Groundwater Essay

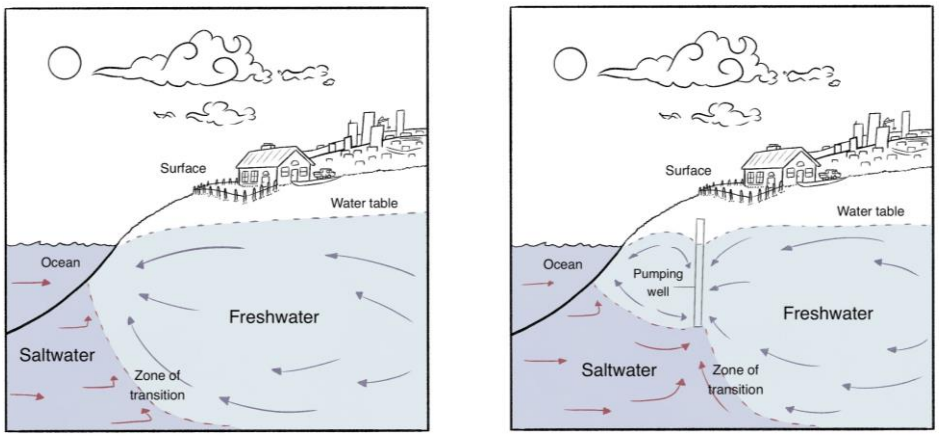
Saltwater Intrusion in Floridian Aquifers

As a Floridian, I like to act as though I despise Florida. In reality it is rather lovely; brimming with biodiversity and an interesting melding of cultures. The Sunshine State is known for its tourist destinations, bright beaches, spectacular wildlife, persistent swamps, and tropical storms. The last thing a visitor would assume is that Florida is on the verge of an interstate freshwater crisis.

Climate change is a monumental threat to Florida in a compounded sense. All of what is typically associated with it-- warming temperatures, warming waters, rising oceans, rising storms-- pose threats to life in the state as is, human or otherwise. The effects are seen through the worsening droughts "every decade" and the ravaging hurricanes that destroy infrastructure, habitats, homes, and lives (Heggie, 2021). But when these events are broadcasted, only the surface of the issue is shown. In reality, the billions of gallons of Floridian groundwater residing deep underground are at stake. Its peril is only exacerbated by each of these changes.

Saltwater intrusion, as described by the United States Geological Survey, is the landward vertical or horizontal movement of saltwater into freshwater sources. The diffuse zone where brackish water results from the two is known as the zone of transition, typically residing along the coast (USGS). Usually, the saline water is prevented from mixing with the freshwater because of the natural seaward movement of freshwater, only combining in this zone. However, with excessive groundwater pumping and drastic changes to the environment, saltwater intrusion becomes more plausible as it moves to take up the space left behind. In effect, it diminishes both the quality and quantity of freshwater as it pushes the zone of transition more inland.

Illustrated by the author of the paper.



Natural Conditions Saltwater Intrusion

The threat of saltwater intrusion is imminent to millions of lives, whether they are aware of it or not; every day, Floridians consume "an estimated 4.1 billion" gallons of groundwater, half of which is delineated to recreational and household use, and the rest is necessary for functions like agriculture, manufacturing, and power supply (Bauta). The Turkey Point Power Plant is a nuclear power plant-- a system meant to provide clean energy for Floridian cities like Miami. It alone requires 39 canals to function as a natural "massive radiator", only to leave saltier water left to seep down to its aquifer (Lambrecht, 2020). When the power plant was first built, there was hardly any consideration for how it would affect the water systems around it. Such is the trend for much of Florida's history in the 20th Century, beginning with the dredging of canals in the Everglades during the 1930s in order to drain it for farmland (Feltgen, 2015). Not only do actions like these disrupt the delicate cradle of an ecosystem that are estuaries and swamps, but saltwater intrusion takes its toll on these "natural barriers to the mainland" by transforming it to an extension of the sea (Machado). Locations like Cape Sable act like "canaries in the coal mine"; the environments that once hosted unique species and life are effectively destroyed because of saltwater intrusion, making life inhospitable for significant species like sawgrass (Lambrecht, 2020). With one fall of a species, the rest are soon to follow.

Though Florida is recognized as the fifth rainiest state in the U.S. and receives approximately 51 inches of rain a year, it is hardly enough to compensate for the apparent rise in sea level and storm surge voracity (Heggie, 2021). Even accounting for the substantial rain, only a rough fourth of precipitation that reaches the earth (about 13 inches) will soak into the ground and recharge Florida's aquifers (Heggie, 2021). In comparison, the Southeast Florida Regional Climate Change Compact determined from data gathered from the Intergovernmental Panel on Climate Change and the National Oceanic and Atmospheric Association that by 2040, the sea level "would rise between 10 and 17 inches" (Lambrecht, 2020). Over the hundreds of years of rapidly increasing groundwater consumption, the water tables of Floridan aquifers have already decreased relative to our current sea level. Thankfully, we can measure not only the changes in weather, but also the changes in a water sample's composition. Aquifers can be monitored for contamination through several methods, including electromagnetism. Since 1999, the USGS has remained vigilant of saltwater intrusion in Florida's groundwater, including that of the Biscayne Aquifer. They recorded that by 2018, the "saltwater wedge" that resides at the bottom of the aquifer had grown in breadth by 20 feet (Lambrecht, 2020). To confirm the intrusion, the USGS tested the chloride concentration of the water. For reference, the level of chloride concentration in seawater approximates 35,000 mg/L; the chloride concentration within the groundwater was rapidly increasing, totaling about 12,000 mg/L (Lambrecht, 2020). What remains is the harrowing fact that much of Florida's freshwater is currently brackish.

Efforts to reverse the effects of saltwater intrusion are occurring all around the state. On smaller scales, children are taught by educational platforms to reduce the amount of water they use in the bathroom. On larger scales, the South Florida Water Management District has reportedly approved 488 "nontraditional" projects since 1997 for aquifer storage and recovery, reclaimed

water use, sustainable irrigation, and reverse osmosis plants for an estimated $1.4 billion (Feltgen, 2015). The SFWMD also incentivizes municipalities to adopt new methods to conserve and monitor their water usage. The establishment of reverse osmosis plants across the state has also improved the state's ability to provide safe and potable water when much of the available water is brackish. While the conversion of the brackish water to distilled water is vital to Florida's water supply-- especially during dry periods-- the process is arduous and requires hefty sums of money to support. Additional efforts to control saltwater intrusion by South Florida governments include maintaining these salinity control centers, performing sustainable methods of irrigation, drawing upon multiple aquifers (as to not rely on one), limiting water use on lawns, and relocating wells that have been compromised (Feltgen, 2015). New facilities and infrastructure alone total more than $30 million (Feltgen, 2015). However, the necessary finance for these facilities does not appear from nothing. While some funding can be sourced from low-interest funds, the rest must be self-funded (Feltgen, 2015). To account for this, civilians may need to pay more for water in the coming years. What this imposes on already disadvantaged communities is yet to be fully understood.

Florida's aquifers are not exclusive to Florida-- they do not follow state bounds, after all. The Floridian Aquifer alone runs 82,000 square miles across the state, additionally providing freshwater for parts of Alabama, Georgia, Mississippi, and South Carolina (Heggie, 2021). Florida's problem of saltwater intrusion is not exclusive to itself either. America's water basins are at serious risk of total depletion in the coming century. It can be observed across Texas, California, all along the East Coast, even extending past America to Mexico, across the seas to China, the Mediterranean, the Middle East, Northern Africa-- anywhere with anthropogenic activity along the coast, there is saltwater intrusion.

To address the issue, society would need to start with understanding the expanse of it. There is no single group of people responsible for it. Not agriculture, not manufacturing, not civilian, not recreation, not power supply, not government. No individual is responsible for the upkeep of our groundwater, nor should we act as if this were so. The effort to prevent and control saltwater intrusion and excessive groundwater consumption is all-encompassing of our society, and like the natural world we draw it from, we must work individually and as a collective to keep a balance within our ecosystem.

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