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Testimony provided by

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It is my great honor to testify before your Commission today. Let me begin by commending the Commissioners and the Commission's staff for their interest in the increasingly urgent need to plan for and implement climate change adaptation actions, and in particular, in how effective governance mechanisms – both old and new – can assist the State and local government in facing an unstable, uncertain, and in many ways unpleasant future due to climate change. As my testimony will make clear, governance is THE key to effective, pro-active adaptation.

I begin below with a brief background on myself, and in particular the intimate and in-depth experience in adaptation science and practice in California that inform my views and recommendations on adaptation governance needs.

Professional Background¹

I am currently the Director and Principal Researcher of Susanne Moser Research & Consulting in Santa Cruz, California and a Social Science Research Fellow at Stanford's Woods Institute for the Environment. A geographer by training (Ph.D., 1997, Clark University), my work over the past nearly 20 years with local, state and federal agencies, NGOs, and foundations has focused on three dominant themes: adaptation to climate change, communication and social change, and science-policy interactions. Most relevant to the topic at hand is my work – primarily in the US, Europe and Australia – on adaptation. Much of my research and consulting has focused on coastal adaptation, and thus frequently on the challenges and opportunities in urban environments, but I have also worked in the human health, conservation, forest, and rural sectors.

Closely related is my extensive involvement in scientific assessments undertaken to support climate responses: I have contributed to the 4th and 5th IPCC assessments, including its 2012 Special Report on "Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation". I also play a variety of roles in the Third US National Climate Assessment, currently underway, including serving on its Federal Advisory Committee and its Executive

¹ For additional information, see; <http://www.susannemoser.com>

Secretariat, and together with Margaret Davidson (Executive Director of NOAA's Coastal Services Center) lead the writing of the NCA's coastal chapter. In preparation for the NCA, I also contributed to the Southwest Regional Climate Assessment, which included California (as co-convening lead author of the Solutions chapter, and lead author on the Coastal chapter).²

Most relevant, however, is my involvement in California's climate impacts and vulnerability assessments since 1999. In my role then as staff scientist for the Union of Concerned Scientists, I was involved in and witnessed firsthand how science can become influential in policy-making.³ The 2004 follow-up study⁴ was similarly impactful, motivating Senator Fran Pavley's and Governor Arnold Schwarzenegger's path-breaking climate policies. Since then I have contributed original research, provided scientific guidance, and assisted with the integration of, the Second and Third California Climate Assessments, and have helped scope research priorities for the forthcoming Fourth assessment. Since moving to California in 2008, my work has become significantly more applied. In my current role as independent researcher and consultant, I have supported the development of the first California Adaptation Strategy (2009) and the follow-on report by the California Adaptation Advisory Panel (2010) (see Testimony by Professor D. Mazmanian, University of Southern California); I conducted social vulnerability analyses for San Luis Obispo, Fresno, Los Angeles (and currently for Hermosa Beach) in support of their adaptation planning; lead or co-lead two statewide surveys of coastal managers to better understand their adaptation efforts; conducted an in-depth analysis of the barriers to adaptation in four local governmental efforts and one regional adaptation effort in San Francisco Bay; researched the challenges related to communicating adaptation to lay publics; and I am currently leading a West Coast-wide study on what "success" of adaptation in coastal areas might mean.⁵

These experiences have given me deep familiarity with adaptation at the local, regional, state, multi-state, and federal levels, my understanding of governance and other challenges faced at these various levels; and particularly, my grounded assessment of the role of science in these policy and practice arenas. It is from this perspective that I view your study as of the utmost importance and incredibly timely.

Timing of the Little Hoover Commission's Adaptation Study in the Context of Emerging Adaptation Efforts in California and Beyond

The timing of the LHC's study on adaptation and governance could not be more timely. Local, regional and state-level activities related to adaptation have expanded rapidly in recent years, with calls for guidance, coordination and support being heard ever more loudly. Now is the time to develop governance frameworks, guidance, the scientific basis, tools and support mechanisms to ensure that:

² *Assessment of Climate Change in the Southwest United States: a Technical Report Prepared for the U.S. National Climate Assessment*. A report by the Southwest Climate Alliance [G. Garfin, A. Jardine, R. Merideth, M. Black, and J. Overpeck (eds.)]. Tucson, AZ: Southwest Climate Alliance.

³ Field, C. et al (1999). *Confronting climate change in California: Ecological impacts on the Golden State*. Cambridge, MA: The Union of Concerned Scientists and The Ecological Society of America.

⁴ Hayhoe, K. et al. (2004). Emissions pathways, climate change, and impacts on California. *Proc Natl Acad Sci USA* 101(34):12422–12427

⁵ See also a related publication: Moser, S.C. and M. Boykoff (eds., 2013). *Successful Adaptation to Climate Change: Linking Science and Practice in a Rapidly Changing World*. London: Routledge.

- the multitude of entities that are and should be involved in adaptation don't all go off in different directions, using different science (or next to no science), different benchmarks, and different goals;
- adaptation planning and implementation minimize the risk or avoid being at cross-purposes with other already-stated or implicit policy goals; and
- adaptation efforts are undertaken in the most timely, efficient, socially and environmentally benign, and cost-effective manner, minimizing duplicate efforts, overlap and related turf issues, and avoiding critical oversights.

All of this is particularly important in fiscally constrained times which, if we are realistic, are all times – just sometimes more acute than others. It is rather remarkable that – at the height of California's Great Recession – interest in adaptation has grown substantially; and yet, what could be done during these tight-belt times is preliminary at best. It makes for one interesting scenario (and flusher ones should be considered also): what is possible and what trade-offs may need to be made, when resources are as constrained as they have been in recent years?

Background:

Local Government Adaptation Activities: In 2005/06, I conducted a survey study of California coastal local governments (municipalities and counties) to assess the extent to which local governments had begun to assess the risks they faced from climate change and whether or not they had developed a first round of plans for how to prepare for and adapt to these risks. With more than 90% of coastal cities and counties represented in the survey, literally only a handful had begun to do so at the time.⁶ Six years later, a consortium of 15 organizations came together to jointly develop and administer an expanded survey that included some of the same questions as the first one, but was also sent to regional, state and federal organizations, NGOs and private sector entities involved in coastal management to assess their level of adaptation activity.⁷ Together with leaders of the University of Southern California's Sea Grant Program, I co-lead this repeat survey. While not directly comparable (due to the differences in survey population), what we found was that about 8 out of 10 survey respondents were involved in some level of climate change risk assessment, adaptation planning or implementation of specific adaptation actions (see Figure 1 below).

⁶ Moser, S.C. and J. Tribbia (2006/2007). Vulnerability to inundation and climate change impacts in California: Coastal managers' attitudes and perceptions. *Marine Technology Society Journal* 40(4): 35-44.

Tribbia, J. and S.C. Moser (2008). More than information: What coastal managers need to prepare for climate change. *Env. Science & Policy* 11: 315-328.

⁷ Finzi Hart, J.A., P.M. Grifman, S.C. Moser, A. Abeles, M.R. Myers, S.C. Schlosser, and J.A. Ekstrom (2012) *Rising to the Challenge: Results of the 2011 Coastal California Adaptation Needs Assessment*. USCSG-TR-01-2012. Available at: http://ca-sgep.ucsd.edu/CCadapt_survey

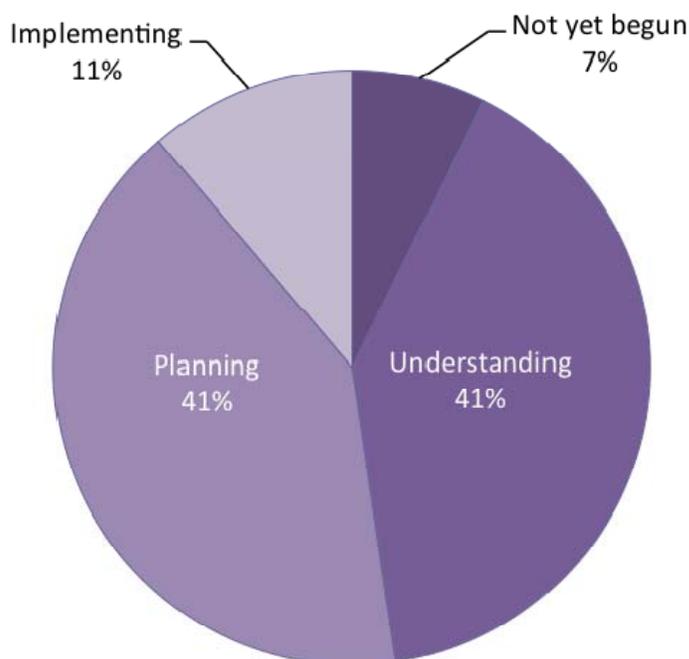


Figure 1: Coastal professionals responding to the question where they are in the adaptation planning/implementation cycle (Source: Finzi Hart et al., 2012)

Again, while not directly comparable, the California Office of Planning & Research's (OPR) annual planning survey⁸ conducted most recently in 2011 found an uptick in the percentage of local jurisdictions that had developed Climate Action Plans over the past five years, but many of these do not yet deal with adaptation (only greenhouse gas reductions/mitigation) or only include placeholders for future adaptation planning.⁹ (Of course, some ongoing planning efforts can have climate risk management co-benefits.) At the same time, only about a quarter of the survey respondents (from 87% of local jurisdictions in the state) have dedicated staff for sustainability matters, mostly the larger jurisdictions.¹⁰ Key barriers in making progress on mitigation or adaptation were identified in both surveys as lack of financial resource (for planning and implementation of adaptation) and limited staff capacity.¹¹

While this increasing interest in adaptation is a notable finding, what exactly is being done by local communities is difficult to assess in a systematic fashion. Based on our survey results and my direct experience with various local and regional adaptation activities, the majority of these local efforts should be thought of as initial, modest, low-risk/low-return risk assessments, attempts to "ready" the political playing field for more substantial adaptation strategies, and efforts in building adaptive capacity among local government staff, rather than launching into big, visible, on-the-ground adaptive activities or expensive structural solutions.

⁸ Office of Planning and Research (2012). *Annual Planning Survey Results* (APSR). Available at: http://www.opr.ca.gov/s_publications.php#pubs-A

⁹ APSR (2012), pp.31-33

¹⁰ APSR (2012), p.21

¹¹ APSR (2012), p.38; see also Finzi Hart et al. (2012), cited above.

Regional Adaptation Efforts: In addition to the rapidly increasing interest in adaptation planning at the local level, California is witnessing an interesting development, namely the emergence of regional consortia that bring together relevant actors from the public, civic, and private sectors to develop coordinated visions and plans for adaptation. San Diego, San Francisco Bay, Los Angeles are the best established ones of these regional self-organizing collaboratives; several other regional consortia are emerging in the Sacramento, Monterey Bay, Fresno, Sierra Nevada, and North Coast (Humboldt) regions. To exchange ideas and insights and to coordinate regional efforts across California, a supra-regional forum has been established: the Alliance of Regional Collaboratives for Climate Adaptation (ARCCA). OPR has taken a key role in engaging with and determining ways to support local and regional efforts, through ARCCA and beyond.

State-level Adaptation Activities: Beyond the local and regional levels, the State is updating its adaptation strategy (see Testimony by Deputy Secretary for Climate Change, Ann Chan). The 2009 strategy, the 2010 status update, and the forthcoming strategy provide a collective and cumulative picture of what is being done and planned in the next few years at that level of government. Notable also are the California Climate Adaptation Planning Guide (for local communities) released in 2012 by the Natural Resources Agency and CalFEMA¹²; the Ocean Protection Council's Guidance on sea-level rise¹³; and a wide range of state agency annual reports and strategic plan updates that provide greater detail on their respective adaptation approaches and activities. California Insurance Commissioner Dave Jones is spearheading statewide and national efforts to promote disclosure of climate risks and response strategies among larger insurance companies¹⁴ – a critically important element in raising awareness of climate risks in both the private and public sectors and in building motivation for risk-smart investment and development. Insurance plays a crucial role in the state's resilience in the face of more extreme events (see also testimony by Professor R. Verchick, Loyola University).

Multi-State-level Adaptation Activities: In a number of sectors, the Western states (mainly Washington, Oregon, and California, in some instances with neighbors to the north into Canada and to the west) have begun to collaborate on environmental, climate change and adaptation efforts. This is most apparent in ocean/coastal management (West Coast Governors' Alliance on Ocean Health, which recently formed a Climate Change Action Coordination Team charged with, among other things, developing a West Coast-wide vision for adaptation success)¹⁵ and in water resource management (involving states drawing on the Colorado River).

Federal Adaptation Efforts: Finally, at the federal level, adaptation is an important focus since October 2009, when President Obama signed Executive Order 13514.¹⁶ The EO ordered all relevant federal agencies to develop adaptation plans. These initial adaptation plans are now in place. This matters to California for at least two reasons. First, the federal government has substantial land holdings in the state, including national parks, national forests, wilderness areas

¹² See: California Natural Resources Agency:

http://resources.ca.gov/climate_adaptation/local_government/adaptation_planning_guide.html

¹³ See: Ocean Protection Council for the most recently updated guidance document at:

<http://www.opc.ca.gov/2013/04/update-to-the-sea-level-rise-guidance-document/>

¹⁴ See: California Department of Insurance, Press Release July 17, 2013. Available at:

<http://www.insurance.ca.gov/0400-news/0100-press-releases/release057-13.cfm>

¹⁵ See: <http://www.westcoastcoceans.org/index.cfm?content.display&pageID=82>

¹⁶ See: The White House (2009) at: http://www.whitehouse.gov/assets/documents/2009fedleader_eo_rel.pdf

and reserves, in addition to jurisdiction over some coastal and ocean areas off the California coast. In many instances managing of these land and water resources does require interaction or coordination with other levels of government or private land owners in the state. Thus, if the federal government acts, it will engage and move others in the state. Second, federal agencies are and must be actively involved in adaptation, as federal laws and regulations require at a minimum consistency of local or state actions with federal statutes, and frequently legal permits from federal agencies for activities other actors may wish to undertake. In addition, compliance with federal regulations affects funding streams to the state. In case of "natural" disasters that exceed local or state capacities to handle, long-standing state-federal agreements also ensure that the federal government with its greater financial, logistical, and human capacities is and will be involved in responding to more frequent and/or more intense extreme events as climate change progresses. In other words, the resilience of local communities or of states in the face of extremes depends in important ways on outside intervention and support.

Thus, contrary to the common adage that "all adaptation is local" (in my opinion an overly simplistic statement at best, and an outright wrong and misleading one at worst), adaptation is rarely if ever "just local" and thus must consider and integrate cross-scale interactions, influences and capacities (incl. limits to those capacities). This makes a focus on adaptation governance – as a deliberate mechanism to guide and coordinate adaptation planning and implementation – maybe the most important focus with immediate relevance if the goal is to develop a rational, comprehensive, and integrated approach to dealing with climate risks in California.

Addressing the Commission's Adaptation Study Goals

According to the information provided by the Commission's Executive Director, your adaptation study has three goals. In what follows, I will speak to each in turn and offer recommendations that are informed by my expertise on adaptation – both its science and practice, focused on the particular circumstances of California, but drawing on my national and international experience.

Goal 1: Identify governance and legal frameworks that tell decision-makers what to do in response to climate threats, as well as allow them to continue making land-use decisions for the future in the absence of stationarity and certainty.

A preliminary, yet important, point is that this first of your stated goals may – quite frankly – be overly ambitious and politically not very palatable. There are too many and quite diverse decision-making contexts for any one framework to work everywhere. And while many in government as well as in private industry and society would like nothing more than the certainty that comes with being told exactly how to proceed and act, most leaders, elected officials and other decision-makers I know don't like to be told what to do. Thus, you may want to consider reformulating this goal as "frameworks and governance principles that provide clear and scientifically informed, practical guidance."

Your most significant point of departure for this goal is the recognition of *non-stationarity* and *uncertainty*. These are two of the key defining features of living in a climate change world. I would add to these the following:

- the distinct and growing possibility (but as-of-yet unpredictability) of major *tipping points*, i.e., significant and abrupt trend shifts, most of which we will only recognize as having occurred in the rearview mirror;
- the risk of *irreversibility* of impacts on relevant human timescales;
- the *increasing frequency of disruption*, leaving less time between extreme events and disasters to recover, rebuild or return to some semblance of "normalcy";
- the *emergence of unexpected problems, i.e. surprises*, resulting from the interactions of multiple system components (climatic and non-climatic) being in flux;
- the *scope or magnitude and pace* of climate change impacts; and
- the need for *much longer planning horizons* than are traditionally used in decision-making.

That said, I am not aware of a single governance or legal framework that is in practical use today or is being developed that accounts for this set of challenges. In a word: not just California, but humanity, is faced with an unprecedented challenge that we all have to learn to navigate with little experience or formal guidance (but also not none!).¹⁷ At the same time, practical realities (such as emerging climate impacts or decisions with long-term implications that have to be made) demand or simply compel us to act in the face of and despite these challenges. Paralysis is not an option. Nor is action that ignores or denies the rapidly changing world we all now live in.

In Appendix A I propose a set of traits of a possible governance framework that addresses each of the features identified above (while considering key features, it should not be considered complete). It is quite possible that no single governance framework can include all of these features. And because no framework exists that includes them all, but many partial experiences and systems can be drawn on¹⁸, such a framework should be developed explicitly and deliberately as a learning experiment, whereby it is tested on a smaller scale in multiple contexts, critically assessed after some time (ideally, multiple times), and lessons gleaned are integrated into an adjusted – and adjustable – governance framework over time.

In essence, governance of adaptation to climate change will be characterized by at least five foundational orientations:

- *vigilance* (through distributed, sensitive, effective detection and monitoring mechanisms),
- *learning* (formal and informal mechanisms that deliberately, continuously/iteratively and collaboratively assess changes in the environment and evaluate the effectiveness of selected adaptation approaches to change);
- *holistic and dynamic systems perspective* (moving away from static management "silos" toward coordination, collaboration and integration across sectors, systems and scales);
- *multiple time scales and longer planning and decision time horizons*; and
- *accommodation of impermanence, disruption, nonlinearity and continuous change* (through more frequent, more rapid, more efficient planning, policy, and action and related societal paradigm shifts).

¹⁷ Candidate frameworks that offer partial answers include (but are not limited to) risk management and risk governance, disaster management, adaptive management, transition management, strategic planning, resilience thinking, and the "five capitals" model underlying efforts to increase resilience and sustainability.

¹⁸ National Research Council (2010) *America's Climate Choices: Advancing the Science of Climate Change*. Washington, DC: The National Academy Press.

Goal 2: Identify barriers – statutory, regulatory or institutional – to government efforts to build resilience to changing climate conditions.

Barriers and limits to adaptation are an increasingly studied topic in the scientific literature, and of perpetual concern to those attempting to advance adaptation planning and action. As part of California's Third Climate Assessment, I participated in a two-part study that first undertook an extensive literature review¹⁹ aimed at developing a systematic diagnostic framework for identifying and understanding adaptation barriers²⁰, and then tested this framework in the empirical context of four local (municipal and county) adaptation efforts and the collaborative regional effort in San Francisco Bay.^{21,22} In parallel, a survey of California coastal professionals examined managers' perceptions of key barriers to adaptation²³, the findings of which were echoed in a statewide survey of local government planners conducted by OPR.²⁴

It is relatively simple to provide an overview of the most persistent barriers identified or perceived by resource managers, planners, and decision-makers. Figure 2 below summarizes the prevalence of different types of barriers from the San Francisco case studies described above, suggesting the importance of institutional/governance related barriers already encountered or anticipated in the future. Figure 3 synthesizes what coastal professionals statewide perceive to be the major barriers to adaptation. Given the very early stages of adaptation overall in California, the primacy of funding and staffing barriers reflect the immediate challenges encountered in undertaking risk/impacts/vulnerability assessments and in adaptation planning, with an emerging sense of the anticipated costs of implementing major structural adaptation options (few of which are being implemented on the ground to date).

It should not come as a surprise that institutional barriers are among the top types of hurdles. The purpose and nature of institutions is to stabilize, routinize and harmonize situations, and/or to standardize procedures. Institutions – understood not as organizations but as the informal and formal rules, norms, clusters of rights, and decision-making procedures – work best when circumstances do not change, and they can make processes clumsy, more costly and inefficient when circumstances change. The greater the contextual change, the more limited become decision-makers' options and action space to accommodate it if institutions remain unchanged. In other words, static institutions and progressive climate change are on a collision course.

¹⁹ Ekstrom, J.A., S.C. Moser, and M. Torn (2011). *Barriers to Climate Change Adaptation: A Diagnostic Framework*. PIER Research Report, CEC-500-2011-004, CEC PIER Program, Sacramento, CA. Available at: <http://www.energy.ca.gov/2011publications/CEC-500-2011-004/CEC-500-2011-004.pdf>.

²⁰ Moser, S.C. and J. Ekstrom (2010). A framework to diagnose barriers to climate change adaptation. *Proceedings of the National Academy of Sciences* 107(51): 22026-22031.

²¹ Moser, S.C. and J.A. Ekstrom (2012). *Identifying and Overcoming Barriers to Climate Change Adaptation in San Francisco Bay: Results from Case Studies*. PIER Research Report, Sacramento, CEC-500-2012-034, 194 pp., available at: <http://www.energy.ca.gov/2012publications/CEC-500-2012-034/CEC-500-2012-034.pdf>.

²² Ekstrom, J.A. and S.C. Moser (2013). Barriers to climate change adaptation: Overcoming challenges in the San Francisco Bay Area. In: *Successful Adaptation to Climate Change: Linking Science and Practice in a Rapidly Changing World*, ed. S.C. Moser and M.T. Boykoff, pp. 97-113, Routledge, London.

²³ Finzi Hart, J. et al. (2012), cited above.

²⁴ APSR (2012), cited above.

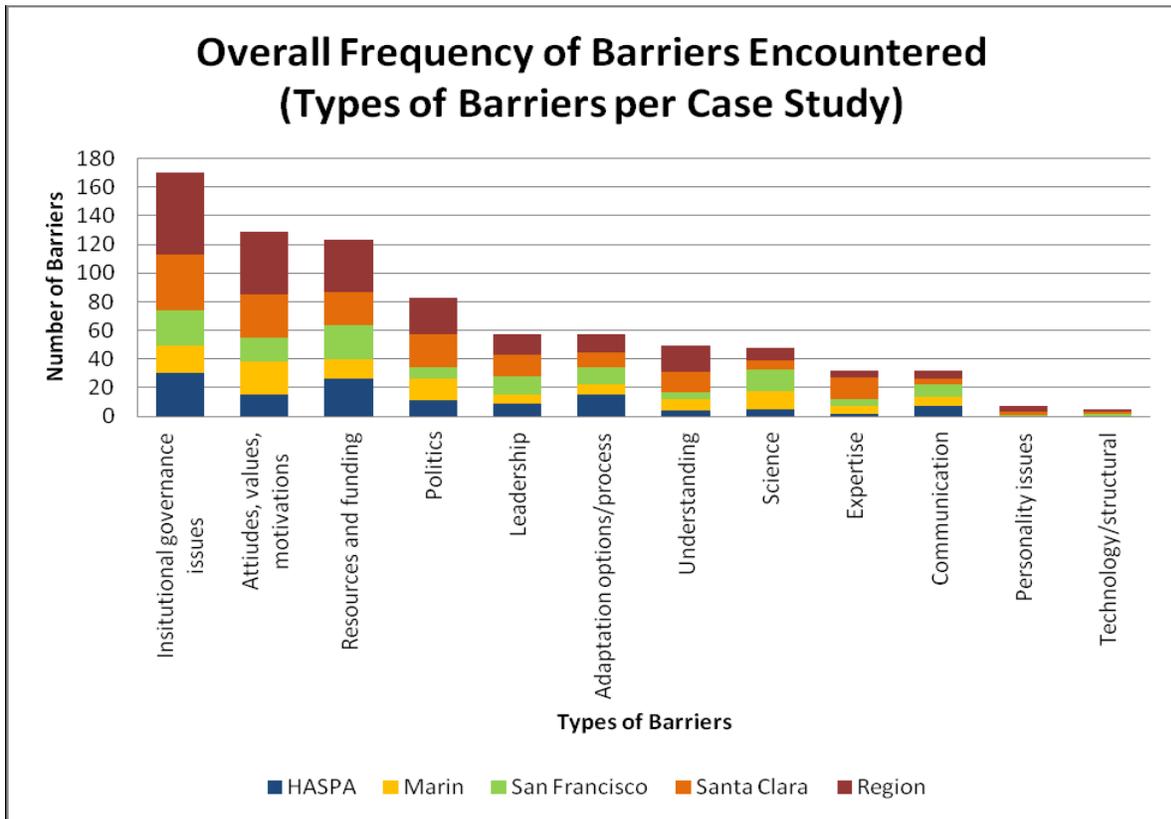


Figure 2: Overall frequency of barriers encountered in five case studies of adaptation in San Francisco Bay (Source: Moser & Ekstrom 2012)

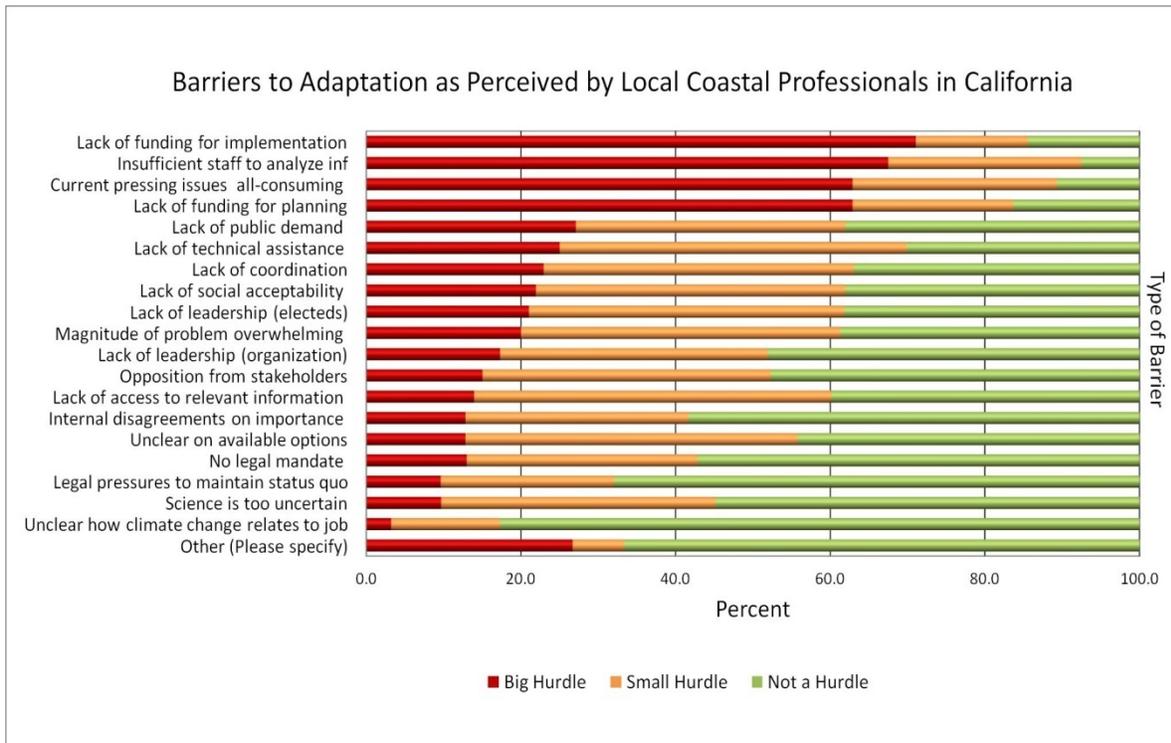


Figure 3: Major and minor barriers to adaptation perceived by California coastal professionals (Source: Finzi Hart et al. 2012)

That said, it is entirely possible to imagine "institutions made for change", i.e. norms, rules and decision-making procedures that do anticipate and account for change. Long before formal laws were established in Western societies (including the US and California), Native peoples lived by cultural norms that demanded attention to the implications of actions for the next seven generations. Decision-making power rested with elders burdened with the responsibility to look out for the tribe's collective good. Even in modern society, some rules, procedures, mechanisms, and intergovernmental agreements have been established to deal with natural, social, or economic disruptions, discontinuities and change (e.g., divorce, insurance, catastrophic events triggering one over another set of rules or procedures).

In contrast to the general overviews given above, it is difficult to provide a specific and detailed list of statutory, regulatory, or institutional barriers for different sectors in which adaptation will need to take place. Reasons include:

- statutory and regulatory barriers are specific to different sectors, and thus to the specific laws, rules, and procedures pertaining to each;
- statutory and regulatory barriers are specific to different adaptation actions and related decisions, and with it to different types of decision-makers involved in these decisions because they have different degrees of authority and jurisdiction, as well as formal or informal influence;
- statutory, regulatory as well as institutional barriers may be specific to different stages in the adaptation planning and implementation process;
- institutional and governance²⁵ barriers frequently are context-sensitive, requiring attention to social, economic, cultural, political and other circumstances; and
- the work to identify them simply has not been done yet (adaptation is in the early stages in most if not all sectors, and the needed changes may not always be large enough yet to require statutory change).

Categorically, however, thinking about institutional, governance and legal barriers should consider two distinct cases:

- (1) Institutional structures and governance procedures for adaptation are *missing*, in which case legal or policy intervention should focus on building a foundation or structure through which adaptation can progress over time. The goal, in other words, is to fill an institutional gap. Examples may include developing regional governance mechanisms that allow for integrative, collaborative planning, delineating and declaring special districts for adaptation (e.g., adaptation action areas invented in Florida), or developing new funding streams.
- (2) Institutions exist to advance adaptation efforts in principle, but they currently do not do so. The goal here is to *integrate* climate change (or more specifically an active recognition of climate change trends and risks) into ongoing governance processes ("mainstreaming"). In this case, the specific institutional governance barriers to doing so must be identified and removed. This can involve, for example, lack of or inadequate authority and cooperation, legal barriers prohibiting the most promising adaptive solutions,

²⁵ Please note the important distinction of government from governance. Governance may involve public- and private-sector actors and is a "political art" of those involved to decide upon and implement a course of action given specific rules and conditions, while government – as a generic label – refers only to public sector actors who may be involved in governance.

contradictory organizational missions, or development policies and tax incentives that promote risk-seeking instead of risk-avoiding or risk-minimizing behavior.²⁶

Specific lists of statutory/ regulatory barriers should be developed by sector experts and involve the range of decision-makers that would be involved in adaptation-related decisions. One good recent example is a study conducted for the water sector by Professor Michael Hanemann.²⁷

Goal 3: Develop recommendations for the Legislature and the Governor to embed appropriate governance, legal and risk assessment frameworks into new or existing institutions.

In addition to the specific features of governance mechanisms suggested in Appendix A, and the recommendations made by others testifying to the Commission, I will focus here on two essential complements to – or rather foundational elements of – effective adaptation governance frameworks and mechanisms.

A scientific foundation for adaptation decisions. For a long time, California was a leader nationally, if not internationally, in supporting and, in fact demanding, a broad scientific foundation for the development of climate change policy. That sadly changed a couple of years ago when funding for the California Energy Commission's PIER Program was eliminated, and subsequently replaced with its new EPIC Program, albeit at reduced funding levels and constrained to a much narrower set of research topics. As a result, there is currently no longer a broad state-sponsored research program that aims at assessing climate change risks, vulnerabilities and adaptation options across California's many climate-sensitive sectors. While individual state agencies still conduct their own or sponsor extramural research (as resources allow), and efforts are ongoing – e.g. through the Climate Action Team – to communicate and coordinate research activities, the current approach is a far cry from a dedicated and integrated effort to conduct periodic assessments and continue to build the necessary knowledge base for climate adaptation. The greatest need and yet greatest risk of neglect is for ecological, economic and social science research on climate change impacts, risks, vulnerabilities and adaptation options. This situation is particularly regretful given that the demand for actionable research grows with every city, every county, every region, every state agency and every business recognizing the necessity of preparing for climate change risks and change. Moreover, past research has identified exactly those areas as crucial for effective adaptation: the role of institutions and human behavior, the cost of adaptation, trade-offs across sectors, time and space, evaluation of effectiveness of different adaptation options, the co-benefits of "green infrastructure" or ecosystem-based adaptation, social and ecological vulnerabilities, and so on. The alternative to a good scientific foundation for decision-making is inadequate, outdated or no science: hand-waving, guessing, or active ignoring of changing conditions. Maybe even worse would be science that is of no use to decision-makers or unusable. Thus actionable science must be established in transdisciplinary partnerships with potential users – a process that requires stable investment in institutions specializing in science-policy/practice interactions. Neither the investment in science nor that in effective science-practice interfaces are cost-free. But lack of such investments will produce lucky outcomes at best and prohibitively expensive results at

²⁶ Ekstrom, J.A. and S.C. Moser (2013), cited above.

²⁷ Hanemann, M., D. Lambe and D. Farber (2012). *Legal Analysis of Barriers to Adaptation for California's Water Sector*. California Energy Commission. Publication number: CEC-500-2012-xxx.

worst due to likely mis-investments, lack of adequate preparedness, and lost opportunities. As the 8th strongest economy in the world is recovering from its budgetary woes, and as it turns to rebuild a strong economy, it *must* reconsider its short-sighted decision to pull the scientific rug out from under its planning and investment in a climate-smart, climate-resilient future.

A climate-educated work force. While multi-disciplinary climate change science can provide the crucial knowledge base for adaptation decisions and adaptation governance frameworks can guide or direct decisions, no scientific finding by itself dictates a course of action and no decision framework, however specific, takes away the need for professional assessment and values-based judgment on priorities and choices. Government staff at all levels, and ideally also the professionals and experts (e.g., engineers, consultants) informing their planning and implementation efforts, should have a solid understanding of the science and complexities involved in climate change, impacts and vulnerabilities, risk management, and adaptation. This systems thinking-based, integrate knowledge must not be constrained to climate science, but include ecological, economic, social scientific and other relevant knowledge. For too long, narrow professional training, job descriptions, and agency missions have cemented and reinforced institutional divides, stove-piping and partial decision-making that resulted in unintended but avoidable negative consequences, inefficiencies, oversights or gaps. The call is not for super-human "renaissance" people, but for investment in human capital, in government staff that is better prepared to handle complexity, rapid change, surprises from unexpected places and uncertainty. The California Department of Fish and Wildlife's recently developed Climate College²⁸ may serve as a good and inspiring model for what could be done. Formalizing such training and education through professional development credits, staff entry-level requirements or de minimis professional credentials for all government employees and contractors would be an important way to strengthen this effort and ensure that whatever adaptation framework is being put in place will be implemented knowledgably and professionally. Building California's government workforce in this way would also go a long way toward addressing the staff capacity limits identified in the adaptation barrier studies cited above.

Conclusion

I close by thanking the Commission again for the opportunity to testify as you prepare your important and timely study and develop recommendations for Governor Brown and the Assembly on how to advance adaptation in California. I can think of no more urgent and important a task than to develop an adaptation governance framework "made for change" and to ensure that decision-makers have at their finger tips the necessary scientific information, financial resources, and human capital to overcome the key barriers they face, thus enabling them to turn adaptation plans into effective action. I would be happy to answer any questions or be of further assistance to the Commission.

Thank you.

²⁸See: http://www.dfg.ca.gov/Climate_and_Energy/Climate_Change/Climate_College/

Appendix A: Key Features of an Adaptation Governance Framework

Features of a Climate Change World	Features of an Adaptation Governance Framework
Non-stationarity	<ul style="list-style-type: none"> • Explicit recognition of the tension between providing near-to-medium-term stability (to create reasonable conditions for day-to-day business and decision-making), while allowing for both adjustments in the longer-term and ensuring institutional durability to achieve goals that may require a multi-decadal policy commitment. This might be done through the following mechanisms: <ul style="list-style-type: none"> ○ Requirements to use the best available science (including projections of future conditions), or alternative scenarios of how relevant variables may change over time. ○ Requirement to periodically review and revise/reset/remap baselines, existing conditions ("indicators"), and trends to update policies accordingly. ○ Revision of existing statutes that use, require or limit permissible information to historical baselines to explicitly allow and/or require projections of trends in climate, environmental, <u>and</u> social variables. • Constant commitment and maintenance of political coalitions (across party lines) around overarching, common goals. • Design for <u>iterative</u> risk management, e.g., through requiring (and funding) reasonably frequent reviews, evaluations, and revisions of pilots, policies, programs and plans. <ul style="list-style-type: none"> ○ Adaptive, iterative management with deliberate monitoring, evaluation and learning are frequently called for but rarely realized. Key reasons include lack of funding for monitoring and evaluation; lack of a "learning culture"; fear of "failure" due to professional norms and standards, incentives for professional or political advancement and recognition, and narrow margins of error; disinterest or competing priorities; politics and the challenge to reopen contested policies. Thus, explicitly requiring and financially supporting the establishment of such iterative, adaptive, deliberately learning-oriented governance systems and addressing underlying problems may be necessary and ultimately a more cost-effective investment. ○ Careful consideration of different approaches, purposes, and implications of evaluation procedures to assess adaptation effectiveness. (This is an area of active research and cannot be adequately summarized here.) • Disclosure requirement of relevant risks (and trends in those risks) <u>early on</u> in all decisions and transactions with long-term implications (e.g., real-estate, development, long-term business

Uncertainty	<p>investments).</p> <ul style="list-style-type: none"> • Explicit recognition that the historically common, deterministic, static or linear governance paradigm is now inadequate, especially for decisions with long-term implications (path-dependencies), and that a risk-based governance paradigm is required instead. • <u>Decision-specific</u> assessment of the importance of uncertainty for any given decision (i.e., does the uncertainty actually affect what might be done? Over what timeframe? Under what conditions?).²⁹ • Maximizing future flexibility in decisions whenever decisions with long-term implications can be made incrementally (i.e., in small steps rather than all at once). The risk of making “the wrong” decision now can be reduced by avoiding choices that create path-dependencies and keep as many future options open as possible. • Maximizing robustness in decisions is critical when they have to be made all at once (for example, to build a piece of infrastructure or not). The risk of making “the wrong” decision can be reduced by selecting robust options, i.e., options that maximize the probability of meeting societal goals or desirable outcomes while minimizing the probability of undesirable outcomes under a wide range of plausible future conditions.³⁰ • No-regrets adaptation options that serve society with or without climate change are excellent actions in the face of an uncertain future. • A clear mandate (or at least clear authority) to act despite uncertainty. • Requirement that uncertainties (magnitude, nature, causes), and resulting alternative outcomes, are clearly communicated early and often to relevant stakeholders.
Risk of tipping points	<ul style="list-style-type: none"> • Explicit recognition of the risk of tipping points. • Involvement of a broad spectrum of relevant stakeholders from different, but interlinked sectors in planning and decision-making processes to air and address concerns over tipping points. • Expert-facilitated use of scenario exercises with stakeholders to explore potential tipping points, surprising interactions, critical vulnerabilities, opportunities and risk-minimizing, preventive response options. • Abrupt changes are believed to become more likely when systems are strongly perturbed (or rapidly "forced"), when systems are already unstable or weak and lack in resilience. Thus all efforts in reducing the pace of climate change and concurrent non-climatic

²⁹ Moser, S.C. (2011). The contextual importance of uncertainty in climate-sensitive decision-making: Toward an integrative decision-centered screening tool. In: *Climate Change in the Great Lakes Region: Navigating an Uncertain Future*, eds. T. Dietz and D. Bidwell, Michigan State University Press.

³⁰ See, e.g., Lempert, R. et al (2003). *Shaping the Next one Hundred Years: New Methods for Quantitative, Long-Term Policy Analysis*. RAND Corporation, Santa Monica. Available at: http://www.rand.org/pubs/monograph_reports/2007/MR1626.pdf.

	<p>stressors, and in increasing the coping capacity and resilience of human and natural systems can be considered "insurance" mechanisms against tipping points.</p>
Risk of irreversibility	<ul style="list-style-type: none"> • Explicit recognition of the risk of irreversibility. • Involvement of a broad spectrum of relevant stakeholders from different sectors in planning and decision-making processes to identify the most unacceptable irreversible changes, and to explore preventive and (in case they occur) transformative responses. • The more unacceptable potential irreversible changes are to stakeholders, the more prudent it is to select a risk-averse, pre-cautionary courses of action. • Investment in science that improves decision-makers' ability to identify, predict, or determine the timing of when changes are so substantial and permanent that current investments, uses, and values can no longer be achieved or maintained. Research should also explore ways to manage major irreversible changes (i.e., how to prepare for, develop, and implement transformative adaptation options).
Increasing frequency of disruption	<ul style="list-style-type: none"> • Improvements in pre-disaster planning and emergency response procedures, including review and establishment or improvement of inter-agency, cross-jurisdictional, cross-scale and public-civic-private disaster assistance agreements. • Building a "culture of partnership" at different, across and beyond levels of government. • Periodic disaster scenario planning, especially for managers of critical infrastructure and functions (e.g., complex/compound disasters, closely spaced disasters, disasters with or without external assistance), and adjustments of disaster preparedness plans and procedures. • Requirement of recovery planning that goes beyond reestablishing the pre-disaster "normal", but increases social, economic, structural and ecological resilience in the face of a changing climate. • Increased public spending in pre-disaster planning, rather than in post-disaster recovery (this may involve carrot-and-stick approaches, given the lack of doing so traditionally). • Requirement (again, via carrot-and-stick approaches) of better disaster preparedness of businesses and private citizens. • Improved risk communication before, during, and after disasters.³¹
Emergent crises, surprises	<ul style="list-style-type: none"> • Requirement that communities and managers of critical systems identify key sensitivities to disruption, and track meaningful indicators to allow for early detection and maximum lead time. • Involve relevant stakeholders in scenario exercises where key sensitivities and potential surprises may be identified.

³¹ See: International Risk Governance Council: What is risk governance? Available at: <http://www.irgc.org/risk-governance/what-is-risk-governance/>.

	<ul style="list-style-type: none"> • In the face of complex problems, where surprises and unintended side effects must be expected and the stakes are high, it is unwise to rely on only one or a small number of actions to attempt to “solve” a problem. Employing a portfolio of actions to increase the chance that one or more will succeed in reducing risk and to provide more options for future decision makers is a wiser option. • Investment in system redundancies and diversity to increase social, ecological, structural, and economic resilience. A diverse scientific literature has emerged over the past 20+ years on resilience. One recent effort – the Community and Regional Resilience Initiative (now Institute) – has attempted to synthesize the breadth of insights from multiple disciplines to build a framework and a set of tools to build resilience.³²
Growing scope and pace of impacts	<ul style="list-style-type: none"> • Explicit recognition that climate change does not recognize geographic or jurisdictional boundaries (e.g., through formal and informal regional and cross-jurisdictional collaboratives and partnerships for planning and/or implementation; special "adaptation districts" in which specific rules or procedures apply and for which funding can be raised explicitly; cross-sectoral and regionally integrated research strategies and planning exercises) • Explicit recognition of the cross-sectoral ripple effects of climate change impacts and extremes (e.g., through multi-sector scenario exercises, trade-off analyses) • Requirements to use the best available science (projections), or a range of scenarios of how variables may change over time. • Requirement to periodically review and revise/reset/remap baselines, existing conditions ("indicators"), and trends to assess the rate of change.
Longer planning horizons	<ul style="list-style-type: none"> • Development of adaptation plans that distinguish (a) options for existing structures, land uses, and resource uses, and (b) options for new structures, development, land and resource uses. • Requirement to illustrate "climate-smart" planning over not just one, but various relevant time horizons (e.g., protection from impacts or ability to cope with expected/likely impacts over the 0-30 year timeframe; plans and financing mechanisms for how to address growing climate change impacts >30 years; assessment of adaptation options >50 years). • Requirement to undertake trade-off assessments, cost-benefit and cost-effectiveness analyses for different adaptation options over different relevant timeframes (e.g., 5, 10, 30, 50, 75 years) • Inclusion of clear sun-setting or review/evaluate/adjust requirements in laws and regulations that affect long-term (>20 years) developments and decisions.

³² See: <http://www.resilientus.org>