change Research Program (2009): <http://www.globalchange.gov/what-we-do/assessment/previous-assessments/global-climate-change-impacts-in-the-us-2009>

<sup>3</sup> "Adapting to the Impacts of Climate Change," America's Climate Choices: Panel on Adapting to the Impacts of Climate Change, National Research Council of the National Academies, (2010): <http://americasclimatechoices.org/paneladaptation.shtml>

<sup>4</sup> Interview with Hans ten Hoeve, formerly of the Dutch Ministry of Housing, Spatial Planning, and the Environment (VroM) now Ministry of Infrastructure and the Environment (October 6, 2010). Ministry of Infrastructure and the Environment website: <http://english.verkeerenwaterstaat.nl/english/>.

<sup>5</sup> Thomas, John V., "Residential Construction Trends in America's Metropolitan Regions," U.S. EPA (2009): [http://www.epa.gov/dced/pdf/metro\\_res\\_const\\_trends\\_09.pdf](http://www.epa.gov/dced/pdf/metro_res_const_trends_09.pdf)

<sup>6</sup> FEMA Hazard Mitigation Planning Grant Program: <http://www.fema.gov/government/grant/hma/index.shtml>.

<sup>7</sup> Grand Lyon Comprehensive Plan (French acronym "SCOT") through 2030: <http://www.scot-agglolyon.fr/>

<sup>8</sup> Interview with Frédéric Segur of the Grand Lyon Trees and Landscapes Office within the Department of Road Engineering (January 12, 2011). Interview with Damien Saulnier and Philippe Mary with the Lyon Planning Agency (January 14, 2011).

<sup>9</sup> Hallegatte, Stephane, Jen-Charles Hourcade and Philippe Ambrosi, "Using climate analogues for assessing climate change economic impacts in urban areas," *Climate Change*, Volume 82, Numbers 1-2, 47-60, 2007.

<sup>10</sup> Interview with Toni Pujol i Vidal, Àrea de Medi Ambient - Departament d'Estratègia, Ajuntament de Barcelona, [www.bcn.cat/mediambient](http://www.bcn.cat/mediambient).

<sup>11</sup> Interview with Toni Pujol i Vidal, Àrea de Medi Ambient - Departament d'Estratègia, Ajuntament de Barcelona (February 2, 2011): [www.bcn.cat/mediambient](http://www.bcn.cat/mediambient).

<sup>12</sup> Agenda 21 is a comprehensive plan for multi-organizational action on environmental impacts from human development and was adopted by over 170 governments at the United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro, Brazil, in 1992. The full Agenda 21 publication can be found at <http://www.un.org/esa/dsd/agenda21/>.

<sup>13</sup> Barcelona's Agenda 21 plans were developed out of the Aalborg Commitments for Local Sustainability, also known as the Charter of European Cities and Towns towards Sustainability: <http://www.localsustainability.eu/index.php?id=4264>

<sup>14</sup> Barcelona School Agenda 21 Program: <http://www.bcn.cat/agenda21/a21escolar/> (Spanish), [http://80.33.141.76/agenda21/documents/EN-Barcelona%20School%20Agenda%2021%20Programme\\_%20REFESP030\\_10.pdf](http://80.33.141.76/agenda21/documents/EN-Barcelona%20School%20Agenda%2021%20Programme_%20REFESP030_10.pdf) (English)

# Policy Brief

<sup>15</sup> Barcelona's plans and regulations to support the redevelopment of 22@: <http://www.22barcelona.com/content/blogcategory/50/281/>

<sup>16</sup> Interview with Toni Pujol i Vidal, Àrea de Medi Ambient - Departament d'Estratègia, Ajuntament de Barcelona (February 2, 2011): [www.bcn.cat/mediambient](http://www.bcn.cat/mediambient). Interview with Lorenzo Chelleri, Universidad Autònoma de Barcelona, Group of Researchers in Coastal Resources, Territories and Landscapes (January 30, 2011).

<sup>17</sup> Bruggmann, Jeb. *Welcome to the Urban Revolution: How Cities are Changing the World*. Chapter 13, Bloomsbury Press (2009).

<sup>18</sup> Interview with Toni Pujol i Vidal, Àrea de Medi Ambient - Departament d'Estratègia, Ajuntament de Barcelona (February 2, 2011): [www.bcn.cat/mediambient](http://www.bcn.cat/mediambient).

<sup>19</sup> Knowledge for Climate: <http://knowledgeforclimate.climate-research-netherlands.nl/hotspots/rotterdam-region>

<sup>20</sup> Deltawerken Online (2004): <http://www.deltawerken.com/Rescue-and-consequences/309.html>

<sup>21</sup> Deltawerken Online (2004): <http://www.deltawerken.com/The-Delta-Works/1524.html>

<sup>22</sup> Delta Works project: <http://www.deltawerken.com/Deltaworks/23.html>

<sup>23</sup> Aerts, Jeroen, "Adaptation cost in The Netherlands: climate change and flood risk management." *Climate Research Netherlands - Research Highlights* (December 2009): <http://www.climate-research-netherlands.nl/research-highlights>.

<sup>24</sup> Federal Emergency Management Agency's National Flood Insurance Program: <http://www.fema.gov/business/nfip/>

<sup>25</sup> PBL Netherlands Environmental Assessment Agency: <http://www.pbl.nl/en/dossiers/Climatechange/content/correction-wording-flood-risks>

<sup>26</sup> Leiserowitz, A., Maibach, E., Roser-Renouf, C., & Smith, N. (2011) *Global Warming's Six Americas*, May 2011. Yale University and George Mason University. New Haven, CT: Yale Project on Climate Change Communication. <http://environment.yale.edu/climate/files/SixAmericasMay2011.pdf>

<sup>27</sup> Janet Larsen, Earth Policy Institute, October 2003, updated July 2006: [http://www.earth-policy.org/plan\\_b\\_updates/2006/update56](http://www.earth-policy.org/plan_b_updates/2006/update56)

<sup>28</sup> Interview with Frédéric Segur of the Lyon Trees and Landscapes Office within the Department of Road Engineering (January 12, 2011).

<sup>29</sup> Instituto Nacional de Estadística (INE) basic data: <http://www.ine.es/welcoing.htm>

<sup>30</sup> Willows, R.I. and R.K. Connell, eds., "Climate Adaptation: Risk, Uncertainty and Decision-Making," UKCIP Technical Report. Oxford: UKCIP (2003).

<sup>31</sup> Interview with Sylvie Josse, Chef de Projets, Lyon Confluence (January 18, 2010): [www.lyon-confluence.fr](http://www.lyon-confluence.fr).

<sup>32</sup> *National Program on Climate Adaptation and Spatial Planning*: National adaptation strategy - The inter-administrative policy paper, VROM, (2008).

<sup>33</sup> Interview with Toni Pujol i Vidal, Àrea de Medi Ambient - Departament d'Estratègia, Ajuntament de Barcelona, (February 2, 2011): [www.bcn.cat/mediambient](http://www.bcn.cat/mediambient)

<sup>34</sup> Interview with members of Fundacion Empresa y Clima (Foundation for Business and Climate) (January 26, 2011): <http://www.empresaclima.org/>

<sup>35</sup> Smart Growth Network: <http://www.smartgrowth.org/network.php>

<sup>36</sup> Few, Roger, Katrina Brown, Emma L. Tompkins, "Public participation and climate change adaptation: avoiding the illusion of inclusion." *Climate Policy* (2007).

<sup>37</sup> Interview with Pieter de Greef, City of Rotterdam (September 10, 2010).

<sup>38</sup> White House Council on Environmental Quality Climate Change Adaptation Task Force: <http://www.whitehouse.gov/administration/eop/ceq/initiatives/adaptation>

<sup>39</sup> Chicago's Climate Action Plan: <http://www.chicagoclimataction.org/pages/adaptation/11.php>.

<sup>40</sup> New York City's PlaNYC 2011: <http://www.nyc.gov/html/planyc2030/html/theplan/climate-change.shtml>.

<sup>41</sup> Keene, New Hampshire's Climate Change Adaptation Action Plan: <http://www.ci.keene.nh.us/sustainability/climate-change>.

### About the Author

Abby Hall is a policy analyst with the U.S. Environmental Protection Agency's Office of Sustainable Communities in Washington, D.C. She manages two key programs that provide technical assistance to communities across the nation: EPA's Smart Growth Implementation Assistance Program, which focuses on complex policy issues, and the Greening America's Capitals program, which provides design assistance to state capital cities. Ms. Hall works on issues of climate change adaptation and helps to manage a partnership between EPA and the Federal Emergency Management Agency (FEMA) that focuses on disaster resilience planning. Ms. Hall also has a background researching local policies to support green infrastructure systems that manage stormwater runoff. Ms. Hall earned both her bachelor's and master's in anthropological sciences from Stanford University.

The views expressed in this article are her own and do not necessarily reflect the policies of the German Marshall Fund, the U.S. Environmental Protection Agency, or the U.S. Government.

### About The Urban and Regional Policy Program

The Urban and Regional Policy Program promotes knowledge sharing among individuals and groups who make, influence, and implement urban and regional policy on both sides of the Atlantic. Through intensive network building, in-depth policy research and analysis, the program connects practitioners and policymakers around innovative solutions to common challenges in the United States and Europe.

### About GMF

The German Marshall Fund of the United States (GMF) is a non-partisan American public policy and grantmaking institution dedicated to promoting better understanding and cooperation between North America and Europe on transatlantic and global issues. GMF does this by supporting individuals and institutions working in the transatlantic sphere, by convening leaders and members of the policy and business communities, by contributing research and analysis on transatlantic topics, and by providing exchange opportunities to foster renewed commitment to the transatlantic relationship. In addition, GMF supports a number of initiatives to strengthen democracies. Founded in 1972 through a gift from Germany as a permanent memorial to Marshall Plan assistance, GMF maintains a strong presence on both sides of the Atlantic. In addition to its headquarters in Washington, DC, GMF has seven offices in Europe: Berlin, Paris, Brussels, Belgrade, Ankara, Bucharest, and Warsaw. GMF also has smaller representations in Bratislava, Turin, and Stockholm.