

**Testimony of Will Travis
on Climate Change Adaptation in California
to the Little Hoover Commission
October 24, 2013**

Thank you for the invitation to present my observations on climate change adaptation in California. Unfortunately, a prior out-of-state commitment prevents me from attending the Little Hoover Commission hearing on October 24, 2013. Therefore, I appreciate the opportunity to provide my testimony in written form.

Don't Blame Others for My Sins. I served as the executive director of the San Francisco Bay Conservation Commission (BCDC) from 1995 until 2011. Starting in 2005, I worked with a broad coalition of stakeholders to build support for BCDC's unanimous adoption of the nation's first state coastal management agency regulations for addressing sea level rise in shoreline development. Last year I served as the senior advisor to the Bay Area Joint Policy Committee, which is coordinating the efforts of four regional agencies to advance economic prosperity and address climate change in the land use planning of the San Francisco Bay region. Based on my recommendation, the Policy Committee unanimously adopted a commitment to embark on the formulation of a regional sea level rise adaptation strategy. Earlier in my career, I spent 12 years in a variety of management capacities at the California Coastal Commission. I am now retired but I am continuing to advance climate adaptation planning through my work as an independent consultant, university instructor, speaker and writer.

The testimony I am providing is based on my professional experience in coastal management, climate change planning and sea level rise adaptation. Much of the technical information about sea level rise is drawn either from *High Tide on Main Street: Rising Sea Level and the Coming Coastal Crisis* or my discussions with the book's author, John Englander. Relying on unimpeachable science Englander has been able to explain the causes, effects and impacts of sea level rise in an wholly understandable manner. Therefore, I highly recommend that this book be made part of the official testimony of your Commission in order to make your record complete and coherent. I have also had the benefit of many conversations with Joseph E. Bodovitz, the first executive director of both BCDC and the Coastal Commission and a long-time student of California government. However, my comments represent my own personal views and not necessarily those of any of the agencies where I have been employed, any of my current clients, any other institutions or any of my colleagues who have been so generous with their time and expertise.

The Times They Are a-Changin'. The Earth's climate has changed dramatically over the life of our planet. During the relatively short geological period of the past 500,000 years, there have been four ice age cycles with vast amounts of the Earth's water freezing during the "cold phase," dramatically lowering sea levels. During the peak of the last ice age 20,000 years ago, sea level was 390 feet below where it is today.

We are now in the "warm phase" of the cycle, with the past 6,000 years being a particularly stable period for climate globally. But since the advent of the industrial revolution, the burning of fossil fuels has led to a rise in global temperatures beyond the normal cycles of the last several million years. This unusual warmer climate is melting glaciers and ice sheets beyond the historical pattern, which combines with thermal expansion of seawater to cause sea level to rise. Over the past century sea level has increased over seven inches in San Francisco Bay. Scientists believe that global temperatures will continue to increase and the rate of sea level rise will accelerate. The exact sea level at any particular date in the future is a subject of intense scientific debate. Some scientists contend that by 2100 sea level could be only a foot higher than it is now; others believe it might be seven feet higher or more. No one knows for certain at this point due to uncertainties about just how warm it will get, which is dependent on variables such as

population levels and how the world produces energy over the course of this century. But what is certain is that sea level rise will not end in 2100. Rather it will continue to get higher in the centuries ahead and the increase will likely accelerate over time.

Don't Be Surprised When Old Dogs Can't Learn New Tricks. With the Earth's climate stable for about 6,000 years, sea level has changed very little. During this same 6,000-year period, human civilization was being developed. Thus, during our entire experience as a thoughtful species, the shoreline has always been where the shoreline always was. It was only natural that humans, therefore, believed that in the future the shoreline would always be where it was in the past. So as we created institutions, developed concepts of property ownership and enacted laws, we treated sea level as a constant and the location of the shoreline as fixed and unchanging. But rising sea level will move the location of the shoreline upland and inland. It is wholly unrealistic to expect that laws, concepts, institutions and other creations of the human mind that were formulated without taking climate change into account will be useful or relevant in a future where climate change is the new reality.

More often than not, laws are enacted to deal with a specific problem and are based on the facts in place at the time the law is enacted. Until very recently, climate change and sea level rise were not considerations when these laws were enacted. As a result, we should fully expect that laws passed and institutions created before we recognized that our climate is changing will not be particularly effective in dealing with the challenges posed by climate change. At best, it may be difficult for institutions created by these laws to effectively deal with the challenges posed by a changing climate. At worst, these laws and institutions may be obstacles to effective climate adaptation rather than agents of innovation. Even with the best of intentions, it is difficult to address climate change within the context of laws enacted to address past problems.

One specific example is the McAteer-Petris Act, which was enacted in 1965 to deal with a serious problem that plagued the Bay Area at that time—the ongoing shrinking of San Francisco Bay. Because the bay is relatively shallow, reclamation is inexpensive so between 1850 and 1960 about a third of the original bay was diked or filled. Seventy percent of the remaining bay could be reclaimed. To control reclamation, the McAteer-Petris Act was enacted to create an all-new state agency, the San Francisco Bay Conservation and Development Commission, which was given regulatory authority over new bay fill projects. This law did not authorize BCDC to become a regional land use regulatory agency that could override local decisions on the types of projects built along the shoreline. Instead, the law directed BCDC to use its legal authority to minimize further filling of the bay, to create a permanent shoreline and to ensure that maximum feasible public access to this shoreline be provided as part of new developments approved by BCDC.

Over its nearly half century of existence BCDC has been remarkably effective in achieving the goals of the law that created the agency. But inundation from sea level rise could make the bay bigger—precisely the opposite of the challenge BCDC was created to address. BCDC has no mandate to deal with this new challenge and very limited legal authority to do anything about it.

To meet this new challenge, at BCDC's recommendation the Bay Area Joint Policy Committee (an organization created to coordinate the work of BCDC, the Association of Bay Area Governments, the Bay Area Air Quality Management District and the Metropolitan Transportation Commission) is overseeing the formulation of a regional sea level rise adaptation strategy. It may take as long as ten years to develop this strategy, which will have to assess the flooding vulnerability of areas around the bay, determine the degree of risk in vulnerable areas, decide which areas should be protected and which should not, and find a means of financing the implementation of the strategy.

It is likely that the most effective regional adaptation strategy will require building some flood protection infrastructure in the bay, prohibiting new development along some stretches

of the shoreline, and removing existing development to accommodate planned retreat from the shoreline in other places. The result would be a bay shoreline outboard of where it is now in some places and inland in others. BCDC's effectiveness in achieving its mandate to create a permanent shoreline will likely be a legal impediment to achieving this outcome.

BCDC was created in 1965 largely because the bay was treated as ordinary real estate destined to be reclaimed and become a source of public tax revenue. The passage of the McAteer-Petris Act ended this approach. Yet along some parts of the bay shoreline—particularly where urban waterfronts, highways, ports and airports border the bay—the most cost-effective means of protecting critical existing infrastructure will be to erect massive levees and seawalls outboard of the existing shoreline. One option for financing the construction of this needed flood protection would be to construct what the Dutch call “super levees,” which are wide enough to accommodate development on top of the levees. In other words, public revenue could again be generated by converting parts of the bay to real estate just as was done in the past. Should this come to pass, what was seen as a problem in the 20th century would become a possible solution to a problem climate change will bring us in the 21st century.

While BCDC has the regulatory authority to prevent the shoreline from moving outboard, it has no general land use regulatory authority that would be effective in advancing planned retreat where appropriate along some parts of the shoreline. Ironically, this lack of authority created a significant political problem when BCDC proposed to amend the *San Francisco Bay Plan*, (the Plan contains the enforceable rules that BCDC uses when regulating shoreline development) to address sea level rise. To introduce the idea of sea level rise to the general public in the Bay Area, BCDC's staff worked with colleagues at the U.S. Geological Survey to produce a series of maps illustrating the extent of possible flooding from future sea level rise around the bay. Recalling the adage that “one picture is worth a thousand words,” BCDC's staff believed these maps would underscore the appropriateness of amending the Bay Plan to deal with sea level rise. However, the staff should have instead realized that the messenger is as important as the message. Some skeptics apparently believe that a goal of all government regulatory agencies is to have more regulatory authority. In short order, local government officials, developers, land use attorneys, infill advocates and anyone suspicious of bureaucrats became convinced that the purpose of the maps was to illustrate the extent of the area over which BCDC wanted regulatory control. To allay these concerns, BCDC's staff used a variety of means to assure critics that BCDC's jurisdiction could not and would not be expanded by the amendment. While this assurance was sincere and clearly necessary to build the widespread political support needed to gain BCDC's unanimous approval of the Bay Plan amendment in 2011, the assurance will likely make it more difficult for BCDC to gain political support should the Commission decide in the future that changes in state law are needed to make BCDC more effective in addressing sea level rise.

The Two Most Effective Approaches for Adapting to Climate Change are: (1) Bold and (2) Audacious. As Englander explains in *High Tide on Main Street* (pp. 39-40), scientists have relied on millions of years of data to calculate that each degree Fahrenheit of warming will *eventually* result in 35 feet of sea level rise. The average temperature in the world's oceans has already increased 1.5 degrees Fahrenheit over the past century. Therefore, even if all greenhouse gas emissions end today, it is inevitable that sea level will eventually rise 50 feet higher than it is today. Stated most simply, 50 feet of sea level rise is already cooked into the system. It is impossible to determine whether this 50-foot rise will come about in hundreds of years or thousands of years because during the last five hundred million years our planet has never warmed as fast as it is warming now. We may be able to slow the pace of sea level rise by going onto a crash diet off fossil fuels but we can no longer stop the rise due to the excess heat already stored in the ocean. Thus it is inevitable that the California shoreline will continue to move inland and upland, and at an increasing rate as long as atmospheric warming continues.

Dealing with this inevitability does not mean we should accept that eventually all of the ice on planet Earth will melt and bring sea level 212 feet higher than it is today, which is a few feet lower than the roadway deck on the Golden Gate Bridge. Nor does it mean that in our coastal planning for the next century, retreat is the only option. But it does mean that we have to develop new concepts for planning, designing and building along our coastline. Erecting a Gothic cathedral along the shoreline and expecting it to endure 1,000 years would not be prudent. But we can continue to enjoy and make productive use of our shoreline by building structures that can either endure occasional flooding, float on rising water, be easily removed and reconstructed elsewhere, purposefully built to serve only as temporary structures or employ other imaginative design solutions. Envisioning communities that are planned in this way requires creativity, innovation and a whole new way of thinking about California in the future. Harder still will be reforming our legal and regulatory systems that are premised on permanence and unchanging conditions to accommodate uncertainty and encourage innovation.

I will not suggest that I know precisely how to bring all these changes about, but as the Little Hoover Commission considers the testimony being presented to you by the many experts who are dealing with climate change, I recommend that you consider seven broad concepts, which can serve as a structural framework onto which specific elements can be attached.

- 1. Planning for Sea Level Rise is Different from Planning for Other Types of Disasters.** Sea level rise involves the slow rise of the *average* level of the ocean. But the first evidence of flooding from climate change in California will likely not be from an increase in average water depths. Instead, it will come about at an extreme high tide or during a storm. Most scientists believe that the frequency of intense storms will dramatically increase in the future. When these storms blow across California from the tropics they contain so much water scientists call them atmospheric rivers. If heavy rain, low barometric pressure, high tide and strong winds all come at the same time the result can be a severe storm surge. The extensive damage from Hurricane Sandy was the result of a combination of heavy rain and wind coming at high tide on top of a foot of sea level rise.

Flood preparedness planning is wisely being coordinated with planning for other disasters. Sea level rise adaption planning should also be integrated with mitigation and response planning for earthquakes and other hazards. Identical resources and capabilities can often deal with different sorts of disasters be they earthquakes, floods, fires, mudslides or other events. Land use and infrastructure investment decisions should consider multiple hazards, not just sea level rise.

While this integrated preparation and response planning is valuable, it is important to recognize that there is a fundamental difference between anticipating and adapting to sea level rise and planning for other hazards. Storm flooding, earthquakes, poor air quality conditions, heat waves, energy shortages and wildfires are serious but temporary events. We try to reduce the likelihood of these disasters happening at all; we attempt to minimize their destruction when they do occur; we endure them when they do occur; and we then do our best to recover from them as quickly as possible. They can be considered short-term events with an expected "return to normalcy" at the end of their cycle.

At the next level, these hazards can become recurring events that demand a more rigorous set of planning and mitigation strategies. For example, as sea level rises there will more days in which storm events can produce damage to shoreline assets. We will likely invest more to protect infrastructure that is flooded and damaged monthly rather than once every few years, particularly when the infrastructure serves communities upland of the flood zones. Similarly, new actions will be required to deal with windstorms that cause power outages if severe storms occur more frequently. In these cases, the consequences may be more frequent or more severe, but they still follow the same cycle of prepare, endure, and recover.

Sea level rise, however, will eventually add one additional danger level to these one-time and recurring events when it causes permanent changes to land now inland of the shoreline. Areas that are now always above water levels or subject only to occasional flooding will become permanently flooded and always below water level—and over time the water will get ever deeper. In this case, the consequences are long-term and will create a permanently altered state. Therefore, in terms of disaster planning, dealing with long-term sea level rise is like preparing for an earthquake that never stops, but instead keeps shaking more or dealing with a fire that keeps burning and getting hotter. This will require fundamentally rethinking how California plans long-term for adapting to sea level rise.

2. Sea Level Rise Will Impact All of California. It is understandable that when members of the public in the Bay Area are first introduced to the notion of sea level rise they look at BCDC's inundation maps to determine whether their homes are in flood zones. If they live upland of the water's edge they are likely to decide that sea level rise does not have to be added to the long list of things they're been warned they should pay attention to, things like high cholesterol, low oil pressure and income inequality. But then they learn that even though their homes may remain high and dry, coastal flooding could prevent them from having fresh water to drink or have their toilets work. Their places of employment might be flooded. Even if their homes and jobs remain above water, they might not be able to get to their jobs, schools or other destinations. Similarly, Californians in inland parts of the state may regard sea level rise as a coastal issue that will have little impact on them, not realizing that coastal flooding could bring power outages, transportation disruptions and other significant problems. Therefore, coastal local governments should not be expected to deal with sea level rise on their own. Rather, it is in the interests of all the people of California that an effective sea level rise adaptation strategy be formulated and implemented.

3. The State Should Provide Political Leadership, Incentives, Guidance, Conflict Resolution Mechanisms and Funding—But Not Detailed Local Adaptation Prescriptions. I found that the most important question posed in your invitation for my comments was this one:

"Given that cities and regions will assume the leading responsibility for adaptation and related land use issues, what would be helpful at the nexus of state government and local/regional government in terms of structures, guidance, grants and incentives?"

This question is profoundly important because it reflects an assumption I suspect will ultimately be found to be incorrect. Nobody knows precisely what revised and new measures will be needed nationally and internationally to deal with climate change adaptation. California is already an international leader in climate change mitigation (i.e., greenhouse gas reduction). As a result, the state is in a position to be a leader in climate change adaptation as well, but not if we assume that local government control over land use is sacrosanct. The California tradition of invention and creativity to deal with new challenges should make us bold enough to approach the problem with a clean slate. Let's figure out what we need to do, and then determine the best way government and the private sector can advance adaptation.

During my tenure as the senior advisor to the Bay Area Joint Policy Committee I was able to participate in the formulation of the Plan Bay Area, our region's Sustainable Communities Strategy (SCS) that was developed to meet the requirements of SB 375. Some critics of this plan have characterized it as an international conspiracy driven by United Nations to force suburbanites to sell their SUVs and move into Soviet style high-rise apartment blocks. At the same time, critics on the other end of the political spectrum complain that the regional agencies developing the plan have virtually no authority over local land use decision-making even though resistance to change by local activists' (often called *NIMBYs*), a complex land use regulatory system, and strong citizen support for tough environmental protection policies have kept the regional housing supply well short of

demand for more than half a century. The acrimony over this planning process has continued even after the Plan Bay Area was adopted. Three lawsuits have been filed challenging the adequacy of the CEQA-required environmental assessment of the plan. One suit claims the plan goes too far and is an unnecessary usurpation of local autonomy. A second claims the plan doesn't go far enough to force local governments to allow more housing to be built. And a third falls somewhere in the middle politically by challenging the technical adequacy of the analysis of goods movement.

Despite the controversies and difficulties encountered, the structural approach employed in SB 375 provides a starting point for crafting state legislation that would lead to formulation of a climate adaptation strategy. Specifically, three lessons can be drawn from the experience with SB 375 that are valuable when dealing with climate change legislation.

First, SB 375 acknowledges that climate change is real and steps must be taken to deal with it. SB 375's primary stated objective is to reduce greenhouse gas emissions by reducing Vehicle Miles Traveled (VMTs). Similar stated objectives should be established for climate change adaptation. Even local officials who don't "believe" in climate change or don't want to do much about it can be stimulated to take action if they are required to do so by state law.

Second, SB 375 relies on a regional approach for dealing with a statewide California issue. The enormity of California makes the wisdom of a composite of regional strategies compelling. The California coastline, including San Francisco Bay, stretches about the same distance as would a drive through 15 states along the East Coast between Portland, Maine and Miami, Florida. San Bernardino County alone is bigger than the State of Connecticut. It's easy to accept that along the East Coast each state will have its own approach to climate adaptation, each reflecting the varied cultural, political and environmental conditions found there. Why then should we in California expect that a single adaptation approach will work equally well in Northern California's fog-shrouded redwood forests and the deserts of Southern California?

At the same time, it is equally unrealistic to expect that a mosaic of local adaptation plans will somehow emerge into a cohesive regional strategy. The 55 cities and counties that border San Francisco Bay have primary jurisdiction over land use and development decisions. Their authority is supplemented by hundreds of independent special districts, each with their own governing boards and budgets, that have responsibility over issues ranging from flood protection and habitat restoration to fire suppression and disaster response. Under the oversight of the Bay Area Joint Policy Committee, its regional agency members intend to more fully integrate sea level adaptation into future iterations of the Plan Bay Area. But SB 375 does not provide any of the agencies with the authority to reconcile difference in intent or approach in adjacent local government strategies for sea level rise adaptation. One local government's decision to build a seawall can be rendered useless if a neighboring local government doesn't build a connecting seawall. Wetlands that can be restored and low-lying areas where retreat is the most appropriate adaptation response sometimes span two or more local jurisdictions. SB 375 does not provide any regional agency with the legal authority to reconcile local differences of opinion. This shortcoming needs to be addressed in any state legislation mandating the preparation of local climate adaptation strategies.

Third, a major shortcoming of SB 375 is that it does not provide state financial assistance for regional and local planning or the implementation of measures to carry out the required Sustainable Communities Strategy. In the Bay Area, the Metropolitan Transportation Commission has stepped forward to provide the lion's share of the funding to prepare the Plan Bay Area and has committed that future transportation funding for local governments will be used to advance the objectives of the Plan Bay Area. This funding is proving to be the major incentive to convince local governments to plan for more mixed-

use, higher density development that will lead to a reduction in VMTs. Rather than hope that all California regions will all adopt this enlightened approach, state funding should be provided for the preparation of local adaptation strategies, oversight by regional authorities, and implementation by regional and local entities.

- 4. Some Issues Are Too Big to Left to Regional and Local Decision-making.** Over the next century, water levels in San Francisco Bay are expected to rise ever faster, and climate change is also increasing the likelihood that a super storm could ravage the Bay Area at any time.

The bay is surrounded by hundreds of square miles of low-lying land, including downtown San Francisco and Oakland, three international airports, and Silicon Valley. Within this area are the homes of over a quarter million residents, major highways, rail lines, schools and businesses together worth over 60 billion dollars—all vulnerable to flooding from extreme storms now and from sea level rise in the decades ahead.

The bay is also home to the nation's largest coastal wetland restoration project outside the Everglades. Over 26,000 acres of former salt evaporation ponds are being restored to wetlands and enhanced natural habitat. These wetlands could become key elements in a massive system that would provide flood protection for low-lying development around the bay. But sea level rise can inundate these wetlands in the same way that it swamps shoreline properties. Therefore, we need to begin thinking about how to protect both our critical built environment and the bay's wetlands from sea level rise.

As the Bay Area begins planning its region's flood protection system it faces this choice: should the region estimate the cost of protecting each area, add up the costs, set priorities for what will be protected and then begin to budget for all the necessary work? Or should the region capitalize on the one big advantage it has over other coastal areas around the world: it has only one opening to the sea—the Golden Gate. California would not be alone in thinking about a possibility such as this: there's already tidal barrier on the Thames River in England; a large, complex system of dikes and barriers is in place in the Netherlands; a barrier system is under construction for Venice, Italy; and proposals for tidal gates in New York Harbor are being considered.

Building some sort of a tidal barrier at the Golden Gate would, of course, not be simple: the water is deep and the currents strong; expensive locks would be needed to let ships into and out of the Bay; and, most important, the bay's fragile ecosystem should not be harmed by a barrier. If a barrier is not evaluated now, we risk a period of indecision: why invest in protecting shoreline areas on a project-by-project, local government by local government basis if the possibility of building a barrier remains a theoretical option?

When considering the possibility of a barrier, the questions that need to be asked are simple to state, but will be difficult to answer:

- Is a tidal barrier of some sort at the Golden Gate or elsewhere in the bay feasible?
- How much would it cost and how long would it take to build?
- Who would pay for it?
- What environmental impacts would the barrier have?
- Finally, if the costs and impacts of protecting all important shoreline areas are compared with the costs and impacts of a barrier, which option makes the most economic and environmental sense?

Evaluating the feasibility, cost and effectiveness of such a barrier should not be left to the Bay Area alone. The implications of such a structure will have impacts well beyond the Bay region because a flood barrier at the Golden Gate could also provide protection for the Delta, Sacramento, and the Central Valley. Similarly, deciding how to finance and paying

for a barrier deserves to be considered in the context of other competing state infrastructure investments.

Climate change will bring other such issues to the state: how to re-engineer its water storage and delivery system, what to do about development in the urban/wild land interface where wildfires are becoming more frequent and severe, and, most importantly, where and how California should be growing in the future. The state should identify these critical issues and take steps to address them.

- 5. California Needs a State Growth Management Strategy.** Looking at the way California has been growing over the past fifty years it is hard to conclude anything other than that the state has decided to limit growth in the metropolitan areas along the coast and stimulate housing development in the Central Valley and the Inland Empire. Until the financial meltdown in 2008, this was clearly the trend. But this growth pattern did not come about because of a conscious decision or state strategy. Rather it was the *de facto* result of restrictions on development along the coast and around San Francisco Bay, and a “sticky” regulatory process that has made it easy for any citizen in any urbanized area in California to challenge most any approval for any project in their neighborhood. Coupled with the availability of large properties, receptive local governments and the absence of complaining neighbors, California’s housing growth moved inland to the hotter and dryer parts of the state. When addressing climate change, this is strategically the worst way for California to grow. Instead, the state should be taking advantage of the mild Mediterranean climate along with coast where nature provides free air conditioning, heating and cooling costs are lower, energy consumption is far less and the goals of SB 375 can be more easily achieved.

Advancing this sort of California growth strategy would require a fundamental departure from past and current land use planning and regulation. It would require the state to lay out its objectives regarding where and how California should grow in the face of climate change, establish new legal requirements and create financial incentives for advancing the state’s climate change growth strategy. This is a tall order. But when one looks at the challenges climate change will bring to California, it is both obvious and necessary.

- 6. Expect the Unexpected.** The “growth” management strategy mentioned above might end up having to be a “decline” management strategy if the impacts of climate change are different or more extreme than currently anticipated. Sea level might accelerate significantly if large portions of the Antarctic or Greenland ice sheets suddenly melt or fall into the sea or if there is an immense release of methane into the atmosphere as a result of melting of the Arctic permafrost. A rise in sea level far more rapid than now anticipated could flood vast areas along the coast, in the Bay Area, the Delta and the Central Valley despite our best efforts to adapt. The cost of dealing with such a tragedy could bankrupt the state and lead to an emigration from California to places with lower living costs, more water, and a tolerable climate. In the 21st century, climate change might reverse the migration from the Rust Belt to southwest states that occurred during the 20th century.

Even if such extreme sea level rise does not come about, San Francisco is likely to get warmer along with the rest of the globe. But it might also get cooler if constant higher temperatures in the Central Valley draw the cooler marine layer over San Francisco on a more regular basis. Whatever the changes, it is likely that overall California’s climate along the coast will remain not only tolerable, but downright pleasant. The Bay Area’s climate may become more like San Luis Obispo’s, which will become more like San Diego’s. What’s so bad about that?

What’s so bad is that a lot of other places won’t fare nearly so well. Entire island nations like the Maldives and Kiribati will likely vanish under the rising waters of the Pacific Ocean. Low-lying Florida, which rests on a foundation of porous limestone, cannot be

defended from flooding. By 2100, Miami will likely become the northern most island of the Florida Keys with a population that is a small fraction of what it is now living on houseboats and stilt houses. Phoenix, Las Vegas and other cities in the Southwest that depend on imported water to survive and vast amounts of energy to cool them to temperatures tolerable for humans may become uninhabitable. Where will all these climate refugees move to? Perhaps where refugees have gone before: California with its relatively mild climate and opportunities. Therefore, one of the possible impacts of climate change that is not currently on our agenda is an enormous increase in immigration and a rapid increase in population.

Because of these uncertainties we don't really know whether over the next century California will continue to grow at about the same rate it is now growing, have to accommodate a huge increase in growth or face of an enormous out-migration of people from the state.

Resilience is defined as the ability to be strong, healthy, or successful again after something bad happens. To deal with the uncertainties of climate change, California's growth management strategy should focus on making the state resilient so California remains vibrant whatever impacts a changing climate bring to the state, including unexpected growth or an unwanted decline in population.

- 7. Even with Mitigation, Adaptation Is Necessary, but Without Mitigation, Adaptation Will Not Be Effective.** Sea level rise is inevitable because numerous studies have determined that the ice sheets will not begin to expand for at least a thousand years, even if we stop emitting greenhouse gases immediately. Therefore, we must begin adaptation now. But as we do, we have to recognize that for adaptation to be effective, and its cost as low as possible, we need to reduce greenhouse gas emissions aggressively and immediately. Many economists believe that a carbon tax would spur the inventiveness needed to transition society to clean energy sooner than now seems possible. The longer we wait to move to clean energy, the greater the damage in the meantime, and the harder it will be to adapt and adjust.

Mark Hertsgaard, the author of *Hot: Living Through the Next Fifty Years on Earth*, describes the interlocking challenges of climate change as "avoiding the unmanageable and managing the unavoidable." Nobody knows whether human ingenuity and inventiveness will come up with ways we cannot even conceive now to mitigate and adapt better than we now envision. But what is clear is that in order to avoid the unmanageable, we have to dramatically cut greenhouse gas emissions. If we do this, we will give adaptation the only chance it has of managing the unavoidable.