Kahlil Scribner
Case Study Paper
IDS 368: Internship in Conservation Leadership
Dr. Hans-Peter Plag
7/5/17

## 1 INTRODUCTION

Coastal ecosystems host a variety of habitats which in turn support large communities of non-human animal populations and plant species. They have evolved to coexist alongside the coast and thus have the ability to naturally migrate if their safe habitable living space is being encroached upon by rising sea-levels. Depending on the period of time we are observing the rate of sea-level rise may be relatively gradual as is the case in times of stability or very rapid as shown in transition periods between ice ages and warmer periods. However, if the speed of sea-level rise or coastal erosion outpaces the coastal ecosystem's ability to migrate landward then the ecosystem will transform into something else and lose its previous shape and size. The reaction to sea-level rise is dependent on the type of ecosystem that is going to be directly impacted through exposure. Subaqueous, marsh, beach, and forest ecosystems have their own unique mechanisms and pathways to retreat from sea-level rise.

## 2 SEA-LEVEL RELATED HAZARDS FOR COASTAL ECOSYSTEMS

The largest threats posed by sea-level rise to coastal ecosystems include the sheer amount of inundation, overwash, erosion, subsidence and salinification that is introduced to the ecosystem. These threats to coastal ecosystems pose major threats and certain ecosystems like barrier islands have a very limited range of tolerance of storm surges and sea-level rise until they experience net loss of the sand on their beaches and begin to migrate landward towards the coast. For many plant species and non-human animal species they rely on relatively tepid

conditions to survive and thus when sea-level encroaches upon their habitat they must adapt by either migrate with their habitat or find an entirely new area to thrive in. Land subsidence, which is the event of the earth and sediment sinking lower into the ground as groundwater escapes or is intentionally removed, too is a significant hazard. Land subsidence works in tandem with sea-level and exacerbates its speed. The rate of sea-level rise coupled with the existence of anthropogenic development may intensify and speed up the rate at which these ecosystems cease to exist in their current forms. The current rate of sea level is 3.2 millimeters per year is almost twice the historic rate of sea-level rise from tide gauges a century ago and is projected to increase over the next 100 years (Adam, 2012).

## 3 VULNERABILITIES OF COASTAL ECOSYSTEMS TO SEA-LEVEL RELATED HAZARDS

The principal reason that coastal ecosystems are vulnerable to sea-level rise is due to the fact they typically have very low lying topography. Being at or below sea-level means that the local plant and animal species must either migrate horizontally or vertically to escape the detrimental effects of inundation, erosion, and salinification. Many coastal ecosystems like brackish/transitional marshes have a limit to how much they can grow vertically unless they receive aid through sediment accretion. Thus, horizontal migration is typically the best method available for coastal ecosystems. This coupled with a projected increase of development of coastal ecosystems as further pressure is placed on cities to accommodate their growing populations leaves vast amount of coastal ecosystems with very limited options in terms of migration pathways to escape sea-level rise. The available space for certain ecosystems to naturally migrate is mitigated and impeded by anthropogenic development on the coast. Anthropogenic development is a unique threat in that it creates a new vulnerability to the

coastal ecosystems and actively impedes its natural ability to migrate in response to sea-level rise. Many plant species have a limited range of tolerance of salinity, especially those that are found in freshwater to brackish habitats. An increase in salinity could kill off endemic species of plant species such as seagrasses and mangroves which serve very important roles in their ecosystems as nurseries for aquatic species and trapping sediment on the beaches respectively. Erosion poses a similar threat to plant species as its occurrence means the coast becomes more susceptible to storm surges and wave impact energy. A decrease of sediment accumulation on a beach ecosystem would have cascading results as the plant species would feel the effects first and eventually reach the other species that rely on those plant species. However, vulnerability to sea-level rise isn't shared equally among the constituent habitats of the coastal ecosystems. Sandy beaches have the potential to repair themselves after storm surges and have their sediment return to them gradually over the course of weeks to months (Steffen et al, 2014). Land subsidence can also compound the effects of and increase the perceived rate of sea-level rise as the ground literally sinks.

## 4 POSSIBLE TRAJECTORIES FOR COASTAL ECOSYSTEMS UNDER SEA-LEVEL RISE

If sea-level rise continues to occur, then it stands to reason that we stand to lose the vast majority of coastal ecosystems as they exist today that do not have proper corridors and pathways available to migrate landward. Our projection of future possible scenarios for the integrity of coastal ecosystems must consider two major components. The first is the projected rate of sea-level rise in conjunction with land subsidence. Projections of possible scenarios are important for conceptualizing which areas are most vulnerable to sea-level rise. Once we know what areas and ecosystems show the most promise we should devote more of our time and

money to ensuring those spaces get as much protection as possible. The second most important component is the placement and extent of anthropogenic development on the coast. This is important because while coastal ecosystems possess the intrinsic ability to migrate in response to sea-level rise, this means little if they have no space to fully migrate. If sea-level not only continues but its rate increases, then we can expect to lose currently existing coastal ecosystems faster and expect the potential increasing rates of sea-level to act in tandem with other hazards and possibly create new hazards. If current rates of urban development continue we will be in a similar situation we are in now however coastal ecosystems will have even fewer pathways and corridors to pursue to adapt to sea-level rise and thus most likely experience a steep decline in total area. The feasible number and size of these pathways will most likely decline significantly if urban development increases in pace. The best case scenario for allowing the coastal ecosystems to properly adapt and migrate in response to sea-level rise is for urban development's rate to lessen.

## 5 SUPPORTING ADAPTATION OF COASTAL ECOSYSTEMS TO SEA-LEVEL RISE

As far as sea-level rise is concerned migration isn't truly an issue for the people near the coast as they can simply move away and travel in response to the coast as long as it is economically feasible to do so. For coastal ecosystems the matter is much more difficult. There are three potential scenarios to consider on two different time scales when evaluating the possible scenarios for coastal ecosystems which are business as usual, one that includes human involvement in mitigating the effects of sea-level rise upon coastal ecosystems, and a happy medium between the two. In order to know which option will yield the most fruitful results we must assess specific ecosystems and areas because individual habitats and regions

are not representative of all coastal ecosystems as revealed in the study done on northeastern coastal ecosystems (Lentz et al., 2015). Allowing the coastal ecosystems migrate has the benefits of being the least expensive option and letting the ecosystem more or less steward itself. Supporting their migration however poses the risk of some species potentially going extinct if they are endemic to one particular location and losing currently existing biological diversity. This hands off strategy involves the ecosystem properly adapting to sea-level rise by entirely by itself. Maintaining the coastline with constant human involvement has the benefit of encouraging observation and analysis of the state of the coastal ecosystem and catering to its defense to preserve locally existing species and habitats. Keeping the coastline static whether by armoring the coast or attenuating wave action to keep various coastal ecosystems intact may also appeal to the sentiments residents have for their local ecosystems especially those that exist in national wildlife refuges. The downsides to this approach include costing more than the hands off approach and potentially wasting money on trying to make the coastline immutable rather than let it naturally migrate and change to fit the changing climate. It is much easier to project the effects of these approaches in the short term however in the face of a dynamic future with dozens of interchangeable factors leaves much to be desired in terms of accurately discerning which method is best for any given coastal ecosystem. Another potential option that involves implementation of both methods is an intermediary approach that allows for certain ecosystems to experience limited flooding so they may safely become acclimated to the increased amount of water and salinification and migrate at a more regulated pace. There are merits to this method as it would be easier than trying to completely prevent the inevitability that is sea-level rise from making some coastal disappear. Thus in order to limit

the impact sea-level rise will have on coastal ecosystems it may in fact be advantageous for the coastal ecosystems to perform risk assessment and analysis of which areas will show promise in adapting to sea-level rise and which may need assistance from human beings.

## 6 DECISION-MAKING FOR COASTAL ECOSYSTEMS

There are many stakeholders involved in the decision making process of preserving and altering the shape and functionality of coastal ecosystems. Several agencies at the state and federal level must collaborate in order to instill positive and lasting change and sculpt adaptation strategies onto the system they are involved with. Some of these agencies include U.S. Fish & Wildlife Conservation Commission, United States Department of Agriculture, the Transportation Sector, Army Corps of Engineers, state and local government, water management, and lastly several non-governmental organizations. Besides these agencies and organizations, the public is also a very important stakeholder that must be a part of the decision making process. Private landowners must be on the same page as the other decision makers as they their choices and actions concerning their property may infringe on the integrity of the coastal ecosystem, they themselves may be vulnerable to climate change or sea-level induced hazards, and/or they may be emotionally invested in the costal ecosystems. NGO's will also play a huge role by putting pressure on the government and multiple levels in order to instigate them into in participating in adaptation strategies in the future. Collaboration and proper risk assessment of the coastal ecosystems must be executed properly and routinely in order to have the most comprehensive information available in order to become the basis for effect adaptation strategies and shape our transformational knowledge.

## 7 RECOMMENDATIONS

It is recommended that locally operating agencies and organizations which have a stake in the integrity and productivity of coastal ecosystems push for legislation and governmental cooperation in order to mitigate the anthropogenic development in the migration paths of coastal ecosystems responding to sea level rise. The most productive method in my opinion thus far is that the ecosystems themselves possess the tools necessary to adapt to sea-level rise. However, the only things that can prevent them from migrating naturally are the rates of sea-level rise and anthropogenic development on the coast. Thus, we must evaluate current projections of sea-level rise and craft adaptation strategies that take these possible scenarios of sea-level rise over the next 100 years into consideration. We must also not shy away from potential adaptation strategies which may result in a decline of some coastal ecosystems if it seems inevitable that they will become nonexistent even with the highest level of anthropogenic intervention. We must evaluate individual ecosystem's vulnerability to sea-level rise and map out what their options are in terms of migration and discuss what we can do to lessen the damage done by sea-level rise. Constant assessment and reassessment must also be implemented in order to identify and tackle emerging hazards of a system. During my internship I hope to investigate Back Bay National Wildlife Refuge's (NWR) barrier system and determine the potential futures that await the coastal ecosystems and habitats. I look forward to comparing the conclusions of currently existing literature analyzing barrier island systems to Back Bay NWR to get a better idea of what areas will be impacted by sea-level rise and how quickly they will potentially be effected and what species and habitats are at risk.

# References

Adam Parris, P. B., 2012. Global Sea Level Rise Scenarios for the United States National Climate Assessment. (NOAA Technical Report OAR CPO-1). Silver Spring, Maryland: NOAA. Retrieved June 2017. Available from http://cpo.noaa.gov/site/cpo/Reports/2012/NOAA_SLR_r3.pdf

Lentz, E. E., Stippa, S. R., Thieler, E. R., Plant, N. G., Gesch, D. B., & Horton, R. M., 2015. Evaluating coastal landscape response to sea-level rise in the northeastern United States: approach and methods (No. 2014-1252). US Geological Survey. Available from https://pubs.usgs.gov/of/2014/1252/pdf/ofr20141252.pdf

Steffen, W., Hunter, J. and Hughes, L., 2014. Counting the costs: Climate change and coastal flooding. Climate Council of Australia. Available from http://www.climatecouncil.org.au/uploads/56812f1261b168e02032126342619dad.pdf