How Cities Think:

Knowledge-Action Systems Analysis for

Urban Sustainability in San Juan, Puerto Rico

By

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ABSTRACT

With more than 70 percent of the world's population expected to live in cities by 2050, it behooves us to understand urban sustainability and improve the capacity of city planners and policymakers to achieve sustainable goals. Producing and linking knowledge to action is a key tenet of sustainability science. This dissertation examines how knowledge-action systems -- the networks of actors involved in the production, sharing and use of policy-relevant knowledge -- work in order to inform what capacities are necessary to effectively attain sustainable outcomes. Little is known about how knowledge-action systems work in cities and how they should be designed to address their complexity. I examined this question in the context of land use and green area governance in San Juan, Puerto Rico, where political conflict exists over extensive development, particularly over the city's remaining green areas.

I developed and applied an interdisciplinary framework — the Knowledge-Action System Analysis (KASA) Framework —that integrates concepts of social network analysis and knowledge co-production (i.e., epistemic cultures and boundary work). Implementation of the framework involved multiple methods —surveys, interviews, participant observations, and document—to gather and analyze quantitative and qualitative data. Results from the analysis revealed a diverse network of actors contributing different types of knowledge, thus showing a potential in governance for creativity and innovation.

These capacities, however, are hindered by various political and cultural factors, such as: 1) breakdown in vertical knowledge flow between state, city, and local actors; 2) four divergent visions of San Juan's future emerging from distinct epistemic cultures; 3) extensive boundary work by multiple actors to separate knowledge and planning activities, and attain legitimacy and credibility in the process; 4) and hierarchies of knowledge where outside expertise (e.g., private planning and architectural firms) is privileged over others, thus reflecting competing knowledge systems in land use and green area planning in San Juan.

I propose a set of criteria for building just and effective knowledge-action systems for cities, including: context and inclusiveness, adaptability and reflexivity, and polycentricity. In this way, this study also makes theoretical contributions to the knowledge systems literature specifically, and urban sustainability in general.

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Chapter 1

Introduction and Theoretical Background

Whenever and wherever societies have flourished and prospered rather than stagnated and decayed, creative and workable cities have been at the core of the phenomenon […] Decaying cities, declining economies, and mounting social troubles travel together. The combination is not coincidental.
Jane Jacobs, 1961

The ways in which a society filters and conveys knowledge at a variety of levels of organization is in itself and essential element in the resilience of that society.
Redman and Kinzig, 2003

1. Introduction

With nearly 70 percent of the world's population expected to live in cities

by 2050 (Worldwatch Institute 2007) and a large ecological footprint globally,

city managers face huge challenges in planning for present and future

development that considers ecological function and social equity along with

economic needs. Urban sustainability calls for the challenging task of balancing

the potentially competing demands of supporting an increasingly large population,

meeting housing and transportation needs, as well as improving the quality of life

and environmental health of the city's human and natural inhabitants (Wheeler

and Beatly 2009). The ability of city managers and sustainability scientists to

address urban sustainability challenges rests in large part on building scientific

know-how and innovation, and linking these to action (Nowotny et al. 2001;

Crow 2007; Miller 2011). Numerous cities worldwide are taking the initial steps

to confront this challenge and show a willingness to make large investments

toward building capacities and institutions that link urban sustainability science to

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action (e.g., user-inspired knowledge and technology programs, indicator programs, long-term research sites, to name a few). Crucial to this effort are knowledge systems that can foster creativity and innovation, while also monitoring the effects of their actions and realize when it is necessary to change[1]. As Ernston et al. (2010) argue, the transformation of cities toward sustainability demands institutions that can learn, innovate, and adapt to changing conditions in the future.

This is a study about how knowledge-action systems work in cities in order to inform what capacities are necessary for the local urban governance context to effectively attain sustainable outcomes. *Knowledge-action systems[2]*, as I define them, are the networks of actors, their future urban visions, and the epistemological practices/technologies used in the making and uptake of knowledge for sustainable actions (Miller, Muñoz-Erickson, and Monfreda 2011). Knowledge-action systems link multiple and diverse knowledge systems (including, but not exclusively, a focus on science)[3] and are considered more than sites where research and information are produced and used in decision-making. They also involve where imaginations, ideals, and beliefs of social order (i.e.,

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[1] This view is consistent with resilience and adaptive governance theories in the lines advocated by Folke et al. (2005) and Olsson et al. (2004) propose. With the exemption of the work of Henrick Ernston (2010) on urban transformations, this literature has focused more on ecosystem management and less on urban systems.

[2] The concept of knowledge-action systems is similar to knowledge systems as in the lines of Cash et al. (2003), but with a greater focus on governance, inclusion of a diversity of organization/institutions involved in knowledge production, circulation, and use, the values and ideas underlying their knowledge, as well as on how these different actors frame and contest knowledge in the political system.

[3] This view of knowledge-action systems is similar to the concept of *civic epistemologies*, the culturally specific, historically and politically grounded, public knowledge-ways, as described by Sheila Jasanoff (2005) and Clark Miller (2008).

what the future city should be) are being forged by different social groups (Miller 2004; Miller et al. 2010). As such, in order to build effective knowledge-action systems for cities, we must understand and compare how diverse social actors — government, planners and scientists, and civic society — 'know' and 'imagine' their cities. In other words – how the city thinks. Not understanding this context may result in anticipatory capacities and knowledge systems that unintentionally inhibit sustainable outcomes. Institutional arrangements that link knowledge and action involve large financial and human investments, yet little is known about how knowledge-action systems already work in cities and how they should be designed to most effectively address the complexity of these urban systems.

Historical analysis of large societies and urban development has demonstrated that the ability to innovate and attain long-term development goals can be unintentionally inhibited by the way in which science and other types of knowledge are produced, shared, and used in the decision-making process of the development of that society– or the societal knowledge system. Redman (1999), for instance, showed how the lack of 'fit' between the knowledge and mental models of dominant institutions and the local social and environmental context was a barrier in the long term resilience of some large-scale societies. In his book, *Seeing Like a State,* James Scott (2005) also presents several examples of failures in urban development schemes in the 20th century cities because of how the state's knowledge system — the expertise, knowledge practices, and technologies that the state used to plan and organize the city — lacked local knowledge of how the cities worked or how people actually lived in the cities.

The point here is that failures in knowledge systems can inhibit a city's capacity to attain sustainability.

In the city of San Juan analyzing knowledge-actions systems is crucial because of mounting political conflict over extensive urban development, particularly in terms of the impacts on the city's remaining green areas, such as urban forests, parks, mangroves, streams and riparian areas. Despite having a land use plan since 2003 that recognizes the importance of green areas to the environmental (e.g. protection of watershed resources) and socio-economic sustainability (e.g. reducing flooding risks) of the city, the Municipality of San Juan faces tremendous challenges in attaining this vision and desired outcomes. Development of these urban green areas and unsustainable building practices are still taking place throughout the city, and conflict over the legitimacy and legality of these actions is rising among city planners, developers, communities, and the state. Because these conflicts are inhibiting the ability of the city to meet its goals, identifying the barriers to implementation, and developing strategies to overcome these barriers, is necessary for the city to move towards sustainability.

Conventional policy scholars would suggest reforming institutions, or 'rules' to limit the influence of powerful interests and political corruption, fix market inefficiencies, or reduce conflict through more public participation, to name a few. While such failures, especially corruption and limited public participation, are common flaws in the land use planning and policy process in

San Juan[4], these diagnoses and solutions to sustainability problems are alone insufficient in explaining the complex context of this and other cities. Through a knowledge-action systems analysis approach, I show how these conflicts and planning inefficiencies are also related to how the knowledge systems in the city are working. Put differently, what may seem as inefficiencies in the banal aspects of political organization and process, such as the production and use of policy-relevant knowledge, can also influence the capacity of cities to attain sustainable goals. Institutional analysis of sustainable governance is then also an exercise in uncovering failures, and successes, in the epistemic practices and interactions of city actors.

Yet, despite great strides in conceptualizing the complex nature of knowledge-action systems, the literature has fallen short of empirically addressing this complexity and offering insights into how we can navigate these systems. For the most part, the empirical literature is limited to simple analyses, focusing on either the networks or on the perspectives of scientists and knowledge producers separately. These studies, however, lack the much needed context sensitive thickness of description (Lahsen 2008). This is helpful but not useful when the ultimate goal is to design effective knowledge-action systems for sustainability. Practitioners want to know how they can best link knowledge and action such that new knowledge can support sustainable governance, yet few studies exist that analyze pre-existing institutional and epistemic dynamics in

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[4] I discuss the role that these failures play in the San Juan planning process more extensively in Chapter Three.

context and the potential barriers that these may present before investing in any intervention.

The implications of this lack of contextually-rich analysis is that the solutions that as a society we design to address a knowledge-action system failure, while appropriate in one context, may not work in others. Assumptions about the co-production of knowledge and society can influence how we structure the co-production of knowledge.[5] In addition, failures in the knowledge-action system may be more pragmatic to address in the short-term than institutional failures in the political and economic system that may be too embedded socially and culturally to address quickly (e.g., corruption and market failures). I do not intend to suggest that reforming knowledge-action system failures is easy to accomplish, nor that if these failures are fixed then better decisions will be made or political problems will be solved. Indeed, reorganizing the way we build knowledge for sustainability is a *transformative* process (Miller, Muñoz-Erickson, Redman 2011). Instead, I suggest that improvements in the knowledge-action system — such as changes in communication, technologies to improve knowledge flow, or routine monitoring and critique of the utility and credibility of knowledge production — may prove to be a more cost-effective way to address institutional challenges for sustainability. At the very least it can be a starting point.

Overall, the literature needs a better understanding of which kinds of knowledge-actions systems work (and which do not), and under what conditions, to systematically and critically compare experience with knowledge-action

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[5] I would like to acknowledge Clark Miller for this important insight.

systems across a wide range of sectors and regions (Miller et al. 2008). There is a great need for studies that employ 'thick analysis' by combining multiple disciplinary perspectives and approaches for a more thorough understanding of context and system dynamics along the empirical/ethnographic lines advocated by Adger et al.(2003). This study seeks to address this empirical gap. Through an empirically-based 'thick analysis' of how the knowledge-action system works in the city of San Juan, I hope to expand our understanding of how knowledge-actions systems work and the cultural, institutional, and political conditions shaping these systems in a given place.

This research makes several important contributions to both the theory and practice of urban sustainability and knowledge systems specifically, and sustainability governance in general. First is the importance of analyzing existing knowledge-action systems in a given place (or context) to understand how these are fostering or creating barriers to implementation of sustainable goals. In terms of institutional and policy analysis, this research shows that we cannot understand sustainable outcomes if we do not understand how the knowledge systems supporting the decisions and actions causing those outcomes work. Hence, this study calls for a more robust policy analysis based on *reflexivity* – or the awareness and routine monitoring of the ideas, framings, and assumptions embedded in the knowledge produced and used in San Juan – to evaluate sustainable outcomes. By providing an analytical tool to study knowledge-action systems, I also offer a framework to enhance policy and institutional analysis through empirical studies.

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Second, this study broadens the scope of how knowledge systems are addressed in the science and technology studies (STS) literature by acknowledging the complexity of these systems, especially in cities, and presenting ways to tackle this complexity analytically. With the use of interdisciplinary concepts and methods I show the importance of looking at knowledge-action systems from multiple angles, as a single analytical approach may miss important institutional and epistemological aspects of these systems. Furthermore, this study contributes new understanding to concept of imaginaries in STS, particularly how cities imagine themselves as they reconfigure themselves to address sustainability.

 Third, from a practical perspective, I hope to show that understanding the complex workings of these systems has implications to how we design and build them in practice. In other words, linking knowledge to action is not as simple as building 'interfaces' or other institutional arrangements drawn from theoretical designs. Rather, it requires that we first assess the political and institutional terrain such that whatever intervention we design actually makes sense to the knowledge-action systems in that particular place. This in turn will ensure that the knowledge and anticipatory capacities created to envision, strategize, implement, and monitor sustainable goals are appropriate and effective. If the knowledge and the actions 'fit', we can then assure that we have the capacities to learn, innovate, and adapt to changing conditions in the future.

 Finally, this is the first knowledge-action systems analysis of urban sustainability in San Juan and in Puerto Rico. This study contributes to

understanding of how knowledge-action systems work in a tropical and Latin American context where issues of urbanization and sustainability, especially as they relate to deforestation and global climate change, are ubiquitous. In many Latin American states, as it is in Puerto Rico, governance failures like corruption and political conflict are major obstacles to implementation of sustainable goals. Yet, as I previously mentioned, I hope to show in the case of San Juan the way our knowledge-actions systems are configured also play a role in our capacities to meet sustainability, and that may transforming these we may be able to meet, if not overcome some barriers of, sustainable goals in cities.

2. Knowledge, Action, and Sustainability: Definitions and Review of the Literature

Producing and linking knowledge to action is a crucial strategy for sustainability and a key tenet of sustainability science (National Research Council 2001, Miller 2011). Political leaders and scientists are increasingly concerned with building the scientific *know-how* and innovation to address sustainability challenges (Crow 2010, Nowotny et al. 2001). While scientific knowledge is crucial to understanding and addressing sustainability, institutional analyses that focus on how rules modify collective behavior often neglect the diversity of rationalities, knowledge systems, and epistemic practices that also influence planning and policy-making context (Roux et al. 2006). In recent years, social science scholars have brought to our attention the importance of multiple *knowledges* with different degrees of rationalities (also variously labeled as

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practical, experience-based, tacit, traditional, among others)[6], that are relevant alongside scientific or technical expert knowledge to environmental and sustainability governance (Rydin 2006; Giampietro et al. 2006; Fisher 2000). Given the diversity of knowledge types considered necessary for addressing the complexity of sustainability, it is important to clarify and define the elements of knowledge, action, and sustainability that I am concerned with in this study.

My definition of knowledge stems from a sociological perspective that acknowledges the complex judgments, ideas, framings, tacit skills and values that shape what knowledge is, rather than viewing it as just simple statements of truth or fact (Jasanoff 1995; Shapin 1994). Miller, Muñoz-Erickson and Monfreda (2010) define knowledge as an "idea or belief that someone, whether an individual or a community, takes to be true, or at least relatively more true than other kinds of statements, and therefore of sufficient character to guide his, her, or their reasoning or, especially for our purposes here, action". (pp. 1). Furthermore, Jasanoff (2005) argues that to understand knowledge requires understanding knowledge-in-the-making. This is because dynamic social processes are involved in knowledge such that its production is a result of the articulation, deliberation, negotiation, and valorization of particular knowledge claims. The structure and dynamics of these social processes determine, in turn, whose knowledge claims matter and how claims are constructed, evaluated, contested, and sanctioned as knowledge (Jasanoff 2005).

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[6] For a more extensive taxonomy of different knowledge types please see Giampietro et al. 2006.

This view of knowledge underlies the basis of a co-production model or idiom regarding the relationship between knowledge and decision-making that influences this study. According to Jassanoff and Wynne's (1998) definition of co-production, knowledge and decision-making are understood as simultaneously influencing each other in various aspects of political life – knowledge both shapes and is shaped by social processes. Put differently, the assumption that the production of science and the political process happen in independent spheres of society, and that they only meet in the 'science-policy interface', is rejected. This social constructivist approach recognizes that knowledge, including knowledge about nature, is not exclusive preserve of any particular domain of society (i.e. science), but that different social and cultural groups (i.e., civic-social, bureaucratic-political, economic, and scientific) may more fruitfully be regarded as a distinctive form of knowledge, ideas, beliefs, and meanings, and sustains these activities in turn through characteristics practices and discourses (Jasanoff and Wynne 1998; Shapin and Schaffer 1985). Scholars using the co-production idiom acknowledge nature's part in controlling the production of scientific and other knowledges, but also consider the complex cultural and social context in which knowledge is formulated and technologies developed. As such, a constructivist account of knowledge seeks to understand the role of human agency and cognition, cultural discourses and practices, and social goals and norms in the production of knowledge.

Now that I have addressed what aspects of knowledge and knowing are important to consider for sustainability, I will clarify what I mean by *action* for

sustainability. In mainstream policy and sustainability literature, action is commonly defined as the application of policies and management strategies that result from a rational policy process. From a governance analytical perspective, actions are not limited to formal governmental processes by the state, but are also the result of social interactions and institutions (i.e., rules) developed in civic society, such as local communities (Ostrom 2005). This understanding of governance, however, treats knowledge conventionally as a common resource that can be efficiently managed through collective action based on specific institutional arrangements (Hess and Ostrom 2006). Less well-developed is an understanding of the values, ideas, epistemic frameworks and politics embedded in the production and application of knowledge to critically determine as preexisting conditions to designing institutional arrangements for action in the context of transforming knowledge-into action for sustainability.

This is where the definition of sustainability matters in terms of defining what counts as an action in sustainability. If, for instance, I take the view that sustainability is an endpoint defined by science, then the solution is to develop courses of actions to get the scientific knowledge 'right' and into the hands of policy makers and managers to make the 'right' decisions. If, however, I take an alternative perspective that sustainability is better understood as a discursive process or public conversation informed by multiple values and knowledge to generate politically useful expectations of the future, then this calls forcollectively deciding on the trade-offs involved when taking alternative course of actions and trajectories towards the future (Moore 2007, Norton 2005). From the perspective

of sustainability as a normative science (what is *ought* to be, rather than what it *is*) (Norton 2005), the definition of 'action' is broadened to include other important ways people use to define and act in the process of defining sustainability-related goals and strategies, such as framing agendas, critiquing and evaluating policy, imagining, anticipating, planning and monitoring, building adaptive capacities, innovating, and many more. Furthermore, based on Foucalt's (1980) ideas of the relationship of knowledge and power, 'action' is also understood to be embedded in values, knowledges and belief structures of competing political cultures in the shaping of social order. Therefore, knowledge alone will not provide solutions to sustainability, rather it can just serve as a tool to what political and social changes are needed to attain sustainability. This distinction underlies my view of the relationship between knowledge, action, and sustainability.

These notions of knowledge, action, and sustainability are important because they challenge the characteristics, mechanisms, and sites that we have assumed to underlie the relationship between science, knowledge, and decision-making. The next section provides a background on the state of the literature and theoretical assumptions of knowledge-action systems for sustainability.

2.1 From Knowledge Systems to Knowledge-Action Systems Analysis for Sustainability

While there is not a specific theory of knowledge systems, the topic has been addressed by multiple disciplinary fields in the social sciences. In anthropology, the focus has been more towards understanding the knowledge of

specific social groups, such as indigenous and scientific cultures. There is also a long tradition of research in the information/computer sciences and business administration that look at knowledge systems from the perspective of technological development and management systems that allow people to use and circulate knowledge more effectively (McElroy 2002). This field is more commonly known as knowledge management. More recently, perspectives from social constructionism[7] and epistemology[8] have taken an interest in the social, political, and epistemic practices and dynamics of knowledge systems.

Blackmore (2007) summarizes the range of theories associated with knowledge management and organizational learning in terms of three generations of theories. The first generation is focused on knowledge sharing and transfer, the second generation is focused on the creation of both tacit and explicit knowledge, and the third generation is informed by social constructionism and complex adaptive systems. (p.522). Progress on the intellectual foundations of knowledge system within the sustainability science and science and technology studies (STS) mirrors the evolution of knowledge management and organizational theories as Blackmore (2007) describes. There appears to be a first generation of sustainability and STS scholars that recognize the need to expand the scientific agenda for sustainability towards one that is interdisciplinary (Gibbons et al. 2007) and problem-oriented (Stokes 1997), among others. For the most part, this

Conventional view of the relationship between knowledge and action.

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[7] Constructivism is the view in philosophy according to which all knowledge is "constructed" in as much as it is contingent on human perception and social experience.
[8] Epistemology is the branch of philosophy concerned with the nature and grounds of knowledge, and the processes and beliefs involved in producing knowledge (or how we know what we know).
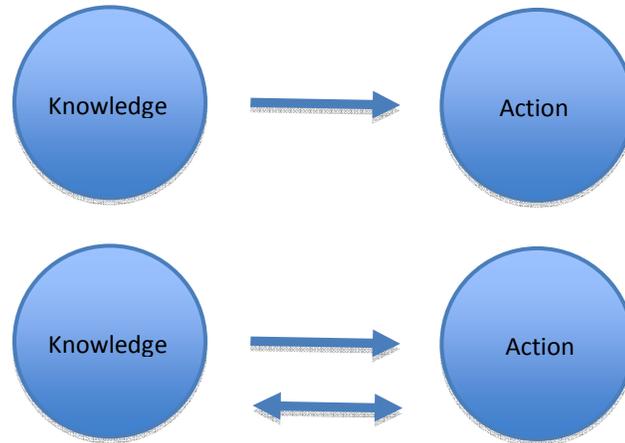
B. The complex and networked view of the relationship between knowledge and action – the knowledge-action system
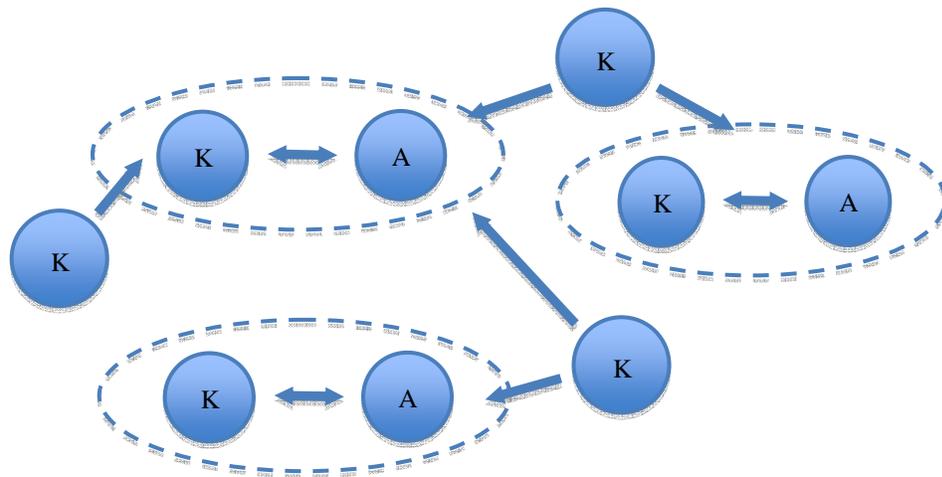
Figure 1. Illustrations of the conventional view of relationship between knowledge and action (1A) versus the more complex view of knowledge-action systems (1B). K= Knowledge (e.g., scientific, technical, practical, tacit) and A = Action (e.g., decision-making, planning, application, policy). Source: adapted from Miller et al. (2010) and Muñoz-Erickson (2009)

generation has focused on the characteristics of academic and scientific

knowledge needed to address social goals and the need to transfer this knowledge

to decision-makers, but less on how this knowledge is accepted and used in the

policy or action side. This is what critical STS historians and scholars would term

the model of "speaking truth to power" (Shapin 1994). These assumptions have

inspired countless of models of science-policy interaction. One example is the

Loading Duck model, wherein science is transferred to the policy 'duck' through

one-way loading truck. Another example is the Bridge model, wherein academia

and policy engage in a two-way interaction by building bridges between the two

(See Figure 1A for a visual representation of these two views).

A second generation of sustainability and STS scholars is concerned with

the linkage between knowledge and action and how policy-relevant knowledge is

used to develop sustainability goals (Van Kerkhoff and Lebel 2006).

Specifically, this literature focuses on how to make knowledge systems – or the

institutions to harness science and technology for sustainability – more effective

(Cash et al. 2003). A key finding of this line of research has shown that

knowledge systems are most likely to be effective in influencing action if they

are perceived to be salient, credible and legitimate by the larger stakeholder

community (Cash et al. 2003). The literature on knowledge to action is moving

away from looking at the relationship between science and society as a one- or

two-way interactions to more of a systematic relationship in terms of multiple

actors, multiple interactions and multiple mechanisms (see Figure 1B). In

general, this school of thought uses 'knowledge systems' to describe both

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formal and informal institutional arrangements as well as the dynamism in the practices of knowing, doing, and learning to bring about actions for sustainable development (Cash et al. 2003; Van Kerkhoff and Lebel 2006).

The recent burst of organized science-policy interfaces, such as "boundary organizations" (Guston 1999; Olsson et al. 2004), participatory processes (Dryzek 1997; Kasemir et al. 2003), and collaborative adaptive management (Lee 1999), reflect the growing importance and social investment given to these institutional approaches as a way to effectively link knowledge systems with user demands (McNie 2007). While this view is mostly limited to scientific knowledge as the primary source of credible knowledge for sustainability, it acknowledges that how we know and view the world is a distributed process and not the result of a linear relationship between knowledge, as in the form of academic institutions on one side, and decision-making on the other (Nowotny et al. 2001; Miller 2008), but more closely aligned with a network view (Matson 2008) or 'spider web' model that has been observed in some contexts (Kasperson 2008).

Finally, the third generation of knowledge systems literature is informed by social constructionist and complex adaptive systems perspectives. This literature acknowledges the networked or web-like structure of knowledge systems (Figure 1B) but also emphasizes the importance of the whole system, not just the link between science and action. It includes the production, circulation, and use of multiple, non-science knowledge systems as well. These systems are reasonably stable, they can persist over relatively long periods of

time, but they are also dynamic, open to change through novel processes of co-production that link epistemic, social, and political contestation and innovation (Miller et al. 2010; Jasanoff 2005). These systems exist and are at work in multiple places, and like complex adaptive systems, they can be open or closed, are multi-scale (Giampietro et al. 2006), and most importantly, are capable of adapting knowledge production practices to meet changing societal concerns (Miller, Muñoz-Erickson, and Redman 2011). This view of knowledge systems is aligned with ideas of the co-production of knowledge described in the previous section. Miller, Muñoz-Erickson, and Monfreda (2010) developed a framework for knowledge systems analysis that focuses on the overall production, validation, circulation, and use of policy-relevant knowledge. This framework lays out specific concepts that should be taken into consideration for analyzing knowledge systems (Table 1). Here, I expand on this framework by incorporating analytical tools of social network analysis to better reflect the emphasis on the analysis of multiple knowledge systems and their interactions in using knowledge for action that is the focus here.

All three generations of knowledge systems theories (and assumptions) discussed are important for sustainability. They highlight the crucial importance of thinking about the content and organization of knowledge for sustainability. More importantly, the literature has accomplished a more sophisticated view of the relationship between knowledge and action. No longer is this relationship seen as a one-way or two-way interaction where knowledge is generated on one side, (the 'knowledge' side of scientists and/or experts that is then transferred to

the other side), and 'policy' on the other side (where decision-making bodies use the knowledge). Rather, the governance landscape of knowledge and decision-making interactions for formulating sustainable options is much more complex (Figure 1B), demanding multiple knowledge production institutions that can at the same time acknowledge this multiplicity of governing sites and transcend existing institutional boundaries (Miller, Muñoz-Erickson, and Monfreda 2010; Rydin 2006).

With this context, one can see multiple definitions and assumptions underlying the concept of knowledge systems. I interpret these as variations within a knowledge-action spectrum in which at one extreme there is the analytical concern for specific and tightly closed *knowledge systems*, such as a scientific model to predict climate change or the government's census system, to the concern with the knowledge-to-action link or science-policy interface, to the more complex extreme of knowledge-action system where multiple knowledge systems (not just science) and social order are analyzed simultaneously. This study is concerned with the latter extreme, what I term *knowledge-action system,* to understand how these multiple knowledge systems and how they are interlinked in a broader network work interacting in carving out sustainable strategies. As previously mentioned, I use the term *knowledge-action systems* to refer to the broader constellations of heterogeneous knowledge systems and the different ways of knowing and reasoning about policy problems as well as how that knowledge is being used, contested and validated by actors in the policy realm (Jasanoff and Wynne 1998; Miller 2005). I consider the knowledge

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Table 1. Knowledge systems analysis framework: Key concepts and definitions of the framework developed by Miller, Muñoz-Erickson, and Monfreda (2010).

Concepts	Definition	Literature
Production	The set of practices, processes, and institutions through which new knowledge claims are formulated and made.	Latour and Woolgar, 1986 ; Norr-Cetina 1999; Kohler 2006; Martello 2004
Validation	The work done to ensure the reliability of data and findings as an integral element of the work done by scientific groups as they develop their knowledge claims. Examples include comparing results and models to theories and/or data, and to results of other researchers, to ensure that results are not outcomes of error or bias.	Pirtle, Meyer and Hamilton 2010; Collins 1992
Review	Processes of review (e.g., peer review of publications, laboratory audits, etc.) involve subjecting knowledge claims to evaluation and judgment by others beyond those who have made the particular claims.	Jasanoff 1985; Edwards 2001; Chubin and Hackett 1990
Synthesis	The concept and practice of integrating multiple knowledge claims together, often from across a wide range of disciplinary or epistemological perspectives to solve complex, multifaceted problems that face 21t century societies.	Hackett et al. 2008; Carpenter et al. 2009; Westley and Miller 2003; Miller 2009
Framing	The set of perceptual lenses, worldviews or underlying assumptions that guide the interpretation and definition of particular issues	Miller 2000; Fairhead and Leach 1998; Krimsky and Plough 1988; Cronon 1992
Styles of Reasoning	Variations in how sciences frame analysis, problems and approaches to reasoning. These variations have been described in terms of paradigms, disciplines, schools of thought, epistemologies, methods, etc. Scholars have also identified styles of reasoning as a critical variable of difference across communities, countries, and political cultures.	Hacking 2001; Hacking 1992; Shackley 2001; Miller 2003
Ontology	Variations in knowledge systems with regard to sets of objects they consider to be epistemically significant and how those objects get classified.	Takacs 1996; Hacking 2002; Miller 2004
Uncertainty	Uncertainty marks the degree to which knowledge claims are thought to be reliable representations of underlying truths.	Sarewitz, Pielke, and Byerly 2000; Wynne 1992; Stirling 2003
Evidentiary Standards	The formal and informal criteria against which evidence is measured in making decisions. Such standards are critical to understanding how knowledge and uncertainty are managed in decision-making	Jasanoff 1991; Jasanoff 2006

Table 1. Knowledge systems analysis framework: Key concepts and definitions of the framework developed by Miller, Muñoz-Erickson, and Monfreda (2010).Continues

Concepts	Definition	Literature
Credibility	The degree to which knowledge claims and/or knowledge claimants are believed by individuals or communities.	Shapin 1994; Shapin 1995; Epstein 1995; Gieryn 1999; Hilgartner 2000
Legitimacy	Legitimacy reflects the challenge of matching knowledge systems to not just the epistemic expectations of communities but also their political expectations. The legitimacy—or lack thereof—of a knowledge system can be critical to its acceptance as an input to policy decisions. Lack of political legitimacy can contribute to a loss of credibility.	Ezrahi 1990; Jasanoff 1990; Miller 2007
Accountability	Accountability structures and relationships determine who is responsible to whom with regard to knowledge production, circulation, and use, as well as how power is allocated within a knowledge system.	Miller 2004; Miller 2004; Miller 2003; Weingart 1999
Boundary Work	Refers to the work done—rhetorical, procedural, institutional, and otherwise—to create the appearance of a rigid boundary between knowledge-making and decision-making, especially where such a rigid boundary does not (and, arguably, cannot) exist for the overall knowledge system to function effectively and efficiently.	Gieryn 1983; Jasanoff 1987; Gieryn 1995; Guston 2001; Miller 2001
Reflexivity	Reflexivity is the idea that knowledge makers and users should be aware of how they are producing and using knowledge. Knowledge claims and knowledge systems inevitably involve embedded assumptions, framings, uncertainties and values that are sometimes explicit but often tacit.	Wetmore 2008; Wynne 1993; Voss, Buaknecht and Kemp 2006

action system a multi-faceted construct that includes not only the practices of knowledge production and flow, but how this knowledge is being used and how it influences visions and desired actions for urban sustainability, specifically in the context of planning for 'green' areas or open space.

Before expanding on the framework I use to address the complexity of knowledge-action systems, let's first take a look at how knowledge-action systems have been addressed in the context of cities.

2.2 *Knowledge-Action Systems for the Sustainable City*

Urban planning and governance scholars increasingly recognize the importance of multiple knowledges or expertise in researching and developing strategies toward the sustainable city (Rydin 2006, Petts and Brooks 2006, Evans and Marvin 2006). Because of the diversity of issues involved in thinking holistically about the sustainable city – gray and green infrastructure, transportation, and waste, to name a few – cities are an ideal site for examining how knowledge is produced and used by particular social groups. As Evans and Marvin (2006) state, "the implications of these perspectives is that contemporary social and environmental problems demand a community of all the experts – in which 'expert' is defined increasingly broadly and in which different experiences, knowledge and politics are all included in an integrated, holistic approach to a complex set of problems". Yet, by and large, much like the knowledge systems literature, the urban governance literature falls short in tackling the complex relationship between knowledge and action – the institutional and epistemic dynamics underlying how knowledge-action systems work – in cities. Nonetheless, key findings from research on the social-ecological [9] and governance dimensions of urban sustainability offer insights into

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[9] Social-ecological systems refer to the dynamic and coupled interactions, through feedbacks, between human and natural systems.

the urban context of knowledge-action systems, the knowledge capacities needed to tackle urban problems, and the opportunities and barriers for employing these towards building the sustainable city.

Over the last decades, an extensive literature has been accumulated on the ecology and social-ecology of urban systems that show the high heterogeneity of urban land-use patterns and their effect on ecosystem function (Grimm et al. 2008, Picket et al. 2008). Scale mismatches between ecological processes and social organization have also been documented (Borgström et al. 2006). These characteristics of urban landscapes not only illustrate the complexity of cities, but make the task of understanding and designing knowledge-action systems much more challenging. Taking a co-production angle, this suggests that the ecological context both shapes and is shaped by the dynamics of knowledge and action in the city's governance structure. In other words, the diverse structure and function of cities is related to examining knowledge-action systems in that the ecological context could be structuring the way that dynamics of knowledge and action are working (e.g. how ecological structure influences the flow of knowledge through administrative units, for instance), or that the urban context is an outcome of the institutional processes producing and linking knowledge with action. While this opens up a host of questions about the relationship of urban ecosystems and governance, the literature pays little attention to actual management and the actors groups involved as part of studying the social-ecology of the city (Ernston 2008).

In his study of how different actor groups in the city interact in mobilizing and managing an urban park in Stockholm, Ernstson (2008) made progress in linking urban landscapes, network governance, and the sustainability of the city's green infrastructure. Through examining the relationship of actors, social movements, and the framing and value creation process that actor groups employ in governing Stockholm National Urban Park, Ernston is able to make a crucial link between actors' power relationships, information flows, and transformations necessary to address the heterogeneity and scale mis-matches that characterize urban landscape. Most importantly to this study, he was able to show that the ability of actor groups to collaboratively manage and decrease scale mismatch depend (in one way or another) on creating and sustaining social networks for information flows (Ernston 2008). The treatment of knowledge and epistemic context in this research, however, is limited to the ecosystem knowledge held by managers and non-governmental organizations, or on artifacts such as scientific reports, used in framing values of the park. A more in-depth analysis of the epistemic practices and dynamics that influence how these actors, including scientists and planning experts, came to know, view, and organize themselves around the governance of an urban park, could provide further insights for developing successful knowledge-action systems for the sustainable city, especially in contexts where conflict permeates the planning and conservation of green areas such as in the city of San Juan.

Studying and reforming or designing knowledge-action systems to adequately address the ecological and social complexity of cities are tremendous

challenges. Evans and Marvin (2006) present lessons from interdisciplinary

programs researching the sustainable city in the UK and show the difficulty of

achieving interdisciplinary knowledge for urban sustainability because of the

differences in the visions that the scientists had of the city given their distinct

scientific paradigms and epistemic backgrounds. Through the analysis of the

perspective and organizational structures of the research programs, they

concluded that it is very difficult to draw together knowledge from different

scientific disciplinary bases to address the holistic concept of sustainable

development. The authors argue that conceptual analysis of the challenges

involved in combining knowledges for sustainability should be addressed before

the practice of institutional design can be tackled. This analysis, however,

focused on the scientific community alone and not the ways of knowing of other

social groups in the city. Therefore, the conceptual analysis of knowledge and

sustainability is even more imperative when we consider the multiplicity of

knowledges in the city and not just science.

How then should we approach the complexity of knowledge-action system

in cities? The next section presents the conceptual framework guiding this study

– the Knowledge-Action Systems Analysis (KASA) Framework –that brings

together three analytical lenses to better understand the dynamics of knowledge-

action systems: social network analysis, visions and epistemic cultures, and

boundary work. The objective of this framework is to develop an analytical tool

that get at some approximation of what the complexity of knowledge-action

systems looks like, obtain an appreciation of what aspects of the knowledge-

action system may be hampering sustainability in cities, and illuminate how these weaknesses can be transformed.

3. Knowledge-Action Systems Analysis (KASA) Framework: Three Analytical Lenses

Figure 2 presents an illustration of the KASA conceptual framework. In general, the framework was operationalized in terms of: 1) the *social networks,* or power structure and its influence on knowledge heterogeneity, integration, and flow; 2) the *visions and epistemic cultures* of central actors and the extent that these converge or diverge in the governance context; and 3) *boundary work,* or nature of the interactions and politics in using knowledges in planning and decision-making. Next, I define these concepts and their utility within the overarching analytical framework. Specific details on methods and data used are provided in the next chapter. Overall, the goal is to offer a theoretical and analytical tool for grappling with this complexity such that we can reform or design new knowledge-action systems that better meet sustainability goals.

3.1 Social Network Analysis (SNA)

Social network theory investigates patterns of social relations among actors interlinked through social exchanges, such as information flows, resources, friendships, and other exchanges (Wasserman and Faust 1994). A key finding of social network analysis (hereafter referred to as SNA) is that, while individuals have agency, their behavior is nonetheless constrained by interactions that constrain decisions. These interactions give rise to emergent social

structures or network patterns that can be analyzed mathematically in the forms

of graphs of nodes (actors) and links (e.g., information and resource flows)
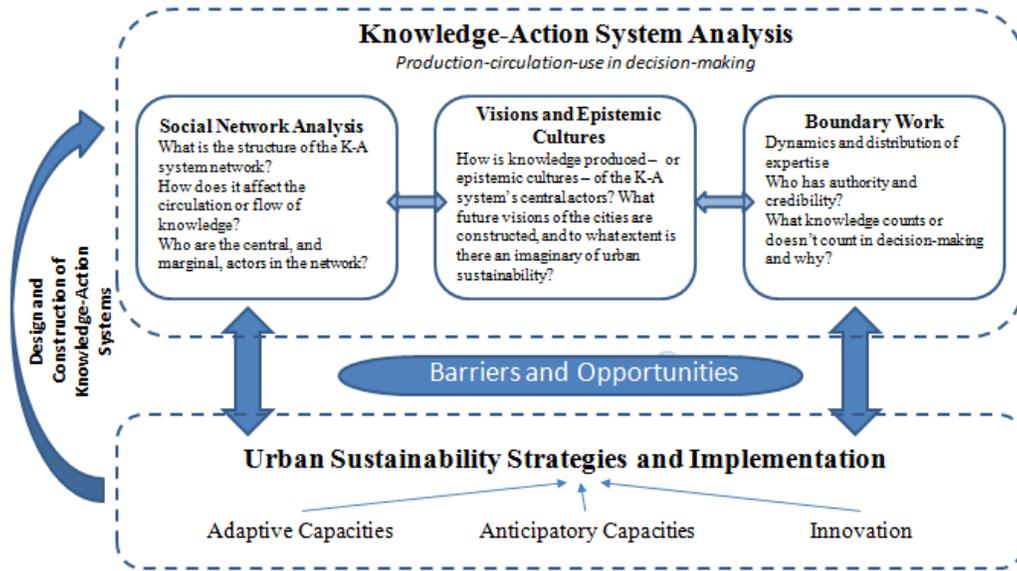
Figure 2. Conceptual Model of the Knowledge-Action System Analysis (KASA) Framework as it relates to the objective of identifying barriers and opportunities to implementing sustainable strategies and building capacities and innovation.

(Wasserman and Faust 1994). More importantly, social networks exhibit

complex effects in that they can facilitate some social interactions while at the

same time constraining others (Diani and McAdam 2003; Ernstson, Sorlin, and

Elmqvist 2008). Thus trade-offs are inherent in the system depending on what

decisions and outcomes are pursued.

   With emerging interest on co-management and networked governance

approaches to natural resource management, application of SNA is rising as a tool

to understand how social structure affects processes such as social learning and

multi-scalar collaborative management (Goldstein and Butler 2010), and how these ultimately influence social and ecological outcomes (Ernston 2008; Bodin, Crona, and Ernston 2006). Analysis of information flows across social networks is increasingly common in the adaptive management literature, but it usually is in relationship to collective action outcomes. As Crona and Bodin (2010) argue, explicit discussions of knowledge–power dynamics, vis-à-vis social structural analysis, is lacking in the literature on natural resource management. Yet, the studies that have examined the effects of network structures on knowledge flow suggest that proper circulation of information, ideas, and knowledge is an important factor in reducing power asymmetries and building innovative and adaptive capacities in governance (Crona and Bodin 2010, Butler and Goldstein 2010, Muñoz-Erickson et al.2010). This has been observed in the sustainable agriculture sector where a lack of social capital for knowledge flow among farmers inhibits rural innovation and capacity building (Arora 2009). More studies are needed to analyze and understand such structural barriers and opportunities to enhance knowledge flows as pre-conditions to co-management and adaptive governance approaches (Muñoz-Erickson et al. 2010; Crona and Bodin 2010).

A number of scholars have shown that policy-relevant knowledge is being produced, shared, and used in a variety places (Jassanoff and Wynne 1998; Miller 2005). For instance, there are formal processes such as scientific and expert committees' providing advice to government agencies, as well as informal ones such as when a community consults scientists with concerns requiring

investigation. Multiple places also serve as venues for such interactions (e.g., in the courts when a scientist provides an expert review, or public hearings where local knowledge is exposed through the concerns of the public). Miller (2005) shows how in the 2004 U.S. elections the voting process was distributed across multiple local and national voting sites, offices, and court rooms, such that the network provided social stability during the uncertain times when the presidential vote was being resolved. Jasanoff and Martello (2004), also draw our attention to the variety of places that knowledge about global environmental governance, including top-down research centers and government agencies, to bottom-up, local non-profit organizations, community groups and partnerships. These diverse and networked forms of knowledge production and utilization must be captured to attain more a comprehensive perspective of knowledge capacities in a governance context.

Knowledge mapping, or the analysis of knowledge flow within and across organizations, is a useful technique to locate, analyze, and visually portray these various sources of knowledge. A common technique in organizational theory, knowledge mapping is used by experts, managers, and staff in organizations as a navigation aid to effective manage knowledge in an organization (Grey 1999). According to Chan and Liebowitz (2006) 'knowledge mapping' is useful for practitioners in revealing the strengths and weaknesses associated with knowledge management and sharing. In this context, I use 'knowledge mapping' to illustrate knowledge flow *across* organizations. The theory and techniques of SNA are useful to understand knowledge flows in an *inter-organizational* landscape and

reveal system sources, constraints and sinks that may be facilitating or inhibiting how knowledge is produced and used in city planning and decision-making. In this study, I rely on SNA quantitative measures of centrality— degree, betweeness, reciprocity, and heterogeneity —as well as qualitative indicators of integration — to inform two main objectives: 1) identify the knowledge-action system network as it pertains to land use and green area governance in San Juan; and 2) analyze the influence of the network's power structure on how knowledge flows among the system's actors and the implications to knowledge-action interactions.

3.1   Visions and Epistemic Cultures

In order to build effective knowledge-action systems for cities it is important to understand and compare how diverse social actors, including government, planners and scientists, and civic society, 'know' and 'imagine' their cities. Not understanding this context may result in anticipatory capacities and knowledge systems that unintentionally inhibit sustainable outcomes or are not plausible culturally and institutionally. There is a long tradition in urban studies and planning to use visualization tools, such as scenario analysis, to inform the design and development of the physical, social, and institutional structures of the city. Since the 1960's, when Kevin Lynch, developing the criterion of *imageability* as a guide for planners to build and rebuild cities that are more vivid and memorable to the city dweller, urban scholars have analyzed what the city's form mean to the people who live in cities. Lynch's approach considered the visual quality of the American city by studying the environmental *image*, or

generalized mental picture, that individuals had of their city. While such visioning approaches are merely descriptive, visioning analyses have evolved to address normative elements – the desirability, values, and beliefs – that actors in envisioning sustainable states (Swart et al 2004; Giampietro and Martin 2005).

Envisioning the future through scenario analysis in the context of sustainability is both a descriptive and normative tool for integrating multiple knowledge systems and expectations of urban actors (Wiek and Binder 2005). Future visions are shared mental models of urban development because visions encompass more than an image or even a mathematical model, but also the way people talk about the future city and represented in numerous ways, as in storylines and narrative form. In a recent analysis of cities transitioning to sustainability, including Austin, Curitiba, and Frankfurt, Stephen Moore (2007) examined the way that social groups in the city talked about the city — or *storylines* of the city — to understand the unique dispositions that each city employ in implementing sustainability. Following Moore's approach, I pose that looking at urban visions can, with the help of science and other knowledge systems, facilitate a public conversation that generates political useful expectations about the future of cities.

Understanding *visions* has crucial implications for urban sustainability. Examining the shared ways that diverse groups conceive of the world, their expectations, and future options for the city can bring to light the plurality, and perhaps conflicting, trade-offs and uncertainties inherit in visions of the future. Furthermore, understanding what knowledge and technologies come to bear in the

production and communication of these visions provides a window into the rationale and capacities to actualize these visions, and whether these are conducive to meet the knowledge challenges for sustainability, such as systems thinking, future and strategic orientation, collaboration and adaptability, among others (Wiek, Redman, Withycombe 2011; Miller, Muñoz-Erickson and Monfreda 2010). In other words, it is not enough to understand the political motivations or institutional priorities that create these visions if one also wants to understand whether the capacities are available and adequate to implement 'actions' for sustainability. I refer to the frames, reasoning styles, and technologies that shape the way that diverse social groups come to 'know' and 'imagine' the city of San Juan as *epistemic cultures* (Jasanoff 2004; Choo 2006; Knorr-Cetina 1999). Variations in *epistemic cultures* across scientific groups, political groups, and even across nations have been well documented by science and technology studies (STS) scholars (see for instance Jasanoff 2005). These variations in epistemic cultures are central to the idea of co-production of knowledge and action (Jasanoff 2004). From this perspective, epistemic cultures are part of the context in which different cultural types or social groups — civic, bureaucratic, scientific, and economic — interact in governance (Jassanoff and Wynne 1998). Choo (2006) makes the argument that organizations of any sort, political, civic, or economic, needs to be understood as a 'knowing' organization. Thus, how organizations use information to construct meaning, create knowledge and make decisions is all part of the way an organization creates an identity and a

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share context for action, makes sense of its environment, is able to anticipate, and adapt early (Choo 2006).

Specifically, I analyze framings, reasoning styles, and information technologies of the central actors. Based on Miller, Muñoz-Erickson and Monfreda (2010) definition of *frames*, these refer to the set of perceptual lens or worldviews that guide the interpretation and definition of particular problems, which in turn give shape to specific political and research agendas. *Reasoning styles* are the multiple ways in which problems are addressed, such as the data and expertise employed, technologies and models used, and conclusions drawn. Variations in reasoning styles have been observed in both scientific and political cultures (Miller, Muñoz-Erickson and Monfreda 2010; Schackley 2001). Finally, *technologies* refer to the preferred methods or tools used to analyze, communicate, and represent data and information, which become a form of representing values or worldviews.

3.3 Boundary work

How experts derive their status in contemporary political processes— or how authority and credibility over knowledge are attributed to that person and distributed across society—has long been a concern to sociologists, political scientists and historians of science (Gieryn 1983; Shapin 1995). Credibility is the idea that a person holds reliable information, or is believable, and authority relates to the power or influence that the person or knowledge possesses. Contrary to conventional belief, the credibility and authority of experts are not assigned solely from the knowledge, skill, or credentials a person has. Many studies have shown

that expert status is an outcome of social processes and practices of negotiation and contestation (Jasanoff 1987). To put it differently, an expert is not a neutral entity with knowledge automatically flowing from observation of nature, but rather his or hers status has been socially-produced through processes of persuasion and contestation (Rifkin and Martin 1997) that society uses to separate and give superiority, thus authority, to one group over another.

Social scientists use the term 'boundary work' to describe the tendency to separate science and policy as distinct and unconnected human activities, such that scientific expertise maintains its credibility and authority in policy-making (Gieryn 1983; Gieryn 1995; Jasanoff 1987). The classic work of Gieryn (1983), for example, shows that scientists have long used various techniques to demarcate their profession from other social domains, such as politics and religion. Dynamics of boundary-making involves the demarcation, through rhetorical, procedural, and institutional processes, and otherwise, the functions of science and policy to create the appearance of a rigid boundary between knowledge-making and decision-making (Gieryn 1986, Jassanoff 1987), especially where such a rigid boundary does not (and, arguably, cannot) exist for the overall knowledge system to function effectively and efficiently (Miller, Muñoz-Erickson, and Monfreda 2010). The boundary between science and non-science, for instance, did not happen overnight. Scientists have long had to work hard to separate themselves from non-scientists using techniques such as credentials, jargon, control over journals, and control over training, to name a few (Gieryn 1983).

While much of the science studies literature has focused on demarcating the separation of science from other aspects of society, it is increasingly evident that boundary making is also a practice employed by other social groups, such as by non-governmental organizations to demarcate their work from others and give authority to their non-scientific knowledge or non-technical expertise (i.e., local expertise) (see, for instance, Eden, Donaldson and Walker 2006). In this way, boundary work is also a practice to demarcate the functions and authority of multiple knowledges. As Jasanoff and Martello (2004) puts it, the emergence of local knowledge as a resource for achieving sustainability has in some cases broadened the definition of an expert to include non-scientists, which has caused expert committees to become more diverse and inclusive (p.19).

Examining the dynamics and practices of boundary work in a knowledge-action system is crucial to understand how the politics of expertise play out in a given place. Particularly, how expertise is distributed across the system – in terms of which actors have credibility and authority and who gets to decide what – reveals how power dynamics actually work in the production, sharing, and use of policy-relevant knowledge. This, in turn, gives an indication of who is taken seriously (and who is not), and hence, what expertise is being privileged in the planning and decision-making process (Rifkin and Martin 1997). This knowledge is also useful to developing capacities for sustainable governance by contributing understanding of which organizational and institutional arrangements are more conducive to explicitly integrating multiple expertise and politics in the planning

and policy process in order to be more effective at resolving complex

controversies.

4. Organization of Dissertation

The chapters in this dissertation generally follow the sequence of the

KASA framework. The next two chapters provide more detailed background on

the specific data collection procedures and analytical methods used for the KASA

framework (Chapter Two), and on the planning and governance context of San

Juan, as it specifically pertains to land use development and green areas in the city

(Chapter Three). The latter described the historical and legal events that set the

context for the political conflict the city faces over development of green areas in

the city and their importance to the protection of watershed values and reduction

of social vulnerability to flooding risks. Next, Chapter Four presents results from

the social network analysis to describe the knowledge-action system in San Juan

and the structural factors affecting knowledge flow through the systems. T he

analysis of the visions and epistemic cultures of the central actors in the network

is presented in the following Chapter Five, with a discussion of how the various

knowledge practices and visions of the future of San Juan influence how the city

is being imagined (or not) as a collective community. Chapter Six takes an in-

depth look at how expertise is distributed in the city, or in other words, what

knowledge counts in decision-making through a specific case of urban re-

development in an urban core of San Juan. The boundary dynamics among

various actors, including the university and local community groups, contesting

how the city is envisioning the future of San Juan and which knowledge gains

authority in the process are discussed in this chapter. In the final chapter, Chapter

Seven, results from the three different analytical approaches – social networks,

epistemic cultures and imaginaries, and boundary work – are discussed together to

generate a synthesis of how the knowledge-action systems works in San Juan. In

the process, I discuss the strengths and weaknesses of each approach for

understanding knowledge-action systems. Specific recommendations to address

these barriers and build appropriate knowledge capacities for San Juan are also

discussed in this chapter, as well as, a number of propositions or criteria for

building effective knowledge-action capacities and institutions for cities,

including: contextualization and inclusiveness, adaptability, reflexivity, and

polycentric structures.

Chapter 2

Knowledge-Action Systems Analysis Framework:

Data and Methods

1. Description of Methodological Framework

This dissertation takes a systems-based approach to study the complex knowledge and decision-making interactions in cities. In this chapter I describe the conceptual framework guiding this research—the **Knowledge-Action Systems Analysis** (KASA) framework (Figure 1 from Chapter 1) —in terms of the data and methods used to operationalize it. In general, the framework was operationalized in terms of: 1) the *social networks* supporting or constraining land use and green area governance and its influence on knowledge flow; 2) the *visions and epistemic cultures* of central actors in the network and the extent that these converge or diverge in the governance context; and 3) *boundary* interactions and politics in generating and applying knowledges spanning the science-policy-public spheres of decision-making.

In keeping with the spirit of a systems-based approach, I use an integrative and triangulated research design that embraces multiple lines of evidence (see Table 1 for a summary of the methods used for each of the analytical approaches under the KASA framework, and Appendix III for a copy of the Institutional Review Board exempt approval for this study). I make use of both qualitative and quantitative data sources and analytical methods. Data sources include interviews, ethnographic and participatory observations, planning documents, and a survey instrument distributed to the main

organizations involved in environmental and green area (e.g., parks, private and public urban forests, riparian areas, open spaces) governance in San Juan. Methods include qualitative analysis of interviews, documents, and field notes of observational data, in addition to a social network analysis of the knowledge flows between the organizations. Together these methods provide a 'thick analysis' of the case study by combining multiple disciplinary perspectives, as well as inductive and deductive approaches for a more thorough understanding of context and system dynamics (Adger et al. 2003; Yin 1994).

The research consisted of three years travelling to San Juan and living on-site during the summers to collect data, conduct field work, establish relationships, and become a participant in the city's environmental and green-area planning context. Field work was supported in part by two key programs, a Dissertation Proposal Development Fellowship awarded by the Social Science Research Council, and a National Science Foundation funded ULTRA- Ex (Urban Long-Term Research Area Exploratory) site at which I serve as co-principal investigator in San Juan. These opportunities were crucial in allowing complete submersion in the case study context and gain first-hand knowledge of the political and cultural dynamics shaping knowledge and decision-making. As I will discuss later, my involvement with ULTRA-Ex was particularly opportunistic for me to understand the local context and to gain access to multiple sources of data and relevant settings to observe decision-making processes.

The implementation of the KASA framework was in some ways
sequential in that the quantitative analysis of networks preceded the qualitative
study of epistemic cultures/imaginaries to select the central actors that would be
analyzed. Nonetheless, I present the data and methods employed as a whole since
this approach is not linear and draws simultaneously on the various sources of
data to map how the system works.

2. Data

I conducted numerous in-person interviews in San Juan during the
summers of 2008 and 2009. A total of 110 organizations were identified through
a combination of available lists and documents, and interviews while conducting
field work in the summer of 2008. Specifically, I used a *snowball sampling*
procedure in which I engaged with key informants and documents to identify
interview subjects that represent key stakeholder organizations (Bernard 2006),
defined here as public and private organizations that work on, are concerned with,
or are affected by urban environmental and green area issues in San Juan. I
identified key stakeholder organizations using the definition described above,
including multiple sectors such as government, academia, civic society (e.g.,
environmental and community groups), media, and private interests (e.g.,
developers and businesses). The objective of the in-person interviews was two-
fold: to assess the context in which knowledge and action interact in the planning
and management of green areas in San Juan and to understand these dynamics in
order to inform the design of the

Table 1. Summary of the KASA framework. Sample, data, and methods used to analyze the three main components of the KASA framework: social networks, visions and epistemic cultures, and boundary work.

Knowledge-Action Systems Analysis			
Data and Methods			
Chapters	**Sample**	**Data Sources**	**Analysis**
IV. Social Network Analysis	**Targeted** from organization lists **and snow-ball sampling** approach to identify actors (organizations) involved, concerned, or affected by urban environmental and sustainability efforts in the city. Once the survey was implemented, *organizations mentioned more than twice* as knowledge sources were selected for network analysis.	**Survey questionnaire**. Quantitative data for network analysis (e.g. sources of knowledge and information on land use and green areas) and attributes of each node (e.g., institution type, expertise, and scale of influence)	**Quantitative analysis of centrality measures** using UCINET software: degree, betweennes, and reciprocity. **Indicator analysis** for heterogeneity and integration of network **Central actors (organizations) to knowledge flow** – nodes with highest centrality measures.
V. Visions and Epistemic Cultures	**Central actors (organizations)** as identified through network analysis.	**Survey questionnaire** – same as above: data on urban future visions; data on information, data, tools and technologies used by organization **Documents** – organizational, white papers, scientific, official governmental, outreach **Media** – newspapers and magazines; public images; websites	**Qualitative analysis** of similarities and differences between the epistemic cultures of central actors and their visions and images for the future of the city. **Convergence/divergence analysis** of visions to determine if there are single or multiple imaginaries

VI. Boundary Work	**Micro case study** of a project to revitalize an urban core in San Juan – town of Río Piedras (RP) – including changes to the town's green infrastructure	**Participant observations** in meetings, events, and daily interactions in the town. **Interviews** that focus on RP case study issues **Documents** – organizational, white papers, scientific, official governmental, outreach **Media** – newspapers and magazines; public images; websites; blogs	of sustainability for the city. **Qualitative analysis** of the interactions among state, city, university, and community actors and the boundary work to demarcate who has expertise, credibility and legitimacy in the planning and decision-making process of development.

structured questionnaire used later in the study. As such, I sought a wide range

of perspectives and used a combination of unstructured and semi-structured

protocols to conduct the interviews (Bernard 2006). I conducted an initial set of

twenty-three interviews, sixteen of which explored knowledge-action

interactions at the level of the city (i.e. green area planning and governance in

San Juan), and seven that explored the theme through a municipal re-

development initiative in the small urban sub-core of San Juan known as Río

Piedras. An initiative promoted by San Juan City's Mayor to revitalize this

urban core, called Río 2012, was the center of a controversy among local

residents, activists, and students and faculty of the University of Puerto Rico

because of concerns over the impacts that rebuilding projects may have on the

local economy (e.g., gentrification) and green infrastructure (e.g., removal of

trees). This case allowed me to delve deeper into actor interactions, specifically in terms of boundary work and the distribution of expertise in a contested context.

The sixteen city-level interviews involved representatives of various stakeholder sectors in San Juan, including governmental, scientific, and civic society sectors. Seven of the interviews were conducted individually, and nine in three different group settings. The group interviews were not planned, but rather, were requested by the respondent to have other knowledgeable participants or employees participate in the interview. The interviews provided an opportunistic setting to gain rich data on the content and process of knowledge and decision-making interaction. Interviews ranged between 60 minutes to 1.5 hours, depending on the availability of the person or group.

The seven, more local interviews for the Río Piedras area followed a similar format as the city-level interviews, but the participants and the questions asked specifically addressed the issues surrounding the Rio 2012 initiative. Also using a snowball sampling procedure, I identified key actors involved in the issue, such as municipal planners, architects, university professors, students, local residents, and community activists. All the interviews were individual and lasted approximately an hour.

Ethnographic and participatory observations were also a source of data for this study, especially to analyze the *dynamics* of how knowledge and decision-making interact in the San Juan context. During my summer and extended stays in the field from 2008 to 2010, I encountered numerous occasions, both planned

and opportunistic, to observe and engage with actors as they build, negotiate and use knowledge in their actions – to frame, plan, decide, manage, implement, collective decisions – surrounding green area management and urban sustainability in San Juan. Formal observations were done in various governmental and community meetings that dealt with urban development and green area issues. These ranged from formal public hearings by the state and municipality to review legislative proposals regarding city-level land use and permitting process, to community meetings and activities coordinated by a local community group in the Río Piedras case to review and critique Río 2012 plans and actions. Also, in my capacity as co-leader in the development of a NSF's ULTRA-Ex proposal in 2008 and 2009 to establish a long-term, social-ecological research site in San Juan, the city's main watershed, I had various opportunities to observe interactions between scientists, government planners and managers, environmental activists, and community leaders. These opportunities included a field trip through various key social and ecological points across the watershed, and group meetings to discuss key environmental and social issues facing San Juan.[10] While informal, these observations were foundational in shaping my knowledge of the San Juan urban governance context and identifying the stakeholder organizations involved in knowledge production, circulation and use in decision-making.

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[10] For a more detailed explanation of these events I refer the reader to the report titled "Meeting Report: Setting an Interdisciplinary Research Agenda for San Juan ULTRA" (Muñoz-Erickson et al. 2008).

The final sources of data were organizational and media documents. Official documents included key municipal and state plans and laws, such as the *San Juan Territorial Ordinance Plan of 2003* by the San Juan Municipality Office of Planning and Territorial Ordinance the architectural plans and designs for Rio 2012, and numerous other legislature documents, public hearing comments, official letters by agencies, and images used in government and non-government advertising. Similarly, I reviewed documents written and published by non-governmental organizations, including white-papers, books, outreach publications, letters, meeting notes, plans, scientific publications and many others. Organizational websites, including blogs, were also a key source of data not only because it was the medium by which these documents were published, but because they contained information on the organization's missions, activities, and networks that were useful in creating the organizational profiles and epistemic cultures. Finally, I reviewed media sources, including major newspapers such as *El Nuevo Día*, *The San Juan Weekly*, and *Claridad*, and local magazines such as *San Juan News*, *Corriente Verde*,

Quantitative data was collected using a survey instrument designed to profile stakeholder organizations concerned with the environment and land-use sustainability in San Juan.[11] Following a similar approach to Svendsen and Campbell's (2008) for developing profiles of the role of community-based urban land management organizations in cities, the survey gathered background data on

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[11] The survey also served the purpose of assessing knowledge needs for the planning and development of the San Juan ULTRA-Ex proposal.

stakeholder organizations involved in, affected by, or concerned with environmental and land use issues in San Juan[12]. The survey design was informed by the interviews and implemented in 2008 and 2009. It consisted of close- and open-ended questions structured under these general sections: 1) problem framing and knowledge priorities (e.g., what their organizations see as the most important urban environmental issues in San Juan and whether more scientific research is needed) ; 2) knowledge and collaboration networks (e.g., what organizations they go to to obtain information, data, ideas, etc.) ; 3) planning and public policy (e.g., what are the institutions or laws that constraint the organization's activities); 4) perspectives on science and policy (e.g. how science should be used in decision-making) ; and 5) descriptive information (e.g., human resources, expertise, scale of influence, etc.) on the organization (See Appendix II for survey questions).

To implement the survey, a leader or key contact for each organization received an invitation to participate in the survey via email. The respondent was given the choice of answering in person or online through a link to Survey Monkey (www.surveymonkey.org), an online survey design and management service, depending on their availability. After repeated contacts, the overall response rate was fifty-seven percent (n=63). The majority of survey respondents represented government agencies, non-governmental organizations (NGO's), and academic institutions at 31 percent, 21 percent, and 18 percent respectively. An additional twenty percent of the sample consisted of businesses and private sector

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[12] Survey respondents were asked to complete the survey from the perspective of their organization.

organizations (professional organizations representing the business sector, including development, planning and architectural consultants) and community groups were represented at 10 percent. As expected from a professional sample, nearly the entire sample had at least an undergraduate level education (ninety-five percent), while the rest had more than a year of undergraduate coursework or preferred not to answer.

3. Analytical Methods

3.1 Social Network Analysis

To build the knowledge network the first methodological issue is to define the boundary of the network, or in other words, what actors (organizations) to include in the network. For a known group of individuals or organizations, a boundary is defined by actors in the group and the network can be built by asking the actors (individuals or organizations) to name or choose from a list which of the other actors they interact with. In the case of this study, the boundary was unknown because there is no pre-set list of organizations working on urban environmental and green issues in San Juan. Additionally, I did not want to define the network boundary *a priori*, but rather, allowed the stakeholder-defined network to emerge. This meant that there was a risk that no network emerged because the range of organizations surveyed could be too sparse or coarse to build a network. To deal with these issues, I followed Ernstson et al. (2008) approach for defining a whole network (group) boundary using ego-network (individual) level information.

The ego network approach uses a recall method (Wasserman and Faust 1994) in which participants list the five organizations that they most frequently interact with to obtain knowledge and information on land use and green areas specifically. Respondents were asked to "Please mention five agencies or organizations (e.g. non-profits, academics, private, etc.) that you consult with or ask questions frequently to obtain knowledge or information specifically about land use and green areas (e.g. urban forests, rivers, parks, etc.) in San Juan." Next, I calculated the frequencies for the organizations mentioned for 60 of the total organizations[13], resulting in a total of 42 mentioned. I then selected the organizations mentioned at least twice by the entire survey sample to define the boundary for the group network (n=26). All twenty-six organizations became a node in the network that are related or 'tied' to other nodes (i.e. organizations) by the transfer of knowledge and information. Overall, this combined ego- and whole-network approach avoided making an *a priori* selection of actors that constitute the network and instead allow the knowledge sources to emerge bottom-up by casting a wider net among the political actors and have them define the key nodes in the network.

Centrality measures were calculated to evaluate the network's power structure and its effect on knowledge flow, heterogeneity, and integration. Network data were analyzed and visualized using the Ucinet and NetDraw

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[13] Three organizations were student groups from the University of Puerto Rico. For the purposes of this analysis, only one survey per organization was used. However, since universities are a conglomeration of multiple programs and departments, I included two program-level responses for the university (Institute for Ecosystem Studies – ITES, and the Urban Action Center- CAUCE), while eliminating the student groups to avoid over representation in the overall sample.

softwares (*www.analytictech.com*). ***Degree*** centrality measures the number of links a node has as an indicator of dominance or power over information flow (Brass and Burkhardt 1993). ***Betweenness*** is an index of information control as it measures how many unique groups are only connected through a particular individual, or how many nodes (i.e., organizations) have to go through a particular node to get to others (Brass and Burkhardt 1993, Chan and Liebowitz 2006). ***Reciprocity*** was used to calculate which pairs of nodes are linked with bi-directional ties (reciprocity), or in other words, are engaging in two-way interaction of knowledge flow. I used all three measures to discover if there is a critical constellation of actors dominating knowledge flow in the network.

Additional criteria were used to operationalize knowledge heterogeneity and integration. ***Heterogeneity*** was evaluated based on the number of different organizations compared to the initial survey population. In other words, this is a simple indicator of the diversity in the composition of the network. To assess whether marginal groups are also included and have meaningful positions in the network, ***social integration*** looks at the extent that minority groups (e.g. civic organizations) have central positions in the network.

3.2 Visions and Epistemic Cultures

Once the central actors in the knowledge-action system were identified through network analysis, I used various sources of data, including survey responses and data gathered from documents, media, and internet sources to compile information on their visions and epistemic culture of each actor. Epistemic cultures are defined as shared practices underlying the way that social

groups and organizations come to know and see the city (Jasanoff 2004, Choo 2006) and that give shape to these visions. For the purposes of this study, I focused the analysis on three aspects of epistemic cultures: frames, reasoning styles, and technologies.

To evaluate *frames,* I used responses from an open-ended survey questions, "What do you think is the most pressing urban environmental issue [that San Juan city faces]?". To analyze *reasoning styles*, I used various sources of evidence from the survey and organizational documents, including the type of data the organization collects and uses, the expertise found in the organization, and their knowledge products (e.g., peer-reviewed journals, models, etc.). Finally, *technologies* refer to the preferred methods or tools (e.g., computer models, statistics, etc.) used to analyze, communicate, and represent data and information. The epistemic cultures of the central actors were qualitatively compared and contrasted to evaluate the extent of convergence (or divergence) between them, as well as to see the extent that these match (or mis-match) into a vision of sustainability for San Juan.

3.2   Boundary Work

In the case of the in-depth case study focused on the Río 2012 controversy, interviews were semi-structured because I asked specific questions regarding their knowledge, networks and roles in this local initiative, what institutions they view as credible in this issue, as well as their perspective on the role of science in decision-making in addition to the general categories used in the larger survey implemented for San Juan (see Appendix II). Because the interviews

involve people with unique roles and perspectives, the specific questions were tailored according to their specialized knowledge of the problem. In other words, each interview was different. Participant observations were recorded in field notes during or following the event. Similar categories as the ones used in the interviews were used to inform what to 'look for' in the observations, but with special emphasis on how actors framed the issues, interacted with each other, and what was the nature of the interaction.

4. Methodological Limitations

As with any investigation, there are limitations to the methodology used in this study. A more longitudinal analysis of knowledge system dynamics through a single organizational case study, for instance, would've have been ideal to delve deep into the nature of interactions between knowledge producers and decision-makers. The scope of this study, however, made such intensive data collection not feasible and it ran the risk of only capturing interactions particular to an organization, rather than the diverse ways that actors are interacting in the governance context of the city as a whole. Similarly, the survey sample was limited to the leadership of the organization and not all planners, technicians, and other staff members (except for a few cases in which the organizational leader asked a staff member or technician to complete the survey). This issue, however, was in part compensated by the interviews I conducted with experts of some of the central organizations, including state and municipal planners and technicians. With more time and resources a more in-depth look at interactions and cultures in each organization, through focus groups for instance, would have been valuable.

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Finally, although I used three different centrality measures to identify central actors and the existence of constellations influencing knowledge flow in the network, it is important to note that actors were selected on basic centrality measures and not more sophisticated network analysis (e.g. block models). The objective here was not to analyze the structure of the network in depth, but get an overall map of who is connected to whom and who has influence over knowledge in order to analyze how these central organizations 'think' and 'act' through an analysis of their epistemic cultures.

Chapter 3

The Case Study: Urban Land Use and Green Area Governance

in San Juan - Past, Present, and Future

1. Introduction

As the capital of Puerto Rico, San Juan has one of the largest economies in

the Caribbean and is often seen as a model for the development of other

Caribbean or Latin American economies. San Juan is part of the San Juan

Metropolitan Area that spans approximately 7 km in the northeast coastal plains

of Puerto Rico and one of the densest areas in the world (Figure 1). In 2010 the

city had a population of around 395,326 people (US Census Bureau 2010),

although this fluctuates with migration and seasonal visitors through the tourism

industry. The city houses most state and federal governmental agencies, serving

as a key political center for the administrative and regulatory activities of the

Island. San Juan is also a major cultural hub for the Island and the Caribbean

region. The significance of this 'Capital City' has prompted many of the Island's

governors and city mayors to give San Juan greater national and worldly status.

For instance, the city's current mayor, Hon. Jorge A. Santini Padilla, is carrying-

out extensive redevelopment and modernization projects across the city, hosting

large events (e.g., IronMan) and even creating a municipal office in Washington

D.C. with the purpose of increasing visibility and attracting global attention to the

city.
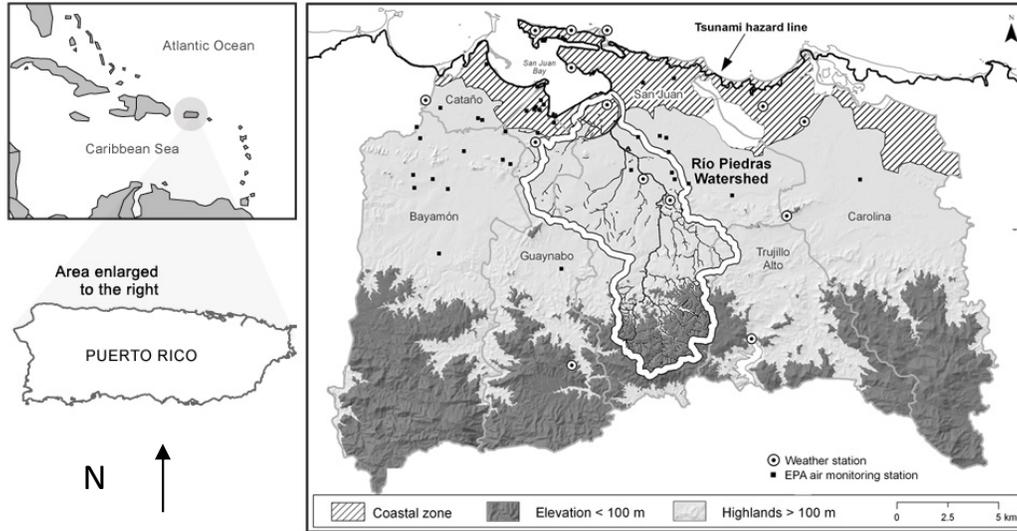
Figure 1. Map of Puerto Rico and the Caribbean (left panel), and the San Juan Metropolitan Area (SJMA) and the Río Piedras River Watershed (right panel). . The perimeter of the region corresponds to the political boundaries of the five municipalities that comprise the SJMA, and the white boundary corresponds to the Rio Piedras River Watershed within the Municipality of San Juan. Source: San Juan ULTRA-Ex 2010.

Driven partly by the availability of cheap oil (Day et al. 2009), the development trajectory of this 500-year old city occurred quite fast with new wave of rapid urbanization (and subsequent suburbanization) in the 1940s (Webb and Gómez-Gómez 1998, Padín et al. undated). This has produced a landscape on which permanent structures such as highways now essentially force people to heavily rely on automobiles and has facilitated urban sprawl, which is a pattern that many developing cities are copying (Figure 2). With the inclusion of the Municipality of Río Piedras in 1951, a mainly rural area that supplied most of the water and food needs to San Juan, San Juan extended from the coast into the alluvial valleys and hillslopes of the Central Mountain Chain in the south. Now a large portion of San Juan is located within the Río Piedras River Watershed

(RPRW) (67 km2) and the city is characterized by polycentric network of various

urban cores with different functions and surrounding suburban areas, including

the Old San Juan (cultural and historic center), Santurce (commercial center),

Hato Rey (financial center), Condado and Isla Verde (tourist center), and Río

Piedras (residential and university center).

Figure 2. Transformation from agrarian use in the 1930's (left image) to urban
land use in the community of Puerto Nuevo in 2007 (right image). Source: San
Juan ULTRA-Ex 2010

The territorial expansion of San Juan and the development of the

highway system facilitated development in the upper areas of the RPRW (Río

Piedras River Watershed) that remain in rural and forested conditions for the

most part. Development on the watershed hillslides with erodible soils have

caused landslides and accelerated erosion, virtually transforming the city

drainage systems (Osterkamp 2000). These changes have increased the risks of

flooding downstream and led to sedimentation of coastal mangroves and

estuaries, affecting aquatic ecology and water quality, and resulting in property

damage (Osterkamp 2000, Pringle and Scatena 1999). Development and

deforestation practices along various parts of the city's main watershed have not

only affected rural communities in these areas, but it has also congested rivers

with sedimentation and pollutants downstream (see Figure 3). In a matter of six

decades the RPRW, which is the city's main supplier of gravity-fed water for

local residents, has been completely transformed and no longer provides this

important service (Lugo et al. 2011). Compounding these issues is a socially

segregated urban pattern in which high-income communities tend to appropriate

better urban space or the open areas in the higher elevations of the watershed,

leaving poor communities in undesirable locations where they are more

vulnerable to environmental and socioeconomic risks, such as flooding in the

lower parts of the watershed (Seguinot-Barbosa 1996).

Figure 3. Example of land development practices that are having negative effects
on watershed functions and the rural communities surrounding these areas. Source:
López 2002

Trends and patterns of development since the mid-20th century appear to

be compromising the sustainability of San Juan and future quality of life for its

residents. Based on the interviews I conducted, of immediate concern to San

Juan residents are the effects that this urban sprawl is having on the health of

communities and green areas, especially the city's remaining parks, forests,

wetlands, streams and riparian areas, among other open spaces.
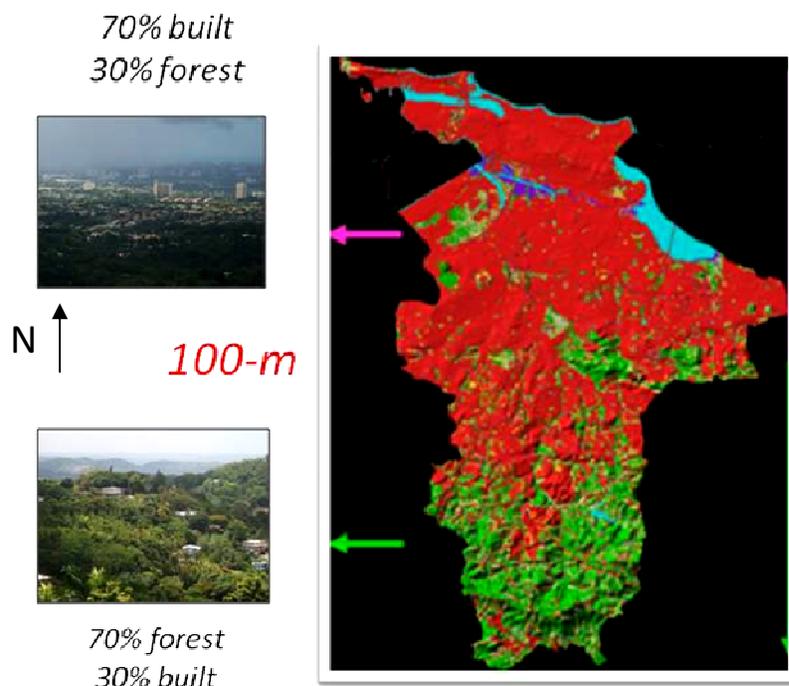
Figure 4. Land use trends in the Municipality of San Juan. The more densely
vegetated rural zone (in green)are located above the 100-m elevation contour,
which encompasses percent of forest and other vegetation cover. The urban area
is represented in red. Source: Ramos González et al. 2005

The city's green infrastructure has generally not been valued and the

remaining continuous forest cover above the 100-m elevation contour is

increasingly threatened by urban sprawl (Figure 4) (Ramos-González et al. 2005,

Padín et al. undated). The highest elevation areas of the watershed therefore now

contain the last remaining contiguous forest fragments of the city and these could

be jeopardized as urbanization into the rural-urban interface increases. Scientists, environmental groups, and citizens alike are demanding better use and management of green areas in urban planning. Some sectors are developing their own visions of development for land use sustainability, such as the Smart Growth Initiative put forth by the Metropolitan University in 2008, the ongoing Cool Cities Initiative by the Sierra Club, the urban forestry programs run by the State and Private Program of the U.S. Forest Service, and many more to be discussed later in this chapter.

This chapter provides a brief historical and contemporary context of the planning and legal framework relating to urban land use, and more specifically, green areas in San Juan[14]. Table 1 presents a chronological summary of the historic and legal events that will be discussed below and Appendix 3 lists the policy actors discussed in this chapter and their acronyms. This analysis of urban land use and green area governance in San Juan is within the context of a much larger and contested political-economic situation that shapes decision-making in Puerto Rico due to its status as a Commonwealth of the United States. I refer the reader to a large body of literature that exists on historical and contemporary analyses of the political economic status of Puerto Rico. Specifically, I recommend Leonardo Santana Rabell (1989) critical analysis of the planning and development policies that were formulated in the early years of the Commonwealth. Here I focus on the institutional and legal framework that

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[14] Information for this chapter derived from various sources in the academic and gray literature, historical documents, official documents, the media, and exploratory interviews with planners, activists, scientists, and residents in San Juan.

specifically affects the planning and use of green areas in the city, which is also

what informed the four major historical and contemporary periods I selected to

organize this analysis: the 1940s to 1960s; the 1970s to 1990s, the decade of the

1990s, and the 2000 decade to the present (Table 1). While other planners

or policy scholars might differ on the logic of these categories, to me they reflect

the progression of socio-economic and environmental tendencies that have most

influenced the state of urban green areas. I end the chapter with a presentation of

the San Juan Territorial Ordinance Plan, the city's main planning document, to

open the discussion on whether the city's knowledge systems support and provide

a roadmap for sustainability that will be the focus of subsequent analyses in this

dissertation.

**2. Urban Green Area Governance: Planning History, Legal Framework,
and Political Actors**

The historical development of green area planning and conservation in

San Juan is not straightforward or easily linked to a few key transformational

events. Rather, it is more a result of dynamic tensions between city and

economic planning tendencies, top-down and bottom-up land use practices, and a

congruence of these with increasing environmental awareness in the city during

the 1990's. While the conservation history of Puerto Rico goes back to the

development of laws for protected areas and forests in the 1960s and 1970s, as

well as to the urban planning framework that began in the 1940's, urban green

areas remained in a sort of planning vacuum because neither of these frameworks

accounted for the rural areas that were to be later converted into patches of urban forests. To provide this context I summarize the urban green area governance, legal framework, and key players in their development, around four major historical and contemporary periods: the 1940s to 1960s; the 1960s to 1990s, the decade of the 1990s, and the 2000 decade to the present. Table 1 is a chronological summary of the historic and legal events mentioned in this chapter and Appendix I list the organizations mentioned in this chapter and their acronyms.

1940s -1960s: Urban Planning and Economic Development

Urban planning in San Juan can be traced back to the New Deal Era of President Franklin D. Roosevelt and the appointed governor of Puerto Rico Rexford G. Tugwell. Through the 1942 Planning Law (later amended in 1975), the Tugwell administration established the legal basis to plan and regulate San Juan's urban and economic development while also creating the Puerto Rico Planning Board (PRPB). The Puerto Rico Planning Board was intended to serve as the main agency overseeing land use planning and development in Puerto Rico and to be semi-autonomous from both the Legislative and Executive Branches. From its establishment to the present the agency has worked in a centralized, top-down, hierarchical style to planning (Marvel 2008). This agency is the state's fundamental branch to inform public policy and guide short- and long-term actions for the Island and has the responsibility to guide the integral development of the country and promote the social welfare through this process.

Table 1. Chronological summary of historic events and legal framework relevant to green area governance and land use sustainability in San Juan.

1940s -1960s: Urban Planning and Economic Development

1942	Planning Law and the creation of the Puerto Rico Planning Board
1952	First Master Plan for San Juan (never adopted)
1956	Regional Plan for the San Juan Metropolitan Area (never adopted)
1960	U.S. Army Corps of Engineers' Flood-Control Plan for Rio Puerto Nuevo

1960s to 1990s: Integrated Planning and Conservation Policy Frameworks

1970	Environmental Public Policy Law and the creation of the Puerto Rico Environmental Quality Board
1972	Establishment of the Puerto Rico Department of Natural and Environmental Resources
1975	Puerto Rico Forest Law
1975	Amendment of 1942 Planning Law and establishment of the Permit and Regulation Authority to separate planning and permitting functions
1976	Puerto Rico Water Law
1982	Land Use Plan for the San Juan Metropolitan Region

1990s: Planning Decentralization and Early Attempts at Urban Green Area Conservation

1991	Autonomous Municipalities Law
1992	Establishment of San Juan Bay Estuary Program
1995	San Juan Municipality begins Territorial Ordinance Plan
1998	Establishment of the Forest for the New Millennium
1999	Urban Forest Law

2000 – Present: Green Area Governance and Sustainable Development Tendencies in Urban Planning

2003	Flood Prevention Policy
2003	San Juan Territorial Ordinance Plan approved by state
2003	San Juan Ecological Corridor Law
2004	Sustainable Development Law
2008	Metropolitan University publishes principles and strategies for Smart Growth as a development model for Puerto Rico
2009	San Juan Municipality becomes an Autonomous Municipality
2010	Implementation of U.S. Army Corps of Engineers' Flood-Control Plan for Rio Puerto Nuevo

It has the faculty to regulate and grant authorizations regarding the distribution of the population and zoning. A weakness of the 1942 law that, as will be discussed later, affected how urban green areas were to be managed in the future was the exclusion of what were rural areas at the time from zoning activities.

Early attempts for comprehensive planning of San Juan, such as the first Master Plan of San Juan 1953 and the first Regional Plan for the San Juan Metropolitan Area of 1956, were never adopted. During this time there was a change in the nature of physical and economic planning to focus on leading the Island out of poverty, fueled by national such as "Operation Bootstrap". (Marvel 2008, p. 41). This economic growth model, led in part by government incentives and tax breaks, an expanding construction sector, and cheap oil, led to rampant urban and suburban sprawl in San Juan and Puerto Rico in general (Webb and Gómez-Gómez 1998, Day et al. 2009, Marvel 2008). In all, during this period, specifically between the 1930s and 1950s, San Juan reached its peak growth promoted by a new model of suburban, horizontal development, and with the preference of automobiles over other forms of transportation, that transformed the urban culture of the Puerto Rican, and of 'Sanjuaneros' in particular (San Juan Municipality Office of Planning and Territorial Ordinance 2003, pp.7). This model proved to be unsustainable for San Juan. In 1970, for instance, while the city's population doubled, the construction quadrupled. Later in that same decade the municipality experienced a decrease in population growth rate and its population reduced by almost 30,000 people. Although the participation of the municipalities and public in general was very limited during this time, these

early planning efforts, and failures in some cases, increased the concern of planners and prompted responses towards more integrated planning (San Juan Municipality Office of Planning and Territorial Ordinance 2003, pp.9)

1960s to 1990s: Integrated Planning and Conservation Policy Frameworks

After experiencing significant growth and relieving Puerto Rico from the pandemic poverty that earned the Island the name of "the Poorhouse of the Caribbean," the economy of Puerto Rico suffered a significant downturn as a result of the oil global crisis in the 1970s (Banco Gubernamental del Gobierno 2011). Puerto Rico's dependence on foreign oil makes it especially vulnerable to these global economic changes (Charles Hall personal communication). As previously mentioned, this rapid expansive growth also had serious environmental impacts. In San Juan, both human and ecological communities have become vulnerable to increasing risks of flooding, erosion, landslides, and water contamination resulting from these urban transformations (San Juan ULTRA-Ex 2010).

Largely in response to economic development, it is during these decades that the environmental movement became widespread in Puerto Rico policies (Concepción 1996, Berman-Santana 1996). Planning analyst, Carmen M. Concepción (1995), notes that underlying all of the environmental issues, which at the time were mostly related to pollution and health risks associated with mining and other industries, was an "implicit critique" of the state's development strategy that mostly "served the interest of external capital" (Concepción 1995

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cited in Gaztambide Arandes 2008). In addition, the environmental movement

was, and in some respects still is, a conglomeration of various political interests

that bring forward economic, environmental and socio-cultural concerns,

therefore linking environmental issues with the political-economic status of the

Island and its association with the US mainland. Some of these political groups

include environmentalists, church groups, professional organizations, community

groups, and nationalists and pro-independent interests. Through the effective use

of media, education and community involvement, activists broadened the

public's understanding of these environmental issues (Gaztambide Arandes

2008).

At the government level, important advances in environmental

legislation reflect an increasing awareness over environmental issues in Puerto

Rico. One of the important advances in environmental protection and

conservation of natural resources in Puerto Rico was the 1970 Environment

Public Policy Law (later amended in 2004). This law recognizes the critical

importance of restoring and maintaining environmental quality for human well-

being, in addition to assuring that natural systems are healthy and have the

capacity to maintain a productive relationship between humans and the

environment (Calero 2009). This law established the Puerto Rico Environmental

Quality Board (PREQB) as the agency that is responsible to evaluate that

government programs meet environmental regulations. Other important steps in

promoting the protection and conservation of natural resources were the creation

of the Department of Environmental and Natural Resources (PRDENR) in 1972

as the entity responsible for the protection and conservation of Puerto Rico's natural resources and biodiversity. Additionally, the Puerto Rico Forest Law in 1975 and, for the protection of watersheds, the Puerto Rico Water Law in 1976, were policy developments that would later be crucial in promoting and supporting the conservation of urban green infrastructure in San Juan. The creations of the PREQB and the PRDENR have been instrumental to urban planning because any zoning or rezoning of potential projects by the Planning Board requires the approval of these state agencies.

Another important change at the state level was the amendment of the Planning Law in 1975 focusing on integrated planning and development. The overall objective was creating the conditions favorable for the optimal use of the land and resources to achieve more balanced growth by integrating and coordinating physical, economic and social aspects in the formulation of public policy in Puerto Rico. With this amendment the Planning Board also transferred some of its administrative permitting powers to the Permit and Regulation Authority (PRPRA). In this way, the planning and permitting functions were by law separated and executed by these two different agencies.[15] Nonetheless, the Planning Board remains responsible for designing and implementing island-wide planning policy for land use and socio-economic development. Part of the functions of the Board was to create an Integrated Development Plan for Puerto

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[15] Recently in 2010, the permit system changed and one state agency, the General Permit Office (Oficina General de Permisos), oversees a new permit system to streamline the bureaucracy through the use of web-based technologies and one central administration. The restructuring of this process is still underway, therefore too early to analyze its impacts, but initial controversies over the new regulation indicate that this process may have repercussions on the knowledge system and which expertise are included as part of the process.

Rico, which included land use plans and four-year investment plans (San Juan Municipality Office Planning and Territorial Ordinance 2003, pp. 9). In this function the Planning Board is also a generator and repository of economic, financial and social data for Puerto Rico (Gaztambide Arandes 2008).

In 1982 a Land Use Plan for the San Juan Metropolitan Region was created for the metro area covering twelve municipalities based on the 1980 US Census Standard Metropolitan Statistical Area of San Juan. This plan meant to be flexible and dynamic to encompass the region but also supplemented with smaller land use plans, or 'special plans'. It also began recognizing the importance of protecting areas from urban development, such as mangroves, forests, and land with high agricultural potential in light of increasing environmental issues. The regional focus of the plan, however, is limited in the identification of potential areas for conservation.

Federal policies and programs have had major influence on land use planning, environmental protection policies, and implementation of these policies for San Juan and Puerto Rico as a whole. In its regulatory role, the US Environmental Protection Agency (USEPA) is responsible for approving or denying federal projects based on Environmental Impact Statement (EIS). Although this agency has minimal jurisdiction over land in San Juan, at times it has questioned local actions that create environmental risks. Environmental and community groups, for instance, have employed this law in protecting against environmental risks, especially from industrial pollution (Concepción 1995). A crucial influence of these policies were their requirement for citizen input and

participation in plan approval, which was a form of democratic expression new to planning in Puerto Rico (Marvel 2008, pp. 53).

Other notable federal influences on Puerto Rico's conservation policy framework and planning were the research activities of agencies like the U.S. Forest Service's International Institute for Tropical Forestry and State and Private Forestry Program, the US Geological Survey, and the US Fish and Wildlife Survey, which have developed an extensive scientific knowledge base on the forest, water and wildlife resources of Puerto Rico and San Juan.

1990s: Planning Decentralization and Early Attempts at Urban Green Area Conservation

Up until the early 1990s the main actors in the planning and conservation stage were state and federal agencies. This began to change with decentralization policies. While historically the Planning Board had jurisdiction over the zoning and development of the Island's 78 municipalities, the approval of the Law 81 of Autonomous Municipalities in 1991 authorized municipalities to establish policies, strategies and plans directed to territorial ordinance, the preservation of resources and their optimal development, and to approve related ordinances, resolutions and regulations. These institutional changes in the land use decision-making process resulted from decentralization policies (Figure 5). The new rules required municipalities to begin developing their own land use plans, at times through the establishment of planning offices or by consulting with outside experts when the resources were not available to develop their own

planning capacity. Due to the complicated process to attain autonomy and lack

of capacities or interest, only 24 municipalities had prepared plans as of 2005,

and only 7 have asked for the transfer of zoning powers from the state (Marvel

2008, pp. 37).

As the Capital City, San Juan benefitted from more resources and thus

already had an office that could begin the process of developing its land use plan,

the Office of Urbanism. The Municipality's Territorial Ordinance Plan (TOP),

discussed later in more detail, was completed in 2003 as part of the process to

gain local autonomy. In 2005, the Municipality's Office of Planning and

Territorial Ordinance was established with an in-house Geographical Information

System (GIS) infrastructure to develop planning maps. The process of gaining

autonomy took several years, however, and the zoning and permitting process

continued to be under the authority of the Planning Board and the Permit and

Regulation Authority until San Juan gained autonomy in 2009. In other words,

while the TOP of San Juan was put into effect on March 13, 2003, it was not

until after 2009 that San Juan Municipality was able to grant its own project

permits. Therefore, the permits requested before 2009 could only be authorized

by the Planning Board and Permit and Regulation Authority (and now the

General Permit Office).

The decentralization of planning and administrative powers and the

appropriate spatial scale at which to make decisions regarding cities generally

have long been a debate in Puerto Rico's planning framework. To ensure that

there is consistency across all the municipalities, the PRPB still has to approve or

deny municipal plans based on their consistency with the Board's guiding vision for the Island, the Integrated Plan for Sustainable Development. As such, although planning and permit functions now reside at the city level, the vision of the state and the way that it 'sees' the city San Juan will continue to have a large influence on the way that this city is planned for the future. This power asymmetry has hampered effective planning due to a lack of clarity, capacity, and desire to assume responsibility of planning options (Marvel 2008, pp. 37). As will become evident in later chapters, these politics of scales is a crucial issue affecting sustainability practices and the way that knowledge is produced and used in the governance of urban green areas.

Mechanisms for effective citizen participation, one of the arguments in favor of decentralization, still remain a weakness in the planning institutional framework in Puerto Rico. An evaluation of two autonomous municipalities that give prominence to environmental issues within the governmental agenda, Caguas and Carolina, revealed that citizen participation in local environmental management was limited to citizens expressing their concerns, rather than participating actively in the setting of priorities, finding solutions, planning and evaluation (Concepción 2006). Therefore, the extent to which municipalities will be effective at integrating public concerns, knowledge and expertise on local environmental issues and sustainable development effectively is still to be determined.

Notwithstanding these institutional changes, several governmental and civic efforts served as early antecedents for urban green area planning and

conservation during the 1990s. At the state level, programs such as Ciudad

Mayor (Main City) and the Red Ambiental Metropolitana (Metropolitan

Environmental Network) sought to create a network of protected and unprotected

green areas across the city and metropolitan region through reforestation and
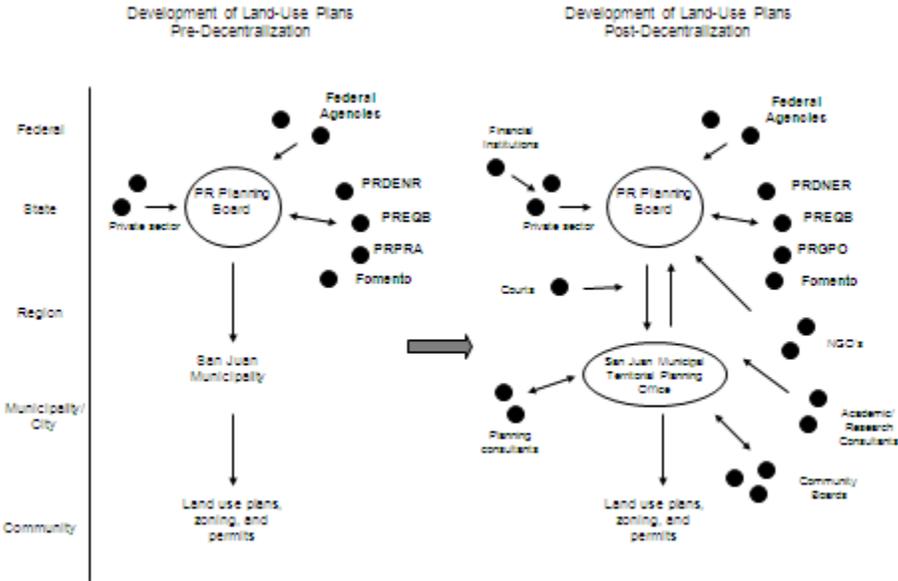
Figure 5. Illustration of the changes in the institutional landscape in San Juan
Municipality with the decentralization planning process that began in 1991 with
the Autonomous Municipality Law. *Circles* indicates institution/organization,
arrows represent their level of interaction in making decisions regarding land use
and green areas (e.g., one-way arrow indicates that an organization go to another
for a consultation, decision or permit, and a two-way arrow indicates that the two
organizations most consult or collaborate in developing a plan or making
decision). The figure on the left illustrates how the process has changed since
decentralization and how the landscape of actors involved in land use planning
looks today.

conservation efforts. These plans, however, discontinued with the changes in administration. Efforts at the municipal level mainly included beautification projects along highways and urban centers, as well as the establishment of new forests, such as Bosque Para el Nuevo Milenio (Forest for the New Millenium) in 1998.

A major accomplishment in green area protection in San Juan was the establishment of the San Juan Bay Estuary Program in 1992 through the US EPA's National Estuary Program, which aims to manage and protect the mangroves, aquatic ecology and other marine biota of the San Juan Bay estuary. The San Juan Bay Estuary Consortium is a non-profit entity that brought together multiple government, civic, and scientific sectors to collaborate in the development and implementation of the plan to restore and manage the estuary (San Juan Pay Estuary Program http://www.estuario.org). This program has also been important in promoting protection of green areas in the upper parts of the Río Piedras Watershed given the relationship between development in higher parts of the watershed and impacts on estuary downstream.

Finally, another important piece of legislation for the protection of urban green areas was the 1999 Urban Forest Law. This law defined an urban forest as a "biological community dominated by trees, including its associated wildlife, which is found in an urban zone of a city or town" (As cited in Calero 2009). With this law the importance of urban forests to the quality of the urban environment (e.g. clean air, lower temperatures, and noise control) and its role in ecosystem function was recognized.

2000 – Present: Green Area Governance and Sustainable Development Tendencies in Urban Planning

As previously mentioned, one of the legacies of the Puerto Rico planning framework that has created great hurdles for the protection of urban green areas was the exclusion of rural areas from zoning activities in the 1942 law. The ambiguity of this planning gray zone facilitated the chaotic development patterns and infrastructure that we see today in San Juan, especially in the southern parts of the Municipality. To fill this gap a governance approach in which multiple planning visions from different sectors, both governmental and non-governmental, is emerging in the city to protect urban green areas, watershed function, and promote land use sustainability in San Juan.

Of great relevance to the Río Piedras River Watershed (RPRW) are several flood control and canalization efforts that negatively affect mangrove, riparian forests, and other green areas around water bodies. In 2003 a law was established that protects rivers and streams to prevent further flood risk. The Flood Prevention Policy establishes that the PRDNER should take flooding control and river canalization measures as long as they are necessary to prevent flooding in areas that have historically caused property damage, but new development in areas of flood risk should not be promoted. As a flood control measure, this law mandates that any new construction adjacent to a body of water must leave a minimum of five lineal meters of riparian areas at each side of a

body of water, such as a river, stream, lagoons[16]. Only passive recreation activities are allowed in these riparian areas and the PRDENR should manage and clear these areas. Also, the U.S. Army Corps of Engineers (USACOE)) recently began the implementation of their Flood-Control Plan for Río Puerto Nuevo for the dredging, canalization, and other infrastructure maintenance in the low-lying San Juan area projects as a 100-year protection flood plan (Caribbean Business, 2011). This plan, however, was developed in the 1960's as involves physical transformation of the river system as part of the canalization and placement of a precast concrete panel system, thus affecting mangroves in the area.

From a scientific perspective, institutions such as the U.S. Forest Service's International Institute of Tropical Forestry and the Institute for Ecosystem Studies of the University of Puerto Rico have researched urban forests and watersheds in San Juan. In the article "What is an Urban Forest?" Lugo (2000) established the characteristics that define an urban forest in Puerto Rico and their ecological importance. In terms of land use in general, the Metropolitan University's Centro de Estudios para el Desarrollo Sustentable (Center for Sustainable Development Studies) published 10 principles and 100 strategies to promote land use sustainability for Puerto Rico. Based on an evaluation of urban sprawl in the San Juan Metropolitan Region and of land use sustainability of four other municipalities in Puerto Rico, the Center recommends the idea of smart growth

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[16] Under its Territorial Ordinance Plan, the Municipality of San Juan designates 10m of land, instead of 5m. This distinction is an important issue when decisions need to be made on whether or not to allow a construction project conflict because of its distance to rivers.

and the strategies promoted by the Smart Growth Network in the U.S., including the protection of green areas, opens spaces, and agricultural lands.

Civic actors, such as non-governmental organizations and community groups, have had a major influence in valuing and governing urban green areas over the last decade. The local community has been successful in protecting various forest patches within the dense urban area of San Juan, such as with the Bosque San Patricio (San Patricio Forest) and the Arboretum of Cupey (Cupey Arboretum). The civic sector has also developed bottom-up sustainable development plans for poor squatter communities located on the mangroves along the Martín Peña Canal, and raised awareness of the importance of reforestation in cities as a climate change prevention strategy by the Sierra Club's "Cool Cities" program. In many of these cases success resulted from alliances among local community and environmental organizations to work as one social movement in defense of public participation in the planning and decision-making regarding land use and environmental problems (Rivera Meléndez 2007).

A major milestone of community-level success in green area governance has been the formation and ultimate legal protection by law of the San Juan Ecological Corridor in 2003 with Law No. 206 (Figure 6). This law seeks to link various urban forest patches in the city, including already protected areas and private lands, to create a forest corridor for recreation, wildlife protection, and overall ecosystem health. With the collaboration of an association of sixty diverse groups, including neighborhood associations, the Alianza Pro-Corredor Ecológico de San Juan (Alliance for the San Juan Ecological Corridor), the

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PRDENR developed a plan with recommendations on properties that would become part of the corridor, including private lands that were acquired because of their location between other forest patches. The law then prohibited construction permits in this zone and orders the PRDENR to acquire these lands and manage all the connected properties. The law established a Comisión Especial del Corredor Ecológico de San Juan (Special Commission for the San Juan Ecological Corridor) made up of governmental and non-governmental entities including the Alianza, to work directly with Municipal planners and continually meet to review and develop a Conservation and Management Plan for the area (Calero 2009). This effort is not only considered transformational for the San Juan planning process due to its bottom-up approach and alliances with Municipal planners, but it was a step in improving urban quality of life through the protection of the "green lungs" of the city.

Figure 6. Map of the San Juan Ecological Corridor.

Over the last decade, the idea of sustainable development has gained prominence in the state and local political discourse. On September 10 of 2004, the Sustainable Development Public Policy (Law 267) was passed by the state legislature. Based on the conventional notion of sustainable development as defined by the Brundlant Commission[17], the objective of the law is to promote the attainment of a desirable and convenient quality of life for all Puerto Ricans; promote the harmonization of policies, programs, and related government activities; direct Puerto Rico towards sustainable development, and establish a Commission for the Sustainable Development of Puerto Rico (Seguinot-Barbosa 2011, pp. 146). The vision of the San Juan Municipality, as presented in its 2003 Territorial Ordinance Plan, also incorporates sustainable development as a guiding concept for its public policy (San Juan Municipality Planning and Territorial Ordering Office 2003, pp. 204). These policies, however, as will be discussed in later chapters, lack clear strategies and objectives for implementing sustainable development.

The governance of San Juan's green areas and visions for sustainability at state and city level, however, appear to be following divergent trends. On one hand, the city's political discourse appears to align with principles of sustainable development and the conservation of crucial watershed and green infrastructure to support long-term ecological, social and economic viability. Yet, what is happening on the ground shows a different picture. As we will see next, on-the-

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[17] Sustainable development is defined by the Commission as development that "meets the needs of the present without compromising the ability of future generations to meet their own needs (National Research Council 1987)

ground development practices continue to put the city's social and ecological communities at risk.

Development Conflicts: Paralysis or Catalysis for a Sustainability Transition?

Despite the strong environmental and natural resource legal framework in Puerto Rico, serious hurdles remain for the effective implementation and enforcement of the laws and the protection of green areas, especially those in the rural areas that were excluded from zoning activities in the 1942 Planning Law. Conflict over San Juan's remaining forests, rivers, parks, and other forms of open space in this area is on the rise (Table 2).

Table 2. Examples of conflicts between urban development projects and the protection of green areas, including open spaces, streams, forests, and coastal areas, in San Juan.

1996	Citizen protest against the cut of trees in Piñero Avenue in order to expand the street
2002	San Juan Municipality vs. Planning Board and Luis Freire Inc. - legal case over proposed development in the green areas designated for conservation under the Municipality's Territorial Ordinance Plan
2003	Quebrada Cheo Case: local community groups and neighborhood associations sue the Planning Board for allowing a development project in the rural/green areas designated for conservation under the Municipality's Territorial Ordinance Plan.
2004	Quebrada Chiclana Case: Municipality of San Juan legally confronted the PR Planning Board and PR Department of Environment and Natural Resources for allowing a housing development project that buried the Chiclana stream, placing Caimito residents at risk of land slides and flooding as a result. Exemplary case of the influence of local community groups on the Municipality's action to confront the state agencies and required that the damage be repaired by the developer.
2009	Rio Piedras community and University of Puerto Rico students and faculty protest the cut of old growth trees in the town's main plaza as part of the Mayor's plan to rehabilitate the urban core.

Many of these conflicts have taken place between the initial developments of the San Juan Territorial Ordinance Plan, described below, and the attainment of autonomy for San Juan in 2009. As previously mentioned, the Planning Board and the Permit and Regulation Authority maintained power over the permitting process while the Municipality gained autonomy. During this time, the Municipality worked with the local community to intervene legally over decisions allowed by the Planning Board, because they violated the TOP's goals of conservation. Some of these cases, such as the 2002, 2003, and 2004 cases (Table 2) involved deforestation (Figure 7) and development projects near a body of water (Figure 8).
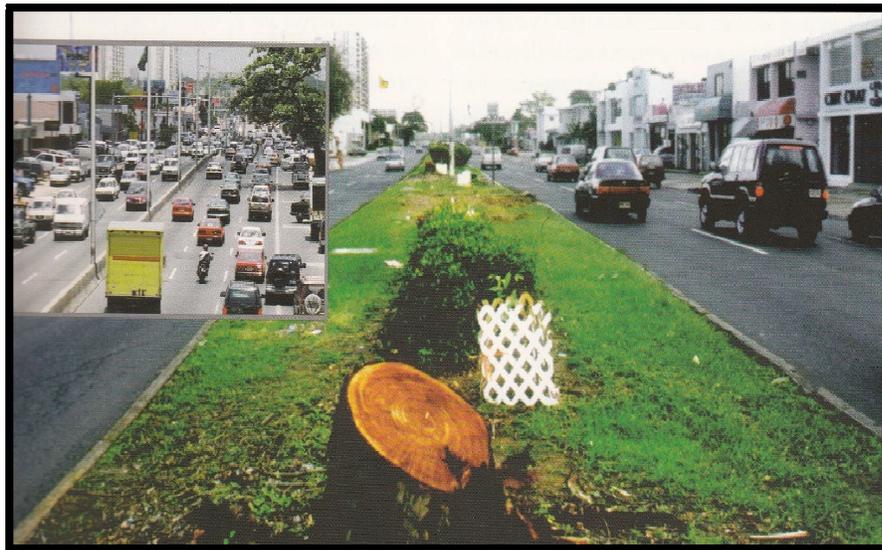
Figure 7. Image of the 1996 deforestation in a major city avenue, Piñero Avenue, that met great resistance by citizens. This event was one of the largest protests against deforestation in the city. Source: López 2002

The 2004 case of "Quebrada Chiclana" is exemplary of these local conflicts between the community and the municipality against developers and the Planning Board. The Caimito community located in the southern boundary of San Juan contested the deforestation and burial of a local creek, Quebrada Chiclana, by a large development company. Developers moved 400,000 cubic meters of earth into the river to make way for a large low-density urbanization. Community leaders, environmental groups, and the municipality questioned the authority and legitimacy of the Puerto Rico Department of Environment and Natural Resources (PRDENR) for allowing this project that put both social and environmental values at risk (Colón 2004). The community took legal action and won a four-year fight against the development company, demanding that the development company remove the land covering the river and restore the creek under guidance and monitoring of the PRDENR. Local scientists from the University of Puerto Rico are now working with community leaders to evaluate the success of the restoration efforts, and it remains to be seen whether the developers effectively carried out the restoration design, and whether the PRDENR was diligent in monitoring the process (Quiñones and Casanova 2010).

Figure 8: Burial of a local creek, the Quebrada Chiclana, by a housing development project.

The ambiguity of the planning gray zone that the 1942 Law left for rural areas has facilitated the chaotic development patterns and infrastructure that we see today in San Juan, especially in the southern parts of the Municipality. While the Board was concerned over cases of non-permitted zoning, land uses continued to convert and growth accelerated, creating a legacy of unregulated land uses that continue today. Lucilla Marvel, in her evaluation of the planning situation regarding urban expansion from the early 1960's to the present comments that,

> "Unfortunately, the conflicts of land use and consequences of urban sprawl continue today, relatively unchecked. Zoning continues to follow rather than dictate land use. Agricultural lands convert to residential and commercial uses, and newly built residential structures convert to commercial use. There is often a blatant contrast between land use permitted on the zoning maps and the actual use" (Marvel 2008, p. 44)

A key discretionary mechanism under the Planning Board that has been cited as allowing these failures in the system is the "Site Consultation" or "Consultation on Location". This is a mechanism by which the Planning Board is responsible to review and issue a decision on a case-by-case basis for developments proposed by public and private entities that are either not compatible with current zoning or are in an un-zoned area. While this mechanism should be an exception in practice, it is commonly used (Gaztambide Arandes 2008). An analysis of the Planning Board's transaction database from 1975 to 2005 revealed that 85% of site consultations were requested by the private sector and 80% of all site consultations evaluated by the Planning Board were approved. Seventy-seven percent of approved projects submitted by the private sector were residential (single family homes or lot subdivisions) (Gaztambide Arandes 2008). As shown in the map below (See Figure 9), site consultations are widespread across the island, contributing to urban sprawl.
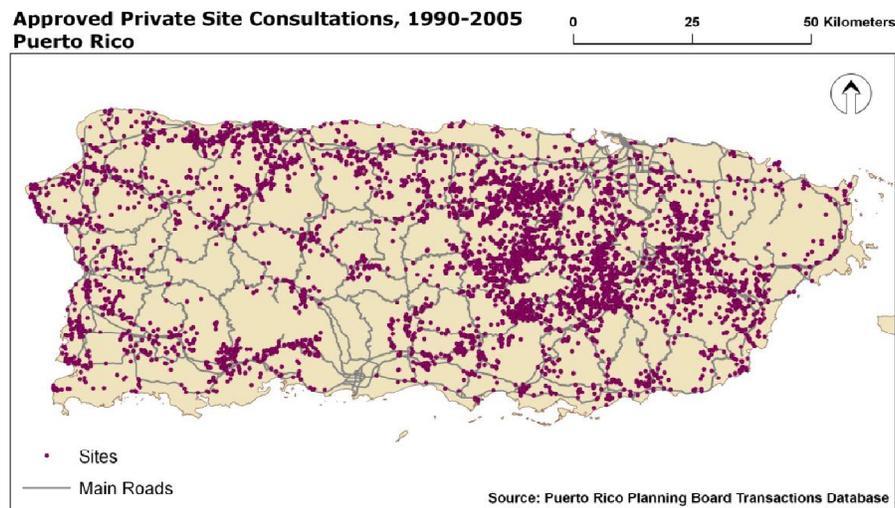
Figure 9. Map of Approved Private Site Consultations, 1990-2005. Source: Gaztambide-Arandes 2008

Preliminary research[18] suggests other factors facilitating these planning and governance failures, such as corruption in the permit process, ineffective coordination between state and city, conflicting views of what the city is and ought to be in the future, and divergent knowledge claims and expertise about the use of land in the city. The following chapters will delve deeper into these issues using the Knowledge and Action System Framework as an analytical tool to unpack the failures in urban planning that limit the capacity for the city to chart a sustainable path. But first let's first take a brief look at the official municipal vision for the future of San Juan since it is a primary focus for my assessment.

3. The Future: The San Juan Territorial Ordinance Plan - Roadmap to a Sustainable City?

Initiated in 1995 by the administration of then Governor Sila M. Calderón and approved by current Mayor Jorge A. Santini Padilla and the Puerto Rico Planning Board in 2003, the San Juan Territorial Ordinance Plan dictates the vision and goals for land use planning and social order for the city as a newly autonomous entity. With the assistance of professionals such as architects, scientists, and engineers, as well as community boards appointed by the acting major, the plan was developed by municipal planners, technicians and administrators of the San Juan Office of Territorial Planning and Ordinance. The Proyecto de Ciudad (City Project), as the vision was titled, aspires to achieve a livable and sustainable city. The overall objective of this city vision is to

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[18] Based on preliminary research I conducted in San Juan during the summer of 2008 through a Dissertation Proposal Development Fellowship (DPDF) awarded by the Social Science Research Council.

"…recover the city, make it more *livable* and for the enjoyment of all its residents: a first class city, an efficient city, clean, orderly, safe, beautiful, that serves well to those that live in it, especially those that have been marginalized" (emphasis mine) (San Juan Municipality Office of Planning and Territorial Ordinance 2003, pp. 11). The vision continues to state

> …the dreamed San Juan aspires to a vital, safe and clean city, a place for cultural and economic exchange, and promoter of the harmonious coexistence between its citizens. We aspire to a green, clean and beautiful San Juan where its ground, air and water are common resource of all. With such aim, it will be policy of the Municipal government to protect our natural and constructed patrimony, and to stimulate a healthy balance between our urban and rural ground, promoting the ordered and compact development of our neighborhoods and the intelligent infrastructure, always safeguarding the common wealth over the personal interest San Juan Municipality Office of Planning and Territorial Ordinance 2003, pp. 187).

Specifically linked to the classification of the land, the vision of the city proposed in the Ordinance Plan centers around five policies as a framework for specific strategies. The policy objectives are as follows San Juan Municipality Office of Territorial Planning and Ordinance 2003, pp. 187):

1) It is Municipal public policy to elevate the quality of life of all municipal territory making San Juan an attractive, safe, and clean place to live, work, and visit;

2) In terms of the urban land use, it is Municipal policy to revitalize, rehabilitate and repopulate its urban districts and center as a framework of community living;

3) In terms of the rustic land use[19], the Municipality will conserve its natural resources, protecting from urban development every land with special location, topography, aesthetic, archeological or ecological value, classifying it under common rustic land use or special protection land use;

4) The Municipality actively promotes citizen participation as a democratic instrument in public administration; and

5) The Municipality promotes on-site rehabilitation of economically disadvantaged communities as a mechanism to eradicate pockets of poverty, balance the distribution of development, and attend to the needs and aspirations of its most vulnerable residents.
This vision and objectives are summarized in the plan through three key

strategies (see Figures 10 and 11): revitalization, redevelopment, and

conservation of rustic lands. The plan has not only recognized the importance of

protecting green areas, including bottom-up initiatives by civic groups such as

San Patricio Forest, the San Juan Bay Estuary, and the Alliance for the San Juan

Ecological Corridor, but it specifically targets the open areas remaining in the

south of the city and in headwaters of the Río Piedras watershed. The objectives

are to protect these green areas from further urban sprawl through conservation

policies and planning strategies, including specific planning tools such as

transfer of development rights, and ten meter linear protection of open area

surrounding water bodies.   In this way, the TOP is perhaps one of the most

important planning documents guiding the future development of San Juan by

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[19] Rustic ground is the technical terminology given to the open and green areas in the Municipality. The specific objectives for this type of land use are: maintain ground free of the urbanizing process; avoid degradation of the landscape and destruction of the natural patrimony; establish measures for nonurban land use; and delimit the ground that must be protected and establish management plans for natural resources and agriculture.
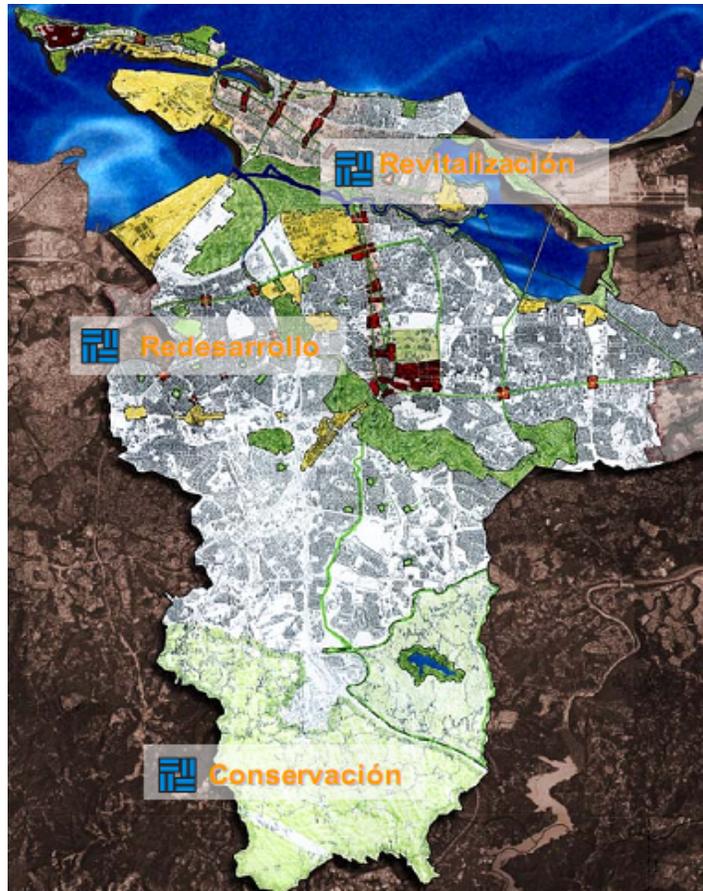
Figure 10. Map of the Municipality of San Juan with its three main strategies for urban sustainability: revitalization, redevelopment and conservation. Source: San Juan Municipality Office of Territorial Planning and Ordinance (2003)

recognizing the importance of urban green areas to the quality of life and

environmental health of the city.

The Municipality's Office of Territorial Ordinance and Planning is

currently evaluating whether these objectives were implemented during the

period between 2003 and 2009, when the permitting process was still under the

jurisdiction of the state's Planning Board. In other words, to what extent were

permits authorized where they should not have been according to regulations and

**Proyección de la Ciudad Capital
en un perfil longitudinal norte-sur**

San Juan antes del Plan de Ordenación Territorial (Figura #1)

Suelo Rústico   Suelo Urbano

San Juan con el Plan de Ordenación Territorial (Figura #2)

Conservación
de Ruralía
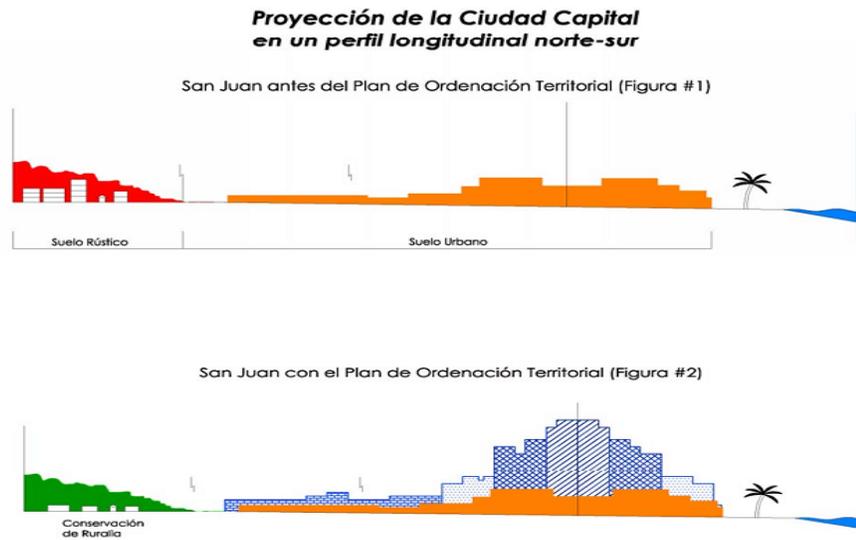
Figure 11.. Vertical projection of the city in a north-south longitudinal profile. The top figure illustrates the vertical projection of urban development (orange) in the urban soil classification and in the rustic soil classification (red) prior to the development of the San Juan Territorial Ordinance Plan. The bottom figure illustrates the strategy to promote build-up and compact urban development in the urban soil land use classification (orange with blue buildings), while protecting remaining open areas in the rustic soil classification (green) expected as a result of implementing the San Juan Territorial Ordinance Plan. Source: San Juan Municipality Office of Territorial Planning and Ordinance (2003)

what were the impacts. Municipal planners are compiling statistical data from the Planning Board (e.g. how many projects have been approved, when where they authorized and what was done on-the-ground) as well as conducting field evaluation in communities across San Juan to examine existing economic and social conditions (Rosemary Cerpa personal communication). This study will be the first to evaluate the effectiveness of the plan and its strategies and used to

assess changes for the future. [20] This evaluation will provide planners and the

public at large a window into the effectiveness of the plan, and the planning

institutions, as roadmaps to the sustainability of the city.

4.   Conclusion

In this chapter I presented a broad historical overview of the legal,

political, and social context underlying controversies over land development in

San Juan, specifically regarding the use, management, and protection of green

areas in the city (e.g., forests, open spaces, riparian areas, rivers, and mangroves).

Overall, I found that governance of San Juan's green areas and the visions for a

sustainable city appear to be following divergent trends. On the one hand, the

city's planning discourse and efforts from civic society appear to align with

principles of sustainable development and the conservation of watersheds and

green areas to support long-term social and economic viability. What is

happening on the ground, however, shows a different picture. On-the-ground

development practices continue to put the city's social and ecological

communities at risk and hamper the ability to achieve sustainability goals for the

future. There is a profound disconnect between the vision and general goals of

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[20] Because the evaluation conducted by the Municipality is based mostly on permit as well as social and economic data gathered during community visits, it will only provide a partial view of whether outcomes meet sustainability goals. A consortium of interdisciplinary researchers under the San Juan ULTRA-Ex program is conducting a parallel study using natural and social science methods to understand the socio-ecology of the Rio Piedras River Watershed. Part of this study will be using land use models to project development scenarios and their impacts on watershed functions and social vulnerability of communities surrounding green areas, one of them using the TOP classifications, as well as other scenarios reflecting potentially conflicting goals, such as further economic development, no action, or greater conservation.

the city's land use plan and the implementation of projects and tasks to carry out the plan.

After reviewing major events, policies, laws, and actors related to green area governance since the 1940's, I found several factors that begin to explain these inefficiencies in the city's planning framework towards the use of land and green areas in the city. First, the exclusion of rural areas from the 1942 Planning Law created a 'planning gray zone' that facilitated reactive development patterns and infrastructure in these areas. Today, this legacy manifests itself in a lack of clear planning and regulations for the management and protection of green areas in the city. Explicit recognition of the importance of green areas to the environmental and human health of the city did not happen until very recently with the passage of laws such as the Urban Forest Law of 1999, the Flood Prevention Policy and the San Juan Territorial Ordinance Plan of 2003, as well as bottom-up community efforts. Yet, city planners and civic actors still have to work reactively to protect remaining green areas in the city because of the lack of foresight in the planning framework as to how suburban development patterns would eventually encroach on these areas and affect their sustainability. Related to this is the gap that exists at the regional scale, another factor that affects planning of green areas in a largely metropolitan region. Regional plans were developed in the 1950's but never adopted. While today regional plans are being developed, there are no institutions at the regional level (i.e., to link municipal development locally in the San Juan area) to execute them. Coordinated efforts

remain at the state level with the Planning Board and uncertainty over their implementation remains.

Finally, failures in zoning and the implementation of plans can be also explained by three key planning inefficiencies taking place today. One is the common use of private site consultations by the Planning Board, a planning mechanism that is supposed to be used as an exemption in practice. Building housing infrastructure without permits and corruption are two other actions affecting the regulatory process. While these are very difficult to document, they are a key obstacle to implementing sustainability goals and therefore must be addressed in efforts to transform the planning process.

Despites these failures, the landscape of land use and green area governance in San Juan is changing to include a broader set of actors in San Juan, which theory suggests can broaden democracy and allow new policy directions for sustainability. Civic actors are having a greater role in the protection of green areas in the city thus expanding governance possibilities beyond the state or the city. Decentralization policies that shifts power from the state to the city is also a crucial institutional change that will affect land use planning and green area governance, but the outcomes of this remain to be seen. Future research on changes on the ground (i.e., environmental, social, and economic conditions) will be necessary establish a connection between decentralization, green area governance, and sustainability in San Juan.

The next chapters take a closer look at what role knowledge plays in this governance context, specifically in the dynamics between multiple city actors as

they share ideas and information, develop plans and visions, and deliberate

strategies for sustainability in San Juan

Chapter 4

The Urban Ecology of Knowledge:

Mapping Networks of Land Use and Green Area Knowledge in the City

1. Introduction

Knowledge dissemination and sharing plays an important role in fostering learning and innovation for sustainability. Sustainability scientists, planners, and practitioners are paying much attention to the flow of information and knowledge in governance (Cash et al. 2006; Butler and Goldstein 2010). Many scholars now recognize that the effective harnessing of science and technology for sustainable action is an outcome of networked and distributed process of knowledge dissemination, as opposed to a one-way knowledge transfer from knowledge producer to user (Roux et al. 2006; Cash 2000). Less is known, however, about the actual social processes and structures affecting knowledge dissemination, or how knowledge and information flows through multiple social actors and how these structures may be facilitating or inhibiting proper knowledge flow.

Because the process of how knowledge flows can have enormous impacts on who is able to access and make use of it (Miller 2004), it is crucial that we understand the relationship between knowledge and power, or the power asymmetries shaping knowledge networks (Crona and Bodin 2010). Furthermore, a multiplicity of sites have been identified where different knowledges (not just scientific knowledge) are being produced, contested, and

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used in the planning and decision-making process for environmental and sustainable governance (Jassanoff and Wynne 1998, Miller 2005).

To deal with this complexity, I use the tools of social network analysis (SNA). Social network theory investigates patterns of social relations among actors interlinked through social exchanges, such as information flows, resources, friendships, and other social exchanges (Wasserman and Faust 1994). This approach allows me to identify the key actors that serve as sources of knowledge, how they interact in the network, and how network structure facilitates or inhibits knowledge flow. As one aspect of the overarching framework of this dissertation – the Knowledge-Action Systems Analysis Framework – the objective of this chapter is to take a snapshot, or 'map', of the landscape of actors (organizations) involved in creating, exchanging, and using knowledge regarding land use and green areas in the city[21].

Since the way that information is disseminated through a network can have enormous impacts on who is able to access and make use of it, SNA is a useful technique to examine how power asymmetries affect the effective flow of knowledge through the system. In addition, according to Chan and Liebowitz (2006) 'knowledge mapping', or the analysis of how knowledge flows through an organization, is useful to managers and practitioners by revealing the strengths and weaknesses associated with knowledge management and sharing. In this context I use 'knowledge mapping' to illustrate knowledge flow *across*

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[21] A more detailed background on social network analysis theory and the methods employed in this dissertation can be found in chapters One and Two respectively.

organizations and reveal knowledge and information sources, sinks and constraints that may be facilitating or inhibiting how knowledge is produced and used in the city's planning and decision-making context. Specifically, I rely on SNA quantitative measures of centrality for two main objectives: 1) to identify the actors that constitute the knowledge-action system network as it pertains to land-use and green-area governance in San Juan; and 2) to analyze the influence of the network's power structure on how knowledge flows among the system's actors.

The basic question informing this chapter then is *who are the actors that make up San Juan's knowledge network, and how does their structural position and power affect knowledge flow in the network?* To examine which actors/organizations have greater influence over knowledge flow in the context of urban land use and green area governance in the city of San Juan, I began by examining the effect of the social network of knowledge flows through the following features deemed important according to theory (Hanneman and Riddle 2005): (1) the *heterogeneity,* or the diverse composition of the network, (2) its *integration* or the extent to which traditionally marginal sectors, such as civic groups, occupy central positions within the network; and, finally, (3) its *reciprocity* or how knowledge is being shared among the top central actors of the network. I then identify the central actors in the knowledge system and discuss how power asymmetries in their structural relationships influence what knowledge is more dominant and influential to decision making than others. Lastly, I present both barriers and opportunities to effective knowledge flow in

the study area system and beyond, along with implications for urban

sustainability. Beyond a conceptual analysis of the circulation of knowledge

among a particular social network, this study seeks a practical understanding of

the sources and constraints in the knowledge-action system to identify

opportunities for addressing any breakdowns in flow.

2.   Knowledge Map of Land Use and Green Area Network in San Juan.

2.1 Knowledge Boundary and Structure

The final network that emerged is composed of 26 organizations most

frequently mentioned as sources of knowledge for land use and green area

information in San Juan. The discovery of a network boundary within the survey

population reflects two important things. First, a potential downfall of the

approach I used in combining the ego and whole networks to cast a wide net of

actors is that a large number of individual organizations with little connections to

each other could emerge. In other words, I expected to have a view of the

'whole world' of organizations in San Juan without specific ties to each other.

This often happens with free-listing methods because the recall approach can

result in a large and unmanageable list of organizations due to all the possible

entities each person can recall. Nevertheless, I was still able to define a

boundary of organizations that have a key role in knowledge flow based on the

frequencies of organizations mentioned by the survey populations (see Figure 1).

Thus, even though there is a large world of organizations 'out there' involved in

environmental and land use issues in San Juan (e.g., I identified 110 and there

could be more), there is a specific set organizations that people associate as knowledge sources on land use and green area issues as evidenced by the network that emerged here.

2.2 Degree and Betweennes Centrality

     Degree and *betweenness centrality* are two useful metrics to identify the organizations that serve as central sources of knowledge and information for the rest of the network[22]. Of the 26 total organizations that make up the network boundary, six organizations serve as central actors based on in-degree and betweenness centrality. The top three central actors based on *degree centrality* included three state agencies, the Puerto Rico Planning Board (PRPB), the Puerto Rico Department of Environment and Natural Resources (PRDENR), and the Puerto Rico Environmental Quality Board (PREQB). The top three central actors based on *betweenness centrality* included once again the PRPB, as well as one federal agency and research organization, the US Forest Service International Institute of Tropical Forestry (IITF), and one local non-governmental organization, the Sustainable Development Initiative (SDI). The San Juan Municipality (SJM) fell at a mid-level of centrality which, given its autonomy and therefore more control over planning and administration of land uses, I expected to receive a higher measure. At the opposite extreme are the actors with the lowest level of power, or low in degree and betweenness centrality. Excluding those

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[22] A more detailed explanation of metrics and data used for this analysis can be found in Chapter Two.
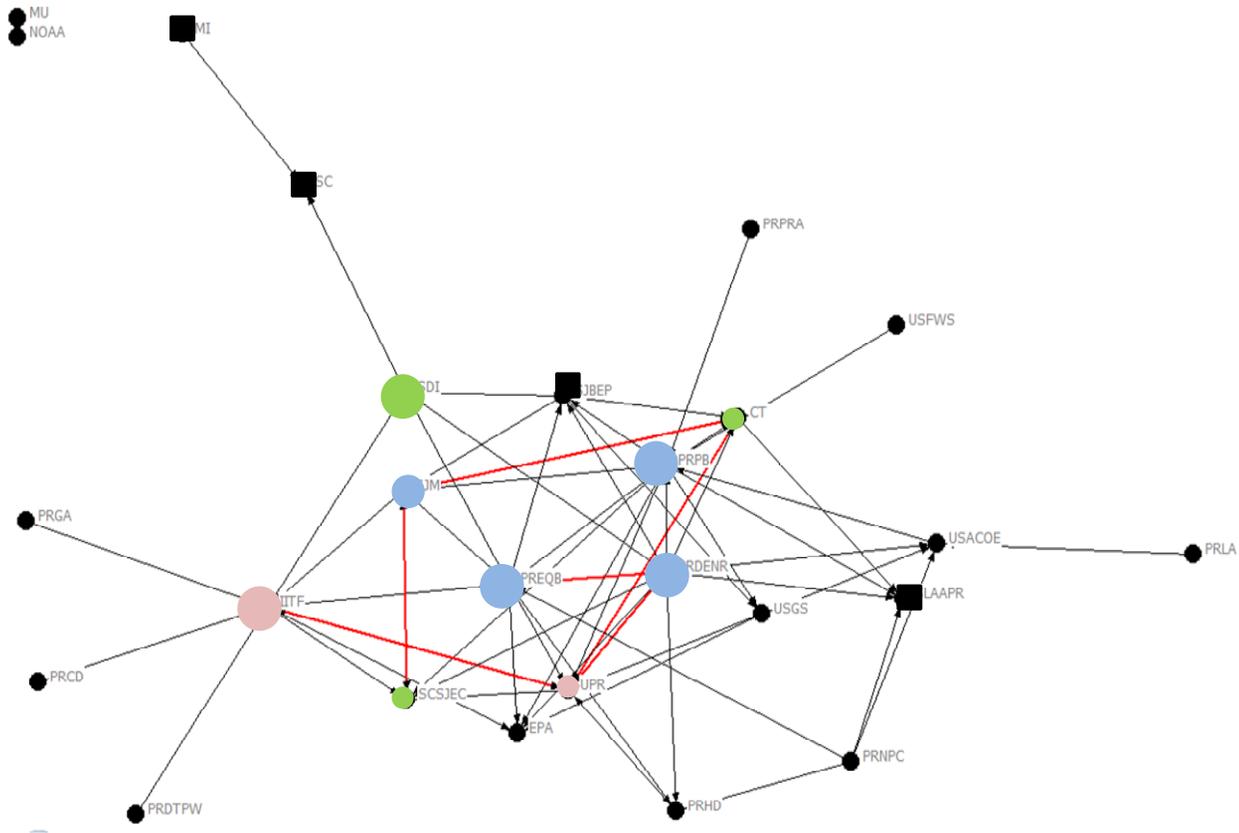
Figure 1. Visual depiction of the knowledge network. *Nodes* represent the organizations and the *lines* represent the flow of knowledge and information (with the direction of the arrow indicating the direction of the flow). The *red lines* represent the bi- directional ties (reciprocity). The nodes in color indicate central actors in the network (*blue* color indicates local or state agency, *green* color indicates local NGO, and *pink* color indicates research/academic institution),

with the larger colored nodes indicating central actors with highest degree and betweennes centrality. Black squared-shaped nodes indicate non-governmental organizations (NGO's), and black circle-shaped nodes indicate governmental agencies.

nodes that only have one link (because they did not answer the question or the survey[23]), those with lowest centrality[24] include: the Sierra Club (SC), a U.S.-based non-governmental organization; the School of Architects and Landscape Architects of Puerto Rico (SALAPR), a local professional non-governmental organization; the Puerto Rico National Park Company (PRNPC), and the Puerto Rico Housing Department (PRHD). The Sierra Club and the School of Architects and Landscape Architects of Puerto Rico did not self-identify themselves as knowledge producers, which is then consistent as having fewer links from others seeking knowledge from them.

2.3 Heterogeneity

The final knowledge network that emerged is composed of a diverse set of stakeholder organizations. Network *heterogeneity*, calculated by the ratio of the 26 different organizations in this network to the composition of the initial survey population (n=110), shows that the mapped knowledge network comprises twenty-five percent of total organizations. Table 1 shows the 26 different organizations that comprise the network boundary. Most of the institutional types represented in this network are of bureaucratic type (governmental), followed by civic (NGOs), and, lastly, scientific institutions (universities and research organizations). Specifically, as

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[23] Details on how these organizations made it to the network and the implications of the absence of their responses to the analysis can be found in Chapter Two.
[24] Values b for in-degree centrality and between 1 and 4 for betweenness centrality

Table 1. Actors (organizations) that make up the knowledge network boundary for land use and green area management in San Juan. Central actors have the greatest **Degree centrality** value, or greatest number of links indicating power or control over information flow, and **Betweennes** value, or the extent to which other nodes have to through a particular node to get to others. Finally, actors that are engaged in two-way interaction of information flow, or **Reciprocity,** are also considered central actors in the knowledge flow network.

Sector	Organization	Degree	Betweennes	Reciprocity	Scale of Influence	Knowledge Producer
Federal Government	**IITF** - International Institute of Tropical Forestry, Forest Service	9	67.608	UPR	federal	yes
	USACOE - Army Corps of Engineers	5	24.632	none	federal	yes
	EPA - Environmental Protection Agency	5	7.536	none	federal	yes
	USGS - Geological Survey	5	3.793	none	federal	yes
	USFWS - Fish and Wildlife Service	1	0	*NA*	*NA*	*NA*
	NOAA - National Oceanic and Atmospheric Administration	0	0	*NA*	*NA*	*NA*
State Government	**PRPB** –Planning Board	14	74.482	none	state region	yes
	PRDENR - Department of Environment and Natural Resources	11	28.449	UPR, PREQB	state	yes
	PREQB - Environmental Quality Board	10	29.043	PRDENR	state	yes
	PRNPC - National Park Company	4	4.024	none	*NA*	*NA*
	PRHD - Housing Department	4	0.932	none	state	yes
	PRPRA - Permit and Regulation Authority	1	0	*NA*	*NA*	*NA*
	PRDTPW - Department of Transportation and Public Works	1	0	*NA*	*NA*	*NA*
	PRGA - General Archive	1	0	*NA*	*NA*	*NA*
	PRCD - Commerce Department	1	0	*NA*	*NA*	*NA*

	(Census)					
	PRLA - Land Authority	1	0	*NA*	*NA*	*NA*
City Government	**SJM** - San Juan Municipality	6	7.55	CT, SJEC	City	Yes
	SCSJEC -Special Commission for the San Juan Ecological Corridor	5	4.914	SJM	city	*NA*
Academic/ Research	**UPR** - University of Puerto Rico	8	16.487	CT, PRDENR, IITF	state	yes
					city	
					watershed	
					neighborhood	
	MU - Metropolitan University	0	0	*NA*	*NA*	*NA*
Non- Governmental Organizations	**SJCEP** -San Juan Bay Estuary Program	7	4.933	none	city	yes
					watershed	
					Region	
	SDI – Sustainable Development Initiative	6	47.848	none	state	no
	CT - Conservation Trust	6	2.338	UPR, SJM	state	Yes
	SLAAPR – School of Landscape Architects and Architects of Puerto Rico	4	2.432	none	state	no
	SC - Sierra Club	2	22	none	state	no
	IM – Industrial Mission	1	0	*NA*	*NA*	*NA*

shown in the *Attributes of Nodes* column, the knowledge network is composed mainly

of governmental (six federal and ten state) and non- governmental organizations (six),

as compared to only three city and two academic/research institutions. Finally, of the

fifteen organizations that specified whether they collect and produce their own information internally, twelve answered yes (80% of the network nodes[25]), including three NGOs.

2.4 Integration

A heterogeneous network also accounts for the various functions and roles that actors have in supporting and having power over knowledge flow in the network. Therefore, it is important to understand the level of social integration in the network to assess whether the diverse composition and its hierarchy is also meaningful in terms of function of the network. Social integration here refers to the extent that minority groups have central positions in the network (Parker 2006). This knowledge network includes civic organizations as central actors and therefore exhibits social integration.

At least 27% are civic organizations (n=6) engaged in knowledge flows and three of these NGO's (the Sustainable Development Initiative, or SDI, the Conservation Trust, or CT, and the Special Commission for the San Juan Ecological Corridor, SCSJEC) are key actors in the network because they have high betweenness centrality (Sustainable Development Initiative) or are part of group of central actors in knowledge sharing (Conservation Trust and Special Commission for the San Juan Ecological Corridor). It should also be noted that other NGOs exhibit important roles in the network even though they did not fall in the top three. For instance, San Juan Bay Estuary Program, a consortium of multiple stakeholders overseeing the management, implementation and restoration of the San Juan bay estuary, as well as

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[25] This number excludes organizations mentioned by others but that did not complete the survey. Therefore, I lack information as to whether they produce knowledge internally. I have indicated these cases in Table 1 with ' – ' next to the organizations that lacks information.

producing knowledge related to the hydrology and ecology of the estuary, also had high in-degree centrality in the network.

2.5 Reciprocity

Through the measure of *reciprocity*, or the presence of bi-directional linkages between nodes, the influence of key actors to knowledge flow can be evaluated (Hanneman and Riddle 2005). In this case, a small but diverse set of actors engage in bi-directional flow of knowledge, hence information sharing. Seven of the twenty-six organizations share knowledge, three of which also have high degree centrality, including the Puerto Rico Department of Environment and Natural Resources, the Puerto Rico Environmental Quality Board, the International Institute of Tropical Forestry, the University of Puerto Rico (Río Piedras), the San Juan Municipality, and the Conservation Trust (Figure 2). The University has a greater number of links than the other nodes, and therefore, also has a higher probability of bi-directional linkages, or reciprocity, with others in the network. Finally, while not a central actor, the Special Commission of the San Juan Ecological Corridor, a local collaborative civic entity, is also engaged in bi-direction knowledge flow.

3.   Discussion

3.1 Power and Influence of Actors

How knowledge flows in San Juan's knowledge-action system is the central concern of this chapter. Previous research on knowledge systems networks in agriculture and fisheries sectors only look at a handful of research or government institutions engaged in the production of policy-relevant knowledge, such as
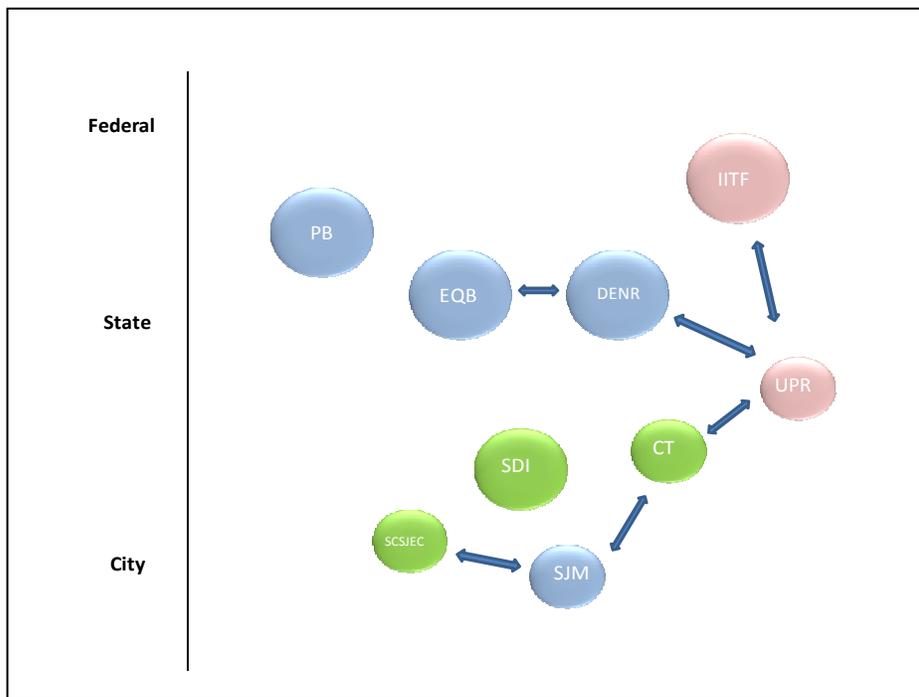
 Figure 2. Detailed picture of the central actors that dominate knowledge flow (larger circles) and the actors that reciprocate knowledge.   IITF: International Institute of Tropical Forestry; PB: Puerto Rico Planning Board; EQB: Puerto Rico Environmental Quality Board; DENR: Puerto Rico Department of the Environment and Natural Resources; UPR: University of Puerto Rico; CT: Conservation Trust; SJM: San Juan Municipality; SDI: Sustainable Development Institute; SCSJEC: Special Commission for the San Juan Ecological Corridor. *Blue* color indicates local or state agency, *green* color indicates local NGO, and *purple* color indicates research/academic institution.

agricultural experimental stations or scientific centers (for instance, Cash et al. 2003).

Through an emergent approach I found a much more heterogeneous and complex

landscape of knowledge in the city. In the context of urban land use and green areas in

San Juan alone[26], twenty-six different organizations were found to be involved in

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[26] As part of this study I also collected information on the knowledge networks supporting urban environmental issues in general and preliminary results show that the actors of the network are different

knowledge production and circulation, of which nearly a quarter were non-governmental and non-scientific research entities. Most of the organizations in the network collect their own data, information or knowledge, suggesting that they have a role as knowledge producers and not just recipients of information. While organizational diversity provides strengths for the knowledge flow and capacity of San Juan actors to address the complexity of sustainability in land use, it is the structure underlying this diversity that most influences the social mechanisms and capacities to influence development (Ernstson, Sorlin, and Elmqvist 2008).

Figure 2 illustrates the structure of the actors with highest degree and betweenness centrality (hereafter referred to as central actors), as well as reciprocity, in the knowledge network of San Juan. The high centrality of a few key actors, and the lack of reciprocity among some of them, shows that power asymmetries and fragmentation of knowledge flow are evident and could potentially be constraining capacities for urban sustainability in San Juan.

As the actors with highest centrality in the network, the Puerto Rico Planning Board, the Puerto Rico Department of Environment and Natural Resources, the Puerto Rico Environmental Quality Board, the International Institute of Tropical Forestry, and the Sustainable Development Initiative, serve as the main sources of knowledge on land use and green areas for the city of San Juan. The presence of the three state's agencies is not surprising given their jurisdictional roles in planning, approving, and

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depending on the subject. Therefore, actors do differentiate knowledge sources specifically regarding land use and green areas in the city from knowledge sources from environmental issues in general. Although not included in this study, these preliminary results further highlight the complexity of urban knowledge-action systems by suggesting that there are multiple knowledge-action systems relevant to urban sustainability.

regulating land development and green area management at both city and state levels. As a research institution focused on basic and applied knowledge of forestry issues, it is not surprising either that International Institute of Tropical Forestry serves an important source of land use and green areas knowledge in the network, and as I will discuss later on, also functions as a knowledge broker linking diverse nodes in the network. Similarly, as an NGO that works with multiple other organizations, the high-betweenness centrality of the Sustainable Development Initiative, and its role also as a knowledge broker, was to be expected, a point that will be discussed further later on. A surprising result from this analysis is the secondary role that the University of Puerto Rico – Río Piedras Campus (UPR – RP) plays as a source of land use and green area knowledge in San Juan, despite its reputation as the leading education and scientific research institution in San Juan and in Puerto Rico. This may be a result of a conventional perspective (and boundary making efforts by the university) that as an academic institution the university should be separate from the social and political spheres to produce basic scientific knowledge.

The importance of these actors' central position in the network is that other actors highly depend on them as key sources of knowledge and not solely based on their administrative functions. In this way, they have more influence over information flows (Brass and Brukhardt 1993) and they are highly likely to become opinion leaders in the network. In an analysis of knowledge network structures for a rural fishing community, Crona and Bodin (2010) show that opinion leaders—that is, individuals in powerful positions that hold a comparative advantage in transmitting their opinions to others—exist from the perspective of the actors' central position, and

more importantly, that these opinion leaders demonstrated little knowledge about the declining status of the fisheries. The implications of these five central actors being opinion leaders in the San Juan knowledge network is not only their important role as sources of information, but that they have influential power over the knowledge, ideas, and beliefs of the information that is circulating through this network. Crona and Bodin (2010) site Adger et al. (2005) stating that "more powerful actors can tilt the playing field [in resource management institutions] such that information and knowledge are further skewed in their favor." In other words, the expertise, or knowledge with authority, of these actors are likely having greater influence over the planning and decision-making landscape in San Juan.

3.2 Knowledge Hierarchies

Because an organization's epistemic culture can influence how conducive the organization is to accepting new information (Choo 2007; Miller, Muñoz-Erickson, and Monfreda 2010), the extent that new information can enter the network is related to the network's expertise structure as well. Nieusma (2007) refers to this hierarchically ordered authoritative structure of diverse expertise as knowledge hierarchies. Knowledge hierarchies can exclude the participation and inclusion of some relevant knowledge domains in the decision-making process, thereby precluding the possibility of integrated planning for sustainable development. As Nieusma (2007, pp. 42) argues, "the existence of knowledge hierarchies creates barriers for effective integration of diverse knowledge domains by linking knowledge authority to institutional power rather than relevance to the problem at hand." Therefore, it is important to understand the expertise domains in various levels of the hierarchy to

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understand which knowledge counts (higher level) more than others, and to what extent this knowledge is effectively addressing land use and green area issues for the sustainability of San Juan.

The knowledge hierarchy, as shown in Table 2 and Figure 3, in San Juan shows that the fields of planning (e.g., economic, physical, and urban), natural sciences, environmental administration, and law, have greater authority in the land use and green area governance landscape than more socially-oriented fields and/or areas of knowledge, such as social sciences, community organizing, and local knowledge. While there is wide-ranging expertise in this hierarchy, the dominant expertise in the network can be characterized mostly by objective, positivistic, and technological epistemologies, or *technocrat rationality*. Alternatively, the fields with lesser authority are more closely aligned with a *cultural rationality* that is post-positivist, humanistic, and more context or experiential oriented (Fisher 2000). The dominance of a technocratic rationality over cultural rationality on how environmental problems are framed, researched, and managed, has been well theorized and documented (Scott 2005; Agrawal 2005; Functowiz and Ravetz 1993; Jasanoff and Martello 2004).

In the case of San Juan it is not surprising that fields such as planning and environmental-based natural sciences are dominating the knowledge network since these are the areas that have traditionally paid more attention to producing such knowledge concerning land use, and now green area protection. Yet, the fact that fields associated with cultural rationality populate, albeit to a lesser extent, this knowledge hierarchy is a positive quality of the network for addressing complex development problems and building capacity for sustainability. For instance, the

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presence of two NGOs, the Sustainable Development Initiative, and the Conservation Trust, as well as a local collaborative created by law, the Special Commission for the San Juan Ecological Corridor, is indicative that civic organizations are finding ways to integrate themselves and influence the dominant discourse.

The presence of local collaborative organizations and NGO's serving central roles in the overall structure and flow of this network supports previous observations that these actors are increasingly more engaged in knowledge production and circulation in addition to their political role in environmental governance and as recipients of information (Eden, Donaldson and Walker 2006). Furthermore, the fact that the Conservation Trust and the Special Commission for the San Juan Ecological Corridor are reciprocating with central actors is a also a sign that they are helping expand network linkages. The Conservation Trust is well-known for its education and outreach efforts and they are now developing a citizen science program with over 500 volunteers, thereby interacting with a large civic network concerned with these issues.

The Special Commission for the San Juan Ecological Corridor includes a diverse set of stakeholders, from governmental to neighborhood associations, in the planning and execution of the San Juan Ecological Corridor[27], which serves both political and knowledge sharing function. Network theory suggests that the integration of a diverse set of actions opens up opportunities for creativity and innovation in a system. Because network integration is important to help minimize the

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[27] The Puerto Rico Department of Environment and Natural Resources (PRDENR) is ultimately the administrator of the lands within the San Juan Ecological Corridor, most of them which are still in private ownership. There is a plan for acquiring, but these lands are still vulnerable to changes in legislation and therefore could still be developed (Pablo Calero, President SCSJEC President, personal communication).

Table 2. Expert knowledge domains for the central actors in San Juan's land use and green area knowledge network.

Sector	Organization	Expert Knowledge Domains
Federal Government	International Institute of Tropical Forestry, US Forest Service (IITF)	forest specialists, natural sciences, social sciences
State Government	PR Planning Board (PB)	planning, public relations, engineering, architecture, natural sciences, social sciences, social work, environmental technician, economics, law, information system technology, public policy, programming, librarians
	PR Department of Environment and Natural Resources (DENR)	natural sciences, planning, forest specialist
	PR Environmental Quality Board (EQB)	environmental planning, administration
City Government	San Juan Municipality (SJM)	administration, engineering, architecture, social sciences, planning, environmental technician, information systems technology.
	Special Commission for the San Juan Ecological Corridor (SJSJEC)	community organizing, administration, public health, natural sciences, planning law, public policy
Academic/ Research	University of Puerto Rico (UPR)	administration, education, natural sciences, environmental technician, information system technician, community organizing, architecture, environmental management, social sciences, social work, planning, law
Non-Governmental Organizations	Sustainable Development Initiative (SDI)	community organizing, natural sciences, planning, economics, law
	Conservation Trust (CT)	public relations, environmental management, business management, natural sciences, environmental technician, forest specialist, law, information systems technology education
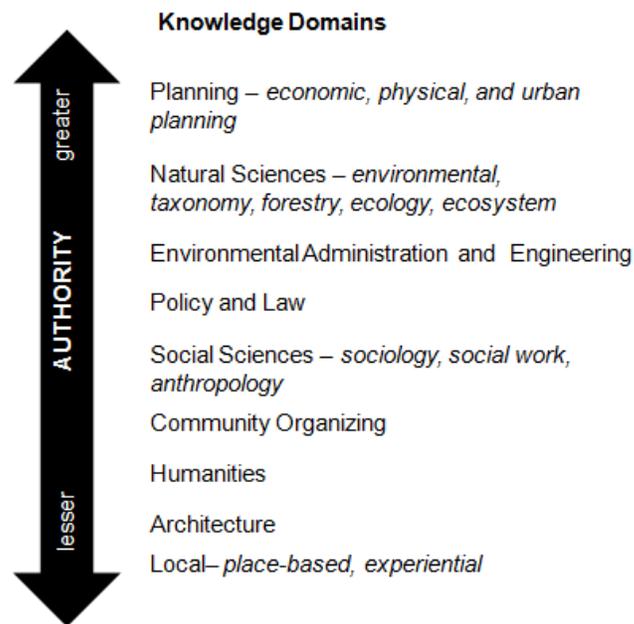
Knowledge Domains

Figure 3. Knowledge hierarchy in the San Juan land use and green area knowledge network. This figure is inspired by a knowledge hierarchy in Nieusma (2007) and constructed based on the knowledge domains of the central organizations of the knowledge network in San Juan (i.e., knowledge domains from organizations with greater centrality, betweenness and reciprocity, have greater authority in this context).

potential for homophily, or the adoption of similar ways of thinking by a group, the presence of marginal groups may allow different knowledges and perspectives to enter the network and facilitate epistemic pluralism, the view that different ways of knowing are necessary to understand complex problems (Healy 2003; Miller and Erickson 2006; Miller et al. 2008)

As many have argued before (Scott 2005; Wynne 1998; Giampietro 2001) the social perspectives, community organizing capacities, and local/tacit knowledge that these marginal groups contribute are crucial knowledge domains for sustainability and therefore should serve greater roles in building knowledge capacities. Yet, the

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presence of these groups is not enough to actualize these potentials as their structural

position. The extent to which central actors can be effective at circulating their

expertise and influencing the pool of knowledge in this network, however, ultimately

depends on the linkages of the actors and how conducive is the structure of the

network for information to flow to multiple actors.

3.3 Barriers to Knowledge Flow

Connections across scales, or multi-scale networks, are vital for addressing

mismatches between governance and ecological processes (Ernston et al. 2010), as

well as the development and dissemination of innovative approaches in natural

resource management. For instance, Butler and Goldstein (2010) suggest that

multiscalar collaborative networks can overcome 'rigidity traps'—or a resistance to

novelty and innovation— through the circulation of new ideas and strategies. In San

Juan's knowledge network there is a divided cluster at the state and local level. In

other words, state knowledge is staying at the state level and city knowledge is staying

local. If we 'zoom-in' on the constellation of actors that are engaged in a bi-direction

flow of knowledge and information (Figure 2), we see that the network's most central

actor, the Puerto Rico Planning Board, is not engaging in two-way flow of information

with other central actors in the network. The specific sources of knowledge for the

Puerto Rico Planning Board's include federal agencies (US Corps of Engineers and

US Fish and Wildlife), state agencies (Puerto Rico Department of Natural Resources

and the Puerto Rico Permit and Regulation Authority) and the city (San Juan

Municipality). Of these agencies only two, the Puerto Rico Department of

Environment and Natural Resources and the San Juan Municipality, completed the

survey so it may be that the Planning Board does engage in knowledge sharing with

the other federal and state agencies but this is not reflected because of the absence of

data from these agencies. The Municipality and the Puerto Rico Department of

Natural Resources, however, did not identify the Puerto Rico Planning Board as a

source of knowledge. There is also a cluster of two state agencies exchanging

information that is not connected to a local cluster composed of the Municipality and

two NGO's.

The lack of reciprocity between these primary agencies responsible for

planning and making policy decisions for land use and green areas in San Juan is

concerning. The exchange of knowledge flow between these organizations is vital for

knowledge-action systems to function properly, but this gap may be hampering

effective governance and potentially sustainable outcomes. As others have noted,

degree of connectivity is not only crucial for integration and social learning between

state and local actors in urban ecosystems (Ernston et al. 2010), but it can actually

influence the effectiveness of the municipal governance system (Andersson 2004).

Furthermore, there are also actors who *did not* make the network boundary and

therefore are not perceived as sources of knowledge, including community-based

groups (e.g. neighborhood councils) and the industrial and private sector (e.g.

developers, financial institutions, and other businesses)[28]. These results are surprising

in the context of San Juan given the increasing alliances that these communities

groups are making with environmental groups (Riveral Meléndez 2007). Perhaps it is

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[28] Organizations from these sectors did complete a survey and are part of the final sample of
organizations (n=110), but were not identified by others as sources of knowledge on land use and green
area issues.

through the relationships to other central actors in the network (e.g., Conservation

Trust, Sustainable Development Initiative, and the Special Commission for the San

Juan Ecological Corridor) that this local knowledge is getting through the system.

Similarly, key stakeholders and sources of local and practical knowledge

regarding land use development are the building and financial industries. While these

entities may not be engaged in knowledge production themselves, they have great

influence over what happens on the ground (decisions over how to move the land, how

to build, etc.), as well as at the national level (through professional organizations,

lobbying, etc.). Organizations such as the Home Builders Association of Puerto Rico

are very engaged in the development discourse at the city and state level. Also, as the

entities that support many of the development projects, banks and other financial

institutions are key stakeholders in land use and green area management and serve as

important knowledge systems as to how land should be used. Research on the

agricultural knowledge system in Mexico has shown that loan institutions have greater

influence over decision-making than science at the individual farm scale (Matson

2006).

Network theory suggests that these breakdowns in the network's information

flow can be addressed through the role of network brokers. This is where the role of

the actors with high-betweennes centrality—Puerto Rico Planning Board, International

Institute of Tropical Forestry, and the Sustainable Development Initiative — is crucial

to reaching groups that would otherwise not be in direct contact with each other

because brokers carry many exclusive links. In the context of natural resource

management and planning, knowledge and scale-crossing brokers are considered one

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of the most important structural roles for social and institutional entrepeneurialship because these broker can gain access to many pieces of group specific information captured inside different groups and across different scales, thus allowing them to synthesize a large knowledge pool (Bodin, Crona and Ernston 2006, pp.58). The fact that the relationship between central actors is not closed – since there are no three organizations only tied to one another suggests that there are opportunities for new knowledge to flow in and outside the network through these brokers.

3.4 Boundary Spanning Opportunities

As an actor with high-betweeness centrality and through its work as a local NGO, for instance, the Sustainable Development Initiative can serve as a broker in the network by helping connect other non-governmental entities to the network, such as other NGO's or community groups, and help them receive knowledge that otherwise they would've not received. Because Sustainable Development Initiative's mission is to develop and promote a socially and environmentally sustainable vision for the Island through planning and policy-making, it could be an important link for the diffusion of policy-relevant knowledge across multiple institutional and spatial scales. However, Sustainable Development Initiative is not engaging in two-way information flow with other central actors, therefore, as the Puerto Rico Planning Board, it needs to increase its connectivity to other actors in order to actualize its potential as a broker.

Other actors, through their role in reciprocity of information, can also serve as knowledge and scale-crossing brokers. The interaction of the Municipality with local NGO's is encouraging, as well as the mutual interaction between the university (University of Puerto Rico) with NGO's (Conservation Trust), the state (Puerto Rico

Department of Environment and Natural Resources) and a federal research institutions (International Institute of Tropical Forestry). The university also has potential to also serve as a multi-scale broker because its scale of influence spans multiple social and ecological scales, including the city's watershed (see Table 1).[29]

To address the power asymmetries and connectivity gaps in San Juan's knowledge network, and to build innovative and learning capacities for land use sustainability in the city, it is important then to improve the degree of connectivity between central actors. Specifically, the connection between those actors that have the greatest potential for serving as knowledge and multi-scale brokers — including the Puerto Rico Planning Board, International Institute of Tropical Forestry, the San Juan Municipality, the Sustainable Development Institute, and the University of Puerto Rico — is crucial to help integrate and synthesize a variety of epistemological and scalar knowledge. Collaboration among these nodes is an important source of creativity and capacity of the network in addressing urban sustainability.

Various institutional models for facilitating these linkages in sustainable development have been proposed in the literature, such as boundary and bridging organizations (see for instance Cash et al. 2003, Brown 1991). The specific institutional arrangements that would facilitate this collaboration in the context of San Juan is beyond the scope of this chapter. The following chapters, however, will demonstrate the complexity of cultural and institutional factors that are at play in this

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[29] It is important to note the caveat here that because the UPR is represented by two departments/organizations, the Institute for Tropical Ecosystem Studies and the Rio Piedras Urban Action Center (CAUCE), the number of potential linkages is double that of the other actors.

network and that may present barriers to the design of institutional arrangements drawn from theory.

4. Conclusion

Knowledge flow across multiple epistemologies and spatial scales is crucial to build innovation and adaptive capacities for sustainability. Through its capability of analyzing relations among actors, social network analysis is a useful tool to map knowledge flows in a given network and to determine how flow is affected by the network's structure and actor interactions. By mapping the flow of land use and green area knowledge in the city, I show how the governance landscape of the city San Juan is not reaching its full potential for innovation and capacity to address sustainability. Certainly the knowledge network in this context exhibits properties that can enhance land use planning capacities, including diversity of knowledge and social integration. The potential of these network properties, however, are hampered by knowledge hierarchies and breakdowns in knowledge flow. To address these weaknesses in the knowledge network and increase connectivity, interaction and collaboration among state and local actors working in the context of urban land use and green area planning and management must improve.

Overall, in this chapter I call attention to the complexity of knowledge in the context of the cities and stress the importance of examining the actor's structural position to understand how and what kind of knowledge, is having greater or lesser influence in the governance landscape. Previous assumptions of knowledge systems present them as a simple interaction of knowledge dissemination between knowledge producers and users. Yet, through social network analysis it is evident that the content

and hierarchy of knowledge, as well as who is linked to whom, can have a great effect on how knowledge systems work in a given place. Scientists, planners, and practitioners working towards building capacities for urban sustainability would benefit greatly from this context-based understanding of knowledge networks in the city.

Chapter 5

Envisioning the Sustainable City:

Convergence and Divergence in Urban Visions and Epistemic Cultures

5.1 Introduction

In addressing sustainability it is important to recognize that humans are not passive agents or victims to environmental changes, but rather, that they actively construct, adapt, and frame the development patterns and futures of society (McLaughlin and Dietz 2008, Norton 2005, Swart, Raskin and Robinson 2004). Complex and networked systems such as cities inevitably bring a plurality of perspectives, visions, and expectations that may be incommensurable and result in conflict (Lewicki and Gray 2003). To make sense of these plural perspectives and to help inform how trade-offs in sustainability options can be evaluated, it is crucial to understand the shared ways that diverse groups conceive of the world, along with their expectations and future visions for the city. Collectively envisioning and developing scenarios and expectations of what the city could and should be — or an imaginary (Taylor 2002, Jasanoff 2005) — can help build community and identity in the process of transitioning to sustainability (Wiek and Iwaniec 2011).

Given this context, understanding peoples' future visions are crucial to deliberating over sustainability problems, conducting sustainability science, and implementing solutions or strategies for the future (Wiek and Iwaniec 2011, Norton 2005). In other words, building the innovative capacity and the tools and processes to envision the future city largely depends on understanding what a city means to its

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inhabitants - how they *talk* about it, how they *know* it, and how they *imagine* it. In this chapter I specifically focus on the future visions and epistemic cultures as part of the larger knowledge-action systems analysis framework used in this dissertation to understand how knowledge systems work in imagining and building sustainable cities. The objective is to understand how the sustainability of the city is being defined and envisioned by the actors in San Juan's land use governance network now and into the future.

To examine what are the most dominant epistemic cultures in San Juan, I began with the central actors or organizations identified through the social network analysis described in Chapter Four. The rationale for describing the epistemic cultures based on the network's central actors is that given the power these actors hold over knowledge flow across the network, their knowledge, visions, and ideas regarding urban land use issues are dominant over the rest and thus have greater influence in the construction of visions and imaginaries for San Juan. In addition, because the knowledge network includes civic organizations, social groups that are traditionally marginal to knowledge production and governance are represented, I felt confident that a diverse range of ways of knowing are being captured, or represented, within the epistemic cultures described here. Where appropriate I include examples from other actors or organizations that share a similar epistemic culture to reflect the broader public discourse. Information for this study derived mainly from content analysis of qualitative data collected through surveys, interviews, and participatory observation,

augmented with documents, such as organizational publications, planning documents, and various media sources, including newspapers, and websites[30].

The paper is divided into four sections. First, I describe each of the future visions identified for the Municipality of San Juan. In particular, I identified four different visions co-existing in San Juan: 1) the Economically Sustainable City; 2) the Modern City; 3) the Livable City; 4) the Ecologically Sustainable City. In the second section I analyze the differences and similarities of each vision and the role that the ways of knowing and practices supporting each vision, or *epistemic cultures,* have in shaping how the city is seen by different social actors. Here I discuss four epistemic cultures that overlap with the visions in the respective order: 1) bureaucratic-planning culture; 2) bureaucratic-aesthetic cultures; 3) civic-stewardship culture; and 3) scientific-managerial culture. Finally, I conclude with a discussion of the deficiencies in the visions and epistemic cultures that are an obstacle to building a shared imaginary of sustainability for the city of San Juan.

5.2 Future Visions of San Juan

This section describes each of the four visions that emerged from analyzing the dominant actors and public discourse in general. Table 1 summarizes each vision based on the goals and values, overall strategies, spatial and temporal scales, procedure to generate the vision, and the actors that overlap with each vision. Figure 1 shows how the main future visions overlap with the key actors in the San Juan land use and green area governance context. It is possible to appreciate the diversity of this institutional landscape, and the challenges it poses to building knowledge-action

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[30] Please refer to Chapter Two for a more detailed description of methods and analysis.

systems that can provide integration, anticipation, and reflexivity to evaluate the outcomes and trade-offs of all these desired futures. None of these categories presented here 'map' precisely unto one another or a specific central actor in the San Juan governance context. The categories are not distinct and static, but rather they are dynamic and their boundaries are porous. By this I mean that the various actors could share the same vision or similar epistemic cultures depending on the issue, changes in time, and external forces (e.g., political economic change). Therefore, even an analysis of visions and epistemic cultures must be iterative and reflexive as time goes by and the city changes.

San Juan the Economically Sustainable City

The Puerto Rico Planning Board (PRPB) recently released its strategic vision for development in Puerto Rico, entitled *Integrated Plan for Strategic Sustainable Development* (Plan Integral de Desarrollo Estratégico Sostenible – PIDES PR). This plan outlines the vision for Puerto Rico's development over the next 20 years under three main pillars of development: economic development, urban-environmental development, and social development. The vision, referred to as "Puerto Rico: the big picture" (*Puerto Rico en Grande*), seeks to make the Island competitive in a globalized world and is based on three fundamental principles: "better quality of life for all citizens, a healthy
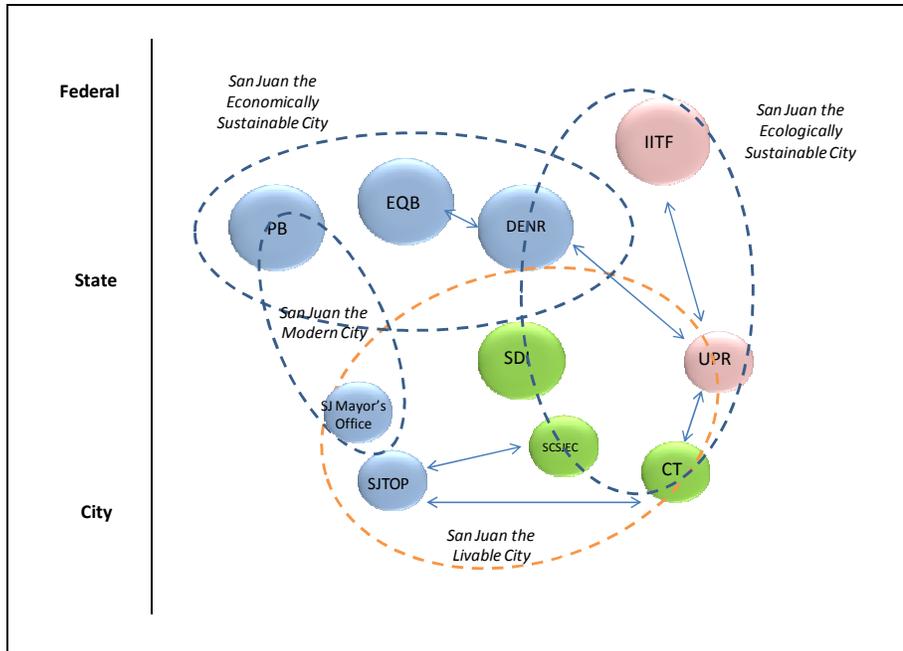
Figure 1. Detailed picture of the central actors in the knowledge network of San Juan and their future visions of the city.   IITF: International Institute of Tropical Forestry; PB: Puerto Rico Planning Board; EQB: Puerto Rico Environmental Quality Board; DENR: Puerto Rico Department of the Environment and Natural Resources; UPR: University of Puerto Rico; CT: Conservation Trust; SJM: San Juan Municipality; SDI: Sustainable Development Institute; SCSJEC: Special Commission for the San Juan Ecological Corridor. Blue color indicates local or state agency, green color indicates local NGO, and purple color indicates research/academic institution. Circles with dash lines represent the different future visions that these actors share. The circle with the orange dash line represents the *Livable City* vision and how it overlaps with all the other visions.

Table 1. Summary of the characteristics of each vision for the future of San Juan.

Elements of Visions	Economically Sustainable City	Livable City	Modern City	Ecologically Sustainable City
1.Goals and Values	Economic growth for the region and Island	Quality of life; vital and safe; clean and green - sustainable development	Efficient and modern infrastructure; economic development; aesthetic qualities	Ecological health; ecological footprint low;
2. Overall strategies	economic investments; promote tourism industry; livable urbanism	revitalization; redevelopment; and conservation of natural areas	revitalization and redevelopment of urban cores	restoration; protection of watershed functions and biodiversity; land connectivity; increase green areas
3.Spatial Scale	metropolitan area	municipality	urban cores	watersheds and other biophysical delineations (e.g. coastal zones, ecological corridors)
4. Temporal scale	20 years	Long-term, but not specifically identified in plan	~ 20 years	Not articulated; depends on long-term ecological renewal processes
5.Procedure to generate vision	expert consultation – economic planning	consultative participation (community boards) and information social networking among civic groups	expert consultation – architecture/urban design	scientific research – biophysical and ecological sciences
6.Actors	PRPB; PRDENR; PREQB	SJ Municipal Planning Office; SCSJEC; SDI; UPR-CAUCE	SJ Mayor's Office	IITF; UPR ITES; PRDENR; SCSJEC

environment, and a competitive and prosperous economy" (Puerto Rico Planning Board 2011). As the capitol city and center for economic, social, and governmental activity in Puerto Rico, this vision greatly affects the goals and strategies for San Juan's development. Specifically, this vision affects San Juan as the epicenter of the San Juan Metropolitan Area. The PRPB's key strategy for development is the regionalization of key areas in the Island based on their economic and social overlaps as well as particular strengths (see Figure 2).

The state's vision for the sustainable development of cities in Puerto Rico is based on the idea 'livability' or livable city. Specifically, the visioning document states that the mission for urban areas is to, "achieve the sustainable development of our municipalities, cities, and metropolitan centers through the implementation of a coordinated and inclusive public policy agenda based on the principles of 'livability' and collective responsibility over our physical environment" (Puerto Rico Planning Board 2011 pg. 33-34). The concept of livability involves more than developing and caring for the physical infrastructure, it also includes the cooperation of citizens in the development of a clean and adequate environment and quality of life for each human being (Puerto Rico Planning Board 2011). While this idea of a livable city is also the center of the Municipal goals, as described in the Livable City vision below, San Juan city is also a crucial driver to promote sustainable growth in the Metro region. The specific vision of the PRPB for San Juan is reflected in this quote by a high administration official in the agency,

The city of San Juan should be a modern urban area in which multifamily projects predominate, serviced by an infrastructure focused on collective transportation, that also utilizes its water bodies as a means of transportation, with green areas or urban parks, strategic developments that include housing for the elderly, specialized hospices and institution. That meet the needs of the population, and a defined industrial area with a functional management plan for solid waste.

Although the PRPB's strategies and actions for San Juan and the Metro Area are still in development, the state has already focused on promoting large scale tourist, commercial and industrial projects, and construction and transportation projects as the key local and global economic development strategies for the city. Some of the projects that the state is promoting and financing are the redevelopment of the city's industrial port area into a commercial and tourist center, the "Urban Bay" (*Bahía Urbana*), and the development of a "Science City" (*Ciudad de las Ciencias*) to promote biotechnology, pharmaceutical and other technological research (Figure 3). It is because of this emphasis on regional development for the case of San Juan that I distinguish this vision as an *Economically Sustainable* vision of the city, as opposed to the *Livable Vision* that I will describe next, which is more conceptually and strategically developed in the Municipality's Territorial Ordinance Plan.

Figure 2. Regionalization strategies as proposed by the PRPB for its strategic sustainable development vision. The red circle indicates the location of San Juan as part of the San Juan Metropolitan Region.

Figure 3. Examples of large-scale developments that the state is creating in the city of San Juan to promote tourism, industrial, and economic development for the Metropolitan Region. The top image is the illustration of the re-development of the "Urban Bay", and the bottom image shows what the "Science City" will look like when completed.

The Livable City vision reflects the goals and expectations of two main sectors of the city: the city government through the San Juan Municipality Office of Territorial and Ordinance Planning, and the civic sector through the work of NGO's, local activists, and community-based organizations. The main values and expectations that connect these two sectors under this vision is a desire for a *city with high quality of life, efficient transportation, and a vital, safe, and clean urban environment for all San Juan citizens to enjoy despite their socio-economic background.* As I will describe later, while this vision embeds principles of sustainability and a concern for the economic, social and environmental conditions of the city, it places a stronger emphasis on improving *current* conditions for collective society, and especially marginal populations. In this way, this vision relates more to *social sustainability*, or development that seeks to improve social well-being and order in the city through economic vitality and protection of natural resources.

The Municipality's vision became official with the approval of the San Juan Territorial Ordinance Plan (TOP) in 2003, and became public policy when the Municipality became autonomous in 2009. The TOP outlines the vision, policies, strategies, and actions for the Municipality of San Juan as a whole. It was initiated in 1995 by the administration of then Governor Sila M. Calderón and approved by current Mayor Jorge A. Santini Padilla and the Puerto Rico Planning Board in 2003. The vision aspires to achieve a livable and sustainable city as expressed in this quote:

> …the dreamed San Juan aspires to a vital, safe and clean city, a place
> for cultural and economic exchange, and promoter of the harmonious

coexistence between its citizens. We aspire to a green, clean and beautiful San Juan where its ground, air and water are common resource of all. With such aim, it will be policy of the Municipal government to protect our natural and constructed patrimony, and to stimulate a healthy balance between our urban and rural ground, promoting the ordered and compact development of our neighborhoods and the intelligent infrastructure, always safeguarding the common wealth over the personal interest.. (San Juan Municipality Office of Planning and Territorial Ordering 2003, pp. 187)

The Municipality describes the current condition of the city as an area where production criterions and economic interests of its central areas have overcome the value of quality of life, public space, and the morphological elements that configure its social framework. As a result this has displaced the 'sanjuanera' community to the outskirts of the city and metropolitan area. This condition can be defined as the undesirable vision for the city of San Juan – it is not sustainable. Instead, the plan wants to "recover the city, make it more *livable* and enjoyable to all its inhabitants and for all its inhabitants: a premier city, an efficient city, clear, orderly, safe, beautiful and that also serve those who inhabit it, especially those that have been *marginalized*"(emphasis added).(San Juan Municipality Office of Planning and Territorial Ordinance 2003,pp. 11).

This vision translates into five policies as an integrated framework with specific strategies of revitalization, redevelopment, and conservation (Figure 4). These objectives are: (1) elevate the quality of life of all municipal territory making San Juan an attractive, safe, and clean place to live, work, and visit; (2) in terms of the urban land use, it is Municipal policy to revitalize, rehabilitate and repopulate its urban

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districts and center as a framework of community living; (3) in terms of the rustic land use, the Municipality will jealously conserve its natural resources, protecting from urban development every land with special location, topography, aesthetic, archeological or ecological value, classifying it under common rustic land use or special protection land use; (4) the Municipality actively promotes citizen participation as a democratic instrument in public administration; and (5) promote on-site rehabilitation of economically disadvantaged communities as a mechanism to eradicate pockets of poverty, balance the distribution of development, and attend to the needs and aspirations of its most vulnerable residents.

The time span of the vision is not specified in the plan, but the strategies are meant to address long-term morphological, socio-economic, and ordering transformations. The plan also recognizes the importance of green areas to hydrological functions of the city's watershed and its long-term sustainability, through efforts of conservation and reforestation, targeting specifically the open areas remaining in the south of the city and headwaters of the Río Piedras watershed. The Municipality seeks to protect green areas from further urban sprawl through conservation policies and planning strategies, including specific planning tools such as transfer of development rights, and ten meter linear protection of open area surrounding water bodies. It also proposes a massive reforestation of both the urban and rustic soil, particularly in urban corridors that can serve as ordering elements for the city.

Figure 4. Map depicting the main planning strategies of the San Juan Territorial
Ordinance Plan: revitalization, redevelopment, and conservation. Source: San Juan
Municipality Office of Territorial Planning and Ordinance (2003)

The civic sector has had a large role in implementing on-the-ground initiatives

that embody the Municipality's Livable City vision, and these were acknowledged and

protected under the TOP. Some key examples of these civic stewardship efforts are

the establishment by law of a Special Commission for the San Juan Ecological

Corridor that includes representation from governmental, scientific, NGO's and

community sectors, to work towards protecting and connecting patches of urban

forests in the city through an ecological corridor, as well as the San Juan Bay Estuary

Program as an effort supported by the federal government to manage and protect the coastal and mangrove ecosystem of the San Juan Bay area. Numerous other environmental and community organizations are getting involved in the political and governance system to formulate ideas, plans, and projects, such as improving and developing alternative forms of transportation, re-vitalizing places through cultural and social activities that promote the improvement of the city's quality of life, and fostering local economic development through markets, fairs, and other community events. The values motivating these stewardship actions in the civic sector converge with the values embedded in the Municipal Territorial Ordinance Plan, such as a city that is "livable", "safe", has "adequate transportation", and collective opportunities. A local environmental activist describes the vision for San Juan as a "city that provides opportunities so that its citizens, independently of its social condition or economic status, can satisfy their basic needs (e.g., nutrition, health, security, and education), and to enjoy an acceptable quality of life". Another community activist describes the vision as "a city with eternal energy, sustainable, with a collective transportation service of excellence. It should be a safe city"

San Juan the Modern City

The vision of San Juan as a *Modern City* primarily reflects the goals of the city's Mayor Jorge A. Santini Padilla for the redevelopment and revitalization of San Juan's main urban cores: historic Old San Juan, Santurce, Miramar, and Río Piedras (Figure map San Juan with circles – identifying each one). Since his tenure began in 2000, Mayor Santini has focused on these areas as places to invest towards increasing the visibility of the city, making San Juan a "wordly" city. In his own words, "We are

building a grand city, to make it again the first planned city of the Americas. So that the beauty we admire and astonishes us in other countries, we can have it here and be proud of it*" (San Juan Municipality 2007).

A key emphasis of this vision is revitalization for aesthetic and modern qualities of the municipality's urban core infrastructure such that it is "attractive" and "new", thus promoting external investment in the areas and increasing economic vitality. Some of the values embedded in this vision include "active", "vibrant", and "safe" communities with "modern" gray, as well as, green infrastructure. Key strategies involved with this vision include remodeling of towns' plazas, streets and sidewalks; increasing vertical housing density; improving transportation and parking facilities; demolishing old buildings and building new ones; planting new vegetation and expand green areas (www.proyectosanjuan.net). Ultimately, the goal for the Mayor is to "move towards new world tendencies, to conserve the environment like we are already doing. Creating alternatives to see a city with a trajectory following the rhythm of the new world. Like we do everything in San Juan" (El Nuevo Dia, October 13, 2010).

The time span for this vision is short, spanning about 20 years for completion of each project. As previously mentioned, each urban core has a strategic plan developed by the Muncipality's Planning Office under the Law 212 for Urban Core Rehabilitation, which include economic and social analyses and strategies for addressing major issues. The Mayor's Office, however, has put forth new project visions for the urban cores with a name, or identity, to characterize the visual and attractive quality that is being envisioned. For instance, the revitalization of the Old

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San Juan core is referred to as the "Walkable City" to reflect a main aspiration of the Mayor to make this city core pedestrian, and "Río 2012" for the economic revitalization plans of this historically the largest commercial center and university core in the city (Figure 5).

"The Walkable City"
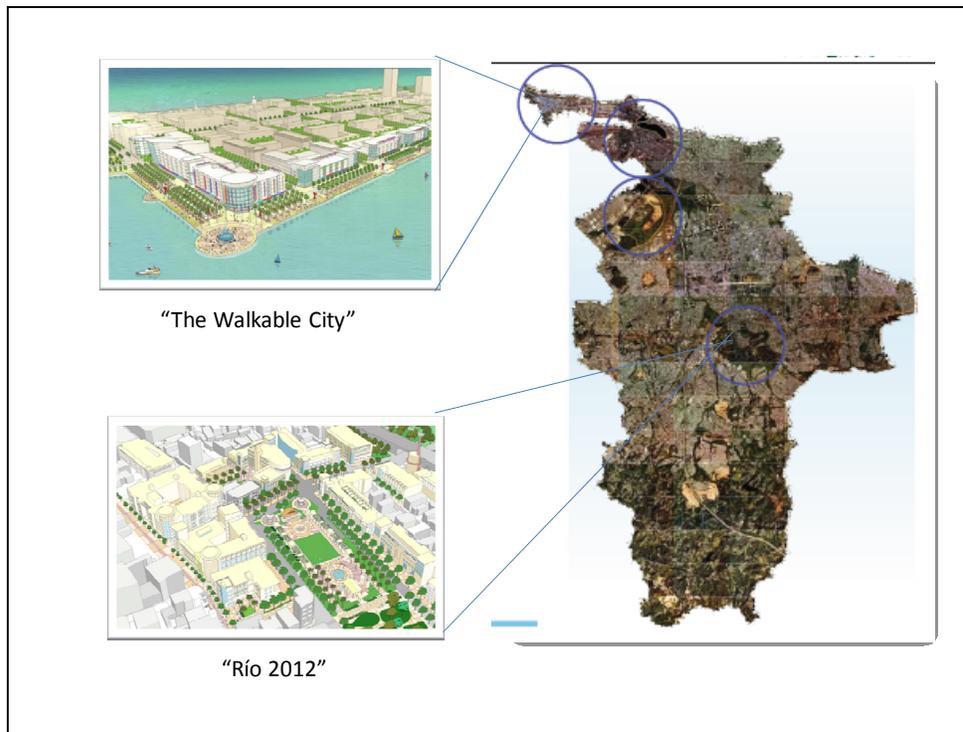
"Río 2012"

Figure 5. Visual representations of the visions for two of the urban cores in San Juan: "The Walkable City" for historic Old San Juan, and "Rio 2012" for the commercial and university center of Río Piedras.

San Juan the Ecologically Sustainable City

As the name of this vision suggests, this vision for the future of San Juan strongly values the sustainability of the city's ecological systems. The specific vision has not been articulated by a particular institution or sector. Rather it emerges from the discourses and actions from both the scientific community and the environmental

civic sector, such as NGOs, environmental education groups, and community-based efforts. There is a strong tradition of scientific research in Puerto Rico, particularly through the University of Puerto Rico (UPR) and the US Forest Service International Institute of Tropical Forestry (IITF), to understand, experiment, and manage tropical forest ecosystems. Long-term studies, such as through programs like the Luquillo Long-Term Experimental Research Program (LTER) by the NSF and IITF has accumulated extensive knowledge on the ecology and recovery of forest ecosystems, thus building understanding of what makes, or does not make, these systems sustainable.

Key ideas defining an ecological sustainable vision are systems thinking at the level of watersheds and landscapes, connectivity among ecological community, green areas, and landscapes, circulation of energy and materials through the system (i.e. metabolism), and networks functioning at multiple spatial and temporal scales. Most importantly is the importance of long-term processes and functions to maintain and enhance the resilience of these systems to disturbance. While these ideas and knowledge have been accumulated mostly for protected tropical forests, the scientific community is taking a strong interest in urban ecosystems given that most landscapes in Puerto Rico are urbanized. In this way, the ecologically sustainable vision is emerging in the city through more research investments moving in these urban areas. As one ecologist from the UPR expressed, the vision for San Juan is of a "city with a reduced ecological footprint, with great connectivity, and aesthetically pleasing".

While the scientific community has not articulated a vision of the future for San Juan, the civic sector is translating ecological and environmental science ideas

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and concepts into visions, projects and efforts throughout the city. Groups like the

San Juan Bay Estuary Programs has raised awareness of the importance of the

watershed and estuary scales to the maintenance of water quality and coastal

ecosystems in the estuary (Figure 6). Another example is the Special Commission

for the San Juan Ecological Corridor whose intersectorial collaborative committee

developed a strategic plan based on ideas of urban ecology and connectivity of green

infrastructure to improve quality of life and support sustainable development for the

city (Figure 6).   In its 2004 Strategic Plan, the Commission states its vision of:

> An Ecological Corridor in the heart of the Capitol City,
> interconnected with the green areas in the rural and coastal zone
> through a system of lineal green connectors, product of a consistent
> urban development, where the protection and improvement of the
> natural capital has been judiciously plan in accordance to accessibility
> and the enjoyment of nature with safety for all citizens, largely
> contributing to the improvement of the quality of life of all citizens,
> especially communities surrounding the corridor, and that it serves as
> an example to promote the virtues of sustainability for all of Puerto
> Rico.

Both of these efforts have been developed in close collaboration with

university and government scientists, such as the University of Puerto Rico, the

International Institute of Tropical Forestry, and the PR Department of Environment

and Natural Resources. These institutions have provided scientific, technical, and

human resources in developing the visions and plans for this

Figure 6. Examples of civic sector programs that promote ecological sustainable visions for the city. The top figure depicts the city by its estuaries and watersheds. The image is the study area for the San Juan Bay Estuary Program (PEBSJ 2001). The bottom figure shows the area for the San Juan Ecological Corridor (Puerto Rico Senate 2002)

effort. While most of this support has been at an individual level by scientists who are dedicated in working with NGO's or community groups to help improve environmental conditions in the city, this collaboration may prove to be crucial in moving and strengthening an ecological vision of the city in San Juan's public discourse.

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5.4. Different ways of seeing the city - The role of epistemic cultures in envisioning the future.

Analysis of the values and discourses embedded in the future visions that emerged from the San Juan governance context reveals that the idea of sustainable development cuts across through all of the visions, yet with varying degrees of emphasis on particular system dimensions, strategies, time spans, and spatial scales (Table 2). While it is surprising to have this concept at the center of political discourse in the context of urban and land-use planning in San Juan, and for that matter in Puerto Rico given its long history of economically-based development policies, it is not surprising that the concept is being described and used in different ways by different sectors of society.

Since the term was coined by the Brundlant Comission in 1987 (WECD 1987), the definition and usefulness of the sustainable development remains contested. Its ambiguity is considered by some to be a weakness because it allows its co-optation (e.g. green washing). On the other hand, it is a strength to others because it makes explicit the value-laden dimension of sustainability (e.g., how should we live?) that other scientific-based concepts avoid (Norton 2005). Nevertheless, the concept of sustainable development is having a strong influence in the public discourse on the future development of San Juan and Puerto Rico in general. As such it is imperative for sustainability analyses and future studies to understand how the concept is defined, how the sustainable city is being imagined by different groups and in what respects do their epistemic cultures match or not, thus elucidating potential sources of conflict or

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incommesurability in the system that may inhibit sustainable outcomes (Vogel et al. 2007).

This section analyzes the similarities and differences between the future visions above described, with a strong emphasis on the role of knowledge and epistemic cultures — the process, styles, and technologies in developing that knowledge - have in shaping these visions. The assumption here is that epistemic cultures can shape the particularities of each vision and thus help can explain the differences or conflicts in how the city is being envisioned by different actors. The four epistemic cultures identified in the context of San Juan are: *bureaucratic-planning culture*, *bureaucratic-aesthetic culture*, *civic-stewardship culture*, and *scientific-managerial culture*. Table 1 provides a summary of each epistemic culture based on the central actors found in this governance context. These cultures are an adaptation of the four political-epistemic cultures previously found in the literature-bureaucratic, economic, science, civic (Jasanoff and Wynne 1998), to fit the San Juan knowledge-action system context. For instance, while not distinctly represented by one of the central actors, the economic type exists in this context within the bureaucratic-planning type and the aesthetic-planning type.

Given the traditional top-down planning and government infrastructure in Puerto Rico, the dominant vision for the city of San Juan and its surroundings is the state's *Economically Sustainable City* and the city's *Modern City*, as embodied by the goals of the PR Planning Board and other state agencies, and San Juan's Mayor's Office respectively. Behind these visions are the political and administrative powers that view San Juan as a player in the global economy

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The state's and city Mayor's visions sometimes conflict, especially over jurisdiction and development rights of the areas classified for conservation in the Municipality's Territorial Ordinance Plan (TOP). Yet, where re-development is possible, both governmental entities share the vision that as the capitol city, San Juan must improve its economic and physical infrastructure. Informing both these visions is a *bureaucratic-planning culture* that is strongly associated with technical and economic planning expertise. As one of the most dominant ways of knowing underlying public administration in modern democratic societies (Jasanoff 2005), this epistemic culture is much like what James C. Scott (1998) describes as *techne*, or what Fisher (2000) terms *technical rationalities,* and relies strongly on the technical ability, efficiency, and expertise of the 'hard' social sciences, such as economics, political sciences, and law, to make decisions on natural and social order. Statistics, census, map making, and, newspaper propaganda are some of the knowledge production practices and technologies that the national and state government often use to make, implement, and justify their decisions (see, for instance, Anderson 1991 and Scott 1998).

For instance, a search in the PRPB website publication and databases reveals a large number of economic statistical publications produced by the agency, yet almost no environmental analyses or scientific publications regarding the ecological functioning of the city (e.g., urban ecological studies). The social information provided is also limited to economic indicators and its census program, such as employment or income distribution, but little information exists on social justice issues crucial to a sustainable development strategy. One influential report to the

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PRPB, and hence a key aspect of its knowledge system, is the Comprehensive

Economic Development Strategy for Puerto Rico developed by an interagency

committee. This document outlines an economic development strategy for Puerto

Rico (see Figure 7) and is considered a key instrument of the PRPB activities and

priorities (CEDS 2010).

As stated in the document, "Although conceived originally as a top down

planning entity within the framework of a strong government role in directly running

the economy, the PRPB is now committed to a much more participative focus and a

conviction that *the market is the primary instrument for allocation of resources in an

economy such as ours*." (CEDS 2010; emphasis added).   In addition, the strategy

includes economic indicators to track progress toward

economic development goals, yet these do not include environmental, social, or

institutional indicators.

With the creation of state agencies responsible for managing and protecting

environmental and natural resources, the *bureaucratic-planning culture* has broadened

to include environmental technical knowledge, and more recently, the use of

Geographic Information Systems as a technology to describe, analyze, and visualize

environmental impacts of planning and development. The PR Environmental Quality

Board (PREQB) and the PR Department of Environment and Natural Resources

(PRDENR) in particular are responsible for providing documentation, monitoring and

environmental statistics, as well as conducting environmental evaluation of state

projects. While the PREQB does not have an articulated future vision for Puerto Rico

or San Juan, the PRDENR has been in the process of developing a long-term

management plan for the Island's natural resources and wildlife (CITE PLAN) also based on regionalization and landscape management which will have an influence on the development of San Juan.). Similarly, now that the Municipality of San Juan has obtained autonomy, it created its own planning office to conduct its own analyses and maps for city planning and development purposes.

Figure 7. Images from the Comprehensive Economic Development Strategy for plan, its main objectives, and indicators to track economic development trends in Puerto Rico.

The bureaucratic-planning way of seeing the city has allowed the emphasis on economic goals and environmental mitigation strategies at the expense of a clear definition of social and ecological visions that must also be a the core of sustainable development planning. Camacho-Meléndez (2000) notes that most PB directors have been engineers who tend to have a functional view and not the interdisciplinary and broader vision of planners. A local environmental activist states that, "the vision that is presented is for the economy and not for the life of the people, of the country.

They think that what is good for the economy is good for the people and what you achieve with that is that the plan is beneficial to the advocates of the economy" (Juan Rosario 2009)   A member of the Association of Housing Contractors has even expressed that "55% of all construction done in Puerto Rico every year does not go through a planning process, nor is it even necessary to mitigate the impacts on the environment" (Blanes 2008).

Similarly, the San Juan city Mayor is placing more emphasis on the fields of architecture and urban design for its re-development and re-vitalization visions, than social and ecological aspects. Therefore, the vision of the Modern City is not only supported by a bureaucratic-planning culture, but also relies on a *bureaucratic-aesthetic culture* whose reasoning styles and practices are strongly visual and aesthetic in representing nature and society (Table 2). This culture strongly relies on modern technologies of visualization, such as AutoCad as standard industrial software in architecture, and most recently, Google Sketch up for 3D rendering. For instance, the "Rio 2012" project seeks to modernize housing, public spaces, and other infrastructures through multiple phases, beginning with the town's central plaza, *Plaza de la Convalecencia.* The vision promotes this plaza as the center for cultural and social activity that new investment is going to be drawn to and be established in the commercial and housing buildings immediately surrounding the plaza. The remodeling of the Plaza has been completed, including adding new physical and green infrastructure (e.g. trees, shrubs, etc.), and fixing an underground parking structure. From the Mayor's perspective, "All of these changes and

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Table 2. The four main epistemic cultures for the dominant actors in the knowledge network of land use and green area planning and policy.

Actors	Knowledge Producer	Knowledge Sources	Epistemic Cultures			
			Expert Knowledge Domains	*Problem Frames*	*Reasoning Styles*	*Technologies*
Bureaucratic-Planning Culture						
PR Planning Board (PB)	yes	federal; state; and city	planning, public relations, engineering, architecture, natural sciences, social sciences, social work, environmental technician, economics, law, information system technology, public	environmental quality	rational planning approach; cost-benefit analysis; regulatory evidence standards; quantitative	economic and statistical models; indicators; GIS; visual images; web-based data
PR Department of Environment and Natural Resources (DENR)	yes	university and state	natural sciences, planning, forest specialis.	environmental quality	scientific regulatory approach; cost-benefit analysis; regulatory evidence standards;	natural resource inventories and statistics; GIS; visual images; web-based data
PR Environmental Quality Board (EQB)	yes	state and city; university, NGO's	environmental planning, administration	urban sprawl	scientific regulatory approach; cost-benefit analysis; regulatory evidence standards; quantitative	environmental (e.g. water, air) inventories, statistics, and indicators; laboratories; web-based data

San Juan Municipality Planning Office (SJM)	Yes	NGO's and architects	administration, engineering, architecture, social sciences, planning, environmental technician, information systems technology	inadequate land use planning	rational and social planning approach; field and regulatory evidence standards; quantitative and	GIS; visual images; statistics field-based tools;
Bureaucratic-Aesthetic Culture						
San Juan Mayor's Office	no	private firm and city planning office	architecture, city planning, and urban design	deterioration of urban cores	legibility and simplification; innovative designs; aesthetic qualities; efficiency	visual and graphic designed images; virtual videos; website as promotional tool
Scientific-Managerial Culture						
University of Puerto Rico (UPR)	Yes	federal and state; NGO's; university	administration, education, natural sciences, environmental technician, information system technician, community organizing, architecture, environmental management, social	urban sprawl	scientific process; hypothesis driven; objectivity; peer review; basic and applied research; quantitative and qualitative	ecological and statistical modeling; laboratories; GIS; website; field instruments
International Institute of Tropical Forestry, US Forest Service (IITF)	yes	state; city; university	forest specialists, natural sciences, social sciences	water quality	scientific process; regulatory evidence; peer review; user-driven and applied research; public service; quantitative	ecological and statistical modeling; laboratories; GIS; website; field instruments

PR Department of Environment and Natural Resources (DENR)	Same as above - overlaps with Bureaucratic-Planning Culture					

Civic-Stewardship Culture

Special Commission for the San Juan Ecological Corridor (SCSJEC)	no	federal; state; city; and university	community organizing, administration, public health, natural sciences, planning law, public policy	land development and environmental quality	collaborative process; inter-agency and civic review; scientific, regulatory and experience-based evidence; quantitative and	pictures; maps; social networks tools (e.g. email); field studies
Sustainable Development Initiative (SDI)	yes	federal and state; NGO's	community organizing, natural sciences, planning, economics, law	inadequate land use practices	civic engagement and policy review; scientific, regulatory and experience-based evidence; applied activism; quantitative and qualitative	GIS; pictures; maps; social networks (e.g. website, email); video documentaries
Conservation Trust (CT)	yes	state and city; university, NGO's	public relations, environmental management, business management, natural sciences, environmental technician, forest specialist, law, information systems technology educatio	urban sprawl	civic engagement and policy review; scientific, regulatory and experience-based evidence; applied activism; quantitative and qualitative	GIS, pictures; maps; social networks (e.g. website, email)

improvements seek to bring back Río Piedras splendor, promote urban living, and avoid that prostitution, vandalism and criminality continue to take over the area" (San Juan News 2010). These urban core revitalization projects have received praise and support from various sectors in the city, including state and local citizens. Some residents are hopeful that these improvements will help re-vitalize the economy in their communities.

There is, however, substantial criticism emerging from residents, business owners, and social activities regarding the legitimacy of the projects and the overall vision. The main concerns expressed by these groups are the lack of a long-term vision, the emphasis on economic investment, and a lack of an integrative participatory process in developing the plans. While the initial plans developed for each urban core were based on a consultative participatory process in the development of the 2003 Municipal Territorial Ordinance Plan, the visions that the Mayor is putting forth were developed separately by a Boston-based expert architectural and urban design firm, Antonio DiMambro and Associates. Community leaders in Río Piedras, for instance, express that while they are not against the re-vitalization of the town, and in fact they support it, the lack of inclusion in the process of envisioning the city resulted in a vision that does not reflect the reality of their physical and social context (Figure 8) or a vision of sustainability that benefits the town's residents.

The lack of context, and the associated environmental and social impacts, are also raising concern among local professionals in San Juan. In regards to the "Walkable City" project in Old San Juan, a well-known planner, Jose Rivera

Santana has expressed that "(the project) is more than an ideal design of what could be done. They are drawings that look very pretty but it does not imply that there was citizen participation" (El Nuevo Dia 2011). He goes on to

Photo: PIDES 2011 (upper); Noticias Online (lower)   Photo: Rio 2012 Plan, Antonio DiMambro + Assoc.

Figure 8. Example of different contexts for the Plaza de la
Convalecencia in Río Piedras. The left images show the existing physical
and green infrastructure, and the right represents the visions for the city
as represented by the architectural firm hired by the City's Mayor.

express that the for the historic district of San Juan, stating that "… is not new to make the Old San Juan and the developments in the port area since these were already in the San Juan Waterfront vision. There is nothing new except for the artificial beach that represents an environmental challenge. It's an attractive proposal that requires much analysis and a massive investment because it will involve elevating the level of the coast, sand movement, and construct coral reefs

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to contain sea currents" (El Nuevo Dia 2011). Figure 9 illustrates the differences

between the vision for the artificial beach as developed by the Antonio DiMambro

firm (left image), and the physical reality of the place. As planner Rivera Santana

expressed, to make the image on the right look like the left will involve great

amount of investment and physical manipulation of the area. None of these plans

include an assessment of unintended consequences for these large transformations

of the land.
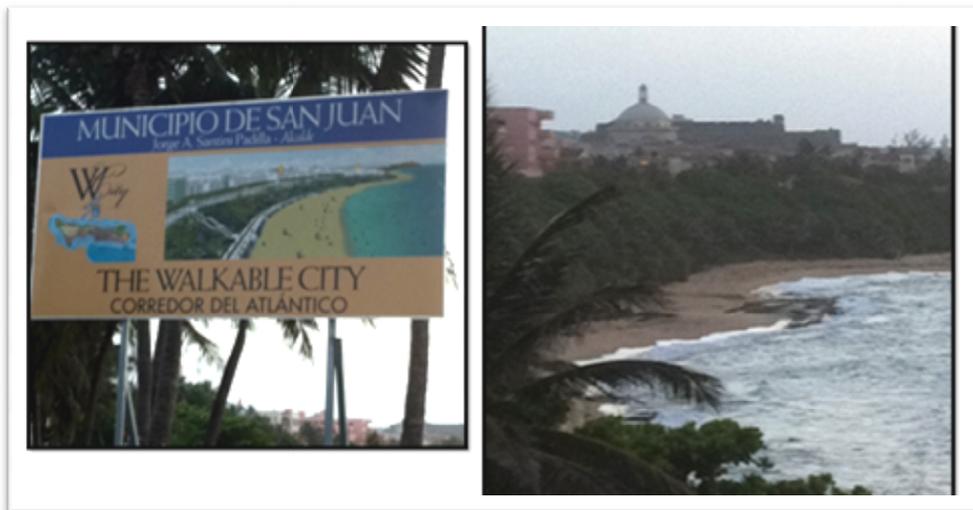
Figure 9. Example of legibility and simplification of landscape through visuals
for the "Walkable City" project. The image on the left reflects the vision of the
Mayor's expert designer, and the right image shows the biophysical reality of the
place.

Much of the criticism revolves around these projects being the vision of

the Mayor, and not reflective of the local context, or acknowledging the

participation that the public had in generating the 2003 Territorial Ordering Plan

for San Juan. The Mayor itself sees these projects as reflection of his own vision

of the city. When asked how much time these Rio 2012 projects will take, he has

said before "how many more years …I don't know. But I will be here a sufficient

amount of time (as a Mayor) to see *my dream* as a reality" (emphasis added) (El

Nuevo Dia, 2011).

   The architectural and urban design ideas influencing the Mayor's Office vision

for San Juan, Antonio DiMambro and Associates, is established in Boston,

Massachusetts, but has carried out projects in the US, Italy, and Puerto Rico. The

epistemic culture of this private firm includes areas of expertise in the planning,

design, and implementation of large-scale physical developments, neighborhoods

and housing revitalization efforts, universities and institutional campuses,

transportation projects, infrastructure and waterfront facilities, urban parks, and

the management of interdisciplinary teams

(http://www.dimambro.com/index.htm. Accessed 2010). The firm trademarks

itself for its visionary planning that responds to clients' needs and addresses the

physical, economic, and social future of large-scale neighborhoods and cities. As

stated in their website,

> Our plans are bold, responsive, and based upon rigorous analysis
> and client feedback to create feasible yet powerful planning
> strategies and visions. AD+A, Inc.'s urban design practice is
> characterized by innovative designs that beautify, strengthen, and
> transform the complex uses and forms of cities….Our analyses
> and explorations yield plans that not only improve the immediate
> site, but enhance the image, quality, and functionality of the city
> as a whole." (http://www.dimambro.com/)

   The *bureaucratic-aesthetic culture* greatly overlaps with the

 bureaucratic-planning culture, particularly in terms of the dominance of

technical rationality and the use of measurements and technological tools to make society more simple and legible. They both share a practice of simplification and quantification of society and nature such that it can be made more legible for the purposes of ordering. As James Scott (1998) argued in the book *Seeing Like a State*, legibility in modern societal development schemes, such as the high-modernist city of Brasilia, is made possible by state measurements (e.g. population statistics and economic indicators) and practices (e.g. land surveying and maps) because it reduces local complexity and allows a more consistent organization of people, structures, and their institutions. This way of planning and organizing society also gave the state the ability to represent a common vision of society and objective information for outsiders (e.g. property investors). He made a crucial point of the unintended consequences that a lack of context can have on the success or failure of modern development project.

A good example of *legibility* achieved through the bureaucratic-planning and bureaucratic-aesthetic cultures is the visual depictions of the city developed through the technologies of visualization mentioned above.   Figure 10 shows the sketches by the AD + A Inc. firm for their visions for the 19th St. and Hyde Park improvements project in Fort Worth, Texas, and the aforementioned Plaza de Convalecencia in Río Piedras, San Juan, Puerto Rico. These are two completely physical, social, and cultural urban contexts, yet the simplistic and 'clean' representations of the city are quite similar. In a way, as Scott suggests, these images attempt to represent a universal vision of a city.

a. Fort Worth, Texas b. Río Piedras, San Juan, Puerto Rico
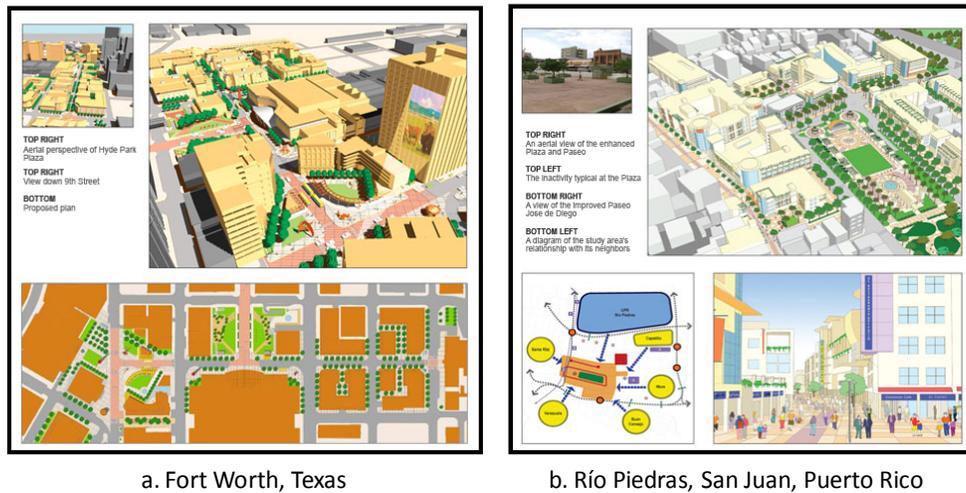
Figure 10. Urban re-development designs produced by the Boston-based architectural firm, Antonio DiMambro and Associates for Fort Worth. The left image is of Texas and on the right is the Plaza de Convalecencia in Río Piedras, San Juan, Puerto Rico.

The *Livable City* vision represented in the goals and strategies of the 2003 Municipal Territorial Ordinance Plan (TOP) is quite distinct from the state's and Mayor's vision of San Juan, even though this is the legal instrument meant to guide Municipal policies and strategies. While this vision overlaps with the *Modern City* vision in terms of viewing the potential of the city of San Juan as one of the most beautiful and enjoyable in the world, it places greater emphasizes on the quality of life of life of the city over its economic growth, and gives attention to the condition of marginal communities. In addition, while both visions incorporate environmental health, in the *Modern City* vision the perspective is short-term and mostly focused on the urban cores, while the *Livable City* seeks an integrated vision for the entire Municipality.

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The TOP also recognizes the role of San Juan as a central element in the state's regional sustainable development goals, but it is also primarily concerned with the quality of life of its citizens and future generations of 'sanjuaneros'. Within the plan the Municipality recognizes that current regional development is not conforming to the principles of sustainable development because of the following issues: 1) a model of individual automobile use and increase in road infrastructure that has fragmented the city; 2) a state's Land Use Plan (referring to the plan at the time of the TOP writing in 2003 and not the one currently in development) that allowed multiple mechanisms of discretionary evaluation of projects, which promoted urban sprawl; 3) a zoning model that did not promote multiple use, high density and integrated use of the land; and 4) periurban development that promoted the depopulation of urban cores. (San Juan Municipality Office of Territorial Planning and Ordinance 2003, pp. 47-48). The Municipality understands that the public policies and strategies it has developed addresses these concerns, as well as the protection and conservation of the natural resources, including watersheds, that support the regional urban population.

These differences between the *Livable City* vision and the state's and Mayor's vision can be explained by traditional factors, such as differences in political ideologies, administrations, and financial resources, to name a few.[31] Yet, differences may also be explained by the process and the knowledge

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[31] The development of the TOP began in the late 1990's with the administration of Sila M. Calderón, or the Commonwealth Party, whereas the current city administration is led by Jorge Santini, a pro-Statehood leader.

systems that were used in the development of the vision and plans. For instance, contrary to the urban core visions developed by the architectural firm for the Mayor's Office, the TOP plan was developed by an in-house team of municipal planners, technicians and administrators of the San Juan Office of Territorial and Ordinance Planning with the assistance of local professionals such as planners, architects and engineers, as well as a consultative public participation process.

While the participatory process was limited to community boards appointed by the city's acting mayor to review and provide input on the plan, and not a bottom-up representation integrated throughout the planning process, the planners were able to establish a direct link with communities. In many cases, such as with the Special Commission for the San Juan Ecological Corridor, municipal planners interacted closely with the community in making sure these efforts became part of the plan and Municipal public policy. Planners also visited the communities to assess residents' issues and concerns. While the planning process was still influenced by the traditional bureaucratic-planning culture, it also inserted local concerns and knowledge to some extent. In this way, the TOP, and the *Livable City* vision in general, is partly influenced by a *civic-stewardship culture* (Table 1) that incorporates experientially-based and relational ways of knowing of the public. As I will explain later in more detail, this epistemic culture refers to the local and social knowledge that people in the city gain through their lived experiences in the city, and not through statistics or quantitative indicators.

Still, major sources of data, knowledge, and ideas for the plan and its

vision come from state government agencies, such as the PRPB, PRDENR, the PREQB, and Department of Transportation and Public Works, private planning firms and territorial plans from other municipalities, and federal agencies, such as the US Geological Survey and the US Corps of Engineers. Geographic Information Systems technology was a major instrument for map and classification of land to inform zoning and policy strategies for land development. Sources outside the conventional, bureaucratic-planning culture were also consulted, including natural (e.g. geologists and hydrologists) and social scientists (e.g. geographers, planners, economists, historians). Therefore, the combination of a bureaucratic-planning culture and a civic-stewardship culture informing this plan resulted in an analysis of San Juan's current condition and future visions that appear to encompass strategies to meet the economic, social, and environmental challenges for the city's sustainability. Yet, because the plan became policy just recently in 2009 when the Municipality became autonomous, outcomes and future trends cannot be directly associated to the actions proposed in this plan. The Municipality's Office of Territorial Planning and Ordinance is currently carrying out an evaluation of the social, economic, and zoning outcomes for 2003 to the present to assess how changes on the ground compare to the vision.

The three visions discussed so far, while incorporating environmental concerns as part of their idea of sustainability; lack an adequate ecological knowledge system to inform and evaluate the condition and sustainability of the city's natural resources. To some extent, environmental analyses and evaluations

are available through the PR Environmental Quality Board and PR Department of Environment and Natural Resources, as well as environmental planning analyses conducted by the Municipality. This, however, does not involve the type of systems-based analysis of the coupled human-natural or social-ecological systems and anticipatory (long-term) analysis that the emerging field of sustainability science espouses for transitioning to sustainability (Turner II et al. 2003; Wiek et al. 2011). The 2003 TOP, for instance, while it recognizes the importance of watersheds for the environmental health of the city, does not have specific strategies for measuring, evaluating or modeling watershed impacts of urban development.

The knowledge base of the Ecologically Sustainable City vision is therefore important to fill in the gaps and facilitate a more systems-based perspective of sustainability. As previously mentioned, this vision is influenced by the scientific community in what I refer to as the scientific-managerial culture. The *scientific-managerial culture* refers to the traditional view of science as a systematic way of knowing the world, but with the concerns for problem-based and societal outcomes that the academic and research central actors in the San Juan network have for addressing urban environmental issues in the city, such as: the International Institute of Tropical Forestry, University of Puerto Rico (specifically the Institute for Tropical Ecosystem Studies and the Río Piedras Community Action Center), and to some extent, the PR Department of Environment and Natural Resources (Table 1). These institutions employ positivistic epistemologies of objectivity, rigorousity, and replication, yet they

also have a belief that these should be applied to help solve environmental and social issues, and not just for the purpose of producing basic scientific knowledge. Individual scientists often offer consultation or work along with communities to develop research projects that will have a direct impact on a local problem.

The scientific-managerial culture in San Juan has several weaknesses that must be addressed to be able to provide a knowledge system that complements and fills the gaps of the bureaucratic epistemic cultures. First, while the disciplines in the social science and humanities are increasingly engaging in urban civic projects to contribute expertise in planning, development, community organizing, and public participation, the natural sciences and quantitative methodologies are generally considered more 'objective', therefore have more credibility in the policy process. In addition, while sustainability calls for interdisciplinary research and knowledge (Functowiz and Ravetz 1993, Palmer et al. 2005), the academic culture in San Juan is very much traditional in drawing boundaries to demarcate different disciplines. There is little collaboration among different disciplines and institutions to address real-world problems in San Juan, yet sustainability demands epistemic pluralism in the scientific order to produce knowledge for sustainability (Miller et al. 2008; Miller, Muñoz-Erickson, and Redman 2010). Second, with the exception of an increasing number of individual scientists that collaborate with NGO's and community groups to develop stewardship and sustainability projects in the city, boundary making also takes place outside of academia, with little involvement of the academic

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community in the civic planning and decision-making process. Finally, and as a result of this disciplinary fragmentation, the scientific community has not articulated a clear vision for the future of the city, therefore making it difficult to integrate across disciplines, and across academic and political boundaries, to put science at the service of the city.

James Scott (1995) observed that numerous modern planning development projects failed because of the dominance of a bureaucratic and technical, or *techne,* way of knowing and seeing the world lacked context of the social and environmental complexities and consequences brought up by technological change. Fortunately, the case of San Juan is different because the civic sector is involved in the governance of the city and in the direction it will take in the future. In this way, the civic sector has contributed to both the *Livable* and the *Ecologically Sustainable Visions* through the stewardship projects they have undertaken in the city to link social, economic, and ecological aspects under the concern for a better quality of life. Specific projects in the city implemented by civic groups, such as clean-up and restoration of coastal and riparian areas, protection of neighborhood and community forests, creation of ecological corridors and community gardens, to name a few, are encompassing sustainability goals at a micro-scale.

These actions are supported by the *civic-stewardship epistemic culture* previously mentioned that draws on the local and social knowledge that people gain through their lived experiences in the city. Fisher (2000) refers to this way of knowing as *cultural rationality*, or the extreme opposite of the technical

rationality. This way of knowing can refer to a variety of non-bureaucratic or non-scientific knowledge, such as indigenous, traditional, local, practical (Giampietro et al. 2006). James Scott refers to this type of practical and contextual knowledge as *mētis*, from the French term for know-how, common sense, experience, or a knack (1998:311). A crucial distinction of the *mētis* way of knowing is its adaptability, or knowing by doing and by learning, which is what has allowed various societies to navigate both natural and societal complexity and be able to change based on experience. Local institutional knowledge, such as knowledge of the local legal and regulatory frameworks, and community organizing are crucial practices in this culture to foster social learning, organize networks, and accumulate local knowledge.

While in traditional contexts this form of experiential and practical knowledge was passed on through oral or other cultural traditions, civic groups in the modern urban context are making use of a much larger variety of popular, artistic and social mediums to represent their knowledge and visions about the city (Figure 11). For instance, along with social and cultural events, civic groups circulate their knowledge and visions through contemporary social network technologies easily accessible through the internet, such as web-based blogs, social network websites (i.e., Facebook and Twitter), and mapping technologies (i.e., Google Maps) (Table 1). In addition, visual tools, such as photography, videos, and documentaries shared through the internet as a form of community press (e.g. YouTube) (Figure 12) have been successful in reaching a wide range of audiences and serving as a bottom-up form of epistemic and political

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expression of what the civic sector expects (or does not want) for the future vision of the city.

This epistemic culture is also increasingly adapting ideas and technologies of the scientific and planning communities in order to represent their knowledge and increase its credibility in the planning and policy arena. NGO's such as the Sustainable Development Initiative and the Conservation Trust use Geographic Information Systems and Geographic Positioning Systems, or scientific monitoring programs that allow them to take their own environmental measurements, such as through citizen science programs (Table 2). In the case of the Special Commission for the San Juan Ecological Corridor, for instance, community representatives worked with scientists and managers from various government and scientific institutions to provide them with technical and scientific support, such as in the form of GIS analysis, as well as gathering other types of information, such as historical plans, images, and urban ecology studies as part of the knowledge system informing their plan for the Ecological Corridor (Figure 13). Some authors refer to this emerging epistemology between the civic stewardship and scientific efforts as civic ecology.

Figure 11. Images of community artistic and social expressions of urban human-natural interactions in the Río Piedras urban core. The image on the left shows graffiti art of a tree on a residential building. The image on the right shows a community demonstration to raise awareness of the ecological diversity in the Río Piedras urban core.

Figure 12. YouTube images of video documentaries done by local citizens on the controversy over cutting old growth trees to build the new Plaza Convalecencia in the center of Río Piedras.
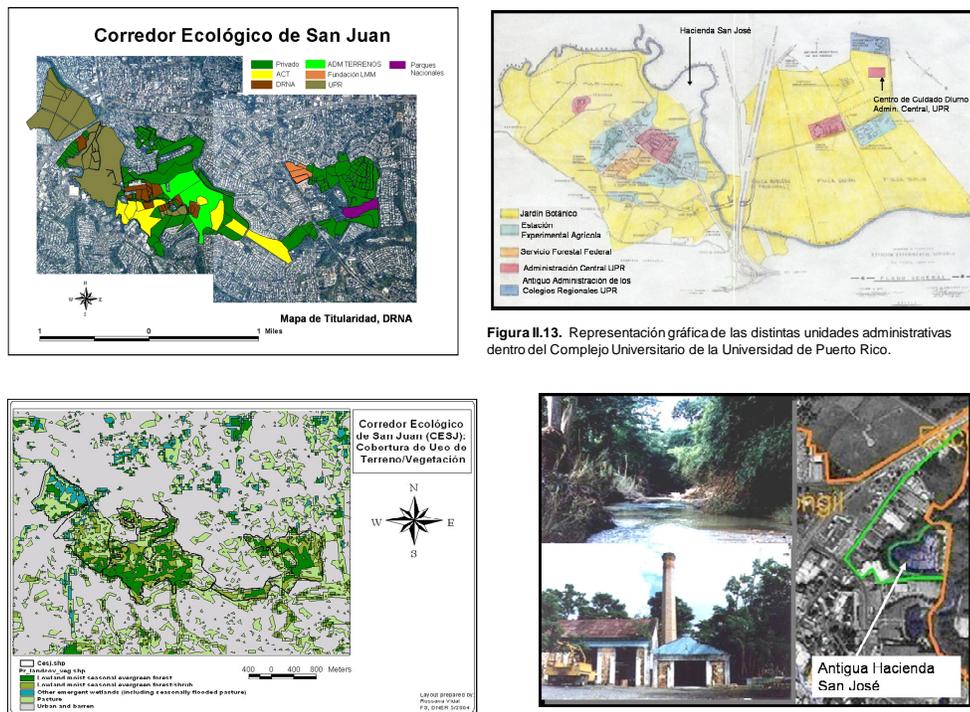
Figure 13. Examples of different visualization techniques used in the collaborative development of the 2004 plan for the San Juan Ecological Corridor by the Special Commission of the San Juan Ecological Corridor. The plan included GIS analyses from the PR Department of Environment and Natural Resources (top and bottom left images), graphic representations of the forested

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areas within the University of Puerto Rico (top right image), and historical images of an old water aqueduct in within the corridor (bottom right image).

The *civic-stewardship culture* emerging in San Juan has the potential of contributing the contextual knowledge that is so crucial for the resilience and sustainability of cities. It can provide, as James Scott suggests, a linkage between multiple different institutions and epistemologies to build adaptability and reflexivity in the institutional context. Collaborations between civic groups and scientists can infuse social, economic, and justice considerations into the academic community. In this way, the civic-stewardship culture has the potential for serving as a bridge between visions in San Juan and contributing to the development of a locally relevant, integrated, and systemic knowledge system to inform an imaginary of the city.

5.5 Conclusion: Constructing an Imaginary of Sustainability for San Juan

Imaginaries is a concept commonly used in anthropology in place of cultural beliefs to reflect a more normative vision or shared cognitive schema that social groups have, not only of what should be done 'in the world' but also how it should be undertaken and why (Strauss 2006, Jasanoff 2005, Taylor 2004). The concept of 'imaginaries'— or peoples' visions what social/political order *should* be — can help understand future visions with respect to the collective mental-schema that social groups have not only of what should be done 'in the city' but also how it should be undertaken and why.

Different from imagination in a fictitious or fantasy form, Appardurai (1996) defines imaginaries as a constellation of social factors, institutions, laws, and symbols common to a particular social group that shape agendas, research trajectories, projects, and policies (Taylor 2002). Benedict Anderson (1983) used the concept of imaginaries to understand how people and states imagined themselves as a political community. He described how institutional dynamics of academic departments and museums, the distribution of the newspaper, the classification of census categories and the use of maps all helped shape the way in which a community (or the *nation* in his case) was imagined. In a recent analysis of urban imaginaries, Cinar and Bender (2007) describe how the modern urban imaginary is produced and sustained by an urban culture located in narratives and practices that "proliferate through daily travels, transactions, and interactions of its dwellers, thereby shaping the collective imaginary" (p xiv). As such, examining the visions of the actors, and the epistemic producing and supporting them, is a way to understand whether these visions coalesce (or not) into an imaginary of sustainability for the city. The rationale here is that, while different groups may have different knowledge systems, ideas and visions for the future of the city, a shared imaginary of the city is still possible if understanding of the city's identity and what should it be in the future align among groups.

Is there an imaginary of a sustainable city for San Juan? The answer to this question is no. While some of the fundamentals of sustainability are embodied in the idea of livable cities that cuts across the different visions, the deconstruction of definitions, values, strategies, scales, and epistemologies of

each vision shows that each one optimizes one dimension of sustainability. The

state's vision of sustainable development is short term and still strongly relies on

the economic ideas and methodologies used for formulating past land use policies.

The scientific community has not made the leap to the interdisciplinarity and

collaborative research necessary to address natural-human interactions as a

system. Most importantly, the city institution itself sees the city differently, with

the Mayor's Office relying on different ways of knowing than its Municipal

Office of Territorial Planning and Ordinance.

The heterogeneity of visions and epistemic cultures, however, is not

problematic for sustainability in itself. As discussed in Chapter Four, social

network theory suggests that this heterogeneity is beneficial to a system's creative

and innovative potential. Similarly, the definition of sustainability as a process,

rather than an end-point, suggests that there is no universal recipe or pathway that

a society must take to attain sustainability (e.g., Moore 2007). The issue here is

the lack of public discussion of what the city *is* and how its inhabitants *see* it. In

other words, the identity of San Juan (or what the city of San Juan is physically,

socially, and culturally) is not shared across residents and decision-makers in San

Juan. Although Moore (2007) found a variety of discourses and storylines about

sustainability in the cities he analyzed, each city still had a shared identity or

cultural repertoire that gave shape to its unique disposition towards sustainability.

In San Juan, a lack of an imaginary of the city itself limits the ability of its leaders

and citizens to deliberate and contest values and visions of what a San Juan of the

future should look like. Also problematic is that neither of the epistemic cultures

underlying the visions contains the anticipatory knowledge and capacities

necessary to evaluate potential outcomes of different urban states in the future.

The lack of public deliberation and evaluation of the specific meanings and

strategies that each vision is espousing in the name of sustainable development,

even within the same institutions, is another obstacle to creativity, innovation, and

anticipatory capacities in developing strategies to manage the city holistically.

The lack of a democratic and anticipatory knowledge-action system that can

provide the space for deliberating and critiquing various epistemologies existing

in the city – from bureaucratic to scientific to civic – could be hampering the

ability to develop and implement a vision of sustainability for San Juan. In short,

public discussion about what the city of San Juan is, what values, ideas, and

beliefs connect San Juan citizens (what makes San Juan residents 'sanjuaneros'),

is a crucial starting point to developing future visions of the city and the

knowledge-action systems necessary to support them. The exercise of forging an

imaginary of San Juan is in itself a tool to link the social groups, organizations, or

sites that are otherwise disconnected but share similar visions, goals, or resources

(Goldstein and Butler 2009).

Understanding existing visions through public discourse analysis then

offers a larger picture of the urban imaginaries of city dwellers, thus contributing

a big picture context to the exercises of scenario building and indicator

development. These exercises, in turn, will be more effective at helping envision

future states because they speak to the shared beliefs of the urban community.

The more that urban scenarios and indicators reflect the visions and expectations

that multiple city actors have of the city, the more the knowledge and modeling tools that sustainability scientists can offer will be relevant for actual decision/policy making and governance efforts.

To conclude, it is important to note that the purpose of this chapter is *not* to define a vision of sustainability for San Juan. Doing this without the interactive participation of local stakeholders in formulating these visions would be unreflexive and in the opposite direction of the normative criteria for sustainability that I discussed in Chapter One. On the contrary, the objective of this analysis was to uncover, or make explicit, the values, expectations, and knowledge claims that already exist in the governance context and public discourse as a first of a series of steps in defining visions, scenarios, and strategies through participatory processes. The goal is to understand the existing cultural contexts, what are the points of conflict or convergence between them, and hence, potential barriers and opportunities for building a coherent, yet locally contextual vision of a sustainable city. As such, the goal here was not to frame a vision, but rather, to map and eventually test[32] existing and emerging ideas of what the city of San Juan should be in the future.

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[32] A long-term goal of this research is to "ground-truth" the validity of these visions with local stakeholders, explore any missing or new visions through a participatory scenario development process, and test these visions through measurable targets and scenario modeling.

Chapter 6

Boundary Work in the City: the Politics of Expertise and Action in the

Re-development of an Urban Core

1. Introduction

In contemporary society, experts are indispensible to the planning and policy process. As Sheila Jasanoff (2005) explains, experts have knowledge with authority, and it falls to them to satisfy society's twinned needs for knowledge and reassurance under conditions of uncertainty. The credibility, or trustworthiness, of experts is as crucial to democratic governance as is the legitimacy of officials. In recent years, the role that experts play in the planning and policy process has received much attention from social and political scholars because of rising conflicts between experts and citizens over what knowledge should count in the decision-making process (see for instance Robbins 2000, Fisher 2000, Miller 2004, Forsyth et al. 2008). The complexity and uncertainty surrounding many environmental and sustainability problems make these especially susceptible to the politics of knowledge (Jasanoff and Long-Martelo 2004).

The concept of *boundary work* is useful to examine politics of expertise. Social scientists use this term to describe the tendency to separate science and policy as distinct and unconnected human activities, such that scientific expertise maintains its credibility and authority in policy-making (Gieryn 1983; Gieryn 1995; Jasanoff 1987). The dynamics of boundary-making involves the demarcation, through rhetorical, procedural, institutional, and otherwise the

functions of science and policy to create the appearance of a rigid boundary between knowledge-making and decision-making (Gieryn 1986, Jassanoff 1987), especially where such a rigid boundary does not (and, arguably, cannot) exist for the overall knowledge system to function effectively and efficiently (Miller, Muñoz-Erickson, and Monfreda 2010). Examining the dynamics and practices of boundary work in a knowledge-action system is crucial to understand how the politics of expertise are playing out in a given place. Particularly, how expertise is distributed across the system reveals how power dynamics actually work in the production, sharing, and use of policy-relevant knowledge. This, in turn, gives an indication of which knowledge is taken seriously (and which is not) and hence what expertise is being privileged in the planning and decision-making process (Rifkin and Martin 1997).

This chapter takes a closer look at the dynamics of boundary work in the land use planning context of Río Piedras, one of the urban cores of San Juan where the city's Mayor Jorge Santini is in the process of implementing a re-development project. The Río 2012 Plan is the Mayor's vision for the rehabilitation of this historical urban core, but it is meeting resistance from the local community who claims that this vision doesn't meet the reality of Río Piedras and is not a plan for sustainable development. In Chapter Five I examined the divergent visions and epistemic cultures between the Mayor's plan and the expectations of the community. As part of the Knowledge-Action Systems Analysis framework, I focus here on the dynamics between the Municipality, the state, the community, and the university in developing and

deliberating the authority of different types of knowledge and action, and in particular, the role of the university in knowledge production and politics in urban planning. I used multiple ethnographic methods to understand political and institutional dynamics, including participant observation, document review, key informant interviews, and opportunistic situations that arose throughout the field work[33]. In order to put together a holistic picture of the role of knowledge in urban decision-making, I make use of multiple substantive examples from the case in Río Piedras that I have observed or been involved with during the last three years.

In the first part of this chapter, I present the environmental, social, and institutional context of re-development in Río Piedras, followed by a closer look at the politics of expertise underlying disagreements on the Río 2012 project. In the next section, I analyze the role of the university through The Río Piedras Urban Action Center, or as it is locally known as CAUCE for its Spanish name *Centro de Acción Urbana, Comunitaria y Empresarial*, an organization established by the university to serve a link between the university, the community, and government agencies. This university-based organization was charged with overseeing the coordination of the re-development of Río Piedras but this role was challenged, and eventually eliminated, by a political culture that believes that the functions of knowledge and action should be separate. In this way, the Río Piedras case provides a microcosm of the challenging political and

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[33] More details on the methods and analysis employed can be found in Chapter Two.

institutional dynamics involved in developing knowledge-action systems for sustainability in urban settings.

2. Environmental, Social, and Institutional Context of Re-development in Río Piedras

Founded in 1714, the town of Río Piedras was an important agricultural and commercial center in the area and crucial to the development of the city of San Juan during the late 19th century. Located in what was the periphery of the Old San Juan, Río Piedras was a major transportation link between rural areas and the city in large part because of its flowing rivers. Adjacent to the town was also located the first aqueduct built in Puerto Rico that supplied water from the Río Piedras River Watershed (RPRW) through a gravity-fed system to the Old San Juan. In 1898 it began its operations and was the main supplier of water to San Juan residents until the 1980's. In 1903 the University of Puerto Rico (UPR) was built and the town became known as the 'University City' as it was the site of the oldest and largest education institution in the Island. In the 1950's the town was annexed to the municipality of San Juan, and the town's quality of life and economic vitality began to decline without its own administrative capacities. Today the town's population is highly diverse with some of the highest immigration populations in the Island, but these have remained largely segregated from the community. The town experiences high levels of crime, poverty, high vacancies and degraded infrastructure. Population has declined as many residents

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moved to suburban areas, or *urbanizaciones*, that were being established all across San Juan. For many years the town was 'forgotten'.

Planners and decision-makers began to direct more attention to the area when in the 1990's the Puerto Rico legislature designated this and other urban cores in San Juan as a special planning district under Law 75 of 1995. In 1996 the Puerto Rico Planning Board developed the Integrated Development and Rehabilitation Plan for the Río Piedras in which it was recognized that the town's condition needed attention through a special incentive program to stimulate rehabilitation. One of the mechanisms included the formation of an advisory group, the Special Interagency Working Group (SIWG), which is composed of close to twenty state and local public entities including the University of Puerto Rico and headed by the Planning Board. This group was in charge of coordinating studies and proposes solutions and public policy to the Planning Board to address the issues in Río Piedras, as well as to oversee the permitting and application of regulation.

In 1999 under Law 236, the direction of the in SIWG was transferred to the University of Puerto Rico. The university created a partly-elected Community Advisory Group (CAG) and an entity to serve as a university-community link, the Río Piedras Urban Action Center (CAUCE). Since 2004, CAUCE has established projects supporting community organization and participatory research, and direct community services. Through the work of the SIWG and the CAG, CAUCE has coordinated communication and initiatives between the community and government agencies as well as between the government units themselves. The

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university's Academic Senate describes CAUCE initiatives as "facilitating the

interaction between academia and the urban center of Río Piedras for mutual

benefit, strengthening the quality of life and social thread of the city, providing a

space for dialog between all sectors that live there, and proposing alternatives for

the problems facing urban cores in the nation" (Soto de Jesús 2009). As Figure 1

illustrates, the institutional landscape created for the rehabilitation of Río Piedras

is complex, made up of multiple actors with multiple functions, some of which,

like CAUCE, mixing elements of knowledge and action.
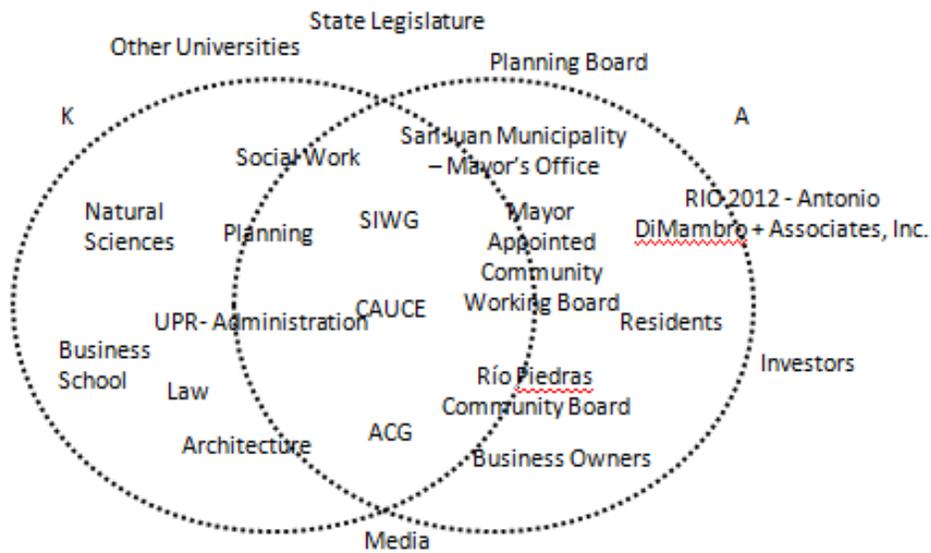
Figure 1. The institutional landscape of the Rehabiliation of the Río Piedras
Urban Core. Note: SIWG = Special Interagency Working Group; CAUCE =
Centro de Acción Urbana, Comunitaria y Empresarial; ACG = Advisory
Community Group; UPR = University of Puerto Rico; K = Knowledge; A =
Action

By the early 2000's, however, the Municipality's Office of Territorial

Ordinance and Planning, not satisfied with the pace of planning and

implementation, adopted the plan and expanded the analysis and interventions

for the rehabilitation of Río Piedras. This plan, titled Rehabilitation Plan for the

Río Piedras Urban Core, became public policy with the Urban Core

Revitalization Law (212) in 2002. Then in 2007, the Mayor's Office presented

the Río 2012, a three-phase Mega Project designed by Boston-based architect

Antonio D'Mambro (Figure 2). The Río 2012 Project includes the remodeling of

the town's center plaza, *Plaza de Convalecencia*, and its new green infrastructure

(e.g. tree planting in phase 1), as well as the demolition and re-development of

residential and commercial building in various parcels (phase 2 and 3)

(http://www.sanjuan.pr/default.aspx).   The project promotes redevelopment and

revitalization of the urban center through densification, repopulation, and

diversification of land uses. Specifically, the project involves re-development of

approximately 25 blocks with a cost of over 25 million dollars, the majority of

which will be coming from private funds with investments from the

Municipality. San Juan's Mayor Santini asserts that the Río 2012 will be the

most dramatic transformation that the area has seen in 50 years (San Juan

Municipality 2007). Indeed, already in its initial phase, the projects design has

been nationally recognized by the Boston Society of Architects (BSA).

Figure 2. Image of the Master Plan for Río 2012 developed by Antonio Di Mambro + Associates Inc. for San Juan's Mayor Santini. Subset image is a news article in the business section of one of the main newspapers in Puerto Rico showing efforts to promote the project to local investors, developers, financial institutions and business owners.

2. Politics of Expertise over Río 2012

The Río 2012 Plan moves forward the on-the-ground implementation of the Rehabilitation Plan of Río Piedras. In Chapter Five I presented Río 2012 as an example of a modern vision of the city produced by a bureaucratic-aesthetic epistemic culture that values aesthetic qualities, design simplicity and economic efficiency. This vision seeks to improve both grey (e.g., roads, sidewalks, buildings) and green infrastructure (e.g. vegetation) to make the city more livable and attract visitors, investors, and new residents. One of the reasons Mayor Santini has focused so much attention on San Juan's urban core has to do with the limits to urban expansion that the city has as part of the 2003 Territorial

Ordinance Plan developed by the Municipality Planning Office. As explained

in chapters Three and Five this plan delineated the remaining green areas in the

city as 'conservation of rustic soil', therefore restricting further development.

Mayor Santini approved this plan and has acknowledged the importance of

these areas to remain in conservation and has focused all new or re-development

activities in the urban cores.

The Municipality drew on the expertise of Antonio Di Mambro +

Associates, Inc., a private architectural and urban design firm from Boston, to

design the vision of the future of Río Piedras and to develop the visual

representations of that vision. Ultimately, the goal for the Mayor is to "move

towards new world tendencies, to conserve the environment like we are already

doing. Creating alternatives to see a city with a trajectory following the rhythm

of the new world. Like we do everything in San Juan" (El Nuevo Dia, October

13, 2010).

Río 2012 has met some resistance, however, from members of the local

community and the university because of concern that the project does not

address the rehabilitation goals originally intended for the area. Local architects

and planning experts from the University of Puerto Rico (UPR) critiqued the

plan for its lack knowledge of existing topography, including in some cases the

design of buildings that do not fit the parcels. One UPR professor called the

plan a "Disney project," and another did not see it as a plan but more of a real

estate proposal. These local professionals have developed their own plans and

recommendations for the re-development of Río Piedras. Their

recommendation is to rehabilitate both the core and periphery of Río Piedras to increase the town's commercial potential that then creates demand for repopulating the core, rather than just focusing on the core as the Río 2012 plan suggests . In addition, academics and students were concerned with the application of the urban renewal ideas espoused by D'Mambro that have long been criticized by urban planners because of the risks of gentrification, or the transformation from a diverse, working class community to a homogeneous rich neighborhood, that these ideas can result in. Members of the community and of a local church were also concerned that this plan will displace local communities. Similarly, some residents and community leaders expressed that the plan lacked context and did not fit the reality of Río Piedras. A local resident and business owner stated:

> " The 2012 program is a dream that the San Juan Municipality had, that will continue being a dream, because to this day the revitalization that is taking place are only drawings that do not say anything. Where are the designs that demonstrate architectural harmony in the Río 2012 Plan?" Local resident and business owner (Fernando Torregrosa, cited in Pérez 2009)

The politics of expertise heightened when in 2008 residents were one day surprised to see that many of the trees in the town's center, Plaza de Convalecencia, were being cut down by Municipal employees (Figure 3). Community leaders, local church members, and students protested and tried to stop the actions of the Municipality. The Municipality had conducted the required inventories and evaluations necessary to obtain permits from the Puerto Rico Department of Environment and Natural Resources and that the trees that

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Figure 3. Images of the Plaza de Convalecencia before the Municipality cut down the trees (top left image) to follow the design for the new plaza as visualized in the Río 2012 Plan (bottom left image). Photo on the right was taken on the day that the protests of the community and students stopped the cutting temporarily to review the Municipality's report indicating the reasons the trees needed to be torn down.

were marked to cut down where sick and had to be removed. Through these protests the community was able to suspend the deforestation and this gave them the opportunity to review the administrative report of the Department of Environment and Natural Resources. Community members, with the help of CAUCE, reviewed the Municipality's tree inventory and claimed to have found numerous irregularities, including decisions to remove trees that were in 'good' conditions and that the trees that would be planted in their place did not meet the species and benefits (i.e., shade) criteria for an urban forest based on DENR regulation. The community claimed that the deforestation was carried out for aesthetic rather than for technical reasons. Ultimately the project was allowed to

continue and the trees were cut down, but every year the community

commemorates the fallen trees with a day of demonstrations, named *La Tala del*

Titán after the oldest tree that was cut down from the Plaza.

Concerned over the long-term impacts of the plan, a community board,

the *Junta Comunitaria del Casco Urbano de Río Piedras* (Río Piedras Urban

Core Community Board) was organized to evaluate, monitor, and propose

complementary ideas to Río 2012 and ensure that actions moved forward with

the rehabilitation and sustainability of the town's community, and not re-

development that benefitted only a few. As previously mentioned, one of the

board's main concerns was the possible displacement of residents due to the re-

development of buildings and wanted to know if all the buildings that the Rio

2012 recommended for re-development actually needed to be torn down.

CAUCE and three students from the UPR's Graduate School of Planning (EGP)

conducted an impact analysis to address these concerns. They conducted field

work, visited each of the buildings, and evaluated the physical conditions of the

structure, its occupancy status, and the surrounding infrastructure.

The CAUCE-EGP study found that only 85, as opposed to the more

than 120 properties as identified in Río 2012, required re-development. This

meant that the rest could remain standing and maintain its historical character

through restoration. Figure 4 shows the differences in the recommendations

made by the Di Mambro study for Río 2012 and the recommendations from the

CAUCE-EGP study. The top image shows a more simplified classification of the

structures – parcels for modernization (in yellow), and parcels for re-development
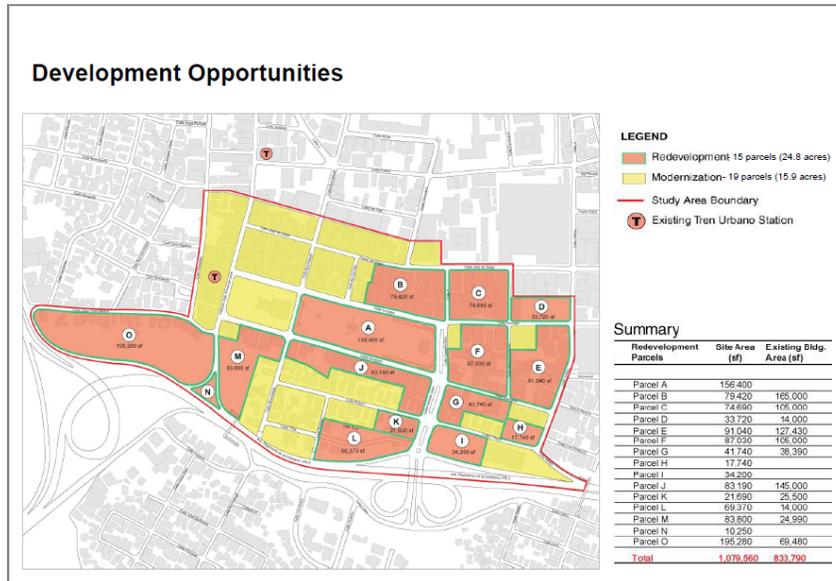
Figure 4. Differences in proposed strategies for re-development between Municipality's Río 2012 Plan and an impact study conducted by CAUCE and the University of Puerto Rico's Graduate School of Planning. The top image shows a more simplified classification of the structures – parcels for modernization (in yellow), and parcels for re-development (in pink). The bottom image shows a more diverse perspective of the structural reality, showing structures that need no intervention (purple), those that do require re-development (brown), and those

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that require some level of re-habilitation (red, blue, and green). The yellow circles indicate areas of opportunity where re-habilitation should focus.

(in pink). The bottom image shows a more diverse perspective of the structural reality, showing structures that need no intervention (purple), those that do require re-development (brown), and those that require some level of re-habilitation (red, blue, and green). The yellow circles indicate areas of opportunity where re-habilitation should focus. bottom image shows a more diverse perspective of the structural reality, showing structures that need no intervention (purple), those that do require re-development (brown), and those that require some level of re-habilitation (red, blue, and green). The yellow circles indicate areas of opportunity where re-habilitation should focus.

As I explained in Chapter Five, simple classifications such as the one in the top image of Figure 4 makes the landscape more legible, but less reflective of on-the-ground reality (Scott 2005). The CAUCE-EGP study conducted in the field produced a more diverse set of recommendations and opportunities. The Community Board agreed with this study and they presented it to others in the community during meetings in CAUCE, churches, the media, and other venues in Río Piedras. Based on this and other studies, the Board crafted a plan to complement (not to replace) the Río 2012 project. They sought to fill the gaps in Río 2012 so that the re-habilitation is more in line with actual needs of the community and assures a more sustainable development (Figure 5). The Board's goal is to "…strengthen the Río 2012 plan.

Figure 5. Images of the Río Piedras Urban Core Community Board's
Complementary Plan to Río 2012 as they present it to the press. The image on
the right shows one of the components of the plan, housing development, and the
specific recommendations that the community gives based on the study done by
CAUCE and the university's Graduate School of Planning

At the heart of the controversy are alternative ways of 'seeing the city' and

differences over whose knowledge should count in defining the future identity of

the city. Specifically, who has the legitimacy and credibility over the

rehabilitation of Río Piedras. The Community Board claimed that they were not

consulted in the visioning process of Río 2012 and that this plan eliminates

opportunities for public participation. To them the plan is not legitimate or

credible because it does not fit the reality of the community and keeps local

knowledge 'out'. From the Mayor's perspective, the Community Board is not a

legitimate political actor because some of its members are not local residents but

involved only for the interests of the church. To him the Community Board was a loud minority, and not representative of the Río Piedras community. In response, the Mayor created a different Community Working Board with residents and business owners he selected. Events such as the *Plaza de Convalecencia* controversy and the questioning of the community over re-development recommendations are useful to understand how knowledge and power simultaneously shape each other such that the politics of expertise are also about politics of identity, visions and expectations of the city. They are also particularly important because the Municipality saw this Plaza renovation as the precedent for future development of all of San Juan urban cores. As such, this case provides a window into the social, political, and epistemic dynamics that are embedded and can possibly be manifested in re-development and planning processes for urban sustainability in other areas of the city. To take a closer look at the boundary work that different actors used to deal with the politics in this case, I discuss the role of CAUCE as a university-community link in the next section and how the credibility and legitimacy of this organization was questioned in an effort to separate the functions of knowledge and action in the rehabilitation of Río Piedras.

3. Dynamics of boundary work to separate knowledge and action

The complexity of this context made boundary work for CAUCE very difficult because it had to manage its credibility and legitimacy with multiple actors at the same time. Key functions such as boundary work involve not just

demarcation of institutional roles, but the deliberation and framing of how knowledge should be used, how, and by whom. Contrary to other examples of boundary work in the U.S., such as science-policy interfaces and boundary organizations where the boundaries between knowledge production and use are more defined (see for instance, Guston 2001), the context in which CAUCE operates in is best described as a knowledge-action system where the boundaries between knowledge and action are more fuzzy and porous.

In a complex knowledge-action system, the function of an organization like CAUCE more closely follows what Miller (2001) terms as hybrid management where value dimensions are made explicit instead of suppressing them. Hybrid management refers to the functions that organizations use to explicitly manage elements of knowledge, identity, and politics – or hybrids - and that have to conduct to maintain their relationships with other actors. Some of these tasks include putting knowledge and political elements together, taking them apart, engaging in boundary work and coordinating activities taking place in multiple domains (Miller 2001). This adequately describes the kinds of activities that CAUCE does in engaging and facilitating both political functions, such as deliberation of issues and visions for Río Piedras, coordinating tasks across the domains of academia, social work, and community capacity building, as well as producing knowledge through research studies that are of relevance to the community and to the specific goal of rehabilitating the town (Figure 6).

Additionally, hybrid management takes into account the broader social context of the organization, such as the politics between the Municipality and the

community in this case, and the role that CAUCE plays in that. CAUCE's role was more complex than just a 'linkage' given that the organization needed to manage multiple political relationships (i.e. university, community, business owners, interagency, state and local government) simultaneously. After a long history of a lack of engagement of the university in its neighboring town, it took many years for CAUCE to gain legitimacy, or to meet the political and epistemic expectations of the community and be considered fair (Ezrahi 1990; Jasanoff 1990).

Hybrid management captures contexts and institutions where the distinction between knowledge and politics is not as sharp. As described above, CAUCE facilitated the development of technical studies to evaluate the physical, social and environmental conditions of Río Piedras. The community, especially the Community Board, came to CAUCE with issues and questions they wanted to explore, such as the validity of the Municipal claims for cutting down the trees in the Plaza, as well as for information and knowledge that reflected their local concerns and own knowledge about the physical and social conditions of the city. As a member of the Río Piedras community notes that "[CAUCE] is a real stage where initiatives from professors, students from different disciplines, and communities leaders of Río Piedras meet and converge" (rioconcauce.blogspot.com). In this way, CAUCE was a vehicle for local knowledge from both the university and the community to interact in the visualization and promotion of ideas for the future of Río Piedras. This example illustrates the co-production of knowledge and the consumption of that

knowledge, between the university and the community for the common goal of understanding and developing strategies for the sustainable development of a city. In this case, while neither CAUCE nor the Community Board had explicit rules or formal agreements for how they should work together, they managed to define together a common problem and questions, coordinate the research and the technical side to explicitly address the questions, and provide recommendations that the community viewed as credible and eventually adopted as part of their plan and vision.

Yet, even in this hybrid role, CAUCE had to engage in boundary work to demarcate its role as a knowledge producer from action to counteract efforts by the Municipality to de-legitimize the role of CAUCE in overseeing the implementation of the rehabilitation plan. The credibility of the UPR and the interagency group was also questioned by the Municipality. From the Mayor's perspective the city could not wait for more studies on Río Piedras and that the interagency group has political motivations (Díaz Alcaide 2007). The Municipality also questioned the applicability of the knowledge and proposed solutions by CAUCE pointing out that since the UPR has taken the leadership role no actions have been implemented and the conditions in Río Piedras continued to decline. By questioning the legitimacy and credibility of the UPR, both the interagency working group and CAUCE could be removed from the 'action' side of the project and let the Municipality execute its Río 2012 project.

Both the Municipality and CAUCE engaged in boundary-making to separate the university from actions to implement Río 2012. In a context where

there are multiple users of knowledge but with different political interests,

entities such as CAUCE can be perceived as taking one side over another.

Indeed, CAUCE was serving as a voice for community interests. From the

perspective of the Mayor, the university aligned with an illegitimate organization

(i.e. the Río Piedras Community Board), therefore lost its legitimacy as a

coordinator of the Rehabiliation Plan.

The boundary work in this case moved from rhetorical to institutional

when the state's Legislature developed a proposal to amend 1995's Law 75 and

transfer responsibilities of the rehabilitation of Río Piedras from the university to

the Municipality. Approved by the Senate (P. del S. 11) and the House of

Representatives (P. de la C. 203), the objective was to restructure the role of the

UPR and the advisory group composed of residents, business owners, and public

agencies, and give the Municipality the authority to name a new Executive

Director. This law also replaced two of the community representative positions

from the advisory group with two Senate representatives, thus further limiting

public participation.

The arguments in favor and against this amendment called into question

the role that CAUCE has had and should have in the rehabilitation of Río

Piedras. Most importantly, the arguments revealed underlying beliefs and values

regarding the roles that *knowledge* and *action* should have in decision-making

and who should make the decision about their distribution. The proposals by the

Senate and House of Representatives frame the need to restructure the

institutional roles in Río Piedras to the lack of implementation on the part of the

UPR-Advisory Group and CAUCE, which as a result has led to little

improvement of the conditions in Río Piedras. The Legislature argued that the

advisory group and CAUCE had only produced one report to the interagency

group (and not multiple ones as the law required), and that no Working Plan was

developed that proposed activities for rehabilitation. On the other hand, the Río

2012 is presented as the only action plan that has been implemented in the area

and which incorporates development strategies and a concrete urban vision for

the area. As the House Proposal stated:

> The Municipality has the knowledge of the specific needs of the area, its
> strengths and opportunities, while at the same time it provides many of
> the services required, therefore should be the one in charge with carrying
> out the purposes of this law [Law 75]. In that way the process can move
> forward faster and the administrative efficiency in achieving the goal of
> the public well-being increases. (Commonwealth of Puerto Rico, House
> of Representatives 2009, page 2)

The argument that the UPR, through the Advisory Group and CAUCE,

was not being effective at executing the rehabilitation plan was also the rationale

behind the president of the Senate's commission heading the proposal, Senator

Larry Selhammer Rodríguez,[34] decision in favor of the Municipality. In a

personal interview with the Senator, he expressed that the intention of the

university and the advisory group's involvement in the rehabilitation of Río

Piedras was good, but the Municipality is ultimately who establishes public

policy. To him the role of CAUCE was effective in coordinating with the

community and conducting research, not action. The operational and executive

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[34] Interviewed August 27, 2009

function wasn't working and the Municipality's Río 2012 was a plan of action that met the original rehabilitation goals.

This framing was in large part due to the information and knowledge that the Senator and the Commission received about the situation in Río Piedras, the work by the UPR, and the Río 2012 plan. In the beginning of the interview, the Senator qualified that he was assigned president of the commission because of his background as an engineer, but that as Senator from a different district, he had limited personal experience in San Juan or Río Piedras. He noted that what he learned about the Río Piedras came from Río 2012, his colleagues in the Legislature and from two public meetings[35]. When asked if any of the studies or reports developed by CAUCE or the university's Architecture Deparment with recommendations for rehabilitation were included as part of the information reviewed for the decision, he responded that he was only aware of a few studies, but not directly familiar with them. The Senator also pointed out his surprise at the lack of analysis and mention of CAUCE in the one-paragraph Letter of Comment submitted by UPR's President and their absence in the public meetings (although representatives of CAUCE did attend). He then showed me the Municipality's two-page letter and the extensive presentation that the Director of Río 2012 gave to the Commission outlining all the problems and potential solutions for Río Piedras. In the presentation to the Comission, the Municipality

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[35] The final version of the Senate's proposal includes a section on the background of the problem and arguments for the Municipality's role that is almost verbatim from the comments that the representative of Río 2012 appointed by the Mayor, Luis A. Velez Boada, presented during a public meeting to the Senate (March 12, 2009), showing that the Municipality's comments were included in the execution of the law.

makes a clear argument why it should have a leading executive role and how the

Río 2012 is an *action plan* with representative graphics of what could and should

happen in Río Piedras, while the Advisory Group and CAUCE had produced no

action plan (Vélez Boada 2009).

In a clear strategy of boundary work, the Municipality was effective in

appearing as the credible and legitimate entity to carry out *action* in the Río

Piedras while delegitimizing the role and expertise of the university. The Mayor

stated in a letter to the Comission's President that:

> …the current institutional structure [UPR-Advisory Group-CAUCE] has
> not implemented any measures to improve conditions in Río Piedras nor
> has it even been successful in integrating the university and the
> community. …besides some meetings and activities of a political nature,
> the group has not contributed anything significant to the sector." (Santini
> Padilla 2009)

CAUCE also established its boundaries as it defended its position and the

outcomes and impacts it has had in Río Piedras. As conceived by CAUCE's

director, the organization didn't see a separation of knowledge and action, but

instead, saw action as encompassing many different things, such as visioning,

planning, coordinating, as well as knowledge production and implementation.

Yet, CAUCE still had to engage in boundary work to demarcate what was and

what *wasn't* its role in the knowledge-action system. In response to the

legislature's proposals CAUCE's director claimed publicly that as a university-

based organization was never meant to do the 'executive' action and have a

leading role in implementing a plan which they admit is the responsibility of the

Municipality. Rather, CAUCE's role was to coordinate and facilitate the various

actors, including the Municipality, in executing the diverse actions needed in the rehabilitation of Río Piedras.

Clearly demarcating the roles of the university and the Municipality was important for CAUCE and the community to counteract the Municipality's and Legislature's argument that the existing structure wasn't successful. In response to the Senate's view that the UPR was trying to have a leading role in Río Piedras when it should be the Municipality, CAUCE's Director argued that the only leading role that the Río Piedras Campus [UPR] aspires to in the urban center is intellectual and civic, a legacy that it has in the University City" (Giusti Cordero 2009, p. 2).   He later commented in the press:

> "The University of Puerto Rico doesn't aspire a leading role in Río Piedras; there is enough work to do here. Under the Law 75, the university's role is coordination, research, and community development… This role should not be confused with the executive role of the Municpality and state agencies that have their mission and responsibility here as in other urban centers. The University does not have the infrastructure or resources to plan the urban center…" (Giusti Cordero 2009)

CAUCE's Director also clarified numerous times the practices that the organization was supposed to take and its outcomes. He points out the various social and cultural activities they've supported and the alphabetization and reading classes they provide to the community. CAUCE provides consultation to local business owners and capacity building for local community leaders, in addition to the student projects, theses, interns, and studies that the coordinate and facilitate with various departments of the university. They also run a community garden in Capetillo, one of Río Piedras's neighborhoods, as a participatory research demonstration project where community members, children, professors

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and students together maintain the garden and clean and conduct restoration

studies for the creek nearby. Outlining all the activities that CAUCE has

incubated, promoted, and achieved was not only a way to show the success of the

program, but it also defined the institutional role that CAUCE has as a knowledge

producer, mediator, and user. Most importantly, the Director has created

boundaries between the action of using knowledge and ideas to support

community capacity and plan development, versus the action of execution and

implementation that is the responsibility of the government.

One important weakness in this structure, however, was a lack of

institutional support from high-levels of the university's administration and from

university departments. The university's chancellor was supportive of the

coordinating and research component as a way to complement the generation and

debate of ideas by the Advisory Group, the interagency group, or the Municipality

with analysis and knowledge production. In a personal interview[36], she expressed

her view of CAUCE's role as one that not only supports the community, but

provides technical support to the Municipality and together come up with

mutually agreeable strategies for the stakeholders involved. This sentiment,

however, seemed not to be shared by the university's President. While the

President's office has publicly expressed its support for CAUCE and considers it

a working community model of high institutional interest for the UPR System,

there has not been an official statement of support. The letter from the

university's President to the Commission overseeing the Senate's P.S. 11 proposal

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[36] Interviewed August, 2009.

included only one paragraph requesting that the community's interests and concerns be considered in the decision, but it lacked any argument in favor of the university or CAUCE in maintaining its responsibilities according to the 236 Law. Senator Selhammer Rodríguez considered the university's letter 'weak in analysis' and a sign that the university wasn't clearly invested in CAUCE. CAUCE's director believes that the university's administration sees the organization solely as social work entity, and not a scientific one (e.g., hard science). Therefore they don't give it the same priority as its other scientific research programs. This has also made it difficult to attain the commitment from university departments at the institutional level and allow its professors to take a more active role in CAUCE. Professors from planning, architecture, natural sciences and law that are active in CAUCE do so out of individual interest and not because they receive incentives or rewards from their departments.

Despite the lack of institutional support from the university, most of the actors I interviewed viewed CAUCE as an active collaborator as well as an entity that develops useful, relevant and credible information and knowledge for the rehabilitation of Río Piedras. The importance of CAUCE in Río Piedras was actively voiced by these actors and they requested the Legislature to not pass the proposals through petitions, the media, and attending public hearings. The community wanted to protect this community-university link that provided them a way to have the voice and role in the development of Río Piedras that they felt Río 2012 was not allowing. They tried to reframe the view that CAUCE had not produced any outcomes by distributing lists and talking to the press about the

various community projects, activities, technical studies, capacity and training

activities they have done in Río Piedras. Their approach was to show that

CAUCE was *acting* and not just doing studies, and that its role is crucial not only

to maintain university-community relations, but to achieve a democratic and

inclusive process towards the rehabilitation of Río Piedras.

Nonetheless, the proposals were eventually approved and signed by the

Governor in 2009. The leadership role of UPR in the Interagency Group was

transferred to the Municipality and the Mayor gained the authority to name a new

Executive Director, thus taking CAUCE out of the coordinating role for the

rehabilitation of Río Piedras (Figure 5). While CAUCE still remains as a

university's unit to serve as a link with the community, through this public policy

the state exerted authority over how the university-community-government

interaction by separating the functions of knowledge (UPR-CAUCE) from the

action (Municipality). In this way, the Municipality and the State Legislature

imposed a rigid boundary between the university and the community by appealing

to the perspective that the functions of knowledge production and action should

be distinct in the context of planning and public policy. As CAUCE's director

saw it,

> "The efforts [to decide on the administrative responsibilities]
> should've met in Río Piedras. The House only adopted the Senates
> project, it approved it and made a report at the last minute.
> Everything has been done with an imposing attitude. With this
> action the structure of consultation, research, and linking of
> capacities in favor of Río Piedras was dismantled" (Alvarado León
> 2009).
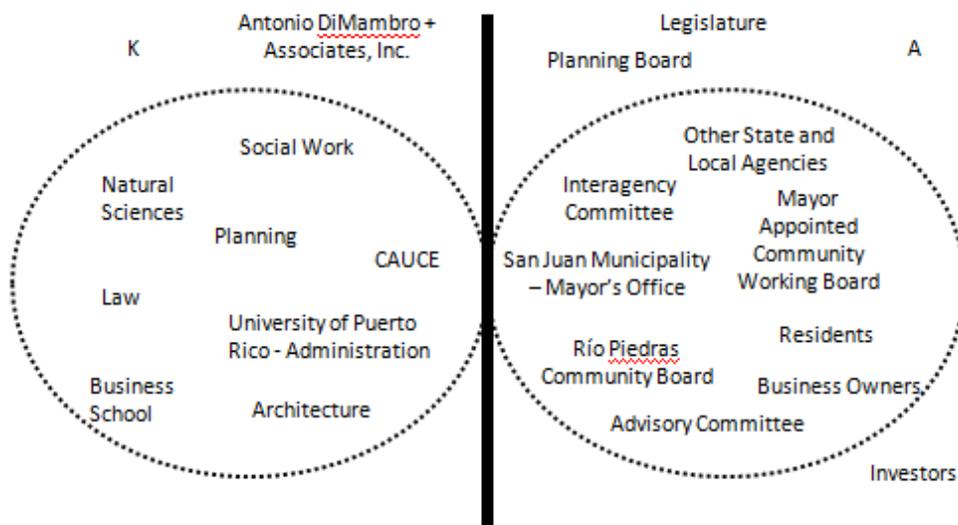
Figure 5. The knowledge-action system landscape of the rehabilitation of Río Piedras after the passing of the Legislature's proposal to transfer coordinating responsibilities from the university and CAUCE to the Municipality. This figure illustrates the artificial boundary imposed, both rhetorical and institutional, between knowledge and action.

The rigidity of the boundaries, both in politically and in terms of the institutional structures, is a key barrier to the transformation of this city. In *Unbuilding Cities: Obduracy in Sociotechnical Change*, Annique Hommels (2008) describes this rigidity as 'obduracy', or the lack of flexibility in traditions, fixed frames, and expectations of what the city should be and look like. Obduracy is common in sociotechnological systems, or systems that have both social and technological elements, such as cities because buildings, for instance, are not just difficult to change physically but in terms of the ideas, visions, and expectations embedded in them as well. Hommels examples of obduracy in Dutch cities to new building strategies, or the 'unbuilding' of old

structures, helps illustrate the crucial role that the malleability (or flexibility) of ideas and different ways of seeing that people have play in the planning process. Based on three cases of city planning initiatives to redesign old urban structures, Hommels found that the Dutch political and social context, although expressed in different ways for each city, was in general quite rigid and fixed on traditions, old frames, and expectations of what the city should be and look like, which made it difficult for planners to reconfigure or adapt technological and social structures in the city. T he idea of 'obduracy' is related to path-dependency, but it goes beyond the economic or technological structures that are deeply embedded in cities to considers also how rigid ways of thinking can be a difficult barrier to overcome for urban change.

The political culture in Río Piedras is also experiencing obduracy. On the one hand, the modern visuals of DiMambro that the Mayor is adhering to are creating rigid frames of what the city should look in the future without being reflective of the identity of this town. The Mayor's Río 2012 project is controversial partly because its design process was 'closed' to alternative framings, ways of seeing the city, and definitions of uncertainty or alternative future pathways. On the other hand, the community vision, while future oriented in its expectation to have a more sustainable community, was linked to Spanish traditions of city planning and design. Old world traditions influence the importance that the community gives to historic preservation (Figure 6). However, as Hommels has observed, these persistent traditions can be an obstacle to urban renewal strategies. Finally, while CAUCE was a vehicle for

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incorporating alternative framing into the knowledge system, it wasn't effective

at managing its relationship with the Municipality and the community, thus

falling vulnerable to top-down boundary work. The lack of a strong

commitment from the university's administration didn't help CAUCE secure its

credibility and legitimacy form the Municipality. In terms of sustainability, the

obduracy in frames, traditions, political expectations may become an obstacle to

the kind of political and socio-technological changes necessary to make cities

more sustainable.

Figure 6. Visual representations of old town plazas as recommendations for the renovation of the Plaza de Convalecencia made by the CACUE-EGP study and the Rio Piedras Urban Core Community Board. Source: University of Puerto Rico's Graduate School of Planning.

Understanding both the context of the political culture regarding

knowledge and expertise about the rehabilitation and planning of this urban

core, and the role of institutions involved in linking knowledge and action from

the perspective of boundary work is useful to explain why organizations such as CAUCE can effectively manage university-community interactions, yet at the same time unable to overcome the rigid boundaries between knowledge and action. As Miller et al. (2010) explain, because knowledge-making occurs in close dialogue with decision-making processes, their integration is often so systematic (and, often, as a consequence, unapparent even to participants) that it is impossible to fully separate knowledge-making and decision-making activities. As a result, knowledge systems face a constant risk of the appearance of policy or political considerations relevant to decision-making inappropriately influencing knowledge-making.

The boundary work of top-down structures, however, was too powerful for CAUCE to defend its credibility and legitimacy. In this case, CAUCE needed to also manage more actively its relationship with the Municipality, particularly with the Mayor's office, as another stakeholder in Río Piedras. Jasanoff (1990) argues that although some level of boundary work is always necessary, organizations that explicitly integrate science and politics are ultimately more likely to be more effective at resolving difficult questions of policy-relevant knowledge. I add that, in this case, effectiveness also depends on managing hybrids at multiple institutional scales. The deliberation and management of the relationship between knowledge and action needed not to happen only in Río Piedras and about CAUCE, but also at higher institutional levels to deliberate the relationships and politics between the university, the Municipality, and the state. CAUCE was able to manage its relationship with

the community because it used strategies appropriate to a hybrid relationship, such as taking time to develop trust with community members, providing capacity and not imposing actions, serving as a stage for deliberation and linking the necessary knowledge, among others. Yet, at the same time, it also adhered to the myth that knowledge and action are separate spheres in governance in order to maintain its legitimacy and credibility.

4.   Conclusion

The case of the rehabilitation of Río Piedras demonstrates the difficulty of effectively linking knowledge to action in complex systems where there are multiple knowledge producers and multiple users of knowledge interacting at once. The implications of this small case study is that the ability to build just and effective knowledge-action systems for urban sustainability largely depends in managing multiple expertise and allowing different types of boundary work. Boundary making happens all over governance systems, not just between science and politics. This case illustrate that it is impossible to separate the politics of expertise and knowledge from the politics of identity. As such, efforts to transition to sustainability is not only about developing more knowledge, but about understanding and managing the political spheres where values, expectations, and ways of knowing the city need to be made explicit, deliberated, and trade-offs negotiated.

Chapter 7

Conclusion: Synthesis and Propositions for Designing

Knowledge-Action Systems for Urban Sustainability

1.   Introduction

This investigation examined how knowledge-action systems work in cities in order to inform what capacities are necessary for the local governance context to effectively attain sustainable outcomes. Specifically, this study evaluated how well the existing knowledge-action system is addressing and building capacities to meet sustainability goals in San Juan, Puerto Rico. Knowledge-action systems are the networks of actors/institutions involved in the production, sharing and use of policy-relevant knowledge.   As Chilvers (2007) has noted "the science-policy interface is being extended to include new actors, new forms of expertise, and new knowledge practices, under conditions of radical uncertainty, contestation and distrust of science in late modern society." (p.2991). Yet, little is known about how knowledge-action systems work in cities and how they should be designed to address the complexity of these urban systems. To address this gap I developed a conceptual framework for examining knowledge-action systems in cities and a practical understanding of how they work through a case study of urban land use planning and governance in the city of San Juan, Puerto Rico.

This investigation has made both theoretical and empirical contributions to understanding how to best link knowledge to action for sustainability. The most significant theoretical contribution is the synthesis of diverse literature on governance of sustainable systems, science and technology studies (STS), and

urban planning to explore the knowledge capacities necessary in the diverse, dynamic, and complex governance context of urban systems. Empirical contributions include a multi-method examination of how knowledge-action systems work using social network analysis, epistemic cultures and boundary work as the three analytical lenses. Through a thick analysis that employs quantitative and qualitative methods on existing knowledge-actions systems in San Juan, I identified multiple barriers and opportunities to effective knowledge-action systems that can be applied in cities in general.

This chapter has two purposes. It begins with a summary and synthesis of the findings from evaluating how existing knowledge-action systems in city of San Juan, specifically in the context of land use and green area governance in the city. Results from the analysis reveals that while there is epistemological diversity reflecting a potential for multi-scalar creative and innovative capacities to address land use sustainability, these capacities are hindered by various institutional and political factors, such as: 1) breakdown in knowledge flow between state and local actors; 2) divergent visions of future urban development, especially within the Municipality itself, resulting in a lack of shared imaginary of sustainability for the city; 3) extensive boundary work by multiple actors, including state, city, community members and the university, to question each other's legitimacy and credibility in an effort to gain authority over the implementation of actions; 4) and privileging knowledge from outside experts, therefore reflecting a competing network of knowledge also influencing land use and green area planning in San Juan. The larger part of the chapter considers the challenges in analyzing and

evaluating the complexity of knowledge-action systems in cities and presents

three propositions, or conditions, to building effective knowledge-action systems

for sustainability. I will argue that knowledge-action systems are likely to be

more effectively at addressing the complex context of cities and supporting

innovation and implementation of sustainable outcomes if they are inclusive of

multiple knowledges, contextually relevant and credible to decision-making,

reflexive of the potential impacts of the knowledge and technologies being

produced and be able to change when needed, and have a polycentric network that

mirrors the local institutional context.

2.   Synthesis: How Knowledge-Action Systems Work in the City of San Juan.

The study of San Juan confirms that knowledge-action systems in cities

work in very complex ways. Linking knowledge to action is not straightforward

as depicted in conventional models of one way knowledge transfer through

science-policy interfaces. How knowledge and action interact in a particular

place is embedded in cultural and institutional practices and social relations that

have evolved over time. This context influences how actors produce and use

knowledge in decision-making, hence, having a direct impact on the acceptability

or productivity of new knowledge to address sustainability problems.

The overall story in San Juan is that the ability of city planners, decision-

makers, and citizens to be innovative in envisioning, producing and implementing

solutions to make the city sustainable is hampered by barriers in the flow of

knowledge across the institutional landscape, conflicting visions and identities of the city, and politics of expertise that inhibits marginal, local knowledge from entering the city's visioning and planning process. While the knowledge-action system in this city is heterogeneous and multiple knowledge systems are interacting, the possibilities of these to be integrated, managed, and put into use — in other words, to inform sustainability science and action — are challenged by pre-conceived ideas and visions of what the city is and should be, as well as power dynamics that limit collaboration, knowledge sharing, and flow of ideas. Put differently, the capacities for multi-scale creativity and innovation for urban sustainability in San Juan are already in the network's structural and epistemic diversity, at least in terms of land use and green areas. How to overcome the cultural and political barriers so these capacities can be harnessed and put effectively into use to solve sustainability problems is the big question for governance. This study offers a first step in understanding and dealing with these barriers.

These contextual particularities, however, might preclude us from having universal truth about how knowledge-action systems work in cities in general. We might ask, what can we learn from San Juan? I argue that, while developing a theory of knowledge-action systems for urban sustainability is too ambitious a proposal for a study that is trying to understand system complexity, at the very least we can gain lessons, or hypothesis to be tested further, which then gives us a point of comparison or perspective when analyzing different cities. Critics may say though that the case of San Juan is too particular or distinctive because of its

unique socio-political situation as a US territory with cultural traditions tied to Caribbean and Spanish histories. I also argue that it is precisely this uniqueness that makes San Juan a useful case study, since it presents an extreme point for comparing the complexity of these systems. In addition, it offers an opportunity for opening the conversation on how do we even tackle the complexity of these systems. Therefore, in addition to summarizing the lessons gathered from the analysis of San Juan's knowledge-action systems, this section discusses the strengths and weaknesses of each of the three conceptual lenses used to tackle the complexity from different angles – social network analysis, epistemic cultures, and boundary work. A general point that emerges from this analysis and applies to any city is the need to analyze and evaluate existing knowledge and power relations (i.e., knowledge-action systems analysis) in order to determine the appropriate and effective designs for knowledge-action system in addressing sustainability. Following this discussion I present three design criteria, or propositions, which were inspired by the San Juan case study but that are relevant to knowledge-action systems for urban sustainability in general.

2.1 Network Analysis

In Chapter Four I call attention to the structural complexity of knowledge in the context of cities and stress the importance of examining the actor's power position to understand how, and what kinds of knowledge, are having greater influence in the governance landscape. Results from network analysis revealed a diverse network of actors contributing different types of knowledge– from scientific, planning, organizational, to local – to urban land use and green area

governance context in San Juan. While there is a small group of actors that dominate knowledge flow, and therefore the information, ideas, and visions that circulate through the network, this too includes marginal actors (e.g. NGOs) not traditionally associated with knowledge production. Based on social network theory, a greater diversity of actors reflects a potential for multi-scalar creative and innovative capacities to address land use sustainability. This potential is hampered, however, by knowledge hierarchies and breakdowns in knowledge flow in San Juan. Specifically, three weak areas in the network require attention. Two of these have to do with the linkages, or lack thereof, between the state and the city. There is a breakdown in knowledge flow between the Planning Board and the Municipality's Office of Territorial Planning and Ordinance, and between the Planning Board and civic organizations. This breakdown is a huge barrier for addressing urban sustainability in San Juan given the powerful position the Planning Board has over urban planning decision-making and policies for San Juan and the larger metropolitan region. It is vital that the two key decision-makers for the city, the state and the Municipality, engage in knowledge exchange and collaborate to address and implement sustainable outcomes effectively. Similarly, as has been argued before, a lack of connection between the state and local knowledge can lead to planning failures (Scott 2005).

On the other hand, local knowledge in San Juan appears to be flowing through the Municipality's Office of TOP, the largest university in the city (University of Puerto Rico), and other local organizations. In addition, a local non-governmental organization (Sustainable Development Initiative) and a

federal research institute (International Institute of Tropical Forestry) are helping connect multiple organizations and can potentially serve as boundary spanners for the overall network. These institutional relationships and roles are crucial capacities which, if fomented, could help strengthen the overall network. For instance, assisting the Municipality with the analysis and evaluation of the 2003 social and ecological outcomes of the Territorial Ordinance Plan for San Juan and making this knowledge widely accessible through multiple boundary spanners is a small, yet direct, way of increasing local network capacities. This is but one example of ways the network can be strengthen through 'tweaking' or transforming local institutional relations.

Previous conceptions of knowledge systems present them as a simple interaction of knowledge dissemination between knowledge producers and users. Through social network analysis it is evident that the connections between actors can have an effect on how knowledge systems work in a given place, at least in terms of knowledge circulation. Scientists, planners, and practitioners working towards building capacities for urban sustainability would benefit greatly from this structural understanding knowledge networks in the city. Examining knowledge-action systems through network analysis, however, does have its limitations. In general, network analysis provides a static picture of social structure and the outcomes of this structure, but lacks the ability to capture changes in dynamics over time. In other words, this analysis provides only a snapshot in time and no explanation for how these relationships have come to be

or how they will change in the future.   As such, social network theory can only

capture one aspect of knowledge-action systems.

The conceptual models applied in Chapters Five (i.e., epistemic cultures)

and Six (i.e. boundary work) are necessary to complement network analysis by

examining the dynamics of how the knowledge is produced and used in decision-

making over time. Network analysis is also very sensitive to data gaps, meaning

that the absence of one actor, or node, can affect other linkages in the network. In

this case, some actors were absent from the network, specifically community-based

groups and the private sector, in the network. In the San Juan case, for instance, the

Mayor's Office did not complete the questionnaire even though they were

approached numerous times throughout this study. The absence of this actor's

network could explain some of the breakdowns in flow, such as, being the link

between the Planning Board and the city. It also misses a dominant epistemic

culture – the *bureaucratic-aesthetic culture* – that is influencing the Mayor's

vision for the future of the city and which is different from the Municipality's

planning and civic perspectives. Without the vision and epistemic culture analysis

that follows, the knowledge-action system in this investigation would've not have

been comprehensive if it relied on social network analysis alone.

2.2 Visions and Epistemic Cultures

Analysis of the diversity of future visions and epistemic cultures in

Chapter Five demonstrates that an understanding of how knowledge systems

work, or how different groups come to 'know' the city, cannot be separated from

the expectations and political goals that society has of the future of the city, or

how people 'imagine' the city and act based on that vision. And vice versa, how people 'imagine' the future city is influenced by the knowledge practices that different social groups employ in 'knowing' the city. Given that urban sustainability conjures up many different issues to different people, strategies and actions will be effective to the extent that they are linked to these complex institutional and cultural landscapes. Understanding existing visions then offers a broad perspective of the urban imaginaries of city dwellers, thereby contributing a big picture context to the exercises of scenario-building and indicator development. These exercises, in turn, will be more effective at helping envision future states because they speak to the shared beliefs of the urban community.

In the city of San Juan I found four different future visions co-existing in the city: 1) San Juan the Economically Sustainable City; 2) San Juan the Livable City; 3) San Juan the Modern City; 4) San Juan the Ecologically Sustainable City. These visions differ in their emphasis of sustainability, spatial and temporal scales, participatory processes, and the epistemic cultures supporting each vision. While sustainable development is a term found across all four visions, they still optimize one dimension of sustainability. The dominant visions of the state and the city -- the San Juan Economically Sustainable City and the San Juan Modern City -- place more emphasis on sustaining economic viability and productivity of the city and the region. The ecological dimension is addressed narrowly in terms of minimizing environmental impacts, but a comprehensive assessment of natural resource distribution and long-term renewal is missing. On the other hand, the Ecologically Sustainable City, while filling the gap in terms of the city's

environmental sustainability, does not clearly articulate an economic and social dimensions of a sustainable city.

The Livable City vision presents the closest integration of the economic, social, and ecological dimensions for planning the city. However, the specific strategies presented in the vision focus primarily on improving current conditions and a clear articulation of future strategies, especially in light of climate and environmental change, are not addressed. For example, the Municipality's Territorial Ordinance Plan has a strategy for protecting remaining green areas in the city through conservation. A strategy for resource renewal and long-term protection of watershed functions, for example through increasing green infrastructure or urban food production, is lacking. The key point here is that none of the visions offers a comprehensive future vision, or imaginary of urban sustainability, that integrates economic, social, and ecological dimensions into a present day and long-term development strategy for the city of San Juan.

The lack of integration in the future visions of San Juan can be explained in part by the way that city actors 'see' and 'know' the city. Each of the visions found in San Juan is supported by different groupings of epistemic cultures — or interlinked knowledge systems — underlying the way that social groups come to imagine the city of the future. The following epistemic cultures emerged from the analysis and overlap with the future visions in their respective order: 1) bureaucratic-planning culture; 2) bureaucratic-aesthetic culture; 3) civic-stewardship culture; and 3) scientific-managerial culture. The dominant visions of the state and the city Mayor's office are both supported by conventional urban

planning visions that emphasize economic efficiency and simplicity in design through their planning practices and ways of thinking. The ecological vision is supported by a scientific-managerial culture that privileges the natural sciences, and thus, lacks the social science integration needed to understand the city as a complex socio-ecological system. The livable city vision incorporates a social planning perspective and local knowledge with the urban planning tradition but also lacks a dynamic perspective of the city as a complex socio-ecological system. In addition, none of these visions were developed through an active public participation process which limits the inclusion of public ways of knowing into the overall discourse of the future of the city.

The science and technology studies literature suggests that the presence of different groups of visions and knowledge is not unusual, but in fact are more common than previously thought. Referred to as *civic epistemologies*, these distinct groupings of judgments, reasoning styles, and ways of reviewing policy-relevant knowledge are what shape the expectations and acceptability of knowledge problems (Miller 2004, Jasanoff 2005). In other words, even when there is scientific consensus about a specific policy problem, this knowledge may not proceed to be integrated and used in the political process because there are other epistemic cultures coming into the process as well. These civic epistemologies influence the credibility, legitimacy, and relevance that is assigned to scientific knowledge. In the context of San Juan, while the bureaucratic planning culture has been the conventional way of knowing the city, it is now meeting resistance from civic and scientific epistemologies that see and expect

different things from the city. A clear example is the divergence of visions within the municipality itself because the Mayor's office and the municipality's Office of Territorial Ordinance are using different epistemic cultures in analyzing and crafting their city visions.

The heterogeneity of visions and knowledge systems in the context of urban planning and politics in the city of San Juan leads to question the repercussions of a lack of imaginary of urban sustainability that can integrate, or at least converge on what the identity of the city is and what its future should be. More importantly it raises a more broad issue that if sustainability is defined for each city, how should anticipatory and knowledge systems be designed to appropriately develop scenarios, strategies, and indicators to assess the outcomes of these visions and their possible alignment. The key message is that city is 'seen' by different actors in different ways, and open deliberation of both the 'knowledge' and the 'action' is crucial in the formation of strategies for sustainability (Chapter Three). As such, knowledge-action systems for cities should be designed with urban civic epistemologies in mind. In this way, envisioning the future through scenario analysis exercises, for instance, can be both a descriptive and normative tool for integrating multiple knowledge systems and expectations of urban actors.

Take for instance a recent analysis of cities transitioning to sustainability by Stephen Moore (2007) — Austin, Curitiba, and Frankfurt — and how each of their visions and strategies were a product of the way that social groups in the city talked about the city, or their collective *storylines* of the city. Understanding

these storylines that encompass both normative and descriptive elements of the city, explained the unique dispositions that each city employ in implementing sustainability. Similarly, I pose that looking at urban visions and imaginaries can, with the help of science and other knowledge systems, facilitate a public conversation that generates political useful expectations about the future of cities. Finally, understanding visions and imaginaries has crucial implications for urban sustainability. Examining the shared ways that diverse groups conceive of the world, their expectations, and future options for the city can bring to light the plurality, and perhaps conflicting trade-offs and uncertainties inherit in visions of the future. Visioning processes can also expose the often implicit assumptions of how humans and nature interact.

This knowledge is crucial to understand the social dynamics influencing how knowledge flows and is used in this context that a static structural analysis such as networks cannot provide on its own. To take the social dynamics underlying how knowledge-actions systems work in the context of urban sustainability even further, I examined how different actors in the city use boundary work to provide credibility and legitimacy to their expertise in the process of planning the city.

2.3   Boundary Work

Analysis of how multiple actors interact in the production, validation, and use of knowledge for sustainability is crucial to an in-depth understanding of how knowledge-action systems work. This analysis provides a window into the politics of expertise, or what knowledge counts or doesn't count in this

institutional context and why, and ultimately, what knowledge gets used in decision-making. Chapter Six takes a closer look at knowledge-action systems dynamics and the politics of expertise through the lenses of boundary work. Boundary work here refers to the work done rhetorically and institutionally to demarcate the functions and authority of different types of knowledge in informing decision-making and implementation of development actions. I used the case of a controversy over re-development and deforestation of one of San Juan's urban cores, Río Piedras, as a window to how various actors, including the community, the university, the Municipality, and the state, interacted in producing, debating, and validating claims and visions for the future of this town. This case illustrates the complexity of urban planning and politics and the difficulty that this presents to knowledge-action systems. The effectiveness of knowledge-action systems depends on their ability to manage the credibility, legitimacy, epistemologies, and interests of a diverse, and often conflicting, landscape of actors, especially in a distinctive multi-institutional context. In this way, this case provides a microcosm of the factors that make knowledge-action systems work and not work in a complex system such as the city of San Juan.

In an unprecedented effort to institutionalize a linkage between the University of Puerto Rico-Río Piedras, the community, and the government to develop knowledge and rehabilitation strategies for this town, the university was given the responsibility under the law to coordinate these relationships. The university created the *The Río Piedras Urban Action Center,* or as it is locally known as CAUCE for its Spanish name Centro de Acción Urbana, Comunitaria y

Empresarial). Along with an Interagency Working Group and community

Advisory Group, CAUCE became the institutional vehicle to facilitate the various

actors involved in research, understanding, and deliberation of ideas and

proposals for improving the conditions of Rio Piedras. In other words, this

institutional arrangement became a knowledge-action system and, from the

perspective of the community and some university members, it was effective.

When it came time to deliberate knowledge and actions with the Municipality's

Mayor over a controversial re-development plan, however, CAUCE wasn't able

to this relationship successful. The state and city conducted extensive boundary

work that questioned the credibility and legitimacy of CAUCE in producing

results for Rio Piedras and ultimately the authority was transferred from the

university to the Municipality. Here boundary work was done both rhetorically

and institutionally. The State and City argued effectively that the Municipality

should have the authority over 'action' and the university over 'knowledge',

creating a rhetorical boundary between the two institutions. While CAUCE tried

to clarify the various roles that 'action' involves and that they were effective in

achieving their intended goals, ultimate the state imposed an institutional

boundary through legislative action that took away CAUCE's role as coordinator.

The lack of institutional support for CAUCE from top administration levels of the

university was a key factor in the Senate's decision to pass responsibilities form

the university to the Municipality.

At the core of this controversy was also a conflict between different ways

of 'seeing the city', but more importantly, who's vision and knowledge has

greater authority over planning and decision-making. In Chapter Five I describe the differences in visions and epistemic cultures between the Municipality's Río 2012 Plan and the local community. Specifically, the community argued that the lacked local context because it was developed by an outside architectural and urban design firm that did not incorporate public participation in the design of the project. They see the plan as visuals without content. On the other hand, the Municipality views the knowledge and expertise of this firm as a more credible form of expertise to develop a plan that can be put into action. While the community, with the assistance of CAUCE and university professors and students, developed studies that proposed alternative recommendations that they believe reflect the reality and needs of Río Piedras, these proposals and studies were not included in the Mayor's re-development plan or the Senate's decision to transfer authority to the Municipality. In this way, outside expertise was favored over local knowledge and experience.

I argue also that the Mayor's plan was also controversial because it was 'closed' to alternative framings and future visions of the city. The rigidity, or obduracy, of this plan can be a barrier to moving forward and successfully implementing actions for sustainability in this case. The rigid boundary also imposed on the university will also likely be a barrier to the flow of local knowledge into decision-making, thus compromising the adaptive capacity of the city. Given other planning failures in the past due to these barriers to local knowledge flow (e.g., Scott 2005), it is questionable that the outcomes of the Mayor's plan will be successful and sustainable over the long run. While CAUCE

provided a hybrid institutional structure to explicitly deliberate the knowledge and the politics of alternative framings and identities that more closely fit the local context, top-down boundary work ultimately limited its success.

This case illustrates the complex but necessary function of managing multiple relationships at multiple scales in order to secure credibility and legitimacy in this institutional context. Through the lens of boundary work I was able to capture the institutional dynamics that worked and didn't work in the case of Río Piedras. This provides a more thorough understanding of the functioning of knowledge-action systems in addition to the structural and epistemic elements presented in Chapters Four and Five. For instance, this analysis captured a crucial knowledge system influencing the decision-making process of the Mayor, the private firm that developed Rio 2012 and which is also developing plans for San Juan's other urban cores. This knowledge system is directly influencing the way that the Municipality 'sees' the city, yet it wasn't captured in the land use and green area knowledge network. In other words, analyzing knowledge-action systems from the lens of network analysis alone would've have missed this competing knowledge system completely. It is important then that an interdisciplinary and multi-method approach be employed to handle the complexity of knowledge-action systems.

3.   Implications: Cultural and Institutional Barriers to Building Effective Knowledge-Action Systems for Urban Sustainability in San Juan.

The case of San Juan shows that developing the adaptive and innovative capacities necessary to envision and implement sustainable outcomes is not solely

a matter of generating and harnessing more science or technology. Actors in San Juan are already producing knowledge relevant to urban sustainability. While the content and usefulness of the knowledge produced can be questioned (e.g., lacks complex thinking and interdisciplinary approaches), the real issue lies on the cultural and institutional barriers that limit how this knowledge is evaluated, shared, and used to inform a public conversation about the future of San Juan. In other words, the problem to building capacities in San Juan is not that knowledge is not being produced or used for sustainability. If anything, it shows that decision-makers and political actors are actively relying on their knowledge systems to support their visions and expectations of the city. The problem lies on the politics of expertise and the diverse ways of seeing the city that underlie how knowledge is debated, selected, and used in the policy process. As a San Juan resident expresses

> Both the knowledge and the information are available in San Juan. The fundamental problem is the external validation of each, their accessibility, and their transfer into public debate such that they can influence decision-making and transform public policy.

Understanding these barriers shifts the discussion of knowledge for sustainability from a quantity or supply problem (i.e., building more relevant knowledge), to transforming the cultural and institutional barriers that hamper innovation and adaptive capacities towards sustainability. In San Juan, four cultural and institutional barriers are crucial to address in order to transform knowledge-actions systems for urban sustainability. Two of the barriers are

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cultural, including a lack of critic or public debate about different visions of the future of the city, especially within the institution of the municipality itself, and epistemic cultures that lack an integrated and complex system perspective of cities as socio-ecological systems. Institutional barriers include failures in the flow of knowledge across the network, especially in key sites where the state and the municipality should be interacting, and political boundaries that keep local knowledge from getting 'in' the urban visioning, planning, and application process. The design criteria I propose in the next section for building-knowledge action systems address these barriers. In the case of San Juan, however, it is important that the strategies recommended in Text Box 1 are taken in order to overcome or transform the particular cultural and institutional barriers found in this context.

Another crucial institutional and cultural barrier in San Juan that is not directly addressed in this analysis is corruption. As discussed in Chapter Three, state and local agencies in Puerto Rico are vulnerable to the pressures of pro-development interests (i.e. land development and construction) (Concepción 2006). Various cases of corruption in the permit process to allow land development have been documented. Agency planners express frustration over the tendency of top-management to hire advisors based on personal or political reasons, what they describe as *amiguismo* (friendship), but they lack the technical and administrative background to understand the complexity of the issues as well as the organization's administrative and legal framework. Even when the

information and resources are available, bureaucrat planners and technicians

believe that the current technical evaluation and permitting process makes it

Text Box 1. Strategies recommended to transform cultural and institutional barriers to knowledge-action systems for urban sustainability in San Juan.

1. The relationship, visions and roles of the state and the municipality need to be clearly articulated. Power play among these two entities stifles implementation and leaves public confused as to which entity is responsible for developing and implementing a sustainable vision for San Juan.
2. Politics of expertise between the Planning Board, the Municipality, and local civic organizations need to be addressed and vertical knowledge flow must increase and be transparent to the public.
3. Each of the future visions need to be evaluated based on three dimensions of sustainability – social, economic, and ecological – in order to inform negotiation about alternative future pathways and trade-offs for the city.
4. Collaboration and negotiation among diverse scientific disciplines needs to be fomented to foster interdisciplinary knowledge production about the city.
5. Knowledge capacities of the Municipality's Office of Territorial Planning and Ordinance must be improved such that all planning outcomes, including economic, social, and ecological, be evaluated and monitored in an iterative process with active public participation.
6. Take advantage of actors with high betweenness centrality to improve knowledge flow across the network (e.g., Sustainable Development Initiative, International Institute of Tropical Forestry, Planning Board).
7. Foment social learning through critic and reflexivity by creating spaces for debate and visioning among San Juan actors. Use an adaptive and anticipatory science approach to evaluate outcomes of multiple visions and alternatives negotiated by actors.
8. A consortium of multiple stakeholder organizations, as opposed to a single organization, is needed to manage the complexity of stakeholder relations, knowledge needs, and diverse criteria for credibility and legitimacy. A common object or space (e.g., city's watershed) can be used as common ground to crossing disciplinary and political boundaries.

easier for decisions to be influenced by economic logic or party politics. As one

planner puts it

> We have a lot of information but it is not implemented. Some examples
> include the Smart Growth program of the UMET and the Xplorah for the
> Planning Bard. This system (Xplorah) is meant to serve the technicians
> to make better decisions, and they are taking the training, but at the end
> this won't matter because the decision-maker doesn't respect the
> technician's opinion, does what he/she wants.

Clearly corruption is another knowledge system having an influence in

planning and decision-making in San Juan. This political dynamic is difficult to

examine, however, and requires the use of very intensive ethnographic methods

to capture this secretive behavior. This was not the goal of this investigation;

therefore this study is limited in capturing the influence of corruption in

decision-making. My interest here was to examine the underlying institutional

and epistemological conditions that make the planning and decision-making

system vulnerable to this type of abuse of power. I was interested in the role that

knowledge plays in facilitating these failures. In other words, I was more

concerned with the lack of on-the-ground inspection to determine whether a

creek has been illegally buried by a developer, for instance, and not whether

ultimately the illegal permit was a as result of corruption. Along the same vein,

my intention here was not to suggest that if these failures in the knowledge-

action systems are fixed then better decisions will be made or political problems

will be solved. Rather I argue that understanding these conditions, including

sources of opportunities or surprises in the system, allow us to develop

knowledge capacities that can better address and navigate the multiplicity of views, opinions, or imaginations of the city, and ultimate build the capacity to adapt and be sustainable to changing conditions in the future. Nonetheless, it is crucial that future institutional research in San Juan, and for that matter Puerto Rico in general, plays close attention to the role of corruption as a knowledge system hindering sustainability.

4. Design Criteria, or Propositions, for Building Knowledge-Actions Systems in Complex Systems

This section describes the criteria to design knowledge-action systems in complex systems based on the theoretical and empirical analysis presented in this investigation of cities. Because every context will present particular barriers and opportunities to linking knowledge to action, a key point of this thesis is the need to analyze and evaluate existing knowledge and power relations (i.e., knowledge-action systems analysis) in order to determine the appropriate architecture of the knowledge-action system that fits the context. Simply put, one size does not fit all. Simplistic assumptions about how knowledge-action systems work in the real world have led to a plethora of lists of ingredients for 'science-policy interfaces' with outcomes that remain unexamined. That is not the purpose here. The following concepts are meant to serve as general guidelines, or as the term I prefer, *propositions* for attributes that have emerged as necessary for knowledge-actions systems to work properly in urban systems; as such, they are not meant to serve as a 'blueprint' or testable guidelines, but more as a roadmap.

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Nonetheless, this analysis would be of little use to sustainability scientists and practitioners if I didn't at least present 'things to look for' based on the lessons from the San Juan case and the emerging literature on knowledge systems. For each proposition then, I try to give an example drawn from the San Juan case or from the literature, and tools for implementation, illustrating how these concepts can be put into practice. Ideally, as government, planners, scientists, or even non-scientific stakeholders, consider building institutions and capacities to produce policy-relevant knowledge for sustainability (e.g. research centers, public organizations, programs, etc.), they would have these propositions in mind when designing the mission, structure, and function of these institutions.

These criteria are not meant to replace or be redundant with the various attributes and competencies that have been extensively developed for sustainability science, such as transdisciplinarity, collaborative, strategic, and normative, to name a few (Wiek et al. 2011; Grunwald 2004; Clark and Dickson 2003). I argue these are also attributes and normative principles for urban knowledge-action systems, and indeed, they do overlap with some of the concepts I discuss below. For instance, anticipation and reflexivity have been associated with strategic knowledge (Grunwald 2004), complex knowledge-action systems call for transdisciplinarity, and all of the concepts involve some level of collaboration among actors. However, this study is largely concerned with *how* we organize complex knowledge-action systems — not just scientific knowledge and the content of this knowledge, but the hybrid space where different knowledge systems and political interests interact in deliberating,

producing and using knowledge for sustainability (Miller 2001). As such, these criteria are meant to fit the broader governance and action landscape of sustainability science. In other words, sustainability science is only one of many knowledges that co-exist in the city, and here are some ideas to develop knowledge-action institutions that encompass this complex knowledge-action context as a whole.

1. Context and Inclusiveness

A theme that cuts across this investigation is the need to take into account the context of how knowledge-action systems work — the diverse institutional landscape, social relations, epistemic practices, and visions that interplay in a complex and dynamic governance context such as cities. Urban planning experts have long argued that context is crucial to the planning process, and participatory approaches to city planning are increasingly common to gain local insight and context in many cities across the world (Jacobs 1961, Marvell 2008, Wheeler and Beatly 2009). In practice, however, the implementation has mostly been through consultative process, where input is solicited after plans have already been developed and the context elicited is limited to people's opinions and concerns. These approaches generally lack a thorough examination of what local people *know* about the city, *how they know and experience* the city, how they *envision* it, and what this knowledge can contribute to the planning process. In other words, plans continue to be developed without first understanding that planning is grounded in a set of institutional epistemic practices and how they city is changing in this context. As such, knowledge

systems that inform the planning and decision-making process need not just to be contextual of the urban socio-ecological system itself, but of the epistemic and institutional dynamics as well (Text Box 2).

Building knowledge-action systems that are contextual entails that we use a more inclusive definition and approach for how we define knowledge and the actors that produce and use it. Breaking down knowledge stereotypes is necessary, meaning that we do not make *a priori* assumptions of who are the experts, producers and users of knowledge, but recognize that there are broader civic epistemologies at play as well. The knowledge flow network presented in Chapter Four for the city of San Juan is an example of urban civic epistemologies. Here the overall network included very different epistemic cultures (e.g. governmental, scientific, civic organizations) linked through information flows. Organizations not usually associated with knowledge production were present in this network, thus illustrating the importance of understanding the epistemic context of the city governance landscape.

Empirically examining the context of the city also addresses several practical issues that are raised in the knowledge systems literature regarding practices to best link knowledge to action for sustainability. For instance, the seminal paper on knowledge systems for sustainability by Cash et al (2003) argues that credibility and legitimacy are key aspects of effective knowledge systems. How these factors play out in different places and sustainability challenges is still under question (Matson 2008). Analyzing and evaluating the local epistemic context allows us to understand not only what knowledge is

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being produced and what the needs of knowledge users are, but how power and expertise are distributed and therefore which actors are viewed as credible and legitimate in the local political context, and more importantly, why. This investigation showed, for instance, a heterogeneous network of land use and green area knowledge with a variety of sources of knowledge, including organizations not traditionally perceived as experts (i.e., civic groups). This may be indicative that credibility and legitimacy in San Juan is more widely distributed among diverse actors than solely on academic, scientific, or technical government institutions as is commonly understood in the US context. As Manuel-Navarrate, Slocombe, and Mitchell (2006) advocate, it is crucial that researches are exposed and experience the complex socioecological realities and meanings of the place, including the biophysical, socioeconomic, and political and cultural aspects. Here ethnographic methods, such as interviews, field work, field trips, and observation, are useful to gain context for science.

Another issue relates to how to the design and effective execution of participatory approaches in research and planning as a mechanism for linking knowledge to action (van Kerkhoff and Lebel 2006) As I discussed in Chapter Six, while university-community relations through the CAUCE organization were inclusive of various community interests and knowledge for the re-vitalization of the Río Piedras urban core, broader political dynamics for the control of the planning and implementation process by the Municipality imposed boundaries that affected the process. However, the community continues to meet informally in 'less' controversial spaces (e.g. churches) and uses its socia

networks and social events to maintain the ideas and critic flowing. Again,

understanding the epistemic and political context is necessary to uncover existing

social dynamics that could challenge inclusiveness and thus avoid potential

failures in designing participatory processes.

The order of this proposition relative to the rest is not coincidental.

Understanding the context and fostering inclusiveness in knowledge-action

systems is a first step to evaluate how knowledge-actions systems need be

reconfigured or newly designed to address the socio-ecological complexity, and

the dynamics of knowledge –power relations, in a specific place or city. It is what provides the lay of the land in which the rest of the design criteria will be embedded in.

2. *Adaptability and Reflexivity*

Increasing recognition of the complexity, dynamism, and uncertainty in social-ecological systems has prompted a shift in decision-making and management that involves learning versus command and control approaches (Gunderson 1999, Lee 1993, Giampeitro et al. 2006). Adaptive management and governance demands awareness of system uncertainty as it allows for lessons learned in one iteration to be applied to the next through monitoring and evaluation of multiple management options or policies (Folke et al 2005, Olsson et al. 2006). In the context of sustainability science, adaptability is often coupled with anticipation to think about alternative future pathways that systems can take to prepare for change and to guide current decisions toward maximizing future alternatives or minimizing future threats (Karinen and Guston 2010; Wiek 2006).

Rather than trying to tame or ignore uncertainty, an adaptive and anticipatory approaches *explores* uncertainty by directing attention to unintended outcomes and *a priori* evaluation of their implications for current and future decision making (i.e., foresight) (Quay 2010). The combination of adaptability and anticipatory approaches for natural resource and sustainability has gained greater popularity among managers and scientists alike (Wollenberg, Edmunds, and Buck 2000; Sisk et al. 2006). Various institutional strategies and methods,

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such as collaborative adaptive management, participatory scenario development, integrated modeling tools, deliberative visualization exercises, and community-based sustainability indicators, to name a few, are being implemented and evaluated as ways to build adaptive capacity and bridge science and policy (Conley and Moote 2003; Muñoz-Erickson, Aguilar-González, and Sisk 2006; Fernández-Giménez et al 2007)

Both adaptive and anticipatory approaches have been developed to foster flexibility in decision-making. As such, most of the institutional adaptations or reconfigurations are done on the policy realm, or the 'action' side of the knowledge-action spectrum. For instance, the common practice is to engage multiple stakeholders to deliberate alternative preferences and policy options that are then evaluated by science. Knowledge-action systems for sustainability must, however, also be flexible and adaptive in their knowledge production practices and structures if they are to be responsive to system changes and provide solutions for sustainability (Miller, Muñoz-Erickson, and Redman 2011). Knowledge-action systems need to be seen as part of, not outside of, the complex socio-ecological system. As such, the knowledge-action system will change as the local context changes, demanding epistemic flexibility in the ways that problems are selected and addressed, determining which knowledges are relevant and how they should be integrated, and how research questions and methodologies are framed and implemented (Manuel-Navarrate, Slocombe, and Mitchell 2006).

As illustrated in Chapter Six, however, 'obduracy' in urban systems, or the rigidity or lack of flexibility in traditions, fixed frames, and expectations of what the city should be and look like that can make it very difficult for knowledge-actions systems in planning to reconfigure or adapt technological and social structures in the city. The implications of rigid ways of thinking or knowing the city is profound to sustainability strategies that seek to adapt or transform development pathways to deal with change in the future (i.e., climate change). Even if the visions, plans and political will to transition to a sustainability future are present, implementation will be very unlikely if the underlying ideas, knowledge and expectations of the city remain unexamined and unchanging. To avoid failures in the future and build more adaptive knowledge-actions systems it is crucial that we build institutional reflexivity. Reflexivity is the idea that those who produce and use knowledge are aware of how they are producing and using knowledge (Miller, Muñoz-Erickson, and Monfreda 2011). It means that the assumptions, framings, values, and practices behind the knowledge that is produced and used for sustainability be open to scrutiny (Hendriks and Grin 2006). In other words, it calls for knowledge producing institutions, whether they are governmental, scientific, or NGO's as in the case of San Juan, to be self-critical and routinely reflect on how they view socio-ecological systems, the assumptions of how these systems work, and their normative premises for how development should be steered in the future. Reflexivity is related to learning and adaptive governance in that the approach demands awareness of system uncertainty and unintended consequences. It goes

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further, however, to consider the effects that such reflection has on how we produce, or change the production, of knowledge as producers and users come to terms with the impossibility of having full and complete knowledge of system dynamics (Leach 2008).

From a practice standpoint, reflexivity involves that we 'open up' the knowledge production process. In other words, it involves developing institutional mechanisms that allows outside actors, including non-scientists, to be part of the design and review of the research process (Stirling 2004). Much like the peer review process in science, knowledge-actions systems need an external review body, such as extended peer communities (Funtowicz and Ravetz 1993) or advisory committees, to provide context and critique to the assumptions, methods, and direction that the research is going in relation to socio-ecological needs, changes, and expectations. These bodies should not only bring accountability to the knowledge-action system by integrating various stakeholder or actor groups involved in governance, but it must also be inclusive of the various ways of knowing needed to address and be congruent with the system[37]. For instance, actors that are knowledgeable about local physical conditions as well as social dynamics (e.g., think from a systems perspective) that employ both quantitative and qualitative ways of reasoning, and are able to span multiple scales or governance levels, are ideal to offer context and advise for knowledge production. Participatory processes, such as the ones I mentioned above, are also mechanisms that build reflexivity, as long as stakeholders are

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[37] This is similar to what Healy (2003) and Miller et al. (2008) describe as *epistemic pluralism.*

engaged upstream in the process (i.e. goal formulation and framing of research question). The process must also be iterative such that outcomes are continuously reviewed by participants (Stirling 2004). The crucial point here is that there needs to be a space where competing knowledges can be deliberated and in the process expose biases and gain appreciation of complexity and trade-offs of sustainable strategies.

A reflexive approach, however, brings up an 'efficiency paradox' because it implies a balance between opening up and closing it down (Voss and Kemp 2005). Opening up is necessary to allow in a diversity of ideas, knowledge and values but this brings greater complexity to the process of knowledge production, Closing down is necessary to do the work and have the ability to act, but the timing of closing may cause rigidity. Voss and Kemp (2005) argue that the issue is not a matter of either/or, but of doing both throughout the process. Figure 1 shows how the acts of opening up and closing down can be strategically incorporated in the knowledge production process so as to build reflexivity.

The key to this balancing act is the timing and structure of the mechanism to open up using an iterative process. For instance, broad inclusiveness is crucial in the beginning and final phases of a project, therefore using methods that allow greater representation and deliberation of ideas, viewpoints, and ways of seeing (i.e., deliberative participatory workshops) are more appropriate at this stage. Other points in the stage are more technical and may require a specific set of expertise to review and provide critique, such as smaller advisory committees.

Finally, mechanisms for monitoring and evaluating the knowledge production process are crucial to assess whether learning is occurring and if both ecological
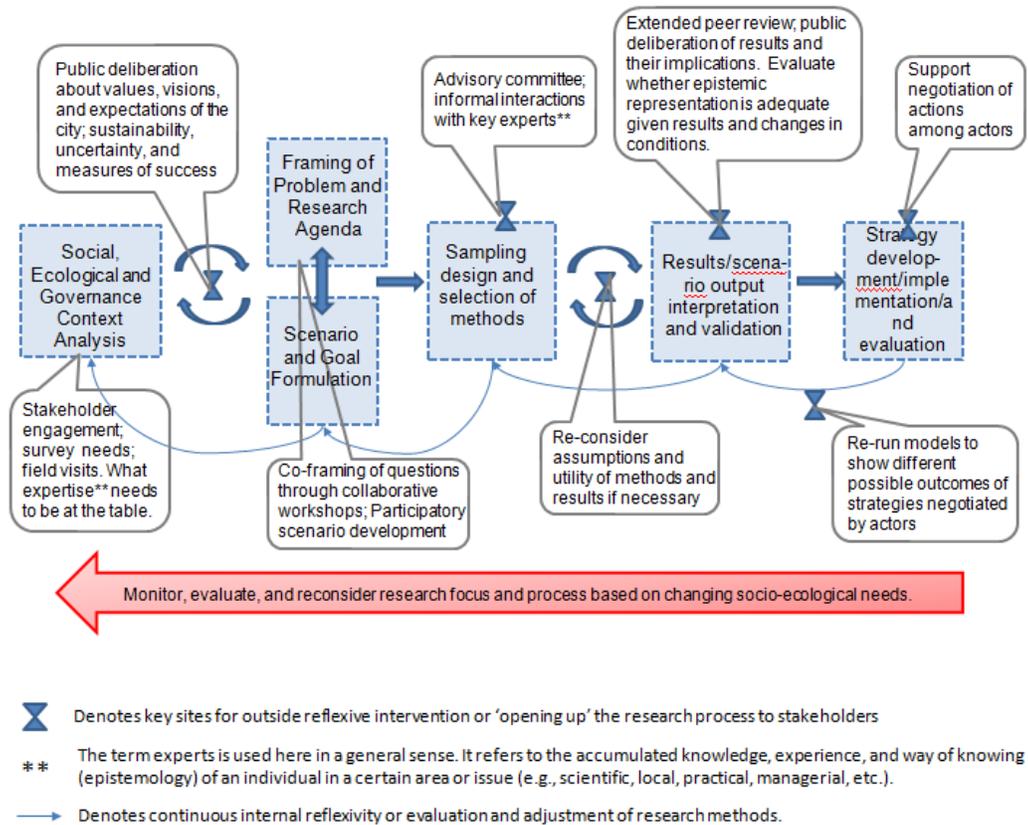
Figure 1. Illustration of a reflexive knowledge-action system. The process 'opens up' and lets in multiple knowledges, values, and visions iteratively throughout knowledge production and visioning/scenario development exercises for sustainability. The arrows reflect stages at which it is crucial to monitor, evaluate, and reflect upon the saliency, relevance, and credibility of the knowledge produced. The comment boxes include examples of diverse stakeholder engagement activities that are appropriate for each stage in the process

Text Box 3. Key questions and strategies for building adaptability and reflexivity in knowledge-action systems

1. Institute an advisory review body in which both political interests and epistemologies (ways of knowing) are represented and builds accountability in the knowledge production process.
2. Be flexible with participatory methods – use a variety of methods with varying frequencies, including consultative (e.g., surveys, rapid appraisals), informal meetings (e.g., office visits, fields trips), to active participation (e.g., engagement in decisions on research) to develop an appropriate framework that fits local context and diversity of ways that people prefer or are able to engage given different reasoning styles, time, and other capacities.
3. Iterative framing of research agenda and process– take knowledge-action systems approaches as experiments to evaluate and adapt.
4. Monitor outcomes of knowledge production through learning indicators and knowledge system analysis and evaluation
5. Account for the 'intangibles', or non-quantifiable elements of quality of life in a city

and social outcomes are being met (Muñoz-Erickson et al. 2010). Here, indicators are a useful tool for building reflexivity if they incorporate organizational indicators to track institutional learning, or as Voss and Kemp (2005) call *special change indicators*, along with social-ecological system changes. Again, depending on the political and social structures the reflexive strategy and indicators of change will take many forms to fit the context. The key is to allow ways for new information, ideas, and values to come in iteratively into knowledge production process for the knowledge-action system to work effectively and be innovative.

3. Polycentricity

While the previous two criteria related more to the dynamics and function of knowledge-action systems, polycentricity addresses the structure, or architecture, of knowledge-action system design. I use the term polycentricity to refer to the multiplicity of spaces (i.e., nodes), both physical and institutional, where knowledge and action are frequently interacting. In San Juan this happens not only in specific organizations producing knowledge and are linked through knowledge flows (i.e., network), but also in churches and stores as the case of Río Piedras reveals. Recent focus by governance scholars and practitioners for sustainability systems has been directed towards the creation new, often single institutions to act as bridges between the science and policy realms, such as boundary organizations (e.g., Cash et al. 2003), bridging organizations (e.g., Olsson et al. 2006), or epistemic communities (e.g., Hass 1993). I argue, however, that these institutional arrangements are not enough to build knowledge-action systems in the complex and distribute context of cities like San Juan. There are examples where these institutional arrangements have been successful at mediating the hybrid space between science and society, such as agricultural extension offices for instance. This is especially in the US context where the appearance that these two spheres are separated, or purified, is necessary for each to maintain credibility and legitimacy (Guston 1999, Miller 2001). Based on this investigation, however, I argue that a context like San Juan demands that knowledge-action systems be flexible and diverse to explicitly work in the hybrid places of a networked society. They must also give the impression that there is a

distinction between science and non-science to have credibility in the current political system.

Essentially what I propose here is that the architecture of the knowledge-action system should fit, or mirror, the ecological *and* political landscape of the city to be most effective (Text Box 4). For instance, based on this investigation, there is a need in San Juan for an institution, or consortium of institutions, that takes the leadership in filling a gap in knowledge and decision-making regarding watershed and regional scales of the city, while at the same time more flexibility is necessary to support and link the diversity of knowledge-action systems already established in the city. Network theory suggests that creativity and innovation is best fostered by a diverse and polycentric network, as opposed to a network composed of entities with similar views and perspectives. Epistemic communities, as those observed by Hass (1993) in international governance for instance, are a good example of a group or network of similarly-minded researchers that provide scientific consensus for a particular problem. In the San Juan context, however, where urban sustainability demands complex thinking, a polycentric design that looks more like a consortium of multiple institutions would facilitate the linkage of the multiple epistemic communities, or cultures, found in the network and hence build creativity and innovation. A polycentric design entails strengthening existing capacities and connections where there are weak links and building new ones where there are absent. Any intervention in this knowledge-action system, such as establishing a new research program, must take these local network properties into consideration.

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Following the adaptive and reflexive approach proposed here, this structure needs to reflect the knowledge-power relationships in these networked and complex contexts, while at the same time be adaptive and recognize when new institutional arrangements are needed. In San Juan this means that a new research program needs to be aware of the politics and implications of being the 'new kid in town', be explicit about the normative goals of its program, and reflect on its effect on the broader political discourse. The structure also needs to be flexible enough to help link existing knowledge and facilitate flow where it is needed, thus allowing local stakeholders to feel ownership of the process and that their knowledge is making a contribution. This network-like structure may keep it from being separated or distinguished as a single entity that can be susceptible to boundary work (i.e., a boundary imposed to decrease its credibility) because it is composed of the very interests and knowledge that the landscape is composed of. Monitoring and evaluation of how the institutional structure is working is part of designing a reflexive structure.

A downfall of this structure is that it can be difficult to manage and maintain a loose network . Strong leadership is needed to be able to hold this diverse conglomeration and to work with existing capacities/projects so as to not compete or be redundant. Developing and maintaining a network imaginary as Goldstein and Butler (2009) has proposed for the US Fire Learning Network (FLN) is an approach that can provide the cultural and organizational 'glue' that

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Text Box 4. Key questions and strategies for designing polycentric knowledge-action systems

6. Evaluate and invest existing institutional structure and capacities –do not assume capacity is already there. Where the capacities do exist, work or help transform them, instead of automatically building new structures (e.g. new organization)
7. Recognize that in an increasingly networked society, power and knowledge are distributed, thus the knowledge-action system needs to be cognizant of the politics of expertise in the governance space.
8. Develop epistemic or transdisciplinary consortiums – Instead of looking for uniformity or consensus, foster diversity and pluralism of ideas, knowledge and ways of reasoning. Individuals trusted and deemed credible by researchers and stakeholders alike can serve as the 'mediators' between knowledge and action.
9. Create a variety of spaces and/or activities or support others in leading them (i.e., field trips, seminars, workshops, retreats, office visits, etc.) to deliberate research questions and outputs such that stakeholders feel ownership of the process.
10. Develop a network imaginary as the cultural glue to keep the network together and allows actors to have ownership of the process and outcomes of the networked structure

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helps balance the social cohesion, yet flexibility, of a polycentric knowledge-action system. Goldstein maintains that the FLN is able to maintain an extensive network of research nodes across the US without the need for a hierarchical authority structure by articulating a network imaginary through technologies, planning guidelines and media. Put differently, a shared-mental schema of a community of diverse interests and knowledge but with a common goal (i.e., manage fire) was created and perpetuated through the communication and research practices of the network such that people working at different locations feel part of this imagined community. I pose that a similar approach can be taken

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in San Juan to coordinate and integrate the diversity of epistemic cultures and visions of sustainability towards a more concerted effort of exploring and deliberating alternative future development options for this city.

5. Understanding knowledge-action systems in cities: Contributions and future directions

Cities present a great challenge to the design of knowledge-action systems for sustainability. As complex and dynamic socio-ecological and technical systems, the landscape of actors involved in their planning and governance is also very diverse and contested. Simple arrangements that link knowledge producer on one side and a knowledge user on the other are not enough address this challenge. Instead, institutional arrangements that are able to mirror or fit the institutional and ecological complexity and dynamism of cities are more likely to be effective in generating useful and innovative strategies for sustainability.

In this study I have argued for the design of knowledge-action systems that are more adaptive and reflexive, meaning that they have the ability to recognize, and reconfigure themselves —including their structure, practices, paradigms, and knowledge — when change is needed. I support this assessment through a thick analysis of how knowledge-action systems work in the very complex context of urban land use planning and decision-making in San Juan. This case illustrates the challenge of building knowledge systems that can foster adaptive capacities and innovation when there are multiple producers and

Table 1. Summary of findings from the San Juan case study and the strengths and weaknesses of the three conceptual lenses used to analyze knowledge-action systems.

	Findings	Strengths	Weaknesses
Social networks	Diverse network - innovation/creativity potential **but** fragmented knowledge flow	Captures actor's structural position (power) and their influence on the flow of resources, in this case information and knowledge. Useful tool to identify barriers and opportunities to information flow across multiple actors.	Relatively static by focusing on actor relationships at one point in time. Highly dependent on how the boundaries of the system, thus may leave some key actors out. Little attention to the cultural and political dynamics of interactions and influence of outside forces.
Visions and epistemic cultures	Divergent future visions of the city can be explained by diversity of epistemic cultures.	This model gives more attention to the co-production of epistemic and political elements in envisioning the future of the city. Helps explain differences in visions from the plural perspectives in knowledge systems.	More focused on the groupings of visions and epistemologies than the individual actors and how they relate to each other (i.e., dynamics).
Boundary work	Multiple actors engage in boundary work to attain legitimacy and credibility in planning and implementation.	Powerful model for explaining the social and political strategies that actors employ to gain authority as experts in public policy.	Fails to address the physical and environmental context and how these influence actor dynamics.

multiple users 'knowing' and 'imagining' the city in distinct ways. Such diversity of actors and visions means that there will be trade-offs in developing sustainable strategies, thus unlikely that consensus can be reached. Knowledge-action systems need to be able to explicitly address these value and knowledge differences to inform the negotiation of alternative pathways to sustainability.

A first step in designing knowledge-action systems for cities is to understand how they work, what works, and what doesn't work. In this study I offered a conceptual framework that uses three analytical lenses – social networks, visions and epistemic cultures, and boundary work – to tackle the complexity of these systems. This interdisciplinary and multi-method approach facilitated the untangling of the structural (Chapter Four), cultural and epistemic (Chapter Five), and functional (Chapter Six) elements of these systems for a more integrated perspective of how they work. Each of these lenses offered a unique strength, as well as limitations, to understanding knowledge-action systems (Table 1). Because they each provided a unique piece of the puzzle, neither of them is useful on their own to analyze knowledge-action systems.

This study contributes a conceptual framework and an empirical analysis of knowledge-action systems with the overarching goal of improving our adaptive and innovative capacities for sustainability. This framework is useful to both scientists and practitioners interested in improving and transforming institutional arrangements to produce better knowledge and facilitate successful implementation of sustainable outcomes. It provides a way to understand existing institutional conditions, as well as to build reflexivity through its long

term application to evaluate how knowledge-action systems are working over time. Future research should apply this framework to understand knowledge-action systems in multiple cities and for multiple resource domains (e.g., water, energy, etc.) to develop more robust assessments of how these systems work in multiple sustainability contexts. Experiments with different institutional configurations could also provide a way to test the design propositions recommended here. This approach will further knowledge on the arrangements and stakeholder engagement processes most useful to tackle urban sustainability issues. Finally, we must be able to evaluate the outcomes, both institutional and ecological, of these arrangements in order to inform innovative governance strategies for sustainability.

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APPENDIX I

LIST OF ACRONYMS

ASJEC	Alliance for the San Juan Ecological Corridor
CAUCE	Centro de Acción Urbana Comunitaria y Empresarial de Río Piedras
CT	Conservation Trust
EIS	Environmental Impact Assessment
GIS	Geographic Information Systems
HBA	Home Builders Association of Puerto Rico
IM	Industrial Mission
MU	Metropolitan University
NGO	Non-governmental Organizations
NOAA	National Oceanic and Atmospheric Administration
PIDES	Plan Integral de Desarollo Estratégico Sostenible para Puerto Rico
PRCD	Puerto Rico Commerce Department
PRDENR	Puerto Rico Department of Environmental and Natural Resources
PRDTPW	Puerto Rico Department of Transportation and Public Works
PREQB	Puerto Rico Environmental Quality Board
PRGA	Puerto Rico General Archive
PRLA	Puerto Rico Land Authority
PRNPC	Puerto Rico National Park Company
PRPB	Puerto Rico Planning Board
PRPRA	Puerto Rico Permit and Regulation Authority
RPRW	Río Piedras River Watershed
SALAPR	School of Architects and Landscape Architects of Puerto Rico
SDI	Sustainable Development Initiative
SC	Sierra Club
SCSJEC	Special Commission of the San Juan Ecological Corridor
SJBEP	San Juan Bay Estuary Program
SJM	Municipality of San Juan

SJMA	San Juan Metropolitan Area
SJMOTPO	San Juan Municipality Office of Territorial Planning and Ordinance
SJTOP	San Juan Territorial Ordinance Plan
UPR-RP	University of Puerto Rico- Río Piedras Campus
USACOE	US Army Corps of Engineers
USEPA	US Environmental Protection Agency
USFS IITF	US Forest Service's International Institute for Tropical Forestry and State and Private Forestry Program
USFWS	US Fish and Wildlife Service
USGS	US Geological Survey

APPENDIX II

SURVEY QUESTIONNAIRE

Note: All questions were used in the survey, but only the questions marked with *
were used for the interviews.

A. Problem Framing and Knowledge Priorities

* 1. Please list up to five *urban environmental issues* that San Juan city faces.

   a. What do you think *is <u>the</u> most pressing urban environmental issue*? Please
briefly describe the causes and potential solutions to this problem.

* 2. In order to understand urban environmental issues broadly in San Juan, *do
you think we need more information or knowledge*?   ____Yes   _____No
_____No Opinion

    a. If you answered *yes*, please list up to *five urban environmental information
gaps*?

* 3. Please list any information, datasets or tools that would *most help you or
your organization* in your work related to the urban environment in San Juan?

* 4. Does your organization have or collect data, knowledge, or other information
that could contribute to our understandings of urban environmental issues?

        a. If you answered yes, please respond to these questions.

        What type of data do you collect? For instance, social, demographic,
        climatic, ecological, geographic, etc.

        Where do you collect the date? For instance: Island-wide, in the city, some
        parts of the city, a specific location, etc.

        How frequently do you collected the data? For instance, continuously, a
        few times a year, every year, every ten years, etc.

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5. Please rank the themes listed below based the priority to your organization.[Scale: highest priority (5) through lowest priority (1).]

a. Air quality
b. Alternative transportation
c. Biodiversity and habitat
d. Built environment
e. Economic growth and development
f. Energy
g. Environmental justice
h. Environmental attitudes and behavior
i. Global climate change
j. Green areas
k. Green design
l. Land use and land cover change
m. Natural disturbance (e.g. hurricanes, earthquakes, etc.)
n. Noise pollution
o. Open space and parks
p. Public health
q. Recreation
r. Resilience and sustainability
s. Solid Waste
t. Urban forests
u. Urban heat island
v. Urban sprawl
w. Water quality
x. Water quantity
y. Other?   _____

6. Please rank the themes listed below based on the importance that, in your opinion, they have for urban research in San Juan. [Scale: highest priority (5) through lowest priority (1).]

    a. Air quality

    b. Alternative transportation

    c. Biodiversity and habitat

    d. Built environment

    e. Economic growth and development

    f. Energy

    g. Environmental justice

    h. Environmental attitudes and behavior

    i. Global climate change

    j. Green areas

    k. Green design

    l. Land use and land cover change

    m. Natural disturbance (e.g. hurricanes, earthquakes, etc.)

    n. Noise pollution

    o. Open space and parks

    p. Public health

    q. Recreation

    r. Resilience and sustainability

    s. Solid Waste

    t. Urban forests

    u. Urban heat island

    v. Urban sprawl

    w. Water quality

    x. Water quantity

    y. Other? _____

B. Knowledge and Collaboration Networks

* 7. Please list five agencies or organizations (e.g. non-profits, academic, private, etc.) that you consult with the most or ask questions more frequently to obtain knowledge or information specifically about land use and green areas (e.g. urban forests, river, parks, etc.) in San Juan?

8. Please list five agencies or organizations (e.g. non-profits, academic, private, etc.) with which you collaborative frequently in projects or political activities related specifically to land use and green areas (e.g. urban forests, river, parks, etc.) in San Juan?

C. Planning and Public Policy

9. Please indicate which governmental plans or regulations directly affect the work of your organization.

10. Please mention the agencies and governmental entities that most directly influence or affect your organization.

*11. Today there is frequently a lot of discussion of the need to have a vision of the future to guide planning. Briefly, please describe your vision of the future of San Juan.

F. Perspectives on the Relationship between Science and Policy.

12. For the following questions, please check the response that best fits your view.

   a. Policy-making in San Juan is informed by science. [Scale: Always; Most of the time; Sometimes; Rarely; Never; No Opinion]

b. Scientific research in San Juan is informed by social and policy concerns.
    [Scale: Always; Most of the time; Sometimes; Rarely; Never; No Opinion]

*13. How would you describe the existing relationship between science and decision-making in San Juan?   What is working and/or not working?

* 14. What do you think should be the role of scientific information in urban planning and decision-making?

15. Please indicate your level of agreement or disagreement with the following statements concerning the scientific process. [Scale: Completely Agree to Completely Disagree]

   a. Scientists should only report scientific results and leave others to make resource management decisions.

   b. Scientists should report scientific results and then interpret the results for others involved in resource management decisions

   c. Scientists should work closely with managers and others to integrate scientific results in management decisions
   d. Scientists should actively advocate for specific natural resource management decisions they prefer.
   e. Scientists should make natural resource management decisions

11. Background Information
   16. Please indicate what is your position or role in your organization.

   17. What is the highest level of education you have completed? [Scale: Less than fifth grade; Eight grade; Twelve grade (no diploma); High School graduate; Less than one year in the university; More than one year in the university; Associate Degree; Bachelors Degree; Masters Degree; Professional Degree; Doctorate Degree; Prefer not to answer; Other]

18. Of the following options, which best describes the type of organization for which you are responding:

    a. Federal agency

    b. Local or municipal agency

    c. Private-Public alliance

    d. Business

    e. Commonwealth of Puerto Rico (state)

    f. Non-profit community group

    g. Student group

    h. Educational institution

    i. Non-profit organizations

    j. Regional or state non-profit organization

19. What profession or expertise area are represented in your organization's work team? Please mark all that apply

    a. Lawyer

    b. Environmental manager

    c. Business manager

    d. Agricultural specialist

    e. Architecture

    f. Natural scientist or researcher (e.g. biologist, ecologist, hydrologist, etc.)

    g. Social scientist or researcher (e.g. anthropologist, sociologist, geographer, etc.)

    h. Economist

    i. Education

    j. Forest specialist

    k. Engineering

    l. Community organizing

m. Planning

n. Public policy

o. Public relations

p. Public health

q. Environmental technician

r. Information Systems Technician

s. Social work

t. Other

20. Of the previous list, please indicate which best describe your profession or expertise area.

21. Please select the scale or spatial unit at which your organization works on.
   a. Neighborhood or 'barrio'
   b. City
   c. Watershed
   d. Metropolitan region
   e. Island (Commonwealth of Puerto Rico)
   f. Federal
   g. Other

22. How many people work in your organization? [Scale for each item below: 0; 1-5; 6-10; 11-20; 21-30; 31-50; >50]
   a. Full time
   b. Half-time
   c. Volunteer

APPENDIX III

IRB APPROVAL

To:	Kelli Larson
	Coor
From:	Mark Roosa, Chair
	Soc Beh IRB
Date:	07/24/2008
Committee Action:	**Exemption Granted**
IRB Action Date:	07/24/2008
IRB Protocol #:	0807003110
Study Title:	Urban ecology in context: A comparative framing approach on urban environmental issues and knowledge needs across the ULTRA Network

The above-referenced protocol is considered exempt after review by the Institutional Review Board pursuant to Federal regulations, 45 CFR Part 46.101(b)(2) .

This part of the federal regulations requires that the information be recorded by investigators in such a manner that subjects cannot be identified, directly or through identifiers linked to the subjects. It is necessary that the information obtained not be such that if disclosed outside the research, it could reasonably place the subjects at risk of criminal or civil liability, or be damaging to the subjects' financial standing, employability, or reputation.

You should retain a copy of this letter for your records.