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IMPLEMENTATION OF CLIMATE CHANGE ADAPTATION SOLUTIONS IN U.S. CITIES

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SUMMARY:

This policy paper explores Seattle, Portland, Philadelphia, and New York City's approach to climate change adaptation and the methods adopted and strategies implemented to mitigate its effect. While each city's approach is different, nevertheless there exists surprising commonality between the methods and strategies adopted to address the effects of climate change. Differences and similarities in approaches are tied to each city's governance structure, resources and financing capacity, and the geographical happenstance for where a city is located. This paper will therefore explore how governance, financing, and location impact each city's response to climate change.

Still, at a macro level, there exists tension between whether cities should mitigate or whether they should adapt to the effects of climate change. Cities struggle with the perception that adopting adaptation strategies is an affront (or outright capitulation) to mitigation of climate change. By peeling back the layers of complexity that cities face when addressing climate change, this paper argues that in a city's quest to manage climate change, one approach cannot necessarily take place at the expense of the other. Indeed, perhaps the most realistic strategy moving forward is to think of ways to adapt while mitigating.

Introduction

The City of Copenhagen is in the process of developing a climate adaptation plan in response to climate change. The response measures developed by the city administration are based on climate projections at the regional level and the potential impact these changes will have on the City of Copenhagen.

Adaptation, as opposed to climate change mitigation, addresses a city's need to prepare and fortify itself against the impact of climate change. In contrast to climate change mitigation, which focuses on actions to reduce greenhouse gas emissions, adaptation explores ways for a city to physically adapt to climate change, such as fortifying a city against rising sea levels or putting in place systems that manage increasingly large amounts of rainfall.

Moreover, adaption also addresses the issue of resilience that includes designing solutions to improve emergency services in cases when climate-related disasters hit. Perhaps not unsurprisingly tension exists between the two policy areas — adaption and mitigation. The work to reduce carbon emissions in cities focuses on working toward a future in which the global temperature remains at a reasonable level to ensure that future generations can still thrive on this planet. In contrast, adaptation work has always had a much more local focus: instead of working to mitigate climate change, adaption addresses the effects of climate change by working to keep the local city safe, attractive, and competitive for local residents and businesses given expected changes to the climate. Some adaptation is necessary given that scientific evidence demonstrates the impact climate change has already had on cities, and which will be more severe in the coming years.

From a climate change position, Copenhagen is in a much better position than many cities around the world. Copenhagen is relatively protected due to its location on the Baltic Sea where there is very little tidal impact. Thus far, the city has not been affected by rising sea levels; indeed, the climate has remained generally stable. Nonetheless, in recent years the city has faced weather-related challenges that have made clear the need for Copenhagen to

take action. Here adaptation has played a key role. The city of Copenhagen had developed a climate change adaptation plan in 2010, but in light of the severe cloudbursts¹ that hit the city in 2011 — causing over \$1 billion in damages and demonstrating the vulnerability of Copenhagen to extreme weather events² — the city decided to focus on developing a cloudburst management plan.

In an effort to learn how other cities are managing the twin issues of storm water management in the case of extreme weather events and coastal protection in the case of storm surges, this paper will present the findings of a case study of four U.S. cities that explore the management of these issues: Philadelphia, New York City, Seattle, and Portland. Increasingly, city-to-

city networks have been created to assist in policy and knowledge transfer in the field of climate change.³

Drawing on the findings from this case study, this paper will explore how and under what conditions cities address the challenges of climate mitigation and adaption.

Specifically, under what conditions do successful and unsuccessful climate change adaptation strategies transfer between U.S. cities? How can the lessons learned in the United States be transferred to a European — or more specifically — a Danish context.

The four cities studied have to some extent started working with adaptation measures. They have done so for varying reasons and with varying degrees of intensity — all at different stages in their implementation processes. In addition, the cities differ in the degree to which they have experienced the effects of climate change through increasingly erratic weather patterns and behavior. The four cities therefore provide invaluable insight, not only to affect the methods applied into the impact of

“ *In contrast to climate change mitigation, adaptation explores ways for a city to physically adapt to climate change.* ”

1 A cloudburst is generally defined as an extreme amount of precipitation in a short period of time. When it occurs in an urban area, it can quickly overwhelm typical storm water management systems.

2 Other recent weather events have further demonstrated the vulnerability of the city, including in 2013, when the city also very close to a large flooding event following a storm surge from a storm in the North Sea.

3 For example, ICLEI Cities for Climate Protection, the C40 Climate Cities, UN HABITAT Cities and Climate Change, and the Urban Sustainability Directors Network.

current methods used to address these problems, but also into the process of developing solutions and how cities learn from each other.

This paper explores four main policy areas:

1. Program and project management, including the financing, implementation, and maintenance of climate change adaptation measures.
2. Capturing co-benefits from adaptation, including social impacts, the use of green infrastructure, ecosystem services, and synergies between mitigation and adaptation.
3. Citizen involvement, including communication and the active participation of local communities in decisions made to address climate change.
4. Local zoning and building regulations governing both adaptation and mitigation.

An analysis of the research suggests that two additional points prove to be especially salient in the U.S. context:

- Communicating climate change to both the political level and citizens.
- The conflict between mitigating climate change and climate change adaptation policies.

This paper therefore begins with a discussion of the drivers of climate change adaptation in the United States, and in particular, the Federal Government's stormwater management mandates. The paper then focuses on the climate change adaptation strategies each of the four U.S. cities have implemented or are in the process of implementing. This research concludes with a description of the lessons learned from the United States and subsequent policy recommendations for the City of Copenhagen.

Communicating Climate Change

While public discourse in the United States about the need to address climate change differs considerably from that in Denmark, some cities in the United States are recognizing the need to take action where the Federal Government has failed to do so. In the

cities visited for this report, climate change, and especially the aim to reduce carbon emissions, was an important issue city officials were grappling with.

What appeared less clear at times was whether the four U.S. cities were willing incorporate climate mitigation, climate adaption, or both into their plans.

It appeared that there was a fear in the city administrations that, due to the U.S. discussions about the reality of climate change, it was important to keep mitigation strategies as the main focus. Does focusing on, for example, just climate mitigation or just climate adaption, result in doing so at the expense of the other? This concern of a trade-off arose through questions city officials asked and concern expressed as to whether Copenhagen had given up on its ambitious climate goals of becoming carbon neutral by 2025 in exchange for its current focus on adaptation. Especially in Portland and Seattle on the West Coast both city administration officials and representatives from local organizations that were interviewed expressed concern about working on an adaptation plan because they saw it as a defeat to efforts to reduce overall carbon emissions.

Communicating adaptation is very different from communicating mitigation. Adaptation is very tangible where the benefits are obvious from the very beginning. For example, if New York City builds a flood protection barrier around the southern tip of Manhattan, citizens and businesses will see the immediate outcome of money spent and understand the benefit to protecting the community. Moreover, adaption can also be used to improve urban spaces and create a greener city. On the other hand, having a goal, like New York City has, to reduce carbon emissions by 80 percent by 2050 demonstrates that the effect to the city's residents is difficult because the gains are not immediately tangible or visible and the net reduction will barely be measurable in terms of global emissions. Thus, reducing emissions is much more symbolic and is too often associated with items that a person has to give up in order to meet a target.

Key Aspects of Adaptation

The following section describes in greater detail the four main policy areas within climate change adaptation that were central in the investigation of the four U.S. cities in the case study. These include program and project management; capturing the

benefits, including social impacts, of the use of green infrastructure; civic engagement; zoning and building regulations governing both adaptation and mitigation strategies.

Program and Project Management

Philadelphia, New York, Seattle, and Portland have all developed programs for implementing green infrastructure and have subsequently integrated the green infrastructure program into the general stormwater management program. In the four case study cities, this program is carried out by the city’s public utilities. In most cities, these are a part of departments for the environment.⁴ In Seattle, Portland, and Philadelphia, the strategic planning on climate action work (mitigation) was located in the same office as the work on adaptation.

This is the same structure that was implemented in Copenhagen in 2014, where the two teams working on mitigation and adaptation were joined in one new Climate Unit. Nonetheless, there are several differences. The most obvious is size. In Copenhagen, a city of 600,000 inhabitants, the Climate Unit has 24 fulltime staff members. In Philadelphia, a city of 1.5 million inhabitants, the office consists of six fulltime staff members who cover a wider range of topics than the Copenhagen office. In Seattle, a city with 650,000 residents, only 2 of the 18 fulltime staff members work on climate adaptation. Like Philadelphia, the Seattle office covers a range of issues that include waste, recycling, and equity. In Copenhagen, these issues, for example, are handled exclusively by other offices.

Given the limited number of staff and resources, it is remarkable what Seattle, Philadelphia, and Portland are accomplishing. Indeed, the essential role of negotiating, networking, and facilitating processes that help the city staffs’ address and improve sustainability issues across the city became clear after meeting with key stakeholders. The deputy director

at the Philadelphia office described the vital role that networking and partnering with other offices in the city administration and with external partners plays in order to create and implement plans to meet the objectives of the sustainability agenda.

In terms of institutions and resources, New York City is very different from Philadelphia, Seattle, and Portland. NYC has an office designated for recovery and resilience that is organizationally linked to the Mayor’s Office for Sustainability. This office has its own director charged with coordinating both the resilience planning and the coordination of the implementation of the many recovery and resilience projects that were initiated following Hurricane Sandy in 2012. This office not only has a significantly higher number of staff, it also has a much stronger political backing from the mayor for the adaptation (resilience) agenda than the other offices in this study. Though this backing gives the office a much stronger role and position in city administration, its scope tends to be undefined and crosses over into the work of other departments. Another problem is that the coordination is very much bilateral. This means that the Office of Recovery and Resilience coordinates with, for example, the Department for Transportation. But there is very little coordination

between the departments themselves when it comes to adaptation.

In terms of funding, green infrastructure measures are typically financed by stormwater taxes or fees. In most cities, users can reduce the stormwater fee by disconnecting their building from the public

sewer system or by creating rain gardens or other ways to locally manage stormwater. In Portland, for example, the “Downspout Disconnect Program” diverts downspouts from sewers and into rain gardens (larger areas with plants and trees that are used for storing and infiltrating storm water), water collection tanks (for watering), and other uses.

Since cities such as Philadelphia and Portland have worked with green infrastructure for several years, they have developed extensive design and maintenance manuals. These manuals are constantly being revised because the cities continue to learn more

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⁴ For example, the NYC Department of Environmental Protection or Department of Environmental Services in Portland.

about what does and does not work. The manuals therefore are an important source of knowledge for other cities — in and outside the United States — on how to work with green infrastructure programs.

Financing the programs has, however, not been without problems. For instance, most of the cities have experienced problems and complaints from companies and individuals when they were acquiring land to use for infiltration. There is disagreement about whether to spend money from the water fees that residents pay for storm and waste water management or from public tax money given that the land tends to become parkland and some of the maintenance ends up being carried out by the city’s park department. Critics argue that this becomes an additional tax that instead should be financed through the city’s own budget rather than through the water rates.

While the upfront costs of constructing green infrastructure measures is cheaper than building traditional sewers and storm water management, the long-term maintenance costs can be substantial. In Portland, for example, the Bureau of Environmental Services has already had to reevaluate green infrastructure maintenance costs. They are now monitoring the measures for a full calendar year in order to establish a new and less intensive maintenance routine. The logic is quite simple. Surface measures like green infrastructure that are exposed to the weather tend to retain garbage, and as a result, often need new soil and plants. This is more costly than the maintenance of a sewer pipe that has to be flushed once every second year. In general, one could describe the maintenance of green areas in a city as “nice to have” measures. It is nice, for example, that the lawns are mowed and the gardens are weeded. But within the context of stormwater management, it becomes a “need to have” measure. A green street needs to be weeded and the garbage must be removed to ensure that the water will continue to flow. Thus paying for these measures is not optional, nor can they be the victim of budget shortfalls.

“ Surface measures like green infrastructure that are exposed to the weather tend to retain garbage, and often need new soil and plants.”

Cities are therefore constantly searching for ways to reduce these maintenance costs. Portland has modelled their green infrastructure standards on Seattle, but Portland is currently looking to revise the standards. In Philadelphia, many of the so-called green infrastructure measures are not as “green” as they may first appear. For example, the tree planting program is combined

with underground water storage that requires little maintenance because there is no green cover on the ground apart from the trees. For a city with a tight budget, this reduction of upkeep costs is particularly important.

Capturing Co-Benefits

Apart from New York City, the other cities in this study have actually not identified climate adaptation as a high priority. Therefore one way of raising the awareness of the adaptation agenda is by looking for co-benefits from adaptation. How can climate adaptation measures be used in such a ways as to mitigate other urban development issues at the same time? More precisely, can adaptation be integrated into other urban development measures such as creating a more liveable city?

Identification of co-benefits has been especially important in Seattle and Portland where climate change adaptation is not a significant policy area but where planners and stormwater managers are looking to capture the co-benefits of the measures. In Seattle, for example, the stormwater program is closely tied to the restoration of streams and rivers for the benefit of salmon. In Portland, the Johnson Creek project aims to prevent flooding in a suburban and socially vulnerable part of the city, but is doing so by reintroducing vegetation and re-establishing the natural flow of the creek. This prevents flooding and provides the area with high quality recreational areas — also attractive for people living outside the neighborhood. Even though the planners in the city have a much stronger political agenda of creating a more resilient city, cities like New York also focus heavily on the co-benefits of adaptation. Green

streets with trees will not only provide rain beds for drainage of rain water, but also provide shading and thus help cool the city.

Social issues also play a substantial role in adaptation measures. It is not a coincidence that the first part of the Dry Line project — ten continuous miles of protection around lower Manhattan’s low-lying areas — will be implemented on the Lower East Side of Manhattan within an area with a high density of public housing that is also highly vulnerable to storm surges. The Dry Line is an example of how a storm surge barrier can be used to upgrade a neighborhood by constructing a physical barrier in a way that the landscape created by the wall can provide green space, sports facilities, and other amenities that can be used by local residents. The project is being developed by the Danish architectural company BIG, and as part of the development, have pursued a comprehensive public outreach process to gain an understanding of local wishes and concerns.

“ ***The United States has a much stronger tradition of voluntary work. Many of the plans that cities are creating also seek to actively engage citizens in the development of work plans.*** ”

Civic Engagement

Civic engagement in the development and adaption of climate measures in the United States is markedly different from Denmark. The United States has a much stronger tradition of voluntary work. Many of the plans that cities are creating also seek to actively engage citizens in the development of work plans. This can be citizens creating their own rain garden in front of their building or engaging in voluntary work in maintaining green infrastructure. Portland and New York City have extensive voluntary programs, which is impressive but would be difficult to transfer to a city like Copenhagen where volunteers may be perceived by the unions as a form of voluntary work that could replace paid employees.

Further, in comparison to the Danish counterparts, the four case study cities appeared to be more aggressive and bold at including civic engagement in the development of climate and adaption policies. In South Seattle, for example, the city has outsourced

some of the green infrastructure development, especially the local involvement to local grassroots organizations called Puget Sound Sage and Got Green. This has the benefit of actually obtaining buy-in from residents about the work being done. The tendency in Denmark would be to keep the work within the city proper — and perhaps use consultants for some of the ground work — but without anchoring the work that the local grassroots organizations can provide.

Further, U.S. cities work closely with the local universities compared to the Danish context. City employees who work on the climate agenda are often recruited from local universities while city employees are often hired to teach and conduct research at universities. This is relatively rare in Denmark, where research tends to be detached from practical work in cities.

For example, in Seattle, the University of Washington is working with the city on the communication of climate change. The University integrates students through university programs in the development of actual solutions. In Philadelphia, the city’s ambitious plan for sustainability was developed under the leadership of a former professor from Penn State University, Alan Mark Hughes. In New York City, Mayor Bloomberg set up the New York City Panel on Climate Change in 2008 to help the city during the development of the PlaNYC process on issues of climate change. The independent panel consists mainly of scholars and experts from the academic community and aims to provide the best scientific knowledge as background for the city’s work. The panel is still continuing its work and has thus far issued three reports — the latest in 2015.⁵

5 Mayor Bill de Blasio announced that the panel will continue its work with a new study on resilience. “Building the Knowledge Base for Climate Resiliency: New York City Panel on Climate Change 2015 Report,” *Annals of the New York Academy of Sciences* 1336: 1-150.

Zoning and Building Regulations

All cities are working with zoning as part of their climate change work in order to reduce weather-related risks. This is especially true in New York City, where the Department of City Planning has selected a number of vulnerable neighborhoods, such as Jamaica Bay, in order to assess how zoning and planning regulations can help to mitigate risks such as coastal flooding. Building regulations are especially important neighborhoods that are located in vulnerable flood zones. The Federal Emergency Management Agency (FEMA) has regulations that require buildings to be elevated in flood areas, which might work in parts of the United States with single family houses but is more difficult in a densely built city like New York. As such, the city has tried to negotiate other measures and other levels of protection that focus on the protection of existing buildings with flood protection measures such as flood gates. One of the lessons from Sandy was that basic installations such as electricity and water failed because they were flooded. By moving these installations higher up, the city aims to reduce damages that will make the recovery after a storm much easier.

Seattle, Washington

With almost 650,000 citizens, Seattle is only slightly larger than Copenhagen. The Seattle metropolitan region has an estimated population of just over 3.6 million people. The city is similar to Copenhagen in that it is located on a sound (the Puget Sound). The city has a relatively mild climate with high precipitation in the winters and relatively dry summers. It is also a city experiencing strong economic growth, which is not without problems. House prices are soaring and neighborhoods are becoming gentrified. This is a real concern for local politicians who have placed equity high on the political agenda.

Expected Impacts of Climate Change

Seattle has set ambitious greenhouse gas emission reduction goals. But when it comes to adaptation to climate change, there appears to be a lack of urgency.⁶ Part of this stems from Seattle having experienced very little impact from climate change related events.

However, there are forecasts that indicate Seattle's summer climate will become warmer and drier and winters will have less snow fall, resulting in snow cover in the mountains while there will be an increase in rainfall. The reduction in snow cover will impact the water supply — critical for power production for the region — and heavier rainfalls will increase the risk of mudslides. A rise in sea level will affect the lower parts of Seattle, and especially in the area around the Duwamish River. Yet, since the city has not yet faced serious, immediate threats as a result of the changing climate, climate preparedness is not a political priority.

Organization

The city has an ambitious goal of becoming carbon neutral by 2050. The city's work on climate action and adaptation is coordinated by the Office for Sustainability, which works on all aspects of sustainability, including climate, waste, energy, and pollution. Within this office, one individual is responsible for overall climate adaptation. This person relies on an extensive network of connections to other departments within city administration and organizations such as the Port of Seattle.

Actions

The planners in the Seattle Public Utilities and in the Office for Sustainability and Environment know that climate change will have an impact on the city, but there does not appear to be a great sense of urgency among the public or at the political level because city policymakers seek to insert adaptation policy into existing projects whenever possible. That may sound simple, but spending time with their staff and their many different stakeholders around the city shows that is a complex endeavor.

For example, during the spring of 2015, the city embarked on crafting its first climate preparedness plan carried out by the Office of Sustainability as part of the city's overall Climate Action work. The climate preparedness plan will address all sectors that will eventually feel the impact of climate change, from the built environment to public health. The plan is intended to launch a more proactive approach toward climate change. In addition, by setting up regional partnerships with local universities and private and

⁶ City of Seattle, Washington, "Seattle Climate Action Plan: Implementing Strategy Progress Report," February 2015.

regional stakeholders, the aim is to share knowledge and develop a solutions-oriented coalition. This is part of a growing realization of the regional impact of climate change, and the need to reach out to local communities to strengthen the knowledge base and make use of limited funds.

The city has an ambitious green infrastructure plan focused more on closing Combined Sewer Overflows than on climate change. That said, the Seattle Public Utilities has begun to include some climate change adaptation concepts into their work. For example, the use of swales to clean runoff from roads is an interesting method. The so-called “Swale on Yale” is an example of this way of cleaning and handling storm water, and when finished, will clean runoff from a site that is more than 400 acres before discharging it into Lake Union.

Another important aspect of the effects of climate change in Seattle is the question of social and racial equity. The city’s most vulnerable areas — those most easily exposed to the negative effects of climate change — are also those areas that have a high proportion of poor residents.⁷ Given that the current mayor is committed to addressing the needs of vulnerable populations in Seattle, the city, with the help of local nongovernmental organizations, has reached out to vulnerable communities to include them in the design of the climate preparedness work. One example of this is an area around an outlet of the Duwamish River that is vulnerable both to flooding from rain and from rising sea levels. The neighborhood has a concentration of small industries and low-income housing, and is therefore of great importance in the climate preparedness plan. The city has partnered with a local nongovernmental organization, Got Green, to involve the local community in the development and protection of the neighborhood.

“ The city’s most vulnerable areas are also those areas that have a high proportion of poor residents.”

Lessons Learned

There are two main lessons to take from the Seattle case study:

- How to raise awareness when there is no real sense of urgency. The extensive networking that takes place in the city is impressive, creating a mutual and shared knowledge base and a common language.
- The community and local stakeholders outreach ensures that actions meet the needs of the local community

Portland, Oregon

Portland is a fast-growing city, and is expected to pass 630,000 residents in 2015, with close to 2.4 million people in the greater metropolitan area. The city has worked on issues of sustainability and liveability for many years. Portland, for example, is widely considered to be one of the most bike-friendly cities in the United States. The number of bicycle riders has tripled since 2001.⁸

In 1993, Portland was the first U.S. city to issue its climate action plan. The goals were ambitious — the city sought to cut emissions by 40 percent before 2020 and by 80 percent by 2050. It is one of the few cities in the United States where carbon emissions have decreased in comparison with the 1990 baseline level (14 percent in 2014).⁹

Expected Impacts of Climate Change

Portland can expect to experience many of the same climate change effects as Seattle, including more winter precipitation and drier and warmer summers. In general, these effects will be relatively minor compared to cities on the East Coast. Nonetheless,

⁷ “Find the Home,” <http://places.findthehome.com/1/138576/Greater-Duwamish-Seattle-WA..>

⁸ That said, compared to Danish cities like Copenhagen, the number of bikes in the city is still low. Indeed, biking in Portland is seen as confined to dedicated environmentalists.

⁹ The City of Portland, Oregon, “From BPS Director Susan Anderson: 2015 Climate Action Plan to guide City of Portland for next five years,” <https://www.portlandoregon.gov/bps/article/540898>.

just like in Seattle, a reduction in snow cover in the surrounding mountains will impact the production of hydropower, which provides the city with about 40 percent of its energy. This could be a setback for carbon reduction goals, as the city will have to look for other sources of energy.

The city will also face the risk of flooding due to increased rainfall. However, the city has yet to experience the massive rain storms that have happened on the East Coast. Finally, it is expected that rising temperatures will negatively impact the urban heat island effect.¹⁰ Even though Portland is a city with relatively low density, this is still likely to be an issue. Indeed, and with record high temperatures on the West Coast in the summer of 2015, this problem may prove to be more severe than expected.

Organization

Of all the cities visited during this study, Portland's climate work is the most integrated within city planning. Climate action work in Portland is organizationally placed in the Department for Planning and Sustainability, making it an integrated part of the city's work on spatial planning and development. The Department for Planning and Sustainability only has two individuals working on adaptation and therefore, similar to Seattle, they rely on an extensive network with other departments and stakeholders to advance their work.

The main actor on adaptation action is currently the Bureau for Environmental Services. They are an individual bureau in the city of Portland that oversees the city's stormwater management program. This includes the green infrastructure program. They are a key stakeholder for the Department of Planning and Sustainability when it comes to actually implementing adaptation measures.

¹⁰ Urban Heat Island effect is a term used to describe the fact that cities because of their high amount of hard surfaces retain a lot of the heat during the day and reflects it out during the night leading to overall increased temperatures in the city. This can lead to increased mortality in vulnerable groups – and to increased energy consumption such as air condition. Green areas and water can help mitigate the effect of urban heat island effects.

Actions

The city is first and foremost focused on reducing CO2 emissions. Climate change adaptation in this respect takes second place. This prioritization is related to the notion that it is important to keep the focus on mitigation; raising adaptation higher on the political agenda will be seen as a defeat. The city has nonetheless developed two strategic documents — a Climate Action Plan¹¹ to reduce CO2 emissions, and a Climate Change Preparation Strategy from 2014.¹²

The Climate Change Preparation Strategy has three main focal points as it relates to climate change adaptation:¹³

1. Urban Heat Island — results from rising temperatures and an increase in high-heat days;
2. Warmer winters with more risk of intense rain events (flooding);
3. Building capacity to respond to and recover from extreme events.

Like many other U.S. cities, Portland has had to face mandates to reduce sewer overflows through the Federal Water Pollution Control Act also known as the Clean Water Act. The city initially started to develop a number of large stormwater tunnels along the river. At the same time, the city started to develop several small-scale green infrastructure projects in order to reduce localized flooding in certain areas of

the city. From these isolated and small projects, the city's approach has evolved into a program that is fully integrated into the general stormwater management of the city. The green infrastructure stormwater management program is

now used to reduce the amount of stormwater that enters into the sewers and therefore reduces incidents of Combined Sewer Overflows and also reduces the need for large scale sewer retention constructions.

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***Of all the cities,
Portland's climate work
is the most integrated
within city planning.***”

¹¹ The City of Portland, Oregon, “Climate Action Plan,” <https://www.portlandoregon.gov/bps/49989>.

¹² The City of Portland, Oregon, “Climate,” <https://www.portlandoregon.gov/bps/64076>.

¹³ The City of Portland, Oregon, “Climate Change Preparation Strategy,” <https://www.portlandoregon.gov/bps/64079>.

The Sustainable Storm Water Program has several elements. The main feature is Green Streets, which consists mainly of handling local runoff from roads in green swales or planters along streets in areas where there are problems with capacity in the sewer system. This is supplemented with a Downspout Program, which encourages property owners to disconnect their runoff from roofs, so it can be directed into rain gardens in yards, for example.

The Green Street and Downspout Programs are part of the overall stormwater management program and therefore, under the Department of Environmental Services, the city is able to pay for these installments through the water fees from the consumers. This has led to several conflicts with local businesses that have questioned the city's right to include the green infrastructure works in the consumer fees for storm water management. The city has also had to defend itself against lawsuits in cases where the city bought land to create storage areas for storm water and then used the land for other purposes such as parks. This mirrors some of the discussions that we have had in Denmark about the new adaptation legislation and some of the features the City of Copenhagen would like install to manage storm water in extreme events. The Ministry of Finance was afraid, for example, that the new legislation would tempt local municipalities to move costs for road maintenance to storm water management, saving tax money by moving expenses to water rates.

Portland has a good business case for doing what they are doing. Just like Copenhagen, they have showed that green infrastructure solutions are a cheaper alternative to expanding the existing sewer system. This is the same argument that has been used by the City of Copenhagen in the city's work to revise national legislation to include climate change adaptation. Because green streets and downspout disconnections are flexible, the program can slowly be expanded in order to meet demand.

Lessons Learned

The main takeaway from Portland was their green infrastructure work and the time required to acquire local professional expertise on the topic. The Green Street program has been running since 2007. Portland therefore has a lot of experience with both the design and operation of green street solutions. The green

infrastructure program is now an integrated part of the stormwater management system, which is precisely the City of Copenhagen's current goal. Portland is one of the cities that has worked with this program the longest, and has developed a design and maintenance manuals that are based on actual experiences and on-the-ground knowledge.

Portland's experience also shows the importance of restoring natural environmental flows as part of a stormwater management program. For instance, this was the case with a project called the Johnson Creek, which flows through the city toward the Willamette River. Cut off by railway and urban development, the creek was developed into a canal, but caused frequent flooding because the natural flood plain was removed. The city finally decided to complete a buy-out program to purchase the properties along the creek and restore the meandering pattern of the creek with room for flooding. Though the project is ongoing, the initial result is an amazing new natural habitat close to the city center and one that has dramatically reduced flooding. This is an example on how nature-based solutions can go hand-in-hand with climate change adaptation.

Philadelphia, Pennsylvania

Located on the Delaware River on the East Coast of the United States, Philadelphia is the fifth largest city in the United States with a population of more than 1.5 million residents and over six million in the greater metropolitan area. Philadelphia is a port city and lies at the intersection of two rivers.

Philadelphia has one of the highest poverty rates and a very low tax base. Although the economic and social context is beginning to improve with new investment and residents, the city still struggles financially. Nonetheless, Philadelphia is a case which proves that innovation and political courage can make a difference.

Expected Impacts of Climate Change

Compared to the West Coast, cities on the East Coast face the prospect of more severe impacts as a result of climate change. The greatest risks are rising sea levels and an increase in intense rainfall and heat.

Some of the consequences associated with climate change have already started to happen. Since 2010, the city has experienced many challenges:¹⁴

- The snowiest winter ever
- The two warmest summers ever
- The most days over 90 degrees ever
- The warmest July ever
- The wettest month ever
- The wettest year ever
- Two hurricanes
- And a derecho

These recent weather experiences show that climate change needs to be taken seriously, especially in a city that is currently experiencing a new period of growth after decades of decline. It is also a challenge given the city's capacity issues and ongoing economic and social challenges.

Organization

Philadelphia's financial challenges come into relief when analyzing the city's work on sustainability. The Office for Sustainability has only six full-time staff, and like other U.S. cities, their main function is to coordinate work that takes place in other departments in the city or outside city government. The Office's main task is to ensure other city departments integrate sustainability and climate change adaptation into their work.

The city has developed an ambitious sustainability plan, call Greenworks. Published in 2009, Greenworks was developed under the former director of the Office for Sustainability, Mark Alan Hughes, a professor from Penn State University, who, at the request of the Mayor Michael Nutter, developed the plan. Though

climate change adaptation does not figure directly in the plan, green stormwater management is one of the plan's central strategies.¹⁵

Additionally, the city's Office for Sustainability has included climate change adaptation strategies into their work — especially since Sandy in 2012. This work culminated in a report *Growing Stronger* published in December 2015 that addresses both climate change and possible adaptation strategies.¹⁶

Actions

One of the issues concerning climate change in Philadelphia is the risk of more frequent storms and, as a result, higher levels of precipitation. That is primarily why stormwater management has a high priority in the city and why it drives the local sustainability agenda. Faced with demands from the EPA to reduce overflows from the combined sewer system, and to some extent build on the lessons from Portland, the city in 2011 launched the plan "Green City-Clean Waters," in which the city proposed moving from grey infrastructure to green infrastructure. One of the arguments for this was the business case. A grey infrastructure-based solution would have cost in the vicinity of 8 billion dollars, while the green infrastructure solution cost much less, amounting to less than 3 billion dollars.

Philadelphia's ambitious green infrastructure plan is an example of the holistic thinking that is also driving the city's policy agenda. While this thinking might be driven by of lack of city funds, it will ultimately add quality to the urban landscape, create climate benefits, and manage stormwater at the same time, as was indicated by city representatives interviewed for this project.

Philadelphia also has a few examples where thinking across sectors has created new opportunities for the implementation of green infrastructure projects. One example is the public schools where a project to create new green schoolyards was combined with stormwater management strategies. In this way, stormwater management can co-finance part of the project, making it possible to rebuild more

14 U.S. Environmental Protection Agency, "Climate Change Adaptation in Philadelphia," April 17, 2013, <http://www.epa.gov/statelocalclimate/documents/pdf/april-17-4-climate-change-adaptation-in-philadelphia.pdf>.

15 City of Philadelphia, Pennsylvania, "Making Philadelphia Greener," http://www.phila.gov/green/greenworks/pdf/Greenworks_OnlinePDF_FINAL.pdf.

16 City of Philadelphia, Pennsylvania, "Making Philadelphia Greener," <http://www.phila.gov/green/pdfs/Growing%20Stronger.pdf>.

schoolyards and handle more water at the same time. Unlike New York, Portland and Seattle, climate change adaptation is much more present in the city's day-to-day operations. The city is working on an ambitious outreach program to property owners and residents in flood zones. Indeed, the city is able to provide financial support for installing sewer backflow prevention in basements because they are able to prove the business case as explained above for making such changes.

Beyond these efforts, the work of climate adaptation in Philadelphia is only in the beginning stages. The Mayor's Office of Sustainability and the Delaware Valley Regional Planning Agency have been working directly with the various sectors, posing key questions: How will changes in the weather pattern affect individual residents? How much will certain types of interventions cost a resident? What can residents do to prevent damages? These interviews have formed part of the basis of what has now been published in the report *Growing Stronger*.

Lessons Learned

There are two primary lessons from Philadelphia that can be applied to the Copenhagen context. First, a lot can actually be achieved with very little money. Integrated planning and thinking can go a long way in achieving citywide impact by making sure that every dollar spent is spent in such a way that it impacts more than one purpose.

Secondly, it is important for cities to take time to craft and develop thoughtful strategies because this allows for more thorough responses. The City of Copenhagen has been in a hurry to implement adaptation techniques as a result of recent severe flooding. This means the City has not been able to carry out a detailed sectoral risk and vulnerability assessment as a city like Philadelphia has already begun to do.

New York City, New York

New York City was one of the first cities in the United States to start working systematically with climate change adaptation on a larger scale. Former mayor Michael Bloomberg put climate change adaptation on the agenda together with setting ambitious goals

for reducing CO2 emissions. Current mayor Bill de Blasio is continuing with this work, while having added an equity component. The work started in 2007 with the New York City Panel for Climate Change. The panel consisted of leading climate change experts and private sector representatives whose role was to advise the mayor on issues related to climate change and adaptation. The panel, among other things, produced a set of climate projections that are specific to New York City in a report that was published in 2009.¹⁷ Nonetheless, progress was slow and the first year only resulted in analyses but little action.

The approach and intensity of the city's work changed significantly after Hurricane Sandy.¹⁸ Pre-Sandy adaptation work in the city consisted mostly of a mapping of risks and possible impacts of climate change. Post-Sandy, the focus has shifted to recovery and resilience, focusing mainly on coastal flooding. This is similar to what occurred in Copenhagen, where the cloudbursts in 2010, 2011, and 2014 focused work on reducing stormwater flooding. The geographic focus in New York City is concentrated around the protection of lower Manhattan, Staten Island, and Rockaways/Jamaica Bay in South East Queens.

Expected Impacts of Climate Change

As a coastal, low-lying and dense city, New York City is one of the cities in the United States that will likely face severe impacts from climate change. The greatest overall threat is in the form of already increasingly hot summers in the city that will only continue to be hotter and more frequent. It is expected that by 2100 the number of 90 degree days will triple. This will have a significant impact in general, but to vulnerable groups in the city, for example, the elderly and those who cannot afford air conditioning, especially.

¹⁷ City of New York, New York, "Climate Risk Information: New York City Panel on Climate Change," February 17, 2009, http://www.nyc.gov/html/om/pdf/2009/NPCC_CRI.pdf.

¹⁸ Hurricane Sandy hit NYC in October 2012 with strong winds, rain and most severely a storm surge during high tide which resulted in a water level up to 14 feet about normal level. The storm led to extensive damage including power cuts on lower Manhattan, fires in Queens, flooding of the subway system etc. Thousands of homes were destroyed and it was estimated that the total loss was at least 18 billion dollars. 53 lives were lost — the number would have been bigger if the mayor had not ordered a mass evacuation

The impact from heavy rain is also expected to be serious, especially in combination with hurricanes. It is predicted that the sea level will rise one to two feet by 2050 and as much as six feet by 2100. The rising sea level is already a problem in parts of the city like Jamaica Bay where flooding with high tides occurs monthly.

Organization

Because of the effects of Sandy, New York City was the only city in this study where the state and federal level were present in climate adaptation work. In New York City three primary plans have been adopted to tackle climate change.

One of the most spectacular projects that came out of the Rebuilt by Design competition is the BIG U, designed by the Danish firm BIG.¹⁹ This project aims to protect the southern part of Manhattan by building a structure to keep out water in case of flooding that is also integrated into the urban design of the city with significant recreational and educational potential. Currently, the city and BIG architects are working on the implementation of the first phase on the lower East Side of Manhattan.

The NY Rising²⁰ plan works with the statewide climate change adaptation strategies. The plan funnels federal funds to communities impacted by Hurricane Sandy to support community resilience and reconstruction projects. At the local level, the third plan, One New York²¹ addresses recovery and resilience in New York City. It is the next generation of the PlaNYC that was the strategic plan developed during Bloomberg's term in office. Federal, state and city government are not always in agreement on the strategies and initiatives. Following Sandy, Governor Cuomo of New York suggested protecting the city by building a central sea wall. This was not, however, recommended by New York City planners, and resulted in significant disagreement between NYC Mayor Bloomberg and New York State Governor Cuomo.

In New York City, the Mayor's Office for Recovery and Resilience is attempting to formulate a more holistic vision for a \$20 billion dollar investment program on resilience covering coastal protection, stormwater management, and extreme temperatures. This is a complex process given the geographic scale of New York City and the web of city agencies, each of which is often considered its own entity. Further, in a city like New York, there are many additional considerations to take into account. These include a lack of space, economic development, social issues, and the city's status as a financial hub and a global economic power. This is also one of the reasons why a strong focus on the plan is on making the city resilient and giving it the capacity to recover quickly from extreme weather events. A cornerstone of this work has been to assess vulnerability and set up measures that can protect central infrastructure such as electricity and water supply.

Actions

The basis for the work that takes place in the city is the plan "One New York," which aims to create "a stronger and more resilient NYC."²² This is the city's overall development plan that includes the Plan for Recovery and Resilience. The NYC Special Initiative for Rebuilding and Resilience, a task force that was set up by Mayor Bloomberg to develop citywide and neighborhood specific plans to tackle both the recovery and resilience work in the city following Hurricane Sandy, expanded the plan in 2013. A primary objective of the task force was to set a time frame that made it possible to spend federal money granted to rebuilding the city within the time limits. The task force was formed by participants from all departments in the city in order to ensure cross-sector coordination, which can be tricky for a large city like New York.

One New York takes PlaNYC one step further. The main difference is the addition of equity as one of the pillars of the plan and a corresponding strong focus on resilience.

One New York is focused around the four pillars:

- Growth

19 Rebuilt by Design was a federal design competition meant to encourage big thinking around the New York/New Jersey areas most impacted by Hurricane Sandy in 2012.

20 New York State, "Governor's Office of Storm Recovery," <http://stormrecovery.ny.gov/community-reconstruction-program>.

21 "OneNYCProgress," <http://www1.nyc.gov/html/onenyc/index.html>.

22 The City of New York, New York, "One New York: The Plan for a Strong and Just City," <http://www.nyc.gov/html/onenyc/downloads/pdf/publications/OneNYC.pdf>.

- Equity
- Sustainability
- Resilience
- Neighborhoods — looking at planning issues and resilience challenges in neighborhoods across the city.
- Buildings — resilient buildings that can handle climate impacts, and can provide safety for people living in them.
- Coastal defense — developing coastal defenses that can provide safety for critical parts of the city.
- Infrastructure — issues like green infrastructure, but also providing a resilient infrastructure when it comes to power, heating, water and transport.

Green Infrastructure

Although the stormwater management plan is included in the total resilience program, the Department of Environmental Protection (DEP) is focused on reducing combined sewer overflows, as is the case in the other three cities that are a part of this study. And just like those plans, DEP works with small local projects to remove stormwater from the sewers wherever possible. Inside the DEP, however, there is a growing concern that the agency must also create a more holistic systems approach that integrates predicted impacts from climate change. This becomes very obvious in the areas of the city where coastal protection collides with stormwater management, such as on Staten Island, where the building of a coastal artificial dune will make it difficult to discharge stormwater into the sea unless it is integrated in the project.²³

²³ As part of her visit, the author also set up a joint workshop between the main city agencies to discuss the challenges of collaboration and also to discuss of the possibility of transferring knowledge from NYC to Copenhagen and vice versa, especially when it comes to stormwater management through green infrastructure. The workshop showed how difficult collaboration can be in a city as complex as New York city. The coordination between agencies becomes even more difficult when there is a time pressure and when the city must also collaborate with federal agencies. The grants from FEMA have to be spent before a given date, and some of the coastal protection measures will be built not by the city, but by a federal agency, The Army Corps of Engineers.

Planning Neighborhoods

Another issue in New York City is the way the city works with planning and zoning. The Department of City Planning works both on a citywide scale with zoning and building codes as well as on the neighbourhood level. The Department has selected ten neighborhoods on the floodplain, and through a detailed planning process, is attempting to guide the development of these neighborhoods in a more “resilient” direction.

Resiliency is sometimes defined across a range of topics, including food access. For example, Hunts Point in the Bronx is a major local and regional center for food distribution. Had Sandy hit at another point in the tidal circle and impacted Hunts Point, the city’s food system could have been temporarily crippled. There are many neighborhoods in Brooklyn, and in particular Jamaica Bay, where major flooding could cut off access to shops and supermarkets and severely impact those communities that already house a disproportionate percentage of those on low and very low incomes.

Coastal Protection

With flood levels at almost 14 feet over normal sea level, Hurricane Sandy provided a warning of what the future climate may have in store for New York City. After Sandy, the coastal protection of the city became one of the city’s main priorities. The design competition Rebuilt by Design came up with ideas for the protection of southern Manhattan, Jamaica Bay, and Staten Island. The city soon decided to concentrate on the most vulnerable parts of the city first.

A special issue for New York City is the fact that the hurricanes consist of both big tidal waves and torrential rains. Creating a system that can handle both the rain and tidal waves simultaneously is not easy. It is here that the coordination of construction work becomes critical. An example of this is Staten Island, which was heavily impacted by Sandy. The federal level is working on a coastal protection project through the Army Corps of Engineers. The project will make it difficult to discharge stormwater from the island, and at the time of writing, the city has not yet found a permanent solution to this problem.

Building Resilience

FEMA (Federal Emergency Management Agency) has requirements for the construction of buildings in flood zones in order to obtain insurance coverage. This includes the elevation of buildings, which is difficult to do in a densely built city such as New York City. The city, therefore, has had to come up with alternative measures. One of these is to use building regulations to make buildings more resilient. One of the lessons from Sandy was that most buildings have installations such as water and electricity located either in basements or in the lower levels. With 12 feet of flooding in some neighborhoods, these systems were flooded, thereby preventing residents from moving back to their homes until long and costly repairs to these systems were made. By moving installations higher up, it will be possible for residents to return to their homes earlier.

Sandy also demonstrated that public utilities such as power plants and electricity generators are vulnerable. The city has therefore embarked on a project to secure these, which can often be done through simple measures such as putting up protective walls. The question, of course, is whether this will be enough in the future if the prognoses are correct and the city could face rising sea levels up to six feet.

Lessons Learned

First, as occurred in Copenhagen, a single serious event became a trigger for institutional action. Sandy also proved to be a reality check for residents and politicians who experienced firsthand what happens when climate challenges facing their city are ignored or not taken seriously enough. In the case of New York City, Sandy created a sense of urgency that prompted the development and implementation of plans to minimize the impact of extreme weather events.

With urgency also comes a risk that cities create adaptation plans that are not fully integrated into a comprehensive agency wide plan, allowing city agencies to carry on with business-as-usual activities. In the case of New York City, the reliance on FEMA funds may also result in investments made that do not incorporate a long-term holistic plan owing to the short time frame within which the city has to spend down the FEMA funds.

Another lesson concerns risk assessment and the cascading effect of climate events. Sandy directly impacted property, infrastructure and businesses across the city. For example, the closures of small businesses because of power cuts threatened the basic economic security of residents. If Sandy had struck at a different time, the food distribution center in the Bronx could have been at risk and as a result caused a food crisis in the city. However, there are a larger set of risks and ramifications that are felt outside the city. The closure of the New York Stock Exchange is a good example of the global economic implications a storm like Sandy can have. Comprehensive risk assessments must be integrated into climate adaptation plans.

Recommendations

There are a number of policy recommendations for Copenhagen's climate adaptation strategy based on the study of four U.S. cities:

- Focus on future maintenance of the projects in the design process. The experiences from the U.S. cities, especially those on the West Coast, show that the long-term maintenance of green infrastructure solutions is higher than expected and that initial designs must take maintenance into account. Maintenance must always be at the core of the design phase.
- In Copenhagen, we have created a cloudburst management plan that covers the entire city — and are implementing everything over a period of 20 years. But the approach that the U.S. cities have taken demonstrates that cities do not have to go all the way at once. Climate change is gradual and therefore the solutions can also be gradual. As long as the path for solutions is a flexible one, the adaptation system can be expanded to handle more severe events.
- It is important to have a thorough vulnerability assessment. Cities are complex systems and impacts can cascade through a city, meaning that the effects can be evident far from the original point of impact.

The sense of urgency does not come by itself. Big events trigger the sense of urgency, but the effects have a way of losing importance over time. Right

after Hurricane Sandy, the climate adaptation plan in New York was at the top of the city's policy priorities. But three years on, it has lost some of that urgency.

Looking at the four cities that were visited as part of this research, it seems as if these U.S. cities are taking a different approach to climate adaptation than Copenhagen. This approach is lower in intensity but also effective in moving policy forward. By tying the first attempts to move more resilient cities to the general stormwater management and the environmental issues connected with this (specifically to reduce CSOs), the cities in this study are choosing a path that can slowly be developed to handle more stormwater as the effects of climate change become real.

By working with green infrastructure to handle storm water outside the traditional grey infrastructure sewer systems, the cities are also choosing a flexible approach to adaptation. For instance, a goal to build a system that can manage a ten year storm can be gradually expanded to manage larger events.

However, this approach also has its weaknesses. The main one is the capacity to handle large events that will continue to happen in the coming decades, and specifically concerning the final discharge of stormwater. The main backbone in the Copenhagen Cloudburst plan is the surface system — connected to large outlets, because the city can already anticipate that we cannot infiltrate the large events. In other words, the amount of rain that falls on the city is simply too much for the ground to absorb, so the city has had to create a system that combines the infiltration with transportation and discharge of water. With time, U.S. cities might have to invest in a similar system. For coastal cities on the East Coast that face the risk of hurricanes like Sandy or the previous Irene with storm surges coinciding with massive amounts of rain, this will be a real challenge.

But at the moment, U.S. cities also have to take a pragmatic approach. Resources for climate work are limited, which is visible in the number of staff actually working with these issues in all the cities visited as part of this research. Copenhagen has a climate unit with 25 individuals — in a city with less than 600,000 citizens. In Philadelphia, a city of similar size, it is only five. Given this, it is impressive what the four U.S. cities have been able to achieve.

Cities Learning From Each Other

Because of the lack of resources, cities are working together and actively trying to learn from each other. Having worked on climate change adaptation for the past seven years I have had the chance to exchange knowledge with representatives from a large number of cities. Because adaptation is a new field in urban planning and development, there is also a great interest in learning from each other. There are lots of things that can easily be transferred from one city to another. This can sometimes involve technical details such as the best way to design a rain garden. But transferring policy knowledge from country to country can be more difficult given the different legislative and financial systems in the various countries.

There does not seem to be any “organized” exchange of knowledge between cities concerning adaptation. There is a network of Sustainability Directors in North America (USDN) that meet and exchange knowledge, and of course adaptation is also a part of this work, but still just as a minor issue compared to other sustainability issues. Despite a lack of a formal network on exchange, it was quite apparent that the cities that I visited had learned from each other. Cities like Portland and Seattle had to some extent paved the way for other cities through their green stormwater management programs. They were among the first cities to negotiate with the federal level to gain recognition of green infrastructure as an alternative to building large tunnels and reservoirs. This ground work made it easier for cities in the next generation not only to “copy” the programs, but also to use the negotiated deals on financing as a starting point for their own work.

Copenhagen has for a couple of years worked with New York City on climate change adaptation. I set up a workshop with representatives from all relevant departments to discuss the challenges of collaboration in a large city like New York. As a result of this workshop, the Mayor for Technical Affairs, Morten Kabell, and the NYC commissioner for Department of Environmental Protection, Emily Lloyd, in September signed a Collaboration Agreement. The aim is to transfer knowledge between the cities. Copenhagen wants to learn more about the risk assessment work in NYC and NYC wants to create its own Climate Quarter, modelled on the Copenhagen example. The learning continues.

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