Ecosystem Services and Climate Change Planning:

An Awareness-, Analysis-, Action-based Assessment of Local Planning Efforts

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A thesis

submitted in partial fulfillment of the

requirements for the degree of

Master of Urban Planning

University of Washington

2014

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Program Authorized to Offer Degree:

Urban Design and Planning

University of Washington

Abstract

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Climate adaptation planning is a developing field both in the United States and globally. Ecosystem-based adaptation, an emerging concept that examines the role of ecosystem services in reducing human vulnerability to climate change, has been touted as a cost-effective, no- or low-regret option that can be implemented in the short-term. Most research concerning ecosystem-based adaptation has been focused on the developing world with little attention given to ecosystem-based adaptation uptake in the United States. This research examines the extent to which ecosystem services are being considered in local climate change planning initiatives that have been produced by local governments in the United States since 2011 and the extent to which these documents have identified actionable opportunities for ecosystem-based adaptation strategies. Fifteen planning documents were assessed utilizing an 'awareness, analysis, action' framework. Of these documents 93 percent showed an awareness of ecosystem services and the impacts climate change may have on these services and 87 percent identified at least one action intended to protect or enhance the ability of ecosystem services to reduce social vulnerabilities. However, 66 percent of documents examined did not include enough detail about identified actions to be considered

strong from an implementation perspective. Results suggest that ecosystem-based adaptation has entered the climate change planning dialogue in the United States, but more guidance is needed to assist local governments in the identification and implementation of ecosystem-based adaptation strategies.

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LIST OF ACRONYMS

ACUPCC	American College and University Presidents' Climate Commitment
APA	American Planning Association
CAP	Climate Action/Adaptation plan
EbA	Ecosystem-based Adaptation
EPA	Environmental Protection Agency
GHG	Greenhouse Gases
IPCC	Intergovernmental Panel on Climate Change
LDC	Least Developed Countries
LID	Low Impact Development
MEA	Millennium Ecosystem Assessment
NAPA	National Adaptation Programme of Action
SER	Socio-ecological Resilience
SES	Socio-ecological System
WRI	World Resources Institute

DEFINITION OF KEY TERMS

Many of the key terms used throughout this study have been defined in a variety of ways by a variety of agencies and actors. For simplicity and consistency, these terms will be used as defined in the Fifth Assessment of the Intergovernmental Panel on Climate Change (IPCC). All definitions provided below have been extracted from the glossary of *Climate Change 2014:Impacts, Adaptation, and Vulnerability* (IPCC 2014a).

Adaptation (IPCC 2014a, 1758) - The process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate harm or exploit beneficial opportunities. In natural systems, human intervention may facilitate adjustment to expected climate and its effects.

> **Incremental adaptation** - Adaptation actions where the central aim is to maintain the essence and integrity of a system or process at a given scale.
>
> **Transformational adaptation** -Adaptation that changes the fundamental attributes of a system in response to climate and its effects.

Adaptive Capacity (IPCC 2014a, 1758) - The ability of systems, institutions, humans, and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences.

Climate Change (IPCC 2014a, 1760) - Climate change refers to a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically

decades or longer. Climate change may be due to natural internal processes or external forcing's such as modulations of the solar cycles, volcanic eruptions, and persistent anthropogenic changes in the composition of the atmosphere or in land use. Note that the Framework Convention on Climate Change (UNFCCC), in its Article 1, defines climate change as: 'a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods'. The UNFCCC thus makes a distinction between climate change attributable to human activities altering the atmospheric composition, and climate variability attributable to natural causes.

Eco-system based adaptation (IPCC 2014a, 1764) - The use of biodiversity and ecosystem services as part of an overall adaptation strategy to help people to adapt to the adverse effects of climate change. Ecosystem-based adaptation uses the range of opportunities for the sustainable management, conservation, and restoration of ecosystems to provide services that enable people to adapt to the impacts of climate change. It aims to maintain and increase the resilience and reduce the vulnerability of ecosystems and people in the face of the adverse effects of climate change. Ecosystem-based adaptation is most appropriately integrated into broader adaptation and development strategies (CBD, 2009).

Ecosystem Services (IPCC 2014a, 1764) - Ecological processes or functions having monetary or non-monetary value to individuals or society at large. These are frequently classified as (1) supporting services such as productivity or biodiversity maintenance, (2) provisioning services such as food, fiber, or fish, (3) regulating services such as climate

regulation or carbon sequestration, and (4) cultural services such as tourism or spiritual and aesthetic appreciation.

Mitigation (of climate change) (IPCC 2014a, 1769) - A human intervention to reduce the sources or enhance the sinks of greenhouse gases.

Resilience (IPCC 2014a, 1772) - The capacity of a social-ecological system to cope with a hazardous event or disturbance, responding or reorganizing in ways that maintain its essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and transformation.

ACKNOWLEDGEMENTS

I could not have completed this thesis without the support, encouragement, and assistance of my professors, friends, colleagues, and family members. First, I would like to thank my committee members, Jan Whittington and Don Miller, for their patience, support, advice, time, and feedback throughout the development of this document. Further, I cannot over emphasize how grateful I am for all of their encouragement and enthusiasm during the course of my graduate studies. Second, I would like to thank my friends and frequent group members Melanie Mayock, Cynthia Krass, Michele Hill, and Stefanie Young for sharing their advice on completing this process. Third, I would like to thank my supervisors and colleagues at Tetra Tech for their support and flexibility while I worked to complete this document. I would like to thank, Rob Flaner, in particular for his enthusiasm and encouragement. Fourth, I would like to thank my parents, Arthur and Carole Gelino, and all of my siblings, Amy, Eric, Kelly, Anna and Nathan, and their families for their advice and encouragement from day one. Finally, I would like to thank Mal Higgins for the too many to count ways that he helped me navigate graduate school and the completion of this document.

CHAPTER 1. INTRODUCTION

STATEMENT OF THE PROBLEM

The most recent Inter-governmental Panel on Climate Change (IPCC) synthesis asserts that climate change is occurring and that anthropocentric causes are extremely likely to be the most significant drivers (IPCC 2014c, 1-4). According to the IPCC, atmospheric concentrations of carbon dioxide have increased by 40 percent since pre-industrial times (IPCC 2013, 11) and "each of the last three decades has been successively warmer at the Earth's surface than any preceding decade since 1850" (IPCC 2013, 5). This warming is resulting in changes to climate and biophysical processes culminating in impacts such as warming ocean temperatures, changes in the hydrologic cycle, sea level rise, and increases in average surface temperatures (IPCC 2014c). These changes are having and will continue to have far-reaching impacts on human and natural systems and the ecosystem services on which all societies rely. At the same time, ecosystem services can be restored, enhanced or protected to help societies adapt to likely impacts. This emerging concept, known as ecosystem-based adaptation (EbA), stems from the idea that socio-ecological systems are inherently linked and reducing the vulnerabilities of ecological systems will contribute to the reduction of social vulnerability. Although, EbA is in no way a panacea, it has many potential benefits that will assist societies in planning for and adapting to a changing climate.

PURPOSE OF THE STUDY

Adaptation planning has recently moved into the forefront of climate change planning discussions as the revelation that climate change impacts are already occurring has gained traction in mainstream discussions. In the United States, climate change planning efforts have been concentrated at the state and local level as a result of a lack of leadership on climate change issues by the federal

government (Barbour and Deakin 2012, 71). Local planning efforts offer a variety of advantages for pursuing climate change planning initiatives and are of particular importance for adaptation, as impacts are locally manifested phenomenon. This study will determine the extent to which ecosystem services are being considered in local climate change plans that have been produced in the United States since 2011 and the extent to which these plans have identified actionable opportunities for ecosystem-based adaptation (EbA) strategies.

Research Question and Hypotheses

The principal research question for this study is: To what extent have local climate change plans developed in the United States since 2011 considered the importance of ecosystem services and to what extent have actions or strategies been identified that utilize, enhance or protect these services for human well-being? This question will be addressed through the following sub-questions:

1. To what extent do plans indicate awareness of the importance of ecosystem services?
2. To what extent do plans connect the importance of these services to human well-being?
3. To what extent do plans analyze the impacts of climate change on ecosystem services?
4. To what extent do plans identify the potential for ecosystems and their services to reduce social vulnerabilities to climate change?
5. To what extent have actions or strategies been identified that protect or enhance the ability of ecosystem services to reduce social vulnerabilities and impacts from climate change?
6. To what extent have actions been identified that have components required for implementation?

These questions were assessed through an analysis of 15 climate change planning documents utilizing an awareness, analysis, action framework (see Figure 1-1). Hypotheses for each research sub-question are shown in Table 1-1.

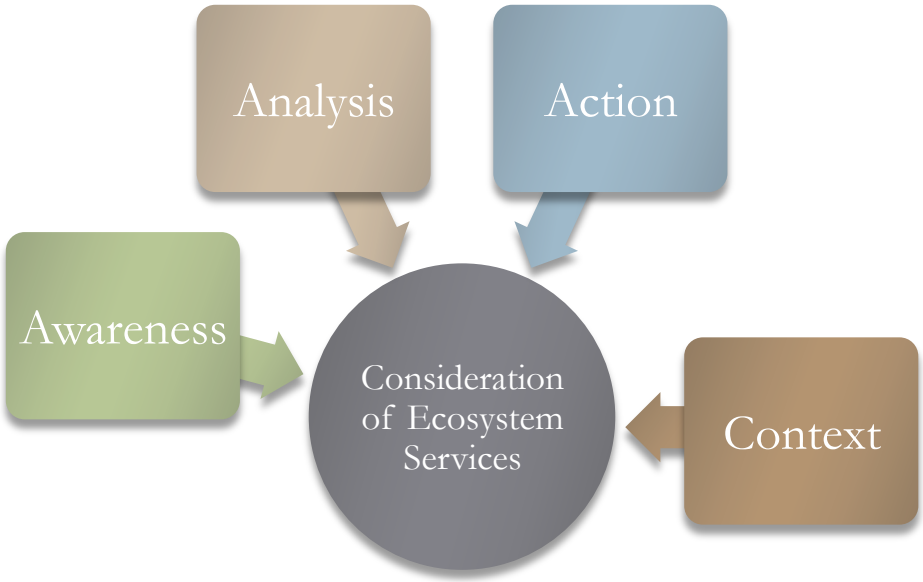

Figure 1-1. Analytical framework for the study.

Table 1-1. Research sub-questions and hypotheses

Research sub-question	Hypotheses
Q1. To what extent do plans indicate awareness of the importance of ecosystem services?	H1. The majority of plans examined will contain references indicating awareness of ecosystem-services.
Q2. To what extent do plans connect the importance of these services to human well-being?	H2. The majority of references to ecosystem services will not link these services to human well-being.
Q3. To what extent do plans analyze the impacts of climate change on ecosystem services?	H3. The majority of plans examined will not discuss the impacts of climate change on ecosystem services.
Q4. To what extent do plans identify the potential for ecosystems and their services to reduce social vulnerabilities to climate change?	H4. The majority of plan examined will not explicitly identify the potential for ecosystems and their services to reduce social vulnerabilities to climate change.
Q5. To what extent have actions or strategies been identified that protect or enhance the ability of ecosystem services to reduce social vulnerabilities and impacts from climate change?	H5. The majority of plans examined will not identify strategies that specifically protect or enhance the ability of ecosystem services to reduce social vulnerabilities to climate change.
Q6. To what extent have actions been identified that have components required for implementation?	H6. The majority of plans will contain less than four of the criteria identified as important for implementation.

Limitations of the Study

This study is focused on one aspect of climate change planning, the consideration of ecosystem services. Plans are evaluated only on this basis and, thus, do not indicate overall plan quality. This study is an exhaustive review of the plans selected; however, the lack of consistently utilized terminology to describe the concepts under review has most likely resulted in the exclusion of some references that should have been included in the analysis. Guidelines for plan review and assessment were established (see Chapter 3. Methodology); however this analysis required that personal judgment be employed on a case-by-case basis. Resultant errors in processing were minimized by the use of a single reviewer and the review of grouped references for similarities in content following the initial analysis. The small sample size may limit the ability to draw conclusions on climate action planning, in general, and may limit the overall transferability of the study results.

Document Organization

The remainder of this document will be divided into four chapters. In Chapter 2 a summary of the relevant literature will be presented. This review will firstly orient the reader within the theoretical framework upon which this study is predicated, then briefly describe the current and potential impacts of climate change. Secondly, the theoretical and analytical framework for climate adaption planning, ecosystem services and ecosystem-based adaptation will be presented. Finally, the literature of practice and empirical literature relevant for climate change planning in the United States will be reviewed and summarized. Chapter 3 will present, in detail, the methodology employed in this study to address the research questions and sub-questions. Chapter 4 will provide the results of the analysis and discuss these results in relation to consistency with previous studies. Chapter 5 will place the results in a wider context by providing recommendations for future research and for practicing planners.

CHAPTER 2. REVIEW OF THE LITERATURE

INTRODUCTION

The purpose of this study is to examine the extent to which the second generation of local government climate planning initiatives have considered the importance of ecosystem services and have translated this importance into actionable, ecosystem-based adaptation strategies. The focus of the study is on climate action/adaptation plans produced by local governments in the U.S. in 2011 or thereafter. This review of the relevant literature will firstly orient the reader within the theoretical framework of socio-ecological resilience and then briefly describe the current and potential impacts of climate change. Secondly, the theoretical and analytical framework for climate adaption planning, ecosystem services and ecosystem-based adaptation will be presented. Finally, the literature of practice and empirical literature relevant for climate action/adaptation planning in the United States will be reviewed and summarized.

SOCIO-ECOLOGICAL SYSTEMS AND RESILIENCE

Human beings are dependent on the ecological systems and functions that comprise the natural world. As S.H. Simon describes in the 2009 *Stockholm Resilience Dictionary* (quoted in Bahadur, 2013, 56), the idea of the socio-ecological system has arisen as a way to conceptualize these "linked systems of people and nature. The term emphasizes that humans must be seen as a part of, not apart from, nature – that the delineation between social and ecological systems is artificial and arbitrary." Although the delineation between the two systems may be arbitrary, this should not be contrived to mean that human decisions do not affect the viability of these systems. In fact, the conclusion should be quite the opposite - human decision-making and exploitation of resources (for example, the conversion of forested land to agricultural production) modifies these coupled systems in surprising and unpredictable ways. A system's ability to absorb these shocks and stressors and still

persist is generally categorized as resilience (Holling 1973, 17). Resilience can be used to describe ecological, social, and socio-ecological systems. The focus of this study is not on resilience per se, but on one avenue through which resilience can be pursued: preserving, restoring, and enhancing ecosystem services for human well-being.

Socio-Ecological Systems and Ecosystem Services

As part of socio-ecological systems, human well-being is dependent on the goods and services provided by ecosystems. In turn, the socio-economic decisions that we make influence the health and functioning of these systems. Ecosystem services are defined as "the benefits that people obtain from ecosystems," while human well-being is situation-dependent, but generally composed of "basic material for a good life, freedom of choice and action, health, good social relations, and security" (MEA 2005, 3). The Millennium Ecosystem Assessment (MEA), an expansive study undertaken from 2001 to 2005, was conducted to "assess the consequences of ecosystem change for human well-being and to establish the scientific basis for actions needed to enhance the conservation and sustainable use of ecosystems and their contributions to human well-being" (MEA 2005, vii). In the MEA ecosystem services are divided into four service categories: supporting, provisioning, regulating, and cultural (see Figure 2-1). These services directly and indirectly impact the components of human well-being (see Figure 2-2).

Figure 2-1. Ecosystem service typologies and services. Adapted from MEA (2005, 21-24)

Figure 2-2. Linkages between ecosystem services and human well-being. Adapted from MEA (2005, 4)

Socio-Ecological Resilience

The provision of ecosystem services is influenced by 'drivers' (sometimes referred to as shocks and stressors or disturbances). The MEA defines a driver as "any factor that changes any aspect of an ecosystem" (MEA 2005, 9). Drivers can be both direct and indirect, operate at different scales (temporal, spatial), and have compounding impacts that create feedback loops (MEA 2005, 9). For example, "urbanization changes land use cover, generally reduces the amount of ecologically intact lands and causes fragmentation of the remaining land, which reduces habitat value for species and increases the likelihood of further ecological degradation" (IPCC 2014b, 552). Examples of direct and indirect drivers include the following (MEA 2009, 9):

- **Direct** – land cover change, air and water pollution, climate change, irrigation, use of fertilizers, harvesting, and the introduction of invasive species.
- **Indirect** – population size, macroeconomic policies, democratization, technology and personal choices.

The interactions of these drivers across space and time are influenced and exacerbated by the complex interactions inherent in socio-ecological systems (SES). While undergoing constant internal change, these systems still display an underlying stability in function or service. Drivers can erode this underlying stability (not to be confused with stasis) and push the system past a threshold where the essential function (or service) in no longer able to be maintained. Ecological resilience is categorized by "the amount of disturbance a system can take before its control shifts to another set of variables and relationships that dominate another stability region" (Folke 2006, 254). Socio-ecological resilience (SER) acknowledges that humans are both the drivers of ecosystem change and deeply impacted by the consequences. SER can, therefore be understood as "the ability of SESs to persist through maintaining essential functions and structures and to evolve mainly by incorporating change while they are confronted with unpredictable and sudden events, disturbances or even

shocks that strongly shape their future development (Walker et al. 2004; Holling 2003; Berkes et al. 2003; Folke et al. 2002)" (Deppisch and Hasibovic 2013, 120).

The concept of resilience is deeply embedded with the notion of vulnerability (risk multiplied by exposure) and some researchers have suggested that the terms are 'loose antonyms' (Adger 2000, 348). More vulnerable systems are by definition less resilient. Vulnerability in social-ecological systems is dependent on the exposure and sensitivity of complex systems of social, built, and natural capital. As Adger et al. (2005, 1037) describe, "the causes of vulnerability are embedded in the political economy of resource use and the resilience of the ecosystems on which livelihoods depend." Vulnerable systems have less capacity to absorb shocks and stressors, which is often categorized as adaptive capacity. Adaptive capacity is "the ability of systems, institutions, humans, and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences" (IPCC 2014a, 1758). Increasing adaptive capacity is often presented as a way to increase resilience. There are many conventional ways to increase adaptive capacity including, increasing legal, technical, and financial resources. However, this study posits that increasing natural resources, specifically through the preservation or enhancement of ecosystems and their services, is also a primary mechanism through which SESs can increase adaptive capacity.

Societies in pursuit of resilient socio-ecological systems must be cognizant of the influential factors and feedback loops inherent in the provision and use of ecosystem services and the influences and consequences of socio-economic policies within and upon them. This notion is complicated by the fact that most of the human population now resides in cities whose socio-ecological functions are reliant on the resilience of systems outside of their geo-political boundaries (e.g. food production, water source protection) (Girot et al. 2012, 9; IPCC 2014c, 548). The lack of institutional authority over ecosystem management decisions constrains the development of adaptive capacity, thus constraining socio-ecological resilient outcomes. The MEA framework

creates a simple, transferable mechanism through which these complex interactions of ecosystem services and human well-being can be discussed and understood within and across decision-making and public policy arenas. Enhancing adaptive capacity through the preservation or enhancement of natural systems is a strategy worthy of pursuit that will become increasingly more relevant as SESs are more frequently disturbed by climate change.

CLIMATE CHANGE AND IMPACTS

Climate change and its associated impacts are increasingly being recognized as a threat to human well-being and the provision of ecosystem services. The most recent Inter-governmental Panel on Climate Change (IPCC) synthesis asserts that climate change is occurring and that anthropocentric causes are extremely likely to be the most significant drivers: "Human influence on the climate system is clear, and recent anthropogenic emissions of greenhouse gases are the highest in history. Recent climate changes have had widespread impacts on human and natural systems" (IPCC 2014c, 1). Some impacts that are already occurring include, shifting hydrological cycles, changes in species distribution, increases in extreme weather events, and rising ocean temperatures (IPCC 2014c). These impacts will become more pronounced and more frequent in the coming decades and will last for centuries. At the present time, the evidence base for impacts to natural systems is more robust; however, impacts to social systems have also been documented (IPCC 2014b, 4). Given a socio-ecological systems framework, it is likely that impacts to human systems will increase over time as the natural systems on which human well-being relies continue to be stressed by both existing drivers (e.g. population growth) and the changing climate. According to the IPCC, the key risks affecting North America include (IPCC 2014b, 23):

- "Wildfire-induced loss of ecosystem integrity, property loss, human morbidity, and mortality as a result of increased drying trend and temperature trend;

- Heat-related human mortality; and
- Urban floods in riverine and coastal areas, inducing property and infrastructure damage; supply chain, ecosystem, and social system disruption; public health impacts; and water quality impairment, due to sea level rise, extreme precipitation, and cyclones."

Further, North America is expected to incur impacts related to water supply and agricultural productivity – key ecosystem services. It is anticipated that climate change will compound existing stressors on the water supply system in much of west, southeast, and southwest (IPCC 2014c, 1457). Snowpack levels are expected to decrease, thus affecting water supply in the northwest and east (IPCC 2014c, 1457). Effects on agricultural productivity, complicated by water supply, are thought to be more variable with some instances of increased productivity. However, without adaptation, "overall yields of major crops in North America are projected to decline modestly by mid-century and more steeply by 2100" (IPCC 2014c, 1462). The implications for SESs that rely on these services are unclear.

Uncertainty is pervasive in climate change science as a result of unknown impacts and interactions in the underlying biochemical and physical processes that shape natural systems. Further, future impacts are dependent on the ability of global societies to mitigate the causes of climate change, namely through a massive reduction in the release of green-house gases. As the most recent IPCC assessment purports "The interaction between climate change and existing environmental stresses can lead to a range of synergies, challenges and opportunities for adaptation with complex interlinkages and often highly uncertain or non-linear processes (Ernston et al 2010)" (IPCC 2014,b 556). Perhaps there is no better example of the complexities and interdependencies of socio-ecological systems than evidenced by the causes and impacts of climate change. This complexity presents challenges to planners, decision-makers, and communities as they develop strategies to prepare for impacts.

PLANNING FOR CLIMATE CHANGE

Planning for climate change is typically divided into two complementary components: mitigation and adaptation. Mitigation activities can be challenging to implement, but are conceptually straightforward in nature. Mitigation is defined by the IPCC as "a human intervention to reduce the sources or enhance the sinks of greenhouse gases" (IPCC 2014a, 1769). Mitigation generally entails identifying sources of greenhouse gas emissions and developing behavioral, political and regulatory measures to reduce or eliminate those emissions. Adaptation on the other hand is still an emerging field of practice that is complicated by deep uncertainty, tradeoffs, and long timeframes. The IPCC defines adaptation as "the process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate harm or exploit beneficial opportunities. In natural systems, human intervention may facilitate adjustment to expected climate and its effects" (IPCC 2014a, 1758). Lara Binder and colleagues note (2010, 353), "the need to adapt to climate will depend on the vulnerability of human and natural systems to climate impacts, which, in turn is a function of a system's sensitivity, exposure and adaptive capacity to climate variation and change." While mitigation and adaptation are interrelated both practically and conceptually, the focus of this study and the remainder of the discussion will be centered on adaptation planning.

Adaptation Planning

The complicated nature of adaptation planning should not be understated. In fact, it has been posited that, "the complexities and uncertainties associated with climate change pose by far the greatest challenges that planners have ever been asked to handle" (Susskind 2010, 219). Because of this sentiment, some researchers and organizations have suggested that new systems and planning frameworks must be developed to overcome the enormity of the challenges presented by climate change, while others have argued that mainstreaming climate considerations into already existing

tools and structures is a more viable approach. For example, the American Planning Association's (APA) 2011 guidance states, "traditional approaches are not enough to mitigate and adapt to climate change. A dramatic new response to climate change is required. Business as usual or small, marginal reforms will not suffice" (APA 2011, 4). While the IPCC's most recent assessment asserts "Mainstreaming adaptation into urban planning and land use management and legal and regulatory frameworks is key to successful adaptation (Lowe et al., 2009; Kehew et al., 2013). It can help planners rethink traditional approaches to land use and infrastructure design based on past trends, and move toward more forward looking risk-based design for a range of future climate conditions (Kithiia, 2010; Solecki et al., 2011; Kennedy and Corfee-Morlot, 2013), as well as reducing administrative cost by building resilience through existing policy channels (Urwin and Jordan, 2008; Benzie et al., 2011; Blanco et al., 2011)" (IPCC 2014b, 578). Likely, both small-scale measures and large paradigm shifts will be needed to rise to the challenges presented by climate change and, it is important to note, these strategies are not mutually exclusive.

The literature also suggests this dual-pronged approach as evidenced by the inclusion of two types of adaptation in the IPCC's fifth assessment: transformative and incremental. Incremental adaptation is defined as "adaptation actions where the central aim is to maintain the essence and integrity of a system or process at a given scale (IPCC 2014a, 1758). While transformative adaptation is defined as "adaptation that changes the fundamental attributes of a system in response to climate and its effects" (IPCC 2014a, 1758). The distinction between incremental and transformational change is not a hard and fast line. An example of an incremental adaptation is switching to the production of more drought-resistant agricultural products in an area likely to experience greater disruption in water supply, while a switch from an agrarian-based economy to one more focused on the production of manufactured goods is transformative.

A recent review of adaptation planning in the United States conducted by Rosina Bierbaum and colleagues (2013, 371) has indicated that "the primary mechanisms that local governments are using to prepare for climate change include land-use planning, provisions to protect infrastructure and ecosystems, regulations related to the design and construction of buildings, roads and bridges, and emergency preparation response and recovery. (Dierwechter 2010; Grannis 2011; Kahn 2009; Selin and VanDeveer 2007; Solecki and Rosenzweig 2012)." These mechanisms, although varied, appear to lean toward the incremental stage of the spectrum. This is not surprising given the fact that adaptation planning is still in its infancy. Identifying small, achievable actions consistent with dominant social and economic paradigms are likely to be more successful in the short-term. The initial tendency toward incremental action is further supported by the idea that beginning steps toward climate change adaptation may be obtainable if strategies are focused on no- or low- regret actions. No-regret solutions are generally categorized as those strategies that have benefits in the immediate future regardless of if they provide expected adaptation benefits for climate change. An example of a no-regret solution would be implementing low impact development requirements for new development or working to build adaptive capacity (Binder et al 2010, 354). These no-regret solutions are being emphasized as a starting point to begin the arduous process of identifying and implementing climate-smart development and adaptation (APA 2011, 3; Binder et al. 2010, 3356). Although, both incremental and transformative approaches will likely be needed to address the adverse effects of climate change and to capture benefits over the long-term (IPCC 2014b, 836), the identification of incremental changes is a good starting point. In fact, the identification of incremental changes at all is a move in the right direction as societies began to move from "awareness raising" and "capacity building" to the development of plans and (hopefully) the implementation of planned actions (IPCC 2014b, 873). The notion of incremental change on its face suggests that such changes are more appropriate in the short-term, while researchers and decision-

makers are still largely in the process of "muddling-through" the development of best practices and information gathering (Lindblom 1959).

Muddling-through to Progress

The matter of "muddling through" to best practices is complicated by the idea that adaptation must be context-specific in that it must be tied to a particular time and location. Further, planners and other decision-makers must muddle through to progress. Several different planning tools with varying degrees of complexity have been employed to assist with developing transferable frameworks to address climate adaptation planning issues. Scenario planning, resilience frameworks and robust decision-making are perhaps the most widely discussed. Researchers worldwide are working to develop transferable, best practices based on these planning models (Bahadur 2013; Wamsler 2013; Wilby and Dissai 2009).

Perhaps one of the simplest models currently proposed is the awareness, analysis, action framework developed by Moser and Luers and employed in this study, which is intended to strengthen the three aforementioned "critical dimensions of adaptation" (Moser and Luers 2008, S312). They describe their framework as follows:

> In the context of planned adaptation to climate variability and change, decision makers in the private and public sectors first need to become aware of the potential impacts and risks, and how these risks may affect them or their specific business and management responsibilities. This *awareness* needs to be coupled with a fuller understanding and *capacity to analyze* such information in order to develop policy initiatives strategies and plans. This ability and resulting understanding can but may not suffice to provide the necessary motivation to act (e.g. Rayner et al 2005; UKCIP 2003). Moreover, decision makers must have the willingness, incentives and ability to use this understanding in decision-making, i.e., to translate their awareness and concern into concrete *actions* (Moser and Luers 2006, S312).

This assessment highlights the oft-overlooked fact that regardless of the theoretical framework employed, decision-makers and others involved in adaptation planning must address issues of agency and implementation. Decisions regarding climate change planning and actions have been described by at least one researcher as 'ad hoc' (Preston, Westaway and Yuen 2011, 410), while planning for adaptation requires a strategic assessment and deliberative approach to selecting viable, robust policies, projects and strategies. Setting aside the issue of agency, adaptation planning must result in concrete actions that are specific enough for implementation. Development of such actions has thus far proven problematic (see further discussion in local planning initiatives section). As some climate change planning guidance has suggested, "initiatives must be measurable and reflective; prioritized; effective, cost effective in the long term; couched within existing policies and catalyzed by strong leadership, particularly at a local level, if it is to be an effective endeavor" (Travers et al. 2012, 9).

One possible remedy to the lack of concrete actions may be found in strategic planning. John M. Bryson defines strategic planning in his well-know work *Strategic Planning for Public and Non-Profit Organizations* (2011, 8) as a "deliberative, disciplined approach that produces fundamental decisions and actions that shape and guide what an organization (or other entity) is, what it does, and why." Most fundamentally, a strategic planning framework can assist decision-makers in the method and requirements for identifying implementable actions, which can then be monitored and reported on in both empirical and practical literature, thus contributing to operational learning and best practices. Bryson states, "action plans are statements about how to implement strategies in the short-term" (Bryson 2011, 301). He notes that they typically should cover the time period of one year or less and include the following information:

- "specific expected results, objectives and milestones;
- roles and responsibilities of implementation bodies, teams, and individuals;

- specific action steps;
- schedules;
- resource requirements and sources;
- a communication process;
- a review and monitoring process;
- accountability processes and procedures" (Bryson 2011, 301).

Utilizing a strategic planning framework may help planners and decision-makers move from 'ad hoc' adaptation to a deliberate approach that identifies concrete, implementable actions, which are subject to monitoring and reporting practices. This purposeful approach would provide a foundation for the development of best practices and effective planning guidance that embraces a range of adaptation approaches, including ecosystem-based adaptation.

Adaptation Approaches

Adaptation approaches are generally categorized as "hard" or "soft." Hard approaches are generally structural-based, engineered solutions designed to encourage stasis. An example of a hard approach would be a levee system. Soft approaches tend to more policy oriented or non-structural in nature (although they may have physical manifestations), such as land use plans and policies. The IPCC has identified two general limitations of engineered approaches: "First, they often must cope with uncertainties associated with projecting climate impacts arising from assumptions about future weather, population growth, and human behavior (Dawson, 2007; Furlow et al. 2011). Second the longevity and cost of engineered infrastructure affect the feasibility at the outset (Koeste and Rietvald, 2012)" (IPCC 2014b, 846). Although engineered and technical responses are most common (IPCC 2014b, 877), these limitations have been instrumental in opening the range of adaptation options under consideration and perhaps the push toward the development of no-regret

solutions, cross-sectoral, and ecosystem-based responses. The aforementioned types of responses are believed to be less well-known in decision-making circles, although there is evidence that the import of soft responses is growing (ProAct Network 2008, 8, 44; IPCC 2014, 53, 387, 880).

ECOSYSTEM-BASED ADAPTATION

Ecosystem-based adaptation (EbA) is an adaptation framework that emerged from the United Nation's Convention on Biological Diversity (CBD) Second Ad Hoc Technical Expert Group on biodiversity and climate change. The IPCC defines EbA as "the use of biodiversity and ecosystem services as part of an overall adaptation strategy to help people to adapt to the adverse effects of climate change" (IPCC 2014a, 1764). Although the overarching principles of EbA are anthropocentric and focused on reducing society's vulnerabilities (CBD 2009; Colls, Ash, and Ikkala 2009; World Bank 2009), an EbA approach can promote both adaptation for ecosystems and ecosystems for adaptation (Pramova et al. 2012, 396). Although, EbA is in no way a panacea, it has many potential benefits in that it will help communities address the adaptation deficit in a way that promotes long-term resilience, adaptive management principles, opportunities for cross sectoral planning, and the identification of no- or low-regret solutions (Pramova et al. 2012; Olsson, Folke, and Berkes 2004; Andrade et al. 2011; Vignola et al. 2009). EbA is likely to be most effective when it is considered in an overall adaptation strategy where the benefits and the costs of different adaptation approaches can be weighed (Travers et al. 2012, 47). Although EbA is a new approach that is still gaining traction, "there is a growing understanding that using ecosystem attributes and services can be a more sustainable and affordable path to social and built environment adaptation" (Staudinger et al. 2012, 6-27).

Core Principles of EbA

Because EbA is an emerging approach, the core principles are still a subject of debate. A document produced by the International Union for Conservation of Nature (IUCN) identifies the following draft core principles for EbA in an effort to promote the discussion of EbA principles and the development of guidelines for incorporating EbA activities into adaptation frameworks:

- EbA "is about promoting the resilience of both ecosystems and societies;
- Promotes multi-sectoral approaches;
- Operates at multiple geographical scales;
- Integrates flexible management structures that enable adaptive management;
- Minimizes tradeoffs and maximizes benefits with development and conservation goals to avoid unintended negative social and environmental impacts;
- Is based on best available science and local knowledge, and fosters knowledge generation and diffusion;
- Is about resilient ecosystems, and using nature-based solutions at the service of people, especially the most vulnerable; and
- Is participatory, transparent, accountable, and culturally appropriate and actively embraces equity and gender issues" (Andrade et al. 2011, 1).

These principles are supportive of a more thoughtful approach to the design and implementation of adaptation efforts that runs counter to the tendency to only consider expensive, hard infrastructure solutions (IPCC 2014b, 846). EbA approaches should help highlight the fact that, in some instances, natural systems already provide cost-effective protection against climate change impacts (e.g. flooding and storm surge), while simultaneously providing other goods and services that humans rely on for well-being (World Bank, 2009, 47; Ranganathan et al. 2008, 4). For

example, the USGS estimates that salt marshes along the central Louisiana Coast reduce storm surge by 3 inches per mile of marshland and each hectare reduces hurricane damages by $8,235 per year (Constanza et al. 2012). Hard infrastructure investments, on the other hand, require large capital investments that can damage or destroy the provision of these services, resulting in social and ecological externalities that reduce, rather than enhance, community resilience. EbA activities need not be (non)structural in nature. Policy-based initiatives such as encouraging adaptive management of forestland, promoting ecotourism opportunities, and strengthening conservation efforts can also be aligned with EbA approaches (IPCC 2014b, 847).

Policies and Interventions of Ecosystem-based Adaptation

Ecosystem-based adaptation interventions can be used in rural, peri-urban, and urban settings. In fact, successful implementation of many EbA approaches will require coordination across multiple levels as many services utilized in urban areas are produced across jurisdictional boundaries and many ecosystems span multiple jurisdictions. Urban leaders pursuing EbA strategies must recognize that they need to "move beyond a focus on street trees and parks to a more detailed understanding of the ecology of the indigenous ecosystems, and how biodiversity and ecosystem services can reduce the vulnerability of ecosystems and people" (IPCC 2014b, 572). At the same time, urban governments should acknowledge that decisions occurring at the local level impact ecosystem health. Land use decisions in particular can exacerbate existing stressors through rapid development, the creation of urban drainage issues and loss of biodiversity through habitat fragmentation (Brody, Highfield, and Carrasco 2004, 33).

In 2008 the World Resources Institute (WRI) published a guide that "develops the conceptual framework from the Millennium Ecosystem Assessment to help decision makers gain a better understanding of how development goals both affect and depend on ecosystem services"

(Ranganathan et al. 2008, iv). Although this guidance was not developed with the explicit purpose of assisting with local climate change planning initiatives, the lessons therein are easily transferable: "Focusing on ecosystem services allows a decision-maker to view services of nature as an input into a strategy to achieve a goal, much like human or physical capital" (Ranganathan et al. 2008, 16). The guide develops a range of broad-stroke policy options to assist decision-makers in promoting development strategies that enhance, rather than detract from the viability of these services (Ranganathan et al. 2008, 60). These policy options (reproduced in part in Table 2-1) are instrumental in identifying cross-cutting strategies to pursue ecosystem-based adaptation initiatives and many will be familiar tools already being utilized by local jurisdictions (Doswald et al. 2014, 187).

Table 2-1. Broad-stroke policy options for ecosystem services

Policy Type	Policy Options
National and sub-national policies	Maintain ecosystem services into economic and development planning
	Include investments in ecosystem services in government budgeting
	Establish protected areas
Economic and fiscal incentives	Use tax deductions and credits to encourage investment in and purchase of ecosystem services
	Use taxes or other public funds to pay for the maintenance of regulating and cultural services
	Fund valuation of ecosystem services and research into improving valuation methods
Sector policies	Require ecosystem management best practices in granting licenses and concessions
	Use zoning or easements to keep land available for priority ecosystem services
	Use regulating ecosystem services such as natural hazard protection or water filtration instead of built structures.
Governance	Clarify or strengthen local community rights to use and manage ecosystem services.
	Establish processes to work across levels of government from local to national
	Ensure public access to information and participation

Source: Reproduced in part from Ranganathan et al. (2008, 61-64)

The continued application and enhancement of these polices at the local level can have significant regional impacts. According to Brody and colleagues, "thoughtful policy decisions at the local level can often protect critical habitats of regional significance more effectively and less expensively than the best intentioned state or federal protection schemes" (Brody, Highfield and Carrasco 2004, 34).

EbA Activities and Interventions

EbA activities and interventions can be as varied as promoting adaptive management strategies for coastal ecosystems or promoting green roofs on new developments. While the IPCC has suggested that it is time for urban adaptation policies to move beyond street trees and embrace the more complex socio-ecological systems on which our societies rely, there is still quite a bit of work that can and should be done in promoting green infrastructure within urban centers. Further, many green infrastructure activities are actionable by single jurisdictions through modifications of building and planning requirements. Low impact development (LID), for example, can be a viable option for reducing stress on urban stormwater systems in areas expecting changes in the frequency and duration of precipitation events and is within the institutional capabilities of all local governments with planning and permitting authority. Additionally, many EbA activities are no- or low-regret options that can be implemented in the short-term. To continue with our LID example, policies can be implemented that affect new developments immediately and such strategies would have immediate beneficial impacts (such as reduced pollution load in receiving bodies in jurisdictions serviced by combined sewer systems). Table 2-2 below outlines a variety of ecosystem-based adaptation relevant activities by various sectors likely to be influenced by climate change impacts.

Table 2-2. Ecosystem-based adaptation relevant activities and interventions

Sector	Activities and Interventions
Food Security	Agroforestry practices; implement crop rotations; choose crops with less intensive nutrient and water requirements; control invasive alien species; maintaining local landraces and crop varieties; and protect reefs and mangroves for sustainable fisheries; plant tree shelterbeds; conservation agriculture; soil conservation; encourage genetic diversity; urban farms
Infrastructure	Plan to protect natural habitats and ecological connectivity; incorporate protection of natural ecosystems into coastal defenses and flood control rather than rely solely on infrastructure such as sea walls and drainage canals; accommodate ecological flows and ecosystem functions in reservoir and dam design
Carbon Sequestration	Reduction of carbon emission through ecosystem-based approaches e.g. establishment of new protected areas and improved management of existing reserves; protection of old growth and swamp forests and wetlands; natural regeneration of forests, reforestation and afforestation; promote ecotourism activities
Water Security	Watershed and forest protection; incorporation of wetlands in water treatment and water quality improvement initiatives; wetlands for water storage and flood control purposes; integrated watershed management
Coastal Zone Management	Incorporate mangroves and other coastal wetlands into storm protection and coastal defense; protect mangroves, sea grass beds and coral reefs for sustainable fisheries; promote integrated coastal management that prevents pollution of marine and coastal environment; managed realignment; integrated coastal zone management; sustainable management of coastal vegetation buffers; beach nourishment programs; protect and enhance dunes
Urban Systems	Protect and enhance urban forests; preservation and expansion of urban green space; low impact development policies; native plant landscaping; critical/sensitive area protections; green roofs; porous pavement
Natural Hazards	Plant tree shelterbeds; wetlands preservation and restoration; rangeland management; vegetation management programs for steep slopes

Source: Adapted from World Bank (2009, 81-82) and supplemented with Doswald et al. (2014); Foster et al., 2011; Gomez-Bagethun and Barton (2013); Munang et al. (2013); Gill et al. (2007)

Ancillary Benefits or Co-benefits of EbA Interventions

In addition to being no- or low-regret strategies that are actionable in the short-term, EbA activities often bring ancillary benefits. In fact Christine Wamsler and colleagues (2013, 78) argue that "what makes the use of blue, open and green spaces for risk reduction and adaptation so attractive is the fact that they also improve citizens' quality of life by providing recreational areas and places that can foster social interaction." An additional benefit that should not be overlooked is the ease with which

EbA activities can simultaneously act as mitigation strategies by serving as carbon sinks and engaging in carbon fixing activities (Munang et al. 2013, 67; ProAct Network 2008, 8). Additional ancillary benefits can enhance economic, social, and natural systems. For example, green roofs that were implemented as a mechanism to reduce urban heat island effect may also reduce the heating and cooling load of the building resulting in economic and carbon savings, reduction in stormwater run-off, and the provision of habitat for urban fauna (IPCC 2014b, 574-575). Similarly, urban trees can serve as carbon sinks, reduce flooding risk, and reduce radiating heat through shade provision (Zimmerman and Faris 2011, 183).

EbA interventions may often appear to be less costly than hard infrastructure investments (ProAct Network 2008, 8); however, the true economic value of preserving or enhancing these systems and their associated services are most likely undervalued. The preservation of functional ecosystems provides hidden benefits that are often unaccounted for in traditional decision-making frameworks. Adaptation actions that preserve or enhance ecosystems services on which we currently rely may reduce the need to make technological or hard infrastructure investments in the near- to long-term (Pramova et al. 2012; TEEB 2010). Although there has been significant progress in recent decades in the valuation of ecosystem services, these services are often overlapping. An evaluation that quantifies the value of a coastal wetland as a hurricane buffer may not include the additional benefits in water filtration or economic activities. Thus, the calculated protection benefit of the wetland may be comparable to the capital investment required for a levee system, but many associated benefits will be uncounted.

Effectiveness of Ecosystem-based Approaches for Adaptation

Due to the recent emergence of Ecosystem-based adaptation (EbA), there are a limited number of empirical studies that have assessed EbA strategy effectiveness. Any assessment is complicated by a

lack of cohesive terminology and a lack of clarity in where such information might be found. In a recent report highlighting the positive role that ecosystems can plan in reducing the negative impacts of natural hazards, the authors made a point to state that quality scientific information was available, but was "quite fragmented and dissipated" (ProAct Network 2008, 14). Further, in a recent review of both peer-reviewed and grey literature, N. Doswald and colleagues (2014, 189) found that peer-reviewed articles describing EbA interventions used very broad terms, such as ecosystem management, or very specific terminology, such as erosion control methods. In fact, none of the peer reviewed articles examined used the term "ecosystem-based adaptation," while the term was present in more than three-quarters of the grey literature reviewed (Doswald et al. 2014, 189). Despite these difficulties, the exhaustive review found ample evidence of EbA interventions resulting in social, economic and environmental benefits and some evidence that EbA interventions may be effective strategies in reducing vulnerability from climate change impacts (Doswald et al. 2014, 199).

The current lack of empirical evidence tying EbA strategies to effective adaptation efforts should not preclude local governments from considering EbA approaches in adaptation planning strategies. Adaptation, itself, is an emerging field and the success of any approach will likely take decades to assess (Doswald et al. 2014, 186). Instead, there should be an increased emphasis on reporting and monitoring efforts, so that government actors and the academic community can develop a better understanding of the processes and contexts where EbA strategies will prove most effective. Several additional gaps in the current evidence base regarding the effectiveness of EbA strategies include:

- Uncertainty on long-term effectiveness in a changing climate;
- Information gaps in some ecosystems;
- Lack of consistent terminology and cross-system measurement;

- Difficulties comparing EbA to alternative adaptation approaches; and
- Unknown distributional impacts of such strategies (Doswald et al. 2014, 199; IPCC 2014b, 847).

As EbA interventions are developed and implemented, special attention should be made to record and report information that will contribute to horizontal learning and will close these knowledge gaps.

LOCAL CLIMATE CHANGE PLANNING INITIATIVES

Although once a topic of considerable debate, it is now generally accepted that all levels of government have a role to play in addressing the issues contributing to and impacts from climate change. A lack of federal leadership over the past several decades has resulted in a largely bottom-up approach where progress and innovation on climate planning issues has been concentrated in state and local governments, rather than at the federal level (Barbour and Deakin 2012, 71). A number of organizations have been formed to support and to promote climate change planning efforts for these local governments. Those most frequently mentioned include ICLEI-Local Governments for Sustainability, the U.S. Conference of Mayors climate change agreement, Resilient Cities for America, the C40 Cities and, most recently, the Rockefeller Foundation's 100 Resilient Cities. ICLEI, founded by local governments in 1990 at the World Congress of Local Governments for a Sustainable Future is likely the most widely known. The ICLEI USA chapter was formed in 1995 with only a few local government members and has grown to 450 member cities and counties in 46 states. At the time of the writing of this study the U.S. Conference of Mayors climate change agreement has 1,060 mayoral signatories, 182 mayors and county leaders have signed the Resilient Cities for America Agreement, there are 14 U.S. C40 Cities and 10 of the first 32 100 Resilient Cities are located in the United States. Although the leadership of local governments may have been

catalyzed by a vacuum created by a lack of federal policy, it is clear that local governments have a critical role to play in shaping and implementing policies and initiatives to both reduce GHG emissions and to prepare for climate change impacts. As the most recent IPCC assessment attests, local urban governments are in a unique position to respond to climate adaptation needs. They understand local contexts, build local awareness, promote common community vision, develop urban planning processes, and provide mechanisms for implementation (IPCC 2014b, 577).

Planning Guidance

Climate action planning is still an emerging practice globally and in the United States. Currently, there are no universally accepted standards for Climate Action/Adaptation Plan (CAP) development processes, although there are a substantial number of guidebooks and guidelines published by a variety of organizations both in the United States and abroad (e.g. ICLEI, U.S. EPA, ACUPCC, APA, NAPAs, among others). These guidelines range in subject matter and thoroughness from the American College and University President's Climate Commitment's (ACUPCC) Implementation Guide, which addresses only GHG mitigation, to the EPA's Climate Ready Estuaries Synthesis of Adaptation Options, which focuses on adaptation for ecosystems.

A review of commonly available guidelines shows a limited emphasis on the explicit incorporation of ecosystem services or ecosystem-based adaptation (EbA) into CAPs. ICLEI-Local Governments for Sustainability is well known for the development of tools and guidelines for assisting local governments with GHG emissions inventories and has recently developed a set of guidance for climate preparedness (ADAPT). The details of ADAPT are restricted to member agencies, although the basic framework is built off of ICLEI's well know five milestones for climate mitigation planning. Based on the limited information available, it is impossible to determine if the guidance expressly encourages the use of EbA initiatives; however, other ICLEI efforts have come

close to promoting EbA activities. A 2007 publication produced collaboratively by the Climate Impacts Group at the University of Washington, King County, Washington and ICLEI, *Preparing for Climate Change: A Guidebook for Local, Regional and State Governments,* was developed to "help [decision-makers] in a local, regional, or state government prepare for climate change by recommending a detailed, easy-to-understand process for climate change preparedness based on familiar resources and tools" (Snover et al. 2007, 1). This guidebook makes many explicit references to ecosystems, although they predominantly appear in relation to climate change impacts on ecosystems and on cultural ecosystem services. The guidebook implies many connections between human well-being and ecosystem services, but rarely makes the connections explicit and does not provide clear examples for ecosystem-based initiatives. Similarly, the American Planning Association (APA) guidance on climate change planning implicitly recommends initiatives that encompass EbA activities, such as the encouragement of green roofs, green infrastructure, low impact development, and natural asset protection, but the guidance does not make clear connections to how these initiatives impact human well-being (APA 2011).

The climate planning guidance intended for a U.S. audience that most aptly incorporates EbA principles is the *California Adaptation Planning Guide: Planning for Adaptive Communities* (CalEMA and CalNRA 2012). The multi-part planning document provides guidance that suggests that local communities consider the impacts of climate change on ecosystem services during the course of a vulnerability assessment (CalEMA and Cal NRA 2012). Although the documents do not specifically use the terms "ecosystem services" or "ecosystem-based adaptation," they do identify some strategies that can be included under the EbA planning umbrella, as indicated by the following excerpts:

- "Increase "above-the-dam" natural water storage;
- Preserve undeveloped and vulnerable shoreline;

- Develop an urban heat island reduction program that includes an urban forest program or plan;
- Restore existing flood control and riparian corridors; and
- Prioritize low-impact development (LID) stormwater practices in areas where storm sewers may be impaired by high water due to sea level rise or flood waters" (CalEMA and CalNRA 2012, 4-8).

In addition the California guidance includes strategies intended to help prepare ecosystems, themselves, for adaptation such as:

- "Establish a management program to track forest and rangeland health;
- Collaborate with agencies managing public lands to identify, develop, or maintain corridors and linkages between undeveloped areas; and
- Use purchase of development rights (PDR) or conservation easements to protect climate-vulnerable habitats" (CalEMA and CalNRA 2012, 4-8).

International guidance, particularly those guidelines focused on the developing world, have shown a greater tendency to embrace the role of ecosystems and ecosystem-based adaptation as a viable response to climate change. For example, the target audience for *Ecosystem-based Adaptation Guidance: Moving from Principles to Practice* is least developed countries, small island nations, and African countries (Travers et al. 2012, 3). This document promotes the use of EbA as one of many tools in addressing climate change impacts:

> Ecosystem-based measures should be part of an adaptation toolkit containing a range of adaptation technologies. The guidance supports selection of adaptation technologies based on an understanding of the context in which adaptation takes place. Appropriate options are selected with clear reference to adaptation goals that have been defined cognisant of the role ecosystem services play in contributing to system sustainability and human well-being. The guidance provides users with the support to determine what adaptation technologies are not

> applicable in their context and also provides guidance on refining the measures that will most effectively meet their objectives (Travers et al. 2012, 3).

The document goes on to develop a decision-making approach based on a context-specific planning process that readily acknowledges that EbA approaches are not always the best strategy. The goal of the guidance is to provide a way to compare conventional and EbA options (Travers et al. 2012, 47). Although the target audience is not the developed world, many useful lessons for mainstreaming EbA activities may still apply.

Empirical Studies

Despite the lack of established guidance, the number of state and local governments developing CAPs has continued to increase over the last decade. In 2008 29 states had published climate action plans (Wheeler 2008, 482). At the time of this study, 32 states have produced climate action plan documents and 14 states have completed climate adaptation plans with 9 additional efforts underway. Although there is no known comprehensive database of local CAPs in the U.S., the literature indicates that such planning initiatives have been increasing. Due to the recent emergence of CAPs as a planning mechanism and tool, there are only a handful of published empirical studies that have addressed these plans. These studies have primarily focused on plan content and quality and have examined plan documents at various levels including state, local, and university. In general, these plans have been found to be primarily focused on GHG emission reductions and the built environment, and tend to focus on awareness-raising, rather than the development of concrete actions (Wheeler 2008, 488; Bassett and Shandas 2010, 442; Tang et al. 2013, 52). These plans have also been shown to vary widely in structure and content (Bassett and Shandas 2010, 442) and the factors influencing plan quality remain unclear (Tang et al. 2013, 51).

Plan Development and Influential Factors

Best practices are still emerging and possibly have been hampered by a lack of federal and state leadership (e.g. vertical learning opportunities), coupled with plan documents produced by one local administration and abandoned by the next. Further, CAP documents are often housed under a number of auspices. A 2010 assessment found a variety of plan document structures ranging from information provided on a web-page, to stand-alone plans, to incorporation in wider planning efforts, such as general plans (Bassett and Shandas 2010, 438). Bassett and Shandas aptly summarize the current state of CAPs: "In climate action planning at present, there is no set of core principles against which to evaluate CAPs [and local] informants emphasize that the plans should be locally appropriate. Many of the plans do not really constitute action plans, as they do not identify actions, designate actors, or lay out timetables" (Bassett and Shandas 2010, 442).

Along with plan structure and content, the departments involved in the planning process vary amongst jurisdictions. Bassett and Shandas (2010, 438) found a variety of individuals and organizations involved in preparing plan documents, but notably, the involvement of local planning commissions was non-existent. Solecki and colleagues (2011, 136) note that adaptation agendas in city governments are generally housed in environmental departments. This does not necessarily mean that planners are not involved in local climate planning initiatives, but that planning departments may not be leading efforts to develop these specific types of plans. The presumed lack of leadership by planning staff may lend some insight into the lack of relatively new, but widely used green planning principles in CAP documents. In their analysis of land use and climate change plans, Tang and colleagues (2011, 87) found that green building and green infrastructure policies were addressed in 95 percent of land use plans and only 60 percent of CAPs. Low-impact surface design was addressed in 50 percent of land use plans, while not a single CAP mentioned low impact development (Tang et al. 2011, 87). Further, their study found that 100 percent of land use plans

adopted policies for the creation of conservation areas and vegetation protection and 80 percent emphasized water-shed based and ecosystem-based land use management strategies, while only 7.5 percent of CAPs addressed either of these items (Tang et al. 2011, 89).

Some studies have attempted to ascertain casual factors for the decision to pursue climate planning initiatives and the resultant plan quality (or lack thereof). Influential factors in the decision to plan include strong support by both elected officials and residents and local membership in organizations involved in climate planning, such as ICLEI (Bassett and Shandas 2010, 441-442). Some studies have shown that jurisdictions perceived to be more vulnerable to the impacts of climate change (e.g. coastal communities) are more aware of climate change issues, although, subsequent studies have been unable to affirm these results (Tang et al. 2011, 97; Tang et al. 2013, 53). The influence of state-mandates or state level polices on plan quality are conflicting: some studies have shown a high correlation with plan quality and the strength of state climate change initiatives (Abbott and Kasprzyk 2012, 581; Tang et al. 2010, 56), while others have indicated that horizontal factors (e.g. peer-to-peer interactions) are more influential than vertical (Bassett and Shandas, 2010, 441-442) or that a combination of mandates and local motivation are needed (Bedsworth and Hanak 2013, 666). The influence of horizontal learning should probably not be understated in a climate where bottom-up approaches have been much more commonplace than state- or federally-led initiatives: "Horizontal coordination and networking across actors and institutions in different municipalities and metropolitan areas can accelerate learning and action (Aall et al., 2007; Lowe et al., 2009; Schroeder and Bulkeley, 2009)." (IPCC 2014b, 577). Further, peer-to-peer sharing has the potential to hasten the development of best practices through the sharing of lessons learned (Zimmerman and Faris, 2011, 185).

While it is important to understand the reasons that may positively influence a decision to plan, it is also important to be aware of those factors that may act as barriers. Identified barriers

include, uncertain information about location-specific climate impacts, conflicting goals and tradeoffs between planning efforts, backward looking regulatory regimes, coordination failure, and limits on institutional authority (Bedsworth and Hank, 2010; Tang et al. 2013, 94). For adaptation planning in particular, significant barriers include "a lack of funding, policy and institutional constraints, and difficulty in anticipating climate change impacts given the current state of the information on climate change" (Bierbaum et al. 2013, 395). The merits behind the claim that more information on climate change will result in greater uptake in adaptation planning may be suspect. As the IPCC notes in its most recent assessment "various studies have questioned a common assumption in the climate change literature that improvements in climate information are needed to facilitate adaptation (Dessai et al., 2009; Hulme et al., 2009; Wilby and Dessai, 2010; Verdon-Kidd et al., 2012)" (IPCC 2014b, 911-912). Instead, institutional authority constraints and coordination failures may be particularly pressing challenges for incorporating feasible adaptation planning initiatives that address ecosystem services in municipal CAPs. Cities typically rely on ecosystem services produced far outside their municipal boundaries. This implies that successful planning efforts must ensure that identified policies and strategies be coordinated across multiple levels of government and institutional settings (IPCC 2014b, 577). Zimmerman and Faris argue that "it is likely that increased attention to the inter-relatedness (geographically and topically) and potential unintended impacts of mitigation and adaptation plans would yield great insights for better integration, increased cost effectiveness and ultimately beneficial results" (Zimmerman and Faris 2011, 185). This sentiment reinforces the import of horizontal coordination in the pursuit of best practices and identification of actionable, effective initiatives.

GHG Emission-Reduction and Lack of Action

It is not surprising that the majority of plans examined have exhibited a focus on GHG emission reductions, as adaptation planning has only recently begun to be addressed by policymakers at any level of government. In fact, no studies were located that focused explicitly on the review of climate adaptation plans. Theoretically, plans produced under a climate action planning framework are expected to address both mitigation and adaptation strategies; however, this has clearly not been typical as evidenced by the literature. Stephen Wheeler's (2008, 484) assessment of state and local CAPs found that only 17 percent (11 of 64 plans) even mentioned adaptation and it was most commonly in the context of a topic for "further research and planning." Further, in a 2010 review of 20 local government plans, only 5 contained noteworthy discussions of adaptation strategies (Bassett and Shandas 2010, 440).

The focus on GHG emission reduction activities makes it unsurprising that these plans also tend to focus on the built environment. GHG emission reduction strategies have traditionally been discussed in the context of human activities (e.g. energy, transportation, waste, and buildings) (Tang et al. 2010, 55). It is surprising, however, that even with a focus on GHG emissions reductions, these plans lack implementable actions (Wheeler 2008, 488; Tang et al. 2010, 55); Bassett and Shandas 2010, 442). There are many tools and resources available for the production of baseline GHG inventories (e.g. ICLEI), which produce measureable and quantifiable information from which implementable actions can be developed. This is in stark contrast to implementable adaptation actions where uncertainty reigns and established best practices are non-existent.

Climate Action Planning and Ecosystem Services

No studies were located that explicitly examined the extent to which ecosystem services were considered in CAPs produced for local governments in the United States. A few content-focused

studies indirectly assessed the degree to which CAPs considered ecosystem services, such as through conservation strategies (Tang et al. 2011, 89 and 2013) or low impact development policies (Tang at al. 2011, 87); however, no studies placed a particular emphasis on plan review for these issues. The only known empirical study that expressly addresses EbA and climate change planning analyzes the extent to which ecosystem services were considered in published National Adaptation Programmes of Action (NAPAs).

NAPAs have been developed in the United Nation's Least Developed Countries (LDC) to address the "high level of vulnerability and low adaptive capacity" exhibited by these states (Pramova et al. 2012, 394). NAPA guidelines expressly link the impacts of climate change to human well-being and support the selection of projects that enhance the resilience of ecosystems and associated socio-ecological systems (LEG 2002). The study, conducted by Emilia Pramova and colleagues (2012), examined the content and project profiles of 44 NAPAs to assess the extent to which ecosystem services had been considered (Pramova et al. 2012, 394). The majority of NAPAs assessed mentioned the role of ecosystem services in background information sections and included ecosystem management activities in approximately a third of the project profiles (Pramova et al. 2012, 398-400). Ecosystem services were most commonly mentioned in terms of "providing the basic materials for a good life, such as sufficient nutritious food and adequate livelihoods" (Pramova et al. 2012 398). Regulating services such as soil rehabilitation, erosion control and water regulation, were addressed in 59 percent of projects (Pramova et al. 2012, 401). Provisioning services were addressed by 37 percent, while cultural services were only mentioned in 4 percent of project profiles (Pramova et al. 2012, 401). Pramova and colleagues conclude, "that more needs to be done in mainstreaming the role of ecosystem services in adaptation and building corresponding awareness and capacity, if sustainable and effective cross-sectoral adaptation is to be achieved. Many NAPAs projects have the potential to jointly address the vulnerability of ecosystems and people, and to

implement strategies in which resilient ecosystems contribute to a decrease in social vulnerability to climate change" (Pramova et al. 2012, 407). If more needs to be done in plans that were developed following guidelines expressly encouraging the use of EbA and in countries that tend to be highly reliant on ecosystem services for economic and social well-being, one wonders the extent to which these services are being considered in adaption strategies in the developed world, where the connection between ecosystem services and human well-being are likely less apparent and guidance is limited.

Summary

Climate adaptation planning for socio-ecological systems is still in its infancy. There are a number of emerging practices that may assist societies with reducing vulnerabilities to climate impacts including ecosystem-based adaptation (EbA). To date most climate change planning guidance and literature has been focused on greenhouse gas emissions reduction, although there are notable exceptions including the State of California's guidance and NAPAs produced by Least Developed Countries. Factors influencing plan development likely include a combination of vertical, horizontal and local factors. In plans that have been produced, most are lacking in adaptation components and discussion on natural systems. Further, these plans generally lack implementable actions.

CHAPTER 3. METHODOLOGY

The purpose of this study is to assess the extent to which ecosystem services were considered in local climate change planning initiatives. This assessment was performed through a content analysis of local Climate Action/Adaptation Plans (CAPs) and related planning documents (hereafter referred to as CAPs). The principal research question and sub-questions assessed in this study follow:

> To what extent have local climate change plans developed in the United States since 2011 considered the importance of ecosystem services and to what extent have actions or strategies been identified that utilize, enhance or protect these services for human well-being?

1. To what extent do plans indicate awareness of the importance of ecosystem services?
2. To what extent do plans connect the importance of these services to human well-being?
3. To what extent do plans analyze the impacts of climate change on ecosystem services?
4. To what extent do plans identify the potential for ecosystems and their services to reduce social vulnerabilities to climate change?
5. To what extent have actions or strategies been identified that protect or enhance the ability of ecosystem services to reduce social vulnerabilities and impacts from climate change?
6. To what extent have actions been identified that have components required for implementation?

This question was assessed through the application of the conceptual framework of the Millennium Ecosystem Assessment (MEA 2005) in an awareness-analysis-action (Moser and Luers 2006) analytical model (Figure 3-1). The research design (Figure 3-2) for this assessment was composed of a content analysis and the collection of background information to inform a qualitative assessment

of plan groupings assessed against potentially relevant contextual factors. Detailed information on how each section was assessed is provided in the following sections.

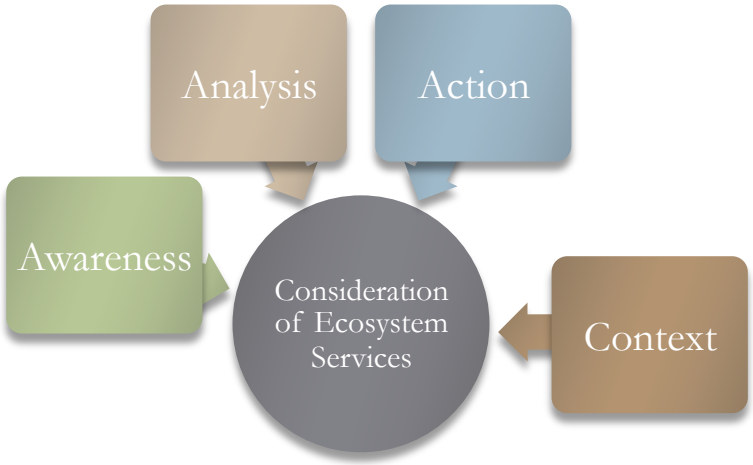

Figure 3-1. Analytical framework for the study.

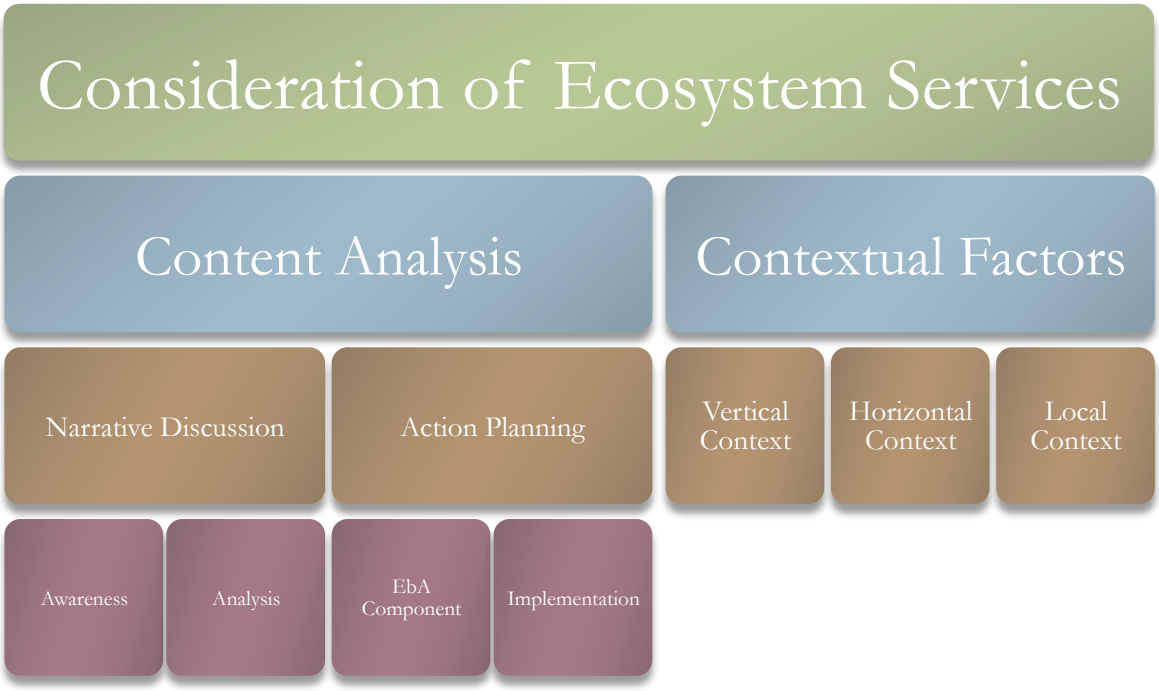

Figure 3-2. Research design for the study.

CONTENT ANALYSIS

The content analysis for this study was divided into two related, but distinct components. The level of awareness and analysis indicated in the content of narrative discussions and the types of strategies, policies or actions identified within the planning documents (actions). Because of the lack of universal standards and requirements for the development of CAPs, a large degree of flexibility was built into the assessment criteria. The author conducted all plan reviews for this analysis; thus, differences in the interpretation of the criteria and related plan groupings was minimized. It should be noted that this analysis focused on the end states of ecosystem services and, therefore, excluded references to supporting services.

Narrative Discussion

The methodology utilized for the assessment of the narrative discussions of each plan was adapted from the methodologies utilized by Pramova and colleagues (2012) in their assessment of NAPAs and the assessment of 40 locally produced climate actions plans conducted by Tang and colleagues (2010). The narrative discussion of each plan was reviewed for content that showed an awareness of the importance of ecosystem services and an analysis of climate change impacts related to these services.

Awareness

Each plan was reviewed for references to ecosystem services as discussed and defined by the Millennium Ecosystem Assessment (MEA). The wording of each reference and the category (i.e., provisioning, regulating, cultural, non-specific) and sub-category (e.g., climate regulation (local), water regulation) of ecosystem service referenced was recorded. Each reference was also analyzed for a connection to human well-being (e.g., security, basic materials for a good life) and the

component of human well-being was recorded. Each plan was assigned to an overall awareness group based on the categories listed in Table 3-1.

Table 3-1. Awareness assessment and grouping

Category	Discussion	Group
None	Plan narrative contains no discussion of ecosystem services.	1
Low	Plan narrative contains discussion of ecosystem services, but generally does not explicitly connect these services to human well-being (i.e. less than half of references link services to human well-being).	2
Medium	Plan narrative contains discussion of ecosystem services and generally makes an implicit or explicit connection between these services and human well-being (i.e. more than half of references link services to human well-being, but there are a below average number of references or a below average number of service sub-categories mentioned).	3
High	Plan narrative contains extensive discussions of ecosystem services and makes an explicit connection between these services and human well-being (i.e., more than half of references link services to human well-being, and there are an above average number of references and an above average number of service sub-categories mentioned.	4

References analyzed in this category generally discussed the importance or the existence of ecosystem services. For example, a reference stating that a community is reliant on snowpack for most of its potable water supply would be included as an awareness reference. The services provided would be recorded as provisioning (fresh water) and regulating (water regulation). Generally, awareness excerpts focused on existing, rather than future conditions. Whether or not human well-being was discussed was determined by context. In the example provided above, the statement clearly links a component of human well-being (access to clean water) to an ecosystem service (fresh water through snowpack). It should be explicitly noted that the use of the term "ecosystem service" was not required in order for a reference to be categorized as "high." Plans were simply reviewed for references to these services, not the explicit use of specified terminology. However, for an excerpt to be assessed in this analysis, it must have been easy to discern the ecosystem service being referenced. Simply referring to planting trees or using the word environment was not counted as a reference.

Further, references to ecosystem services in terms of hazards (e.g., soil erosion) were not recorded, as the focus of the analysis was on the beneficial functions of ecosystems and their services. Finally, references to energy-generating ecosystem services, such as through geothermal energy or solar energy production, were not generally counted. The Millennium Ecosystem Assessment (MEA) framework only accounts for the service of energy provision within the context of wood for fuel.

Analysis

Each plan was also reviewed for an analysis of the impacts of climate change on ecosystem services and the potential for human societies to use ecosystem services to reduce social vulnerabilities to climate change impacts. Each reference was recorded as well as the type of ecosystem referenced and the potential for the reduction of social vulnerability. Each of these references was assigned a group to provide information on the relative frequency of the categories of impact discussion. Each plan was then assigned to an overall analysis group based on the categories listed in Table 3-2.

Table 3-2. Analysis assessment and grouping

Category	Discussion	Group
None	Plan narrative does not contain a discussion of the impacts of climate change on ecosystems or on ecosystem services, nor does the plan discuss the potential for ecosystem services to reduce social vulnerabilities.	1
Low	Plan narrative contains some discussion of the impacts of climate change on ecosystems but does not discuss climate change impacts on ecosystem services or the potential for ecosystem services to reduce social vulnerabilities.	2
Medium	Plan narrative contains discussion of the impacts of climate change on ecosystems and on ecosystem services, but does note discuss the potential for ecosystem services to reduce social vulnerabilities.	3
High	Plan narrative contains discussion of the impacts of climate change on ecosystems, ecosystem services, and discusses the potential for ecosystem services to reduce social vulnerabilities.	4

References analyzed in this category generally discussed future conditions. Keeping with the example used in the awareness assessment section, an excerpt stating that snowpack levels are

expected to decline as a result of climate change would be included as an analysis reference. This example excerpt does not contain discussion of the potential for the reduction of social vulnerability. Such an excerpt would include a sentiment similar to the following: preserving wetland functions will help mitigate future and current flooding.

Action Planning

The methodology utilized for this portion of the assessment was adapted from the analysis of NAPAs conducted by Pramova and colleagues (2012) and the guidelines established by Bryson for action plan development (Bryson 2011). This portion of the study examined specific strategies, policies, or actions outlined within the planning document. There was a large degree of variation between the layout, content and terminology utilized in the planning documents, thus, for the sake of simplicity, any item identified for analysis will be referred to as an "action" in the remaining description of the methodology. Each action was assessed based on the embodiment of ecosystem-based adaptation (EbA) principles and the presence of information generally considered important in implementation. Descriptive information was recorded for both the EbA strategy assessment and the implementation assessment for each plan.

Action EbA Assessment and Group

Each action was assessed and assigned to a group based on the decision tree (Figure 3-3) adapted from Pramova and colleagues (2012). Table 3-3 below provides additional information on the types of actions that fall within each scoring category of the decision tree. It should be noted; this assessment was conducted at the most-detailed level of action available. For example, if a plan identified goals and actions, only the actions were assessed.

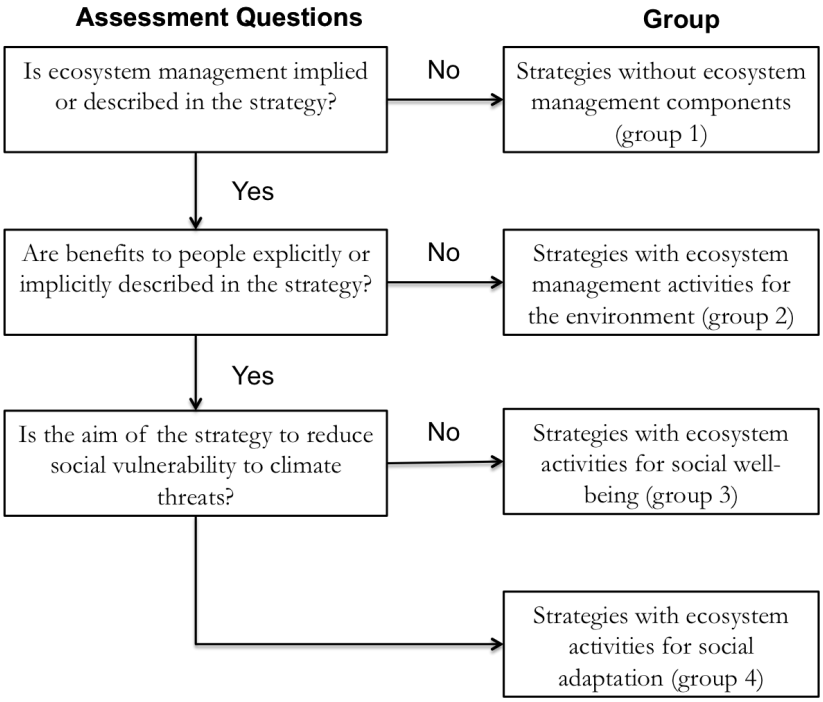

Figure 3-3. Decision tree for action assessment. Adapted from Pramova and colleagues (2012).

Table 3-3. Action EbA assessment and grouping

Category	Discussion	Example	Group
Strategies without ecosystem management components	Does not include ideas or activities directly related to ecosystem management (conservation, restoration, sustainable management).	• Non-ecosystem related mitigation activities • Infrastructure hardening activities	1
Strategies with ecosystem management activities for the environment	Aims at conserving or restoring ecosystems, but does not explicitly link to human well-being or ecosystem services.	• Purchase of development rights programs for habitat preservation • Track indicators of ecosystem health	2
Strategies with ecosystem activities for social well-being	Aims at conserving or restoring ecosystems or ecosystem services and implicitly or explicitly indicates potential social benefits.	• Preserve lands for carbon sequestration or eco-tourism • Restore marine fisheries to protect economic livelihoods	3

Category	Discussion	Example	Group
Strategies with ecosystem activities for social adaptation	Aims at conserving or restoring ecosystems or ecosystem services by reducing social vulnerability to climate threats.	• Low impact development strategies to reduce flood hazards • Urban forestry programs for heat island reduction	4

Source: Adapted from Pramova and colleagues (2012, 397-398)

Action Implementation and Group

Each plan was also assessed based on the degree to which the actions identified therein contain information relevant to implementation (i.e. modified from Bryson's list presented earlier). The implementation group was not intended to be a value-laden judgment or an assessment of relative feasibility. Action plans were grouped based on the degree to which the action plan contained the following components: the ability to measure progress, an anticipated timeline, priority, possible funding sources, a lead agency responsible for implementation, staffing considerations, and specificity. Table 3-4 below outlines the action implementation assessment guidelines.

CONTEXTUAL FACTORS

Contextual factors were collected for each plan analyzed in order to provide anecdotal information for factors that may influence the degree to which ecosystem services and EbA approaches were utilized in each plan based on. Contextual factors were collected in three areas: vertical, horizontal, and local contexts. Vertical factors generally refer to influences from or pertaining to higher regulatory authorities. Horizontal factors are contextual variables that may influence peer-to-peer learning. Local factors refer to jurisdiction- or plan-specific context. Table 3-5 outlines the specific information that was recorded.

Table 3-4. Action implementation assessment and group

Category	Discussion	Example	Group
Very Weak	Strategies that are broad goal or policy statements with no clear mechanisms for or discussion of implementation.	Preserve urban trees.	1
Weak	Strategies that lack specific details on implementation but provide more information than a highly generalized goal or policy statement.	Work with the scientific community to assess climate change impacts on the urban forest and develop a plan to reduce their vulnerability.	2
Moderate	Specific strategies that include discussion of two of the following criteria: ability to measure progress, an anticipated timeline, priority, possible funding sources, a lead agency responsible for implementation, staffing considerations, and specificity.	The urban forestry team shall strive to replace 300 dead or dying trees with drought-resistant varieties.	3
Strong	Specific strategies that include discussion of at least four of the following criteria: ability to measure progress, an anticipated timeline, priority, possible funding sources, a lead agency responsible for implementation, staffing considerations, and specificity.	The urban forestry team shall replace 300 dead or dying street trees with drought-resistant varieties by 2016. Possible funding sources include a grant from the City Trees initiative.	4

Table 3-5. Contextual factors to be recorded for each plan

Factor Type	Factor
Vertical Factor	State CAP completed or in progress
	Pacific Coast State
	Coastal State
Horizontal Factor	Consultants utilized in preparation of the document
	Academic representatives or institutions involved in plan development
	Grant funding used to produce document
Local Factor	Planning department involved in planning process
	Coastal jurisdiction
	Type of entity preparing plan
	Type of planning document

PLAN SELECTION

There is no known database containing a comprehensive listing of local climate planning initiatives. However, the Georgetown Climate Center maintains a database of state and local plans with adaptation components. Municipalities looking for best practices or with an eye toward what other jurisdictions are doing are likely to visit the site. Previous content analyses of these plans focused on the first generation of climate action plans, which were published in or before 2010. This analysis was concerned with the second generation of climate planning initiatives and selected plans that were published in or after 2011. In previous studies the pacific coast states have been found to be "pioneers" in climate change initiatives. In addition they have strong land use policies in place and are typically perceived to have environmentally friendly reputations. Because this study focused on an emerging concept that embraces both land-use planning principles and environmental protection, more plans from pacific coast states were chosen for review (7 plans). An additional 8 plans were randomly selected and reviewed. In total, a purposive sample of 15 plans was reviewed using the methodology described above. While the small sample size limits the external validity of the results of this analysis, the results do allow for a snapshot of common practices across the country with a particular emphasis on the traditionally "pioneering" pacific coast states. The results can be used to frame future research by identifying variables and factors that should be examined in a larger and more representative sample. Table 3-6 lists the planning areas, document title, date of publication and plan type for each plan.

The plans chosen for analysis varied in typology. They ranged from a white paper, to jurisdiction-specific sea level rise assessments, to more typical climate action plans. All plans that were selected were identified as including an adaptation-specific element; however, it should be noted that the differing plan typologies may predispose the plan documents to include or exclude certain variables or factors. For example, a white paper concerned with advocating for a particular

climate change adaptation planning process is unlikely to provide much information on the importance of ecosystem services, as the focus is on process rather than impacts or outcomes. Conversely, documents produced as hazard mitigation plans are focused on vulnerability reduction. This focus may predispose these documents to consider and examine regulating ecosystem services, such as those associated with natural hazard reduction, and to identify ecosystem-based approaches to the reduction of these vulnerabilities. In theory, the more typical climate action planning documents are expected to cover all variables examined within this study; however, the lack of generally accepted formats and guidelines may inhibit uptake of these factors in practical terms.

Table 3-6. Plans selected for analysis

	Planning Area	Document Title	Date	Plan Type
1	Baltimore, Maryland	Baltimore Climate Action Plan	2013	Climate Action Plan
2	Benton County, Oregon	Benton County Climate Change Adaptation Plan	2014	Climate Change Adaptation Plan
3	Boulder County, Colorado	Boulder County Climate Preparedness Plan	2012	Climate Preparedness Plan
4	Chula Vista, California	Climate Adaptation Plan: Implementation Strategies	2011	Implementation Plan
5	Cleveland, Ohio	Cleveland Climate Action Plan: Building Thriving and Healthy Neighborhoods	2013	Climate Action Plan
6	Dane County, Wisconsin	Climate Change and Emergency Preparedness	2013	Climate Change and Emergency Preparedness Plan
7	Fresno County, California	Integrated Strategies for a Vibrant and Sustainable Fresno County	2011	Climate Action Plan
8	Hampton Roads, Virginia	Climate Change in Hampton Roads	2012	Sea Level Rise Impact Assessment
9	Hawaii and Maui Counties, Hawaii	Facing our Future: Adaptative Planning for Sea Level Rise in Maui and Hawaii Counties	2012	Sea Level Rise Assessment

	Planning Area	Document Title	Date	Plan Type
10	King County, Washington	Strategic Climate Action Plan: What King County is doing to reduce green house gas emissions and prepare for the impacts of climate change	2012	Climate Action Plan
11	Lewes, Delaware	The City of Lewes Hazard Mitigation and Climate Adaptation Action Plan	2011	Hazard Mitigation and Climate Change Adaptation
12	Oakland, California	Community-Based Climate Adaptation Planning: Case Study Of Oakland, California	2012	White Paper
13	San Francisco Bay, California	Living with a Rising Bay: Vulnerability and Adaptation in San Francisco Bay and on its Shoreline	2011	Climate Action Plan
14	Santa Cruz, California	City of Santa Cruz Climate Adaptation Plan	2012	Hazard Mitigation Plan
15	Waveland, Mississippi	City of Waveland Local Hazard Mitigation Plan	2013	Hazard Mitigation Plan

CHAPTER 4. RESULTS AND DISCUSSION

CONTENT ANALYSIS

The methodology of the content analysis described in chapter 3 was developed to address the following research question: To what extent have local climate change plans developed in the United States since 2011 considered the importance of ecosystem services and to what extent have actions or strategies been identified that utilize, enhance or protect these services for human well-being? Research sub-questions and hypotheses are shown in Table 4-1.

Table 4-1. Research sub-questions and hypotheses

Research Sub-question		Hypotheses	
Q1.	To what extent do plans indicate awareness of the importance of ecosystem services?	H1.	The majority of plans examined will contain references indicating awareness of ecosystem-services.
Q2.	To what extent do plans connect the importance of these services to human well-being?	H2.	The majority of references to ecosystem services will not link these services to human well-being.
Q3.	To what extent do plans analyze the impacts of climate change on ecosystem services?	H3.	The majority of plans examined will not discuss the impacts of climate change on ecosystem services.
Q4.	To what extent do plans identify the potential for ecosystems and their services to reduce social vulnerabilities to climate change?	H4.	The majority of plan examined will not explicitly identify the potential for ecosystems and their services to reduce social vulnerabilities to climate change.
Q5.	To what extent have actions or strategies been identified that protect or enhance the ability of ecosystem services to reduce social vulnerabilities and impacts from climate change?	H5.	The majority of plans examined will not identify strategies that specifically protect or enhance the ability of ecosystem services to reduce social vulnerabilities to climate change.
Q6.	To what extent have actions been identified that have components required for implementation?	H6.	The majority of plans will contain less than four of the criteria identified as important for implementation.

Awareness

In the narrative portions of the 15 plans analyzed there were 101 excerpts identified that discussed the importance of ecosystem services. Each excerpt was reviewed and categorized based on ecosystem service category (e.g., provisioning) and ecosystem service sub-category (e.g., water regulation) discussed. Additionally, excerpts were examined for connections to human well-being.

Categories of Ecosystem Services

Table 4-2 provides examples of excerpts for each ecosystem service category. On average the plans referenced the importance of ecosystem services 6.7 times. These references generally referred to one category of ecosystem service (1.2 categories per reference on average). Because some excerpts contained references to multiple ecosystem service categories, there were a total of 126 references recorded across the service categories.

4-2. Example excerpts for each ecosystem service category

Ecosystem Service Category	Sub-category	Example Excerpt
Provisioning	Fresh Water	Total available water is directly related to the amount and timing of snow accumulation and snowmelt in the high mountains of Boulder County. As noted in Chapter 2, the climate of Boulder County is highly variable and strongly influenced by elevation and topography. The high mountains on the western edge of the county collect significant snowpack that melts and runs off into the plains, providing the bulk of water supplies for most utilities and other providers (Boulder County, 2012, 2-3).
Regulating	Natural hazard regulation	Coastal storms can cause extensive beach and dune erosion, which results in the destruction of dunes, narrowing of the beach or overwash of the beach and dune system. Sand and water may wash over or break through the dunes and rush over property and streets behind the dune. When overwash occurs, breaking waves and high velocity currents can cause extensive damage to properties located behind the breached dune system (Lewes 2011, 12).
	Climate regulation (local and global)	There are many ways that mitigation and adaptation can work hand-in-hand. For example, planting trees in residential areas will decrease the need for air conditioning (mitigation), sequester carbon (mitigation) and increase livability even as temperatures increase

Ecosystem Service Category	Sub-category	Example Excerpt
		(adaptation). (Fresno County 2011, 17)
Cultural	Recreation and ecotourism	Waterfront parks and beaches promote enjoyment of the Bay, the region's most important open space, and enhance the quality of life for Bay Area residents. Recreation on the shoreline and in the Bay foster a life-long bond between residents and the Bay, improves their health, and provides a respite from the stress of living in a crowded, high-paced urban environment (BCDC, 2006). Recreational opportunities can be found at beaches, parks, marinas, shoreline trails and water trails, boat launches and fishing piers. People use waterfront parks, beaches, and public access to hike, bicycle, kayak, swim, fish or just watch the sunset. (San Francisco Bay, 2011, 71).

Table 4-3 shows the number of times each plan examined mentioned the importance of a service category (i.e., provisioning, regulating, cultural, non-specific). Regulating services were mentioned most frequently with 70 references (56 percent of total excerpts), followed by 25 references to cultural services (25 percent of total excerpts), and 21 references to provisioning services (21 percent of total excerpts). Ten (10 percent) of the excerpts examined included references that were too vague to categorize (e.g. ecosystems that sustain us, natural capital, valuable environmental resources). Figure 4-1 shows the relative frequency of each service category for all 126 references examined.

Sub-Categories of Ecosystem Services

91 of the 101 excerpts provided enough information to categorize the type of ecosystem service referenced. Of these, the most frequently mentioned ecosystem service sub-category was water regulation with 34 references (37 percent of excerpts), followed by climate regulation with 30 references (33 percent of excerpts) and natural hazard regulation with 27 references (30 percent of excerpts). Table 4-4 shows the ecosystem service sub-categories referenced by all plans.

Table 4-3. Total excerpts and ecosystem service categories mentioned by plan

Plan	Total Excerpts Analyzed	Ecosystem Service Categories				Total
		Non-Specific	Provisioning	Regulating	Cultural	
Baltimore	8	1	1	6	2	10
Benton County	2	0	1	1	0	2
Boulder County	9	1	4	7	3	15
Chula Vista	4	0	1	3	0	4
Cleveland	13	2	2	11	0	15
Dane County	3	1	0	1	1	3
Fresno County	12	0	5	9	1	15
Hampton Roads Planning District	0	0	0	0	0	0
Hawaii and Maui County	9	0	1	7	4	12
King County	2	0	0	2	0	2
Lewes	6	0	1	5	2	8
Oakland	1	0	0	1	0	1
San Francisco Bay	27	4	5	16	9	34
Santa Cruz	4	1	0	1	2	4
Waveland	1	0	0	0	1	1
TOTAL	101	10	21	70	25	126

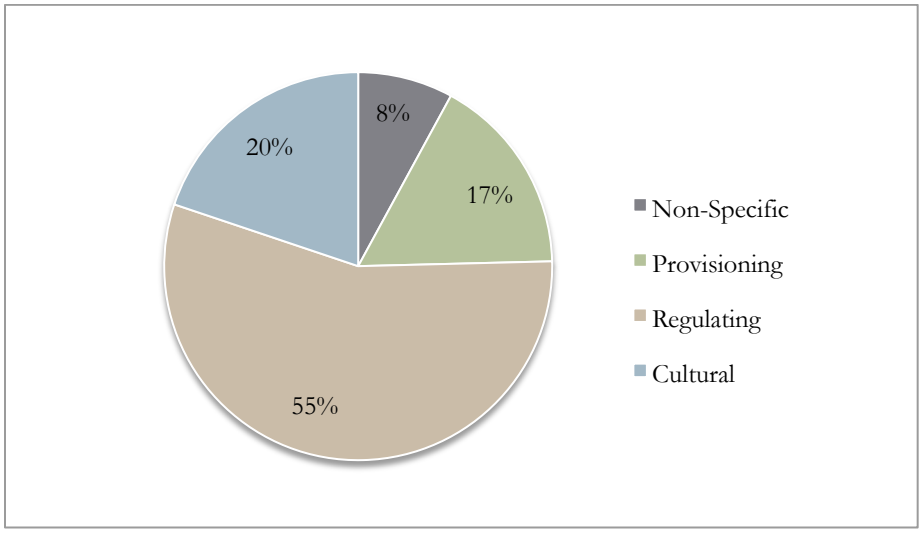

Figure 4-1. Categories of ecosystem services in analyzed plan excerpts.

Table 4-4. Ecosystem service categories referenced for all plans

Category	Sub-category		Total	Percent
Provisioning	Non-specific		0	0%
	Food	Crops	5	3%
		Livestock	3	2%
		Capture fisheries	0	0%
		Aquaculture	1	1%
		Wild plant and animal food products	1	1%
		TOTAL	10	6%
	Fiber	Timber	2	1%
		Cotton, hemp, silk	0	0%
		Wood fuel	0	0%
		TOTAL	2	1%
	Genetic Resources		12	7%
	Biochemical, natural medicines and pharmaceuticals		0	0%
	Fresh water		7	4%
	PROVISIONING TOTAL		31	18%
Regulating	Non-specific		4	2%
	Air quality regulation		6	3%
	Climate regulation	Global	14	8%
		Local	16	9%
		TOTAL	30	17%
	Water Regulation		34	20%
	Erosion Regulation		4	2%
	Water Purification and waste treatment		13	8%
	Disease Regulation		0	0%
	Pest Regulation		1	1%
	Pollination		1	1%
	Natural Hazard Regulation		27	16%
	REGULATING TOTAL		120	70%
Cultural	Non-specific		2	1%
	Cultural diversity		0	0%
	Spiritual and religious values		1	1%
	Knowledge systems		0	0%
	Educational values		1	1%
	Inspiration		0	0%
	Aesthetic values		1	1%
	Social relations		0	0%
	Sense of place		6	3%
	Cultural heritage values		0	0%
	Recreation and ecotourism		10	6%
	CULTURAL TOTAL		21	12%
TOTAL			172	100%

Hypothesis 1

H1. The majority of plans examined will contain references indicating an awareness of ecosystem-services.

This hypothesis is **supported** by the results of the analysis. 93 percent (14 of 15) of plans analyzed were placed in groups that indicate some awareness of ecosystem services (groups 2 through 4). However, the term 'ecosystem service' was only used twice in the 101 excerpts analyzed (2 percent of excerpts). These instances were in two different plans, 13 percent of the sample. The term 'functions' was used more frequently with five uses (5 percent of excerpts) in three plans (20 percent of plans).

The services referenced most frequently (water regulation, climate regulation, and natural hazard regulation) are at the same time surprising and unsurprising. These services are not as visible in the patterns of everyday life as other services, such as food and fresh water. However, they are highly intertwined with climate change impacts. Speculatively, the focus on these services, or regulating services in general, may be the result of the adaptation focus of these documents and the centrality of city and county governments in their production. The services most frequently mentioned are all directly tied to climate change impacts likely to have significant effects on the built environment, which is fundamental to and managed by municipal governments.

Components of Human Well-Being

Of the 101 excerpts analyzed, 49 percent (49 excerpts) connected the importance of these services to human well-being (Table 4-5). Table 4-6 shows examples of excerpts connecting ecosystem services to the components of human well-being. Discussion of each component was evenly spread over 3 of the components: 35 excerpts discussed health (71 percent), 34 excerpts discussed security (69 percent), and 30 excerpts discussed basic material for a good life (61 percent). Only 12 excerpts

(24 percent) discussed good social relations and the vast majority of these resulted from a reference to "quality of life," which was categorized as a reference to each component of well-being.

Table 4-5. Excerpts connecting ecosystem services to human well-being by plan

Plan	Excerpts			Components of Human Well-being				
	Analyzed	Connecting to Human Well-being	Percent	Security	Basic Material for Good Life	Health	Good Social Relations	TOTAL
Baltimore	8	0	0%	1	0	1	0	2
Benton County	2	2	100%	0	2	0	0	2
Boulder County	9	5	33%	2	1	5	0	8
Chula Vista	4	0	0%	0	0	0	0	0
Cleveland	13	6	40%	1	4	3	0	8
Dane County	3	2	67%	1	2	2	1	6
Fresno County	12	9	60%	7	8	6	4	25
Hampton Roads Planning District	0	0	0%	0	0	0	0	0
Hawaii and Maui Counties	9	6	50%	4	1	4	1	10
King County	2	0	0%	0	0	0	0	0
Lewes	6	3	38%	2	0	1	0	3
Oakland	1	1	100%	0	1	0	0	1
San Francisco Bay	27	12	35%	15	8	12	5	40
Santa Cruz	4	3	75%	1	3	1	1	6
Waveland	1	0	0%	0	0	0	0	0
Total	101	49	49%	34	30	35	12	111

Ecosystem Services and Human Well-Being

In general, excerpts analyzed that referenced cultural services were most likely to also reference a component of human-well being (76 percent of excerpts referencing cultural services). Excerpts discussing regulating services were least likely (40 percent of excerpts referencing regulating services). Table 4-7 shows the excerpts by ecosystem service category and the number of these excerpts referencing at least one component of human well-being.

Table 4-6. Examples of excerpts for each component of human well-being

Human Well-Being Component	Ecosystem Service Category	Example excerpt
Security **Health**	Regulating and Provisioning Services	The Bay is inhabited by numerous plants and animals and provides many benefits to humans. For example, tidal wetlands provide critical flood protection, improve water quality, and sequester carbon. Brackish marshes in the North Bay and Suisun Marsh support the greatest diversity of species and provide an important resting place along the Pacific Flyway (San Francisco Bay 2011, 100).
Security **Basic Material for Good Life** **Health** **Good Social Relations**	Provisioning, Regulating, and Cultural Services	The purpose of this effort is to develop new strategies that will increase the resilience of both human and natural communities to near-term and long-term stressors and changes in Fresno County. Actions taken now can reduce stressors and improve the quality of life that residents of this exceptional and diverse region have come to enjoy. By preparing for change in a cohesive and ecologically sound manner, Fresno County will not only reduce the vulnerability of community members to stressors such as poor air quality and drought, but will also maintain the value of services, such as tourism, flood abatement, water supply, cattle forage, and pollination, that are provided by natural systems across the county (Fresno County 2011, 7).

Table 4-7. Excerpts by ecosystem service category and connection to human well-being

Ecosystem Service		Human Well Being Component	
Category	# of Excerpts	# of Excerpts	% of Excerpts
Non-specific	10	5	50%
Provisioning	21	14	67%
Regulating	70	28	40%
Cultural	25	19	76%
TOTAL	126	66	100%

Hypothesis 2

H2. The majority of references to ecosystem services will not link these services to human well-being.

The hypothesis is **supported** by the results of the analysis. 49 percent (49 of 101) or almost half of the excerpts linked the services referenced to human well-being and only six plans (40 percent) provided linkage in 50 percent or more of the excerpts examined. Although, the results support the hypothesis, the number of excerpts linking ecosystem services to human well-being is surprising. The tendency for cultural service references to mention components of human well-being is understandable as it is difficult to untangle the importance of cultural services from human well-being or quality of life. Regulating services, on the other hand, have a significant effect on human well-being, but the connection is more abstract. In fact, regulating services tend to operate in the background, only noticed when there is a "failure of regulation" (e.g. a flood) that interferes with human well-being.

Analysis

Each plan was reviewed for analysis of the impacts of climate change on ecosystem services and the potential for humans to use ecosystem services to reduce social vulnerabilities to climate change impacts. In total, 224 excerpts were reviewed. On average, each plan discussed impacts to ecosystem services 14.9 times. The San Francisco Bay Plan (2011) had the most references (53 references) and the Hawaii and Maui County Plan the least (1 reference) (Owens et al 2012).

Each reference was assigned a group based on the categories described in the methodology section. Half scores (e.g., 2.5) indicate references that fell between groups, such as when the reference was vague or only alluded to an ecosystem service. The ecosystem being impacted, the ecosystem service being impacted, and any identified potential to reduce impacts was recorded for each reference. Examples for each group are shown in Table 4-8. The most frequently occurring score was 3 (107 excerpts) and, on average, excerpts were categorized as 2.5.

Table 4-8. Example excerpts of each grouping for analysis of climate change impacts

Group	Example Excerpt
1	N/A – placement in this group indicates no discussion of ecosystems, ecosystem services or impacts.
1.5	The region faces significant environmental and economic challenges stemming from climate change, including stressed and rapidly changing ecosystems, costly impacts on public and private property, and new public health risks (King County 2012, 39).
2	Changes in wetlands: Freshwater wetlands are likely to be affected by changes in precipitation and temperature (Burkett and Kusler, 2000). Decreases in precipitation or changes in precipitation timing, especially in combination with increased evaporation from higher temperatures, can shrink the wetland area or change the species composition of a wetland (Kling et al., 2003). (Boulder 2012, 6-5).
2.5	In addition to wildfires, extreme heat days in Chula Vista could triple over the next 40 years, which will lead to further public safety and health concerns including poor air quality (from ground level ozone) and infectious disease transmittal (from mosquitoes and rodents) (Chula Vista 2011, 24).
3	Finally, climate change is likely to upset economic activities in the Great Lakes. For instance, in a warmer climate, evaporation from the lakes is projected to increase, which could cause water levels to drop by one to two feet by the end of the century. Although such a drop in water levels could benefit public beach access, it could adversely affect coastal ecosystems. Lower water levels would also make some key shipping channels too shallow for fully loaded ships, requiring more dredging. On the other hand, warmer temperatures may have a positive impact on shipping, as ice-free seasons lengthen. The net impact of these changes, however, is likely to impose costs on the Midwest through increased shipping, maintenance, and repair costs, as well as lost recreation and tourism (Cleveland 2013, 10).
3.5	Within the next 10 to 50 years, the Baylands will face more flooding of potentially greater magnitude that could erode or degrade water quality and existing wildlife habitat in irreparable ways. While restoring historic habitat conditions may not be feasible, restoring ecosystem function is essential for enable habitats to adapt to the new stressors and challenges resulting from climate change. The best available science must be used to strategically select restoration sites that are likely to continue to provide ecological services as they evolve in response to sea level rise and other climate change impacts (San Francisco Bay 2011, 95).
4	Our ecosystems are also threatened by climate change. A healthy ecosystem supports native land and water species, crops, and public health. Programs that promote nature's resilience to climate change impacts will protect our natural environment, our food and water sources as well as human health. Incorporating local, regional and statewide efforts to protect ecosystems will build our community's resilience. "... Such ecosystem-based approaches are thereby not simply about saving ecosystems, but rather about using ecosystems to help "save" people and the resources on which they depend." (Santa Cruz 2012, 28).

Ecosystem Services

Climate change impacts to regulating services (142 references) were discussed most frequently, followed by provisioning services (120 references). Table 4-9 shows the total number of references to impacts on ecosystem services.

Hypothesis 3

H3. The majority of plans examined will not discuss the impacts of climate change on ecosystem services.

The hypothesis is **not supported** by the results of the analysis. 93 percent (14 of 15) of plans examined were placed in groups indicating that climate change impacts on ecosystem services were discussed. Almost two-thirds of all excerpts examined were placed in groups indicating discussion of impacts to ecosystem services (groups 3 through 4). The attention to potential climate change impacts on ecosystem services is surprising. These results may suggest that climate change planning is moving from a dominant focus on the on the built environment to a more holistic assessment, addressing impacts to both built and natural capital. Further, these results suggest that those involved in plan production may be engaging in the translation of the available evidence (e.g., impacts to natural systems) into anthropocentric assessments (e.g., focus on services), indicative of the capacity to analyze that Moser and Luers suggest (2006, S312).

Table 4-9. Ecosystem services and references to climate change impacts

Category	Sub-category		Total	Percent
Provisioning	Non-specific		3	1%
	Food	Crops	18	6%
		Livestock	8	3%
		Capture fisheries	6	2%
		Aquaculture	0	0%
		Wild plant and animal food products	1	0%
		TOTAL	33	12%
	Fiber	Timber	2	1%
		Cotton, hemp, silk	0	0%
		Wood fuel	0	0%
		TOTAL	2	1%
	Genetic Resources		30	11%
	Biochemical, natural medicines and pharmaceuticals		0	0%
	Fresh water		52	18%
	PROVISIONING TOTAL		120	42%
Regulating	Non-specific		3	1%
	Air quality regulation		6	2%
	Climate regulation	Global	2	1%
		Local	1	0%
		TOTAL	3	1%
	Water regulation		37	13%
	Erosion regulation		5	2%
	Water Purification and waste treatment		23	8%
	Disease Regulation		16	6%
	Pest Regulation		15	5%
	Pollination		6	2%
	Natural Hazard Regulation		28	10%
	REGULATING TOTAL		142	50%
Cultural	Non-specific		3	1%
	Cultural diversity		0	0%
	Spiritual and religious values		0	0%
	Knowledge systems		0	0%
	Educational values		0	0%
	Inspiration		0	0%
	Aesthetic values		0	0%
	Social relations		0	0%
	Sense of place		0	0%
	Cultural heritage values		1	0%
	Recreation and ecotourism		19	7%
	CULTURAL TOTAL		23	8%
TOTAL			285	100%

Potential to Reduce Impacts

Only 8 percent (18 of 224) of the excerpts analyzed discussed ecosystems, ecosystem services and the potential for the services to reduce impacts. The most commonly discussed ways included:

- Flood or shoreline protection;
- Generalized protection of natural functions to reduce vulnerability;
- Water conservation and water quality-related activities;
- Protection of natural hazards; and
- Creation of resilient local food systems.

Hypothesis 4

H4. The majority of plans examined will not explicitly identify the potential for ecosystems and their services to reduce social vulnerabilities to climate change.

The hypothesis is **supported** by the results of the analysis. 53 percent (8 of 15) of plans examined did not explicitly identify the potential for ecosystems and their services to reduce social vulnerabilities to climate change. Of the seven plans that did discuss this potential, discussion was limited. The average number of excerpts meeting the criteria was 2.6 per plan. Three plans (43 percent) only had one excerpt meeting the criteria. Although this hypothesis was supported by the results of the analysis, many plans did discuss the potential for ecosystem services to reduce social vulnerabilities to climate change. The limited discussion does not necessarily indicate a lack of uptake of ecosystem-based adaptation (EbA) principles. EbA is one of many approaches that can and should be addressed in climate planning documents. The results indicate that EbA principles are entering the discussion in almost half of the plans examined.

Action Planning

A total of 588 actions were identified within the plans analyzed. The average number of actions per plan was 39.2, with the City of Baltimore's plan (2013) with the greatest number (134 actions) and the City of Lewes, Delaware (2011) and Hampton Roads Planning District (McFarlane 2012) with the fewest (6 actions).

EbA Assessment

Each action was assessed using the decision tree presented in the methodology. Some actions were too vaguely worded to analyze, necessitating the development of an additional group (group 0). Placement in group 0 indicated that the action was too vague to analyze, while placement in group 4 indicated that an action had ecosystem activities for social adaptation. Figure 4-2 shows the distribution of the EbA assessment for all plans. Table 4-10 shows the group for each plan analyzed.

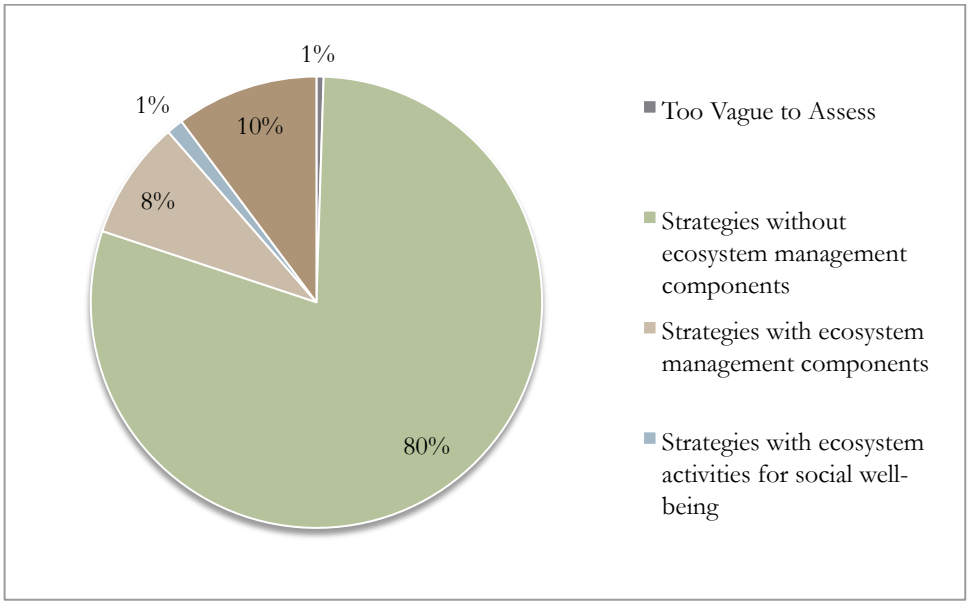

Figure 4-2. Distribution of EbA action assessment groups.

Table 4-10. EbA action assessment groups by plan

Plan	Group					
	0	1	2	3	4	Total
Baltimore	0	126	4	0	4	134
Benton County	0	8	0	0	0	8
Boulder County	0	30	6	0	3	39
Chula Vista	0	21	5	1	2	29
Cleveland	0	67	4	1	6	78
Dane County	2	32	5	2	7	48
Fresno County	0	6	11	1	16	34
Hampton Road Planning District	1	4	1	0	0	6
King County	0	21	4	0	2	27
Lewes	0	4	0	0	2	6
Maui and Hawaii Counties	0	6	1	0	1	8
Oakland	0	43	1	0	7	51
San Francisco Bay	0	19	6	1	1	27
Santa Cruz	0	32	2	1	5	40
Waveland	0	49	0	0	4	53
TOTAL	3	468	50	7	60	588
PERCENT	1%	80%	9%	1%	10%	100%

Hypothesis 5

H5. The majority of plans examined will not identify actions that specifically protect or enhance the ability of ecosystem services to reduce social vulnerabilities to climate change.

This hypothesis is **not supported** by the results of the analysis. 87 percent (13 of 15) of plans examined identified actions that specifically protect or enhance the ability of ecosystem services to reduce social vulnerabilities.

According to the IPCC, the key risks to North America from climate change include wildfire, extreme heat, and urban flooding issues (IPCC 2014b, 23). Ecosystem management activities can be utilized to reduce negative impacts of each of these keys risks. Of the 60 actions identified as having ecosystem-based adaptation components, more than half (32 of 60, 53 percent) addressed at least one of these key risks:

- Wildfire – 3 actions (5 percent)
- Extreme heat – 8 actions (13 percent)
- Flooding (although not necessarily urban) - 26 actions (43 percent)

This implies that these plans are on the right track in considering likely impacts of climate change.

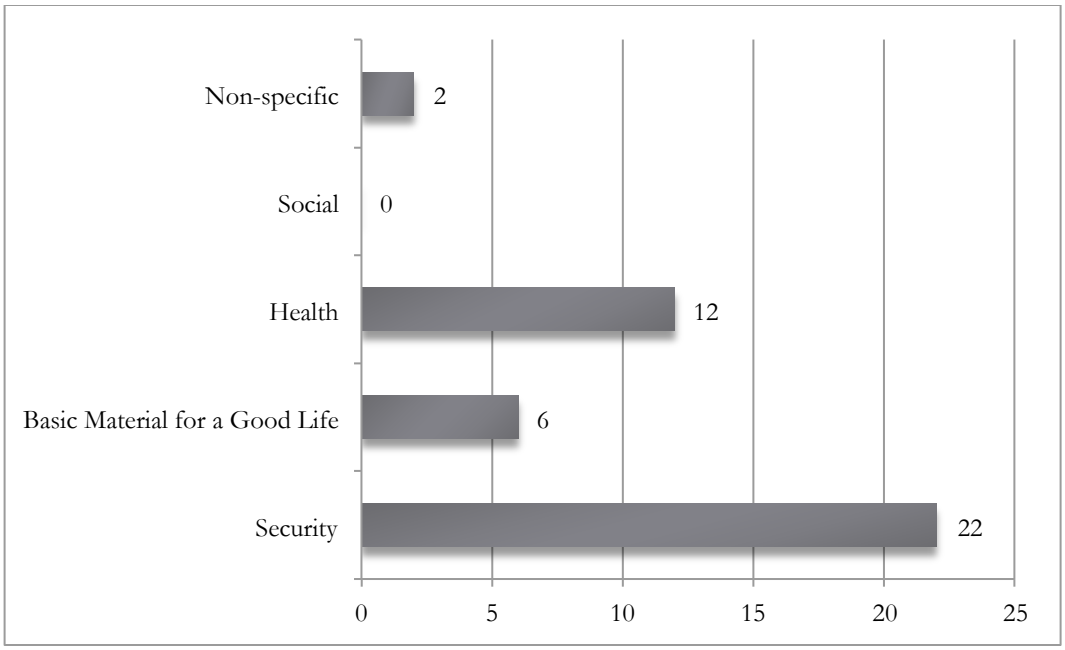

Figure 4-3. Components of human well-being referenced in top-scoring actions.

The ecosystem services referenced and the component of human well-being identified in the action were recorded for each action in group 4. The most commonly targeted areas were water regulation and natural hazard regulation with 30 (50 percent) and 21 (35 percent) of actions referencing these services, respectively. Figure 4-3 shows the components of human well-being identified in the top-scoring actions. Security was the most commonly referenced component. Given the focus on water regulation and natural hazard regulation this is understandable since both of these services are strongly correlated with security from disasters. There were no actions that referenced good social relations, which is interesting, but not surprising. It is difficult to conjure an action that would directly address issues such as "social cohesion, mutual respect, or ability to help

others" (MEA 2005, 4). It may suggest that good social relationships are implied rather than explicitly addressed.

Implementation

Each plan was assessed for components of implementation using the categorization parameters outlined in the methodology. Placement in group 1 indicates very weak actions, while placement in group 4 indicates very strong actions. The average placement for all plans was 2.6, indicating generally weak to moderate actions in the plan analyzed.

Hypothesis 6

H6. The majority of plans will contain less than four of the criteria identified as important for implementation.

This hypothesis is **supported** by the results of the analysis. 66 percent (10 of 15) of plans were placed in groups where most less than four elements associated with implementation were present. It is notable, however, that all plans contained elements that could be classified as actions.

Overall Plan Assessments

The overall assessment for each plan analyzed is shown in Table 4-11. If each assessment group assigned to a plan were added together, a plan that was placed in the most preferable group for all assessments (awareness, analysis, action and implementation) would receive an overall assessment score of 16. The lowest possible overall assessment score would be 2 (group 1 in action and awareness and no actions identified). The average total score was 12.4 or 78 percent of the possible group assessment points. Figure 4-4 shows the distributions of plan overall assessment scores over each assessment category.

Table 4-11. Overall plan groups for each assessment category

Plan	Awareness	Analysis	Action EbA	Action Implementation	Average	Total
Baltimore	2	3	4	3	3.0	12
Benton County	3	4	1	1	2.3	9
Boulder County	4	3	4	2	3.3	13
Chula Vista	2	3	4	4	3.3	13
Cleveland	2	3	4	3	3.0	12
Dane County	3	4	4	1	3.0	12
Fresno County	4	4	4	1	3.3	13
Hampton Roads Planning District	1	4	2	1	2.0	8
Hawaii and Maui Counties	4	4	4	3	3.8	15
King County	2	2	4	4	3.0	12
Lewes	3	3	4	4	3.5	14
Oakland	3	3	4	2	3.0	12
San Francisco Bay	2	4	4	2	3.0	12
Santa Cruz	3	4	4	4	3.8	15
Waveland	3	3	4	4	3.5	14
AVERAGE	2.7	3.4	3.7	2.6	3.1	12.4

While the analytical framework for this assessment suggests that plans showing high scores in awareness and analysis will translate that information into ecosystem-based adaptations, this does not appear to be supported by the evidence. Although no statistical tests were run to determine casual or significant factors, plans scoring high on awareness did not necessarily score notably higher on analysis or action. In fact, the average score for EbA actions for plans receiving a score of 3 or 4 on awareness was lower on average than those plans that received a score of 1 or 2 (2.4 and 2.8, respectively).

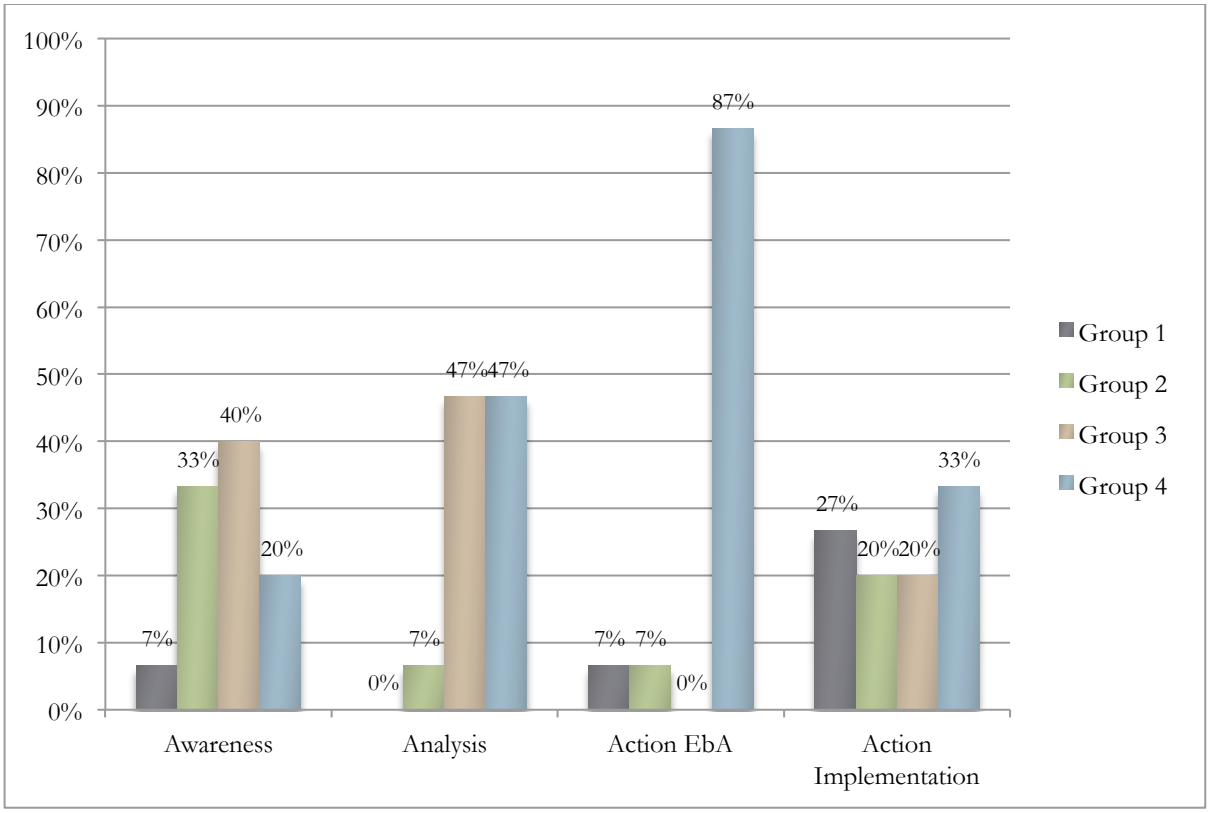

Figure 4-4. Distribution of plan groups across assessment categories.

Contextual Factors

A series of contextual factors was collected for each plan analyzed in order to assess potential influences on plan performance. Table 4-12 shows the contextual factors collected for each plan. In general, the plans analyzed performed better than expected in terms of the attributes under consideration for this study. Pacific coast states were represented more heavily in the plans analyzed because it was believed that they would be better performers based on the perception of their progressive approach toward climate change issues. The plans selected generally did not perform better than their non-pacific counter parts (Figure 4-5). In fact, grouping distributions across categories were extremely close across all plans regardless of location. This may indicate that the scoring procedures utilized did not allow for enough distinctions between plan performance measures or it may indicate that the awareness/analysis/action level is similar regardless of

geographical location. Because there are no required mandates pertaining to adaptation planning, all jurisdictions are engaged in pioneering planning processes. Similarities in group distributions may be representative of the best available information for engaging in these processes at this time.

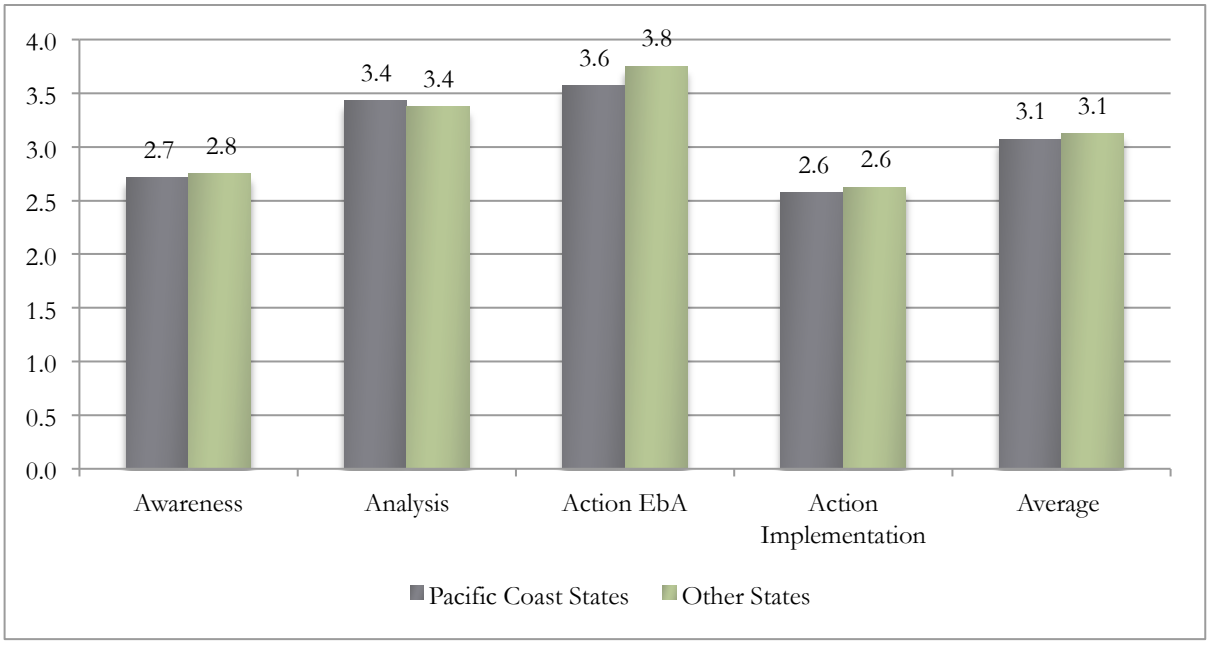

Figure 4-5. Average group placement for pacific coast states and other states.

Table 4-12. Contextual factors

Plan	Vertical Factors			Horizontal Factors					Local Factors	
	State Climate Adaptation Plan[1]	Pacific Coast State[2]	Coastal State[3]	Consultants	Academics	Grants	Planning Department Involvement	Coastal Jurisdiction[4]	Entity Type	Plan Type
Baltimore	Yes	No	Yes	Yes	No	No	Yes	Yes	City	Climate Action Plan
Benton County	Yes	Yes	Yes	No	Yes	No	Yes	No	County	Climate Change Adaptation Plan
Boulder County	Yes	No	No	Yes	No	No	Yes	No	County	Climate Preparedness Plan

Chula Vista	Yes	Yes	Yes	Yes[5]	No	No	Yes	Yes	City	Implementation Plan
Cleveland	No	No	No	Yes	No	Yes	Yes	Yes	City	Climate Action Plan
Dane County	In progress	No	No	No	Yes	No	Yes	No	County	Climate Change and Emergency Preparedness Plan
Fresno County	Yes	Yes	Yes	No	N0	Yes	Yes	No	County	Climate Action Plan
Hampton Roads Planning District	Yes	No	Yes	No	No	Yes	Yes	Yes	Planning District	Sea Level Rise Impact Assessment
Hawaii and Maui Counties	In progress	No	Yes	No	Yes	Yes	Yes	Yes	County	Sea Level Rise Assessment
King County	Yes	Yes	Yes	No	No	No	Yes	Yes	County	Climate Action Plan
Lewes	In progress	No	Yes	Yes	No	Yes	Yes	Yes	City	Hazard Mitigation and Climate Change Adaptation
Oakland	Yes	Yes	Yes	No	No	Yes	Yes[6]	Yes	Coalition of stakeholders	White Paper
San Francisco Bay	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Conservation and Development Commission	Climate Action Plan
Santa Cruz	Yes	Yes	Yes	No	Yes	No	Yes	Yes	City	Hazard Mitigation Plan
Waveland	No	No	Yes	Yes	No	No	Yes	Yes	City	Hazard Mitigation Plan

Notes:

1. As reported on GeorgeTownclimate.org on November 9, 2014.
http://www.georgetownclimate.org/adaptation/state-and-local-plans
2. Includes Washington, Oregon and California.
3. States bordering the Great Lakes were note considered to be coastal.
4. Jurisdictions bordering bays or the Great Lakes were considered to be coastal.
5. A representative from ICLEI served on the plan development committee.
6. It does not appear that City planners were directly involved in this effort; however, interviews were conducted with planning staff from a variety of jurisdictions in the planning process.

To further address the lack of distinction in average scores, the contextual factors catalogued were examined against plan scores. Although purely exploratory due to the anecdotal nature of the sample, there are a few contextual areas where variation was seen (Table 4-13). Highlighted cells indicate that plan scores for the contextual factor noted were a half of a point above or below the average score for that assessment category.

Table 4-13. Contextual variable and plan groups

Contextual Variable	Category	# of plans	Awareness	Analysis	Action EbA	Action Implementation	Average
State Plan Completed	Yes	10	2.6	3.4	3.5	2.4	3.0
	In Progress	3	3.3	3.7	4.0	2.7	3.4
	No	2	2.5	3	4	3.5	3.3
Coastal States	Yes	12	2.7	3.4	3.6	2.8	3.1
	No	3	3.0	3.3	4.0	2.0	3.1
Grant Funds Used for Plan	Yes	7	2.7	3.6	3.7	2.3	3.1
	No	8	2.8	3.3	3.6	2.9	3.1
Consultants Assisted with Plan Development	Yes	6	2.7	3.0	4.0	3.3	3.3
	No	9	2.8	3.6	3.5	2.3	3.1
Academic Institutions or Representatives Assistance	Yes	5	3.2	3.8	3.4	2.6	3.3
	No	10	2.5	3.2	3.8	2.6	3.0
Coastal Location	Yes	11	2.5	3.3	3.8	3.1	3.2
	No	4	3.5	3.8	3.3	1.3	2.9
Entity Type	City or County	12	2.9	3.3	3.8	2.8	3.2
	Other	3	2.0	3.7	3.3	1.7	2.7
Plan Type	CAP	8	2.8	3.4	3.6	2.1	3.0
	HMP	3	3.0	3.3	4.0	4.0	3.6
	Other	4	2.5	3.5	3.5	2.5	3
All Plans	Average		2.7	3.4	3.6	2.6	3.1

Notable distinctions were seen in both the awareness and action implementation assessment categories. While previous studies have had conflicting results in terms of plan quality and state-level policies and mandates (Abbott and Kasprzyk 2012, 581; Tang et al. 2010, 56), this study does not provide any clarification. Plans assessed with state-level adaptation planning processes currently underway were more favorable performers, on average, in the awareness assessment. However, very little distinction was shown between plans from states that had completed or had not yet begun adaptation-planning initiatives. In terms of action implementation, jurisdictions without state-level plans performed most favorably.

Plans produced in jurisdictions that are not on a coast performed more favorably in the awareness assessment than plans from coastal jurisdictions; however, these same plans performed less favorably in terms of action implementation. This is somewhat consistent with the statistical evidence in studies where no significant difference in plans quality was seen in coastal versus non-coastal jurisdictions (Tang et al. 2013). Further, plans produced from states that were not considered to be coastal performed less favorably, on average, in terms of action implementation. Interestingly, plans that were produced outside of city or county government showed less awareness on average and performed less favorably on action implementation. No previous studies were identified that examined this component of plan performance, but it may be of interest to future researchers. Additionally, plans produced with assistance from consultants performed better on action implementation. This may provide evidence that horizontal networks are important in plan development consistent with Bassett and Shandas's assessment (2010). Finally and most notably, plans classified as hazard mitigation plans were the nest performers in terms of action implementation. This is likely the result of vertical mandates discussed in more detail in the mainstreaming section of Chapter 5.

Other Findings

Although the sample size of this analysis was quite small, the results can be used anecdotally to comment on trends noted in previous more-comprehensive assessments. The existence of these plans indicates that climate change planning is moving from a sole focus on greenhouse gas mitigation to encompassing adaptation concerns. These documents still lack consistent structure and focus as described in previous assessments (Bassett and Shandas 2010; Tang et al., 2013) and the resulting impacts on overall plan quality are unclear. Although plans still need to work to address implementation of identified actions, it is notable that all plans examined contained elements that could be described as actions. Assessments of the first generation of CAPs indicated that this practice was not commonplace (Wheeler 2008; Bassett and Shandas 2010).

In the first generation of CAPs, involvement from planning departments and commission was lacking (Bassett and Shandas 2010, 442). In all of the plans analyzed for this assessment, planners were involved in the planning process to some extent. Planning departments or commissions were not necessarily the lead authors, but were indicated as participating in the planning process. Further, land use planning principles and actions appear to be playing a larger role than had previously been documented (Tang et al. 2011). Discussion of planning documents, such as conservation and habitat protection plans, water-shed based approaches, and reductions in impervious surfaces were discussed in a substantial number of plan assessed.

SUMMARY

Four of the six hypotheses put forth in this study are supported by the results of the analysis; however, plans scored better than anticipated in several categories. Most notably, 87 percent of plans examined contained at least one action that was determined to contain ecosystem-based adaptation components. Overall, the results of this analysis indicate that plan developers are

considering ecosystem-based approaches in the development of adaptation planning documents. The degree to which plans that follow an awareness, analysis, action framework supports the development of ecosystem-based approaches is questionable.

CHAPTER 5. DISCUSSION

REVIEW OF THE STUDY DESIGN AND LIMITATIONS

Fifteen climate adaptation planning documents was selected from the Georgetown Climate Center's database. These plans were reviewed using an awareness-analysis-action framework that applied that conceptual model of the Millennium Ecosystem Assessment. The small sample size of this analysis may limit the ability to draw conclusions on climate action planning in general, but is helpful in framing the discussion for future work. This study entailed an exhaustive review of the plans selected; however, the lack of consistently utilized terminology to describe the concepts under review has most likely resulted in the exclusion of some references that should have been included in the analysis. Guidelines for plan review and assessment were established (see Chapter 3. Methodology); however this analysis required that personal judgment be employed on a case-by-case basis. Errors in processing resulting from the application of judgment were minimized by the use of a single reviewer and the review of grouping of scores for similarities in content following the initial analysis.

REVIEW OF THE FINDINGS

Four of the six hypotheses put forth in this study were supported by the results of the analysis; however, plans performed better than anticipated in several categories (see Table 5-1). Most notably, 87 percent of plans examined contained at least one action that was determined to contain ecosystem-based adaptation components. Overall, the results of this analysis indicate that plan developers are considering ecosystem-based approaches in the development of adaptation planning documents.

Table 5-1. Research sub-questions and hypotheses

Research Sub-question		Hypotheses		Results
Q1.	To what extent do plans indicate awareness of the importance of ecosystem services?	H1.	The majority of plans examined will contain references indicating awareness of ecosystem-services.	Supported
Q2.	To what extent do plans connect the importance of these services to human well-being?	H2.	The majority of references to ecosystem services will not link these services to human well-being.	Supported
Q3.	To what extent do plans analyze the impacts of climate change on ecosystem services?	H3.	The majority of plans examined will not discuss the impacts of climate change on ecosystem services.	Not supported
Q4.	To what extent do plans identify the potential for ecosystems and their services to reduce social vulnerabilities to climate change?	H4.	The majority of plan examined will not explicitly identify the potential for ecosystems and their services to reduce social vulnerabilities to climate change.	Supported
Q5.	To what extent have actions or strategies been identified that protect or enhance the ability of ecosystem services to reduce social vulnerabilities and impacts from climate change?	H5.	The majority of plans examined will not identify strategies that specifically protect or enhance the ability of ecosystem services to reduce social vulnerabilities to climate change.	Not supported
Q6.	To what extent have actions been identified that have components required for implementation?	H6.	The majority of plans will contain less than four of the criteria identified as important for implementation.	Supported

DISCUSSION

The results of the analysis were reported and discussed in Chapter 4. The following sections discuss other notable findings that fall outside the initial scope of the analysis including, discussion of drivers, mainstreaming, incremental changes, and no-regret strategies.

Discussion of Drivers

Although drivers aside from climate change were not directly assessed through this study, a number of plans mentioned the connections between these drivers and secondary effects or feedback loops with climate change. For example, the San Francisco Bay Plan repeatedly addressed

the issues of buffers for wetlands to protect the ecosystems from the negative impacts of other land uses (e.g., pollution). Effects on ecosystem functions as a result of invasive species and fertilizers were commonly addressed. Additionally, the plans focusing on sea level rise and coastal areas tended to outline the potential for negative impacts to ecosystems and land uses for shorelines that were protected by structural shoreline protection measures. Anecdotally, most attention to drivers appeared to focused on direct drivers, while indirect drivers, such as economic policies, population growth, etc., were seldom, if ever, mentioned.

Mainstreaming

The plans chosen for this analysis varied greatly in length, format, structure, and purpose. This is consistent with previous studies (Preston, Westaway, and Yuen 2011, 415; Bassett and Shandas 2010, 442) and unsurprising given the lack of formal guidance or mandates. Several of the plans examined exhibited attempts at mainstreaming. The documents from Lewes, Santa Cruz and Waveland were not meant to be stand-alone climate plans, but were integrated into pre-existing and federally required planning documents - hazard mitigation plans. Hazard mitigation plans, specifically, and disaster management efforts, in general, have been heralded as potential avenues for mainstreaming climate change concerns (IPCC 2014b, 905; Solecki, Leichenko and O'Brien 2011, 138). Although there did not appear to be significant variation in the performance of these plans in all categories assessed, these plans were all high performers on action implementation scores (see Table 4-13). This is likely a result of the fact that the Robert T. Stafford Disaster Relief and Emergency Assistance Act (Public Law 93-288), (which requires FEMA approved hazard mitigation plans for pre-disaster mitigation grant eligibility) requires that these plans include action plan matrices that contain the following elements: "how specific mitigation actions will be implemented, including who is responsible for which actions, what funding mechanisms and other

resources are available or will be pursued, when the actions will be completed, and how they are prioritized" (FEMA 2013, 6-10). Based on the other plans examined in this analysis, specific information for implementation is generally not included in single-focus planning efforts.

Two additional plans offered notable examples of mainstreaming: Hawaii and Maui Counties and the San Francisco Bay Plan. Hawaii and Maui County's approach to mainstreaming was based on the adjustment of land use regulations to incorporate likely impacts from sea level rise. The overall purpose of the document was to offer recommendations to the respective planning departments on regulatory modifications that could be implemented now to reduce current and future impacts to structures and systems on their expansive shorelines. Although it is unclear if the planning departments have moved forward with the recommendations, the document, analysis and recommendations therein may prove to be useful resources to other jurisdictions working to address sea level rise concerns. The San Francisco Bay Plan also made recommendations to mainstream climate change planning into already existing plans and programs. The Plan offered recommended amendments to the Bay Plan to address the issues brought forth in the vulnerability assessment. These recommended amendments range from modifying the permitting process to protecting public access (San Francisco Bay 2011, 140). Although less notable, many additional plans contained instances of mainstreaming in their actions. For example, the Chula Vista Plan included an action that involves updating the City's Municipal Shade Tree Policy to address issues related to climate change mitigation and adaptation (Chula Vista 2011, 9).

Incremental Change and No-regret Strategies

Incremental change and no-regrets solutions were not specifically addressed by this analysis; however, it is notable that at least two plans mentioned the idea of no-regret options (San Francisco Bay 2012, 120; Boulder County 2012, 3-10). Most adaptation actions that were identified

as having ecosystem-based adaptation components can be described as no- or low-regret. Not surprisingly, these actions all are also best described as incremental rather than transformative.

RECOMMENDATIONS FOR FUTURE RESEARCHER

Climate change planning, in general, and climate adaptation planning, in particular, are still in their infancy. Much additional research will be needed as local governments continue the process of "muddling through" to best practices. Although this exploratory study provided some interesting insight on the degree to which ecosystem services are being considered in current planning efforts, this is just one small part of a very large puzzle. Additional research is needed that assesses adaptation planning efforts for more wide-reaching plan quality factors than were assessed in the narrow focus of this analysis. In addition to plan quality, more research is needed on how plan quality translates into actions and how these actions translate into progress. Preston and colleagues (2011, 409) note three key reasons why evaluating the implementation and effectiveness of actions are important to climate change planning:

- ensuring reduction in societal and ecological vulnerability;
- learning and adaptive management;
- the need for accountability in an evidence-based policy environment.

Ecosystem-based adaptation (EbA) is also an emerging field. More research is needed on the effectiveness of EbA options and on the long-term viability of these strategies given the uncertainty inherent in climate change impacts to ecosystem services, themselves, and the biophysical processes underlying them. Further, research addressing potential mechanisms for ecosystem service valuation should continue. Such valuation methodologies are likely to become increasingly important as adaptation strategies are implemented and are subject to cost-benefit assessment and other financial and risk-management based analyses.

Additionally, further study is needed on the implications of the jurisdiction-crossing nature of ecosystem services. Urban areas are typically the end consumers of a great deal of ecosystem services (e.g. food) that are managed outside of their jurisdictional authority (Girot et al. 2012, 9; IPCC 2014c, 548; Ranganathan 2008, 31). A modification to this study may provide a useful way to assess the degree to which the extra-urban nature of these services and issues of agency are considered. For example, do plans indicate awareness of the reliance of ecosystem services outside their jurisdictional authority? Do plans suggest collaboration between neighboring or far-flung jurisdictions from which their ecosystem services are derived? These issues could also be influenced by the continuing work on ecosystem service valuation, as cities may need to incentivize the protection and enhancement of the services on which their residents depend. There is some evidence that ecosystem services are regional, while the costs of maintaining those services are born locally through opportunity costs (Balmford et al. 2011, 167). Protecting these services may require payment for services as impacts from climate change compound existing pressures to manage these areas in ways that protect or enhance these services. Providing some mechanism for payment may increase the likelihood that these services will be maintained and will work to increase understanding that these services are, as one researcher puts it, "costly, if not impossible to replace" (Baron et al. 2002, 1248).

Although many services utilized in urban environments are produced far away, urban areas do allow for the production of some ecosystem services: "they moderate urban climate, regulate hydrological cycles, provide habitat for plants and animals, and offer […] recreational services […] (Haase 2003; Qureshi et al. 2010)" (Breuste, Qureshi, and Li 2013, 676). The MEA has been criticized for neglecting urban ecosystem services (Cilliers et al. 2012, 683), thus, additional research is needed on these services, how to protect them, what constraints that they face, and trade-offs they entail.

RECOMMENDATIONS FOR PRACTICING PLANNERS

It is certain that planners will play a critical role in climate change planning, so it is encouraging that the results of this analysis show an increasing trend in planners' involvement in local climate planning initiatives. Of particular importance may be the role that planners can play in mainstreaming climate change adaptation considerations into existing planning frameworks, such as land use ordinances and permitting processes. This is evidenced by the plan produced by Hawaii and Maui Counties that suggests revisions to existing codes and ordinances to accommodate sea level rise, while still protecting property rights, ecosystem functions, and public access to culturally and economically significant areas. There have also been suggestions that mainstreaming climate change efforts into sustainability plans, comprehensive plans, and hazard mitigation plans may be an effective way to address climate change issues. As major players in the development of these planning documents, planners are uniquely positioned to ensure that holistic planning approaches incorporate likely future impacts from climate change. Further, planners must work to ensure that the opportunity to raise awareness and to highlight connections between land use decisions, ecosystem services, and human well-being are captured within the framework of these documents. Planners must embrace their role in information sharing, knowledge transfer, and framing. There is evidence that highlighting co-benefits of climate planning initiatives is beneficial in two ways. Firstly, uptake of action development and implementation may be more prevalent when co-benefits are emphasized (Kousky and Schneider 2003), and it is reported that "the American public, when given information about management alternatives, supports ecologically based management approaches (CEQ 1996)" (Baron et al. 2002, 1249). To support the development of an evidence base supporting ecosystem-based management approaches for adaptation, planners must ensure that actions developed in climate adaptation planning documents are detailed enough for effective implementation and monitoring. Further, planners must ensure that monitoring

efforts result in effective reporting to support the development of best practices. By advocating for and embracing no- or low-regret, implementable actions that strive to protect ecosystem services, planners will be helping to move climate adaptation planning from theory to practice.

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