

Coastline Restoration and Innovative Responses in the Bay Area: A Literature Review

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Will Steffen, Paul Crutzen, and John McNeill (2007), all globally renowned in the field of climate science, are incredibly concerned that human beings and their activities have become so invasive that they combat the forces of nature and are now pushing the earth into an unknown territory (Steffen et al.). Due to this invasive behavior, the Earth is slowly declining into a much wetter and stormier state. It cannot be clearer that these are the signs of climate change and that we as a species are one of the primary causes of this calamitous phenomenon. It goes without saying that the destructive phenomena such as Hurricanes Katrina, Sandy and many more are directly affecting the coastlines for a number of years. With the added threat of sea-level rise now, it is these coastlines we will be depending on as the first line of defense from flooding of our world's cities.

This literature review offers a look into current conditions of the coastlines, (using the Northern California Bay Area as an example), human impacts on the coastal regions, concluding with postulating various coastline restoration trends and their implications on the rising sea levels. These readings should be considered vital to policy-makers, designers, and planners looking at developing waterfronts as well as individuals concerned with the currently depleting coastlines. It would not only help these aforementioned groups, but would also raise interest and awareness in communities living in coastal regions globally, with respect to what could and could not work in their area to help mitigate large scale inundation.

This review could begin to show that the research and work done towards understanding human impact on the coastal ecosystems, especially during the industrial revolution was astronomical. While there are motions towards building resilient waterfronts and coastlines, it is important to remember the words of Harvard botanist Peter Del Tredici, "It is unrealistic to assume that turning back the ecological clock will be any easier than reversing the economic forces that created these landscapes." It is also important to understand that a lot of the following articles do not mention the Bay Area, but could be addressed through postulation. With that in mind, the push towards a more adaptable and resilient coastline needs to be made.

Accretion: *The process of growth or increase, typically by the gradual accumulation of additional layers or matter.*

Subsidence: *The gradual caving in or sinking of an area of land.*

02_Current Coastal Conditions of California

Coastal regions are often seen as the first line of defense for our major cities with the threat of sea-level rise. DeLaune and Patrick Jr. (1990) of Louisiana State University attempted an intensive study on three salt marshes in the Northern California Bay Area that vastly vary in subsidence but have similar elevation levels. They came to the conclusion that the growth rate of the marshlands in question (particularly through sedimentation and peat formation) are helping maintain the rate of sea-level while simultaneously retaining surface elevations above mean water level (DeLaune et al.). On observing salt marsh trends nationwide, they observed that on the west coast in particular, with record rises in sea level, marshes are barely keeping pace. Nearby marshlands suffer from higher rates of subsidence due to subsurface water extraction on a large scale, resulting in a higher increase in water level (DeLaune et al.). From this we can see how over time the ability of salt marshes to negligibly hold back sea level rise has been diminishing, and is most definitely a cause of concern. It is a given that these estuarine salt marshes need to be protected as they provide protection to a variety of residents of the ecosystem.

Kiehl and Isermann (2007) from Germany analyzed current trends in coastal ecosystem degradation and determined that salt marshes and dunes - prevalent along most coastlines - not only protect these regions from natural calamities such as flooding and erosion, but also provide safe haven for native plants and animals under harsh environmental conditions. Kiehl and Isermann claim that the restoration of these coastlines is hindered by the attempt to restore the natural dynamics of flooding, sedimentation, sand accumulation and erosion processes (Kiehl et al.) - a situation Del Tredici has stated is an impossible task when considering ecological restoration. The various examples delineated by Kiehl and Isermann indicate that the restoration of beaches, dunes and salt marshes should address the natural dynamics of the environment as well as accretion of native flora and fauna (Kiehl et al.), but should also adapt from their current state without causing further harm to the region. It appears that coastal conservation policies and habitat management are being used worldwide to maintain and restore coastal ecosystems. The gradual depletion of these regions will not only affect the permanent residents of the regions, but also the temporary ones, such as migratory birds.

Galbraith and his peers from The Waterbird Society (2002), perturbed by the destruction of coastal areas from human interference and sea level rise, assert that the devastation of this particular ecosystem could lead to the displacement (and potential eradication) of several non-human residents in the ecosystem (Galbraith et al.). By studying the foraging habits of migratory birds from various sites in

the United States, Galbraith and others witnessed the loss of coastal habitats ranging from 20% to 70% (Galbraith et al.). Such great losses could seriously jeopardize the number of migratory birds, which could potentially set off a chain reaction that could affect the survival of both human and non-human actors nationwide. This will definitely affect the California Bay Area, being directly in the Pacific Flyway, a regular migratory path for birds that stop at these wetlands for foraging. Clearly, the coastal ecosystems in the United States are in a terrible condition, with the added concern of getting worse. It is of utmost priority that relevant communities and authorities need to look into this region with a lot more concern.

03_Human Responsibility in Coastal Devastation

Humans have very discernibly had both positive and negative impacts on the natural environment. However, on the coastlines, human impact has had an overall negative influence. Vitousek and his colleagues at the Department of Biology (1997) at Stanford University observed the slow but significant disruption of vast ecosystems by human activity. Tracing human interference on the natural environment from the demolition of large acres of forests to the terracing of hills and mountains, they discerned that human intrusion has steadily been increasing for development, non-renewable energy and general expansion of the human footprint (Vitousek et al.). Over half the Earth's land surface has been manipulated for personal benefit, drastically increasing the concentration of carbon dioxide and chlorofluorocarbons in the atmosphere. Clearly, humans as a species are dominating the planet and are developing and altering the world to their benefit at a great rate. The coastlines, although not mentioned in this reading directly, are one such ecosystem that is so clearly being altered by the placement of industries, ports and railroads. Not only has the terrestrial portion of the ecosystem put at risk from the incessant development of industry, the aquatic portion has been polluted with refuse and runoffs even to this day. One such example of this occurring in the Northern California Bay Area is the neighborhood of Bayview-Hunter's point, which used to house a naval shipyard and since, has been seen as a significant example of displacement and marginalization, now being termed as "one of the most economically disadvantaged areas of San Francisco" (Browne).

Cloern of USGS and other professionals in the varying fields under environmental sciences (2016) provided an “update” to Vitousek’s article from almost a decade ago and laid out how the rate of change in estuarine-coastal ecosystems is increasing greater than predicted (Cloern et al.). While Cloern and others preface by stating that there have been positive motions towards coastal restoration, they also point out several hindrances in areas where human intervention has been a focus. These hindrances have been impeding both coastline restorative methods as well as regional responses to climate variability over land and sea. This rate of change will only increase as the human population grows. In fact, the changes at the land-sea interface have become far more pervasive and complex than when Vitousek concluded in 1997 that “we are changing Earth more rapidly than we are understanding it” (Vitousek et al.). Authoritative figures are lacking in responsibility and need to be made fully aware of how crucial the sustenance and expansion of programs to cope with the irreversible changes of climate change and human intrusion on the coastal regions.

Kareiva and his peers (2007) at The Nature Conservancy - like Vitousek and others - stress how humans have been exercising their impulse to propagate themselves with no concern to the world they live in. Through this mindless sprawl, they have domesticated land, devastated natural environments and introduced invasive flora and fauna to such an extent that we enhance and modify our food supply, reduce exposure to natural dangers and promote commerce (Kareiva et al.). This reckless behavior may prove beneficial to the human race, there have been innumerable irreversible mistakes done to the natural ecosystems on the planet. There may not be a direct mention of coastlines in this article, but one can draw conclusions from Kareiva, Cloern, and Vitousek’s work that the coastal regions also fall under victims of human interference and devastation on the natural environment.

As we go into the future, we need to be more judicious and cautious of how we domesticate nature, by understanding the change in balance of the resilience of the altered ecosystems. Lotze and his team (2006), all various professionals in history, environmental sciences and biology studied the change in 12 estuaries around the world and noticed that human interference has depleted a significant number of resources and habitats, alongside degraded water quality and propagated the invasion of foreign species. Recent conservation efforts have only achieved partial success, primarily failing in the restoration of original ecosystems. Comparing targets for marine and coastal conservation with historical baseline data has only proven that more focus needs to be given to the natural dynamics and resources of these coastal ecosystems (Lotze et al.). Clearly, human intervention on coastal regions has been an invasive process for centuries now, producing positive results only for themselves with little regard to the non-human entities present in these areas.

There needs to be severe consideration given to coastal ecosystems, with the possibility of implementing policies aiding and restoring them, knowing full well that “restoration hinges on the mistaken assumption that somehow we can bring back past ecosystems by removing invasive species and replanting native ones” (Del Tredici 1). California has the third-longest coastline among US states, spanning approximately 840 miles (1,352 km). According to USGS scientists, “with human intervention, 31 to 67 percent of California beaches may become completely eroded (up to existing coastal infrastructure or sea-cliffs) by the year 2100 under scenarios of sea-level rise of one to two meters.” (Gordon). Without a doubt, this is a serious cause for concern not only among communities residing in and around these regions but at various levels of government as well. There are various policies and strategies being implemented into coastal restoration in the country. It would be beneficial to understand some of these strategies in order to implement them on a larger scale, not just to the state of California.

04_Trends towards Coastal Restoration

As we now know of the severe consequences human beings have impacted on coastal environments, studying various methods that could be implemented on these regions to help conserve and allow for restoration will be crucial as early as possible. Baird and Mace (2006) of the California Resource Agency assert that a more regional approach for ocean and coastal resource management is necessary, and would help benefit resource managers to account for more factors that affect a particular ecosystem, and not be constrained by the rules of jurisdictions (Baird et al.). California’s extensive coastline has developed and been implementing several innovative approaches to address coastal management such as the Coastal Sediment Management Workshop that studies sediment transport issues, the Marine Life Protection Act Initiative to assess the adequacy of marine protected areas and the Southern California Wetlands Recovery Project for wetland restoration and management. These workshops and initiatives could help participants learn from existing approaches and help design new ones that could serve future generations. Workshops and seminars made open to all will not only increase awareness but allow for more insight into first responses and what communities in and around coastal regions can do to help the natural environments that affect them.

Another method to raise awareness and understand potential conservation methods would be through the in depth analysis of case studies. Nicholson-Cole and O’RIordan (2009) observed that the risks of coastal flooding and erosion in the United Kingdom are changing in response to climate change

which has resulted in coastal instability. Through the research and analysis of this project, they observed a shift in coastal management policy in England, away from investing in hard engineered defense, and towards a naturally functioning coastline. While this particular case obviously focuses on the United Kingdom, the United States can learn from such practices, specifically understanding that restoration of coastlines need to be focused towards assisting in the creation of a more natural environment and not an artificial one.

A more local example of case studies being helpful to understanding coastline restoration methods would be from Zedler's (1997) research into state laws of California and the protection of native rare species that reside on the coastline, and how the Coastal Act regulates development adjacent to coastal wetlands (Zedler). This seems to be more of a planning restriction against development close to coastlines, which could lead to positive outcomes for the rejuvenation of these endangered species. There are more layers of legislation that further push the prevention of further wetland destruction. Unfortunately, trade-offs that allow further wetland losses in exchange for restoration of degraded salt marshes are still possible.

Of course, one of the methods to coastline restoration is sustainable and environmentally cautious architecture and planning. Watson and Adams (2011) focus on the coastal areas, considering the potential of flooding and harm to both human and non-human actors, and posit the best practices and lessons to create buildings and communities that are more resilient in the face of severe weather, especially rising sea levels. By taking the initiative to go further into aspects such as new design and business opportunities, stormwater and floodplain management, adaptation to sea level rise, multidisciplinary design that integrate sound ecological and engineering principles, and innovative design and construction to protect and improve water security are many ways that architects, planners and construction professionals can be careful with design and building practices on coastal regions.

Finally, one of the easily forgotten practices in coastline restoration is community involvement and engagement, Egan, Hjerpe, and Abrams (2011) proclaim that the community aspect of ecological restoration is extremely critical, as it tends to be more subjective and quantifiable. Not only that, communities at risk (whether it be natural or human influenced) tend to be more assertive in working towards saving their neighborhoods. It should be common knowledge that one of the fundamental aspects of restoration of any kind is "a better relationship between humans and the rest of the world". With experience in fields varying from restoration ecology to art, the authors are diverse in the localities they come from and issues they discuss. From the creation of engaged participants in Toronto to social actions

in Iraq and restoration activities after Hurricane Andrew in Florida. Egan, Hjerpe and Abrams intermittently place the lessons learned from these case studies, regardless of them being successful or not (Egan et al.). While the Northern California Bay Area is not mentioned in this article, it seems evident in involving community-driven projects focused on neighborhoods, such as social designer Liz Ogbu's work to create an interim event space in Bayview Hunter's Point region, powered by local stories curated by StoryCorps, a national storytelling project. The success of this project led to more focus in the neighborhood and has resulted in the creation of a public access shoreline trail, providing direct access to the shoreline and creating awareness as to what a community-informed project could look like.

It is evident that the main cause of coastline devastation is the incessant intrusion of human beings, manipulating the landscape and developing to their benefit and comfort, with absolutely no care to the fragile landscape and the non-human residents that call it their home. What makes matters worse is that even after centuries of trespassing, there are no restorative measures practiced by relevant authorities unless it is absolutely dire, leaving a lot of coastline ecosystems in ruin. While Tredici stated that we as a species need to understand we cannot go back to how things were, we need to learn to leave these ecosystems to their own, to heal and recuperate on their own. Furthermore, community awareness and engagement, and better design and building practices need to be implemented and possibly made mandatory in coastal regions. Only then can we hope for a restored natural waterfront in these times of rising sea levels.

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