

An isometric illustration of a city skyline where every building has a green roof. The buildings are rendered in various colors like grey, blue, purple, and orange, and are set against a background of a blue grid. Green trees are scattered throughout the city, some on the ground and some on the roofs. The overall style is clean and modern.

Gardens in the Sky: Greening Cities with Green Roofs

A comparative case study analysis of governance arrangements and the role of private and public actors in green roof adoption

Jennifer Stamatelos
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Master's Thesis

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Abstract

Climate adaptation is being taken seriously by cities around the world because of the significant risks posed by climate change. Cities' geographical location, high population densities, and built environment make them especially vulnerable to stormwater flooding and the urban heat island effect. The cities analyzed in this paper are taking measures to combat the potential and already realized impacts of climate change. Chicago, London, and Stuttgart are all active in the green roof implementation field and have instituted a variety of regulatory, economic, and communicative mechanisms to help spearhead the implementation process in their respective cities. The cities' green roof governance arrangements are the subject of focus in this paper. Governance arrangements are a determinant of implementation success or failure, and their configuration determines the extent to which green roofs are adopted and mainstreamed as an adaptation measure. The responsibilities of public and private actors in the governance process are explored, as well as the considerations they take into account during the decision-making process. These considerations, along with other external conditions, influence the (1) allocation of responsibilities throughout the policy cycle; (2) policy instruments utilized to promote green roofs; and (3) steering strategies used to 'steer' behavior toward adaptation. The findings of this research strongly suggest that public responsibility and engagement throughout the policy cycle are pivotal for the extensive adoption of green roofs.

Keywords: green roofs, climate adaptation, governance arrangements, responsibilities

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Chapter I

Introduction, Background, and Methodology

1. Introduction and Background Information

Climate change is one of the most pressing environmental problems currently facing our society. Anthropogenic activities such as deforestation, the combustion of fossil fuels, and intensive agricultural production have contributed to increased atmospheric concentrations of carbon dioxide and methane. The increase in concentrations of these greenhouse gases in the atmosphere has corresponded with the rise of the earth's average temperature. Although skeptics contest the linkage between the emission of greenhouse gases and the earth's rising temperature, the scientific community has acknowledged that climate change is occurring. The Intergovernmental Panel on Climate Change (IPCC), a scientific body responsible for providing assessments on the current state of the climate, supports the view that the warming of the earth's temperature is indisputable. During the past 100 years the earth's temperature has risen by an estimated 0.56 to 0.92°C, and it is expected to increase at a rate of 0.2°C per decade for at least the next two decades (IPCC, 2007). Some estimates suggest that the earth's global mean temperature will rise between 1.4 to 5.8 degrees Celsius during the next 100 years (IPCC, 2001). According to the IPCC 2007 Synthesis Report, "[c]ontinued GHG emissions at or above current rates would cause further warming and induce many changes in the global climate system during the 21st century that would very likely be larger than those observed during the 20th century" (p. 7). The current and potential ramifications of climate change on the economic, environmental, and social aspects of our society are considerable and will be felt on a global level. Climate change, however, poses a particular threat to cities because of their high population densities and their tendency to be located near coastal areas.

Urban areas and cities are highly vulnerable to the impacts of climate change. The warming of the earth's temperature is expected to further exacerbate and stress already overburdened urban environments. Increasing precipitation rates and rising sea levels are expected to cause a higher frequency of flooding, coastal erosion, and flash floods. Flooding and storm surges present significant risks to coastal cities such as Rotterdam, London, and New York; these cities are projected to experience a wetter climate in the coming years (ICLEI, n.d.). In addition to water-related issues, heat-related events are also expected to increase because of climate change. For instance, it is anticipated that there will be an increase in the frequency and duration of heat waves throughout all regions in the United States (Pew Center on Global Climate Change). An increasing occurrence of heat waves and the number of 'very hot summer days' is also expected to affect the United Kingdom (UKCIP website). The negative effects of prolonged high temperatures will be felt more in cities as opposed to rural areas because of the urban heat island effect (UHI). The UHI effect is associated with metropolitan areas because of their high concentration of buildings, dark-colored surfaces (i.e. roads, roofs), and the absence of large expanses of green space (as opposed to rural areas) (US EPA website). City temperatures are generally higher than those of the surrounding regions because of the urban heat island effect. The implications of this are significant because it increases the susceptibility of urban residents to heat stress. Heat

stress not only affects the quality of life and health of humans, but also negatively impacts the environment and economic activities.

Given the negative repercussions that cities are currently experiencing or are expected to experience, governments have already begun or are in the process of implementing measures to deal with climate change. Mitigation and adaptation are the two approaches that can be taken to address the current and potential impacts of climate change. While mitigation aims to reduce greenhouse gas emissions, adaptation focuses on the implementation of measures and strategies that will help reduce the earth's vulnerabilities to the climate. The IPCC (2001) defines adaptation to climate change as an "adjustment in natural or human systems in response to actual or expected climatic *stimuli* or their effects, which moderates harm or exploits beneficial opportunities" (emphasis by original author, p. 365). An adaptation measure that has been identified as a promising method for providing relief against the effects of climate change is the green roof. The benefits of green roofs as an adaptive measure are discussed in the following section.

1.1 Green Roofs as a Climate Adaptation Measure

Green roofs are considered to be a viable means to help cities deal with the impacts of climate change. Green roofs, also known as living or vegetated roofs, "typically contain layers of engineered growing media and drainage materials which are incorporated into a roof membrane and support plant communities which are tolerant of the extreme weather conditions found on rooftops" (Carter & Fowler, 2008, p. 152). The system, which can either be intensive or extensive, is generally installed on roofs with a pitch of twenty degrees or less (Lawlor et al., 2006). The difference between the two categories is the amount of moisture absorbed by the system. Intensive green roofs are capable of retaining more stormwater because of their greater depth, while extensive green roofs retain less water but provide greater surface area coverage (Getter & Rowe, 2006). Green roof systems offer many environmental, economic, and social benefits. Environmental benefits include the improvement of the water quality of run-off; reduction in the amount of stormwater entering sewage systems; and the reduction of the urban heat island effect (Carter & Fowler, 2008). Economically speaking, buildings with green roofs benefit from reduced heating and cooling costs, thus providing a financial incentive for their installation. In addition to their environmental and economic advantages, green roofs provide social benefits as well. They are aesthetically pleasing and provide a place where people can relax and 'escape' from the urban environment (Carter & Fowler, 2008). These benefits, however, are not only enjoyed by those who install them, but are also enjoyed by the public. Given this non-exclusivity, the following issues arise: who is (or should be) involved in the implementation of green roofs (i.e. government/private actors); and how responsibilities between the different groups should be distributed.

1.2 Problem Description

The governance of climate change adaptation is a challenging task because of the complexity of the issue at hand and the multitude of actors involved. Governments have played an important role in the establishment of laws, regulations, and institutions dedicated to protecting the environment and addressing environmental problems such as climate change. However, during the past several decades we have witnessed a shift in the perception of government and the role that the market and civil sectors should play in environmental decision-making processes. This shift has been associated with the rise of new forms of governance arrangements that involve public as well as private actors (Falkner, 2003). The

reasons for the increasing involvement of private actors in climate change adaptation are two-fold. First, because climate change impacts are trans-boundary and vary between and within regions, the problem cannot be tackled by government alone. These public-private governance arrangements enable the leveraging of resources, knowledge, and expertise between the different actors and also provide relief to governments whose resources are already overstretched. Second, because the benefits of adaptation are local, as opposed to mitigation (Aakre & Rübhelke, 2010), private actors are encouraged to participate in the process because they are also reaping private benefits.

The involvement of both public and private actors is necessary to facilitate climate change adaptation measures such as the adoption of green roofs. A government-only approach or market-only approach to the problem is sub-optimal. Aakre and Rübhelke (2010) argue that government intervention is necessary for efficient adaptation because market failure will result due to: uncertainty and imperfect information; missing and misaligned markets; and financial constraints. Mendelsohn (2006) also supports this view and states that:

“markets will encourage efficient adaptation in sectors whose goods are traded, such as agriculture, timber, and energy. The market will not be effective encouraging adaptation for jointly consumed goods...Impacts in areas with both private and public involvement, such as water, coastal defenses, and heat stress, require a mixture of market (private) and governmental responses to be efficient” (p. 204).

The joint involvement of public and private actors in the implementation of green roofs is evident in a multitude of cities, including Basel, Toronto, and London (Lawlor et al., 2006). Although governments have been responsible for spearheading the adoption of green roofs, it has served as an important catalyst for private sector involvement. Private actors are becoming more engaged in the process and are assuming responsibilities that were once in the government’s domain. Despite this proliferation of private involvement, little research has been done regarding the allocation of responsibilities in these governance arrangements and how they can be designed to be effective. In *Unraveling the Central State, but How? Types of Multi-level Governance*, Hooghe and Marks (2003) also raise this point and state that there is a lack of consensus on how multi-level governance should be organized. This study will begin to fill in this literature gap by focusing on green roof governance arrangements in Chicago, London, and Stuttgart and their contribution to the implementation of green roofs.

For the purpose of this study, a *governance arrangement* consists of three components. An arrangement encompasses the following: division of responsibilities between the actors in the policy cycle; steering strategies employed to influence behavior; and policy instruments utilized to promote green roofs. Different styles of steering strategies exist (i.e. hierarchical, market, network) to steer behavior toward adaptation. A hierarchical steering strategy is representative of government dominance, while market steering is driven by the private sector. Network steering takes place within ‘networks’ (i.e. epistemic, policy, non-governmental organizations), and involves interaction among a variety of actors. Similarly, different types of policy instruments can be used to influence the behavior of private actors. This study focuses on three types of instruments: regulatory, economic, and communicative. They correspond with the three control models outlined by Glasbergen (1992) that can be used to achieve policy goals. Glasbergen advocates the use of instruments from multiple categories in order to create effective policy. For this reason, different categories of policy instruments are explored in order to capture the variety of types that cities are using to help promote the adoption of green roofs.

The operationalization of a governance arrangement in this manner was influenced by the work of Arts et al. (2006). In their paper, *Political Modernisation and Policy Arrangements: A Framework for*

Understanding Environmental Policy Change, policy arrangements are discussed. They “refer to the substance and the organisation of policy domains in terms of policy discourses, coalitions, rules of the game and resources” (p. 93). The four dimensions that are focused on include actors and coalitions; division of power and influence between actors; rules of the game; and policy discourse and programs (Arts et al., 2006, p. 99). By focusing on these aspects, the following can be distilled: patterns of engagement between different types of actors; who the relevant stakeholders are; values of importance; and what conditions are influencing the decision-making process. Hence, the definition of a governance arrangement as applied to this study is appropriate.

1.3 Scientific and Societal Relevance

There is a clear knowledge gap in the scientific literature regarding the green roof governance process in cities. A lack of information exists on the following: the roles of private and public actors in green roof governance arrangements; the allocation of responsibilities in these arrangements; the factors and considerations that are influencing the governance process; and the manner in which such governance structures can be designed to be more effective. This topic is just one part of a PhD thesis that is being conducted by Heleen Mees, a PhD student at Utrecht University. Her PhD study is part of a larger project that is being spearheaded by the Dutch Knowledge for Climate Research Program. The three themes of focus in her PhD thesis are fresh water supply, water safety, and water storage; green roofs fall into the latter category and are the focus of my thesis. By conducting a comparative analysis on different cities, I can contribute to the existing body of literature by providing greater insight into the workings of these governance processes. Furthermore, this research can also highlight the logic and factors that influence the decision-making process for allocating responsibilities and the design of the arrangements. As Heleen Mees will be focusing on green roof implementation in Rotterdam, the findings of my thesis can provide a better understanding of what is being done in other cities and can be used to help generate recommendations for the City of Rotterdam.

In addition to the scientific relevance of this study, this research also has significant societal implications. As previously mentioned, the negative impacts of climate change will affect our environment as a whole and will also impact human quality of life. People who live in cities and those who suffer from poverty will be most impacted by the effects of the changing climate. The installation of green roofs can provide necessary relief to societies that are suffering from these impacts. This will not only benefit humans, but also the local environment and fauna which rely on the services provided by green roof systems.

2. Research Objective

The aim of this study is to gain an understanding of the current role of private and public actors in the governance of green roof implementation, and to also identify prospective roles and responsibilities that they can assume in the future. Additionally, this investigation will explore and identify the considerations that are taken into account by public and private actors in the decision-making process. The dependent variable in this research is the *governance arrangement*, while the *considerations* are the independent variable since they influence the configuration of the governance arrangements. These arrangements are influenced by considerations that encompass the following three perspectives: economic, political, and juridical-administrative.

The objective of this research will be achieved via a cross-country case study that will analyze and compare the governance arrangements and policy/legal instrument use in Chicago, London, and Stuttgart. This analysis will yield descriptive, explanatory, evaluative, and prescriptive knowledge with regard to the design of public-private governance arrangements and the factors that influence the scope and capacity of private/public actor involvement in the implementation of green roofs by:

- Analyzing the current relationship and governance arrangements that exist between various public and private actors responsible for implementing green roofs.
- Analyzing the current policy, legal, economic and communicative instruments that are in use in these cities to help promote green roof development.
- Exploring the cities' policy, legal, and institutional frameworks pertaining to climate adaptation and urban green planning and management.
- Evaluating relevant policy, planning, and legal/regulatory documents relating to green roofs, green planning, and climate adaptation and mitigation strategies. This investigation can shed light on why public-private governance structures dedicated to advancing the adoption of green roofs are configured the way they are.
- Comparing the cities' governance structures and instrument use in order to observe the advantages and disadvantages they present to the cities' efforts in implementing green roofs.
- Discussing the potential ways in which the cities can improve the allocation of responsibilities between the private and public sectors in order to facilitate the expansion of green roofs. This will be achieved by utilizing the Theoretical framework for public-private considerations in governance arrangements for adaptation developed by Heleen Mees (2010). This assessment can generate recommendations that the cities can use to design new and effective governance arrangements.

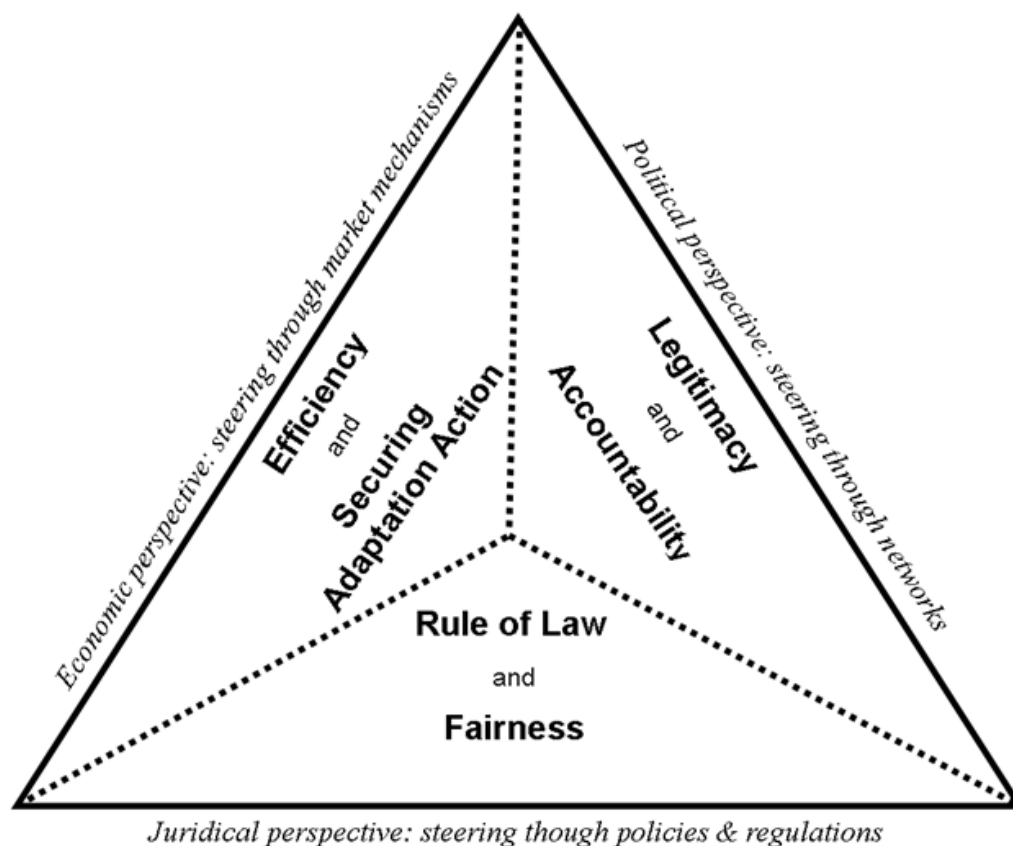
3. Research Perspective

The analytical framework that will be used in this research has been developed by Heleen Mees and is based on Nico Nelissen's (2002) JEP triangle. In *The Administrative Capacity of New Types of Governance*, Nelissen (2002) constructs the JEP (juridical, economic-business, political-societal) triangle, an instrument that can be used to assess the administrative capacity of new types of governance arrangements. The utilization of a multi-perspective framework is appropriate for this type of comparative case study analysis. The economic, juridical, and political perspectives are three underlying rationales for public policy. Policy evaluation can be conducted from different perspectives, and these 'angles' are also elaborated upon by Crabbé and Leroy (2008) via their discussion on Nelissen's JEP triangle. Within each of these approaches, or perspectives, criteria have been developed to assess governance arrangements. The juridical approach is grounded in legal principles and is concerned with "due process, fairness, [and] equality before the law" (Nelissen, 2002, p.14). The economic-business approach is concerned with efficiency, effectiveness, and simplicity, values that are associated with the principles of New Public Management. Political accountability, transparency, and democracy are related to the political-societal approach (Nelissen, 2002). The objective of this framework is to enable an evaluation of the current governance arrangements in the cities. It allows for a comparative analysis in terms of the considerations that are taken into account by stakeholders in the allocation of responsibility. Not only is the framework useful in helping to identify the considerations and other

factors that are driving the allocation decision-making process, but it can also be used as a tool to evaluate and improve the process and the design of future governance arrangements. The analytical framework can be seen on the following page.

One of the most important aspects of this framework is that it highlights the inherent tensions and contradictory nature that exist between the different perspectives. The following statement by Crabbé and Leroy (2008) illustrates this point: “The well-known dilemma of policy-makers, who must strike a balance between power and legitimacy, can now be translated in terms of the opposing criteria of economic efficiency, on the one hand, and political legitimacy, on the other” (p. 26). This points out a fundamental fact about the policy decision-making process, which is that trade-offs are constantly being made by stakeholders as they see fit in order to achieve their desired objective. These trade-offs can elucidate why some considerations are of more relevance and why certain paths of action are chosen. An evaluation from one perspective would not present an accurate picture because it would ignore other potential relevant considerations that are taken into account during the decision-making process. Thus, the theoretical perspectives in the framework and their underlying considerations are a suitable tool for this analysis. The considerations are explored in further detail below.

Figure I.1: Framework for public-private considerations in governance arrangements for adaptation, inspired by Nelissen (2002)



Juridical perspective

The juridical perspective places responsibility in the hands of public actors. It is concerned with regulations/legal principles, and the two considerations associated with this perspective are 'Rule of Law' and 'Principles of Equity and Fairness.' Rule of law is concerned with adherence to regulations and other policies which have a remit over an (adaptation) measure. Furthermore, this consideration also relates to regulations and/or constitutions that place a specific duty of care on behalf of public authorities to protect their citizens. As an example, the United Nations Framework Convention for Climate Change places a duty on all parties to institute precautionary measures in order to anticipate and mitigate the effects of climate change (Paavola & Adger, 2002, p. 11). This same obligation can be found in national legislation. A prime example of this will be seen in the London case study, where national law obligates the Mayor to create policies and institute strategies in order to protect London citizens from floods risks and other events.

Fairness is another consideration of the juridical perspective. There are various principles which encompass this consideration, but I will focus my discussion on the precautionary principle. In relation to climate change, the precautionary principle advocates (governmental) action despite scientific uncertainty surrounding projected climate change impacts. Instead of waiting to experience and visibly observe the actual impacts of climate change, the precautionary principle encourages action *now* instead of later. The reasoning behind this is that by the time climate change effects actually manifest (which may occur in several decades), it may be too late for society to adequately cope with the climatic changes. Hence, in order to minimize risk and avoid greater damages in the upcoming years, many governments are taking action now to secure their future economic, social, and environmental capital.

Economic Perspective

The economic perspective renders a more dominant role for private actors compared to the juridical perspective. The rise of new public management and neo-liberalism during the 1980s encouraged a more (business) economics approach to policy evaluation, where performance was considered to be a key measure. Hence, effectiveness, efficiency, and policy goal attainment are of relevance for the economic perspective (Crabbé & Leroy, 2008, p. 25). The two considerations which comprise this perspective are 'Efficiency' and 'Securing Adaptation Action.' Allocative, or Pareto efficiency, is attained when resources are allocated in a manner which maximizes societal welfare. According to Gode and Sunder (1997), "Allocative efficiency is high if the consumers who value a good the most are able to buy it from the lowest cost producers" (p. 603). There are various conditions which activate and influence the consideration of efficiency. For instance, the level of economies of scale that can be reached for an adaptation measure will determine how 'efficient' it is to produce the product. The expansion of the green roof market will allow greater efficiencies in production to be achieved, and this will be reflected in the systems' market price. The maturity of Stuttgart's green roof market will illustrate this point in Chapter 4. The involvement of a plethora of actors and the expansion of the market have brought prices down significantly in Germany during the past two decades, hence an increase in efficiency. Another condition which activates efficiency is the extent to which an adaptation good can be traded through efficient market systems, and/or private actors can react to proposed climate risks via changing variable inputs in their businesses. Mendelsohn (2006) states that:

“markets will encourage efficient adaptation in sectors whose goods are traded, such as agriculture, timber, and energy. The market will not be effective encouraging adaptation for jointly consumed goods such as infectious diseases or biodiversity. Efficient adaptation in these sectors will require government support” (p. 204).

Consequently, the efficiency of an adaptation action will be affected by how easily it can be traded and by the degree of the market’s development. Efficiency will rise if the benefits that are achieved by private actors are exceeded by the costs of production. In other words, the reaping of profits will encourage efficiency because more private actors will be urged to get involved so that they can have a ‘piece of the pie.’

In addition to efficiency, securing adaptation action is also representative of the economic perspective. This places responsibility in the hands of public authorities to ‘secure’ adaptation due to market failure. This directly relates to the last portion of Mendelsohn’s (2006) above-mentioned quote. Efficient private adaptation will occur when it is beneficial to private parties. However, in the case of jointly consumed goods, private adaptation will not be efficient because private actors do not have an incentive to act if they are not the sole beneficiary of the benefits. Hence, interventions by public authorities are needed to ensure that adaptation is indeed encouraged. As an example, the extent of (perceived) lack of private benefits, or the time lag between expenditures and reaping of benefits are potential barriers to adaptation. In the absence of long time lags, adaptation can be expected to take place autonomously (Stern, 2007). However, if benefits are expected to accrue sometime in the future, citizens may not be inspired to procure an adaptation measure. For this reason, public action is required to help make sure that private behavior is steered in the right direction.

Political Perspective

The political perspective places responsibility in the hands of both public and private actors. It presumes joint responsibility via a collaborative decision-making process. Representation, accountability, transparency, and participation relate to the political perspective, in which democratic principles are of significance (Crabbé & Leroy, 2008, p. 26). The concept of deliberative democracy relates to this idea of inclusiveness and joint participation. One of the main strong points of deliberative democracy is the fundamental principle of inclusiveness. Deliberation is important because it theoretically should allow a range of actors to voice their opinions and share their viewpoints on a particular (environmental) issue. According to Dietz and Stern (2008), public participation serves to enhance quality, legitimacy, and capacity building. A deliberative democratic process can help bring about more *legitimate* political decisions because the views of others are allowed to be expressed and taken into account (Smith 2003). The two considerations which comprise this perspective are ‘Legitimacy’ and ‘Accountability.’ Legitimacy relates to societal support for a particular adaptation measure/goal and the decision-making process. A condition which activates this consideration is the extent of multi-level, sector and actor complexity. With regards to climate change, the profound complexity of the problem and the various societal segments that are expected to be affected suggest that the adaptation decision-making process should be more inclusive. The objective of this inclusiveness is to garner societal support for the implementation of a measure, especially from those that are most vulnerable to climate change. Lidskog (2010) claims that an adaptation strategy must not only be relevant, but also legitimate in the view of those that are impacted by them (p. 37). Another condition which influences legitimacy is the extent of scientific and policy uncertainty surrounding the climate change problem. Pahl-Wostl (2009) states that the increasing role of non-state actors in policy

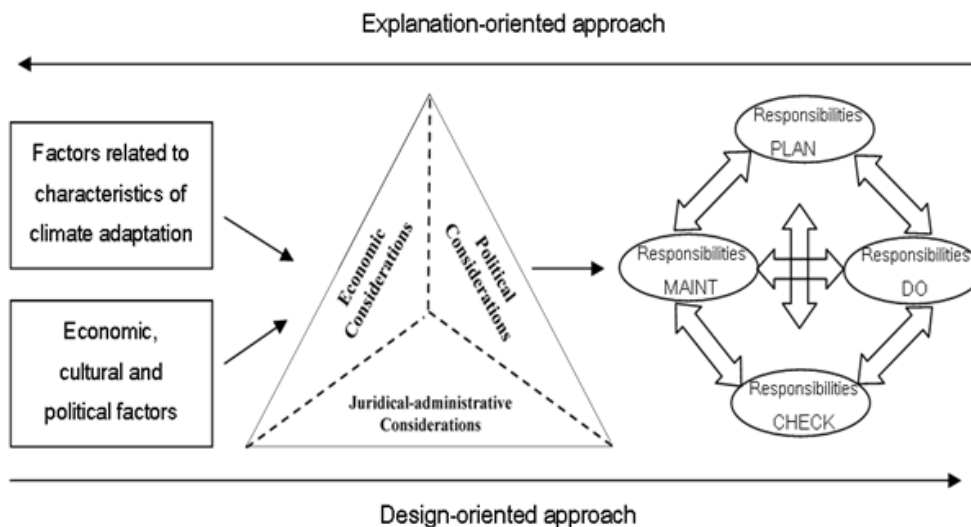
development and implementation “reflects the need for new modes of governance and knowledge generation to deal with increasing uncertainty and complexity” (p. 357). As it will become apparent in the upcoming chapters, this uncertainty has prompted governmental authorities to consult and seek assistance from private actors because of their strong knowledge base on certain issues.

Accountability is another consideration that comprises the political perspective. It relates to transparency with respect to the decision-making process and to the clear demarcation of responsibilities. A condition which prompts this consideration is the extent of vagueness of responsibilities. A lack of clarity with respect to who is responsible for what task is not conducive to the implementation of an adaptation measure because nobody is held accountable for inaction. In the absence of such clarity, it is necessary for a (neutral/independent) public actor to designate responsibility and accountability to ensure that private and public actors alike are engaged and committed to the adaptation process. In *Institutional challenges to climate risk management in cities*, Fünfgeld (2010) claims that transparency and clearness in roles and responsibilities among governmental, civil, and private actors is necessary to bring about local adaptation action (p. 158). Overall, legitimacy and accountability are important considerations that can affect the extent of implementation.

Theoretical Framework

The theoretical framework below provides additional insight into how the considerations relate to the responsibilities of public and private actors in the policy cycle and how external factors can also influence these considerations, and hence the entire governance arrangement. This study takes the explanation-oriented approach because the framework will enable me to evaluate existing governance arrangements and to see to what extent the allocation of responsibility is influenced by certain considerations; and in turn, how these considerations are influenced by specific conditions.

Figure I.2: Theoretical Framework



For an in-depth discussion on the framework of considerations and the theoretical framework please refer to:

H.L.P. Mees, P.P.J. Driessen & H.A.C. Runhaar (under review). Exploring the scope of public and private responsibilities for climate adaptation.¹

4. Research Questions and Sub-questions

Central Research Question:

- (1) Which roles and responsibilities have been fulfilled, and can be fulfilled by public and private parties in the governance of green roof implementation, and what are the advantages and disadvantages of this involvement in stimulating the implementation of green roofs?

Sub-questions:

- (1) What type of public-private governance arrangements and instruments (regulatory, economic, communicative) are currently present in Chicago, London, and Stuttgart for spearheading green roof implementation, and what similarities and differences can be seen among the different cities?
- (2) Based on the Theoretical framework for public-private considerations in governance arrangements for adaptation, what considerations are taken into account when allocating responsibilities across the public and private sectors for the implementation of green roofs?
- (3) What opportunities and/or barriers are impacting private actor involvement in the green roof governance process, and what can be done to best encourage their participation?
- (4) What advantages and disadvantages does each city's specific governance configuration present for the advancement of green roof implementation?
- (5) What lessons can be learned from a cross-city comparison and what recommendations can be made to accelerate and improve green roof implementation in these cities?

5. Research Strategy, Materials, and Framework

5.1 Research Strategy

The research strategy employed in this thesis is the case study method. Conducting a case study for this topic is appropriate because it enables an in-depth qualitative assessment of the governance structures and the role of private and public actors in the implementation of green roofs. Gerring (2004) states that “[c]ase studies enjoy a natural advantage in research of an exploratory nature...one of the primary virtues of the case study method is the *depth* of analysis that it offers” (p. 349; p. 348). Hence, the advantage of conducting a case study is that it offers the opportunity to study a subject intensively;

¹ This paper is currently under review and therefore not publicly available yet.

such an analysis can bring forth information and knowledge that would otherwise have not been captured by an alternative approach. The trade-off associated with such a thorough examination is the limited generalizability of the results because of the small sample size and the qualitative nature of the study. Notwithstanding this concern, a comparative case study approach is suitable for this research because of its scope and the potential applicability of the recommendations and knowledge generated across the different cities.

The first phase of this research commenced with an examination of important policy, legal, and regulatory documents pertaining to the cities, as well as an extensive literature review on climate adaptation strategies, planning, and green roof policies. A total of 76 documents were reviewed and this allowed me to obtain a sound overview of the current policy framework in the cities; who the relevant stakeholders are; and what types of instruments are being used, among other things. Locating policy documents and other related literature for Stuttgart was challenging because of the language barrier. For this reason, the interviews conducted in Stuttgart were crucial in helping me to gain a thorough understanding of the policy landscape over there. **Appendix 2** provides a listing of the documents studied for this research. As Heleen Mees developed the analytical framework, I focused on reviewing the relevant theoretical literature.

Following this desk research, the second phase involved conducting interviews with relevant stakeholders in each of the cities. Key actors were identified during the literature review and include: urban planners; green roof consultants; engineers; landscape architects; and other stakeholders involved in the governance process. In addition to the literature review, the identification of key contacts was also made possible via the snowballing technique. Stakeholders in each of the cities referred me to other persons of interest who they believed could contribute to my research. A total of twenty-seven semi-structured (in-person) interviews were conducted, while an additional three interviews were completed over the phone. A questionnaire was developed to guide the interviews and consisted of questions pertaining to all three perspectives; it can be found in **Appendix 1**. The interviews ranged between one and two hours in length and were recorded and transcribed. The interviews in Stuttgart presented an additional challenge because of the language barrier. Several of the interviews were conducted in German (with simultaneous translation in English) with the generous assistance of Wolfgang Ansel. The information and insights gathered during these interviews were invaluable in helping to fill in the research gaps encountered during the literature review phase.

As an additional quality control check, the case study chapters were sent to a total of nineteen respondents in order to verify the factual content and to ensure that the information they presented to me was captured in an accurate light. Feedback and comments were received from eleven interviewees, and they were very helpful and clarifying. The objective of this added measure was to further reinforce the validity of this research.

5.11 Selection of Cities

The selection of Chicago, London, and Stuttgart for this case study was based on several criteria. First, they were chosen because they are all Western democratic societies. The political, economic, and social background of the cities should be comparable, which is why only Western democratic cities were considered. Second, the cities have the authority to develop green roof policy and are active leaders in the field of green roof implementation. This is evident by the number and variety of strategies that they have in place to encourage the adoption of green roofs (i.e. laws, financial incentives), as well as the actual number (or percentage) of green roofs in the cities. Lastly, the cities employ an array of instruments (regulatory, economic, communicative) to encourage the development of green roofs. The

variety in the duration and breadth of these instruments is useful for comparative purposes and allows us to see the advantages and disadvantages of the different mechanisms employed.

5.2 Research Materials

The following material was used for this research:

- City-specific documents: policy statements, plans, and notes; regulatory and legal documents.
- General literature: books, academic journal articles, and newspaper articles.
- Electronic sources: relevant national, ministerial, and organization websites.
- People: governmental officials/representatives; experts from consultancies, green roof supply firms, and other private sector institutions; and stakeholders from other relevant disciplines.

5.3 Research Framework

Figure I.3: Research Framework

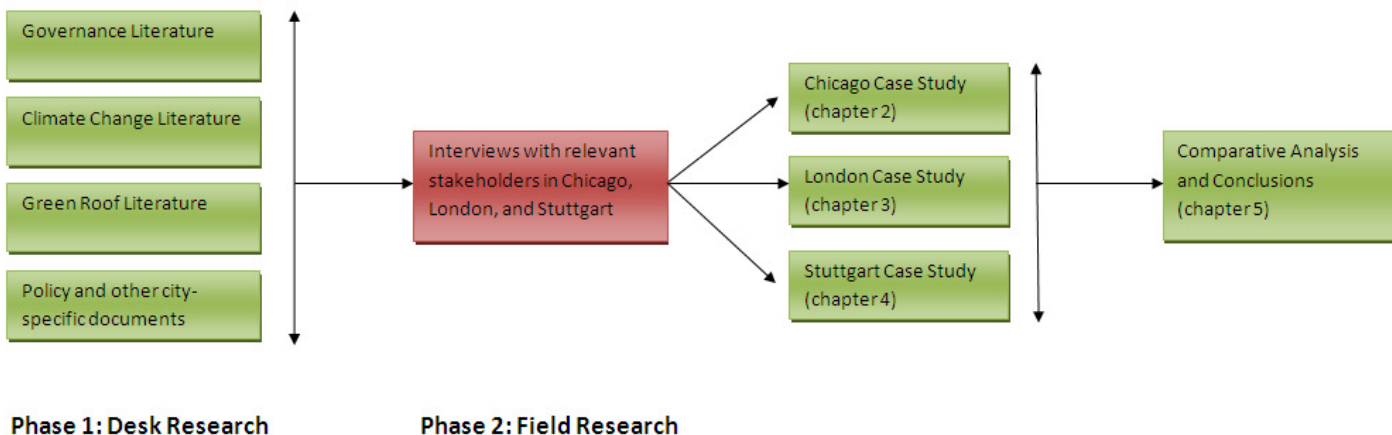


Figure I.3 depicted above illustrates the different phases of my research and the organization of my thesis. Phase 1 commenced with a literature review in the following subject areas: governance, climate adaptation, and green roofs. This was supplemented with a review of city-specific reports, plans, and policy documents in order to gain a better understanding of each city's circumstance (i.e. policy, legal). The information obtained in the literature review phase also aided in the creation of the questionnaire that was used during the interviews. Phase 1 was followed by Phase 2, or the field research stage. All three cities were visited and interviews took place from January 2011 until September 2011. The information gathered during the interviews and literature review was used to build my empirical case study chapters for Chicago, London, and Stuttgart (Chapters 2, 3, and 4, respectively).

The case study chapters are organized in a manner so as to facilitate a comparative analysis (which is presented in Chapter 5). The core of each chapter is the section on the *Analysis of*

Perspectives. Each perspective and its corresponding considerations are discussed in detail. Additionally, each aspect of the governance arrangements (i.e. policy instruments, steering strategies, allocation of responsibility) is explored. This is followed by a discussion on possible contextual factors that are influencing the considerations. The organization of each case study chapter corresponds with the analytical framework, and this allows me to more easily distill the similarities and differences between the cities. As already mentioned above, this facilitates the comparative analysis in the final chapter.

The objective of the final chapter is to synthesize the information presented in the preceding chapters and to enable an evaluation and comparison of the governance arrangements. This chapter also addresses each of the sub-questions and central research question stated in the introductory chapter. Chapter 5 also contains concluding remarks and recommendations; it is hoped that both private and public stakeholders will find them of practical use and of relevance to their work.

References

- Aakre, S. and Rübhelke, D. T.G., 2010, 'Objectives of public economic policy and the adaptation to climate change', *Journal of Environmental Planning and Management*, vol. 53, no. 6, pp. 767-791.
- Arts, B., van Tatenhove, J. and Leroy, P., 2006, 'Political Modernisation and Policy Arrangements: A Framework for Understanding Environmental Policy Change', *Public Organiz Rev*, vol. 6, pp. 93-106.
- Carter, Timothy and Laurie Fowler, 2008, 'Establishing Green Roof Infrastructure Through Environmental Policy Instruments', *Environmental Management*, vol. 42, pp. 151-164.
- Crabbé, A. and Leroy, P. (2008). *The Handbook of Environmental Policy Evaluation*. Earthscan, London, United Kingdom.
- Dietz, T. and P.C. Stern (2008) "Justifications for and Problems of Public Participation", in: T. Dietz and P.C. Stern, *Public Participation in Environmental Assessment and Decision Making*, The National Academies Press, pp. 46-66.
- Falkner, Robert, 2003, 'Private Environmental Governance and International Relations: Exploring the Links', *Global Environmental Politics*, vol. 3, no. 2, pp. 72-87.
- Fünfgeld, H, 2010, 'Institutional challenges to climate risk management in cities', *Current Opinion in Environmental Sustainability*, vol. 2, pp. 156-160.
- Gerring, John, 2004, 'What is a Case Study and What Is It Good for?', *American Political Science Review*, vol. 98, no. 2, pp. 341-354.
- Getter, K. and D. Rowe, 2006, 'The Role of Extensive Green Roofs in Sustainable Development', *HortScience*, vol. 41, no. 5, pp. 1276-1285.
- Glasbergen, P., 1992, 'Seven steps towards an instrumentation theory for environmental policy,' *Policy And Politics*, vol. 20, no. 3, pp. 191-200.
- Gode, D. and S. Sunder, 1997, 'What Makes Markets Allocationally Efficient?', *The Quarterly Journal of Economics*, pp. 603-630.
- Hooghe, Liesbet and Gary Marks, 2003, 'Unraveling the Central State, but How? Types of Multi-level Governance', *American Political Science Review*, vol. 97, no. 2, pp. 233-243.
- ICLEI, n.d., Local government perspective on adapting water management to climate change, Retrieved October 29, 2010, from http://www.worldwatercouncil.org/fileadmin/wwc/Library/Publications_and_reports/Climate_Change/PersPap_07_Local_Government.pdf.

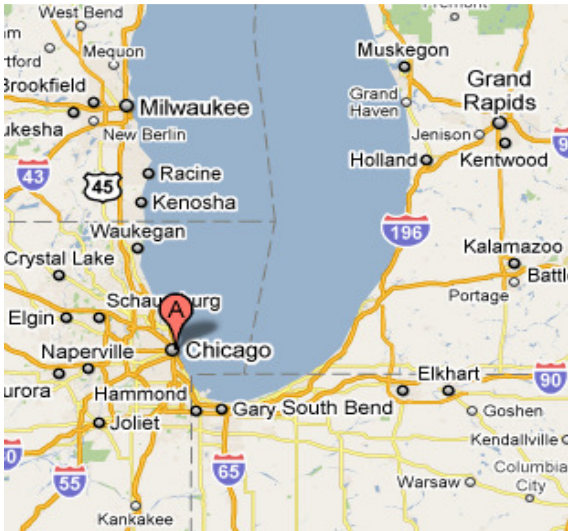
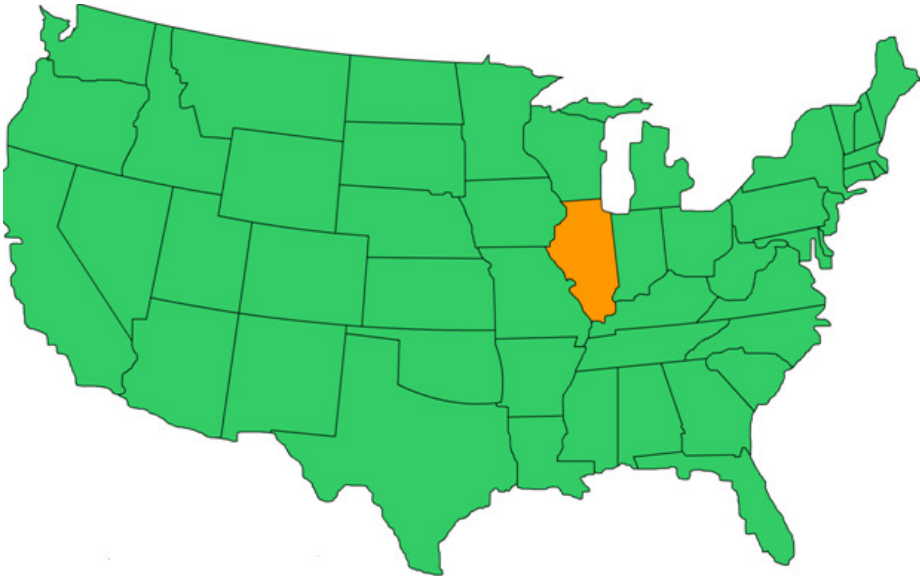
- IPCC, 2001, Climate Change 2001 Synthesis Report, Retrieved October 29, 2010, from <http://www.ipcc.ch/pdf/glossary/tar-ipcc-terms-en.pdf>.
- IPCC, 2001, Climate Change 2001 Synthesis Report: Summary for Policymakers, Retrieved October 29, 2010, from <http://www.ipcc.ch/pdf/climate-changes-2001/synthesis-spm/synthesis-spm-en.pdf>.
- IPCC, 2007, Climate Change 2007 Synthesis Report: Summary for Policymakers, Retrieved October 29, 2010, from http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr_spm.pdf.
- Lawlor, Gail et al., 2006, Green Roofs: A Resource Manual for Municipal Policy Makers, Retrieved October 10, 2010, from http://commons.bcit.ca/greenroof/publications/resource_manual.pdf.
- Lidskog, Rolf and Ingemar Elander, 2010, 'Addressing Climate Change Democratically. Multi-Level Governance, Transnational Networks and Governmental Structures', *Sustainable Development*, vol. 18, pp. 32-41.
- Mees, Heleen, 2010, 'Climate Greening London, Rotterdam and Toronto: A comparative analysis of the governance capacity of adaptation to climate change in urban areas', Master Thesis, Universiteit Utrecht, Retrieved October 5, 2010, from <http://igitur-archive.library.uu.nl/student-theses/2010-0507-200245/UUindex.html>.
- Mendelsohn, Robert, 2006, 'The Role of Markets and Governments in Helping Society Adapt to a Changing Climate', *Climate Change*, vol. 78, pp. 203-215.
- Nelissen N., 2002, 'The Administrative Capacity of New Types of Governance', *Public Organization Review: A Global Journal*, vol. 2, pp. 5-22.
- Paavola, Jouni and W. Neil Adger (2002). *Justice and adaptation to climate change*. Tyndall Centre Working Paper No. 23.
- Pahl-Wostl, C., 2009, 'A conceptual framework for analysing adaptive capacity and multi-level learning processes in resource governance regimes', *Global Environmental Change*, vol. 19, pp. 354-365.
- Pew Center on Global Climate Change, 2009, *Climate Change 101: Understanding and Responding to Global Climate Change*, Retrieved October 29, 2010, from <http://www.pewclimate.org/docUploads/Climate101-Adaptation-Jan09.pdf>.
- Smith, G. (2003) "Deliberative democracy and green political theory", in: G. Smith: *Deliberative democracy and the environment*, Routledge, pp. 53-76.
- Stern, N. (2007). *The Economics of Climate Change. The Stern Review*. Cambridge University Press.

UK Climate Impacts Programme, Retrieved October 29, 2010, from
<http://www.ukcip.org.uk/index.php?option=com_content&task=view&id=237>.

US Environmental Protection Agency, Heat Island Effect, Retrieved October 10, 2010, from
<<http://www.epa.gov/heatisd/>>.

Chapter II

Green Roofs Chicago



1. Chicago: Introduction

The City of Chicago is one of the most influential cities in the Midwestern United States. It is the largest city in the state of Illinois and has a population of approximately three million people (CityData website). Chicago lies on Lake Michigan and its geographical location has played a very significant role in shaping the city's industry. Its emergence as an important transportation hub began in the mid-1800's with the rise of the railway industry and the city continues to maintain that status to this day. Chicago's primary commercial activities include manufacturing, food processing, and the transportation and distribution of goods. Its position as a major rail, highway, and air hub has contributed to the growth of the city's vibrant economy and as a result it is one of the most important business and financial centers both in the United States and internationally (CityData website).

During the past twenty years, Chicago has been working hard to distinguish itself from other cities on another level—it aims to become the “greenest city in America.” Former Mayor Richard Daley,² elected in 1989, was instrumental in pushing the environmental agenda in Chicago. Mayor Daley was the chief executive of the City Council, which is the legislative branch of the City of Chicago. The council is composed of fifty alderman which represent each of the city's wards. The City Council, along with the mayor, have the authority to pass by-laws and ordinances. It was through Mayor Daley's leadership that a mandatory green roof policy and various greening initiatives were implemented across the city. Because of his efforts, Chicago has become a leader of green roofs in the United States. There are currently 700 green roofs in Chicago with an estimated area coverage of 7.5 million square feet, or 700,000 square meters.³ The impetus for the adoption of green roofs in Chicago stems from the urban flooding issues that the city has experienced and continues to face. These flooding events can be partly attributed to the changes that the earth's climate is undergoing, which is why Chicago has taken important steps to address climate change. The Chicago Climate Action Plan (CAP), published in 2008, provides a detailed and comprehensive blueprint for lowering greenhouse gas emissions in order to reduce the city's carbon footprint. The goal of the CAP is to reduce greenhouse gas emissions by 25% by 2020 and 80% by 2050, using 1990 levels as the baseline (CAP, 2008). The following sections provide an overview of the climate change effects Chicago is expected to experience along with a discussion on the Chicago CAP and green roofs.

2. Climate Change Adaptation and Green Roofs

2.1 Climate Change Impacts

Urban areas and cities are highly vulnerable to the impacts of climate change. The warming of the earth's temperature is expected to worsen environmental conditions in already overburdened urban environments. Increasing precipitation rates and rising sea levels are expected to cause a higher frequency of flooding, coastal erosion, and flash floods. Flooding and storm surges present significant risks to coastal cities such as Chicago, New York, and London; these cities are projected to experience a wetter climate in the coming years (ICLEI, n.d.). According to a study by Vavrus and Van Dorn (2010), by

² Richard Daley held the office of Mayor until May 2011. Chicago's new mayor is Rahm Emanuel; he has neither repealed green roof policy nor has he pushed it forward either.

³ The number of green roofs mentioned is not limited to completed projects only, but also reflects green roof projects that are in the design and implementation stage.

the end of this century Chicago's precipitation amounts are expected to increase by 20%. A projected rise in precipitation rates will further aggravate surface flooding in Chicago, and sewage overflows are a consequence of heavy rain events. The type of collection system that is currently in place in Chicago is known as a combined sewer system, in which waste from both residential and commercial areas is combined with stormwater runoff (City of Chicago website). During intense storms the sewer system is unable to cope with the increased volume, thus resulting in overflows. Untreated sewage is discharged into the Chicago River and Lake Michigan (Chicago's source of drinking water, among other things), in order to relieve the pressure placed on the system. The City of Chicago commissioned the Tunnel and Reservoir Plan (TARP) in the 1970s to help mitigate the impacts of urban flooding. Instead of dumping untreated sewage into natural bodies, TARP will permit the diversion of excess sewage water into reservoirs. Construction of TARP is still undergoing and it is expected to be completed by 2019 (MWRD website). Despite the scale of the project, it has been acknowledged that TARP is not a panacea for Chicago's flooding issues and overflows will still occur.

In addition to water-related issues, heat-related events are also expected to increase because of climate change. The negative effects of prolonged high temperatures will be felt more in cities as opposed to rural areas because of the urban heat island effect (UHI). According to Vavrus and Van Dorn's (2010) findings, "future heat waves in Chicago are projected to become more frequent, intense, and long-lived, while the time of year during which they occur should expand" (p. 27). Chicago has already felt the impacts of such excessive heat weather events. In 1995 approximately 525 people died in Chicago over a period of five days because of the heat wave that struck the city (Illinois State Water Survey website). Temperatures during that time period peaked to 106 °F, and conditions were aggravated by the high humidity levels. Overall, the projected changes in Chicago's average mean temperature and precipitation rates are expected to have negative repercussions for the city on various dimensions—economically, environmentally, and socially. For these reasons, stormwater management and urban heat island reduction are important climate change adaptation issues for the City of Chicago.

2.2 Chicago Climate Action Plan

Chicago's Climate Action Plan represents the city's commitment to reducing greenhouse gas emissions and outlines steps that the public, private, and civil sectors can take to help accomplish this. Concerned by the potential effects of climate change on the city, former Mayor Daley requested the Chicago Department of Environment (DOE) to launch a Climate Change Initiative in order to formulate a plan. The Climate Change Task Force was created in 2007 to help steer this process and consists of stakeholders from the business, civil, and government sectors (CAP, 2008). What makes the Chicago CAP unique compared to plans by other cities is that it addresses both mitigation *and* adaptation. Adaptation has been traditionally absent in climate change plans, and efforts have primarily focused on mitigation. Wheeler's (2008) analysis of 35 city plans in the United States supports this view; he found that only five cities mentioned the issue of adaptation in their documents. The inclusion of adaptation in the Chicago CAP is noteworthy because it illustrates that mitigation alone will not suffice to help alleviate the impacts of climate change, and therefore adaptation efforts are also key in helping to tackle it. The following five key strategies are presented in the CAP for mitigating greenhouse gas emissions and preparing for climate change: energy and efficient buildings; clean and renewable energy sources; improved transportation options; reduced waste and industrial pollution; and adaptation (CAP, 2008).

Strategies 1 and 5 in the CAP are particularly interesting because they specifically discuss green roofs as both a mitigation and adaptation measure. For example, green roofs are considered a mitigation strategy (Strategy 1) because they can help improve buildings' energy efficiency, resulting in

lower carbon emissions and energy costs (CAP, 2008). Conversely, green roofs are an important adaptation strategy (Strategy 5) because they can help the city with stormwater management and heat reduction. The goal of the CAP is to have 6,000 green roofs installed in Chicago by 2020, which represents an estimated 2.4% of the buildings that are structurally suitable for a green roof. Currently, green roofs cover less than one-tenth of one percent of eligible buildings in Chicago (GreenSource website).

2.3 Green Roofs

The inspiration for green roofs as an adaptation measure came from former Mayor Daley. He became interested in them following a trip he took to Europe and was determined to set the example by having one installed on Chicago's City Hall in 2001. The green roof on top of City Hall is approximately 20,000 square feet and serves as an important demonstration project for raising awareness among Chicagoans about the benefits of green roofs (City of Chicago website). For instance, data collected on top of City Hall and the adjacent Cook County building⁴ supports the fact that green roofs are instrumental in helping to reduce surface rooftop temperatures, thus cooling the surrounding microclimate. Studies show that the air temperature surrounding City Hall's portion of the roof was measured to be as much as 80 degrees cooler compared to that of Cook County's roof portion (ASLA website). The table below highlights various statistics pertaining to Chicago's green roofs for 2010.

Table II.1: Chicago Green Roof Statistics

CHICAGO GREEN ROOF STATISTICS	
Impetus	Urban heat island reduction, stormwater management
Square meters of installed green roofs*	700,000
Per Capita	0.2333
Percentage of green roof area coverage	Less than 1%
Roof type breakdown	Dominance of extensive green roofs
Percentage of Extensive	80%
Percentage of Intensive and Other (Semi-extensive, Semi-intensive)	20%
Green roof sales figures (2010)	€6.7 million
<i>*This figure represents installed and planned green roofs The above estimated figures are as of 2010 and were provided by industry experts.</i>	

⁴ The black asphalt roof on top of the Cook County building was recently coated in white.

The City of Chicago has utilized the promotion of green roofs as an avenue to highlight climate change issues, and as a result of its efforts green roofs and other adaptation measures have manifested themselves in various departmental plans across the board. The former mayor's mantra of "lead by example" is clearly visible in this instance. In order to attract public interest in green roofs it was necessary for the city to take the first step, and Mayor Daley's City Hall project was successful in creating a buzz in Chicago and in other cities around the United States interested in implementing green roofs and other urban greening measures. Mayor Daley in this instance could be considered a policy entrepreneur, or someone who champions an issue or agenda. The presence of policy entrepreneurs is important to recognize because they can help explain the emergence of urban climate governance (Bulkeley, 2010). Urban climate governance "refers to the ways in which public, private, and civil society actors and institutions articulate climate goals, exercise influence and authority, and manage urban climate planning and implementation processes" (Anguelovski & Carmin, 2011, p. 1). The governance of the green roof implementation process in Chicago is just one aspect of urban climate governance. It is imperative to understand the key players involved, their motivations for becoming involved, and how responsibilities are allocated among the respective actors. Governance configurations and the dynamic interplay between the different stakeholders will shape the direction of the green roof movement and whether or not Chicago will achieve its goal of having 6,000 green roofs by 2020. By understanding the nuances and underlying considerations and motivations of the actors, one can effect change so as to improve the arrangements in order to achieve the desired goal. The subsequent section presents an analysis of the two dominant perspectives that have prevailed in Chicago: the Economic Perspective and the Juridical-Administrative Perspective. It is followed by a discussion on the Political Perspective, which is currently marginalized in Chicago.

3. Analysis of Perspectives

3.1 Economic Perspective

The present dominance of the economic perspective in Chicago is discernible. The economic perspective is based on the considerations of efficiency and securing adaptation action. The green roof industry, which is a small and tight-knit community in Chicago, is at present being primarily driven by the activities of the private sector. The tasks and responsibilities of the private sector include: the design of green roofs; installation and maintenance of green roofs; and consultation on green roof projects. In relation to the four phases in the policy cycle, these responsibilities fall under the policy implementation or "DO" phase, and the policy maintenance or "MAINT" phase.

The increasing prominence of private sector involvement coincided with the stepping-back of government involvement which began during the 2007-2008 period. This occurred around the same time that the global financial crisis struck in 2008. The negative repercussions of the financial crisis were felt (and continue to be felt) at every level of society, and city governments are no exception. The City of Chicago currently has a budget deficit of nearly \$650 million,⁵ and as a result has had to make significant budget cuts. Departments across the city have been downsized, and grant programs such as the one dedicated to green roofs have not been replenished. The impact of the financial crisis is a topic of discussion among many scholars, and there is valid concern that this event will result (or already has resulted) in the marginalization of climate and environmentally-related issues. Zimmerman and Faris

⁵ This was the status of the budget at the time of my interviews in January 2011.

(2011) touch upon this point and state that “it remains to be seen if the 2008-2009 global financial crisis will have a longer term impact on public will and commitment to adaptation and mitigation” (p. 2). Based on the interviews that I conducted in Chicago, I can confidently say that it does in fact appear that the environmental agenda (with respect to green roofs) is not in the fore of the city government’s agenda, as compared to earlier in this decade. The lack of green roof financing available, the absence of new, more stringent developments on the policy front, and the absence of active governmental steering/promotion of green roof events suggests that Chicago is at a new phase in its green roof cycle where the government no longer takes the lead. This inertia is also acknowledged by a city environmental engineer. When questioned about this stage of inertia, the respondent recognizes that the city has reached a plateau with respect to green roof implementation. However, the interviewee mentions that at this phase it is important for the city to reflect on the programs that it has employed and to figure out what else it can do to help revitalize interest in green roofs (Environmental Engineer Interview, 2011). The considerations of efficiency and securing adaptation action are explored in detail below in order to highlight the reasoning behind the current dominance of the private sector in the green roof arena in Chicago

Consideration 1: Efficiency

One of the hallmarks of the private sector is its continual drive to improve efficiency, or to produce goods and services ‘cheaper, faster, and better.’ The green roof industry in the United States is still in its infancy compared to its European counterpart. Hence, it is not surprising that the costs of installing a green roof are much cheaper in Europe than it is in the United States. In terms of material costs only, the cost of installing a green roof in Germany may be as low as \$1.50 per square foot, compared to \$4.50 per square foot in the United States. The efficiencies that the European industry has achieved in terms of production, installation, and distribution have come with time and the involvement of a variety of stakeholders in the green roof arena. Although the American green roof industry is only about ten years old and still has a steep learning curve to climb, significant accomplishments have been made over the past decade and this is reflected in the decreasing costs of green roofs. Lower costs are a function of economies of scale and improved efficiency, and there are many ways in which green roof businesses are trying to achieve this in Chicago. The formation of partnerships between green roof specialists and professionals from other disciplines is one example of how greater efficiencies are being achieved in the Chicago area.

Partnerships are an important vehicle for bringing together a diverse range of actors. Collaboration between different actors is significant because it is through this type of engagement that creative ideas and solutions are produced. The green roof industry is no exception, and the creation of partnerships has undoubtedly been fruitful on a number of fronts. A prime example of this is Kurt Horvath’s partnership with professionals from various backgrounds, which he has labeled the Dream Green Team. Horvath is the president of Intrinsic Landscaping⁶ and states that “the idea behind the Dream Green Team is really to bring all of the disciplines and all of the people together, to offer a single source for a project...” (Horvath Interview, 2011). One of the major problems that Horvath has witnessed in the field is a lack of integration between the disciplines, from the architecture side to landscape architecture. This ‘compartmentalization’ is detrimental because a lack of communication between the different disciplines can (and has) resulted in installation problems and even catastrophic structural failure. Therefore, cooperation among engineers, landscape architects, membrane

⁶ Intrinsic Landscaping is a green roof specialty company based in Glenview, Illinois.

manufacturers, and others from the very beginning can help avoid issues that may surface later on during a project. Another advantage of the Dream Green partnership is that it offers clients a one-stop shop for all of the services they need, and focuses “on what the owner expectations are” (Horvath Interview, 2011). Consequently, this creates a smoother and more efficient process for the client because all of their needs can be addressed by a single source.

The transportation of green roofs is another area that has benefitted from partnerships. A considerable cost of a green roof is transport cost. This not only encompasses the cost of shipping the green roof to its destination, but also includes the time and cost of actually having to hoist the green roof on top of a building. When looking at a skyscraper with a green roof, the first thing that comes to mind is ‘how did they get that up there?’ In the case of tall buildings, it may be necessary to use a crane or even a helicopter to place the garden on top of the roof. However, two important advances have been made in this area that can help keep costs down. The development of the modular green roof is an important advancement because unlike a traditional green roof, it consists of self-contained portable trays that can be placed directly on a rooftop. Hence, one of their biggest advantages is that they are much easier to transport and move around. An additional benefit is that customers are able to purchase the green roof in segments. So if a client can only afford a certain amount at a point in time, they still have the option of expanding their garden and adding additional units in the future. The partnership between Weston Solutions, a green roof service provider, and ABC Supply, a distributor of roofing materials and supplies, allowed the GreenGrid roof system to enter the mainstream market. This partnership began during the 2001 to 2002 period when ABC Supply approached Weston Solutions with the product and expressed interest in bringing it to the mass market. Weston liked the product and a partnership was created in which Weston has exclusive rights to the GreenGrid roof modules. The collaboration between the two companies has enabled them to produce a product that is competitive in terms of price compared to other green roof systems currently on the market. Although prices vary depending on the size and the types of plants used, in terms of installed costs an extensive green roof may run from \$8 to \$20 per square foot, compared to \$11 to \$17 per square foot for a modular green roof. The costs of an intensive green roof are more expensive, so the modular system opens up the market to clientele that cannot afford the more expensive options.

The second interesting development with respect to transport relates to the type of carrier used to bring the vegetation to the rooftop gardens. As already mentioned above, in the GreenGrid system modules are separated into self-contained trays which are made out of plastic and then placed onto a roof. However, for projects that involve the typical intensive or extensive green roof, transporting vegetation onto a roof still presents a challenge. Horvath, in partnership with Paul Kephart of the ecological design firm Rana Creek, have developed and refined the design of an organic BioTray that can transport vegetation. This type of vegetation carrier is more efficient than a traditional plastic carrier because it can be placed directly onto a garden and then left to biodegrade. Although Horvath cautions that the BioTray is not suitable for every project, he asserts that “it has its place, and I think it really should be specifically for [a] native type of project where it biodegrades and so on...” (Horvath Interview, 2011). Rights to the BioTray have been purchased by Tremco, a market leader in the roofing industry. The addition of a powerful market player such as Tremco will play a strong role in the marketability of the BioTray. It can be anticipated that through their extensive networks and production processes additional efficiencies can be achieved with the BioTray, thus helping to further reduce green roof costs.

Improvements in efficiency within the green roof sector can also be realized via the integration of green roof systems with other types of public or private investments. One area which presents a valuable opportunity for this to take place is the integration of green roofs with a building’s energy

system. One of the added benefits of green roofs is that they help reduce heating and cooling costs because of the insulation they provide. This concept can be taken a step further by means of actually linking green roof systems with a building's mechanical/energy system in order to realize energy efficiency gains. This idea was presented by Horvath and it is a project that he is currently working on. The goal of his project is to harvest the cool air surrounding the green roof (which occurs because of evapotranspiration) and transfer it inside a building where it can be used for cooling purposes. The project is in the testing phase and "it's all about return on investment for lower electricity use from mechanical systems" (Horvath Interview, 2011). In a similar vein, another possibility for improved energy usage stems from the ability to harvest stormwater or condensate water from air conditioning units so that it can be used for irrigation purposes, including the irrigation of green roofs. This can reduce green roof maintenance costs because the system can be watered through these sources instead of using potable water. There are strict requirements in Chicago which govern the standard of quality and use of water. The use of stormwater is prohibited for irrigation purposes. Proposed changes in Illinois state law to ease this restriction and to permit rainwater harvesting (via Senate Bill 2549) have been rejected (Metropolitan Planning Council website). According to one respondent, the easing of such restrictions will encourage innovation in the private sector and the development of more integrated-type systems. Urwin and Jordan (2007) reinforce this sentiment and claim that "it is becoming more obvious that new policies in climate and *non*climate sectors will need to be designed in ways which facilitate rather than hinder adaptive decisions..." (emphasis placed by original authors, p. 181). Hence, government plays an important role in encouraging private sector involvement by ensuring that laws and regulations do not present a barrier that prohibit the execution of new ideas.

Innovation is another important driver in the green roof industry. According to figures provided by Green Roof for Healthy Cities (GRHC), the green roof industry grew by nearly 29% in 2010, compared to a 16% growth rate in 2009 (GRHC website). Although figures are not specifically available for the City of Chicago, Chicago is unquestionably the industry leader in the United States in terms of square footage installed. The two main conditions that activate the consideration of efficiency include the no-regret nature of green roofs and the need for creative solutions to deal with climate change. As already mentioned, green roofs have many benefits: lower energy costs; stormwater management; and noise reduction, to name a few. These benefits are an added bonus provided by the roofs, and because of this further innovation within the green roof industry is encouraged. Additionally, creativity and the generation of "crazy ideas" drive innovation, and the private sector is well positioned to invest its time and resources into developing solutions that will help their bottom line. Innovation is key for the continued growth of the industry because it is through the innovation process that new products and services are developed to satisfy the evolving demands of customers. A significant innovation that we are witnessing in the green roof sector in Chicago is the creation of food-producing green roofs.⁷ The reason why this development is so noteworthy is because it is reinvigorating interest in green roofs not only on the public side, but on the private side as well. Food-producing green roofs are not only a unique way to farm in the city, but are remarkable in the sense that they have the power to change people's perception of green roofs. One of the primary barriers to installing a green roof is their up-front cost. When deciding on whether or not to purchase a green roof, many people focus on the short-term, up-front costs instead of looking at the long-term, intangible benefits provided by the roofs. However, food-producing green roofs can break through this barrier because of their revenue-generating potential. This change in perception- from viewing green roofs as an economic liability to an

⁷ While food-producing green roofs are becoming increasingly popular throughout the United States, it should be noted that Chicago is not at the forefront compared to other cities such as New York.

economic asset- is critical if the green roof industry wishes to sustain the growth it is experiencing. While some European countries such as Germany have strict laws mandating the use of green roofs, such tight regulation is absent in Chicago. This may partly explain why there is a lack of interest in food-producing green roofs in Germany as opposed to the United States (Meyer Interview, 2011). In the absence of sweeping, mandatory regulation, it is necessary to have an alternative incentive that will appeal to the American consumer. Molly Meyer, a green roof consultant and owner of Rooftop Green Works, is an ardent supporter of the urban rooftop farm (coined by Michael Repkin)⁸ and states that food production:

“helps justify the economics of green roofs...green roofs won’t be successful unless they are implemented on a broad scale. And, they can’t be implemented on a broad scale unless they make financial sense” (Meyer Interview, 2011).

So while a traditional green roof offers tangible benefits such as a reduction in energy costs, this represents a savings in cost, not revenue generation.

Another important economic benefit of a *productive* green roof is job creation. Demand for professionals that specialize in planting, maintaining, and harvesting these rooftop gardens will undoubtedly be required, and as a result a new niche industry can be created. The potential to generate employment opportunities, especially in the current economic climate, is definitely a positive attribute of these types of roofs. However, the most ingenious aspect of the urban rooftop farm is its actual design, which will serve to open up the green roof market in Chicago. Besides the costs of a green roof, another deterrent to installation is the structural limitation of many buildings in Chicago’s current housing stock. A majority of the buildings are unable to support the additional weight that is required for a roof farm, which may range from 80 to 100 pounds per square foot. While many buildings may be able to hold an additional load of 20 pounds per square foot, the weight of a traditional roof farm would require extensive retrofits and costs in order to fortify the building. The project that Meyer and Repkin are working on will produce a rooftop farm that has a load of 12.5 pounds per square foot. So not only can this type of rooftop generate income, but it opens up the green roof market for buildings that otherwise would not have been structurally capable of holding a greater load.

The concept of urban agriculture and rooftop farming is not limited to vegetable/fruit-producing green roofs. Although biodiversity preservation is not the primary driver for green roofs in Chicago (as is the case for London), green roofs have become a haven for many types of insects and invertebrate, including bees. Many people are starting to recognize the economic value of biodiversity preservation and are taking steps to reap monetary benefits. For instance, the production and harvesting of honey on rooftop gardens currently takes place in Chicago. According to Aaron Durnbaugh, Deputy Commissioner of the Natural Resources and Water Quality Division of the DOE, there are bees located on top of Chicago’s City Hall as well in several other areas around the city. There are approximately nine bee hives on city-owned green roofs and a total of seventy-one bee hives located at public facilities.⁹ The primary reason for having the bees is for the production value of the honey. The DOE works with a private partner that is responsible for harvesting the honey twice a year. These hives produce an average of 3,550 pounds of honey per year, which generates estimated revenues of \$50,000. Not only

⁸ Michael Repkin is a biologist and founder of Repkin Biosystems. He is currently working on an urban rooftop farm demonstration project with Molly Meyer (expected completion date is June 2012).

⁹ The public facilities referred to here include parks and the Center for Green Technology.

does the honey production produce income for the city, but it also provides business for the private company that manages the beehives.

Consideration 2: Securing Adaptation Action

Financial Incentives

The City of Chicago has offered (and in some instances continues to offer) a range of financial and indirect financial incentives to encourage the adoption of green roofs. It has provided various financial incentives to encourage private individuals, developers, and businesses to install green roofs. A portion of the money that financed the different grant and funding schemes came from a 1999 legal settlement that the city won against its electric utility, Commonwealth Edison. The utility established a \$100 million fund that was managed by the Department of the Environment, and approximately \$2.5 million was set aside to finance the DOE's Urban Heat Island Initiative. The following economic incentives were available to fund green roof projects: the Green Roof Grant Program; the Green Roof Improvement Fund (GRIF); and the Small Business Improvement Fund (SBIF). The grant program was active between 2005 and 2007 and it awarded \$5,000 for residential and small-scale commercial projects. Criteria for the selection of projects included visibility, geographical location, and whether the benefits of the project were public or private. The GRIF TIF, which ran from 2006 to 2009, offered a 50% grant match for the cost of placing a green roof on an existing building located in the Central Loop TIF District. This program advocated the use of tax increment financing to fund installations. A total of \$500,000 was available in the TIF pool, with a maximum grant amount of \$100,000 per project. The SBIF is also a function of TIF financing, and it is one of two financial incentives that is still active today. Money can go toward funding projects such as green roofs, energy efficiency upgrades, and building façade rehabilitation.

In addition to the funding opportunities provided by the city, grants have also been offered by the state of Illinois to support green roof projects. The 2009 Illinois Green Roof Grant Program was funded by the American Recovery and Reinvestment Act of 2009. It was active for one year only with a maximum award of \$100,000 for a green roof project. In terms of square footage, the maximum incentive was \$10 per square foot (Illinois DCEO website). Another grant available via the state is the Illinois Green Infrastructure Grant Program for Stormwater Management. It is available on an annual basis and remains active. The grant funds a variety of projects that fall under the following categories: combined sewer overflow rehabilitation; stormwater retention and infiltration; and green infrastructure small projects. Green roofs are eligible for financing, and the amount awarded for a project varies per category (Illinois EPA website).

Effectiveness of Financial Incentives

There are a variety of factors that constrain the adoption of green roofs in Chicago. Several that have already been mentioned include: up-front costs; structural building issues due to the aging building stock (requires additional costs for retrofitting); limited regulatory drivers; outdated zoning/building codes; and the perception of the green roof as a liability rather than an asset. The majority of these issues relate to economics and whether or not green roofs "make sense" financially. As already discussed in the previous section, the city government of Chicago has offered financial incentives to help improve the attractiveness of green roofs. However, an important question that needs to be addressed

relates to the effectiveness of the grants as a primary driver for green roof adoption. This issue is discussed in detail below.

Financial incentives are a good tool for attracting people to commit to a project they otherwise would not have approached. Despite the availability of various funding schemes in the City of Chicago, it is important to give consideration to the effectiveness of the grants as a driver for green roof installations. Although it is difficult to assess the actual efficacy of the grants, the following can be indicative of their impact: the number of projects that received funding; whether or not the funding in the different programs was fully exhausted; and whether all of the programs were utilized. With respect to the GRIF TIF, the figures are disappointing and the program was under-utilized. Despite the DZP's efforts in advertising the availability of tax increment financing for retrofits in existing buildings, only one application was received. The Green Roof Grant Program attracted much more interest. Between 2005 and 2007 an estimated 80 projects were funded. Application requests were for the most part evenly represented by the residential and commercial sectors. However, because of the lengthy and complicated application process, economically distressed areas within the city were underrepresented in the application pool.

Differing views exist between government officials and individuals from the business sector regarding the effectiveness of the grants. City officials within the DZP and DOE have a positive view on the grant program and believe that it was useful in helping to promote the spread of green roofs. On the other hand, members of the private sector have expressed scepticism on the effectiveness of the grants as a key motivator for installations. One respondent makes a good point in stating that a \$5,000 grant is probably only enough money to fund a green roof the size of 500 square feet. This area of square footage is quite small, and the financial burden is therefore placed on individuals that want to install a larger green roof. Several respondents agree that such small grants do not make a dent in the financial costs. With respect to the grants offered via tax increment financing, Horvath states that "those were few and far between that were ever taken advantage of..." (Horvath Interview, 2011). Based on interviewee responses and the limited monetary amount of the grants (along with their availability for a short time period only), it appears that other policy instruments¹⁰ were influential in driving the spread of the technology.

Indirect Financial Incentives

In addition to the financial incentives provided by the city, there are two indirect financial incentives that are still active today. The first is the density bonus system, which applies to new public buildings, planned developments, and privately funded structures that are subsidized by the city. Developers are allowed to build more units per square footage if their buildings have a minimum vegetative coverage on the roof of 50% or 2,000 square feet, whichever is greater. According to the Environmental Action Agenda (2005), up until 2005 eight projects had received density bonuses for installing green roofs. The second instrument is the Green Permit Program. This program is part of the Department of Buildings and was created in 2004 by Erik Olsen. The impetus for creating a fast-track permitting process to review permits for green projects (including green roofs, solar, wind turbines) came from the Environmental Action Agenda; it was listed as one of the environmental initiatives. The program is quite popular especially among developers because of the perks that it offers, which include a shortened review period of four to six weeks, or thirty business days; the possibility of receiving a

¹⁰ The policy instruments that are referred to here include the Sustainable Development policy and the fast track permit process.

permit fee waiver; and a 5 cents credit per every square foot of green roof installed. The total credit received goes toward reducing the permit fee. The most attractive aspect to developers is the amount of time saved in the review process. Meyer also shares this view and believes that the permit program is one of the most successful policy measures that has been instituted in Chicago. According to Meyer,

“It really is a brilliant solution, and has been very effective in getting Chicago at the forefront of green roofing in the United States. To structure a system that doesn’t require any additional money, from taxpayers, but gets lots of green roofs built [is]...brilliant” (Meyer Interview, 2011).

Overall, both the green permit program and the density bonus have been taken advantage of by residents and developers alike. **Table II.2** on the following page provides an overview of the different policy instruments employed by the City of Chicago to encourage the adoption of green roofs.

Table II.2: Chicago Policy Instruments

Chicago Policy Instruments	
Legal control model (influencing behaviour through rules and regulations)	
Technology-based regulation (i.e. building codes)	Sustainable Development Policy (2003)- mandatory for plans that receive city financing or are required to undergo review
Performance-based regulation (i.e. LEED)	Green roofs are considered a legitimate measure for achieving targets for stormwater retention, energy conservation, and landscape beautification for the following, respectively: <ul style="list-style-type: none"> • Stormwater Ordinance (2007) • Energy Conservation Code (2002) • Landscape Ordinance (2000)
Economic control model (influencing behaviour through costs and benefits)	
Direct financial incentives	<ul style="list-style-type: none"> • Green Roof Grant Program: 2005-2007 • Green Roof Improvement Fund (GRIF): 2006-2009 • Illinois Green Roof Grant Program: 2009 • Small Business Improvement Fund (SBIF): still active • Illinois Green Infrastructure Grant Program for Stormwater Management: still active
Indirect financial incentives	<ul style="list-style-type: none"> • Density bonus offered to developers • Expedited green permit approval process (since 2004)
Communication control model (influencing behaviour through knowledge and information)	
Information and education	<ul style="list-style-type: none"> • Public demonstration roof on City Hall (2001) • Chicago Center for Green Technology- resource center for citizens and professionals
Contractual agreements	None

Mobilization and Leveraging of Societal Resources

In addition to employing policy instruments to support the uptake of green roofs, the mobilization of different societal sectors so that resources and knowledge are leveraged is also needed to promote the adoption of green roofs. Adaptive capacity is crucial in determining how a community or population can handle the effects of climate change. The complex nature of climate change and the uncertainty surrounding future impacts means that the problem cannot be tackled by any one single actor. Although governments have traditionally been responsible for safeguarding their citizens against environmental problems, their lack of financial resources, man-power, and expertise in certain areas prohibits them from being able to manage an issue as daunting as climate change. This holds true in Chicago where both private and public actor involvement is visible with respect to climate change adaptation. Infusing private sector involvement is needed so that that resources can be leveraged between the different stakeholders involved, thus enhancing the city's ability to cope with climate change. Lemos and Agrawal's (2006) discussion on global environmental governance can apply to the Chicago context as well. They state that:

"The fragmentary nature of the sources of complex environmental problems, such as global climate change, and the reluctance or inability of nation states to regulate the sources of these problems, means that nonstate actors and organizations may be able to play an essential role in mobilizing public opinion and generating innovative solutions" (p. 301).

Hence, the involvement of non-state actors is considered to be important in helping to deal with the complexity of the climate change problem. A well-known instance of this type of cooperation was with the publication of the Chicago Climate Action Plan. Scientists, economists, consultants, and government officials donated their time and expertise in order to produce this comprehensive document. Nearly \$10 million of pro bono work went into the creation of the CAP.

The Red Line Green Roof Initiative in the 48th Ward is another example that demonstrates the need to mobilize private sector involvement in order to help the city move forward with its adaptation measures. The 48th Ward was formerly headed by the 'green' alderman of Chicago, Alderman Mary Ann Smith.¹¹ The beautification of rooftops along the Chicago Transit Authority's (CTA) red line was something that Smith desired to do since 2000. However, the idea did not come to fruition until she was approached by Repkin and Dave Hampton of Hampton Avery Architects. The goal of the project is to install 50,000 square feet of green roofs along the red line. The preliminary proposal that was prepared for the project states that the aim is to:

"re-imagine a considerable portion of the urban environment...as a diverse, robust, productive, and beautiful constructed rooftop ecosystem, using a major public transit artery as an organizing element to increase visibility by the public" (Red Line Green Roof Preliminary Proposal, n.d).

Besides beautification, other green roof benefits such as stormwater management and reduction of the urban heat island effect have also been mentioned. Although the project is still in its initial phase—documentation of buildings, determination of their suitability, and outreach to potential building owners—private actor involvement was a necessary catalyst to 'get the ball rolling.' The 48th Ward

¹¹ Alderman Mary Ann Smith headed the 48th Ward at the time of interview in January 2011 but has since retired. The new appointed alderman is Harry Osterman.

does not have all of the requisite technical or financial know-how to make this project happen on its own, nor is it the responsibility of the alderman to ensure that green roofs are installed within the ward. Repkin and Hampton's recognition of this opportunity and the example it can set for other cities around the world reinforces the need for private actors to become more involved in climate adaptation.

Conclusions

The dominance of the economic perspective and private actor involvement in the green roof sector can be attributed to improving efficiencies and innovation in the field. Green roof partnerships among the different disciplines, the integration of green roof systems with other investments, and the design of green roofs for a specific purpose (i.e. food production), represent a few examples of the various activities that continue to drive private actor involvement. Their no-regret nature also facilitates interest in green roofs because of the multitude of benefits that they offer. The City of Chicago is also invested in the green roof process, although its influence appears to be waning. In order to secure adaptation action the city instituted a variety of economic and non-economic incentives; however, many of the economic incentives have expired due to budgetary reasons and there are no signs of them being reinstated in the near future. Despite this 'stepping-back' of government, it is important to note that private actors can and must play a critical role in addressing the risks and opportunities posed by climate change. Their interest in, and advocacy of, adaptation measures such as green roofs will help ensure that Chicago moves toward its implementation goals.

3.2 Juridical-Administrative Perspective

The juridical-administrative perspective, which indicates the dominance of government in Chicago's green roof governance arrangements, was visible during the 2000-2008 period. This perspective is based on the considerations of rule of law and equity and fairness. The city departments that are most involved in green roof matters include the Department of Buildings (DOB); Department of Environment (DOE); and most importantly, the Department of Zoning and Planning (DZP). While the DOB is responsible for reviewing permit requests for green roofs, during the 2005 to 2007 period the DOE was responsible for distributing green roof grants via the Green Roof Grant Program. The DOE was assigned this administrator responsibility because it had control of the funding pool. Although it no longer has any direct responsibilities, the DOE does liaise with the DZP in various matters relating to green roofs as issues arise. The DZP, in particular the Sustainable Development Division, is the primary authority on green roofs in the City of Chicago. Its responsibilities include: development and implementation of the Sustainable Development Policy; review of projects' compliance with the zoning code; and (future) aerial inspections of green roofs. The activities of these three departments encompass all four phases of the policy cycle. It is important to note though that these departmental responsibilities chiefly lie in the "PLAN" and "DO" phases. Policy evaluation and policy maintenance are areas that have not received a lot of attention. However, both the DOB and DZP affirm that steps are being taken to address issues that are developing in these areas. The considerations of rule of law and equity and fairness are explored in detail below to explain the dominance of the government sector for nearly a decade in the green roof arena in Chicago.

Consideration 1: Rule of Law

There are several factors that necessitated the involvement of the Chicago city government to help encourage interest in green roofs as a feasible adaptation measure. First, the up-front costs for installing the roofs are the primary deterrent for many individuals who do not have the requisite financial resources to install one. Second, many consider green roofs to be passive structures—and due to their shortsightedness do not appreciate the intangible benefits they offer. Although these benefits can result in cost-savings in the future, in the short-term the roofs may be seen as a liability rather than an asset. The third issue relates to the time delay in the realization of the advantages that the roofs have to offer. For these reasons, government engagement within the green roof field was crucial during the early stages of the green roof industry in Chicago. Regulations, financial incentives, and indirect financial incentives are the different instruments that the city has employed to help spark and maintain interest in green roofs. Chicago's regulatory instruments are specifically addressed in this section.

There are various regulations that have been enacted by the City of Chicago that support the adoption of green roofs, both indirectly and directly. The following ordinances promote the use of green roofs: the Stormwater Management Ordinance (2007); Chicago Energy Conservation Ordinance (2002); and the Landscape Ordinance (2000). These ordinances advocate green roofs indirectly since they are not the only solution prescribed—there is flexibility in the options that can be employed to satisfy the ordinances' requirements. The 2007 Stormwater Ordinance requires large commercial and industrial sites to manage their stormwater run-off on-site. The ordinance mandates that these large-scale developments capture the first one-half inch of rain on their properties, hence reducing the volume and rate at which run-off is entering the city's sewer system. The Department of Water Management is responsible for ensuring that the ordinance is being followed and that the figures provided by these commercial sites are in fact accurate. The 2002 Energy Conservation Ordinance requires all new and refurbished roofs to install either reflective roofing or green roofs in order to deal with the urban heat island effect. The roofs must meet a minimum standard of solar reflectance (City of Chicago website). The 2000 Landscape Ordinance, which was originally adopted in 1991, requires commercial or large residential development projects of a certain scale to incorporate landscaping into their plans (ILSR website). Rooftop gardens are specifically mentioned in the ordinance as a possible option to be utilized.

In contrast to the above-mentioned ordinances, the Sustainable Development Policy (2003) of the City of Chicago specifically mandates the installation of green roofs.¹² It applies to new buildings that receive city financing or are subject to review by the Department of Housing and Economic Development.¹³ The idea behind the policy is that projects receiving (financial) assistance from the city should provide some sort of public benefit. This benefit could be defined as achieving a certain energy efficiency standard, installing a green roof, etc. In addition to incorporating green elements such as green roofs, projects are also required to attain building certification (i.e. LEED, Energy Star, Chicago Green Homes). The requirements of the policy, such as the percentage of the roof that needs to be greened, is dependent upon a variety of factors, including: building type; size; category (residential, institutional, industrial, commercial, existing, landmark); building certification achieved; and whether or

¹² In lieu of a green roof (if installation is not possible), other green, sustainable elements can be incorporated. Please see **Appendix 4** for details.

¹³ At the time the Sustainable Development Policy was enacted in 2003, reviews were conducted by the Department of Planning and Development. Due to restructuring, that department has now been incorporated into the Department of Housing and Economic Development.

not financial assistance is received. Additional detail can be seen in the Sustainable Development Policy Matrix in **Appendix 4**. Michael Berkshire of the Department of Zoning and Planning was explicitly hired to craft a policy that would encourage green roofs. The impetus for this came from former Mayor Daley, who was dissatisfied with the work that the Department of Planning was doing in this area. Berkshire collaborated with a working group and commissioners from the Department of General Services, Department of Environment, and representatives from the Mayor's office. Following the initial completion of a draft version, feedback was requested from a focus group that consisted of developers, attorneys, architects, and engineers. Adjustments were made to the initial draft and the policy was subsequently approved and has been in effect since 2003. Several of the city officials interviewed agree that this "stick" is one of the most important drivers for the installation of green roofs in Chicago. The reason why so many green roofs have been installed is because they are required if a developer goes through the planned development process. In addition to this mandatory policy, it is essential to recognize that the precautionary approach that the government has adopted in response to climate change is also supporting greening measures such as green roofs.

Consideration 2: Equity & Fairness- Precautionary Principle

The City of Chicago is taking a precautionary stance toward climate change. In recognition of the complexity of the problem, the city has embarked on integrating adaptation policies across various policy sectors. The effectiveness of adaptation policies will be affected by the extent to which they are integrated across sectors. Because of the considerable extent of uncertainty and complexity, integration is important because "climate change will often broaden the optimal scale and scope of planning, making it necessary to consider new forms of interagency coordination and wider geographical spheres for decision making" (Bedsworth & Hanak, 2010, p. 478). Hence, the likelihood of success of an adaptation measure can be improved if the responsibilities span across different departments and agencies instead of residing within a single unit, in most cases the environmental department. There is ample evidence that illustrates the City of Chicago's efforts to integrate and incorporate green roofs among the different policy domains. Although the DZP's Sustainable Development Policy is the only mandatory policy measure for green roofs in Chicago, various departments and agencies advocate the use of green roofs in their respective department plans and publications. In addition to the departments already mentioned, the following also support the use of green roofs: the Chicago Park District; Department of Water Management; Department of Transportation; and the Public Building Commission of Chicago.¹⁴ However, one of the most important publications that showcases the extent of interdepartmental cooperation in greening Chicago is the *Adding Green to Urban Design Plan* (GUD Plan, 2008), which was produced in collaboration with different departments and sister agencies in the City of Chicago.

The GUD Plan is the first comprehensive interdepartmental greening plan in Chicago. It is an implementation roadmap that outlines key actions that should be taken by departments in order to 'green' themselves. Green roofs are mentioned but the plan focuses on an overall greening strategy for the following areas: water; air; land; and quality of life (GUD Plan, 2008). There are several different factors that promote progress in the mainstreaming of green elements. First, a specific agency is assigned to key action items. This is significant because it creates a sense of accountability and eliminates ambiguity as to who is responsible for developing a strategy to address the issue at hand.

¹⁴ Relevant publications include the: Urban Forest Agenda (2009); Water Agenda (2003); Green Alley Handbook (2007); and Site Development Guidelines (2010), respectively.

Second, the DZP has been designated a moderator role in this process. It therefore has the responsibility of overseeing and following up with the various departments to ensure that implementation is feasible. One way in which the DZP encourages this is by requiring departments to provide it with a timeline that outlines the tasks they will execute. Third, progress meetings are held every 1.5 to 2 years¹⁵ to evaluate the progress the departments have made. These sessions are important because it allows the DZP to evaluate whether or not departments are following through and executing their commitments. Per the GUD Plan, responsibilities for green roofs fall under the domain of the DZP. However, these responsibilities are not static and are subject to change in the future. Green roof issues overlap with those of different sectors such as water management and buildings. For these reasons, along with the advancements that are being made in green roof technology,¹⁶ it is likely that responsibilities will shift and will fall under the jurisdiction of other departments in the future. This will serve to further reinforce and mainstream green roofs 'on paper' and in practice.

Infusing the concept of sustainability in decision-making processes is another important step in the City of Chicago's long-term plan for greening the city. This is imperative in order to guarantee that green and other climate-friendly adaptation measures such as green roofs are not an afterthought but are brought into consideration at an early stage in project negotiations. The DZP has taken an active role in making sure that this 'infusion' of sustainability and incorporation of green elements is in fact taking place, and this is evident within their own departmental procedures. For instance, projects under evaluation go through a series of internal reviews to assure their compliance with the Sustainable Development Policy. The idea is to make sure that before a building is constructed, developers and planners have thought about the incorporation of sustainable features into their designs. According to one government official, the goal is to make it "standard operating procedure to have sustainability in mind." This kind of mindset will help underpin and extend sustainability efforts beyond the DZP (and DOE) to other departments, with the ultimate goal of institutionalizing sustainability across the policy spectrum.

Conclusions

While Chicago has not made the installation of green roofs mandatory across the board, there are various regulations that indirectly and directly promote their adoption. Most notably, the city's 2003 Sustainable Development Policy has been a key driver in the installation of green roofs, particularly for large (residential) developments. In addition to the consideration of rule of law, the precautionary principle has also stimulated government involvement. Because the city wants to protect its economic, environmental, and social interests, it has promoted the integration of adaptation policies among the different policy domains to strengthen the city's ability to cope with climate change. Despite the city's efforts, green roofs constitute a small portion of roofs in Chicago. The city can work on strengthening its regulatory requirements in the future or can contemplate employing new instruments to help instigate further adoption of the technology.

¹⁵ The long-term feature of the action items makes a meeting schedule of every two years more suitable than an annual meeting.

¹⁶ Technological advances in green roof technology may bring to surface issues that were previously not taken into consideration, thus requiring the involvement of new departments.

3.3 Political Perspective

The considerations of legitimacy and accountability and transparency govern the political perspective. This perspective is not prominent in Chicago and there are various reasons for this marginalization. The political perspective distinguishes itself from the economic and juridical-administrative perspectives because it is characterized by joint public-private collaboration in the sharing of responsibilities. The public and private sectors have worked together on climate adaptation and green roof matters; however, this assumes the form of consultation rather than true collaboration. As an example, private actors (i.e. economists, lawyers, engineers) were involved in the creation of Chicago's Climate Action Plan and in the development of the Sustainable Development policy. Their involvement was limited in the sense that they provided recommendations and feedback but were not a part of the decision-making process-- this clearly falls in the domain of governmental authorities. The civilian sector is also absent in this decision-making process and there does not seem to be any attempts to promote their inclusion. Transparency is vital and stakeholders must be engaged; moreover, it is something that people value. For instance, the creation of the Sustainable Development policy was favored by many developers because it enhanced transparency as to what the government expected. This increase in transparency also leveled the playing field because everyone would be subject to the same rules, thus reducing nepotism.

Communication channels are a vital prerequisite for the exchange of information and ultimately for the delivery of adaptation measures. Institutionalized channels of communication between government officials and green roofers in Chicago appear to be lacking. Although the city has a list of green roof companies on their website, based on interviewee responses there has been limited effort on behalf of the government to engage with green roof firms. This engagement can take many forms and can include discussions on topics such as maintenance and guidelines for green roofs. One such example of this is the Green Roof Summit which took place in June 2010.¹⁷ The conference was attended by Chicago-based professionals in the green roof field and addressed issues such as best practices and challenges confronting the industry. Meetings such as this should become the norm in order to facilitate information exchange.¹⁸ The absence of a strong network and avenues of communication may explain why the implementation of green roofs has not reached its full potential yet.

In order for adaptation to be successful, the support of a variety of stakeholders is needed to execute the city's mandate on tackling climate change. The multi-level sector and actor complexity of adaptation requires their involvement because the city is limited in what it can accomplish on its own. The city can green all of its buildings, improve energy efficiency, etc., but without consensus from the civilian and private sectors its achievements will be limited. Powerful stakeholders such as housing agencies, real estate management firms, and development firms must be 'on board' with the city's plan and should be a part of the deliberative process so that their concerns are voiced as well. Civilians should also have the opportunity to engage in this process because it creates a sense of accountability and the feeling of being invested in a cause. Regardless of the path that the city decides to take, it would be wise for it to open up the adaptation process to a greater segment of society. Chicagoans have a stake in their future and should have a say in how to protect it.

¹⁷ Additional detail on the Summit can be found at:

<http://www.cityofchicago.org/city/en/depts/dae/supp_info/green_roof_summit.html>.

¹⁸ One such example of this is the Green Roofs for Healthy Cities conference, which will be held in Chicago in October 2012.

Conclusions

The marginalization of the political perspective in Chicago is of relevance because it can elucidate as to why adaptation measures such as green roofs have not been adopted on a wide scale. The lack of *true* collaboration among non-governmental actors and policy officials can be partly attributed to institutional conditions. The absence of a framework to encourage civilian participation and limited communication avenues/forums for the exchange of ideas can explain the slow progression of green roof installations. The inclusion of a diverse range of actors in the climate adaptation process can help facilitate the spread of the technology, and this is evident in Stuttgart (see Chapter 4 for discussion).

4. Green Roof Governance Arrangements: Contextual Factors

The configuration of green roof governance arrangements and the allocation of responsibilities in Chicago have been influenced by the characteristics of the climate change problem, as well as by political and economic factors. There are many uncertainties surrounding climate change and the actual impacts that Chicago is expected to experience. The existence of various climate scenarios (i.e. low emissions, high emissions) along with the complexity of the problem make it difficult to predict in what way and to what extent Chicago will be impacted. Despite this uncertainty, there are certain occurrences that are expected to manifest (if not already). Higher (prolonged) temperatures, storm surges, and increased frequency of precipitation during the winter months have a high probability of taking place in the future. In order to deal with this public authorities in Chicago have taken precautionary steps, including the creation of the Climate Action Plan which includes both mitigation and adaptation measures. Additionally, the city's attempts to integrate adaptation and the concept of sustainability across different policy sectors demonstrate its acknowledgement that such actions will better prepare itself for the future.

In addition to the characteristics of climate change, political and economic factors play a chief role in the allocation of responsibilities and governance configurations. First, the political climate in Chicago provides insight as to why the public sector was so actively involved during the first phases of the policy cycle. The impetus for green roofs came from former Mayor Daley, and he is "famous for his green thumb and his iron fist" (Baldwin Wallace College website). The enactment of the Sustainable Development Policy in 2003 along with the city's deployment of financial and indirect financial incentives reflects its steering strategy for encouraging the uptake of green roofs. The consideration of securing adaptation is apparent in this instance. By instituting regulations and making financial and indirect financial incentives available, public authorities were taking into account the high up-front costs of the systems and the challenge that this poses for the procurement of green roofs.

Following the financial crisis in 2008, the city's role took a step back and the economic consideration of efficiency appears to have become more prominent, thus highlighting the post-2008 dominance of private actor involvement. Private actors are especially active in the (physical) implementation of green roofs and in their maintenance. The industry has experienced double-digit growth in the past several years and its future prospects are positive. This coupled with improved efficiencies, consumer demand for unique products, and the fact that green roof systems can be specifically tailor-made in the future to deal with climate change (i.e. enhanced water retention capacity to deal with storm surges, advanced features for cooling), are propelling the flow of private investments in the green roof industry.

5. Allocation of Responsibilities

The allocation of responsibilities among the different public and private actors in the green roof governance process in Chicago coincides with the ‘public/private’ divide. In other words, the government sector is primarily responsible for policy-making and policy implementation, while the private sector is ‘on the ground’ dealing with design, installation, and maintenance of green roofs. The city officials at the DOE and DZP are satisfied with the current status quo in regards to the distribution of responsibilities and are reluctant to assume any additional ones in light of budget cuts and an overstretch in human resources. However, one area in which city officials can imagine future involvement for the private sector is in the financing of green roofs. Currently, green roof funds are non-existent in Chicago and there are no plans to replenish the funding pool in the near future. Because costs are such a significant factor for many Chicagoans when deciding whether or not to install a green roof, the possibility of creating a joint public-private venture to help finance green roofs is one possibility for overcoming this barrier. Although concrete steps have not been taken to make this happen, the idea has been discussed and conditions in the future may promote its realization.

6. Green Roofs: Going Forward and Future Goals

Demand for green roofs in Chicago is being driven by a variety of factors. Concerns for stormwater management and the alleviation of the urban heat island effect are the primary impetus for the government to encourage their installation. However, other factors are also serving as catalysts for green roofs. Based on interviewee responses, the ‘sustainable’ image coveted by corporations, the existence of an environmental ethos among citizens, and the desire to produce things locally—as opposed to importing them from abroad—have all contributed to the growth of the green roof industry. Despite these positive drivers, less than one percent of rooftops have been greened in Chicago during the past ten years. As a comparison, Stuttgart has been greening its rooftops for the past twenty-five years and nearly 22% of roofs have been greened.

Given that Chicago wants to green an estimated 2.4% of roofs by 2020, there are various things that can be done to accelerate their implementation. Because up-front costs are a deterrent to many, the city can consider a joint public-private partnership in a financing venture; this has been suggested as a possible option by one respondent. This will lessen the financial burden on the city and will place some of the responsibility in the hands of a private entity. This may be a well-suited arrangement for the City of Chicago because of the private sector’s expertise in financial matters and in obtaining investments. Another interviewee proposes that the city consider expanding its mandatory green roof policy. It can incorporate the installation of green roofs into the building code and can make them obligatory on certain structures (i.e. flat sloped roofs, or sloped roofs with a set maximum inclination). Respondents agree that a wide-scale policy such as this would be fruitful in increasing green roof coverage. However, the political climate in Chicago coupled with economic concerns will make such a policy unfeasible in the near future. Besides a direct policy intervention, other regulatory avenues are possible. According to one respondent, enlarging the scope of the 2007 Stormwater Ordinance so that it is not only limited to large commercial and industrial sites can encourage the uptake of green roofs. Because of their aesthetics and no-regret features, building owners may be more inclined to choose them as an option as opposed to alternatives such as water tanks.

In addition to the above-mentioned suggestions for supporting the adoption of green roofs, a current hot topic in Chicago concerns their maintenance. Improvements in maintenance procedures can be made to ensure that green roofs are not failing and are functioning as intended. A potential option that is mentioned by a respondent is the inclusion of a mandatory installation clause in green roof contracts; there are many benefits to such an agreement. Besides the obvious economic benefit that is reaped by companies that conduct maintenance, another advantage is that installers can observe any problems that may arise after installation. Maintenance can clearly serve as a learning experience for green roof firms. Considering that the industry is in its infancy compared to other markets and is still experimenting with different designs, substrates, etc., a mandatory maintenance plan can result in the production of knowledge that can be used by stakeholders throughout the industry. In general, there are various actions that both public and private stakeholders can take to improve the implementation of green roofs. It is up to these stakeholders to communicate in a holistic manner and to strategize as to the best path to take in executing potential recommendations.

The table below presents a snapshot of the key items mentioned in this section.

Table II.3: Potential Future Goals for the City of Chicago

Potential Future Goals
<ul style="list-style-type: none"> • Possibility of joint public-private financing scheme to provide citizens with the funding needed to overcome high installation costs • Strengthening of the mandatory green roof policy via its inclusion in the building code to make it obligatory on a variety of building types • Enlarging the scope of the 2007 Stormwater Ordinance so that it is not only limited to large industrial/commercial sites • Possibility of a mandatory maintenance clause to ensure that green roofs are not failing and are being maintained to a minimum quality standard

7. Synthesis and Conclusions

Although the United States is considered a laggard in the green roof industry compared to other countries such as Germany, the American industry has made significant strides during the past decade. Chicago in particular is on the forefront in the implementation of green roofs in the United States. Public officials are pushing the adoption of green roofs because they are a suitable means to help the city deal with stormwater management control and the reduction of the urban heat island effect. The allocation of responsibilities among the various actors involved and the policy instruments employed are strong determinants of the effectiveness of the governance arrangements, which is why their investigation is pertinent for understanding the implementation process.

Responsibilities in Chicago's green roof governance arrangements follow a strict public-private divide. Government officials are primarily involved in the earlier stages of the policy cycle and dominate tasks such as agenda setting, policy initiation, target setting, and strategy making. Private actors on the

other hand are more active in the policy implementation and maintenance stages, and their chief activities include the financing and implementation of green roofs, post-installation maintenance, and information provision. The primary considerations driving public involvement in the governance process are *rule of law*, *securing adaptation action*, and *fairness* (precautionary principle). The City of Chicago has issued various regulatory and economic incentives in order to overcome the barriers that are hindering the widespread implementation of green roofs. The consideration of fairness comes into play because the local government is taking preemptive action to protect the city from future climate change impacts. The main motivation for private actor involvement is *efficiency*. There are various conditions which activate this consideration; the need for tailor-made solutions, innovation in the field, and increasing economies of scale are all promoting private sector participation in the green roof arena. The current and (potential) future profitability of this growing niche industry will encourage additional entrepreneurs to enter the business, thus further perpetuating improvements in technological innovation and the creation of ‘crazy ideas’ that may one day enter the mass market.

The policy instruments employed by city officials showcase their desire to encourage the uptake of green roofs. Regulatory, economic, and communicative instruments are all present in the city’s ‘arsenal’ to help steer private behavior toward adaptation. The instruments vary in duration and scope, and the effectiveness of some (i.e. financial incentives) is up for debate. However, it is clear that Chicago’s Sustainable Development Policy has been instrumental in spreading the technology throughout the city despite its limited applicability. The density bonus and expedited green permit program have also been helpful in convincing developers and private citizens to install green roofs.

A variety of barriers and opportunities exist to the implementation of green roofs. Up-front costs, limited mandatory regulation, structural limitations of buildings, and a general lack of knowledge represent some of the most commonplace barriers. However, these barriers can be dealt with and they should not (and have not) deterred the uptake of green roofs. The continued growth of the industry is a testament to the desirability of these rooftop landscapes. Corporations’ quest to display their ‘sustainability,’ along with the intangible benefits that owners can reap from green roofs, have helped to maintain green roof sales. Chicago’s future in the green roof industry is positive. However, the government sector must do more to help encourage interest in the technology and must work with the private sector if it does not have the requisite resources to accomplish this on its own. Additionally, civilians must feel vested in the adaptation process and their inclusion should be seen as a positive aspect as opposed to unnecessary. This type of engagement can serve to bring the political perspective to the fore. Chicago can achieve its goal of becoming the “greenest city in America,” but in order to do so it needs to ensure the participation of all societal segments to help it move its vision forward.

References

- American Society of Landscape Architects. Retrieved April 5, 2011, from <http://www.asla.org/meetings/awards/awds02/chicagocityhall.html>.
- Anguelovski, Isabelle and Carmin, JoAnn, 2011, 'Something borrowed, everything new: innovation and institutionalization in urban climate governance', *Current Opinion in Environmental Sustainability*, vol. 3, pp. 1-7.
- Baldwin Wallace College. Retrieved November 30, 2011, from <http://www.bw.edu/news/current/sustainability-daley/>.
- Bedsworth, Louise W. and Hanak, Ellen, 2010, 'Adaptation to Climate Change', *Journal of the American Planning Association*, vol. 76, no. 4, pp. 477-495.
- Berkshire, Michael (2011). Green Projects Administrator, Department of Zoning and Planning. Interviewed by Jennifer Stamatelos, Chicago, February 2, 2011.
- Bulkeley, Harriet, 2010, 'Cities and the Governing of Climate Change', *Annual Review of Environment and Resources*, vol. 35, pp. 229-253.
- Chicago Tribune. Retrieved April 5, 2011, from http://articles.chicagotribune.com/2010-04-20/news/ct-met-0421-green-roof-0100420_1_green-roofs-conventional-roof-flat-roofs.
- CityData. Retrieved April 5, 2011, from citydata.com.
- CityData. Retrieved April 5, 2011, from <http://www.city-data.com/city/Chicago-Illinois.html>.
- City of Chicago (2008). Adding Green to Urban Design.
- City of Chicago (2008). Chicago Climate Action Plan.
- City of Chicago. Retrieved April 5, 2011, from http://www.cityofchicago.org/city/en/depts/bldgs/supp_info/combined_sewers.html.
- City of Chicago. Retrieved April 5, 2011, from <http://www.cityofchicago.org/city/en/depts/bldgs.html>.
- City of Chicago. Retrieved April 5, 2011, from http://www.cityofchicago.org/city/en/depts/bldgs/supp_info/chicago_energy_conservation_co_deoverview.html.

- Constantino, Ernie (2011). Aide to Alderman Mary Ann Smith, 48th Ward. Interviewed by Jennifer Stamatelos, Chicago, January 27, 2011.
- Dougherty, Kelly (2011). Proposal Administrator/Manager, Weston Solutions. Interviewed by Jennifer Stamatelos, Chicago, January 30, 2011.
- Durnbaugh, Aaron (2011). Deputy Commissioner of the Natural Resources and Water Quality Division, Department of Environment. Interviewed by Jennifer Stamatelos, Chicago, January 31, 2011.
- Environmental Engineer (2011). Interviewed by Jennifer Stamatelos, Chicago, February 4, 2011.
- Green Roofs for Healthy Cities. Retrieved April 5, 2011, from <http://www.greenroofs.org/>.
- GreenSource. Retrieved April 5, 2011, from http://greensource.construction.com/features/currents/2010/1011_Plastic-Alleys.asp.
- Horvath, Kurt (2011). President, Intrinsic Landscaping. Interviewed by Jennifer Stamatelos, Chicago, January 26, 2011.
- ICLEI, n.d., Local government perspective on adapting water management to climate change, Retrieved October 29, 2010, from http://www.worldwatercouncil.org/fileadmin/wwc/Library/Publications_and_reports/Climate_Change/PersPap_07_Local_Government.pdf.
- Illinois Department of Commerce and Economic Opportunity. Retrieved April 5, 2011, from http://www.commerce.state.il.us/dceo/Bureaus/Energy_Recycling/Economic+Stimulus/Illinois+Energy+Plan.htm.
- Illinois Environmental Protection Agency. Retrieved April 5, 2011, from <http://www.epa.state.il.us/water/financial-assistance/igig.html>.
- Illinois State Water Survey. Retrieved April 5, 2011, from <http://www.isws.illinois.edu/atmos/statecli/General/1995Chicago.htm>.
- Institute for Local Self-Reliance. Retrieved April 5, 2011, from <http://www.newrules.org/environment/rules/land-use-policy/landscape-ordinance-chicago>.
- Lemos, Maria Carmen and Arun Agrawal, 2006, 'Environmental Governance', *Annual Review of Environmental Resources*, vol. 31, pp. 297-325.
- Martinez, Sophie (2011). Program Manager/Projects Administrator Green Permit Program- Department of Buildings. Interviewed by Jennifer Stamatelos, Chicago, February 1, 2011.
- Metropolitan Planning Council. Retrieved April 5, 2011, from <http://www.metroplanning.org/news-events/blog-post/5799>.

Metropolitan Water Reclamation District. Retrieved April 5, 2011, from
<<http://www.mwrd.org/irj/portal/anonymous/tarp>>.

Meyer, Molly (2011). Green Roof Consultant, Molly Meyer LLC. Interviewed by Jennifer Stamatelos, Chicago, January 25, 2011.

Red Line Green Roof Preliminary Proposal, n.d. Prepared by Dave Hampton, Michael Repkin, and the 48th Ward of the City of Chicago.

Roback, Bradley (2011). Coordinator of Economic Development, Department of Zoning and Planning. Interviewed by Jennifer Stamatelos, Chicago, January 28, 2011.

Urwin, Kate, and Jordan, Andrew, 2007, 'Does public policy support or undermine climate change adaptation? Exploring policy interplay across different scales of governance', *Global Environmental Change*, vol. 18, pp. 180-191.

Vavrus, Steve and Van Dorn, Jeff, 2009, 'Projected future temperature and precipitation extremes in Chicago', *Journal of Great Lakes Research*, pp. 1-11.

Wheeler, Stephen M., 2008, 'State and Municipal Climate Change Plans: The First Generation', *Journal of the American Planning Association*, vol. 74, no. 4, pp. 481-496.

Zimmerman, R. and Faris, C., 2011, 'Climate Change Mitigation and Adaptation in North American Cities', *Current Opinion in Environmental Sustainability*. Article in press, pp. 1-7.

Images:

Map of the United States: <<http://tinyurl.com/7nh5pr4>>.

Map of Chicago: <<http://tinyurl.com/7ghvhxk>>.

Chapter III

Green Roofs London



1. London: Introduction

The City of London is one of the most influential cities in Europe. It is the largest city in the United Kingdom with an estimated population of 7.8 million people (GLA website^a). London is located in southeastern England and is situated on the banks of the River Thames. Its geographical location has played a very significant role in shaping the city's industry. Its location on the river fostered the city's growth into becoming one of the most influential trading and commercial hubs in Europe. The financial sector is currently a dominating industry in London, which is why it is considered the financial center of Europe. Other prominent industries include: food processing; business services; education; and television and media. Its position as a vibrant commercial, industrial, and cultural hub has contributed to the city's economy and consequently it is one of the most important business and financial centers in Europe and abroad.

For over the past decade the City of London has been trying to distinguish itself from other cities on another level—it is being preemptive in preparing itself to cope with the future impacts of climate change. The Greater London Authority (GLA) is a strategic administrative body that is responsible for formulating policies relating to a host of issues, including: economic development; spatial planning; urban greening; and transport. The GLA consists of the elected Mayor of London and the elected London Assembly; the Mayor of London is the executive head of the GLA (GLA website^b). The Mayor and his team at the GLA have produced a range of strategies and plans that are aimed at increasing the adaptive capacity of the city so that it can cope with future environmental changes. As a response, the London Plan was created in order to provide strategic guidance to the City of London as well to the additional 32 boroughs in the greater London area. The plan is a regional spatial strategy that presents an economic, environmental, and social framework for the future development of the city (London Plan, 2008). It represents London's commitment in maintaining its economic, environmental, cultural, and social viability. In relation to green roofs, the plan specifically advocates their use. Another plan that deserves mention is the Mayor's Climate Change Action Plan (CCAP). It was published in 2007 and provides a blueprint for lowering greenhouse gas emissions in order to reduce the city's carbon footprint. The goal of the CCAP is to reduce greenhouse gas emissions by 60% by 2025, using 1990 levels as the baseline (CCAP, 2007). The following sections provide an overview on the climate change effects London is expected to experience along with a discussion on green roofs.

2. Climate Change Adaptation and Green Roofs

2.1 Climate Change Impacts

Cities and urban areas are highly susceptible to the impacts of climate change. Rising temperatures are expected to exacerbate overheating in already overburdened urban environments. Increasing precipitation rates and rising sea levels are expected to cause a higher frequency of flooding, coastal erosion, and flash floods. Flooding and storm surges present significant risks to coastal cities such as London, and the city is already experiencing the effects of climate change. Between 1961 and 2006 precipitation rates increased by an average of 22% during winter time, compared to a 16% decrease during summer time. Under a high emissions scenario, average rainfall is expected to increase from a range of +3 to +10% by the 2020s and +11 to +22% by the 2050s (City of London, 2010, p. 10). A projected rise in precipitation rates will further aggravate surface flooding in London, resulting in

property damage, flooding of underground train stations and power systems, sewage overflow, and the disruption of business activities.

In addition to water-related issues, the frequency of extreme heat-related events is also expected to increase because of climate change. The negative effects of prolonged high temperatures will be felt more in cities as opposed to rural areas because of the urban heat island effect (UHI). Between 1961 and 2006 the average mean temperatures across the United Kingdom increased by an estimated 1°C and 1.7°C (City of London, 2010). Future projections show that higher summer temperatures and ‘very hot days’ will become more frequent, and that very cold winters will become even more rare. Under a high emissions scenario, the average temperature in London is expected to increase between 1.2 to 1.7°C by the 2020s and 2.4 to 3.2°C by the 2050s (City of London, 2010, p. 10). The projected changes in London’s precipitation rates and average mean temperature are expected to have negative repercussions for the city on various dimensions—economically, environmentally, and socially. For these reasons, stormwater management and urban heat island reduction are important climate change adaptation issues for the City of London.

2.2 Green Roofs

Interest in green, or living roofs, as they referred to in London, initially stemmed from biodiversity concerns for the black redstart. The United Kingdom is on the fringe of the bird’s range, and its conservation became an important issue for ecologists beginning in the 1990s (English Nature, 2003). Brownfields, or previously developed land, are the preferred habitat of the bird.¹⁹ However, the catalyst that ignited action on behalf of nature conservationists was the publication of the Urban White Paper in 2000. It is a strategic document that identifies the value of brownfield land and recognizes its importance for the economy’s future. Because of this conflict of interest between land development and habitat preservation, Dusty Gedge (also known as the green roof guru of London), was motivated to travel to Switzerland to liaise with Stephan Brenneisen and to discuss the work he has done on green roofs and biodiversity. The objective of Gedge’s trip was to obtain the necessary information needed to convince governmental officials, planners, consultants, and other relevant stakeholders that green roofs are “both technically and an ecologically sound method of roofing” (livingroofs.org website). The industry’s growth during the past decade is evidence of his success. Gedge is currently the foremost authority on green roofs in the United Kingdom, and he can be considered a policy entrepreneur (similar to former Mayor Daley in Chicago) because of his tireless efforts in championing this cause. Gary Grant, a colleague of Gedge’s, states that “Dusty is a one-man industry...personally he has met everyone...he has virtually created it [the industry] from nothing himself” (Grant Interview, 2011). The table on the following page provides some statistics pertaining to London’s green roofs as of 2010.

¹⁹ The definition of a brownfield varies between the American and British context. In the United States, brownfields refer to post-industrial sites that are *contaminated* with pollutants. The term does not have this negative connotation in the United Kingdom.

Table III.1: London Green Roof Statistics

LONDON GREEN ROOF STATISTICS	
Impetus	Biodiversity (habitat mitigation), stormwater management, urban heat island reduction
Square meters of installed green roofs	715,000
Per Capita	0.0917
Percentage of green roof area coverage	Less than 1%
Roof type breakdown	Dominance of extensive green roofs (brown/biodiverse green roofs)
Percentage of Extensive	60% - 70%
Percentage of Intensive and Other (Semi-extensive, Semi-intensive)	30% - 40%
Green roof sales figures (2010)	Not available
<i>The above estimated figures are as of 2010 and were provided by industry experts.</i>	

Although Gedge continues to be instrumental in helping to spark interest in green roofs, the industry's expansion has resulted in the involvement of a plethora of actors in the implementation of green roofs. It is critical to identify and understand the key players that are involved, their motivations for becoming involved, and the division of responsibilities among the respective actors. Governance configurations and the dynamic interplay between the different stakeholders will shape the direction of the green roof movement and whether or not London will achieve its urban greening goals. By understanding the nuances and underlying considerations and motivations of the actors, one can effect change so as to improve the arrangements in order to achieve the desired goal. The subsequent section presents an analysis of the two dominant perspectives that have prevailed in London: the Economic Perspective and the Juridical-Administrative Perspective. This is followed by a discussion on the Political Perspective, which is currently under-represented in London.

3. Analysis of Perspectives

3.1 Economic Perspective

The economic perspective has primarily dominated London since the late 1990s. The underlying considerations of the economic perspective are efficiency and securing adaptation action. The green roof industry is being driven by the activities of a range of actors, including nature conservationists; ecologists; roofing suppliers; landscape firms; and green roof consultancies. The tasks and responsibilities of the private sector include: policy writing; consultation on green roof projects; design of green roofs; and installation and maintenance of green roofs. In relation to the four phases in the policy cycle, these responsibilities fall under the policy making or “PLAN” phase; policy implementation or “DO” phase; and the policy maintenance or “MAINT” phase. The considerations of efficiency and securing adaptation action are explored in detail below in order to explain the dominance of the private sector in the green roof field in London.

Consideration 1: Efficiency

The drive for efficiency is a defining characteristic of the private sector. Whether it is improved efficiency in the production of goods and services, or efficiency in terms of creating innovative products and solutions, the private sector is constantly changing to meet new market trends and consumer demand. Although the green roof industry in London is more mature than its Chicagoan counterpart, it lags behind the German green roof industry.²⁰ This difference in market maturity is reflected in the price of green roof systems, which are considerably cheaper in Germany. For instance, a green roof with a 100mm substrate depth costs around 63 Euros per square meter in the United Kingdom compared to an estimated 30 Euros per square meter in Germany. The efficiencies that the German industry has achieved in terms of production, installation, and distribution are a result of a larger market, or efficiencies of scale.

One of the major problems currently facing London is the installation of inefficient green roof systems that underperform and/or do not function the way they are intended. According to one respondent, green roof systems are important for a city or region since they contribute to societal well-being and to the city’s environmental health. An optimal green roof should help to improve the overall health of a city (i.e. performing an ecosystem service) while also enriching community building and societal relations. Given the plethora of green roof systems and the possibility of optimizing them for a variety of functions,²¹ it is not surprising that a lot of uncertainty exists regarding the type and quality of green roofs that consumers should procure. Consumers’ lack of knowledge on green roof systems as well as the specific circumstance of each individual client has created a unique niche for consultancies to fill. One of the conditions which activates the consideration of efficiency is the extent to which uncertainty creates the need for variety and innovation in adaptation solutions to tackle climate change impacts. The creation of consultancy firms that specialize in providing advice on roof greening is an example of how greater efficiencies are being achieved in London. Consultancies not only facilitate the procurement process and alleviate uncertainty regarding the types of green roofs that a consumer

²⁰ While the green roof industry in Chicago began to take off in early 2000, the German industry experienced its surge in growth beginning in the mid-1980s.

²¹ Several ecosystem services provided by green roofs include: stormwater retention; evaporative cooling; and biodiversity habitat.

should purchase, but they also encourage the installation of innovative green roof systems that satisfy client demand while also advancing other interests (i.e. city, communal).

Green roof consultancies perform an important role in London since they bridge the gap between consumer and supplier, thus streamlining the procurement process and educating the consumer on the suitability of various systems. The majority of consumers in London go directly to suppliers and roofing contractors for their green roof systems. This is problematic because businesses are going to try and market their specific products regardless of their suitability for the client. This means that a client's choice will be solely limited to the provider's designs, systems, and materials. In addition to the procurement process, inefficiencies also exist in the installation of green roofs. Unlike in Germany where nearly all green roof systems are installed by green roof specialists, over 50% of extensive green roofs in London are installed by waterproofing contractors. This poses a problem since waterproofing contractors are not specialists and may lack the requisite knowledge needed to install and maintain a green roof properly. Peter Allnut, a green roof product manager at Alumasc,²² states that the risk with this is that "you end up with roofs that survive instead of flourish..." (Allnut Interview, 2011). This sentiment is expressed by another respondent who emphasizes that installing a green roof should be likened to building a landscape rather than buying a *product*. The absence of a traditional green roof expert in London has created an opportunity for consultancies such as the Green Roof Consultancy (GRC) to perform a vital service for consumers, both individuals and commercial organizations, which seek to install green roofs.

The GRC has been in existence for nearly five years and one of its core responsibilities is to provide clients with "detailed specifications on how to meet certain objectives" (Grant Interview, 2011). The majority of the GRC's projects prior to the 2008 financial crisis comprised of residential new build. During the past several years their focus has been on retrofits for commercial and institutional properties. The GRC team is a collaboration of several individuals with backgrounds in ecology, environmental management, botany, and nature conservation (GRC website). Both Dusty Gedge and Gary Grant are consultants at the firm, and their objective is to help clients make well-informed decisions and to prevent them from buying green roofs the 'wrong way.' Besides providing advice, the GRC also designs and supervises the construction of green roofs. Cooperation among the different disciplines presents a distinct advantage for the GRC's clients. First, the consumer is receiving advice that is being generated from multiple perspectives. Second, the GRC does not aim to sell a particular product—green roofs are built 'from the ground up,' and are therefore built according to the client's specifications. The GRC can be seen as a neutral body in the sense that its chief motivation is to ensure that clients are installing appropriate green roofs that are also multi-functional.

While the remit of consultancies such as the GRC is to facilitate the procurement process of green roofs, improved efficiencies within the green roof sector have also been aided by the no-regret and multi-functional nature of green roofs. These two factors have helped the industry make noteworthy strides during the past several decades with regards to innovation and the marketability of their products and services. The growing interest in green roofs is reflected in the industry's growth figures. The green roof industry is one of the few sectors that has expanded and experienced rising sales during the current economic downturn. According to some industry expert estimates, sales during the past five years have increased by at least 50%. Many in the green roof field are optimistic about the industry's future. One of the primary advantages of this optimism is that it sustains interest in green roofs and promotes innovation in the sector. Because green roofs have the ability to perform a variety of (ecosystem) services simultaneously, businesses have been dedicating their time and financial

²² Alumasc is based in the United Kingdom and is a supplier of roofing and other building material.

resources to produce creative and innovative systems that will satisfy the diverse needs of their clientele. It is important to note, however, that this drive for innovation was not the norm several decades ago. For instance, during the early 1980s the motivation for selling green roof systems was chiefly monetary; in other words, it was a way for roofing companies to double the value of their sales effort. However, environmental issues such as biodiversity and climate change have changed people's minds on why to sell (or procure) green roofs. One respondent expresses a similar sentiment and claims that the various potential uses of a green roof were not actively explored during the 1980s. Since the initial catalyst for installing green roofs was for biodiversity purposes, interest in other possible uses (i.e. drainage, cooling) came on the agenda later on.

As already mentioned above, the multi-functionality of green roof systems has contributed to their success in terms of sales and continued innovation in the sector. However, another factor that has influenced the industry's advancement and rate of innovation has been the expertise and clout of ecologists. The ecological profession has been a strong proponent of the multi-purpose use of green roof systems. Grant asserts that it is an:

“old fashioned idea that in the built environment you only do one thing in one place...an ecologist intuitively knows that actually you can do a lot of different things in one place...so it's this idea of multi-functionality that goes back to the substrate issue...substrate is not just for one thing, it's not there just to grow plants...” (Grant Interview, 2011).

The type of substrate that is used is important since it determines the extent of a system's multi-functionality. A substrate mix dictates a variety of things about a green roof, including: plant species; depth of the system; and water retention capability. According to Grant, there is a lot of research presently taking place on identifying new material that can be used for substrates. The development of new substrate material can serve a variety of purposes. As an example, the creation of a new type of lightweight material can be used for a green roof system that is suitable for structures unable to handle the extra load of a traditional green roof. Grant states that “getting the substrate right has really come onto the radar in the past couple of years” (Grant Interview, 2011). However, he cautions that some research efforts in this area may be ‘reinventing the wheel.’ Years of research and development (especially by the Germans)²³ has resulted in blends of materials that support a variety of plant life, are lightweight, free-draining, and water absorbent. Some new research appears to ignore or discount the multi-functionality of green roofs and instead focuses on a particular issue such as drainage or plant health. Nonetheless, the possibility of advancement should not be dismissed; and the fact that the German industry has been working on substrates for so long has not discouraged stakeholders in the green roof industry in the United Kingdom or the United States from pursuing substrate research.

In a similar vein, innovation efforts are also targeted at improving the water storage capabilities of green roofs. This issue is of relevant interest to London because of the constant risk of flooding. While multiple studies which assess the water run-off from green roofs exist, the majority of these studies calculate run-off under normal rain conditions. There is a lack of information regarding the water retention performance of green roofs under surge or heavy storm events; this is also acknowledged by various private and public actors such as the Environment Agency (EA). The EA is especially interested in learning more about how green roofs react under big scenarios because they are

²³ The German substrate mix is 20% organic (due to fire regulations) and 80% inorganic. Highly absorbent and free-draining material such as recycled brick and porous rocks are used due to their water absorption capacity and promotion of drainage.

one of many methods that can be used for flood defense. The aim of increasing the saturation capacity of green roofs has resulted in firm's such as Alumasc in trying to develop new solutions to address this issue. Alumasc is currently in the research and development phase and the successful execution of their idea "will be a major step forward in green roof technology" (Allnut Interview, 2011). London's unique circumstance is driving Alumasc and other firms alike to push the innovation envelope and to generate tailor-made solutions that will help the city adapt and cope with the future impacts of climate change.

Another example of an innovative solution developed by the green roof industry is the green roof 'shelter.' Creativity in the field is limitless and constantly evolving, and the products produced by Green Roof Shelters Ltd. are a prime example of this.²⁴ Their work can literally be considered green building; in lieu of installing a green roof system on a traditional roof, the company installs them on alternative structures such as shipping containers (see **Figure III.1**).



Figure III.1: Green roof shelter used as a home office²⁵

These containers can serve a variety of purposes, including: bike sheds; storage; outdoor classrooms; exhibition rooms; and habitat for fauna and flora (Green Roof Shelters website; Gedge Interview, 2011). The shelters are custom-made and sustainable/recycled material is used for the substrate and other parts of the system. The design and versatility of these containers has attracted the attention of both the public and private sector. Firms may find it financially lucrative to engage in this type of business as consumer interest in these kinds of products grows, hence improving (dynamic) efficiency in the green roof sector.

²⁴ Green Roof Shelters Ltd. was founded by Dusty Gedge, John Little, Duncan Kramer (director), and Dan Monck.

²⁵ Image obtained from: <<http://greenroofshelters.co.uk/>>.

Consideration 2: Securing Adaptation Action

Despite the multitude of benefits that green roofs offer, their uptake in London and in other parts of the world has not reached its full potential. Although the green roof industry in the United Kingdom has increased significantly during the past several years, there is a considerable amount of space in London that has yet to be greened. According to an industry expert estimate, 10 million square meters of flat roofs in London could potentially be greened. Between 2004 and 2009 approximately 500,000 square meters of green roofs were installed in London, and current estimates for installed *and* planned are placed to be around 1,000,000 square meters. This represents less than 1% of the total roof area of greater London²⁶ (GLA, 2008). This figure is extremely low but it should be noted that not all buildings are suitable to have green roof systems due to issues such as structural limitations. The GLA's *Living Roofs and Walls Technical Report* (2008) assessed the greening potential of four areas in central London and found that an average of 32% had the opportunity to be greened in each of the following areas: Oxford Street; Cannon Street; Tottenham Court Road; and Canary Wharf (p. 25). From this estimate researchers can extrapolate the surface area that could be possibly greened in other parts of the London area. In spite of the obvious growth opportunities that the industry has in London, the adoption of green roofs has been hampered by various factors. Perceived barriers to their implementation include: structural issues; maintenance costs; lack of mandatory regulation; and up-front costs (GLA, 2008).

While the above-mentioned factors have influenced the implementation rate of green roofs in London, they only partly explain the (limited) uptake of green roofs. The nature of the climate change adaptation problem itself is one of the principle reasons why adaptation solutions have not been deployed at the rate and scale they are needed to deal with climate change. The impacts of climate change are trans-boundary and will affect people across regions and generations. The scope and complexity of adaptation can constrain the actions of private (and public) actors, thus leading to market failure and the under-provision of a good. Although some economists "suggest that much adaptation will occur spontaneously through marginal adjustments in markets and individual behaviour" (Tompkins et al., 2010, p. 628), the general consensus among academics, government bodies, and others in the scientific field is that both private and public intervention is required to provide the necessary financial, technological, and human resources needed to deal with climate change. The Stern Review (2007) also supports this viewpoint and maintains that public policy intervention is needed since the involvement of market actors alone will not lead to efficient adaptation. There is ample evidence in London to indicate that public and private stakeholders are actively consulting with each other in order to leverage their resources to promote the implementation of green roofs.

Both private sector individuals and organizations are dedicating their resources, time, and expertise to advocate the adoption of green roofs. The most visible and well-known promoter of green roofs in London is Dusty Gedge. Given that he is the green roof 'guru' of London, for over the past decade he has shared his knowledge and expertise with many stakeholders in the field. He is involved in a variety of activities, including: founder of livingroofs.org; writes policy and advises governmental officials on green roof matters;²⁷ works with the GLA to track the surface area coverage of green roofs; helped to develop the Environment Agency's green roof online toolkit; and provides training workshops

²⁶ According to an industry expert there is an estimated 200 million square meters of roof area which could possibly be greened, provided that the buildings can take the additional load and that it is financial feasible for the building owner.

²⁷ Dusty Gedge (along with Gary Grant) were involved in writing the section on Living Roofs in the London Plan.

to individuals interested in constructing green roofs. Although this list is far from being all-inclusive, it provides an idea of the extent of his responsibilities. The common thread among these activities is the information provision aspect of Gedge's work. Gedge recognizes that his work has made more officers and agencies knowledgeable; his advice is sought because of his years of experience in the field and since he is considered to be an independent expert. Gedge's involvement with government officials is important because his awareness of what is happening 'on the ground' could potentially lead to policy recommendations. This is significant because it can help bridge the potentially divergent visions between policy makers (who may be more idealistic in what can be achieved) and policy implementers (who may have a more realistic view of what can feasibly work and how it should be executed).

Green roof companies have also taken an active role in collaborating with government and academia in order to take advantage of each segment's area of expertise. As an example, Alumasc sponsored the Green Roof Center at the University of Sheffield. The firm provided the center with various green roofs so they could put on exhibition to showcase clients. One of the reasons why Alumasc decided to specifically collaborate with the University of Sheffield is because of the presence of Nigel Dunnett, an avid supporter of green roofs. Another important aspect of Alumasc's work is outreach to the architecture profession in terms of educating them on how they should be specifying green roofs. This currently falls under the responsibility of Allnut and his goal is to inform architects that they should be specifying green roof systems by performance. In other words, instead of requesting a green roof by type (intensive, extensive), architects should define the drainage layer, water capacity, and other parameters. In the absence of performance specifications, an architect will receive a standard off-the-shelf sedum blanket. Alumasc has also been involved in sponsoring a research team for the GLA to look into the benefits of green roofs. Although firms such as Alumasc possess impressive financial and scientific expertise that can be very useful to government, such resources may be underutilized due to public sector suspicion on the 'motivation' of private firms. This is not to say, however, that government officials do not welcome advice from private sector firms. For instance, Paul Edwards²⁸ of Hammerson has a working relationship with the GLA. He is part of the Sustainable Development Commission which functions as an advisory body to the Mayor's team at the GLA. Edwards' collaboration with them is not surprising considering his firm's reputation within the real estate management field as a promoter of green roofs and other sustainable elements.

In addition to private actors and organizations, the public sector has also taken initiative to promote the adoption of green roofs. Another factor that has hindered the implementation of green roofs is the amount of time it takes to reap the benefits of having a system. For instance, one of the benefits of green roofs is that owners can expect lower heating/cooling costs because of the insulation and evapotranspiration provided by the roofs. These costs in savings, however, are not immediate and will accrue over time. Because of the time lag between expenditure on the system and benefit reaping, many people opt against installing a green roof. The work of governmental departments such as the Environment Agency is to dispel people's misconceptions about green roofs and to educate them on their long-term benefits. Awareness-raising falls under the agency's statutory remit, and they have been utilizing electronic media as a method of outreach to the public and private sector. Their green roof toolkit²⁹ is available on their website and it is a resource that citizens, developers, consultants, and others interested in procuring green roofs can use to help them better understand what green roofs are and the steps they need to take to construct one. Similarly, the GLA is also in the process of creating a

²⁸ Paul Edwards is the Head of Sustainability for Hammerson PLC.

²⁹ The green roof toolkit was created with the help of external consultants- this is a project that Dusty Gedge worked on.

green roof portal³⁰ that can be used as a forum for information exchange. The electronic portal will serve as a social medium that allows cooperative interaction among developers, public officials, and other stakeholders. Individuals will have the ability to create forums, contact others, and share their experiences. In depth case studies³¹ documenting green roof projects will also be available on the portal, thus allowing stakeholders to observe what is happening in other boroughs and to obtain advice from those that have gone through the project phase.

Public action has not been limited to information provision via electronic media. Another step that the government has taken to continue to secure and stimulate interest in green roofs has been through research projects. The Drain London project was established by the GLA in 2007 and its objective is to better understand the risks that flooding poses across the different parts of London as well as to create solutions to deal with surface water flooding. Because of green roofs' water attenuation capabilities, funding has been set aside to conduct research on several green roof test sites in London. The aim of the research is to collect data and to monitor the run-off from the green roofs. This will allow researchers to generate a run-off coefficient and to determine the water saturation and drainage capacity of the roofs. These studies are important on various levels. First, there is growing demand among the private sector to conduct this kind of research in London versus relying on estimates generated from test plots located beyond the region. The validity and applicability of 'external' figures to London is driving this demand for more local research. Second, the generation of hard, quantifiable figures regarding the benefits of green roofs on water drainage, cooling, etc. will resonate strongly with contractors, developers, and their consultants. Both the GLA and the EA admit that more quantitative evidence is needed in order to convince these stakeholders that green roofs are in fact worth incorporating into their projects. According to one respondent, additional research in this area will help drive green roofs since consultants can incorporate such figures into their technical calculations. Hence, consultants can conduct a cost-benefit analysis and can subsequently advise their client (i.e. developer, housing corporation) that utilizing a green roof will be more cost efficient in lieu of an alternative structure.³²

Conclusions

Efficiency and innovation in the green roof sector are significant factors that are driving private actor involvement, hence the dominance of the economic perspective. The formation of green roof consultancies to facilitate procurement, innovations in system design and uses, and improvements in green roofs' functionality represent a range of activities that businesses are engaged in. The no-regret nature of green roofs along with the research and promotional work that the private and public sectors are involved in are important for overcoming the barriers to the adoption of the technology. However, the consideration of securing adaptation action does not appear to be a strong consideration for activating government involvement in the issuance of financial incentives. The city does not provide any direct or indirect financial incentives to encourage the uptake of green roofs. Changes in this approach

³⁰ Per my current (2012) discussion with interviewees, the development of the green roof portal has been placed on hold.

³¹ Case studies compiled by the City of London can be found at: http://www.cityoflondon.gov.uk/Corporation/LGNL_Services/Environment_and_planning/Urban_design/Sustainable+Design.htm.

³² An underground water storage tank is an example of an alternative structure.

can open up the market to segments of society that were previously unable to procure roofs because of financial constraints, thus further advancing the spread of the technology.

3.2 Juridical-Administrative Perspective

The juridical-administrative perspective has also been a dominant perspective in London and it is based on the considerations of the rule of law and principles of equity and fairness. The city agencies that are most actively involved in green roof matters include the Environment Agency and the GLA. The Environment Agency's statutory remit encompasses flood risk and biodiversity matters. It is also a statutory consultee in the planning process; the agency provides advice to local authorities but it does not make decisions on their behalf. Local authorities can seek advice from the agency but they are not required to accept its recommendations.³³ Specifically relating to green roofs, the Environment Agency's responsibilities include the dissemination of information and research on green roof test plots. The agency is also involved with green roofs via their statutory remit which obligates them to comment on drainage systems for new developments. The GLA is the primary governmental authority on green roofs in London, and its responsibilities include the development and implementation of policy; research; information provision; and tracking green roof installations. The activities of both of these agencies encompass the "PLAN", "DO", and "CHECK" phases of the policy cycle. It is important to note though that these responsibilities lie chiefly in the "PLAN" and "DO" phases. Policy evaluation and maintenance are areas that have not received a lot of attention. The considerations of rule of law and principles of equity and fairness are explored in detail below to explain the dominance of the government sector in the green roof field.

Consideration 1: Rule of Law

There is considerable uncertainty surrounding the future impacts of climate change and when those impacts will manifest themselves. London is expected to have wetter winters and hotter summers (City of London, 2010). Because the time horizon for experiencing these changes is uncertain, many cities and governments do not have an incentive to change the status quo because there is no sense of urgency. For this reason, most adaptation appears to be reactionary instead of anticipatory. Mendelsohn (2000) reinforces this point and states that:

"it seems that most adaptation is likely to be reactive. That is, in most cases, it is sufficient that firms, individuals, and governments react to the climate as it is observed to change. There is little additional benefit to acting in anticipation of a predicted change in climate" (p. 596).

London is departing from the status quo and being preemptive by taking steps to ensure that the city is prepared to cope with the future impacts of climate change. The government is attempting to realize its goals via the enactment of various plans and regulations that will help facilitate: the reduction of carbon emissions; uptake of sustainable adaptation solutions such as green roofs (and other SUDs);³⁴ creation

³³ The planning department of each local authority is the entity responsible for issuing building permission within its area.

³⁴ SUDs refer to sustainable drainage systems. Examples include permeable paving, rainwater harvesting, and infiltration trenches.

of flood risk management plans; and overall urban greening. The Greater London Authority Act (2007) also mandates the Mayor to contribute to climate change mitigation and adaptation (GLA, 2008). The execution of the Mayor's mandate is made possible via the London Plan.³⁵ The Plan is an overarching guiding document that addresses a host of issues relating to adaptation, sustainable building, the economy, and how to improve Londoners' overall quality of life. The significance of the document with regard to green roofs is that it contains a section that explicitly promotes their use. According to Policy 4A.11, "the Mayor will, and boroughs should, expect major developments to incorporate living roofs and walls where feasible and reflect this principle in DPD policies" (GLA 2008, p. 210). It should be noted that in its earlier version the London Plan "encouraged" rather than "expected" the installation of green roofs. The revised 2008 version now places the burden on developers to explain why they cannot incorporate a green roof into their plans. Boroughs are also required to support this policy and to incorporate it into their planning documents and local development frameworks. Although Policy 4A.11 is not iron-clad, boroughs have the power to pressure developers via the planning permission process. Local authorities can reject a project or slow down the approval process if it does not meet certain standards. Consequently, developers can be compelled to incorporate a green roof in order to make sure their project proceeds.

There are other various regulations and documents that have been enacted or are in the process of being drafted to support the adoption of green roofs, both directly and indirectly. First and foremost, the Mayor's Biodiversity Strategy (2002) deserves mention since the initial catalyst for the implementation of green roofs was due to habitat and biodiversity concerns. The Biodiversity Strategy advocates green roofs because they can serve as habitats for birds (such as the black redstart) and other flora and fauna. In relation to climate change concerns, the Flood and Water Management Act indirectly supports green roofs since it requires the incorporation of sustainable drainage systems in new developments where feasible. The aim is that these drainage systems are "built to standards that reduce flood damage and improve water quality" (GLA, 2009, p. 62). The most important provision within this act that helps give it 'teeth' is that developers are only permitted to connect to public sewers if their projects receive consent from the SUDs approval body. Hence, developers will be encouraged to install green roofs or other SUDs into their designs. Another important strategy that supports the implementation of green roofs is the Mayor's 2010 Draft Climate Change Adaptation Strategy.³⁶ It specifically discusses the benefits of green roofs as a SUDs technique and how they can be used to mitigate climate change risks.

In addition to the aforementioned, there is an even more compelling reason why climate change adaptation is essential for the City of London. According to one government official, a duty of care is requisite because the city is a strategic asset of national importance. An estimated 90% of London's GDP is generated within the city, which translates to about 3% - 4% of the United Kingdom's GDP. Thus, adapting to climate change will not only ensure that the city is able to cope with future environmental impacts, but it also ensures the city's future financial and economic viability.

³⁵ The London Plan was first published in 2004 but is continually undergoing revisions (it was last published in July 2011).

³⁶ The finalized version of the climate adaptation strategy was published in October 2011.

Consideration 2: Equity & Fairness- Precautionary Principle

The shift in responsibility with respect to flood water management is one example of how climate change considerations are extending to the local level. Throughout the past several years, changes in UK legislation have placed greater responsibility for surface water management to the local authorities. Such changes will affect the uptake of green roofs because they are a SUDs technique. The reason for this reallocation in responsibilities stems from the 2008 Pitt Review, which was commissioned in response to the flooding that London experienced in 2007. In response to Sir Michael Pitt's findings, the government enacted several changes. First, it extended the Environment Agency's remit to include flood risk. Second, it mandated local authorities to prepare local surface water management plans.

Besides the Environment Agency, local planning authorities and their consultants are closely involved in the development of strategic flood risk assessments.³⁷ The burden of implementing the flood management plans now primarily falls into the hands of local authorities. The passage of the Flood and Water Management Act (2010) reinforces this shift in duties and states that "lead local authorities must develop, maintain, apply and monitor a strategy for local flood risk management in their areas" (British Property Federation, 2010, p. 2). However, the act takes it a step further and also requires local authorities to establish SUDs approval bodies that will be responsible for assessing and approving the sustainable drainage systems that developers are required to incorporate into their projects. Hence, local authorities will have more 'on the ground' responsibilities and can use their extended remit to actively promote green roofs. The path of green roof implementation will undoubtedly be affected by the act and it is up to the boroughs to take advantage of this in order to promote the uptake of green roofs in their areas.

The table on the following page provides an overview of the different regulatory, economic, and communicative instruments used in London to promote green roofs.

³⁷ The GLA provides guidance and sets guidelines for the strategic flood risk assessments.

Table III.2: London Policy Instruments

London Policy Instruments	
Legal control model (influencing behaviour through rules and regulations)	
Technology-based regulation (i.e. building codes)	London Plan (since 2004)- there is the expectation that major developments will incorporate green roofs; onus is on the developer to explain why they cannot incorporate them
Performance-based regulation (i.e. LEED)	Green roofs qualify as a SUDs technique – The Flood and Water Management Act requires the incorporation of sustainable drainage systems in new developments where feasible
Economic control model (influencing behaviour through costs and benefits)	
Direct financial incentives	None
Indirect financial incentives	None
Communication control model (influencing behaviour through knowledge and information)	
Information and education	<ul style="list-style-type: none"> • Livingroofs.org website • Drain London project • Environment Agency online green roof toolkit • GLA green roof portal (in the process of being developed)
Contractual agreements	None

Conclusions

Although London has not made the installation of green roofs mandatory, there are various regulations that support their adoption both directly and indirectly. The London Plan is most explicit since it *expects* developers to incorporate them into development projects where feasible. Furthermore, the Flood and Water Management Act is also influential because it mandates the use of sustainable drainage systems. The considerations of rule of law and equity and fairness have stimulated governmental involvement in green roof matters. Flooding is of great concern to the City of London, and the Mayor and local authorities have a duty to protect their citizens from this risk. Because mandatory regulation is unlikely in the near future, the city should explore alternative options that can be deployed to break down barriers and encourage its citizenry to procure green roofs.

3.3 Political Perspective

The political perspective, which is governed by the considerations of legitimacy and accountability and transparency, is currently marginalized in London. It sets itself apart from the other perspectives since it is characterized by joint public-private collaboration in the sharing of responsibilities. The marginalization of this perspective does not imply that there has not been collaboration between the public and private sectors with respect to the implementation of green roofs. The previous sections have cited a number of examples that illustrate cooperation between government officials and green roof firms. In spite of these instances of cooperation, there is a lack of widespread collaboration among civilians, governmental officials, and green roof businesses throughout the different phases of the policy cycle. For instance, although acts and plans undergo a public examination (i.e. London Plan), the actual policy-making is executed by the government. While the public examination provides a platform for different stakeholders to voice their opinions, these opinions are not welcomed during the actual policy-writing stage. It is also important to note that it may very well be that civilians do not feel vested in the process or do not feel the need to get involved in climate change adaptation issues. Therefore, this disconnect between a truly joint public-private collaboration can be attributed to a range of factors, including the absence of institutional structures that can help support greater interaction between the different societal segments.

One respondent attributes this disconnect to the “Anglo-Saxon way” of doing things, which encourages the marginalization of the public. The interviewee maintains that this approach intends to keep policy in the hands of professionals while deliberately isolating the public from the decision-making process. The respondent acknowledges that for issues as complex as climate change, public involvement is necessary. He stresses the importance of engaging the public in adaptation solutions such as green roofs and asserts that this can be accomplished in a holistic way. Corfee-Morlot et al. (2009) reinforce this view and state:

“The successful integration of adaptation into local development processes depends on a number of enabling conditions. There needs to be broad and sustained engagement with and participation of local stakeholders, including local governments, communities, civil society and businesses. Local authorities need to adopt a collaborative approach where local actors are seen as legitimate decision-making agents” (p. 33).

The interviewee recommends reaching out to activists in communities and identifying actors who are championing causes such as climate change adaptation. This kind of outreach has the potential to be much more effective in generating interest in green roofs and other adaptation issues as opposed to disseminating information via leaflets, etc. The multi-level sector and actor complexity of adaptation requires the involvement of a variety of stakeholders; the current status quo of governmental and private sector domination in the green roof implementation process has not been detrimental to the uptake of green roofs. However, the adoption of green roofs has yet to reach its full potential in London and this can be attributed to people's lack of awareness on green roofs and their benefits, or simply their disinterest in them. By garnering public support and making the average London citizen feel a sense of accountability in the process, the adoption of green roofs and the move toward a more sustainable society can be facilitated.

Conclusions

The marginalization of the political perspective in London is of relevance because it can explain why climate adaptation measures such as green roofs have not been adopted on a wide scale. The lack of *true* collaboration among non-governmental actors and policy officials can be partly attributed to the political climate and London's legal/institutional framework. Climate adaptation is a complex issue and touches upon various policy sectors and affects society on multiple levels. Because of this complexity and the uncertainty surrounding future climatic impacts, all segments of society should be encouraged to participate in the adaptation process. The establishment of rules which provide the public the legal right to participate in the review process of plans³⁸ (as is done in Stuttgart) and the creation of communication channels/venues where Londoners have access to policy-makers can help activate the considerations of legitimacy and transparency. It is key for the public to feel more vested in the process. Mitigation alone will not suffice to help the city cope with the future impacts of climate change. Hence, it is important that Londoners understand this and participate in the climate adaptation process in order to facilitate the spread of green roofs and other adaptation measures.

4. Green Roof Governance Arrangements: Contextual Factors

The allocation of responsibilities and the configuration of green roof governance arrangements in London have been shaped by the characteristics of the climate change problem along with economic and political factors. The importance of economic considerations explains the dominance of private actor involvement in the green roof sector. Innovation and improved efficiencies are driving market demand and hence ensure that green roof businesses will continue to engage in research and development. Innovation in green roof usage (i.e. green roof shelters) and the development of systems with a specific purpose in mind (i.e. biodiversity, water retention for stormwater management), are just a few of the many ideas that we are seeing from the private sector. The green roof industry has experienced double digit growth in the past several years and shows no sign of slowing down. Consumer demand and climate change concerns have helped to sustain interest in the roofs. Economic

³⁸ Although the public can review plans via a Public Examination (as is done for the London Plan), citizens should also have the right to provide recommendations and to make objections that will undergo consideration. For instance, citizens in Stuttgart can seek recourse via the courts if they object to some aspect in a spatial plan that will result in a detrimental effect on them.

considerations are clearly influencing private actors and their decision to join this expanding niche industry. The political climate in London also elucidates as to why the government is taking a more 'hands off' approach in terms of instituting mandatory regulation. The ethos of not placing undue burdens and restrictions on businesses and the civilian sector coupled with the belief that government should not get 'involved' is prevalent, and explains why government officials have not adopted additional measures for fear of stifling the market.

Besides economic and political factors, the inherent nature of the climate change problem has also impacted London's governance arrangements and the division of responsibilities. Uncertainties surrounding future potential impacts and their long-term character make it difficult to project the actual impacts that London will experience. Because of London's importance, both economically and culturally, the government is being precautionary and taking steps to ensure that the city's future is safeguarded from potentially detrimental effects. The various plans and acts that it has issued (i.e. Climate Change Adaptation Strategy, Flood and Water Management Act) represent a few examples of the government's precautionary approach toward the problem.

5. Allocation of Responsibilities

The allocation of responsibilities among the different public and private actors in the green roof governance process in London generally coincides with the 'public/private' divide. In other words, the government sector is primarily responsible for policy-making and implementation, while the private sector is engaged in the design, installation, and maintenance of green roofs. However, one interesting fact to take note of is that private individuals (specifically referring to Dusty Gedge and Gary Grant) did take part in the policy-writing process for the London Plan (in its earlier versions).³⁹ They were commissioned to contribute to the section on living roofs. This is a departure from Chicago's Sustainable Development policy-writing process since it was in the hands of Michael Berkshire, a governmental official. It is important to note, however, that while the writing was sub-contracted in London to private individuals, control in what was written was retained by the public authorities. This can be interpreted in a favorable light because it suggests that the government is not opposed to involving external actors when it deems it fit.

City officials interviewed at the Environment Agency and at the GLA are satisfied with their current responsibilities and are not actively seeking to assume other tasks to execute in relation to green roofs. However, governmental officials recommend that there are ways that the private sector could further contribute to the uptake of green roofs. Both the Environment Agency and the GLA stress the importance of additional research being carried out with regards to assessing the water attenuation capacity of green roofs under heavy rain events. In a similar vein, Grant mentions that more research should be dedicated to assessing roof gardens and their functionality. He states that there is a plethora of studies on extensive green roofs while there is a limited number on roof gardens. One of the reasons for this discrepancy is due to the fact that roof gardens are highly variable and complex, and therefore the applicability of data results may be limited. Regardless, research in this area is needed because it is critical to know whether they are performing as expected. While government officials state that more research is needed, they are in favor of the private sector assuming this responsibility. Interestingly enough, during my interviews individuals from the private sector asserted that government entities such

³⁹ Dusty Gedge and Gary Grant did not take part in policy-writing in the latest London Plan (2011). They were consulted along with other experts in the industry.

as the GLA should spearhead this kind of research. Nevertheless, the consensus among both public and private stakeholders is that more research is needed to help drive the implementation of green roofs.

Another area that requires attention is the development of green roof standards. Currently, green roof firms in the United Kingdom follow the German FLL standards. The UK has also produced its own green roof code, which some actors refer to as the watered down version of the FLL. These codes provide guidance on best practices relating to the specification, installation, and maintenance of green roofs (GRO, 2011). The quality of green roofs is a growing issue in London and in other parts of the UK, and one way to ameliorate this is through the development of quality standards. According to one respondent, there are a lot of roofing firms that do not have a proper understanding of the technology which is why a number of green roofs fail after installation. However, it is unclear as to who this responsibility of 'standards development' should fall under. This would be an ideal opportunity for public-private collaboration due to the private sector's expertise in green roofs. Furthermore, ensuring adherence to the standards is an even more complex matter. Suggestions that surfaced during my interviews included the incorporation of standards within building regulations, or that insurers demand that only accredited professionals have permission to install green roofs on the buildings they insure. This topic will certainly remain on the green roof agenda given the continued interest and growing popularity of green roofs in London. As the issue becomes more prominent decisions will have to be made regarding the actor(s) who will be responsible for (1) creating standards and (2) making sure that they are being adhered to and implemented.

6. Green Roofs: Going Forward and Future Goals

While the initial primary motivator for green roofs was for biodiversity reasons- the preservation of habitat for the black redstart- there are currently other important drivers that are sustaining interest in them. In particular, concerns about climate change, flooding, and the urban heat island effect are influencing the actions of a variety of stakeholders and are a catalyst for their incorporation of green roofs into their homes and businesses. An additional factor that is driving the implementation of green roofs is the 'sustainable green image.' Per interviewee responses, many organizations are embracing the urban greening agenda and are taking measures to incorporate green roofs to improve the aesthetics of their local environment. Green roofs provide valuable amenity space for residents and employees, and there is growing demand for this in cities. According to one respondent, London's smoking ban encouraged employers to install green roofs in order to provide their employees with an external space to congregate. Corporations, in their desire to present a sustainable image, are being proactive in procuring green roofs. Whether the aspiration to be green is genuine or not is another matter. Nevertheless, corporations are taking sustainability seriously and this is evident in the creation of sustainability departments within their firms and their production of corporate social responsibility reports which document their activities and progress in the field.

Although the above-mentioned factors are helping to promote green roofs, more can be done to encourage their uptake. Several of the actors that I interviewed are highly in favor of mandatory regulation. However, mandatory regulation in the future is very unlikely; in lieu of it, financial incentives can be used to attract interest in green roofs. Several respondents have mentioned that developers have expressed interest in receiving financial support for the structural surveys they conduct when assessing the capacity of a building. Incentivizing retrofits (but not new construction) is recommended by another respondent as an option for supporting green roof uptake. Retrofits can be significantly more costly than installing green roofs on a new building because often times buildings will have to be

structurally fortified before they could have them installed. Because retrofitting is becoming more popular and is a growing market, several respondents emphasize that it is important to take advantage of the momentum because this segment of the market will continue to expand into the future as the building stock ages.

Improvements in policy-writing and the knowledge base of planning officers can help to increase the quality of future green roof installments as well as their rate of implementation. According to one interviewee, during the policy-making phase it is essential that the city receives advice from ‘independents’ and does not solely seek advice from the market. The reason why this demarcation is important is because the market will use its influence to promote policy that is in its favor. While the respondent believes that developers should be mandated to install green roofs, he maintains that the city should write policy that tells the market the kind of green roofs that they should supply. He also advocates the creation of policies that are not just carbon or water based, but policies that allow the city to articulate its regionality and specific circumstance. This means that policies should be constructed in a manner that promotes the health and social well-being of the city.

Beyond policy writing, several respondents acknowledge that the level of expertise possessed by planning officers is another issue at hand. Planning officers are responsible for advising committees who issue permission for projects. If they lack the appropriate expertise they could potentially be encouraging the approval of projects that are installing subpar green roofs. While interviewees recognize that this is a problem, they point out that planning officers are not green roof experts. Although planning officers are responsible for reviewing the details of proposed green roof systems and looking out for certain specifications, many do not have the requisite knowledge to definitively determine whether or not a system is of good or bad quality. This topic also came up during the last green roof stakeholder meeting because there is concern on whether or not planning officers in the boroughs have the necessary knowledge and “confidence” to deal with green roof quality and other related issues. It is evident that work in this area is needed and that planning officers should be trained appropriately if they are dealing with green roofs. One interviewee suggests that what is equally as important is that the application process should be improved so as to facilitate the work of the planning officers. Green roof design proposals should be detailed, well-researched, and presented by the applicants or their consultants. It appears that the application/submission process can be enhanced by requiring clients to provide more details and information on their green roof systems. This would enable planning officers to accurately assess and approve projects in a timely manner. Alternatively, boroughs can appoint a green roof specialist that can exclusively deal with that aspect of the application process. Overall, there are various areas that have the opportunity to be improved and it is up to green roof stakeholders to ensure that these issues are addressed.

The table below presents a snapshot of the key items mentioned in this section.

Table III.3: Potential Future Goals for the City of London

Potential Future Goals
<ul style="list-style-type: none"> • Possibility of stronger regulatory measures in the future given that mandatory regulation is not currently feasible due to the political climate • Provision of financial support for structural assessment surveys • Provision of funding for retrofitting • Improvement in the knowledge base of planning officers and in policy writing (with quality control in mind)

7. Synthesis and Conclusions

London's green roof industry has grown considerably over the past decade. While the impetus for green roofs has shifted from biodiversity to climate change concerns, biodiversity still remains on par (albeit not as visible in terms of media coverage) as a push for green roofs. The green roof governance arrangements in London reflect the dominance of the economic and juridical perspectives. From the very beginning, ecologists and nature conservationists used their influence to advocate for their implementation, especially with respect to habitat conservation for the black redstart. Parallel to that, private sector firms initially expressed interest in green roofs since they were a means to increase sales. However, growing environmental concerns (flooding, urban heat island effect) and research and development into the benefits and multi-functionality of green roofs have helped to sustain private sector interest in them. The government's objective for advocating green roofs stems from climate change concerns and the desire to protect London from (future) detrimental impacts.

The allocation of responsibilities in London's green roof governance arrangements corresponds with the public-private divide. Public officials are heavily involved in the policy-making and implementation phases, while private actors assume greater responsibility in the latter phases of the policy cycle. The activities of private actors focus on information dissemination, financing, and the physical installation of the systems. It is interesting to note, however, that in London a private actor (Dusty Gedge) was responsible for placing green roofs on the political agenda. The consideration driving his involvement was *securing (biodiversity) action* since he believed that green roofs could serve as habitat mitigation for the black redstart. The consideration of *rule of law* influenced policy initiation on behalf of public authorities. The two national acts discussed earlier in this chapter place the responsibility for flood water management and protection on the mayor and local authorities. *Securing adaptation action* is another consideration taken into account by public officials. Their decision to place the onus for installing green roofs on major projects onto developers is one additional method to help ensure that green roofs are being considered for inclusion in development projects. Because London is of national strategic importance, the *precautionary principle* also comes into play in the decision-making process. Taking action now is vital in order to safeguard its future. The potential future effects of climate change have the ability to significantly (and negatively) impact London on a variety of scales, including economically and environmentally. As in Chicago, private actors are driven by the consideration of *efficiency*. The industry is expanding rapidly and there is strong demand for green roof systems because of the multitude of benefits they provide. Dusty Gedge stands out in this respect because he was motivated by the desire to protect a bird species.

The policy instruments that London has at its disposal for promoting green roofs are limited. Its primary mechanism is via the non-binding policy in the London Plan. London's Climate Change Adaptation Strategy also mentions green roofs and promotes their use as a SUDs technique. The city offers no economic incentives to alleviate the financial burden of installing a green roof. In light of this, the government has been active in knowledge-sharing and research. The city is opting to pursue non-economic measures to promote the adoption of green roofs and is taking steps to ensure that green roofs are being integrated into different departmental plans.

There are various barriers and opportunities to the implementation of green roofs. Structural limitations of buildings, up-front costs, lack of mandatory regulation, the time lag between cost expenditure and benefit-reaping, and a general lack of knowledge/interest in green roofs represent common barriers. It is important to note that although these factors can be a strong deterrent to some (especially those with limited financial means), they are not overwhelming in the sense that they cannot

be overcome. In spite of these barriers, the adoption of green roofs continues to grow in London. One of the most important drivers for green roofs is the quest for the 'green' corporate image. There is a lot of pressure on corporations to be (or appear to be) green and sustainable. Green roofs present a perfect opportunity for them to showcase their sustainability ethos because they are so visible. Additionally, the desire for green space in the 'urban jungle' is also driving the implementation of green roofs since there is a growing demand for employers to provide amenity space to their employees. Further research into the water attenuation benefits of green roofs also presents an ideal opportunity for attracting additional interest. Quantitative data in particular will resonate strongly with the construction community, and various interviewees mentioned that additional research in this area will be favorable to the green roof sector.

The outlook for the future of green roofs in London is positive. However, responsibilities and involvement must also extend to the civilian sector. The political perspective is marginalized in London just like it is in Chicago. Although interaction and collaboration exists among stakeholders in the public and private sectors, it can be characterized as being more of a 'consultation' rather than a true collaboration throughout the policy cycle. During my interviews this was acknowledged as being a problem, and changes need to be made in order to shift the current status quo into a more collaborative process. It does not suffice to have the involvement of government and business only—there is an untapped segment of society that can help further this cause along and their input is necessary for this process to be successful.

References

- Allnut, Peter (2011). Green Roof Product Manager, Alumasc. Interviewed by Jennifer Stamatelos, London, May 23, 2011.
- Blackburn, Ian (2011). Development and Flood Risk, Environment Agency. Interviewed by Jennifer Stamatelos, London, May 19, 2011.
- Burdock, Lesley (2011). Planning Officer, City of London. Interviewed by Jennifer Stamatelos, London, May 16, 2011.
- British Property Federation (2010). Briefing on the Flood and Water Management Act, 2010. Retrieved August 11, 2011, from http://www.bpf.org.uk/en/files/bpf_documents/commercial/BPF_briefing_on_the_Flood_and_Water_Management_Act_2010.pdf.
- City of London (2010). Rising to the Challenge- The City of London Climate Change Adaptation Strategy. First published May 2007, revised and updated January 2010.
- Corfee-Morlot, Jan, Lamia Kamal-Chaoui, Michael G. Donovan, Ian Cochran, Alexis Robert and Pierre-Jonathan Teasdale (2009), "Cities, Climate Change and Multilevel Governance", *OECD Environmental Working Papers N° 14*, 2009, OECD publishing, © OECD.
- Edwards, Paul (2011). Head of Sustainability, Hammerson. Interviewed by Jennifer Stamatelos, London, May 20, 2011.
- Environment Agency. Green Roof Toolkit. Retrieved August 11, 2011, from <http://www.environment-agency.gov.uk/business/sectors/91967.aspx>.
- Gedge, Dusty (2011). Founder of livingroofs.org. Interviewed by Jennifer Stamatelos, London, May 13, 2011.
- Grant, Gary (2011). Green Roof Consultant and Ecologist, Green Roof Consultancy. Interviewed by Jennifer Stamatelos, London, May 11, 2011.
- Grant, Gary et al., 2003. Green Roofs: their existing status and potential for conserving biodiversity in urban areas. English Nature, United Kingdom.
- Greater London Authority (2002). The Mayor's Biodiversity Strategy. Mayor of London, UK.
- Greater London Authority (2007). The Mayor's Climate Change Action Plan. Mayor of London, UK.
- Greater London Authority (2008). Living Roofs and Walls Technical Report: Supporting London Plan Policy. Mayor of London, UK.

Greater London Authority (2009). The Mayor's Draft Water Strategy. Draft for public consultation. Mayor of London, UK.

Greater London Authority.^a Retrieved August 11, 2011, from <<http://www.london.gov.uk/who-runs-london/mayor/publications/society/facts-and-figures/population>>.

Greater London Authority.^b Retrieved August 11, 2011, from <<http://www.london.gov.uk/>>.

Green Roof Consultancy. Retrieved August 11, 2011, from <<http://greenroofconsultancy.com/>>.

Green Roof Shelters. Retrieved August 11, 2011, from <<http://greenroofshelters.co.uk/>>.

GRO (2011). The GRO Green Roof Code: Green Roof Code of Best Practice for the UK 2011.

Hayes, Jack (2011). Major Projects Officer, Environment Agency. Interviewed by Jennifer Stamatelos, London, May 19, 2011.

Kane, Kerstin (2011). Planning Officer (Urban Design), City of London. Interviewed by Jennifer Stamatelos, London, May 16, 2011.

Mendelsohn, Robert, 2000, 'Efficient Adaptation to Climate Change', *Climate Change*, no. 45, pp. 583-600.

Mills, Simon (2011). Head of Sustainable Development, City of London. Interviewed by Jennifer Stamatelos, London, May 17, 2011.

Stern, N. (2007). The Economics of Climate Change. The Stern Review. Cambridge University Press.

Thomas, Matt (2011). Urban Greening - Transport & Environment, Greater London Authority. Interviewed by Jennifer Stamatelos, London, May 24, 2011.

Tompkins et al., 2010, 'Observed adaptation to climate change: UK evidence of transition to a well-adapting society', *Global Environmental Change*, no. 20, pp. 627-635.

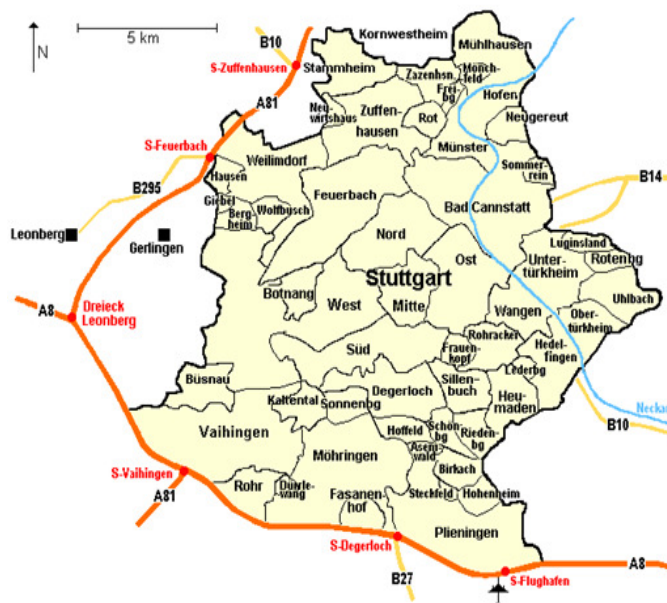
Images:

Map of the United Kingdom: <http://tinyurl.com/8xkqwf7>>.

Map of London's boroughs: <http://tinyurl.com/7wvyla6>>.

Chapter IV

Green Roofs Stuttgart



1. Stuttgart: Introduction

The City of Stuttgart is one of the most important economic and cultural centers in Germany. It is the capital of the State of Baden-Württemberg and is the sixth largest city in Germany. Stuttgart has an estimated population of 600,000 people, while the greater Stuttgart region comprises of an estimated 2.7 million inhabitants (ECONOMIC expert website). The city is divided into twenty-three districts; while each of the smaller districts has a local council, the main authority is the City Council of Stuttgart. The council consists of a parliament and is headed by the Lord Mayor, Wolfgang Schuster. Local authorities in Germany “are not restricted to the duties mandated to them by the national government...The Basic Law (Grundgesetz) and constitutions in each of the German Länder guarantee the right of ‘self government’” (Bulkeley & Kern, 2006, p. 2239). The decentralized government system in Germany provides municipalities with the latitude to execute their mandate and statutory duties as they see fit within the national legal framework.

Stuttgart’s repute as a center of economic importance stems from its commercial activities. The city’s economy has been heavily influenced by the industrial sector. It is best known for its automotive industry and it is the home of companies such as Porsche and Daimler AG. The high-tech and chemical industries are also dominant in Stuttgart, and industry giants such as Hewlett-Packard, IBM, Pfizer, GlaxoSmithKline, Bosch, and Roche have chosen Stuttgart as their headquarters. The city enjoys a fairly low unemployment rate and nearly 24% of Stuttgart’s workforce is employed in the high-tech sector (Stuttgart Region Economic Development Corporation, n.d.). Stuttgart is also known for its academic institutions and the cutting-edge technological research they are engaged in. Its status as an academic and industrial hub has helped Stuttgart to become one of the wealthiest cities in Germany.

Stuttgart has set itself apart from other German cities on another dimension—it is one of the greenest cities in Germany. The city covers an area of 207 km² and nearly 24% of this is woodland (Office of Urban Planning and the Environment, 2010). Stuttgart is also one of Germany’s main wine producing regions. Greenery in the form of vineyards, forests, parks, etc. is prevalent throughout the city. Despite this greenery, the city’s location and geographical characteristics have had a negative impact on its environmental health. Stuttgart is located in the southern part of Germany and is situated in the River Neckar valley basin. Steep hill slopes surround the city on three sides, thus influencing the city’s climate and air flow exchange. Stuttgart’s poor air quality is a symptom of its mild climate, low wind speeds, geographics, and industrial activities (GRaBs website). Development on the valley slopes has further exacerbated the issue because built construction blocks air flow corridors that serve to cool the city at night. In order to combat poor air quality and future changes that are expected to manifest because of rising global temperatures (i.e. urban heat island effect, increased precipitation), the City of Stuttgart is being preemptive in preparing itself to cope with the effects of climate change. Its focus on mitigation, adaptation, and urban greening helps to create a climate strategy that aims to tackle the problem on a variety of fronts. Green roofs are one of the many tools that the city has at its disposal to help with climate adaptation. The following sections provide an overview on the climate change effects Stuttgart is expected to experience along with a discussion on green roofs.

2. Climate Change Adaptation and Green Roofs

2.1 Climate Change Impacts

The negative repercussions that cities are facing (or will face) because of climate change have the potential to be significant. Urban areas in particular are highly susceptible to the impacts of climate change because of their location (usually near coastal areas) and their high populations. Increasing temperatures and rising sea levels are expected to further aggravate the problems already plaguing stressed urban environments. Climate projections for Stuttgart show an increase in temperature of 2°C between 2071 and 2100. The Baden-Württemberg region has already experienced a 1.2°C rise in temperature during winter months and a rise of 1.0°C during the summer months for the period between 1931 and 2005. Climate models predict that these figures could rise to 2°C and 1.5°C, respectively. Furthermore, the frequency of 'very hot days'⁴⁰ is expected to jump by nearly 30% (Office of Urban Planning and the Environment, 2010). The problems that increasing temperatures pose are manifold. First, heat stress presents a significant risk to human health, in particular to the very young and elderly. During the 2003 heat wave, Germany experienced temperatures of up to 40.4 °C and an estimated 7,000 people died (Bhattacharya, 2003). Besides humans, flora and fauna will also be affected by the heat. For instance, certain species of animals may need to migrate to other regions if their native territory is no longer tolerable. While some animals may be forced to relocate to other areas, other species with higher tolerance levels may have the opportunity to expand their range because of the changing temperature. The introduction of exotic species into new geographical areas is likely and will undoubtedly impact the natural ecosystem balance.

Climate change is also expected to impact precipitation levels and rainfall frequencies. Storm surges and flooding present a risk to Stuttgart and precipitation levels are expected to rise. In particular, winter precipitation levels are projected to increase by 30%, while levels are anticipated to drop during the summer months by 10% (Office of Urban Planning and the Environment, 2010). However, it is important to note that the frequency of heavy rainfall events is expected to grow. This projected rise in precipitation rates will result in increasing incidents of surface water flooding, which can be expected to cause sewage overflows and property damage. Overall, changes in Stuttgart's average mean temperature and precipitation rates are likely to have detrimental effects on the city in an economic, social, and environmental dimension. Hence, urban heat island reduction and stormwater management are significant climate change adaptation issues for the City of Stuttgart.

2.2 Green Roofs

Green roofs, also known as dachbegrünung, have become an ever-increasing feature in Stuttgart's urban environment. The green roof area coverage in Stuttgart is approximated to be 1,000,000 square meters. According to one estimate, 22% of eligible roof space has been greened in the city. Extensive green roofs are most prevalent throughout Stuttgart and in other parts of Germany because they are low maintenance and they satisfy local regulatory requirements. Although the first known green roofs in Stuttgart were installed during the early part of the twentieth century, interest in their potential uses began to surge in the 1980s. The initial catalyst for the mandatory installation of green roofs came from a site redevelopment project in 1986. The factors that motivated urban planners to utilize green roofs included aesthetics, the creation of new green space to improve the surrounding

⁴⁰ This refers to temperatures greater than 25°C.

microclimate, and stormwater management. Details of this redevelopment project are discussed in the subsequent section. Because the technology was fairly new in the 1980s, a variety of stakeholders were involved in promoting the systems. Original pioneers in the green roof field include Gerda Gollwitzer, Werner Wirsing, and Hans-Joachim Liesecke. Gollwitzer and Wirsing⁴¹ outlined the concept of a modern green roof in their book *Roof areas inhabited, viable, and covered by vegetation*⁴² (1971). Their publication was followed by Liesecke’s book, *Roof and Terrace Gardens*⁴³ (1972); this book focuses on intensive green roof systems (greenroofs website). The formation of a coalition during the early critical stages in the 1980s- which consisted of the original pioneers, major green roof firms,⁴⁴ and government officials from Urban Planning- was crucial in the take-off of the green roof movement in Stuttgart. The table below provides some statistics pertaining to green roofs for 2010.

Table IV.1: Stuttgart Green Roof Statistics

STUTTGART GREEN ROOF STATISTICS	
Impetus	Poor air quality, urban heat island, stormwater management
Square meters of installed green roofs	1,000,000
Per Capita	1.67
Percentage of green roof area coverage	22%*
Roof type breakdown	Dominance of extensive green roofs
Percentage of Extensive	90% to 95%
Percentage of Intensive and Other (Semi-extensive, Semi-intensive)	5% to 10%
Green roof sales figures (2010)	Not available
<i>The above estimated figures are as of 2010 and were provided by industry experts.</i>	
<i>*Source: greenroofs.com^a</i>	

⁴¹ Gollwitzer and Wirsing were landscape architects by trade.

⁴² The publication was originally written in German.

⁴³ The publication was originally written in German.

⁴⁴ This refers to firms such as Bauder, Opti-gruen, and ZinCo.

Green roofing in Stuttgart shows no evidence of slowing down in the near future. The industry's growth has resulted in the involvement of a plethora of actors dedicated to the implementation of green roofs. A better understanding of the governance configurations in Stuttgart is important because it can illuminate the potential path that the green roof movement is likely to take in the coming years. It is critical to identify the chief stakeholders that are involved, their motivations for becoming involved, and how responsibilities are allocated among them. By understanding the underlying considerations and motivations of the actors, along with the factors that influence these considerations, adjustments can be made to the governance configurations in order to improve their effectiveness. The following sections present an analysis of the two dominant perspectives that have prevailed in Stuttgart: the Juridical-Administrative Perspective and the Economic Perspective. This is followed by a discussion on the Political Perspective.

3. Analysis of Perspectives

3.1 Juridical-Administrative Perspective

The juridical-administrative perspective has been a leading perspective in Stuttgart and it is based on the considerations of rule of law and principles of equity and fairness. City agencies, including the Office of Urban Planning and Urban Renewal (hereof referred to as Urban Planning), Office for Environmental Protection, and the Garden, Cemetery, and Forestry Office are most actively engaged in green roof matters. Urban Planning is responsible for a variety of things, including: landscape planning; green structure planning; review of building plan submissions; and the review of impact mitigation compensatory measures. The office also makes recommendations to the Mayor and to the City Council on the specific issues they are involved in. Urban Planning is considered to be a key governmental agency where green roofs are concerned because the local development plans (also known as binding land-use plans) issued by the department are the primary regulatory tools which mandate the construction of green roofs. The Office of Environmental Protection is comprised of six divisions and it indirectly and directly supports the implementation of green roofs (and other greening measures) via its remit in the following areas: nature conservation, energy, pollution control, urban climatology, and city planning. With regards to city planning, the department provides environmental information, proposals, and consultation advice to Urban Planning so that they can use in developing the different land-use and urban framework plans. The Garden, Cemetery, and Forestry Office has various responsibilities with respect to green roofs, and these include: processing of green roof grant applications;⁴⁵ construction,⁴⁶ installation and maintenance of green roofs on public buildings; and tracking city-owned green roof installations. The activities of the above-mentioned agencies encompass all four phases of the policy cycle: "PLAN," "DO," "CHECK," and "MAINT." Although governmental responsibilities span the entire policy cycle, they primarily lie in the "PLAN" and "DO" phases. Policy evaluation and maintenance does occur but the focus of the efforts is on public green roofs, and not on privately-owned systems. The dominance of the governmental sector in the green roof field is explored in detail below.

⁴⁵ The City of Stuttgart is no longer offering green roof subsidies as of 2010 due to the financial crisis.

⁴⁶ In the past the department was responsible for constructing green roofs but they no longer continue that practice; they now outsource it to other companies.

Consideration 1: Rule of Law

Regulations

Germany's legal framework on the federal and state levels has established a platform which supports environmental conservation, 'smart' urban development, and greening measures such as green roofs. Two of the most important pieces of legislation that aim to safeguard and promote sustainable urban development and land-use are the Federal Nature Conservation Act⁴⁷ (BNatSchG, 2010) and the Nature Conservation Act of the Land of Baden-Württemberg (NatSchG). The objective of the federal act is to support environmental improvement and to protect green spaces from anthropogenic interference. According to Article 1 paragraph 3 of the act, it is necessary "To sustainably ensure the efficiency and functional capability of the natural balance, in particular...no. 4) the air and climate must be protected by nature and landscape conservation measures" (Office of Urban Planning and the Environment, 2010, p. 40). The act defines targets for environmental protection and landscape preservation, and it also contains provisions for ecological compensation. The application of the principle of ecological compensation⁴⁸ ensures that (potential) negative impacts on nature and on the landscape (i.e. reduction in the ecological value of an area) are avoided, minimized, or compensated for. Ecological compensation is a significant aspect of the act because it ensures the replacement of green areas. Green roofs are a popular option for mitigation because of their environmental, social, and economic benefits.

Legislation on the state level has also been vital in protecting green space and encouraging the uptake of rooftop greening. The Nature Conservation Act of the Land of Baden-Württemberg (1995) regulates landscape conservation, nature protection, and the designation of recreational areas. Among the act's goals are the preservation of nature in order to maintain a healthy functioning ecosystem for future generations; sustainable use of natural resources; and the safeguarding of biodiversity (Ministry of Economic Affairs et al., 2009). The federal and state-level conservation acts have been instrumental in helping Stuttgart achieve its status as one of the greenest cities in Germany. Approximately 39% of the city's surface area is protected under nature conservation law, and 60% of the city is covered with greenery (Environmental Protection Office et al., 2009). Vineyards, forests, and parks can be seen everywhere and are valuable in terms of helping to improve the climatic conditions of the surrounding region. In a similar vein, the German Federal Building Code BAUGESETZBUCH⁴⁹ (BauGB) has been pivotal in encouraging sustainable urban development. Building codes can often times present a barrier to sustainable building design and construction. This can stifle innovation and therefore deters businesses from investing in projects that have the potential to become commercially viable. The code adopts a precautionary environmental stance and promotes the incorporation of environmental aspects into urban planning. According to Section 1 (5) of the code,

"Urban development planning has to be sustainable, integrate social, economic and ecologic demands and assume the responsibility for future generations. Urban development plans have to contribute to an environment fit for human beings, to the protection and development of natural resources, also in regard

⁴⁷ This Act was originally passed in 1977 and last updated in 2010.

⁴⁸ Section 8 of the Federal Nature Conservation Act refers to the principle of ecological compensation and has been legally binding since 1993 (Döveling, 2009)

⁴⁹ The German Building Code has been in force since 1960 and was last amended in June 2011.

to climate protection, as well as preserve and develop the urban pattern and the appearance of the landscape and of the town or city” (Ministry of Economy Baden-Württemberg, 2008).

The code’s relevance to green roofs is in its ability to mandate and regulate plantings (i.e. trees, shrubs) in a development plan area or individual area (Ansel, 2009). Section 9 (1) 25 of the code gives the municipality the authority to require green roofs on buildings (Ministry of Economy Baden-Württemberg, 2008). It is important to mention that the State Building Code of Baden-Württemberg also offers the opportunity to make green roofs mandatory. The nature conservation acts along with the federal and state building codes provide the legal basis for requiring green roofs in the City of Stuttgart’s land-use and local development plans. The plans and their effects on rooftop greening are discussed in further detail below.

Planning

Urban planning is one of the main tools that cities can utilize to govern (sustainable) urban development. The City of Stuttgart is no exception, and for over the past twenty years it has strategically implemented urban planning measures to ensure compact urban growth and the continued preservation and expansion of green spaces. As an example, a distinguishing feature in Stuttgart is the Grüne U. It is an eight kilometer long green tract of gardens and parks that runs through the center of the city (Environmental Protection Office et al., 2009). This ethos of ‘urban, compact and green’ has become embedded in Stuttgart’s planning strategy, and its establishment was facilitated by the efforts of various stakeholders. Although the installation of green roofs (on flat roofs)⁵⁰ has become the norm in Stuttgart and in other parts of Germany, this was not the case in the 1980s. Stuttgart was not the first city to have green roofs in Germany; however, it was the first German city that mandated the installation of green roofs on an industrial development project.

The incorporation of the first obligatory green roof clause in the Weilimdorf site development plan (1986) materialized because of the strategic vision of the Head of City Planning and Urban Renewal⁵¹ at that time, Albert Ackermann. Ackermann and his staff were commissioned with the task of developing a region located in the northwestern part of Stuttgart. The property was a former piece of farmland and the objective was to redevelop it into a residential/commercial complex. Ackermann and his team decided that 60% of the area would be developed while the remaining 40% would be greened with trees, meadows, green roofs, and other flora. The reasoning behind this decision was based on the characteristics of the property. Because it was farmland (and not built construction), Urban Planning determined that the construction of green space would compensate for the development of the area. In addition to the principle of ecological compensation, aesthetics and stormwater management also played a factor in the decision-making process. It should be noted, however, that Ackermann’s leadership and vision were critical to the adoption of a mandatory green roof clause. He can be considered both a policy entrepreneur⁵² and visionary. Ackermann believed that this project could serve as a model for future land-use plans, and the acceptance of this particular site plan would set a crucial precedent. It was a strategic decision on his part not to advertise this because of the resistance that would have been generated from the political and business spheres. However, the successful

⁵⁰ Green roofs are required on flat-sloped roofs with a pitch of up to 10 degrees.

⁵¹ The department is currently known as the Office of Urban Planning and Urban Renewal.

⁵² Ackermann’s role in supporting green roofs is similar to the role assumed by former Mayor Richard Daley and Dusty Gedge in Chicago and London, respectively.

construction and timely execution of the farmland redevelopment project convinced many that roof greening was in fact a safe and legitimate practice. This project's achievements, along with the building codes and the nature conservation acts mentioned in the previous section, further strengthened the city's authority in requiring green roofs. Stuttgart executes its urban greening mandate via its spatial plans which are discussed in detail below.

Spatial Plans

The decentralized nature of Germany's planning system permits authorities on the municipal level to have sufficient discretion on how to best implement acts and other regulations issued on the federal level. There are three different levels of spatial planning in Germany: federal, state, and municipal. Although local planning autonomy can be affected by higher-level directives and certain sectoral plans⁵³ (City Planning and Urban Renewal, 2007), municipalities have the mandate to formulate and execute policies as they see fit within the boundaries of the national legal framework. The primary spatial documents that guide the City of Stuttgart's development are the following: preparatory land-use plan; landscape plan; and the local development plan. The preparatory land-use plan, also known as Flächennutzungsplan (FNP, F-Plan), provides a blueprint for the use of all land within the city's jurisdiction. This plan determines the development of housing areas, industrial zones, green zones, etc. and is generally updated every ten years. While the plan is legally binding for public authorities, it "does not establish any direct legal rights for land owners from which claims for compensation can be derived...This is why the FNP can be modified without compensation" (City Planning and Urban Renewal, 2007, p.7). Although owners are ineligible to receive compensation in the event of modifications to the FNP (which negatively impact them), they are eligible to receive compensation via other avenues. For instance, if Urban Planning determines that a specific piece of brownfield land should be prohibited from being developed, the owner would be entitled to monetary compensation. This aspect of compensation for climate change adaptation is noteworthy because it highlights an important equity issue and the dilemma of whether or not governments are responsible for compensating citizens that are adversely impacted by the effects of climate change, or by policies that are meant to address climate change impacts.

While the preparatory land-use plan focuses on the general organization of the municipality, the landscape plan or Landschaftsplan (LSP) concentrates on green open spaces. The landscape plan complements the FNP because its objective is to ensure the continued protection of green areas. The LSP also designates mitigation areas, or areas that will be ecologically improved to compensate for built construction in other regions within the city (City Planning and Urban Renewal, 2007). The most important plan relating to green roofs is the local development/legally binding land-use plan, or Bebauungsplan (B-Plan). The legal basis for the local development plan is derived from the Federal Building Code. This plan focuses on lot-level development and is legally binding to everyone. It dictates a variety of things, including the construction/modification of a building; location of streets; location of infrastructure; and the mandatory installation of a green roof. Although all new local development plans require the installation of green roof systems on flat roofs, there are areas that are governed by old land-use plans that do not obligate the construction of green roofs. Exemptions for the installation of green roofs are also possible for buildings that are constructed architectonically specially. Stuttgart's green roof statute has been an effective stick in promoting the adoption of green roofs. An estimated

⁵³ This refers to sectoral plans for infrastructure projects that are based on special laws (i.e. nature protection, water, energy).

300,000 square meters⁵⁴ have been installed because of the green roof policy, while another 1.5 million square meters are provisioned to be built in new urban planning areas (Kapp and Reuter PPT presentation). Hence, regulations have contributed to the spread of green roof technology throughout Stuttgart.

Consideration 2: Equity & Fairness- Precautionary Principle

The uncertainty surrounding the future impacts of climate change has affected the way in which many cities are approaching the climate change problem, including the City of Stuttgart. Stuttgart is expected to experience hotter summers and wetter winters (Office of Urban Planning and the Environment, 2010). Because of this uncertainty and the potential negative impacts of climate change, the city is being proactive in employing measures that will help it cope with future climatic changes. The city has adopted a precautionary approach to deal with climate change and this is evident in the various climate change-related initiatives it has deployed. The city established a climate protection program known as KLIKS in 2007 to facilitate the reduction of carbon emissions. This program focuses on mitigation and provides an outline of action plans that can be adopted to help prevent further increases in carbon dioxide emissions. However, mitigation is not a panacea to the climate change problem. Scientists, politicians, and other experts acknowledge that changes in our climate are already occurring and that mitigation alone is insufficient to help us manage these problems. Adaptation is also needed to help reduce our vulnerability to climate change risks. The City of Stuttgart is taking action to address this via the creation of a climate adaptation strategy (CAS). The impetus for a CAS came from Stuttgart's City Council, Mayor, and from various governmental agencies such as the Urban Climatology division within the Office of Environmental Protection. The CAS is expected to be completed within the next two years and it will present a vision on the city's direction for coping with the future impacts of climate change along with action plans to help realize those goals. The division of Urban Climatology is the chief governmental department that has played (and continues) to play a strategic role in shaping the city's response to climate change.

The study of Stuttgart's environmental and climatic features is an important endeavor that falls under the responsibility of Urban Climatology. Stuttgart's geographical features have ensured that this topic receives sufficient attention. While the initial efforts of urban climatologists centered around understanding air flow exchange and ventilation corridors in order to combat air pollution and keep the city cool, this has now extended to climate change. In other words, Urban Climatology has to factor in a new dimension into its assessments and calculations— i.e. the urban heat island effect, increased precipitation, and other scenarios relating to climate change. In response to these concerns, Urban Climatology produced the Climate Atlas in 1992 (last updated in 2008) to better understand Stuttgart's physical and climatic setting. The atlas includes information pertaining to various features such as wind patterns, air pollution concentrations, surface temperature, and cold air flows (Office of Urban Planning and the Environment, 2010). The Climate Booklet for Urban Development, which was first published in 1977 and last revised in 2008, complements the Climate Atlas because it contains detailed information on Stuttgart's climate while also providing planning advice and recommendations.

⁵⁴ 90,000 square meters of green roofs built (out of the total of 300,000 square meters) are located on municipal buildings.

Another tool that the department has at its disposal is the GIS⁵⁵ version of the Climate Atlas. Its main advantage is that it permits urban climatologists to change input parameters and therefore allows them to see the different model outcomes. As an example, if Urban Planning is contemplating changes in land-use—these modifications can be entered into the GIS system to see their potential effects. Based on this modeling, Urban Climatology can issue recommendations on various things, including which areas can (or cannot) be built on or areas where land owners are required to plant specific tree species. The recommendations produced by the Urban Climatology division are taken into account in the urban planning process.

The common thread among the above-mentioned climate initiatives (specifically referring to the Climate Atlas and Climate Booklet) is that they emphasize the vital role that scientific modeling plays in helping to predict the future impacts of climate change. Electronic modeling is important, but it also has its limitations since it cannot definitively inform us on what will actually happen in the future. According to van der Sluijs and Turkenburg (2006), the precautionary principle

“requires further development of models of integrated social-ecological systems that exhibit complex behaviors on a variety of spatial and temporal scales...By placing a greater emphasis on direct measures to systematically monitor observable effects, a precautionary approach offers a way to be more responsive to harm when the first signals of it manifest themselves in the real world, however ambiguous these first signals may be” (p. 15).

Advances in modeling techniques can help improve the accuracy of forecasts and expand the range of things that can be estimated. In relation to this, I asked a government official the amount of green roof area coverage that would be required to cool the temperature of the entire city by an estimated one to two degrees Celsius. Due to current model limitations he was unable to provide me with an answer, although future enhancements in modeling techniques may eventually enable him and other scientists to provide answers to these types of questions. In light of such constraints, it is important that these efforts are accompanied by adaptation initiatives such as a climate adaptation strategy. Behavioral change and physical adaptation are integral in enabling society to cope with climate change impacts.

Conclusions

The regulatory instruments that the city has deployed to encourage the uptake of green roofs have resulted in their widespread implementation in Stuttgart. Regulations on both the federal and state levels- the Federal Nature Conservation Act, Nature Conservation Act of the Land of Baden-Württemberg, State Building Code of Baden-Württemberg, and the German Federal Building Code- provide the city the legal authority it needs to execute its mandate for the installation of green roofs. Furthermore, the complementary spatial plans issued by Urban Planning- the preparatory land-use plan, the landscape plan, and most importantly the binding local development plan- form a cohesive strategy in helping to promote urban greening measures such as green roofs. The dominance of the juridical-administrative perspective and the role that the government has played since the 1980s has undoubtedly sealed Stuttgart’s reputation as a clear leader in the green roof movement.

⁵⁵ GIS, or Geographic Information Systems, is a “computer-based system for capture, storage, retrieval, analysis and display of locationally defined (spatial) data” (City of Lowell website).

3.2 Economic Perspective

The presence of the economic perspective is also apparent in Stuttgart. This perspective is based on the considerations of efficiency and securing adaptation action. The green roof sector is being propelled forward by the activities of a plethora of actors, including: green roof manufacturers and suppliers; landscape firms; and associations such as the German Roof Gardener Association (DDV) and the International Green Roof Association (IGRA). The responsibilities and tasks of the private sector include the design of green roofs, installation and maintenance of green roofs, consultation on green roof projects, and the dissemination of information to promote rooftop greening. In relation to the four phases in the policy cycle, these tasks can be categorized under the policy implementation or “DO” phase and the policy maintenance or “MAINT” phase. The considerations of efficiency and securing adaptation action are discussed in detail in the subsequent sections in order to explain the dominance of the economic perspective in Stuttgart.

Consideration 1: Efficiency

The German green roof industry is ‘ahead of the curve’ in terms of efficiency relating to green roof systems. Because the green roof sector has been engaged in research and development since the 1970s, its production, installation, and distribution efficiencies surpass those of other countries. Efficiency is a hallmark of the private sector, and it can be achieved via the creation of new products, innovative solutions, or improved production processes. The cost of a green roof in Germany is considerably cheaper compared to other countries and this reflects the market’s maturity.⁵⁶ Extensive green roofs are standard across Stuttgart and in other parts of Germany. Because these systems are fairly easy to install (compared to intensive roof systems), competition has driven their prices down. An extensive system can range from 10 Euros per square meter to around 40 to 50 Euros per square meter.⁵⁷ The efforts of major suppliers such as ZinCo have helped to move the industry forward with respect to innovation, the range of systems offered, and competitive pricing.

Green roof firms such as ZinCo play an important role in Stuttgart since they are drivers of innovation. They conduct research, develop new systems and roof-related products, and also provide consultation advice on roof greening projects. A condition which activates the consideration of efficiency is the extent to which uncertainty creates the need for variety and innovation in adaptation solutions to tackle the effects of climate change. ZinCo and other suppliers fulfill a vital niche and their technical expertise has enabled them to create a variety of unique products that appeal to consumers. ZinCo sells more than one million square meters of green roofs a year,⁵⁸ and the systems sold range from extensive/biodiverse to semi-intensive and intensive. The availability of a mixture of systems is important because it ensures that differing client expectations can be met.

Approximately 90% to 95% of the green roofs in Stuttgart are extensive, and this is driven by the government’s regulations along with the predominance of flat-sloped roofs.⁵⁹ Extensive roofs require

⁵⁶ The costs of a green roof depends on a number of factors, including the type of system (i.e. extensive, intensive), slope of the roof, types of plantings, etc. and therefore prices may range significantly between systems.

⁵⁷ This price quote pertains to ZinCo extensive green roof systems.

⁵⁸ ZinCo annually sells more than one million square meters of green roofs worldwide—a specific figure for Stuttgart is unavailable.

⁵⁹ Many roofs in Stuttgart are not designed to hold the weight of heavy green roof systems which is why extensive systems are prevalent.

minimal maintenance and are therefore less of a burden to owners. ZinCo has developed a low-maintenance green roof system known as the “Summer Meadow” to satisfy the demands of customers that desire an intensive green roof that does not require as much work as a traditional system. Although it is an intensive green roof system, it requires less water for irrigation because of the plant selection and the technology used for the system. It utilizes a new drainage and water retention element which reduces the amount of water required. Furthermore, clients have the option of how the ‘summer meadow’ can grow by controlling nutrient levels and the frequency of mowings. The customer has the option of having a roof system that resembles a hard-wearing lawn to a system that is more like a flowering meadow (Walker, 2011).

Another significant innovation that we are witnessing in the green roof sector is the development of light-weight roof systems. Because of structural limitations, especially in the older building stock, the installation of green roofs is often not an option because of the additional weight burden. However, the creation of lighter systems can open up the market to customers that previously would not have considered installing a green roof. ZinCo has developed a new compact system that utilizes only 10cm of soil, in contrast to the usual 20cm that is required for grass systems. In a similar vein, advances are also being made with respect to the functional range of green roofs. For instance, in Chicago food-producing green roofs have been receiving a lot of attention because of their potential revenue stream and the fact that they can help alleviate food deserts in Chicago. Although urban agriculture is not a ‘buzzing’ topic in Stuttgart, people have expressed interest in these types of systems. For example, the concept of having a glass structure (containing a green roof system) on top of a building has been presented. Because the green roof system is sheltered from the elements, it can be used as a farm to produce vegetables and fruits throughout the year. In addition to new system designs, innovation is also evident in the manner in which substrate is placed on buildings. As an example, one respondent mentioned that his father was inspired by the agricultural sector to utilize machinery that blows material onto the roofs. This facilitates the installation of roof systems because it reduces the amount of time needed to place the substrate onto the roof, as well as reducing costs because of less worker hours needed.

Efficiency improvements within the green roof sector are also being realized via the integration of roofing systems with other types of energy systems. A growing trend is the use of extensive green roofs with solar technology. A symbiotic relationship exists between their simultaneous use. Based on Köhler et al’s study (2002) of combination systems in Berlin, the benefits of a green roof-solar system include: higher electricity generation of photovoltaics that are located on a green roof versus a conventional roof; improved plant growth; and increased diversification of plant species due to the shading provided by the photovoltaic panels. Taken on a higher level, the ability to incorporate green roofs into infrastructural works is another aspect that facilitates efficiency. The city of Scharnhausen presents a prime example of the fusion of green roofs within the overall water management strategy of the area. I had the opportunity to visit Scharnhausen⁶⁰ with Wolfgang Ansel, the director of IGRA. This area presents a unique vision on urban water management. Stormwater flows *above-ground* and it is treated as a resource and not as a waste product. The presence of green roofs, bio-swales, and above-ground drainage corridors (which permit water to drain into the bio-swales) reinforces this concept. It appears that green roofs are becoming an integral part of the urban landscape because of their multi-functionality.

⁶⁰ The sustainable water management plan for the development area in Scharnhausen was created by the Atelier Dreiseitl.

The uptake of green roofs has been aided by their versatile and no-regret nature. This is evident in the continued growth of the industry. Since the 1980s, the German green roof industry has grown by an average of 10% to 15% annually. According to 2008 figures, the industry was annually worth an estimated \$77 million (Wickstead, 2008). Approximately six to ten million square meters of green roofs are installed yearly throughout Germany; green roofs represent about 7% of all new roof construction (greenroofs website). Besides the regulatory and economic instruments that encourage their adoption, the marketability of green roofs can be attributed to the multitude of benefits that they provide. Green roofs improve the microclimate of buildings and the immediate surroundings via evapotranspiration; they filter air, thus reducing particulate matter—something that is relevant in Stuttgart because of its air pollution problem; and they are effective in stormwater management. The multi-purpose use of green roofs can be extended in helping to deal with the effects of climate change. As an example, innovation efforts by green roof companies can be targeted at improving the water storage capacity of the systems. Although green roofs retain water, the performance of the roofs under various climate change scenarios is unknown. Given that Stuttgart is expected to experience heavier rainfalls with increased frequency, the design of a roof that is capable of handling this extra volume is of great significance. One respondent agrees that a main future topic on the green roof agenda is climate change adaptation. Special and innovative solutions will be needed to deal with problems such as the urban heat island effect and stormwater management, and green roofs are an attractive tool for dealing with these issues. Climate change concerns coupled with the beneficial properties of green roofs will continue to sustain interest in the systems, thus further encouraging private sector involvement and the generation of new ideas.

Consideration 2: Securing Adaptation Action

The City of Stuttgart has offered various financial and indirect financial incentives to encourage private individuals, building owners, and developers to install green roofs. The costs of a green roof can present a significant barrier which is why the city offered subsidies between 1986 and 2009.⁶¹ The subsidy covered 50% of actual costs, or a maximum of 17.90 Euros per square meter (Döveling, 2009). The grant applications were processed by the Garden, Cemetery, and Forestry Office. The subsidies could not be used to fund the construction of green roofs in areas where they were legally required by local development plans. The aim was to motivate the construction of green roofs on new buildings and retrofits that were not bound by the green roof statute. An annual funding pool of 51,000 Euros was set aside for this purpose and it was exhausted every year. This was a modest amount that was used to fund between one and two dozen projects a year. In exchange for funding, owners were obligated to maintain their roofs for a minimum of ten years after installation. The grants were helpful in encouraging the uptake of green roofs. Nearly 400 private green roof projects covering an area of 66,000 square meters were completed between 1986 and 2010, with an estimated cost of 1.2 million Euros (Kapp and Reuter PPT presentation). With regards to the financing of green roofs on public buildings, the city set aside 90,000 Euros per year for that purpose. An area totaling 120,000 square meters was installed on city buildings between 1986 and 2008, with a total cost of 2.4 million Euros.⁶²

⁶¹ The financial subsidy was canceled in the 2010 budget (and has not been reinstated since) due to the economic crisis. Those eligible for the subsidy included: building owners, their legal representatives, and tenants with the agreement of the owner (Döveling, 2009).

⁶² Extensive green roofs comprise 88,000 m² while the remaining 32,000 m² were intensive green roofs.

Financial subsidies facilitated the increase in Stuttgart's green area coverage by a total of 186,000 square meters.

Indirect financial incentives have also been used to promote the spread of green roof technology. As in Chicago, a density bonus is an option that can be offered to developers if they agree to construct a green roof. The density bonus system in Stuttgart is not institutionalized as it is in Chicago. In other words, it is granted on a case by case basis rather than being automatically given to developers that approve the condition. The levying of stormwater fees is another tool that has been used by the city to support green roofs. It has been in effect since 2007 and two separate fees are charged for the disposal of wastewater: one for sewage, and the other for stormwater. The charging of separate fees "has resulted in a distribution of wastewater costs which is fairer, as it conforms with the causer-pays principle" (Ansel, 2009, p. 123). The stormwater fee is based on the ratio of a property owner's impervious area in relation to the total area of the plot. Property owners that install green roofs receive a 50% reduction in stormwater fees⁶³ because of the roofs' water retention capabilities, given that a roof has a minimum substrate of six centimeters. Over time the reduction in fees can compensate for a considerable part of the original installation costs of the system.

The private sector is actively engaged in advocating the adoption of green roofs. The establishment of the following organizations attests to the importance of having a well-organized network that supports green roofs on a variety of fronts: the International Green Roof Association (IGRA); Fachvereinigung Bauwerksbegrünung (FBB); German Roof Gardener Association (DDV); and the German Landscape Research, Development and Construction Society (FLL). The FLL was formed in 1975 and its objective is "the improvement of environmental conditions through the advancement and dissemination of plant research and its planned applications" (Philippi, n.d.). Unlike in other countries, green roof guidelines in Germany have developed in tandem with the technology. The reason why this is of significance is because the FLL has had the opportunity to revise its recommendations over time because of trial and error and the knowledge it has gained from the practical application of the systems. The FLL has been conducting research on green roofs for nearly three decades and their guidelines are used as a global standard.

The DDV is also engaged in a variety of promotional work. Its creation in 1985 coincided with the launch of the green roof industry in Germany. The DDV's activities include conducting green roof seminars and workshops, organizing symposiums, and distributing press releases and informational brochures. When asked whether publicity and awareness (or lack thereof on green roofs) was a problem in the 1980s for major green roof supply firms, one respondent claims that it was the DDV's goal to fulfill that role and it therefore did not present a significant challenge to his firm. The activities of the FBB (founded in 1990) also overlap with those of the DDV. The FBB is focused on supporting roof and façade greening and it is heavily involved in public relations work; advertising; organizing professional lectures; and bringing members together via their internet forum (FBB, n.d.). The FBB represents the interests of a range of stakeholders including manufacturers, planners, and contractors. A common theme shared among all of these organizations is the emphasis that they place on knowledge creation and sharing. This is also a focal point for IGRA, an organization whose mission is to promote the technology via the dissemination of information. Although green roofs are well-known throughout Germany, a lack of knowledge regarding their benefits and uses still persists and therefore presents a barrier to their adoption. The objective of organizations such as IGRA is to help educate citizens on the benefits of green roofs so that any misconceptions they may have can be dispelled. The above-

⁶³ The stormwater fee is currently 0,53 Euros per square meter.

mentioned organizations have been successful in leveraging their resources and connections within the green roof sector to promote the adoption of green roofs.

Green roof companies have also taken an active role in dedicating their expertise, resources, and time to advocate their products. Beginning in the 1980s, companies such as Bauder, Opti-gruen, and ZinCo were involved in promotional marketing campaigns to increase the visibility of their products. City officials advised them that it would be wise to undertake this kind of work because it would complement the efforts they were taking to convince politicians and others that rooftop greening was a viable practice. Green roof companies also engage in a plethora of other activities. Industry-related conferences/seminars, green roof journals, magazines, and information sharing via electronic media are present on most of the companies' agendas. For example, ZinCo offers training seminars to professionals such as roofers and landscape architects; in 2010 more than 1,000 people have attended the seminars located in Germany. Green roof firms have also been proactive in forming partnerships to leverage their resources with academic institutes. ZinCo is engaged in research with different institutes including the University of Sheffield in the United Kingdom. Such partnerships are beneficial to both parties because of the specific expertise each has to offer. While the private sector has clearly been active in promotional activities, it is important to note that the public sector is also committed to public relations work. In order to set an example for others to follow, the city has been greening municipal buildings since the 1980s to showcase green roofs. Furthermore, the Garden, Cemetery, and Forestry Office offers consultation advice and even has a 'green' hotline dedicated to addressing citizens' questions and concerns on urban greening measures such as green roofs.

Table IV.2 on the following page provides an overview of the regulatory, economic, and communicative instruments that are used for promoting the adoption of green roofs.

Table IV.2: Stuttgart Policy Instruments

Stuttgart Policy Instruments	
Legal control model (influencing behaviour through rules and regulations)	
Technology-based regulation (i.e. building codes)	Mandatory green roof policy (since 1986)- required on flat-sloped roofs for all new developments. Legal basis: <ul style="list-style-type: none"> • German Federal Building Code • Local development plans
Performance-based regulation (i.e. LEED)	None
Economic control model (influencing behaviour through costs and benefits)	
Direct financial incentives	<ul style="list-style-type: none"> • Subsidy of €17.90 or 50% of actual costs (offered between 1986-2009) • Stormwater fee reduction- in effect since 2007, 50% (fee is 0,53 Euros per square meter)
Indirect financial incentives	Density bonus- offered on a case by case basis
Communication control model (influencing behaviour through knowledge and information)	
Information and education	<ul style="list-style-type: none"> • Public demonstration roofs throughout city due to municipal greening • Free consultation advice and 'green' public hotline • Various private partnerships and professional networks (i.e. DDV) • Green roof industry involved in education and information sharing (i.e. via seminars, workshops, industry journals)
Contractual agreements	None

Conclusions

Improvements in efficiency within the green roof industry coupled with the efforts of green roof firms and other private sector organizations have contributed to the prevalence of green roofs in Stuttgart. Advances in the design, construction, and distribution of green roofs and related products are due to the research and development endeavors of a variety of stakeholders. The no-regret nature of green roofs, the government's offering of financial and indirect financial incentives to spur their uptake, the formation of private partnerships along with the promotional work that the private and public sectors are involved in are important factors that help explain the dominance of the economic perspective. The outlook for Stuttgart's green roof industry is positive since there is sustained interest in green roofs, which is not solely due to mandatory regulation. Because green roofs have a vital role to play in the future with regards to climate change adaptation, green roof manufacturers and other private businesses will continue to drive innovation and efficiency. The dominance of the economic perspective will ensure that green roofs will remain a part of Stuttgart's urban landscape for many years to come.

3.3 Political Perspective

Given Stuttgart's success in the implementation of green roofs and the pervasiveness of an environmental ethos throughout Germany, it is unsurprising to find the presence (but not dominance) of the political perspective. This perspective is governed by the considerations of legitimacy and accountability and transparency. It is unlike the other perspectives because it emphasizes joint public-private collaboration in the sharing of responsibilities. The uncertainty surrounding climate change and the fact that the problem cannot be tackled by any one single actor suggests that it is rational that a variety of stakeholders should be involved in climate change adaptation decisions throughout the entire policy cycle. According to Brooks and Adger (2005),

"Stakeholder involvement...in the identification and prioritisation of adaptation options is absolutely vital, since to be successful, adaptation measures must be acceptable to those who are to implement them. Where there is no consensus as to the feasibility and acceptability of these options, the capacity to adapt will be very limited, and what adaptation does occur will be constrained by conflict" (p. 177).

Public participation and consensus are vital to help advance the progression of a particular climate adaptation strategy. Cooperation and collaboration between the government, civil, and private sectors is promoted and in some cases legally mandated in Germany. For example, public participation in the evaluation of spatial planning documents can take two forms: legally binding participation, or non-binding participation. The German Federal Building Code requires two stages of open public participation for the following plans: preparatory land-use, landscape, and local development plans. Transparency is key and the plans (both the draft and final versions) must be available for public display. It is important to note that public participation takes many forms and is not limited to *consultation*, as is the case in Chicago and London. Both public and private stakeholders have the ability to make recommendations or to raise objections. These objections cannot be ignored and must be taken into consideration before the completion of the final draft. Furthermore, actors that are affected by binding land-use plans can seek further recourse via the courts by demanding the re-examination of plans (Institute for Urban Design and Housing, n.d.). The institutionalization of a public participation

mechanism via a legal framework has helped to support greater interaction and collaboration between different societal segments.

Conclusions

The non-marginalization of the political perspective in Stuttgart is of relevance because it highlights the importance that the city places on the input from the private and civil sectors. A spectrum of public participation exists and it can range from information provision to collaboration. It is clear that public participation in Stuttgart is in fact a legitimate endeavor and is not simply 'for show.' Although collaboration does exist, it is essential to emphasize that it is limited. It is not true collaboration in the sense that representatives from the private and civil sectors are involved in policy-writing and in co-decision making throughout every single phase in the policy cycle. However, the City of Stuttgart's willingness to receive recommendations from citizens and others and to take their objections into account demonstrates its commitment to having a more transparent and legitimate planning process. By garnering public support and making people feel vested in the decision-making process, the adoption of green roofs can be further moved along to the next level.

4. Green Roof Governance Arrangements: Contextual Factors

The division of responsibilities and the configuration of green roof governance arrangements in Stuttgart have been shaped by the inherent nature of the climate change problem, as well as by political and economic factors. The uncertainties surrounding various climate scenarios and the long-term aspect of climate change makes it difficult to predict the actual impacts that Stuttgart will experience in the future. Given the uncertainty and complexity of the problem, one can ask how does a city adapt itself to the uncertain? This aspect of uncertainty has been an important factor driving public involvement in developing and encouraging the uptake of climate adaptation measures such as green roofs. The City of Stuttgart is being preemptive in its actions and the precautionary principle is discernible in its decision-making process. This is evident in its decision to initiate the drafting of a climate adaptation strategy. Government policy-makers, scientists, politicians and others understand that mitigation alone will not suffice to help Stuttgart adequately prepare for future climatic changes. The active involvement of government scientists in climate modeling and in the creation of the Climate Atlas demonstrates the city's dedication in trying to gain a better understanding of (projected) climate conditions so that it can make well-informed decisions.

In a similar vein, public officials have assumed responsibility in the creation and dissemination of information in order to advocate the adoption of green roofs. Representatives of the Urban Planning department were intensely involved in this during the 1980s because of the novelty of the concept. Public authorities worked with major players in the industry to convince investors, developers, and other skeptics that rooftop greening was beneficial on a number of different levels. Currently, city officials participate in information dissemination via brochures, consultation sessions, and public demonstration projects. Given that multiple sectors and actors will be affected by climate change, public officials have been prompted to take the consideration of legitimacy into account. The City of Stuttgart values the input of its citizens and comprehends that without public support instituting climate adaptation measures will be problematic. The city encourages citizen involvement in the spatial planning process and takes their views into account when developing spatial plans. The consideration of legitimacy also relates to the political climate of the city. The Green Party currently dominates the City

Council, and a strong environmental ethos is pervasive throughout society. As one respondent explains, the force from the base is powerful and therefore the demands of the citizenry cannot be ignored.

Economic factors also play a principal role in the allocation of responsibilities and governance configurations. The predominance of economic considerations explains the extensive presence and involvement of private actors in the green roof sector. Improved efficiencies and innovation in the green roof field ensure that private actors will continue to make investments in research and development. Economies of scale in Stuttgart and in other parts of Germany have been achieved because of the rapid growth and expansion of the industry. Efficiencies have been realized in the design, construction and distribution of roofing systems because of the research efforts of green roof firms and the continued growth of the sector. Innovation is another prevailing force, and companies are always striving to develop new products that will satisfy the demands of their customers. Economic considerations have also figured prominently in the government's decision-making process. The consideration of securing adaptation action is an underlying rationale for the government's decision to provide financial subsidies and other indirect financial incentives to promote the adoption of green roofs since installation costs present a barrier to their uptake.

5. Allocation of Responsibilities

The allocation of responsibilities among stakeholders in Stuttgart's green roof governance process follows the 'public/private' divide. Public authorities are significantly involved in the early phases of the policy cycle and dominate the policy making and implementation phases. The government has been proactive in utilizing regulatory and economic instruments as a steering strategy to encourage the uptake of green roofs via local development plans and the availability of financial and indirect financial incentives. Although private actors are involved in these early stages as well, government officials assume the lead role in agenda setting, policy initiation, target setting, and strategy making. The private sector's participation in the policy implementation phase predominantly centers on information provision, financing, and the physical implementation of green roofs. Private stakeholder involvement is also apparent in the maintenance phase since this generates revenues for their businesses.

City officials interviewed at Urban Planning, Urban Climatology, and the Garden, Cemetery, and Forestry Office appear to be content with the mandate of their respective departments and the duties they are responsible for executing. However, governmental officials have made recommendations regarding steps that can be taken to further promote rooftop greening and greater acceptance of climate adaptation measures. First, the participation of all relevant stakeholders is necessary to help move climate adaptation forward. The climate adaptation strategy that the city is working on will essentially be an action plan that outlines the activities that various public, private, and civil actors should take to facilitate adaptation in order to reduce Stuttgart's risk to the impacts of climate change. One respondent stresses that relevant private stakeholders must get involved for this to be successful and to achieve specified targets. Furthermore, it is also important that people understand that mitigation alone is not enough and that adaptation *is needed*. The city is limited in what it can accomplish on its own, which is why developers, housing corporations, urban planners, and investors must cooperate and engage in open dialogue. The capacity and role that these private actors should assume in the creation of the climate adaptation strategy is unclear at the moment and has not been elaborated upon. Moreover, it has yet to be determined which organization or government agency should take the lead role in acquiring support from the private sector. However, their cooperation and

acceptance of the climate action plans in the strategy is undoubtedly needed to effect change. As Stuttgart continues to develop, open communication and collaboration are needed to facilitate the planning process and to help ensure that urban development demands are balanced with the needs of nature conservation and climate adaptation.

The auditing and quality control check process for green roofs is another area that can be improved. The Garden, Cemetery, and Forestry Office keeps track of green roof installations on public buildings by default of their work since they maintain the roofs on all municipal buildings. They have a GIS system that contains data on the city's public green spaces. The department has offered other agencies to take ownership of this process and to input and keep track of green roof data in their GIS system. This strategy is advantageous because it demarcates clear responsibility for the task and it would enable the department to manage the data and to observe changes in the roofs over time. The department can set certain indicators to flag their attention in the event that roofs appear to be performing poorly. Such findings could potentially lead to adjustments in green roof guideline requirements. While some departments have agreed to this shift in responsibility, others have not. Hence, the extent to which other departments are documenting the various characteristics of their roofs is unclear. Quality control is an important issue but at present accountability and responsibility for this task is ambiguous and blurred by departmental boundaries. In a similar vein, there is a lack of quality control regarding inspection on private roofs. There is no follow-up check once the initial green roof installation inspection has been completed.⁶⁴ Due to limited departmental budgets and personnel, it is unrealistic for the government to undertake such a task on its own. An attractive option for the city would be to conduct a survey via satellite imagery, a strategy that the City of Chicago has employed. As climate adaptation concerns grow and become more prominent in the future, this topic will become increasingly visible on the agenda since well-functioning roofs are needed to help the city cope with climate change.

6. Green Roofs: Going Forward and Future Goals

The City of Stuttgart has been supporting the implementation of green roofs for the past twenty-five years. The initial driver for green roofs was for air quality reasons. Stuttgart's industrial activities combined with its geographical features contribute to the poor air quality in the region. However, climate change effects are also an important driver for Stuttgart's desire to encourage the installation of green roofs. Due to potential future climatic changes such as urban heating and flooding, the City of Stuttgart is trying to protect itself via adaptation measures such as green roofs because of their cooling and water retention capabilities. Another noteworthy factor that is driving the adoption of green roofs is the 'sustainable image.' According to several respondents, being seen as 'sustainable' is a motivating factor, especially for corporations. Relatedly, the environmental consciousness and 'green' ethos that is palpable in Stuttgart's governmental and societal segments undoubtedly support green roof implementation. The various regulations on the federal, state, and local levels which advocate the preservation and expansion of green space coupled with the inclusion of public actors in the spatial

⁶⁴ Because of Stuttgart's obligatory green roof requirement on flat-sloped roofs, general inspections were (at one point) made by the Department of Building Law to ensure that the roofs were in fact installed. While an amendment to the State Building Code makes this inspection no longer mandatory, they still do occur. Inspections for private roofs were at one point also made by the Garden, Cemetery, and Forestry Office. This was standard procedure for roofs that were installed with the aid of a financial subsidy from the city (up until 2009).

planning process attest to the fact that sustainability is a significant issue. The decision-making process is not exclusive to government officials alone, but also takes into account the considerations of the public.

Although the above-mentioned factors are helping to promote green roofs, additional actions can be taken to encourage their uptake. One respondent asserts that a possible avenue for the city to take is to make green roofs a requirement on sloped roofs. Presently, green roofs are only required on flat-sloped roofs. Making their installation on pitched roofs obligatory would contribute to further greening.⁶⁵ Another interviewee suggests that improvements in the regulatory framework can further strengthen the mandate for green roofs. While respondents are overall satisfied with the various regulations that are in place to promote green roofs, they claim that more needs to be done with regards to quality control. One respondent states that there needs to be greater and improved *application* of the regulations. For instance, the city can mandate more stringent standards for substrate depth and species mixture. There is a minimum substrate depth and substrate mix that is standard and used throughout Stuttgart. The downside to standard guidelines is that they fail to take into account the specific environmental circumstance of the various areas in the city. Guidelines should be prescribed so as to adapt to local needs. One public actor stresses that regulations should be improved specifically with climate change in mind. Because green roofs are a flood protection measure, guidelines should encourage or mandate minimum standards for green roofs to ensure that they perform accordingly.

Providing funding for green roofs is another measure that can be taken to encourage their implementation. While the city provided funding between 1986 and 2009, this has been suspended because of the financial crisis. However, respondents emphasize that it is critical to provide subsidies for *retrofitting*. Because retrofitting is expensive, they believe that the establishment of a program to provide grants specifically for this purpose would aid the spread of the technology. Overall, it is clear that there are various areas where green roof stakeholders can institute changes in order to further support the implementation of green roofs. The table below presents a snapshot of the key items mentioned in this section.

Table IV.3: Potential Future Goals for the City of Stuttgart

Potential Future Goals
<ul style="list-style-type: none">• Improve regulatory framework with quality control and climate change in mind• Possibility of mandatory requirement for sloped roofs• Provision of funding for retrofitting

⁶⁵ Stuttgart's City Council is against making green roofs mandatory on sloped roofs due to the increased costs compared to flat roofs.

7. Synthesis and Conclusions

Stuttgart's green roof industry continues to grow strong after being in existence for nearly three decades. Poor air quality, stormwater management, and urban heating are issues that the city has to cope with and green roofs present a viable option for dealing with these problems. The configurations of the green roof governance arrangements in Stuttgart reflect the dominance of the juridical-administrative and economic perspectives, and the division of responsibilities between public and private actors follows the public-private divide. The city is considerably involved throughout all stages of the policy cycle, and in contrast to other cities it is also very active in the "CHECK" and "MAINT" phases. The city has dominated the "PLAN" and "DO" stages and the consideration of *securing adaptation action* is influential in this respect. The consideration of *efficiency* underlies private firms' involvement in the green roof sector and explicates the dominance of the economic perspective. Efficiencies in manufacturing and distribution, technological advances in the designs of systems, materials used, substrate mix, and other aspects have resulted in competitive system pricing. This has promoted consumers to purchase green roofs systems because they have an assortment of affordable options to choose from. Innovations relating to the multi-functional use of green roofs (ranging from stormwater management to food-production) also ensure that private firms will continue to invest and generate new products to satisfy the demand of consumers. For these reasons, private firms are proactive in marketing, financing, and in the implementation of green roof systems.

Since the 1980s, the government has supported the implementation of green roofs via regulatory, economic, and communicative instruments. The mandatory green roof policy on flat-sloped roofs combined with the availability of subsidies (up until 2009) have encouraged the uptake of rooftop greening. Additionally, the introduction of a dual water fee has incentivized property owners to install green roofs because of the discount they are entitled to. The city has engaged in promotional work to educate its citizens via electronic media, demonstration projects, and professional consultation sessions. In addition to the consideration of *securing adaptation action*, *fairness* also appears to be a dominant consideration for public involvement.

There are various barriers and opportunities for the implementation of green roofs. Up-front costs and a general lack of knowledge and interest in green roofs represent common barriers. Although prices are competitive in Stuttgart (particularly for extensive green roofs), people with limited financial means will be deterred from installing them in the absence of subsidies. While green roofs are visible throughout the city, they are only mandatory on flat-sloped roofs. Hence, building owners with pitched roofs do not have an incentive to install them; their lack of motivation to install (in the absence of mandatory regulation) may also be due to their limited knowledge on the benefits and various uses of green roofs. Because of this public relations work is important and explains the existence of organizations such as the FBB and IGRA. Despite the existence of these barriers, green roof installations continue to grow in Stuttgart and respondents agree that the future is promising for the industry. Green roofs' no-regret nature and their representation of an ethos of sustainability have secured their future in Stuttgart's urban landscape.

Unlike in Chicago and London, the political perspective is present (although not dominant) in Stuttgart. The political influence of the green party and widespread environmental consciousness of the citizenry have created a climate where public participation is encouraged, and in some cases legally mandated. The public has the legal right to participate in the spatial planning process. Citizens can provide recommendations and can also make objections if they disagree with certain points in a plan. These objections cannot be ignored and must be taken into consideration. This aspect of public

participation is a departure from how other cities operate. It is noteworthy because the government's inclusion of a variety of stakeholders acknowledges the significance of encouraging all segments of society to have a vested interest in dealing with an issue as complex as climate adaptation and showcases the importance of *legitimacy* in the governance process.

Stuttgart is a global leader in the implementation of green roofs. However, actor involvement can be extended so as to include more 'powerful' players (i.e. developers, housing corporations) in the climate adaptation process. Furthermore, the clear demarcation of responsibilities and the assumption of additional responsibilities by different societal segments can inspire additional interest in green roofs.

References

- Ackermann, Albert (2011). Former Department Head, Department of Urban Planning and Urban Renewal. Interviewed by Jennifer Stamatelos, Stuttgart, September 22, 2011.
- Ansel, Wolfgang (2011). Director, International Green Roof Association. Interviewed by Jennifer Stamatelos, Stuttgart, September 22, 2011.
- Ansel, Wolfgang, 2009, 'Green Roof Incentives in Germany- Proven Procedures and Current Trends.' In: Green Roofs- Bringing Nature Back to Town, Proceedings: International Green Roof Congress 2009. pp. 123-126.
- Appl, Roland (2011). Technical Director, ZinCo. Interviewed by Jennifer Stamatelos, Stuttgart, September 22, 2011.
- Arnold, Stephan (2011). Managing Director, Otto Arnold GmbH. Interviewed by Jennifer Stamatelos, Stuttgart, September 22, 2011.
- Bhattacharya, Shaoni, 2003, 'European heatwave caused 35,000 deaths', Retrieved November 20, 2011, from <<http://www.newscientist.com/article/dn4259-european-heatwavecaused-35000-deaths.html%3E>>.
- Brooks, N. and Adger, W.N., 2005, 'Assessing and Enhancing Adaptive Capacity. In Lim, B., Spanger-Siegfried, E., Burton, I., Malone, E. and Huq, S. (eds) *Adaptation Policy Frameworks for climate change: developing strategies, policies and measures*, pp. 165-181. Cambridge University Press.
- Bulkeley, Harriet and Kristine Kern, 2006, 'Local Government and the Governing of Climate Change in Germany and the UK', *Urban Studies*, vol. 43, no. 12, pp. 2237-2259.
- City of Lowell. Retrieved November 20, 2011, from <<http://www.lowellma.gov/services/gis>>.
- Department of City Planning and Urban Renewal (2007). Levels of spatial planning in Stuttgart. State Capital Stuttgart, Germany.
- Döveling, John, 2009, 'Two Decades of Green Roof Policies in Stuttgart- a Field Report.' In: Green Roofs- Bringing Nature Back to Town, Proceedings: International Green Roof Congress 2009. pp. 145-148.
- ECONOMIC expert. Retrieved November 20, 2011, from <<http://www.economicexpert.com/a/Stuttgart.htm>>.
- Environmental Protection Office et al., (2009). For our environment- Protecting the environment, conserving resources, saving energy. State Capital Stuttgart, Germany.

- Federal German Building Code (Baugesetzbuch, BauGB), last amended in 2011.
Retrieved November 25, 2011, from:
<<http://www.iuscomp.org/gla/statutes/BauGB.htm>>. (English version)
<<http://www.gesetze-im-internet.de/bundesrecht/bbaug/gesamt.pdf>>. (German version)
- GRaBS. 'Stuttgart: Combating heat island and poor air quality with green aeration corridors'.
Retrieved November 20, 2011, from <<http://www.grabs-eu.org/membersArea/files/stuttgart.pdf>>.
- Greenroofs. Retrieved November 20, 2011, from
<http://www.greenroofs.com/archives/sg_oct03.htm>.
- Greenroofs.^a Retrieved November 20, 2011, from
<http://www.greenroofs.com/Greenroofs101/industry_support.htm>.
- Institute for Urban Design and Housing, n.d. Spatial Planning in Germany.
Retrieved November 25, 2011, from:
<http://www.internationalplanninglaw.com/files_content/ISW-Spatial-Planning-Germany.pdf>.
- International Green Roof Association (2009). Green Roofs- Bringing Nature Back to Town, Proceedings: International Green Roof Congress 2009. Berlin, Germany.
- Kapp, Rainer (2011). Chemistry Engineer, Office of Environmental Protection- Urban Climatology Division. Interviewed by Jennifer Stamatelos, Stuttgart, September 27, 2011.
- Kapp, Rainer and Ulrich Reuter (n.d.). Green roofs in Stuttgart. [PowerPoint slides]. Provided via email.
- Köhler et al., 2002, *Photovoltaic-Panels on Greened Roofs- Positive Interaction Between Two Elements of Sustainable Architecture*. Retrieved November 20, 2011, from
<http://commons.bcit.ca/greenroof/publications/photovoltaic_kohler.pdf>.
- Maier, Wolfgang (2011). Urban Planner, Department of Urban Planning and Urban Renewal.
Interviewed by Jennifer Stamatelos, Stuttgart, September 21, 2011.
- Ministry of Economic Affairs et al., (2009). Schwetzingen- A Prince Elector's Summer Residence.
Retrieved November 25, 2011, from: <http://www.schloesser-magazin.de/fm/staatsanzeigerbw01.a.37.de/schwetzingen_unesco_antragsband_e_2009-180110.pdf#page=157>.
- Ministry of Economy Baden-Württemberg (2008). Climate Booklet for Urban Development- References for Zoning and Planning. Retrieved November 20, 2011, from
<http://www.staedtebauliche-klimafibel.de/Climate_Booklet/index-1.htm>.
- Office for Environmental Protection (2009). Environmental aspects in spatial planning in Stuttgart. State Capital Stuttgart, Germany.

Office of Urban Planning and the Environment (2010). Climate Change- challenge facing urban climatology. State Capital Stuttgart, Germany.

Patzold, Peter (2011). City Councillor, Green Party. Interviewed by Jennifer Stamatelos, Stuttgart, September 20, 2011.

Philippi, Peter, n.d., 'Introduction to the German FLL-Guideline for the Planning, Execution and Upkeep of Green-Roof Sites', Retrieved November 20, 2011, from <http://www.epa.gov/region8/greenroof/pdf/IntroductiontotheGermanFLL2.pdf>.

Sluijs, J.P. van der and W. Turkenburg, 2006, 'Climate Change and the Precautionary Principle'. In: Elizabeth Fisher, Judith Jones and René von Schomberg, *Implementing The Precautionary Principle, Perspectives and Prospects*, ELGAR, 2006 chapter 12, pp. 245-269.

Stuttgart Region Economic Development Corporation. No Title. Retrieved November 20, 2011, from http://www.taiwan.ahk.de/fileadmin/ahk_taiwan/Dokumente/BWI_Stuttgart_Region_-_Facts_and_Figures.pdf.

Wagner, Walter (2011). Department Head, Garden, Cemetery, and Forestry Office. Interviewed by Jennifer Stamatelos, Stuttgart, September 21, 2011.

Walker, Ralf, 2011, 'ZinCo invents the "low-maintenance" intensive green roof,' Retrieved November 20, 2011, from http://www.zinco-greenroof.com/EN/news/press_releases/press_release_details.php?id=59.

Wickstead, Mark, 2008, 'Green roofs cool cities, combat climate change, say Germans', Retrieved November 20, 2011, from http://articles.cnn.com/2008-06-26/tech/green.roofs_1_green-roofs-roofs-for-healthy-cities-regular-roof?s=PM:TECH.

Images:

Map of Germany: <http://tinyurl.com/85qkrpt>.

Map of Stuttgart: <http://tinyurl.com/6t556pw>.

Chapter V

Comparative Analysis and Conclusions

1. Introduction

The implementation of green roofs across various cities as a climate adaptation measure is on the rise. As the preceding chapters have elucidated, cities are adopting green roofs for a plethora of reasons relating to the (future) impacts of climate change. Chicago is encouraging the uptake of green roofs in order to deal with the urban heat island effect and stormwater flooding. While London's initial primary impetus for green roofs was for biodiversity reasons (habitat mitigation for the black redstart), stormwater management and urban heat island reduction are important problems that the city is trying to cope with. Stuttgart's interest in green roofs overlaps with the aforementioned; it is attempting to minimize the urban heat island effect and is implementing a variety of measures to manage stormwater runoff. Another driving factor for Stuttgart's widespread incorporation of green roofs stems from its poor air quality, which is partly a consequence of its geographical characteristics.

The climate adaptation issues that Chicago, London, and Stuttgart are facing have served as a catalyst for both public and private actors to get involved in the green roof field. A variety of actors, including government officials, green roof consultants, ecologists, green roof industry associations, and landscape architects, are propelling the industry forward via their activities. However, the approach that the cities have taken to promote the spread of the technology varies. This difference in strategy is apparent in various areas, including the types of policy instruments and steering strategies employed. The variance in governance arrangements that we see in each of the cities stems from and is influenced by the underlying considerations of the stakeholders. An analysis of these arrangements and underlying considerations is imperative because it can lead to fruitful insights that explain why some cities have more successful implementation rates than others. Although governance arrangements can assume a variety of permutations, the dominance of certain considerations may explain why certain arrangements are configured the way they are; why mandatory regulation is possible in some cities (i.e. Stuttgart) but not in others; and why certain steering strategies are employed as opposed to other alternatives. Hence, the objective of this chapter is to conduct an in-depth comparative analysis of the public-private governance arrangements in the three cities via an exploration of the following: mix of policy instruments; division of public-private responsibilities and their underlying considerations; steering strategies; and opportunities/barriers that are impacting private actor involvement in the green roof governance process. This analysis will not only highlight the similarities and differences with regards to the above-mentioned factors, but can also help generate recommendations that public and private actors alike can adopt in order to accelerate and improve the implementation of green roofs in their respective cities. Each of the sections also highlight the sub-question or the central research question they are addressing.

2. Governance Arrangements: Chicago, London, and Stuttgart

Sub-question 1:

What type of public-private governance arrangements and instruments (regulatory, economic, communicative) are currently present in Chicago, London, and Stuttgart for spearheading green roof implementation, and what similarities and differences can be seen among the different cities?

Sub-question 2:

Based on the Theoretical framework for public-private considerations in governance arrangements for adaptation, what considerations are taken into account when allocating responsibilities across the public and private sectors for the implementation of green roofs?

2.1 Responsibilities and Underlying Considerations

The division of responsibilities in the green roof governance arrangements for all three cities is demarcated along a strict public/private divide. While public authorities are heavily involved in the earlier phases of the policy cycle (i.e. policy making), private actors assume greater responsibility during the latter phases of the cycle (i.e. policy implementation and maintenance). This allocation of tasks and responsibilities between the two spheres is dictated and influenced by the underlying considerations that stakeholders take into account during the decision-making process. Understanding these considerations is important because they can be influenced to effect change. In other words, if a city currently has a governance arrangement that is ineffective, alternative arrangements could be envisioned that could better help the city cope with the task of implementation. However, a governance arrangement will not spontaneously adjust itself to the desired or optimal configuration. If one understands the underlying considerations and rationale behind the decision-making process, these can be manipulated and used as a mechanism for achieving the desired goal. The role of public and private actors, their responsibilities, and considerations are explored in detail below.

Public Responsibility

Public responsibility for the development of policy and the implementation of green roofs lies with several main authorities. In Chicago, the Department of Zoning and Planning (in particular the Sustainable Development Division) is heavily involved in green roof matters. The planning divisions of London's thirty-three local authorities, the Greater London Authority, and the Environment Agency have responsibilities relating to green roofs, while Stuttgart's Office of Urban Planning and Urban Renewal is the main authority on green roofs. The activities of these public entities center primarily around the policy making stage, and entail the following: knowledge creation; agenda setting; policy initiation; and target setting. While public authorities are involved throughout the entire phase of the policy cycle, their influence is most notably seen in the policy making and implementation phases. In all three cities,

government officials were responsible for crafting their respective green roof policies. The exception to this is London since the section on green roofs in the London Plan was (in part) written by Dusty Gedge. Although Gedge was commissioned to write the piece, control in what was written was retained by governmental authorities. Because of the complexities of the climate change problem and the potential negative environmental repercussions that cities are expected to experience, government officials are deploying a variety of policy mechanisms to secure adaptation action. All three cities have done so via the initiation of policy, whether mandatory (i.e. Chicago, Stuttgart), or non-binding (i.e. London). In addition to policy, the provision of direct and indirect financial subsidies to encourage the installation of green roofs also stems from the consideration of securing adaptation action. This is the case for both Chicago and Stuttgart; due to high up-front installation costs, private citizens and developers alike are still reluctant to incorporate green roofs onto their properties. The availability of subsidies is aimed at reducing this barrier in order to increase implementation rates. Another barrier to the uptake of green roofs is a lack of education and knowledge among citizens regarding their costs, multi-functionality, and intangible/tangible benefits. Because of this municipalities and local authorities have engaged in the dissemination of information, creation of websites, and installation of green roof demonstration projects to overcome this issue.

In relation to the above, the consideration of legitimacy is also a factor in the policy making phase. Stuttgart distinguishes itself in this instance compared to the other cities because of the steps that local authorities have taken to legitimize their stance for the promotion of green roofs. During the 1980s government officials consulted with a variety of stakeholders to fortify the case they were making to politicians for the push for green roofs. The head of Urban Planning enlisted the support of major green roof supply firms, industry pioneers, and ecologists to help strengthen his position. Their involvement in knowledge creation and strategy making was vital because their support helped to dispel notions of bias or inaccuracy. This facilitated the legitimacy of the department's objective because of the independent advice it received from outside experts in the field.

Another consideration taken into account during the policy making phase is the rule of law. This is specifically applicable in the policy initiation phase for London. Under the 2007 Greater London Authority Act and the 2010 Flood and Water Management Act, the Mayor and local authorities, respectively, have a statutory remit to deal with flood management issues. Fairness is another consideration that manifests itself in the initiation of policy. Because of scientific uncertainty and the long-term (and costly) impacts of climate change, government officials have taken the precautionary principle into account when developing their strategies to combat climate change. Both Chicago and London have issued climate adaptation strategies, while Stuttgart is currently in the drafting phase of its plan. Furthermore, this consideration of fairness is also pertinent for target setting because certain geographical regions are more susceptible to events such as stormwater flooding. Hence, it is in the cities' interest to protect those areas that are most vulnerable (i.e. city centers) because they are assets of strategic importance for the economy.

Public authorities also take the consideration of fairness into account in the policy evaluation phase. Monitoring, enforcement, and quality control are conducted in order to ensure an equal playing field for everyone. In other terms, it is necessary to have some sort of check to verify that developers, homeowners, etc. are in fact upholding their end of the agreement. For projects that received Chicago city financing, proof had to be provided to the green roof grants administrator that a green roof was in fact installed. With respect to tracking, Chicago authorities have acknowledged that the monitoring of green roofs is not done in a systematic manner, and changes are being made to streamline this process. The Department of Zoning and Planning will be taking steps to access satellite imagery so that it can obtain additional parameters on Chicago's green roofs. With this data they can better approximate the

area coverage of green roofs, quality of the roofs, species mix, etc. London's monitoring of green roofs is not entirely systematic either. While Gedge does track green roof area coverage for the GLA, he is dependent upon the information he receives from corporations, major developers, and others regarding the installations they have made. Therefore, the figures he has are estimates and are not entirely accurate. Moreover, there is no standardized follow-up check for projects that receive approval from local planning departments to verify whether or not a green roof was actually installed.

The consideration of fairness is most prominent in Stuttgart, and it plays a significant role in the policy evaluation phase. Because of Stuttgart's obligatory green roof requirement on flat-sloped roofs, general inspections were (at one point) made by the Department of Building Law to ensure that the roofs were in fact installed. While an amendment to the State Building Code makes this inspection no longer mandatory, they still do occur. Besides the Department of Building Law, inspections were also made by the Garden, Cemetery, and Forestry Office. This was standard procedure for roofs that were installed with the aid of a financial subsidy from the city (up until 2009). The tracking of green roofs, at least on public buildings, also falls under the remit of the Garden, Cemetery, and Forestry Office. The requirement of a minimum substrate depth for green roofs by Urban Planning also relates to the 'fairness' consideration. The substrate depth of six centimeters guarantees that there is a minimum quality standard and that the roofs are functioning for their intended purpose. For instance, a roof with very little substrate will not be efficient in retaining stormwater. The stormwater fee reduction of 50% is only given to property owners that meet this requirement. Having this quality control check ensures that property owners are not receiving financial compensation for green roofs that are not contributing to stormwater flow management.

Efficiency, a prominent consideration which drives private involvement in the green roof field, is also taken into account by public authorities. This is the rationale behind Stuttgart's Garden, Cemetery, and Forestry Office's involvement in policy maintenance. The department is responsible for maintaining green roofs located on publicly-owned buildings. While maintenance is usually performed by green roof firms (as is the case in Chicago and London), the department has taken it upon itself to conduct this 'in-house' because of their knowledge and years of experience in these matters.

Private Responsibility

There are a variety of private actors that are involved in the implementation of green roofs. Consultants, green roof suppliers, landscape architects, and developers represent a few of the many different types of stakeholders that are part of the industry. Some of these actors have played a significant role in promoting the uptake of green roofs in their respective cities. This is most notable in London, where Dusty Gedge (urban ecologist/consultant) played a pivotal role in building the industry from the 'ground up.' The consideration of securing adaptation action for biodiversity purposes was a driving factor for his involvement. Protection of the black redstart, a bird whose preferred habitat is brownfield land, was the main impetus for Gedge to seek out solutions on habitat mitigation for the protected species. Through extensive research, consultation with other experts (particularly in Switzerland), and lobbying, Gedge managed to convince public authorities that green roofing was a viable solution. Gedge can be considered a policy entrepreneur because of the role he has played in creating knowledge, educating governmental and non-governmental individuals, and in agenda setting. Because of his expertise his role has also extended into policy writing. The work that has been accomplished by Dusty Gedge is an exceptional example of how a single individual could influence the development of an industry. The consideration of securing adaptation action (on the behalf of a private

individual) is absent in Chicago and Stuttgart. The push for implementing green roofs in those cities primarily stemmed from public authorities.

The consideration of securing adaptation action is also evident in Stuttgart in the policy making phase. One of the initial (and biggest) barriers to green roof uptake was a lack of knowledge on how to go about constructing them, as well as the absence of minimum quality standards. The German Landscape Research, Development and Construction Society, or FLL, has been conducting research since the 1970s to overcome this barrier. Through their networks and years of practical experience they have created guidelines which are the default standard in countries that do not have their own guidelines. The recommendations and guidance provided by the FLL guidelines have alleviated concerns on how to construct high quality and reliable green roofs.

While the consideration of securing adaptation has been important in activating private actor involvement (primarily in London and Stuttgart), one of the *key* considerations for the participation of private actors in the green roof field is efficiency. The quest for efficiency is a trademark of the private sector, and it has driven private actors to become involved in all aspects of the policy cycle, from policy making to policy maintenance. Efficiency is a common rationale and recurring theme that surfaced in stakeholder interviews in all three cities. The consideration of efficiency has manifested itself in a variety of forms in the cities. For instance, in Chicago 'efficiency' has motivated stakeholders to establish private partnerships to serve their business interests. The formation of Intrinsic Landscaping's Dream Green Team brought together professionals from different disciplines in order to better serve their clients' needs because the creation of a green roof is a cross-disciplinary task. Similarly, the partnership between Weston Solutions and ABC Supply was forged to take advantage of Weston Solutions' market position as a major green roof service provider. Weston has exclusive rights to ABC Supply's modular green roof system. The availability of this type of system opens up the market to individuals who could not procure more expensive, traditional green roofs. Another example that demonstrates private stakeholders' consideration of efficiency is the partnership established by Molly Meyer (green roof consultant) and Mike Repkin (biologist). These individuals are leveraging their expertise to create a commercial, urban rooftop farm in Chicago. Their objective is to create a lightweight farm that is commercially viable.

In London and Stuttgart, the consideration of efficiency is strongly connected with innovation. Innovation in the field has come about because of years of research and development and the expansion of the green roof market. Private actors are trying to benefit from economies of scale in various ways. One of the most attractive aspects of green roofs is their multi-functionality, and this can be honed to make green roofs more suitable to deal with the increase in radical weather events that cities are expected to experience in the future. Because of climate change London is projected to experience more rainfall in the upcoming decades. Green roof firms such as Alumasc are taking advantage of this by conducting research to discover ways into increasing the saturation capacity of green roofs. There is a need for this type of innovation, especially for London since flooding is a major concern for the city. In a similar vein, firms are attempting to create more market demand for their products by developing tailor-made systems for consumers. A prime example of this is the Green Roof Shelter. These 'shelters' are innovative and appeal to consumers that desire something more than just a standard green roof system. In Stuttgart, innovation has led to the creation of lightweight substrate mixes that are suitable for roofs that are unable to carry heavy loads. Additionally, consumer demand for alternative types of green roof systems has inspired green roof firms to create low maintenance intensive green roof systems. This has undoubtedly opened up the market to individuals that previously would not consider procuring intensive systems because they require greater maintenance.

Property owners and developers are also involved in the green roof policy cycle. Their responsibilities fall under the policy implementation and maintenance phases. More specifically, these private actors are engaged in the financing, physical implementation, and post-installation maintenance of green roofs. One of the most significant barriers to the adoption of green roofs is their up-front costs. Because of this and the time delay in the accrual of (tangible/intangible) benefits, many citizens refrain from procuring green roofs. While private property and building owners in Stuttgart are active in purchasing green roofs, this is the case because they are legally mandated to do so under their municipality's binding land-use plans. Hence, the responsibilities of private property owners in Stuttgart are less compared to those in Chicago and London in the sense that their actions are primarily motivated by their legal obligations to the municipality.

In spite of their costs and apart from mandatory requirements, private actors in all three cities are busy purchasing green roofs for their homes, businesses, and other places of occupancy. There are a variety of reasons driving their interest in green roofs, including the quest for the 'sustainable' image; the need for outdoor amenity space as an oasis in the city 'jungle;' space for urban agriculture; and for the other beneficial uses provided by a green roof (i.e. energy savings, aesthetics). As an example, according to one respondent there was an incentive for a building owner in Chicago to install a green roof on an additional side of the building due to the rental patterns that were witnessed. Initially, only one side of the building had a green roof—and all the demands for rental space were for those offices that had a view of the green roof. In response, another green roof was installed so that those who rented offices on both sides of the building could enjoy the aesthetics of the rooftop landscape. While building owners and others (such as developers, housing corporations) can easily decide to install green roofs on their properties, they are reluctant to do so because of the split incentive problem. The costs of installing a green roof are borne by the building owner/developer, while the benefits are enjoyed by the tenants. This creates a disincentive for the property owner because often times they are unable to remedy this via higher rents. However, there are an increasing number of examples which demonstrate the efforts that tenants are taking to overcome this financial barrier. An interviewee in London mentioned that renters, in particular corporate tenants, are approaching their building owners to request permission to install green roofs on their own expense. Because the financial burden is now placed on the tenant and not the building owner, there should be no disincentive on the part of the owner to approve such a request given that it is structurally viable to do so. The consideration of efficiency plays a significant role in both of these instances; both the property owner in Chicago and the corporate tenants in London are encouraged to purchase green roofs because of their 'no-regret' nature.

Public-Private Responsibility

While the above-mentioned examples illustrate 'pure' forms of public and private responsibility, there appears to be a lack of *true* public-private responsibility. Public-private responsibility by means of collaboration and joint task sharing throughout the entire policy cycle is for the most part absent in all of the three cities. This is not to say that collaboration between public and private actors does not occur; this does take place in all of the cities, however this is *consultation* and not co-decision-making. As an example, in Chicago professionals from the legal, economic, and scientific communities were pivotal in helping to create the Chicago Climate Action Plan. This task of knowledge creation was extended to the private sector to leverage their knowledge in areas that the city lacks sufficient expertise in. Securing adaptation action is the main consideration which explicates the city's task allocation for this

undertaking. Its goal was to create a plan that can be used to help tackle future climatic impacts. In order to do so it required the assistance of the private sector to help create it.

In a similar vein, public-private responsibility during the policy-making phase could also be seen in Stuttgart in the 1980s. Both public and private actors, in particular green roof firms and industry pioneers, participated with government officials in knowledge creation and in the dissemination of information to educate the public and politicians alike about the merits and benefits of green roofing. As in Chicago, however, control during the “PLAN” phase resided with public authorities. Nevertheless, it is interesting to note that legitimacy was a driving consideration for the involvement of a multitude of stakeholders in this process. Because of the novelty of the green roof in the 1980s, it was necessary to involve a range of stakeholders, especially industry experts, to convince people that green roofing was a safe practice and that ‘it works.’ Given the multi-level, sector and actor complexity that is characteristic of the green roof implementation process, the considerations of legitimacy and accountability and transparency have not been dominant in the three cities (with the exception of Stuttgart). This is something that public authorities should reflect on in the future because without strong support from its citizens and business/commercial sectors, the widespread adoption of green roofs as a climate adaptation measure will fail to materialize.

The table on the following page provides a synthesis on the different actors involved, their responsibilities, and considerations taken into account.

Table V.2: Overview of Responsibilities and Considerations

Actors	Considerations	Roles per stage	Clarification of considerations
Public Responsibility			
Local Authorities	Securing Adaptation Action	Policy making: agenda setting, knowledge creation, and policy initiation	Lack of incentives to encourage private actors to install green roofs; uncertainty regarding climate change impacts; cost-benefit ratio of green roofs
		Policy implementation: financing (Chicago and Stuttgart) and implementation of green roofs	Installation of green roofs on city-owned buildings as demonstration projects; upfront costs of green roofs vs. time delay in reaping of the benefits has resulted in poor adoption rates on private buildings
		Policy implementation: information provision and dissemination	A lack of knowledge exists among public and private actors regarding the benefits of green roofs, their actual costs, etc. Cities are attempting to educate their citizens via exhibitions, distribution of literature, electronic media
	Fairness	Policy making: policy initiation and target setting	Uncertainty regarding future climate impacts has encouraged public actors to take the precautionary principle into account; focus is on vulnerable areas (i.e. city centers)
		Policy evaluation: monitoring (all cities) and enforcement (Stuttgart)	Guarantee of a level playing field where everyone shares the same burden (Stuttgart); recipients of (financial) benefits from public policies should maintain their end of the contract (Chicago)
		Policy evaluation: quality control (Stuttgart)	Requirement that green roofs have a minimum substrate depth; plant species recommendations are also provided-- this ensures that there is some minimum quality and that the roofs are functioning for their intended purpose (i.e. roof with very little substrate won't be efficient in retaining stormwater)
	Legitimacy	Policy making: knowledge creation and strategy making (primarily Stuttgart)	Consultation processes with green roof suppliers, consultants, scientists, and economists
	Rule of Law	Policy making: policy initiation (London)	Acts that place duties for flood management on local authorities: GLA Act 2007, Flood & Water Management Act 2010
Efficiency	Policy maintenance: maintenance after installment (Stuttgart)	Stuttgart's Garden, Cemetery, and Forestry Office has trained teams that are responsible for checking/maintaining publicly-owned green roofs on an annual basis	
Private Responsibility			
Consultants/ecologists	Securing (Biodiversity) Action	Policy making: agenda setting and knowledge creation (London)	Research and lobbying on behalf of these private actors has convinced local authorities that green roofs are a legitimate roofing technique, and are a viable measure for habitat mitigation
	Securing Adaptation Action	Policy making: knowledge creation (Stuttgart)	Initially one of the biggest barriers to green roof uptake was a lack of knowledge regarding standards and how to go about constructing them. The FLL has been conducting research for years and has published comprehensive guidelines on how to go about greening rooftops
Green roof industry (associations)	Efficiency	Policy making; policy implementation; policy evaluation; policy maintenance	Innovation in green roof field with respect to green roof systems and related products; this has led to economies of scale and a reduction in costs. Through their lobbying efforts they have raised awareness and secured market demand for their products
Property owners/developers	Efficiency	Policy implementation: financing and implementation of green roofs	Green roofs are considered a 'no-regret' measure because of all of the benefits they offer. These benefits make them cost effective over the long-term. Stuttgart's green roof market is mature and this is reflected in the prices for green roofs (in particular extensive roof systems)
		Policy maintenance: maintenance after installment	Many firms are including a maintenance clause in their contracts; this enables them to make additional money while also observing system performance over time

2.2 Steering Strategies

The steering strategies employed in the green roof governance process are important because they influence the activities and decisions made by both public and private authorities, which in turn impact the effectiveness of implementation rates. In Chicago, London, and Stuttgart, two forms of steering strategies are distinguishable- hierarchical steering and market steering. Hierarchical steering lies in the hands of public officials because they have the legal authority to enforce rules and to obligate their citizens to abide by certain standards or regulations. Market steering is visible among the private sector and influences the actions of private actors. The former type of steering takes place in all three cities. Government officials were responsible for initiating the green roof policies in their respective cities as well as deciding which policy mixes to employ. However, differences can be seen with respect to the level of coerciveness among the cities. For example, Stuttgart's policy is the strictest since its

scope applies to all buildings with flat-sloped roofs. Chicago's policy is more 'middle-ground' since it is not as expansive, while London's policy is the weakest since there is no legal obligation to install a green roof. Hence, it appears that hierarchical steering is in its most dominant form in Stuttgart, while London represents the opposite end of the spectrum. In the absence of powerful regulation, Chicago and London have introduced various instruments to encourage the uptake of green roofs. Chicago in particular has provided several financial grants and other indirect financial incentives to spur the installation of green roofing systems. While London has not provided any financial support to subsidize green roofs, communicative instruments appear to be the mechanism of choice to help spread knowledge and awareness about their beneficial uses. Although hierarchical steering is found in varying degrees in all three cities, public authorities in all of the cities use the 'carrot' in addition to the 'stick' to influence private actor behavior.

In addition to hierarchical steering, market steering is visible and pronounced in all of the cities. The green roof industry is actively engaged in marketing, information dissemination, and research and development with the aim of creating consumer demand for their products. The consideration of efficiency is a strong motivator for private actor involvement in the green roof industry. Innovation, the formation of private partnerships, and increasing economies of scale have facilitated the growth of the market and private stakeholders are taking advantage of this in order to maximize their benefits.

2.3 Green Roof Policy Instruments

The cities of Chicago, London, and Stuttgart have adopted an array of policy instruments to encourage the uptake of green roofs. In terms of regulations, London has the least stringent policy. There is no mandatory requirement in London; however, according to the 2008 revised version of the London Plan, there is the expectation that major developments will incorporate green roofs, where feasible. Therefore, the onus is on the developer to justify why green roofs cannot be incorporated into a development project. Despite the absence of mandatory regulation, there are other avenues that local authorities can pursue to pressure developers into adopting green roofs. The planning permission process presents an opportunity for local authorities to exercise their clout via time delays in the approval process, or rejection of an application if it fails to include a provision for green roofs. Additionally, the 2010 Flood and Water Management Act indirectly promotes green roofs since it requires the inclusion of sustainable drainage systems in new developments, where feasible.

The City of Chicago's mandatory, albeit not all-encompassing, 2003 Sustainable Development Policy requires the inclusion of green roofs (or other green, sustainable elements) for plans that either receive city financing or undergo review in the planned development process. In addition to this policy, green roofs are also encouraged through performance-based regulations. They are considered a legitimate measure for achieving targets for stormwater retention, energy conservation, and landscape beautification for the following, respectively: 2007 Stormwater Ordinance; 2002 Energy Conservation Code; and 2000 Landscape Ordinance. In comparison to Chicago and London, Stuttgart's regulatory requirement for green roofs has been in place the longest. Since 1986, the city of Stuttgart has made it obligatory to install green roofs on flatly-sloped rooftops (up to 10 degrees) via the *Bebauungsplan* (B-Plan), which is also known as the local development or legally binding land-use plan. This requirement applies to everyone, both commercial and residential property owners alike. However, exemptions are possible in a limited number of instances. In terms of regulatory output, Chicago and Stuttgart have more robust policies that mandate to varying extents the incorporation of green roofs on residential and commercial developments.

In addition to regulations, the cities have also introduced an array of direct and indirect financial incentives to encourage building owners and citizens to procure green roofs. The only exception is London; the city has not taken any steps to financially incentivize the installation of green roofs. Although Chicago has been promoting green roofs for a much shorter time period than Stuttgart, it has offered a greater mix of incentives for its citizens. There were several grant programs in place between the 2005 through 2009 period that subsidized the construction and installation of green roofs. While three grant programs no longer exist, two are still active today.⁶⁶ It is important to note, however, the limited impact that the grants actually had as a driver for green roof installations. The short duration of the grants, limited funding pools, and the under-utilization of some of the funding schemes suggests that these financial incentives were not the primary catalyst. In a similar vein, Stuttgart provided a financial subsidy between 1986 and 2009 in the amount of 17.90 Euros, or 50% of actual costs. The annual funding pool of 51,000 Euros (which can be considered quite limited) was exhausted every year. In 2007 the city also introduced a stormwater fee reduction of 50% for properties that have green roofs. Both Chicago and Stuttgart also incentivize green roofs indirectly via a density bonus system. This allows developers to build more units per square meter if they consent to installing a green roof. A unique incentive offered by Chicago is an expedited green permit approval process. The Green Permit Program has been in force since 2004 and it reduces the review period for plans, as well as offering the possibility of a permit fee waiver.

While legal and economic-based instruments have been useful in helping to further advance the uptake of green roofs, the use of communicative mechanisms has also contributed to the growth of the industry. All three cities have taken steps to create and exchange knowledge on green roofs via stakeholder forums, public demonstration projects (such as the one on top of City Hall in Chicago), and through online media. London in particular is focused on developing an electronic green roof portal⁶⁷ that will serve as a forum for information exchange and as a repository for case studies documenting various green roof projects in the United Kingdom. While Chicago also has pertinent information accessible on its websites, another valuable resource that can be tapped by its citizens is the Chicago Center for Green Technology. It is a resource center for citizens and professionals that are interested in green roofs and other sustainable elements. Stuttgart's Garden, Cemetery, and Forestry Office has a 'green' public hotline and also provides free consultation advice to parties interested in green roofs.

Although the aforementioned examples focus on what the public sector has been doing to generate and distribute knowledge on green roofs, it is important to recognize that the private sector has been active in this area as well. In particular, green roof supply firms and industry associations are especially proactive and well-organized in Stuttgart. Various private partnerships and professional networks (i.e. IGRA, DDV, FBB, FLL) are well established and are constantly engaged in seminars, workshops, and in contributing to industry journals. In London, a plethora of information can be found on the livingroofs.org website. Dusty Gedge is the founder of the website and he possesses a wealth of information and experience in the green roof field. The most noticeable difference between London and Stuttgart is that while the latter has had a vast array of stakeholders working in tandem to convince people on the benefits of green roofs, the industry in London has been propelled forward (at least initially) by the vision of a single stakeholder.

The development of climate action plans and greening strategies is an endeavor that all three cities have undertaken. Chicago was the first city out of the three to issue its Climate Action Plan (2008). The Chicago CAP addresses both mitigation *and* adaptation, and it explicitly mentions green roofs as a

⁶⁶ Additional details on the policy instruments can be found in **Table V.1** on the following page.

⁶⁷ The development of this portal is currently on hold.

suitable measure to address climate risks. Similarly, London published a Climate Change Adaption Strategy in 2010. This document also specifically highlights green roofs and their beneficial uses as a SUDs technique. Stuttgart is the only city that does not currently have a climate adaptation strategy, although efforts are currently underway to develop one. However, Stuttgart has developed a Climate Atlas that contains an abundance of information on the region’s different physical and climatic features. Because of Stuttgart’s location in a valley basin, a lot of research has gone into studying the environmental and climatic features of the region in order to mitigate environmental problems such as poor air quality. The city’s Climate Atlas is important because it has been used to make recommendations to the Urban Planning department. Hence, this advice can be utilized to form the basis of climate action recommendations in Stuttgart’s future climate adaptation strategy.

The table below provides an overview of the various policy instruments employed in the cities.

Table V.1: Overview of Policy Instruments

Policy Instruments	Chicago	London	Stuttgart
<i>Legal control model: influencing behaviour through rules and regulations</i>			
Technology-based regulation (i.e. building codes)	Sustainable Development Policy (2003)- mandatory for plans that receive city financing or are required to undergo review	London Plan (since 2004)- there is the expectation that major developments will incorporate green roofs; onus in on the developer to explain why they cannot incorporate them	Mandatory green roof policy (since 1986)- required on flat-sloped roofs for all new developments. Legal basis: German Federal Building Code Local development plans
Performance-based regulation	Green roofs are considered a legitimate measure for achieving targets for stormwater retention, energy conservation, and landscape beautification for the following, respectively: Stormwater Ordinance (2007); Energy Conservation Code (2002); Landscape Ordinance (2000)	Green roofs qualify as a SUDs technique- The Flood and Water Management Act requires the incorporation of sustainable drainage systems in new developments where feasible	None
<i>Economic control model: influencing behaviour through influencing costs and benefits</i>			
Direct Financial Incentives	> Green Roof Grant Program: 2005-2007 > Green Roof Improvement Fund (GRIF): 2006-2009 > Illinois Green Roof Grant Program: 2009 > Small Business Improvement Fund (SBIF): still active > Illinois Green Infrastructure Grant Program for Stormwater Management: still active	None	> Subsidy of 17.90 Euros or 50% of actual costs (offered between 1986-2009) > Stormwater fee reduction- in effect since 2007, 50% (fee is 0,53 Euros per square meter)
Indirect Financial Incentives	> Density bonus offered to developers > Expedited green permit approval process (since 2004)	None	Density bonus- offered on a case by case basis
<i>Communication control model: influencing behaviour through knowledge and information transfer</i>			
Information and education	> Public demonstration roof on City Hall (2001) > Chicago Center for Green Technology- resource center for citizens and professionals	> Livingroofs.org website > Drain London project > Environment Agency online green roof toolkit > GLA green roof portal (development is temporarily on hold)	> Public demonstration roofs throughout city due to municipal greening > Free consultation advice and 'green' public hotline > Various private partnerships and professional networks (i.e. DDV) > Green roof industry involved in education and information sharing (i.e. via seminars, workshops, industry journals)

Synthesis: Policy Instruments

All three cities have employed legal, economic (except London), and communicative instruments to promote the implementation of green roofs. Although the duration and scope of the instruments vary, there are commonalities among the cities' choices. Both Chicago and Stuttgart elected to institute mandatory requirements and to offer direct and indirect financial incentives. Furthermore, all of the cities are using communicative instruments to further their goals. It is evident that Stuttgart has the most expansive and stringent policy, while London is the least restrictive. Green roofs are promoted via the London Plan, but the absence of regulation that has 'teeth' explains why it is a laggard in terms of green roof implementation rates (less than 1% of green roof area coverage) compared to Stuttgart. While both Chicago and London have approximately the same amount of green roof installations (around 700,000 m²), in terms of m² per capita there is a significant discrepancy: 0.2333 versus 0.0917 for Chicago and London, respectively. However, it is interesting to note that despite Chicago's mandatory requirement and the fact that the city has been promoting green roofs for nearly ten years, its progression in implementing green roofs is far slower than Stuttgart's. Stuttgart's mandatory policy has been in place for twenty-six years, and during this time period an estimated 22% of rooftops have been greened. Chicago, in contrast, has greened less than 1% of rooftops. Hence, it appears that the scope of the mandatory requirement has impacted the installation rates in the cities. Stuttgart's more extensive policy can be seen as being more effective than that of Chicago. Respondents in all of the cities agree that the most powerful and effective instrument for encouraging the uptake of green roofs is a mandatory policy. While it was possible to institute such a policy in Stuttgart and Chicago, London's political climate has prohibited this type of policy from being enacted.

3. Factors Impacting Private Actor Involvement

Sub-question 3:

What opportunities and/or barriers are impacting private actor involvement in the green roof governance process, and what can be done to best encourage their participation?

The involvement of private actors in the green roof implementation process is crucial in order to help promote the advancement of green roofs. Currently, a range of private actors are active in the green roof field, including: consultants, ecologists, major roofing supply firms, and landscape architects. However, there are barriers that are impacting private actor involvement in the green roof governance process. In particular, these actors have very limited involvement in the policy making phase. The extent of their participation is limited to providing expertise requested by public authorities. For this reason, private actors are not considered 'partners' with public authorities in the governance process because they give advice but do not make decisions—the decision-making process is in the remit of public officials.

There are various factors that are perpetuating the current status quo and impeding greater private actor involvement. First, some public actors do not see the *need* to include private stakeholders in the governance process, especially during the "PLAN" stage. They believe that this duty is exclusively in the government's domain, which is why external involvement is limited to consultation only. So while

non-governmental officials have engaged in policy writing (i.e. London), control over the strategy and on *what* is written are retained by public authorities. An experience of mine during an interview in Chicago highlights this sentiment. When I questioned a government official as to why more private actors (including civilians) were not more involved he appeared to be surprised and somewhat perplexed by the question. The impression that I got from his response was that this topic was not even a matter of discussion among policy officials. This instance underscores the separation of what public officials deem to be *their* responsibility versus the responsibility of non-governmental actors.

In relation to the above, another barrier that is hampering private actor participation is the lack of *space* where they can share and voice their opinions. This goes hand in hand with the first barrier mentioned- if public authorities see no need for true collaboration between the two spheres, an absence of communication channels and forums for idea exchange will exist. It is important to note, however, that this is not the case in all of the cities. Stuttgart legally mandates citizens with the right to a public review of local development plans and provides a forum where they can voice their disagreements. In London, an Examination in Public for the London Plan does exist. While the public can provide input on the plan, there is no legal recourse which obligates public authorities to take them into consideration; this is in contrast to the current process in Stuttgart. Unlike in London and Stuttgart, there was no public evaluation of Chicago's Sustainable Development Policy prior to its issuance. While input from private actors was received, this could be characterized as a 'closed door' session that was limited to a small audience of experts from the legal, architectural, and engineering fields.

Although the above-mentioned barriers are hindering additional involvement from the private sector, they are various opportunities that can overcome these constraints. One of the most important factors that is perpetuating private actor involvement is the need for research. Governmental authorities have limited resources and expertise and therefore need to seek advice and knowledge from the private sector. This was made explicit by city officials in London; they were clear that they want to see more private research investigating the water retention capacity of green roofs so that future improvements can be made. Unique solutions for climate adaptation are needed, and the private sector is best equipped to (1) provide the research and (2) develop the products that will help society cope with climate change impacts. An additional opportunity for private actor involvement stems from the very nature of the climate change problem itself. Because climate adaptation is a multi-sectoral policy issue which requires expertise from a range of policy and issue areas, the participation and contribution of different private actors is needed to execute the implementation of the adaptation measure. The consideration of legitimacy plays a significant role in this because the inclusion of outside experts serves to legitimize and substantiates the efforts of policy officials. This consideration of legitimacy could in the future extend itself to encouraging greater private actor involvement in the "PLAN" phase. While the impetus for this would have to come from public authorities, their decision to promote private actor participation in the earlier phases in the policy cycle should stem from their realization that non-governmental stakeholders can (and do) possess more knowledge on certain issues such as green roofs. It therefore makes sense to include these actors in the very beginning to ensure that policy is being written in a 'smart' way that will encourage adaptation.

There are various measures that public authorities can take to further engage private actors in the governance process. First, public officials need to conduct more outreach. In order to achieve this, institutionalized communication channels need to be established where both parties can easily communicate with each other and exchange ideas. Electronic forums and stakeholder meetings would easily facilitate and improve communication between both sectors. While some of this already exists in the cities, there needs to be greater consistency and openness. These forums and meetings should be accessible to everyone so as to not marginalize or favor any one particular societal segment.

Additionally, there is a lot of opportunity for joint public-private partnerships. The green roof industry is expanding at a rapid pace in the cities, and hence there are ample prospects for some kind of joint venture between public and private actors. Joint research and/or financing schemes are examples of how both segments can leverage their experience and assets to promote green roofs. However, a difficult challenge that governmental authorities in all cities face is how to entice and encourage the involvement of the most powerful private stakeholders, such as real estate developers and housing corporations. The impact of city policies is limited to certain types of buildings and projects, and cities have a finite number of publicly-owned buildings that can be greened. Because the majority of the building stock in cities is held in the hands of private owners/corporations, in order to make adaptation widespread it is necessary to have their buy-in. The refusal of developers and housing corporations to incorporate rooftop greening into their projects will have negative repercussions on the cities' long-term urban greening vision. For this reason, public authorities may need to 'flex their muscle' in terms of regulatory options to see how they can best persuade developers and others to make green roofs a standard design feature in their plans.

4. Governance Arrangements: Advantages and Disadvantages

Sub-question 4:

What advantages and disadvantages does each city's specific governance configuration present for the advancement of green roof implementation?

This sub-question directly answers the last part of Central Research, "***...and what are the advantages and disadvantages of this [i.e. public/private] involvement in stimulating the implementation of green roofs?***"

The governance configurations in each of the cities have been influenced by a variety of economic, political, and cultural factors. These factors have in turn impacted the underlying considerations of public and private actors and the scope of their involvement in the green roof governance process. Each governance arrangement has its advantages and disadvantages. According to one respondent, too much public dominance (i.e. Stuttgart) can lead to a reduction in efficiency and can stifle creativity. The respondent claims that because green roofs are heavily regulated in Stuttgart, we see an overabundance of extensive green roof installations because there is no desire on the part of citizens to go beyond meeting the regulatory requirement. Additionally, because the mandatory requirement is driving the installation of green roofs, there is limited demand for unique systems that are manifesting themselves in other cities, such as green roof shelters; fish farms; urban rooftop farms; and green roof energy systems.⁶⁸ Based on interviewee responses, it appears that the entrepreneurial environment in Chicago and London fosters greater creativity in terms of thinking 'outside of the box' to generate new possible uses for green roof systems. So while innovation has taken place in Stuttgart (i.e. substrate mix, creation of lightweight systems), we are not witnessing the generation of 'crazy' ideas that are present in other cities.

⁶⁸ This refers to the incorporation of green roofs in buildings' energy systems for cooling purposes.

While the over-dominance of the public sector can appear to mute innovation, the dominance of the private sector can lead to insufficient levels of adaptation action. This is clearly the case in London. Because there is no mandatory requirement or incentives offered by governmental authorities, there is a lack of uptake of green roofs. The onus of supporting the advancement of green roofs is based on how well green roof firms can market their product and on citizens' desire to install them. Without a push from the government sector, an under-provision of green roofs will occur. Hence, public and private actor involvement are needed in the green roof implementation process because both spheres have their respective contributions to make. The most obvious conclusion that can be made from this analysis is that consistent public involvement and steering throughout the different policy phases, especially in the beginning, is of *absolute importance* if green roofs are to be implemented on a wide scale. Furthermore, mandatory policy that can be applied to a large segment of the building stock is also crucial in helping to improve implementation rates. **Table V.3** below shows some statistics pertaining to the implementation rates in the cities.

Table V.3: Green Roof Implementation Rates

Characteristic	Chicago	London	Stuttgart
policy since	2003	2004	1986
m ² installed by 2010	700,000	715,000	1,000,000
inhabitants	3,000,000	7,800,000	600,000
m ² per capita	0.2333	0.0917	1.6667
% of eligible roof space covered	< 1%	< 1%	22%
average price/m ² in Euros for an extensive green roof	40-80	60-65	10-40

5. Lessons to be learned

Sub-question 5:

What lessons can be learned from a cross-city comparison and what recommendations can be made to accelerate and improve green roof implementation in these cities?

The implementation of green roofs in Chicago, London, and Stuttgart has taken a variety of forms and each city is employing its own unique strategy and instruments to push adoption forward. The results of this research have shown that public involvement and hierarchical steering, which is representative of Stuttgart, has been pivotal to the widespread and successful uptake of green roofs. Given this conclusion, there are a number of lessons to be learned and recommendations that can be made to facilitate the spread of the technology in the other cities. First, it is important to stress that policy transfer can work, but must be conformed to fit in with each city's unique economic and political

circumstance. A policy instrument that is effective in one city may not be suitable for another due to reasons such as the political climate or institutional conditions. A case in point is Stuttgart's mandatory regulation; at the moment it would not be possible to implement this in London because of the city's political environment. In a similar vein, the sudden introduction of mandatory regulation is cautioned. Several respondents emphasize that this process needs to be more organic; people should be introduced to the idea of a green roof, its benefits, and should have the opportunity to see them in person via demonstration projects in order to become more familiar with them. By making people more knowledgeable and dispelling the 'abstractness' of a green roof, it is expected that less resistance will be encountered when regulations are enacted. A prime example of this resistance can be seen in Toronto, where developers are arguing against the city's mandatory by-law for green roofs.

The integration of green roofs with other policies is essential if green roofs are to be mainstreamed and adopted on a wide scale. Because they are a climate adaptation measure, green roofs overlap with a range of other policy issues. Their integration with policy goals for urban greening, biodiversity, energy efficiency, and water management is needed because this type of mainstreaming will ensure that it is on the agenda of a host of departments, and not just in the domain of the 'environmentalists.' Smit and Wandel (2006) point out the relevance of mainstreaming and state:

"The whole point of the work on adaptation processes is to have risks (and opportunities) associated with climate change (or other environmental changes) actually addressed in decision-making at some practical level...Practical climate change adaptation initiatives are invariably integrated with other programs, and often aim to enhance adaptive capacity" (pp. 285-286).

Another important aspect of this is that the cross-sectoral nature of the climate change problem requires the expertise of various policy domains. Integration will serve to leverage the knowledge and resources of all stakeholders involved, thus enhancing adaptive capacity.

In addition to mainstreaming green roof goals, transparency, fairness, and accountability are factors that are valued by stakeholders. The reflection of these aspects in governance arrangements and in the policy process is important if green roofs are to receive 'buy-in.' For instance, developers in Chicago appreciate the transparency of the Sustainable Development Policy because it clearly lays out the expectations of the government. Additionally, the policy makes everyone subject to the same regulation, hence reducing nepotism. This levels the playing field which is why *fairness* assumes a meaningful role. *Accountability* in the governance process is also integral for the effective implementation of green roofs. This can be seen in Stuttgart and in the responsibilities assumed by public officials. They are responsible for conducting inspections on green roof installations; this task is significant because it signals to people that the government wants to ensure that everyone is abiding by the mandatory regulation, hence discouraging free-riding behavior.

A common thread between the cities is that each one had a policy entrepreneur championing the cause from the very beginning. Former Mayor Richard Daley, Dusty Gedge, and Albert Ackermann were pivotal in jumpstarting the industry in Chicago, London, and Stuttgart, respectively. Their vision and desire to green the urban landscape is why the industry stands where it is today. However, if green roofs are to be considered a viable adaptation measure to help us cope with the projected impacts of climate change, they need to be advocated on a wide scale. For this reason, the participation of all societal segments is required to move this forward. Most importantly, however, is the continued support for implementation by public officials throughout the policy cycle. Stuttgart exemplifies this approach and it is because of government involvement that nearly a quarter of its rooftops have been

greened. Guidance and pressure from the government will help to steer the green roof implementation process in the right direction.

6. Governance Arrangements Synthesis: Analysis, Explanation, and Evaluation

Central Research question:

Which roles and responsibilities have been fulfilled, and can be fulfilled by public and private parties in the governance of green roof implementation, and what are the advantages and disadvantages of this involvement in stimulating the implementation of green roofs?

Analysis

While the motivation for spearheading green roofs in all three cities overlap in terms of stormwater management control and reduction of the urban heat island effect, key similarities and differences exist in the approach that the cities have taken to deal with the implementation of green roofs. These similarities and differences can be seen in the allocation of responsibilities, steering strategies, and the policy instrument mix employed by the cities. A key similarity that is apparent in all three cities is that public authorities are heavily involved during the earlier phases of the policy cycle, in particular during the policy making and implementation phases. The tasks of agenda setting, policy initiation, target setting, and strategy making are firmly in the hands of public officials. One key difference that can be seen in the “PLAN” phase between the cities is that while governmental officials in Chicago and Stuttgart were responsible for getting green roofs on the political agenda (i.e. Richard Daley and Albert Ackermann, respectively), a private actor (Dusty Gedge) was the driving force behind the green roof movement in London. Another notable difference concerning the allocation of responsibilities is that unlike in Chicago and London, public authorities in Stuttgart are a great deal more involved in the “CHECK” and “MAINT” phases. Public authorities conduct general inspections to check the installation of systems on both public and private properties, while also conducting maintenance for green roofs located on publicly-owned buildings. Another responsibility assumed by Stuttgart city officials was the establishment of a minimum substrate depth for green roofs. Although general guidelines and industry standards are available in the cities, Stuttgart is the only one that has taken the extra step to mandate some sort of minimum quality standard.

The responsibilities assumed by private actors are consistent throughout all of the cities. Private actors are more active in the “DO” and “MAINT” phases; their core tasks include financing, the physical implementation of the systems, information provision, and maintenance after installment. An important difference that was mentioned above and must be stressed again is the responsibility that Dusty Gedge took upon himself to build the green roof industry in London. His motivation for doing so was not monetary, nor was his primary driver the consideration of efficiency. His underlying consideration was *securing biodiversity action* since his objective was habitat mitigation for the black redstart. The responsibilities assumed by other private stakeholders (i.e. green roof supply firms, landscaping contractors) are primarily economically motivated.

In addition to the division of responsibilities among public and private actors, there are noteworthy differences in the steering strategies and policy instruments utilized by the cities in the green roof governance process. The steering strategy in Stuttgart is hierarchical and the regulatory policy instrument employed by public officials is strict. Stuttgart's policy is far-reaching because it targets all flat-sloped roofs. Public steering in Chicago and London is less dominating, and in order to compensate for the absence of an expansive regulation a greater policy mix can be seen (for Chicago only). Chicago offers a variety of financial and indirect financial incentives (more so than Stuttgart), while such incentives are non-existent in London. So while public authorities in Chicago and Stuttgart have contributed to the financing of green roof installations, city officials in London have made the decision to leave that responsibility in the hands of private actors. All three cities incorporate communicative instruments in their repertoire of tools that can be used to help facilitate knowledge and information exchange.

Explanation

Economic considerations dominate the green roof implementation process in all of the cities. Private actor involvement is strongly driven by the consideration of efficiency, while public domination in the earlier phases (specifically in the policy initiation phase) is motivated by the consideration of securing adaptation action. Because of the high installation costs of green roofs and the fact that this could lead to insufficient adaptation by private actors, public authorities have taken the responsibility to either institute mandatory regulation or to provide financial incentives to help promote their uptake. The exception to this is London, where mandatory regulation and the offering of financial or indirect financial incentives do not occur. London's reluctance to institute mandatory regulation or to offer any type of incentive stems from its political climate. There is a pervasive ethos in London which advocates a 'hands-off' policy on behalf of the government. The belief that government should not impose any undue restrictions on the market has prevented the execution of these types of policies. The rule of law is a primary consideration in London's policy initiation phase since public officials are mandated by national acts to take action to secure London against the impacts of climate change. It is interesting to note, however, that political conditions in Chicago and Stuttgart were conducive to the enactment of mandatory regulation. The political power held by Chicago's former Mayor Richard Daley and his desire to install green roofs was the catalyst that propelled the industry forward. In Stuttgart, the vision of Albert Ackermann and his push to make green roofs mandatory for an industrial redevelopment project were instrumental in their eventual widespread adoption. An additional factor which has facilitated the movement in Stuttgart is its cultural environment. The city's strong 'green' and environmental ethos has aided the adoption of green roofs.

Economic and juridical considerations are not the only underlying considerations propelling public officials. The decision by public authorities in Stuttgart to become more involved in the "CHECK" and "MAINT" phases has to do with the consideration of fairness. This is a chief distinction between Stuttgart and the other cities. In order to ensure that all citizens are conforming to the legal requirement, public officials have mandated minimum substrate depths and also perform general installation checks to ensure that citizens are upholding their legal obligations. *Accountability* is an additional consideration that is taken into regard in this instance. Clear responsibilities have been defined and officials are executing their checks to ensure that actors are performing their duties.

Evaluation: Implications of Governance Arrangements for the Advancement of Green Roofs

The type of governance arrangement in force in each of the cities is a strong determinant of implementation effectiveness. The public-dominated governance arrangement in Stuttgart has been the most successful in helping spread green roof technology on a wide scale. The government's accomplishment in this matter is in contrast to the general perception that many scholars have regarding governments' inability to adequately address large-scale (environmental) problems. This viewpoint also stems from numerous examples which cite governmental failure in trying to cope and 'fix' environmental problems. One reason for this is negative perception is due to the limited resources that governments have to deal with these types of problems. According to Florini (2000), "many of the most pressing collective action problems cannot be resolved by individual states acting alone..." (p. 15). The capacity and resources that governments have (whether on the national, state, or local level) at their disposal to cope with complex issues is limited, which is why networks and more inclusive forms of governance arrangements are seen as being more advantageous. Falkner (2003) also expresses a similar sentiment, and states that the rise in private forms of governance is "intimately linked with a decline in state power and results from the failure of the states-system adequately to govern the global commons" (p. 75). Hence, many believe that more inclusive forms of governance in which various private stakeholders are involved hold more promise for resolving complex environmental problems.

Despite the benefits that more private-dominated arrangements can provide (i.e. resources, time, capacity), their main disadvantage is that they cannot *force* citizens, businesses, and others to install green roofs. Private actor stakeholders in the green roof field support the implementation of green roofs via their marketing activities, actual and 'showcase' installations, and ability to provide consumers with the types of systems that suit their needs. Hence, actual implementation rates in part depend upon the private sector's capability to generate interest and convince consumers to procure their products. As is evident in Chicago and London, this has not resulted in the wide scale installation of the systems. While the private sector is quite active in both of these cities, their activities clearly have not catalyzed a take-off in rooftop greening. Moreover, Chicago's limited policy and London's non-binding policy have not been conducive to making this a cohesive or effective adaptation measure. In other words, if green roofs are to be successful in helping the cities cope with the impacts of climate change, they need to be geographically prevalent in order to function as envisioned. If less than 1% of the city is covered, the benefit of having a green roof (for cooling or stormwater control) is limited to the immediate building/vicinity. However, if a large percentage of the city contains greened rooftops, then the benefits realized are more widespread and effective. Overall, expansive mandatory regulation and public dominance and guidance throughout the policy cycle are considered fundamental for the ubiquitous adoption of green roofs.

7. Conclusions

Climate adaptation is becoming an increasing priority for many cities around the world. Cities are especially vulnerable to the impacts of climate change because of their dense population and high concentration of assets. An increase in seasonal rainfall and rising temperatures will have negative repercussions on an environmental, economic, and social scale. The uptake of green roofs by cities such as Chicago, London, and Stuttgart for climate adaptation purposes (among other things) reflects their recognition of the serious risks that climate change poses. Each city has a distinctive green roof governance arrangement that consists of a variety of stakeholders, policy instruments, and steering strategies for the execution of their green roof implementation goals. Overall, the green roof governance process in each of the cities is on the right track. The cities have an array of regulatory, economic, and communicative instruments at their disposal to promote the uptake of green roofs. While some cities are far more advanced than others in terms of green roof area coverage, there is room for improvement and there is a lot that the cities can learn from each other. There are barriers that need to be overcome if green roofs are to become widespread in Chicago and London as they are in Stuttgart; however, these barriers are not insurmountable and over time improvements in the governance arrangements can be made so as to increase their effectiveness.

One of the most important findings of this study is that public dominance and hierarchical steering are crucial for the successful implementation of green roofs. This finding is in contrast to the general line of thinking in current theoretical literature on environmental governance. Networks and other forms of hybrid governance arrangements are viewed as being superior to government-only or market-only type arrangements. Hybrid forms of governance are seen as being ideal for addressing issues as complex as climate change because of the magnitude of the problem and the resources needed to tackle it. According to Lemos and Agrawal (2006),

“A more inclusive global environmental governance paradigm holds the promise not only of innovative governance strategies, but also of expanded cooperation among social actors that may have been previously outside the policy process: corporate interests, social movements, and nongovernmental organizations” (p. 301).

Hence, this expansion of cooperation is seen as enhancing learning, increasing capacity to deal with the problem, and facilitating the leveraging of resources. However, ‘governance without government’ does not appear to be the solution for promoting the spread of green roofs. While there are many benefits and synergies that can come about from a more network-type style of governance, the fact of the matter is that governments are the sole authority that have the power to make and execute regulations. Because of the various barriers that are hampering green roofs, making them obligatory on a wide scale (i.e. Stuttgart) was the primary means to force citizens to install them. Less hierarchical governance arrangements (i.e. London) have been unsuccessful in promoting the widespread adoption of rooftop greening. This comparative case study analysis suggests that for certain types of issues it appears that a more government dominated approach is in fact the better alternative.

The theoretical model used in this study was invaluable in helping me to analyze the current governance arrangements in the cities. Governance arrangements in reality comprise and reflect a mixture of perspectives, and the multi-perspective aspect of the framework enabled me to distill and pinpoint the various considerations (and their weight of importance) for the stakeholders. Besides the influence of considerations on the allocation of responsibilities, the theoretical framework also takes

into account the influence of external conditions on the considerations. As I have highlighted throughout my study, political, economic, and other factors can have a strong impact on the governance process, and thus on the effectiveness of the governance arrangements.

The methodology used for the execution of this research was effective because it allowed for the triangulation of data. The desk research conducted during the first phase was crucial in providing me with an understanding (albeit incomplete) of the current situation in the cities. The interview phase of this study was absolutely invaluable in helping me to really understand what was happening ‘on the ground.’ The semi-structured nature of the interviews was conducive to extracting a breadth of information. While the questionnaires provided guidance and helped to steer the conversations, there was sufficient room for the interviewees to elaborate on other points of relevance. And it was sometimes during these tangents that I obtained very useful information and insights. An element that is important to mention is the bias that can emerge during interviews. Each actor has their own specific worldview, and they will attempt to explain and portray things in a particular light. This is not to imply that actors would deliberately try to deceive a researcher, but their point of view must be assessed objectively and against other informational resources. In order to minimize this bias a range of public and private actors from different disciplines were interviewed so that I could gain a range of perspectives. One improvement in the interview phase would have been the inclusion of more civilian actors; they were under-represented in my interviewee pool and their perspective would have been welcomed. Although attempts were made to secure interviews with these types of actors, they were unfruitful.

The contribution of my research has been to highlight the roles and responsibilities of public and private actors in the green roof governance process, as well as to draw attention to the considerations that are influencing this process. Because of the societal relevance of climate change, it is hoped that the findings in this paper will (1) serve as an important learning tool for cities that are searching for ways to improve the implementation of green roofs and (2) help open up dialogue among relevant governmental stakeholders regarding the role of citizens in the adaptation process. The contribution that citizens can make has been taken for granted (in part) because of their lack of expertise in scientific matters. However, this should not preclude lay people from participating in the process. While climate change is a scientific issue, its societal dimension should not be ignored. Lidskog (2010) states:

“Scientific knowledge is indeed necessary for responding to the challenges of climate change. However, to find adequate responses, it is important not only to investigate how nature works, but also how society functions. In other words, to create socially robust abatement strategies, it is not enough to be relevant but also to be legitimate in view of those who are affected by these strategies” (p. 37).

The conclusions of this study suggest that *legitimacy* is also important for the uptake of green roofs because societal support is needed for their widespread adoption. Hence, governmental officials need to reflect on their current strategies and participatory processes to ensure that they are more representative and inclusive.

The validity and generalizability of my conclusions are limited to a certain extent because of the limited focus of this case study analysis. This is the trade-off between conducting a large-N versus a small-N study. The results of the latter type of analysis are not applicable on the scale that those from the former are. Nonetheless, the conclusions of my paper and the various insights that surfaced during my empirical research can be useful to other cities. Preliminary feedback that I received from some

interviewees after they had reviewed my case study chapters was positive; one respondent from London stated that my findings will be useful for his department's ongoing research. With regards to other adaptation topics such as water safety, these findings may not be as applicable because of the difference in urgency and scope of the problem.

While this study was limited to Chicago, London, and Stuttgart, future research in other international (i.e. non-American/European) cities would be interesting. The governance process is strongly influenced by a variety of conditions, and analyzing governance arrangements in a different societal, cultural, and political context would certainly make an interesting study. Additionally, the evaluation of the arrangements in this study was done for a particular point in time—observing changes and the evolution of governance arrangements over time is another possibility for future research. A time series analysis can help bring to light what critical factors are responsible for shifting the equilibrium of governance arrangements to another (and hopefully more effective) state.

References

- Falkner, R., 2003, 'Private Environmental Governance and International Relations: Exploring the Links', *Global Environmental Politics*, vol. 3, no. 2, pp. 72-87.
- Florini, A.M., 2000, 'Theoretical Considerations: The Changing Nature of Authority Relations' in: R.A. Higgot, G.R.D Underhill, A. Bieler (eds.), *Non-State Actors and Authority in the Global System*, Routledge, 2000, pp. 15-31.
- Lemos, Maria Carmen and Arun Agrawal, 2006, 'Environmental Governance', *Annual Review of Environmental Resources*, vol. 31, pp. 297-325.
- Lidskog, Rolf and Ingemar Elander, 2010, 'Addressing Climate Change Democratically. Multi-Level Governance, Transnational Networks and Governmental Structures', *Sustainable Development*, vol. 18, pp. 32-41.
- Smit, Barry and Johanna Wandel, 2006, 'Adaptation, adaptive capacity and vulnerability', *Global Environmental Exchange*, vol. 16, pp. 282-292.

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Appendix 1: Interview Guide

ECONOMIC PERSPECTIVE

- The cost of a green roof is an important factor that may deter people from installing one--what trends have you seen over the past 10-15 years in regards to the technology's costs?
 - What is currently being done to minimize the costs for installing green roofs in small-scale commercial and residential projects?
 - How well-informed are the public and private sectors with regards to the benefits of green roofs? What is being done to educate homeowners, developers, private building owners, etc. about the long-term benefits of green roofs?
 - In light of knowing these benefits, are costs still the predominant consideration? Or are people more willing to invest despite the fact that the benefits will be reaped over the long-term?
- Given that green roofs offer a variety of benefits (aesthetics, energy efficiency), how has this influenced their marketability?
 - To what extent and in what ways are landscape architects and others in the green roof business using these benefits to market and sell their product?
 - How has the 'image' of the green roof changed over the years, and how is the private sector shaping this image and using it to its advantage?
 - How have landscape architects influenced the image and perceived functions of the green roof? (i.e. from just a plot of [inaccessible] green expanse to something that is fully accessible to the public and has multiple functional uses)
 - What other types of innovations are we seeing from the private sector that are offshoots of green roofs? (i.e. roof farming for food production)
- In what ways has the city collaborated with the private sector so that they can leverage their resources (technological/scientific expertise, financial resources) in order to further promote green roofs?
 - Has there been discussion in regards to activities/responsibilities that the government believes that the private sector is better equipped to handle and execute?
 - What responsibilities can the private sector do better than the city with respect to the green roof process? (i.e. community outreach, professional outreach [architects, contractors, developers], generating financing, monitoring the health of gardens—possibility for public-private partnership to achieve this)

JURIDICAL-ADMINISTRATIVE PERSPECTIVE

- In what ways can the push for green roofs be further incorporated in your city's policies and regulations in order to strengthen their legitimacy as an adaptation measure, thus strengthening the city's mandate in advocating their adoption?
 - Where do you see opportunity to legally strengthen green roof policy?
 - Is it the city's strategy to avoid mandatory regulation? What kind of resistance do you think it will meet?
 - Besides mainstreaming green roof policies at the city level, what is being done to integrate/promote these policies on the national level?
- How has the (un)certainly surrounding the potential effects of climate change impacted the policies and actions you have taken to institute adaptation measures such as green roofs?
 - The actions that the city is undertaking are preemptive—to what extent does the precautionary principle factor into the decision-making process?
 - Why were these specific policies/instruments chosen? What were the most important factors that influenced this decision? What criteria did you use to select these instruments?
 - Were there other instruments that you were thinking of employing but didn't? What factors were most important in influencing your decision to not employ them?
 - Have you seen other policies/activities being implemented elsewhere that you are interested in trying here?
- Given the (limited) amount of financial resources that is available to fund green roof projects, how is it determined which projects receive funding?
 - Is priority given to projects in poorer areas because of the inability of individuals/businesses in those communities to pay for the technology? Or is the allocation of grants based on other (more scientific) criteria (i.e. identifying hotspot areas)?
- Given the up-front costs of installing green roofs and the fact that their benefits are not immediately visible, what kind of urgency/pressure did this place on the city to be proactive and 'set' the example for others to follow?
 - What kind of response did the city receive from others when it started initiating projects?
 - How has the significance of these factors changed over time? Do you feel they are becoming less of a constraint now as people are becoming more aware of green roofs?

POLITICAL PERSPECTIVE

- In what ways and to what extent have non-state actors been included in the green roof policy-making process?
 - Which non-state actors are involved? Do you see an under/over representation of a particular societal segment?
 - In what capacity are these private actors involved?
 - Is their involvement passive (i.e. observing proceedings) or more advisory in nature (i.e. recommendations made by private sector are taken under consideration)?
- What is the general consensus on climate change and the push for adaptation within government circles and the public overall?
 - Has there been resistance to the implementation of green roofs and other greening measures?
 - If so, who is most dissatisfied with the city's push for green roofs and what arguments have they put forth? (i.e. have they advanced other solutions in lieu of green roofs such as reflective coating?)
 - Have there been forums where this issue has been debated? What kinds of strategies have been employed to encourage cooperation and to win over support for green roofs?
- To what extent is the green roof policy-making process transparent? Does the government issue new policies/rules without consulting relevant business and civil stakeholders, or does it engage with these actors to get their input?
- Given the trans-jurisdictional nature of climate change and scientific uncertainty regarding future impacts, what kind of effect do you believe this has on accountability (with respect to the responsibilities and actions that individuals/businesses/government can take to mitigate the effects of climate change)?
 - To what extent has the government made clear the actions that individuals, business, and the city itself can take to improve the adoption of green roofs and other measures?
- What learning/communication channels are in place to encourage knowledge exchange within the green roof community and various governmental departments?
 - What kind of communication is there between government agencies and private actors? (i.e. official liaisons)
 - Is there an institutionalized forum where knowledge exchange can take place between different actors? (i.e. annual meetings, conferences)
 - What kind of networks are in place? Are they limited to a specific group (i.e. policy-makers/epistemic community) or are they open to others interested in green roofs?

Appendix 2: Overview of Policy Documents

Chicago Policy Documents	Date	Issuer
Regulations		
Guide to the Chicago Landscape Ordinance	2000	City of Chicago
The Chicago Standard	2004	City of Chicago
Chicago Energy Conservation Code (enacted in 2002)	2008	City of Chicago
Clean Energy Stimulus and Investment Assurance Act of 2009	2009	United States Federal government
Illinois Green Infrastructure for Clean Water Act of 2009	2009	Illinois State government
Sustainable Development Policy (enacted in 2003)	2010	City of Chicago
Regulations for Sewer Construction and Stormwater Management	2010	City of Chicago
Stormwater Management Ordinance Manual	2011	City of Chicago
Green Roofs/Urban Greening		
Chicago's Green Building Agenda	2005	City of Chicago
Environmental Action Agenda: Building the Sustainable City	2005	City of Chicago
Adding Green to Urban Design- A City for us and future generations	2008	City of Chicago
Chicago's Urban Forest Agenda	2009	City of Chicago
Chicago- Green Jobs for All	2009	City of Chicago
Conservation Development in Practice	n.d.	The Nature Conservancy/Chicago Wilderness
Climate Change/Flood Risk		
Chicago's Water Agenda	2003	City of Chicago
Chicago Climate Action Plan	2008	City of Chicago
Chicago's Greenhouse Gas Emissions: An Inventory, Forecast and Mitigation Analysis for Chicago and the Metropolitan Region	2008	Center for Neighborhood Technology
Chicago Area Climate Change Quick Guide: Adapting to the Physical Impacts of Climate Change	2008	MWH
Corporate Risk Case Study	2008	Oliver Wyman
Lessons Learned: Creating the Chicago Climate Action Plan	2009	Julie Parzen
Potential Workforce Impacts of the Chicago Climate Action Plan: Quantitative and Qualitative Assessments	2009	Greg Schrock; Eric Sundquist
Chicago Climate Action Plan- Progress Report 2008-2009	2010	City of Chicago
Engaging Chicago's Diverse Communities in the Chicago Climate Action Plan	2010	Environment, Culture, and Conservation/The Field Museum
Climate Action Plan for Nature	2010	Chicago Wilderness
Other		
Sustainability: CMAP Regional Snapshot	2007	Chicago Metropolitan Agency for Planning
Go To 2040: Comprehensive Regional Plan	2010	Chicago Metropolitan Agency for Planning
Energy Efficient Green Building Practices	2010	Chicago Metropolitan Agency for Planning
Site Development Guidelines	2010	Public Building Commission of Chicago

London Policy Documents	Date	Issuer
Acts/Plans and related documents		
London Plan: Spatial Development Strategy for Greater London	2004	Greater London Authority
Sustainability Appraisal of the London Plan	2004	Greater London Authority
Sustainable Design and Construction: The London Plan Supplementary Planning Guidance	2006	Greater London Authority
Greater London Authority Act	2007	Her Majesty's Crown
Climate Change Act	2008	Her Majesty's Crown
London Plan: Spatial Development Strategy for Greater London- Consolidated with Alterations since 2004	2008	Greater London Authority
Flood and Water Management Act	2010	Her Majesty's Crown
London Plan: Spatial Development Strategy for Greater London	2011	Greater London Authority
Green Roofs/Urban Greening		
Green Roofs: their existing status and potential for conserving biodiversity in urban areas	2003	English Nature
Green Roofs- Research Advice Note	2003	British Council for Offices
Green Roofs Planning Advice Note 1	2005	London Borough of Barking and Dagenham
East London Green Grid Primer	2006	Greater London Authority
Living Roofs and Walls- Technical Report: Supporting London Plan Policy	2008	Greater London Authority
Grey to Green- How we shift funding and skills to green our cities	2009	Commission for Architecture and the Built Environment
Leading to a Greener London- An environment programme for the capital	2009	Greater London Authority
Green Roofs: Drain London and Urban Greening- Request for Director Decision, DD421	2011	Greater London Authority
London's Urban Forest: A Guide for Designers, Planners and Developers	2011	Mayor of London
The GRO Green Roof Code- Green Roof Code of Best Practice for the UK 2011	2011	Green Roof Organisation
Climate Change/Flood Risk		
Flood Risk Assessment Guidance for New Development	2006	Department for the Environment, Food and Rural Affairs London Climate Change
Adapting to Climate Change: Lessons for London	2006	Partnership/Greater London Authority
Climate Change: The UK Programme 2006	2006	Her Majesty's Crown
Planning Policy Statement 26- Tackling Climate Change Through Planning: The Government's Objectives, Discussion Document	2006	Town and Country Planning Association/Friends of the Earth
Action Today to Protect Tomorrow: The Mayor's Climate Change Action Plan	2007	Greater London Authority
Action Today to Protect Tomorrow: The Mayor's Climate Change Action Plan- Executive Summary	2007	Greater London Authority
Climate Change Adaptation by Design: a guide for sustainable communities	2007	Town and Country Planning Association London Climate Change
Wild Weather Warning- a London climate impacts profile	2009	Partnership/Greater London Authority
Economic incentive schemes for retrofitting London's existing homes for climate change impacts	2009	London Climate Change Partnership/Greater London Authority
Surface Water Management Plan Technical Guidance	2010	Department for the Environment, Food and Rural Affairs
Rising to the Challenge- The City of London Climate Change Adaptation Strategy	2010	City of London Corporation
Policy Planning Statements		
Planning Policy Guidance 2: Green Belts	1995	Department for Communities and Local Government
Planning Policy Guidance 17: Planning for open space, sport and recreation	2002	Department for Communities and Local Government
Planning Policy Statement 1: Delivering Sustainable Development	2005	Her Majesty's Crown
Planning Policy Statement 9: Biodiversity and Geological Conservation	2005	Her Majesty's Crown
Planning Policy Statement: Planning and Climate Change- Supplement to Planning Policy Statement 1	2007	Department for Communities and Local Government
Planning Policy Statement 25: Development and Flood Risk	2010	Department for Communities and Local Government
Other		
The Mayor's Biodiversity Strategy	2002	Greater London Authority
Securing the Future: The UK Government Sustainable Development Strategy	2005	Her Majesty's Crown
London's Urban Heat Island: A Summary for Decision Makers	2006	Greater London Authority
The Mayor's Draft Water Strategy	2009	Greater London Authority
State of the Environment in London	2010	Environment Agency

Stuttgart Policy Documents	Date	Issuer
Regulations		
German Federal Building Code *(last amended)	2011*	Federal Republic of Germany
The New Federal Nature Conservation Act	2010	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety
FLL Guidelines	2002	Landscaping and Landscape Development Research Society
Green Roofs/Urban Greening/Spatial Planning		
For our environment- Protecting the environment, conserving resources, saving energy	2009	State Capital Stuttgart
Environmental aspects in spatial planning in Stuttgart	2009	State Capital Stuttgart
Levels of Spatial Planning in Stuttgart	2007	State Capital Stuttgart
Climate Change/Flood Risk		
Climate Booklet for Urban Development- References for Zoning and Planning	2008	Ministry of Economy Baden-Württemberg
Climate Change- challenge facing urban climatology	2010	State Capital Stuttgart

Appendix 3: Overview of Respondents Interviewed

Overview of Respondents

Name	Title	Organization
Chicago		
Michael Berkshire*	Green Projects Administrator	Department of Zoning and Planning
Ernie Constantino	Aide to Alderman Mary Anne Smith	48th Ward, City of Chicago
Kelly Dougherty	Proposal Administrator/Manager	Weston Solutions
Aaron Durnbaugh	Deputy Commissioner	Natural Resources and Water Quality Division, Department of Environment
Bryan Glosik	Assistant Project Coordinator	Chicago Center for Green Technology
Theo Harduvel	Director	Environmental Exchange
Kurt Horvath	President	Intrinsic Landscaping
	Environmental Engineer**	City of Chicago
Sophie Martinez	Program Manager/ Projects Administrator Green Permit Program	Department of Buildings
Molly Meyer	Green Roof Consultant	Molly Meyer LLC
Bradley Roback	Coordinator of Economic Development	Department of Zoning and Planning
London		
Peter Allnut*	Green Roof Product Manager	Alumasc
Ian Blackburn	Development and Flood Risk	Environment Agency
Lesley Burdock	Planning Officer	City of London
Paul Edwards*	Head of Sustainability	Hammerson
Lee Evans	Founder	Organic Roofs
Dusty Gedge	Founder	livingroofs.org
Gary Grant	Green Roof Consultant	Green Roof Consultancy
Jack Hayes	Major Projects Officer	Environment Agency
Kerstin Kane	Planning Officer (Urban Design)	City of London
Simon Mills	Head of Sustainable Development	City of London
Matt Thomas	Urban Greening- Transport & Environment	Greater London Authority
Stuttgart		
Albert Ackermann	Former Department Head	Department of Urban Planning and Urban Renewal
Wolfgang Ansel	Director	International Green Roof Association
Roland Appl	Technical Director	ZinCo
Stephan Arnold	Managing Director	Otto Arnold GmbH
Rainer Kapp	Chemistry Engineer	Urban Climatology Division, Office of Environmental Protection
Wolfgang Maier	Urban Planner	Department of Urban Planning and Urban Renewal
Peter Patzold	City Councillor	Green Party
Walter Wagner	Department Head	Garden, Cemetery, and Forestry Office
*Represents interviews conducted over the phone		
**Respondent is anonymized if quote permission was not obtained		

