Too Little, Too Late:

How the MOSE Project Failed Venice

(and How 21st Century Environmental Science Can Save it)

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The MOSE Project

Venice has of course endured a long history of flooded streets and high water, christening the tragic phenomenon "Acqua Alta," but the most intense floods have been those that occurred most recently. Of the ten highest tides in recorded Venetian history, five have been in the last twenty years. The most recent tide, measuring six feet above sea level, the highest since 1966, occurred in 2019[1].

Venice's greatest feat of environmental engineering was supposed to have been the MOSE project, whose construction began in 2003, set for completion in 2011, then 2018, and now 2022. And, while officials say that if MOSE had been completed on time the city might have been spared the consequences of the deadly flooding event of 2019[2], there is yet to have been any proof of the gate's eventual effectiveness. Now seventeen years old, the gates are lightyears behind the modern coastline prevention technology trends of the 21st century. According to Paola Malanotte-Rizzoli, an oceanographer at the Massachusetts Institute of Technology on Venice's problem-solving panel, "We have evidence that Venetian engineers drafted mechanical contraptions to hold back the sea as long ago as in the 18th century[3]."

MOSE's aim may not even be ambitious enough to prevent against newer, higher estimates for sea level rise over the next hundred years - the gates were meant to defend against 2 feet of rise. Since then, climatologists have been grappling with a much wider range of scenarios, though, some far beyond the expected 24 inches of gain.

Environmental groups and local politicians reportedly tried repeatedly to halt progress on the MOSE project repeatedly, citing concerns that the flood gates would certainly be obsolete by the time of their completion. Coincidentally, several Italian politicians connected to the project have been charged with corruption and have been forced to accept plea bargains[4].

In 2020, after having just recently endured the second largest flood event in the city's recorded history, Venetians seem to understand that the MOSE Project, despite all of Italy's efforts, was simply too little, too late.

Gray Infrastructure Solutions

Civil and environmental engineers have made some advances in the last twenty years towards finding better, more effective mechanical solutions for mitigating the effects of climate change, including improvements to levees, dams, super dikes, and sea walls. Effectively either serving as barriers to keep a city dry from high water, or moats to hold that water in place. These simple solutions, as well as more complex, mechanical ones, like the MOSE gates, are all considered *gray infrastructure.*

According to a report from The Guardian, Shanghai may be the most vulnerable city in the world to the effects of 3 degree sea-level rise, with up to 17.5 million estimated people to affected, based on demographic data revealing overall population density figures and average proximity to likely flood zones[5]. Further efforts to mitigate the risk of flooding in the Shanghai area include a new drainage system to disperse drainage from the Suzhou Creek across a 58 square kilometers area with 15 kilometers worth of pipes.

Shanghai has, until recently, relied on an extensive system of levees (think: castle moat), some deep enough to protect against even the most vicious storms. According to a New York Times report in 2011, the lowest of these pits is prepared to withstand a "one-in-1,000 year tidal surge[6]." Though, because such simple solutions offer little reassurance to potential real-estate investors, the Chinese government aims to engineer another defense against high water - a new floodgate to control the inflow of water to the Yangtze. While such a project is projected to be

costly, the Chinese government had already spent more than $6 billion on coastal infrastructure between 2001 and 2011[7].

Another series of projects paid for by the "Miami Forever" bond provides an important contrast to this brute-force method of keeping water out and economic engines turning. The bond was approved by voters in 2017 to allocate a total of 400 million dollars to protect the high-risk coastal city from the damaging effects of flooding, with $192 million going towards infrastructure projects that (from the website) "keep our property values high and our streets dry[8]."

While Miami's plan also includes plans to build a new seawall, most of the funds are allocated less to outright flood *prevention*, and more-so to flood *resiliency* - an important concept for urban planners utilized in disaster-prone communities around the world. Miami's plan includes stormwater pumps for the streets, raised roads to prevent flooding, and bonds for real-estate owners to reinforce their property against flood damage[8].

By applying a strict focus to preserving and waterproofing existing infrastructure, which could well be done with the help of architectural historians and preservation experts in an ancient city such as Venice, the city stands to save on reconstruction and maintenance costs.

The Miami Forever bond also includes about $100 million to be invested in affordable housing, as an obligation to provide greater protections for those disadvantaged populations who stand to loose the most to rising sea levels, and $78 million for investments in Miami's public parks, to make the city's green spaces more durable against flooding and stormwater[9].

Shortcomings of Grey Infrastructure

The troublesome caveat to these otherwise sound solutions, in many coastal cities, is ground subsidence - a phenomenon associated with settlements built on structurally unsound

sediment, like could be found near the silt-laden river cities, or muddy saltwater lagoons. The American city of New Orleans, after investing $14 billion into levee infrastructure, has noticed its barriers beginning to lose height on account of unstable ground like this[10]. Suddenly, maintenance costs are looking to be much higher than projections anticipated.

For the Indian beach community of Kerala, some of these grey-infrastructure solutions are doing worse than nothing to defend against rising sea levels. 193 miles of the city's 367 miles of shoreline have seawalls to protect against storm damage[11] and, while erosion is an unavoidable symptom of powerful surges, there is evidence that these seawalls prevent ocean currents from re-depositing sediment on shore, actually *worsening* the effects of natural erosion.

In sum, the effectiveness of gray infrastructure solutions, exemplified in case studies like that of New Orleans, Kerala, and Venice, is not obvious, and further solutions are too unproven to depend on them far into the future.

Green Infrastructure Solutions

Green infrastructure is the 21st century alternative to concrete walls and dirt levees, trading intentionally designed In most situations that would pertain to the Italian coastline, including Venice (tip: an island archipelago is effectively nothing but coastline), this means physically extending the coast, which can be accomplished by either adding sediment onto the edges of coastal areas (as was done in New Orleans) or replacing existing human developments with naturally resilient alternatives.

This idea has taken hold especially in the at-risk community of Miami, on top of the resiliency investments allocated by the Miami Forever bond. Instead of wasting resources fighting an impossible battle to maintain Miami in its entirety, the thinking goes, the city must focus its efforts on protecting areas most important to its economy and identity. The Shorecrest

area, among the city's highest risk neighborhoods, sitting just 2.3 feet above sea level, may be a lost cause entirely[12]. By restoring an at-risk area like this to its native marshland, the city's core gains a whole neighborhood-worth of buffer between it and the sea.

Many American shoreline advisory committees, such as those in Virginia, South Carolina, and Massachusetts have already put into place recommendations in favor of use of these so-called "soft-armoring" techniques to aid in shoreline preservation and coastline resiliency. An existing tool from the Venice Project Center, created at Worcester Polytechnic Institute, maps current and potential spaces on the Venetian island of Guidecca that could be added or improved to be used as coastal buffers as a part of this armor.

Other unconventional approaches to soft armoring have shockingly proven even more effective. The presence of mangrove trees, for instance, has showed evidence of helping to slow the effects of erosion from storm surges. As estimated in a publication from the World Bank, in Malaysia, Mangrove forests are worth a calculated $300,000 per kilometer when used as coastal defenses, which should explain why Malaysian communities have been preserving and planting them since 1994[13]. According to the same report, "an initial investment of $1.1 million saved an estimated $7.3 million a year in sea dike maintenance and significantly reduced the loss of life and property from Typhoon Wukong in 2000 in comparison with other areas[14]."

In contrast, Thailand's lack of mangrove-maintenance is likely to have increased storm-damage costs by $585,000, costing them $187,898 per square kilometer of mangrove, without considering inflation since 1996[15].

The Billion Oyster Project, one of New York Harbor's most innovative forces against the climate crisis, further proves the effectiveness of unconventional solutions for unconventional problems. According to the project website, the last hundred years have seen a full extinction of

oysters in New York's waterways. Oyster "reefs" are an important backbone for marine wildlife in cold water environments (not unlike coral reefs), play an important role in removing pollutants like nitrogen from our water sources, and provide a great deal of natural defense against storm surges, especially helping to prevent flooding and reduce damage from large waves. They are also fairly resilient and could be a useful tool for other coastal cities.

While none of these methods are without their flaws, any of them, in conjunction with each-other, especially, are certainly better than what Venice relies on today. The MOSE Project has already admitted being incredibly expensive and semi-broken, on top of the fact that it requires a full-time operation staff, and is an obvious unsightly blemish on all three entrances to the city's lonely lagoon. While Acqua Alta is a more difficult challenge to deal with than simple waves, a number of these solutions - shoreline extensions, new marshland, resiliency planning, and drainage trenches on the Terraferma could be incredibly helpful in combating Venice's climate woes.

Education, Politics, and Moving Forward

As an immediate response to Venice's catastrophic Acqua Alta in 2019, minister of education Lorenzo Fioramonti announced in November that Italy would be the first country to mandate climate change and sustainability education as for every one of the nation's public schools, coming out to about 33 hours per year, or one hour a week. The state has also told teachers specializing in science and technology to try to study their subjects from the "perspective of sustainable development[16]."

MOSE's issues were not helped by constant political disagreements in the Veneto region, Venice itself still a sitting bastion of progressivism, with the region still largely controlled by the right. This sad story extends backwards to a long history of Italian reluctance to make prohibitive

investments for long-term benefit - infrastructure investment, especially, has been affected negatively by such a political climate. In 2017, the leader of Italy's far-right league, Matteo Salvini, has a habit of scapegoating excessive regulation from the European Union for his country's failures, including the collapse of a road bridge in Genoa that killed 43 people[17].

Fioramonti, long a target of right-wing criticism in his country, represent the "antithesis of Matteo Salvini's hard-right League[18]," which has surpassed Italy's populist 5 Star party, claiming 30% voter support. He has proposed new taxes on airline tickets, plastics, and sugary foods to fund further sustainability-related educational programs that sit at 70 to 80% approval among Italians[19], but these policies have no real chance of making their way into law. While many Italians rightfully live in fear of the consequences of climate change, this political disfunction and disconnect with voters serves as a prime example of one of the completely avoidable obstacles to implementing sensible, **pro-active** climate change policy.

With the MOSE Project's hardest part already completed, and only a few years left to go on its current schedule, Venetians should be optimistic about what a finished floodgate system could do to protect them against the high waters of history, but that optimism should be approached with caution. Floodgates designed to defend against two feet of sea level rise are better than nothing, but Italians now know the cost of undershooting a budget and, now more than ever, it is abundantly clear that time is of the essence. Seventeen years after the beginning of the MOSE Project, environmental technology has come a long way, and planners have developed tried and true methods for building more resilient and longer-lasting cities. If the global community honestly believes that the Art & History of Venice are worth preserving, there has never been a better time to invest in any of these science-backed solutions – oysters, mangroves, schooling, or otherwise.

Notes

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