

**AOSS 480 Final Project Narrative: Corporate**  
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## **1. Introduction**

Our group has been tasked with investigating a naval shipbuilding company along the James River. They have recently faced challenges due to flooding from both small storms and hurricanes. Since moving their operations to a less flood prone area is not, currently, an option, we looked into what is currently being done in the Norfolk/Hampton Roads region and what could be done in the future. If this shipbuilding company were to lose their dry dock operations, not only would it directly hurt the economic viability of the shipbuilding company itself, but it could affect the local economy and threaten jobs.

One of the major issues with the Norfolk area is that sea level rise has, in the past, not been addressed on an intergovernmental level. Later, we will discuss future programs and next steps for more coordination between political entities and the residential community. This issue is not something that one group can solve on all on it's own. The more stakeholders involved in the planning process the better the result and sustainability of the program.

Our approach largely focuses on the analysis of current knowledge systems. There is a solid base of research on the topic of flood damage mitigation specific to our region. For our technical analysis will use peer reviewed literature and notes from our discussion with Ray Toll, a retired naval officer and the NOAA Navy liaison to Old Dominion University. We'll start by looking at the scientific perspective on rising sea levels and flooding issues specific to the region. We'll then examine the degree to which losing naval shipbuilding capacity could affect national security from mission readiness perspective. There will also be an in depth analysis of the stakeholders involved in the region and how they individually respond to the impacts. Lastly we'll explore a recent pilot program that aims to solve the sea level rise and flood issue from an intergovernmental perspective.

## **2. The Problem**

In terms of the scientific problem, there are many processes combining to make a bad situation worse. To start, the land in the Norfolk region is sinking. Aquifers below the surface are being depleted faster than they can recharge. As regional population continues to increase, so does ground water use. The number of gallons of water withdrawn per day has tripled since the mid 1950s (Figure 1). At current rates, 43.8 billion gallons of water are withdrawn every year. That is enough water to hydrate the entire world's population for about twelve and a half days! To little surprise, the average groundwater level has sank by more about 20 mm since 1970 (Figure 1).

This land subsidence (sinking) is very dangerous because it enhances the rate at which the net sea level rises.

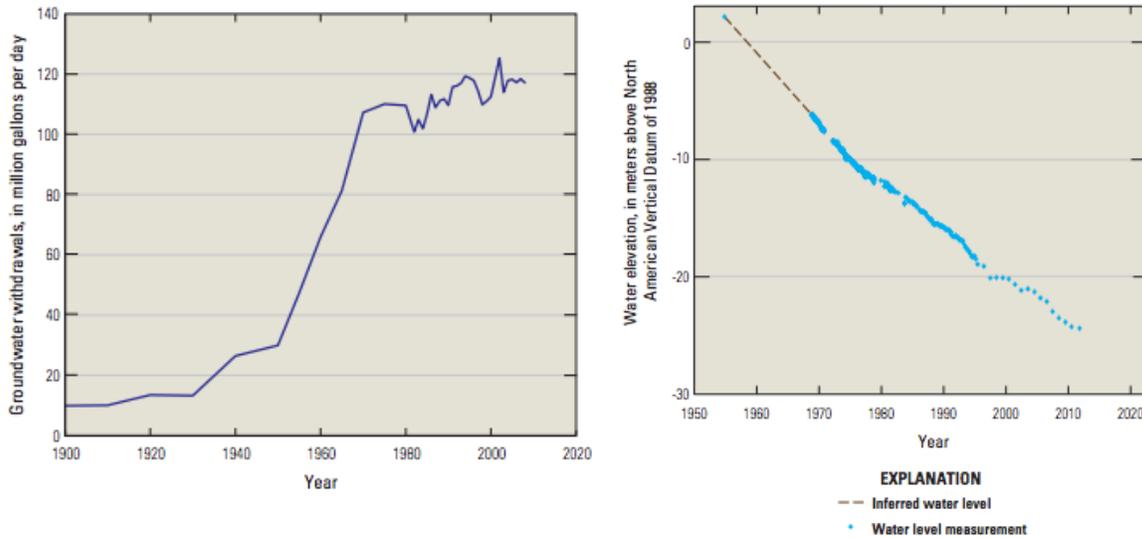


Figure 1: Groundwater withdrawal in millions of gallons per day (left), groundwater elevation in mm (right) (Eggleston)

Global sea levels have been rising at about 1.4 mm/yr since 1928, but sea levels in the Norfolk area have been rising much faster with rates currently at about 4 mm/yr. At the NOAA CORS (Continuously Operating Reference Station) in Gloucester Pt., VA, land has sunk by about 2.6 mm/yr for the second half of the 20th century (Boon). Adding global sea level rise of 1.4 mm/yr to the rate at which land sinks, the net sea level rise is an even 4 mm/yr, on average.

Part of the implications of higher sea levels is that it shortens the life cycle of historically periodic floods. A flood that used to occur every 80 years would then occur every 40 years once sea levels rise by 0.1 m. Similarly, for another 0.1 m rise in sea level, the same historical flood would occur every 20 years (Boon). This is one of the many reasons sea level rise is so dangerous. Adverse conditions and the severity of the effects are compounded leading to perpetually worsening conditions.

Since flooding is highly variable spatially and temporally, denoting what constitutes actual flooding must be established. From a study on flooding by professors at Old Dominion University, Ezer and Atkinson define flooding as certain threshold above the mean high higher water mark (MHHW) (Ezer). The MHHW mark is essentially the average of the highest daily tidal elevation measured at NOAA tidal stations (NOAA). For the Norfolk area, flood stage is considered 0.3 m above the MHHW (Ezer).

Now that a flood stage has been defined, a way of quantifying flooding for comparison purposes is to measure the hours spent at flood levels. Looking at Figure 2, Norfolk has seen drastic increases in time spent flooding, in recent decades.



Figure 2: Measure of hours per year at flood stage, each grid space is 20 hours (Ezer)

There's been a 577% increase in flooding since 1971 meaning that a region which used to flood 20 hours a year now floods almost 130 hours per year (Figure 2). This is the equivalent of a city wide flood, one hour in length, every three days. Looking at a longer time scale, one can see that there is an increase in hours spend flooding with time since the early 1900s. This is apparent for the standard 0.3 m above the MHHW mark as well as at 0.6 m and 0.9 m above the MHHW (Figure 3).

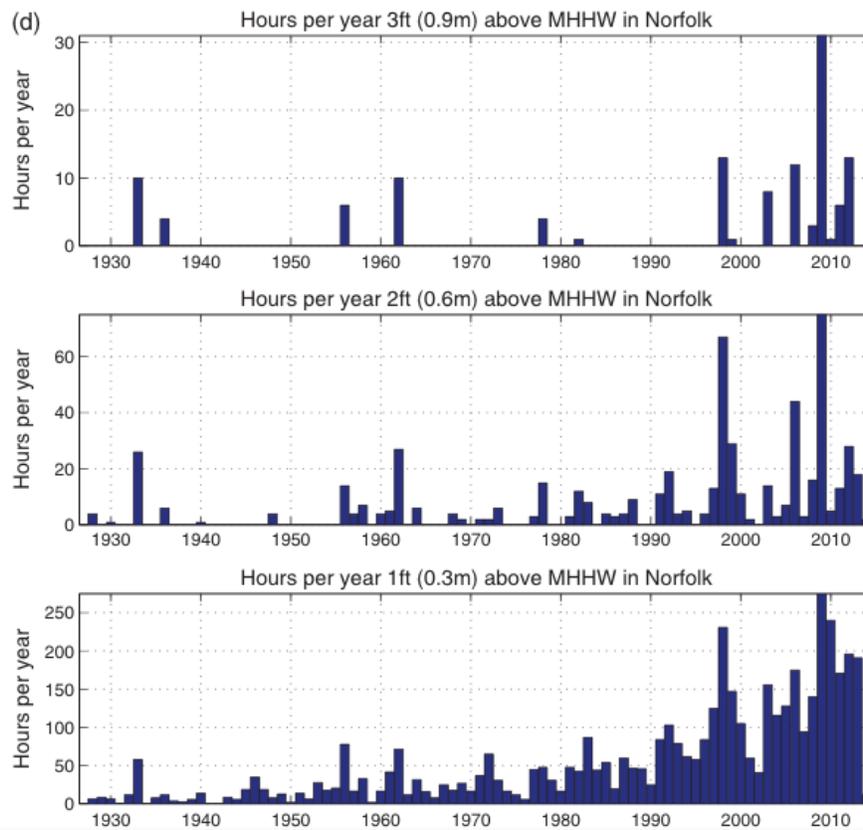


Figure 3: Norfolk hours per year spent at various flood stages about the MHHW mark (Ezer)

Looking at individual storms that lead to flooding, there has been a distinct increase in the frequency of storms. Looking at Figure 4, for the 17 worst storm surges for since 1930, nine have occurred in the last 12 years. These are only storms that are classified as a hurricane/tropical storm or a major midlatitude cyclone: Nor' easter.

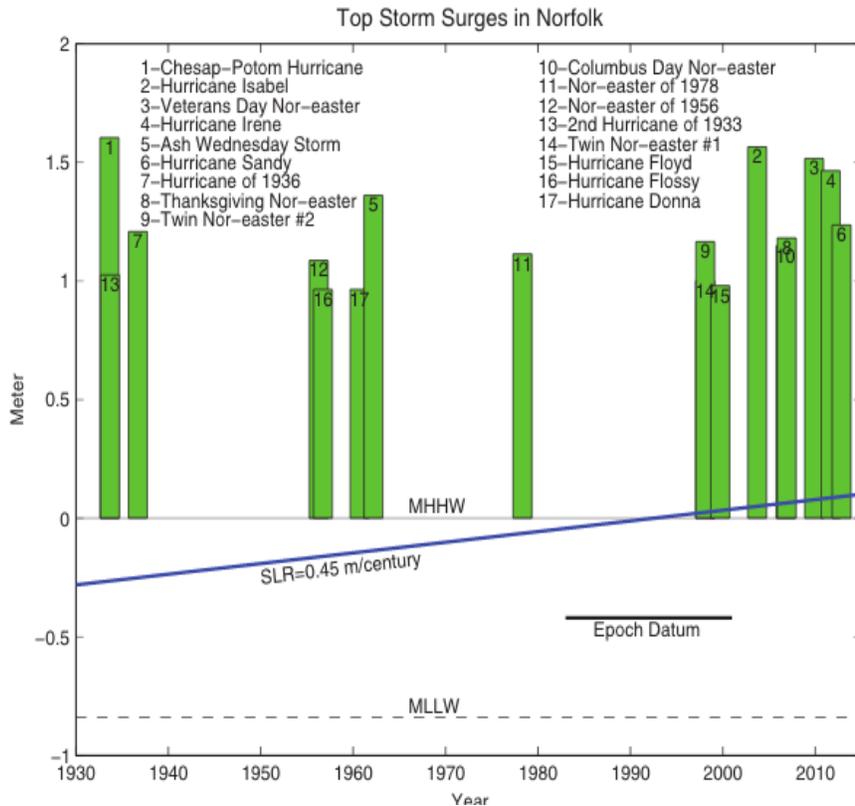


Figure 4: Major storm surge events affecting Norfolk since 1930 (Ezer)

Before 1997, only six storms brought storm surges greater 1 m over a 67 year span. Since 1997 there have been seven storms delivering surges greater than 1 m (Figure 4). This shift in storm frequency shows that storms are happening twice as often, contributing to the increased frequency of hours spent flooding.

The last major scientific component to the flooding problem is the Gulf Stream shift. When the North Atlantic Oscillation (NAO) is in phase, it can have precipitating effects on the Norfolk region. If the NAO index is in a positive phase, the east coast is more likely to see steady, frequent, and heavy, non severe precipitation (NOAA Glossary).

Additionally, when the NAO is in a strong positive phase, there is an increase in the transport of water from the southeast Atlantic coast into the Norfolk region via the Gulf Stream. When this occurs, more water ‘piles up’ than can advect away from the region. This is ‘pile up’ occurs in

part because the NAO slows the flow of the Gulf Stream away from the region. This increase in sea water volume ultimately leads to locally higher sea levels and increased potential for flooding (Atkinson).

### **3. The Four Main Stakeholders**

The following sections will discuss how the local government, local business, local residents, and the military are being affected by sea level rise and flooding. It will also provide an overview of some solutions each of the stakeholders are exploring.

#### **3.1 Municipal**

The City of Norfolk Coastal Flood Mitigation Program is one example of how local government is taking initiative. This program focuses on data derived analysis. It incorporates city wide vulnerability assessments and mission critical facilities such as schools and hospitals. A majority of the funding for this program comes from the Federal Emergency Management Agency (FEMA), but some is local. To determine how the funding should be distributed the program created a scoring system based on present vs. future risk and cost vs. benefit comparison. The system also takes into account the importance of mission critical areas. Ultimately, the program hopes to see its successes become a role model for other regions and polities. Some preliminary mitigation strategies being investigated are berms, raising roads, flood gates, flood walls, culverts and topography. The result and effectiveness of these strategies is pending.

With so many options, the program has a great deal of research to accomplish before making any definite decisions (norfolk.gov). With money going out to support the locals coping with sea level rise and subsequent damage, municipal damage cannot be ignored. Damage also affects municipal buildings, causing the local governance to continue to pay out more money to repair local infrastructure damages associated with climate change. This money will need to come from somewhere, whether that is from the federal government, the local taxpayers, or the municipal budget that must support all other functions of the area such as education and transportation. Given the beauty of the coastal area, the municipality also has an extra challenge in that it's long term solutions must try to accommodate the wishes of the local residents without disturbing the aesthetics of the shoreline.

*“We love our views of the water, we need to move commerce and military in and out...We're not going to close it with dykes.”*

-Ray Toll

#### **3.2 Local Business**

Flooding and sea level rise are threatening many local businesses, especially those near the coast. O'Sullivan's Warf is an example of a small local business experiencing the effects of these two major threats. This business is losing revenue due to both high maintenance costs and being forced to shut down for the maintenance. To put it into perspective, the company loses anywhere between \$5,000 to \$10,000 every day they are shut down (Noguchi). These huge mitigation costs are a burden to local businesses and can dramatically affect their performance as they miss revenue goals and repeatedly incur higher costs. Another major concern of the area is the completion of the Panama Canal expansion. Businesses need to be fit enough to handle the additional commerce coming into the region. With much more traffic coming into the port city, the effects of these floods will begin to be magnified as the businesses will lose more potential revenue during shutdown and will need to sink more money into mitigation investments as well as maintenance.

Huntington Ingalls Industries is an example of much larger local business in the area that is working to counter these environmental effects. Huntington Ingalls has begun to mitigate flooding and sea level rise by raising their air and power systems. Additionally, they are also helping out other utilities to the same. When approaching this problem, the local economy is adamant in the fact that they are not going to run from this problem, but will instead adapt to changing conditions.

*"It's about designing for resiliency. Adapting to it. For shipyards and businesses, it's **not about relocation** ....Decades from now, the company will be there, just operating on **higher ground**"*

-Bob Fallon, Director of Facilities and Waterfront Support, Huntington Ingalls Industries

### **3.3 Local Residents**

The local residents of the Hampton Roads have seen their houses flood over and over again, causing damage to their homes, cars, and other property. Although the people in the area are determined to stay in the area, they will face expensive repair costs as well as necessary investments to mitigate the flooding moving forward. Moreover, the residents of this area, which have seen relatively high real estate prices given its coastal location, will see their homes devalue in price as the floods further damage the region. Additionally, the insurance premiums will continue to rise and place additional burden on the individual welfare in the region (Koch).

It is much more difficult for people to respond to flooding and sea level rise on an individual basis. The options are limited and the expense is high. However, projects to address the issues are already getting funded. For example, there have already been changes to the National Flood



The Navy currently has 14 WWII-era piers under maintenance at an average cost of \$35 million each due to flood damage. To combat this program moving forward, the Navy's Climate Change Roadmap details their short term and long term plans for adaptation and mitigation. The Navy is planning, strategizing, and working with the federal government to make effective policies. They are also training to be fully mission-capable while carefully considering their investments for all potential climatic conditions. Finally, the Navy is reaching out to the media, government and international community to understand how and why they are responding to this issue (U.S.). An impressive example of the Navy's ability to respond quickly and efficiently to climate change is the deployment of the Great Green Fleet. The fleet consists of ships and carriers that use alternative sources of fuel, including nuclear and biofuels. Some also utilize multiple energy conservation measures including solid state lighting, stern flaps and smart voyage planning decision aid (Great).

*"This is a matter of national security... It's a mission readiness issue,"*

- Alice Hill, senior adviser for preparedness and resilience, National Security Council.

#### **4. The Solution**

An environmental problem such as sea level rise is very complex given the amount of stakeholders in the affected area. Thus, with so many moving parts the solution in itself must inherently be complex. Given the drastic nature of these issues and the scope of the people that it affects, some would expect changes to happen very quickly. However, this is not realistic given that the solution must be taken on by many stakeholders, some of which have already been mentioned. To complicate things further, the interplay between federal and municipal entities can also work to slow down the decision making process. When mentioned in lecture about moving towards action with regards to climate change, it was stated that, "These elements sit in a complex and changing relationship within any specific application, as well as across multiple applications" (Rood).

With so many parties involved, the solution must have some plan to incorporate all of the stakeholders to make a concerted movement towards fixing the problem at hand. Even though the Hampton Roads area itself can not work to fix the global causes of sea level rise in their area, they can work together to find a way to adapt and mitigate the effect that sea level rise has on the region. In order to do this, it is imperative that the local government, federal government, local businesses, national corporations, residents, and the science community have an effective way to communicate with each other and share information to facilitate a multi-faceted approach to the issue at hand.

## 4.1 The Intergovernmental Pilot Program

The need for this type of connecting organization started in 2007 when the City of Norfolk began to assess sea level rise impact on the city. Then, in 2010, Old Dominion University launched the Climate Change and Sea Level Rise Initiative (CCSLRI), at which time they began holding forums to connect and engage government, business and the public. Seeing as though the members of the CCSLRI had backgrounds in both the military and science lines of work, ODU thought that this institution would be the perfect place to create this multi-disciplinary entity. Thus, in June of 2014 the Intergovernmental Pilot Program was kicked off.

The program has a main objective of creating both a “whole of government” and “whole of community” approach to sea level rise that is meant to be far reaching with the parties that are involved. As mentioned by the program, their vision is to become “An intergovernmental planning organization that can effectively coordinate the sea level rise preparedness and resilience planning of Federal, state and local government agencies and the private sector, taking into account the perspectives and concerns of the citizens of the region.”

This program is directed by Mr. Ray Toll, a retired Navy Captain who is now the Director of Coastal Resilience Research at ODU and has worked in the fields of Meteorology and Oceanography since 1978. Given his involvement with the community, academia, and the government he was able to help form the program to allow for insight from different perspectives on the problem.

Headed by eleven senior members of the steering committee which have backgrounds in the federal, commonwealth, and local government as well as local industry, the program has four committees which tackle the main problems that can hold back progress in the area:

- **Legal** - This Working Group will address legal issues that arise during the Pilot Project and draft a Memorandum of Understanding (MOU) for the follow-on project that emerges from the pilot project. Some of the legal issues that are include, but are not limited to, interaction between different scopes of government, laws around infrastructure implementation, and political action moving forward.
- **Infrastructure** - This Working Group will recommend which infrastructures in Hampton Roads require adaptation planning and create recommendations for intergovernmental coordination of that planning. They will also work with the Private Infrastructure Advisory Committee in order to formulate recommendations for privately owned infrastructure planning.
- **Land Use** - This Working Group will recommend which land use related plans, programs and policies in Hampton Roads require adaptation planning and create recommendations for intergovernmental coordination. they will work with the Municipal Planning Advisory

Committee to address land use planning, floodplain management, local government comprehensive plans, zoning, building codes and other plans, programs and policies it identifies in the course of its work.

- **Community Engagement** - This Working Group will prepare a communications and engagement plan for the Steering Committee that will allow the program to address the public on the Pilot Project on an on-going basis, and soliciting public comment on recommendations for intergovernmental coordination of planning. They will also coordinate messaging, oversee the ODU public-facing website, and organize public events (Hampton Roads Charter).

#### **4.2 Analysis of Intergovernmental Pilot Program**

Although there are many different initiatives already in place that vary in scope and scale, there remains no intergovernmental coordination across these initiatives. Thus, The Pilot Project closes the gap in intergovernmental coordination of planning, which is critical to the success of each of the individual initiatives. We believe that a program hosted through a university is a very effective solution, as they can act as a neutral party and serve as a center for intellectual capital.

As we learned both in class and through our reading on knowledge systems by Lisa Dilling and Maria Carmen Lemos, there is a disconnect between users and producers of climate information that can lead to inefficiencies with regards to combating climate change, and in this case rising sea levels. The solution to this problem is an effective knowledge system that can increase communication between the two parties. One critical aspect of the design is “the creation of the conditions and mechanisms that enable **iterativity**, that is, the purposeful and strategic interaction between climate knowledge producers and users so as to increase knowledge usability.”

When analyzing the Intergovernmental Pilot Program as a communication system between stakeholders, it is important to evaluate it through the lens of the innovative mechanisms that Dilling and Lemos claim facilitate iterative relationships:

**Information brokers:** By definition, the broker is an intermediary between the users and the scientists, and is fluent in both worlds. Inherently Dilling and Lemos state that they must not be producers of this information. However, we would like to classify Ray Toll as an information broker given that he has experience in both academia and the Navy. Ray has the unique opportunity to act as the director of the program and be surrounded by members such as Larry Atkinson, who are very focused on the producing the climate information. Thus, he will be able to provide information to both the government agencies and the scientific community on what information is needed and what will be effective in sculpting a viable solution.

**Collaborative group processes:** Given the different scopes of government that are involved, the Pilot Program is able to facilitate collaborative group processes that highlight the interests of the different parties in both the public sector and private sector. This is done mainly through the Steering Committee, that has appointed a diverse group of people to spearhead the issue and guide the program. What might have been hard to communicate across the federal and local governments is now dramatically easier to do through the fact that they have committee meetings to openly communicate and increase transparency.

**Embedded capacity:** Through the creation of this program, there has become an inherent need to build capacity with regards to individuals that can attack a problem like this and reach across different entities. This embedded capacity can manifest itself through encouraging the emergence of internal training and hiring of professionals that understand the different perspectives with regards to the problem, thus becoming “internal champions” in this interplay who facilitate communication. This can allow for better usability of science information in the decision making process and also allow for current professionals to become aware of the explicit need for a multidisciplinary perspective to the problem.

**Boundary organizations:** Since Ray Toll is an information broker, the CCSLRI and the Intergovernmental program are the boundary organizations that can further add value to the process of individual brokers. Through their resources, the organization has the capacity as a whole to translate and customize climate information to specific users. They are the entities through which the research and science information of the university flow through to be communicated to policy makers and government agencies. Without these organizations it would be almost impossible to syndicate the thoughts and messages of the scientific community and relay it to the government and corporations, as it would be handled on an individual level. Through these boundary organizations, the users of the information can be rooted into the thought process of the producers of the knowledge, and vice versa.

**Knowledge networks:** Knowledge networks are comprised of policy makers, scientists, government agencies and nongovernmental organizations that communicate with one another and share information across areas of practice. Inherently, the Pilot Program was established in order to set up this network. Ray and the rest of his team are working to facilitate knowledge gathering and action, stating, “Along with our initiatives, it is imperative to start looking at integrating a network of information gathering. Science must be placed as a priority because our models and projections suffer” (Steinhilber & Toll).

## **4.2 Role of Business in the Solution**

Given a corporate context, we believe that a shipbuilding corporation can do a lot to facilitate the effectiveness of the program. Corporations in the area have a lot of access to intellectual and economic resources that they could provide. For example, they have industry experts who can provide counsel on the feasibility of infrastructure and the costs with implementing any solutions. They can also help to run financial analysis of the programs provide resources for project management and sourcing of necessary materials.

Corporations in the area also have a large influence on the community and their actions, so they will be able to help get the community involved and facilitate public awareness and backing of the work being done. Although all of this will not be possible in every context, the businesses should frequently communicate with the program in order to find out the most effective ways to give back to the program in return for long term operational sustainability in the region. What makes this problem hard from a business perspective is that it cannot be solved by throwing money at one project, but is rather a long term investment of the stability and well being of the region and the people that live there.

## **5. Conclusion**

Many factors play into the troubled Norfolk shipbuilding economy. Scientifically speaking, globally rising sea levels are only a small piece of the problem. Local sea level enhancements due to sinking land and Gulf Stream interactions with the NAO further strain the flood infrastructure for the region. This strain is further amplified when the yearly time spent at flood stage correlates with more frequent storms that bring storm surges exceeding 1 m. This all contributes the Norfolk region earning the title as the second most flood prone region in the continental United States, after New Orleans (Lucier).

When it comes to the Hampton Roads region, it is not a question of if sea levels are going to rise in the area, but when and by how much. This problem is not going to affect just one party in the area, but everyone who lives and works in the area. The local community is suffering as residents and businesses alike constantly sink money into mitigating and repairing from damages of each storm and flood. Also, the local government and military are struggling to keep up with constant flooding and downtime, which can lead to risks in local governance and national security throughout the region. To make things worse, the nature of this issue makes it hard for a business or government to tackle the problem on their own, requiring all parties affected to get involved.

However, the intergovernmental program hopes to allow for better scientific gathering and communication of those needs to the makers of policy, acting as an epicenter for iterative processes and information sharing. It has characteristics of each innovative solutions that are cited in the reading. Beyond the reading, we believe that the program is a very effective starting

point when looking to build a replicable prototype that can be used to tackle environmental programs across the country. It has been able to engage all of the stakeholders and give them input in

With so many stakeholders, the local area has the ability to dramatically help this program by providing insight as well as engaging the CCLRI to start a dialogue to find the most productive way to contribute. If this is done with effectiveness, enthusiasm, and passion for the future beauty and future of the Hampton Roads area, the progression of this model can help form a national intergovernmental program, which is critical to adapting and mitigating to our changing environment, before it is too late.

## References:

Alexander, Jilliane. "Department of the Navy." (n.d.): n. pag. Department of Defense, 21 May 2010. Web.

Atkinson, Larry P., and Tal Ezer. "Gulf Stream's Induced Sea Level Rise and Variability along the U.S. Mid-Atlantic Coast." *JOURNAL OF GEOPHYSICAL RESEARCH: OCEANS* 118 (2013): 685-97. Web. 14 Aug. 2015.

Boon, John D., John M. Brubaker, and David R. Forrest. "Chesapeake Bay Land Subsidence and Sea Level Change." (2010): n. pag. Web. 13 Apr. 2015.

Center for Sea Level Rise. Old Dominion University Center for Sea Level Rise, n.d. Web. 20 Apr. 2015. <http://www.centerforsealevelrise.org/>

City of Norfolk. "Flooding Awareness & Mitigation." Web  
<<http://www.norfolk.gov/index.aspx?NID=1055>>

Dilling, Lisa, and Maria Carmen Lemos. "Creating usable science: Opportunities and constraints for climate knowledge use and their implications for science policy." *Global Environmental Change*, Volume 21, Issue 2, May 2011, Pages 680-689, ISSN 0959-3780, <http://dx.doi.org/10.1016/j.gloenvcha.2010.11.006>.

Eggleston, Jack R., and Jason P. Pope. *Land Subsidence and Relative Sea-level Rise in the Southern Chesapeake Bay Region*. N.p.: n.p., n.d. USGS. Web. 13 Apr. 2015.

Ezer, Tal, and Larry P. Atkinson. "Accelerated Flooding along the U.S. East Coast: On the Impact of Sea-level Rise, Tides, Storms, the Gulf Stream, and the North Atlantic Oscillations." AGU, 11 Aug. 2014. Web. 14 Apr. 2015.

"Great Green Fleet." U.S. Navy: Energy, Environment and Climate Change. Office of the Secretary of the Navy, Washington, DC, n.d. Web. 23 Apr. 2015

*Hampton Roads Sea Level Rise Preparedness and Resilience Intergovernmental Planning Pilot Project Charter*. 10 Oct. 2014. Agreement necessary for Intergovernmental Pilot Program.

Koch, Wendy. "Rising sea levels torment Norfolk, Va., and coastal U.S." *USA Today*. USA Today, 18 Dec. 2013. Web. 20 April 2015.

Lucier, Amanda. "Built on Sinking Ground, Norfolk Tries to Hold Back Tide amid Sea-level Rise." *Washington Post*. The Washington Post, 17 June 2012. Web. 15 Apr. 2015.

NOAA. "Tidal Datums - NOAA Tides & Currents." NOAA Tides & Currents. NOAA, n.d. Web. 15 Apr. 2015.

NOAA Glossary. "NOAA's National Weather Service - Glossary." NOAA's National Weather Service - Glossary. N.p., n.d. Web. 15 Apr. 2015.

Noguchi, Yuki. "As Sea Levels Rise, Norfolk Is Sinking And Planning." *NPR*. NPR, 24 June 2014. Web. 24 Apr. 2015.

Rood, Ricky B. "Lecture 3: Knowledge Systems." AOSS 480 Lecture. Ann Arbor. 15 Jan. 2015. Lecture.

Steinhilber, Emily, and Ray Toll. "Conference Call with Ray Toll,." Telephone interview. 15 Apr. 2015.

Toll, Ray. "Hampton Roads Sea Level Rise Preparedness and Resilience Intergovernmental Planning Pilot Project." ODU Campus Retreat. Norfolk. 6 Aug. 2014. Lecture.

"U.S. Navy Climate Change Roadmap." *Department of Defense*. Task Force Climate Change / Oceanographer of the Navy, 1 Apr. 2010. Web. 24 Apr. 2015.