Biographical Sketch

At the time he was awarded the Aydelott travel scholarship, Joseph Hanlon was a fourth-year architecture student at the University of Tennessee (UTK). Having spent much of his life traveling from state to state following his father's naval career, he became interested in travel and experiencing new cultures. Joseph's interest in design began with regular art classes where he honed his skills in drawing and sculpture. The decision to study architecture at the University of Tennessee's College of Architecture and Design came from a continued desire to explore the world with a new lens in art and design. At UTK, Joseph took great interest in architecture along the coastline, and

eventually was chosen for a master's landscape architecture studio his senior year. Hs spent a semester abroad studying architecture in Copenhagen, Denmark. Beyond the classroom, Joseph pursued multiple architectural opportunities such as interning in Dallas, New York City, and Washington DC between semesters. Through his endeavors in and out of school, Joseph developed a passion for research that would lead to his application for the Aydelott Travel Award.

Outside of school, Joseph is passionate about painting and photography, which contributed to the documentation of his Aydelott travels. His passion for traveling and experiencing differing cultures also helped him conduct interviews abroad with residents. In his free time, he competes in triathlons across the country and designs furniture. Whether it is at home, at school, or abroad, Joseph is fascinated by how international cultures shape design.

Student:

Joseph Hanlon

Faculty Mentors:

Dr. Gregor Kalas

James Rose

Buildings:

1. Sluishuis Residential Building | Architect: Bjarke Ingles Group and Barcode Architects | Amsterdam, The Netherlands
2. Querini Stampalia | Architect: Carlo Scarpa | Venice, Italy
3. Itsukushima Shrine | Architect: Unknown | Miyajima, Japan
4. Nan Madol | Architect: Unknown | Pohnpei Island, Micronesia

Institution:

University of Tennessee, Knoxville, College of Architecture and Design

Fig. 1. The courtyard view that opens out to the IJ Bay, Sluishuis Residential Building, Amsterdam, the Netherlands, 2022.

In recent years we have seen an increase in the intensity of water-based disasters around the world. Just this year, hurricane Helene reached far inland with unprecedented intensity, impacting areas of the United States that previously were not at risk of major hurricane-based flooding. Landlocked cities like Asheville, North Carolina found themselves completely underwater and destroyed. Despite advance warning and tracking, weather predictions and storm infrastructure were caught off guard. Major weather events like Helene demonstrate that the impact of rising sea levels is a relevant and

current issue that is not restricted to the coastline. Are there lessons that can be learned from designing along the coastline that can be useful for ensuring safe shelter from coastline events that reach even far inland?

The following study attempts to explain how architecture along the coastline creates shelter that transcends the act of mitigating the negative consequences of rising sea levels. This study argues that architects have responded to rising sea levels by designing safe shelter that protects against high water levels and that stands apart for their interaction with the water. Those design choices are heavily influenced by the architect's "agency over the water"—the degree to which the architect can control the flow of water at the site itself. That "agency" varies at each of the four selected locations and shapes innovative design. I use the theme of rising sea levels to analyze four distinct sites across culturally specific architectural responses to water.

The challenge of rising sea levels has only intensified the need for safe shelter. The growing intensity of water-based natural disasters is a global issue. A culturally diverse response is needed. Since 1993, we have seen the highest annual global mean sea level rise an average of 3.99 inches.[1] Governments have resorted to addressing the challenge, and architects are at the forefront of the response. Large-scale water management systems, highly integrated building forms, and differing cultural techniques are a few of the many methods architects employ along the coastline.

The four selected sites: Sluishuis Residential Building in Amsterdam, the Netherlands, the Querini Stampalia in Venice, Italy, the Itsukushima Shrine in Miyajima, Japan, and Nan Madol in Pohnpei Island, Micronesia, represent a wide range of regions affected around the world. They include modern sites, like Sluishuis Residential Building, built by Bjarke Ingles Group in 2022, and the Querini Stampalia, renovated by Carlo Scarpa in 1963, to historic sites like the Itsukushima Shrine, with structures dating back to 1168, and the ruins of Nan Madol, originating some 2,000 years ago. Through the analysis of these four coastal sites, I identify culturally and technologically diverse methods that architects may employ to create climate conscious architecture.

A primary theme of interest is the relationship between infrastructure and architecture, and the subsequent shifting in the responsibility of the architect. My goal is to provide a point of reference for those responsible for building on the coastline in the 21st century.

The investigation of the four sites reveals three themes about the impact of rising sea levels on architecture along the coastline. The first theme centers on the question of agency, mainly the degree to which the architect is responsible for managing water at the site. In light of the architect's agency, the design goals generate a concept of how preexisting infrastructure shapes the water conditions of the site.

The concept of safe shelter is a second theme prominent throughout the four sites. In each location, architecture has gone beyond simply providing safe shelter in the face of rising sea levels. Rather, each site has unique nuances that integrate, embrace, or invite the flow of water rather than resisting or blocking it. The architect is thus responsible for making accommodations with rising sea levels to achieve the goal of safe shelter.

The final theme highlights how the architect's response to rising sea levels transcends functionality and embodies cultural values. In the face of rising sea levels, the design of each structure does more than just address the issue of mitigating high water levels. The architects designed beautiful innovative, and breath-taking structures that stand apart for their design and not just because they are sited along the water. In so doing, their designs also embody the surrounding cultural values that further influence those designs.

Sluishuis Residential Building

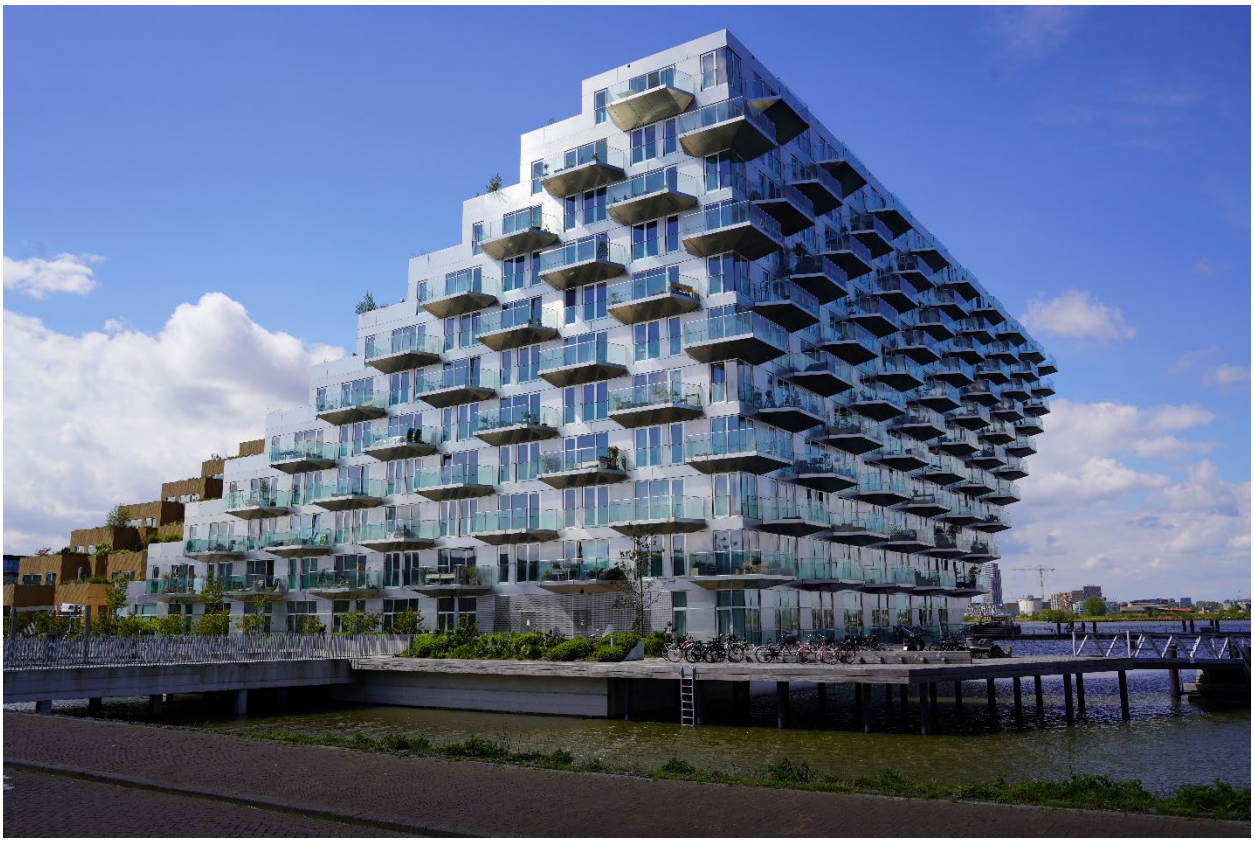

Fig. 2. Sluishuis Residential Building rests on a manmade island, Sluishuis Residential Building, Amsterdam, the Netherlands, 2022.

"Interacting with the barriers is as common as driving over an overpass in the United States" said one of the many Dutch residents of the Sluishuis Residential building whom I had the pleasure of interviewing. I had asked about the Netherlands' country-wide water management infrastructure system and its effect on her everyday life. She was referring to the many dikes and storm surge barriers that also serve as bridges dotting the Dutch landscape. For a country that finds almost one-third of its land below sea level, the systems at play barely inconvenience the lives of its citizens. In fact, these systems

are so common that she, like so many of those I interviewed, highlighted that "we rarely if not ever think about them." When asked about her home's proximity to the water, she referred to it as a "condition all Dutch people face" and that it is a blessing more than a curse.

Situated on the IJ Bay like a houseboat, Sluishuis Residential Building, a floating neighborhood that provides 442 zero-energy homes, walks a fine line between dry land and inundation. With the protection of large-scale water management employed at a country-wide scale, Sluishuis is able to safely reside along the coast. Unlike the other countries visited in my Aydelott travels, the Netherlands is a country of long-term safety and security from the threat of rising sea levels. Sluishuis is an example of a building designed not only on but also under the water, with a carpark constructed below the water level, that benefits from a complex history of flooding, a subsequent country-wide water management infrastructural system, and a shift in control over the water management from architects to the country as a whole. The result is to give the architect wider license to design in flood prone zones, and in the case of Sluishuis, to actually reinject the conflict with the water into the design of the building.

The country-wide water management system is one of the most important factors determining architectural designs in the Netherlands, and particularly at the selected site of Sluishuis Residential building. Upon touring the coastline, I was constantly reminded of the water. Traveling along the coastline took me over a

considerable number of these country-wide systems. Dikes, canals, and storm surge barriers are a few of the many pieces of this system. It did not occur to me until my return home that I was traveling from the top of one system to another, never fully reaching the water level. Although a substantial portion of the Netherlands is below sea level, within the country, much of the water ways are controlled to match the lower-level land. These systems seamlessly transition from one to the other, providing a uniform line of defense against the water. These systems also step the water down to a more manageable level, allowing architecture a closer proximity to the water. In the event of water based storms, storm surge barriers, the systems responsible for isolating interior water, close further severing the connection to the storming ocean.

This water management system has been shaped by the country's complex history with water. Much of the Netherlands was founded predominantly on wetlands. Until the 1950s, little stood between the open oceans and the cities of the Netherlands. Devastating floods were able to reach deep into the country, overflowing waterways and leveling dunes. After devastating floods in 1953[2] resulting in a significant loss of life and property damage, water management became a country-wide focus and resulted in large scale public works projects that produced the systems we see today.

Fig. 3. View of the barrier resting on dry dock surrounded by rolling grass hills, Maeslant Barrier, Rotterdam, the Netherlands, 1997.

Rather than employ smaller scale systems where flooding had been worse, the Netherlands guaranteed future safety by securing the entire coastline. By securing the coastline, there was no need to remove the water from their everyday lives. A country that was once held captive by the whims of the ocean was now able to guarantee the safety and security of its citizens without cost to their quality of life. The polder, once flood-prone land, is now able to be safely inhabited and developed.[3] Cities such as Rotterdam and Amsterdam were able to grow without the risk of a flood.

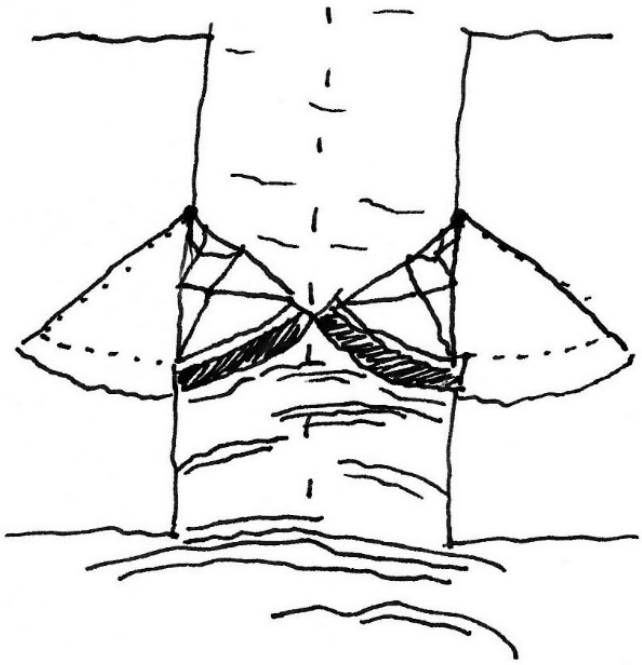

Fig. 4. When closed, the barrier blocks the entire water way, Maeslant Barrier, Rotterdam, the Netherlands, 1997.

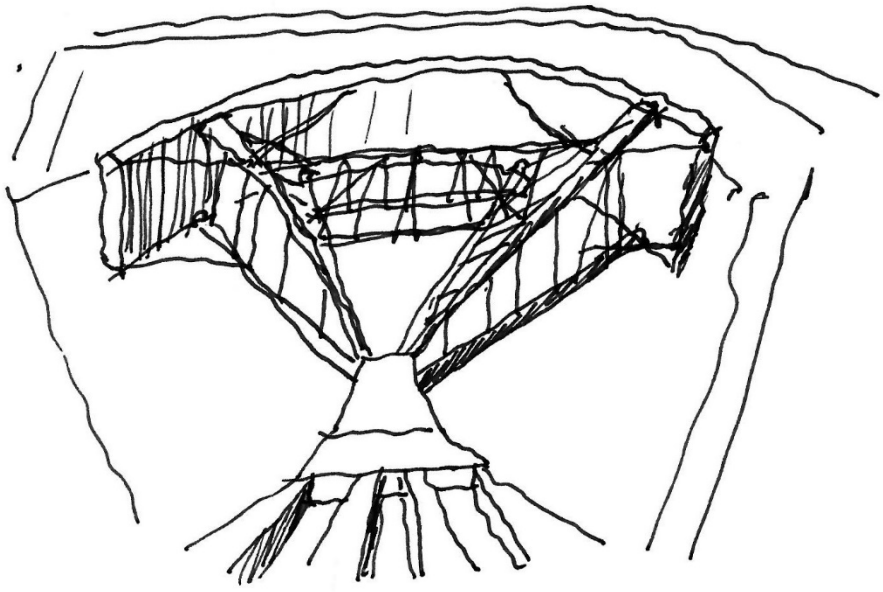

Fig. 5. View of the barrier in its concrete housing, hidden by the surrounding hills, Maeslant Barrier, Rotterdam, the Netherlands, 1997.

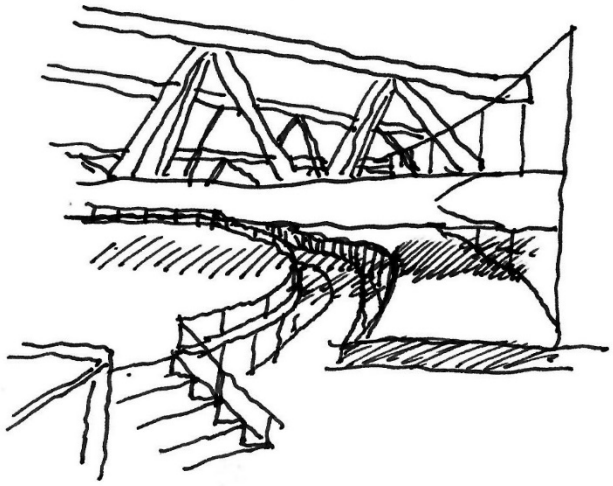

Fig. 6. The barrier towers over the walkway blanketing the space in shadow, Maeslant Barrier, Rotterdam, the Netherlands, 1997.

One of the remarkable components of this water management infrastructural system is the Maeslant Barrier (Fig. 3). At the length of two Eiffel towers resting on their sides and one of the world's largest movable structures, the Maeslant Barrier acts as the front-line defense to the city of Rotterdam.[4] Its sheer size is necessary to secure the Nieuwe Waterweg, the main waterway to the port of Rotterdam. Should an impending storm surge be detected, the barrier is designed to automatically close without human intervention (Fig. 4). With the scale and level of responsibility placed on the Maeslant Barrier, I had expected it to be well known and highly visible in the landscape. However, it was so well integrated into the landscape that it could be easily missed. Among the people I had the opportunity to interview, very few even knew of the barrier's existence.

The Maeslant barrier is one of many large-scale systems providing a level of security and safety in the Netherlands second to none. Architecture located below sea level that would otherwise be completely inundated is able to be safely inhabited. The perspective of architectural permanence also saw a change with the integration of a large-scale water management system. Not only were areas around the country once prone to flooding able to be safely inhabited, but architecture in these areas no longer had a lifespan limited by the water.

Fig. 7. The building rests on an artificial island just off the water, Sluishuis Residential Building, Amsterdam, the Netherlands, 2022.

Upon first vising Sluishuis Residential Building, little hides the abundant number of waterways surrounding the site. Throughout the city of Amsterdam, there was a constant connection to the water.

Whether it was the IJ bay, where Sluishuis resides, or the many canals, I found I was never fully away from the water. Like much of the coastal architecture along the interior waterways of the Netherlands, Sluishuis Residential Building resides just off the water on an artificial island (Fig. 7). This high-end apartment complex was built in an area that was once at great risk of flooding.

Fig. 8. The residence building rests in the water like a ship at dock, no change in building façade, Sluishuis Residential Building, Amsterdam, the Netherlands, 2022.

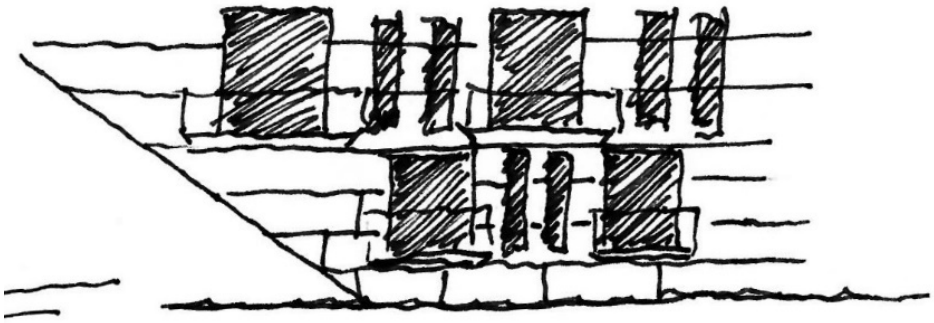

Fig. 9. The building remains motionless, its ordered façade perfectly linear, as if growing out of the water, Sluishuis Residential Building, Amsterdam, the Netherlands, 2022.

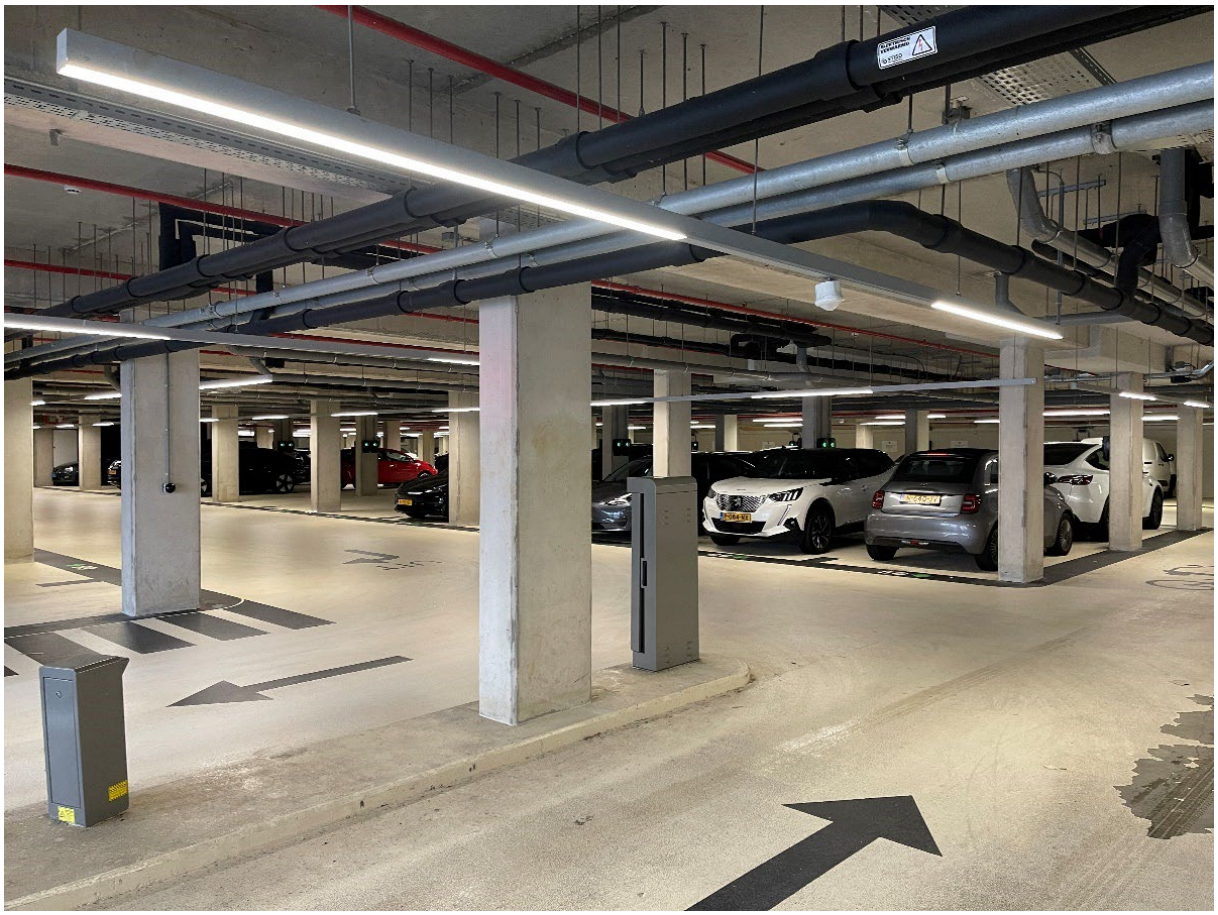

Fig. 10. View from the entry of the below water parking garage, Sluishuis Residential Building, Amsterdam, the Netherlands, 2022.

Despite Sluishuis Residential buildings proximity to the water, little design is wasted on addressing the surrounding water. The few visible support pillars come directly out of the water and terminate into the building; their concrete bare and exposed (Fig 7). At the rear of the building where the courtyard opens onto the bay, the building meets directly with the water, its exterior paneling in contact with the water (Fig. 8-9). From within the fully submerged parking garage, little can be discerned from its above-ground counterpart, with the exception of a lack of windows (Fig 10). The water management systems of Sluishuis do not differentiate it from any other Dutch architecture sited completely away from the water. Its connection to the water, in regard to water management, is minimal and easily overlooked. The building is designed and planned as if the threat of the water is of no consequence.

Situated along waterways, Sluishuis Residential Building allows for the Dutch lifestyle to flourish. But rather than embrace the safety and security experienced by much of the Netherlands, Sluishuis reinjects a sense of conflict with the water. In a similar way to that of the Dutch houseboat, Sluishuis is sited for its connection with the water, providing multiple means of accessing it (Fig 7). The water is just outside the door, within arm's reach. Unlike the houseboats that surround the residential building, Sluishuis does not share the same liberty of rising and falling with the tides. The residential building cannot be moved to avoid an incoming storm, its immovable concrete columns are fixed to the bed of the Bay. And the building cannot be raised to match the rising of the sea. Rather, the water is always

present, lapping against the façade. There are no visible barriers in place. Walking around the exterior deck of Sluishuis, you are greeted by the calm and beauty of the water. The fear of flash flooding came to my mind but was immediately subsided by the sight of residents swimming and laughing in the calm water.

Fig. 11. The surrounding coasts of Sluishuis are populated with layers of houseboats, Amsterdam, the Netherlands.

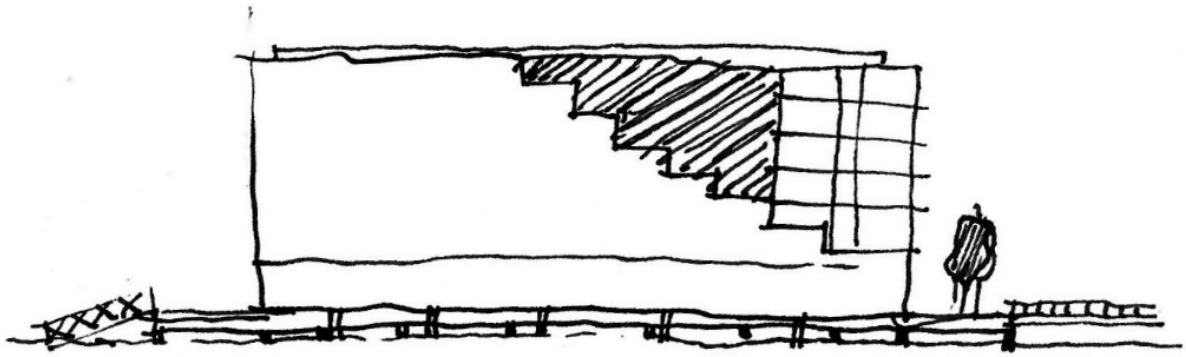

Fig. 12. The footprint of Sluishuis is expanded by the surrounding deck and docks, Sluishuis Residential Building, Amsterdam, the Netherlands, 2022.

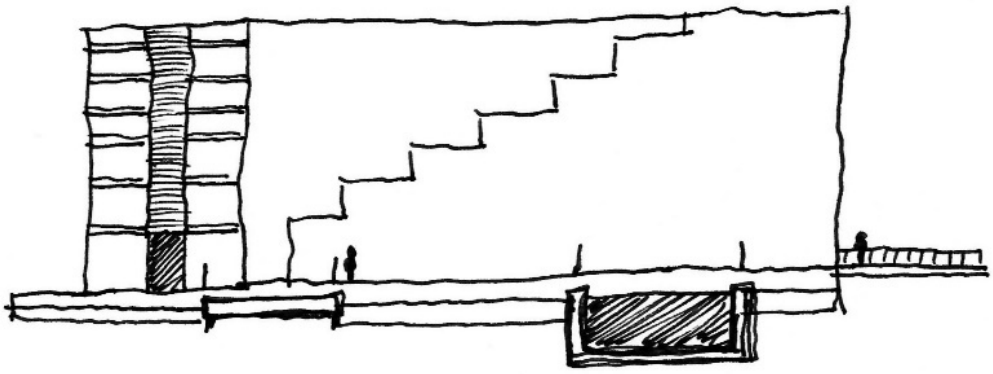

Fig. 13. Main access to the building is provided by two bridges: one for pedestrians and bikes, and the other for cars, Sluishuis Residential Building, Amsterdam, the Netherlands, 2022.

Despite all the differences of Sluishuis when compared to the Dutch houseboat, Dutch lifestyles are still allowed to flourish. (Fig. 11). Residents are given constant access to the water. Docks, decks, and ladders grow from all sides of the residence building, giving the sense of a much larger footprint than if Sluishuis were on land (Fig. 12-13). Personal boats are moored just off the many docks, their sails ready to open up at a moment's notice. Swimming areas fill the space between the building and its many docks, ladders welcoming you in. The courtyard, a unique feature that acts as a flood garden, carries the water inward and connects to the interior facing apartments. More decks, steps, and ladders are present for residents to jump in and enjoy the water while protected from the wind.

What separates Sluishuis Residential Building from the other selected buildings is its lack of conflict with the water despite its proximity to it. Despite its low lying location, it is situated directly on the water with no visible water management systems employed. Ultimately, the country-wide water management infrastructural system allows Sluishuis to successfully provide safe and beautiful shelter along the coastline. The highly integrated systems employed on and around Sluishuis result in architecture that does more than solve the problem of rising sea level. Sluishuis fulfills more than just the role of shelter. Rather it acts as a place of repose on the water, and armature for the Dutch lifestyle on the water.

Querini Stampalia

Fig. 14. View of the steps exposed during low tide, Querini Stampalia, Venice, Italy, 1963.

The smell of the Venetian Lagoon welcomes me the moment I step out of the airport. I begin to feel the cooling breeze as I approach the docks. The waves lap against the free-standing wood piers, my first sight of erosion. I climb aboard a river bus, bags clutched to my side as I try to make my way through the small boat. The air is stuffy with the smell of my fellow passengers and the surrounding water. The journey is choppy; the boat is constantly stopping to avoid the wakes of passing river taxis. My fellow passengers take no notice of the water splashing through the window. By the time I reach the

island, I am damp from the passing waves. I know the city will be a maze to get around, but I find the streets of Venice empty and peacefully waiting for me to explore. The lack of cars is like a breath of fresh air.

After a short walk through the narrow streets, I arrive at the second site in my Aydelott journey. The Querini Stampalia is a hidden gem, tucked away among the surrounding buildings, only the decorative plaque gives the building away. Any similarities with the buildings to its left and right, however, stop at the door. Rather than being met with a standard Venetian dock entry, I experience something wholly different upon entering. Not only is there water from the canal inside the entryway, but it has been let in and put on display, interacting with the steps in a clearly designed way. Light from the entry arches washes over the steps, brightening the space. The integrated planters full of lush greenery sip from the water below. No matter the tide, the Querini Stampalia is ready to welcome its visitors.

Nestled in the heart of Venice, the Querini Stampalia, like much of the architecture in Venice, has evolved with time. An original sixteenth-century palazzo and home to the Querini Stampalia Family, the building has undergone a shift in program. Today, the Querini Stampalia building is home to the Querini Stampalia Foundation. It is open to the public and offers a library, museum, and civic center.

The ground floor renovation by Carlo Scarpa, which was completed in 1963, is the focus of this research. Scarpa modernized the historic architecture to better suit the needs of the Querini Stampalia

Foundation by augmenting the ground floor to match the changing climate and restore what had been lost to the water. The Querini Stampalia is an example of an historic building rooted in tradition that benefits from a reinterpretation of the surrounding culture, a shift in perspective of the flood cycle, and the integration of building growth with the landscape. The result is a renovated historic building that incorporates mitigation strategies where water is purposefully allowed to flow in at specific, regulated points as a means to connect to an authentic experience of place.

The most noteworthy area, which is the focus of this analysis, is Scarpa's unique approach to addressing building flooding in a historic city. Being in the heart of Venice, this sixteenth-century palazzo faces a challenge unique to Venice: it is sinking.[5] Now, with the rise of sea levels due to climate change, the city of Venice is faced with an inevitable inundation of water should nothing be done. In an attempt to address this issue and maintain shelter for its inhabitants, the city of Venice and its architects are left with the complex challenge of adapting and reacting.

This is not a new challenge. Over the last two centuries, the island of Venice has faced both rising sea levels and regular flooding.[6] Regular flooding is ingrained in the Venetian culture through the Aqua Alta, the yearly seasonal flooding of the city. Each year much of the island is overrun by excess water covering walkways and bridges. The ground floors of Venetian homes and businesses are inundated, leaving them completely unoccupiable. Tighter areas of the

city are completely cut off by flooded paths. In some areas, the water rises enough to make boats passing under Venetian bridges impossible. The island is essentially held captive, but the residents carry on. Venetians do not let the rising water stop them. Instead, alternate paths through higher parts of the city are identified, temporary barriers are set up, and boat activity adjusts to the closures. Life continues to go on as if it were a rainy day. But these measures provide only a temporary fix. The historical architecture of Venice is slowly eroding away into the lagoon.

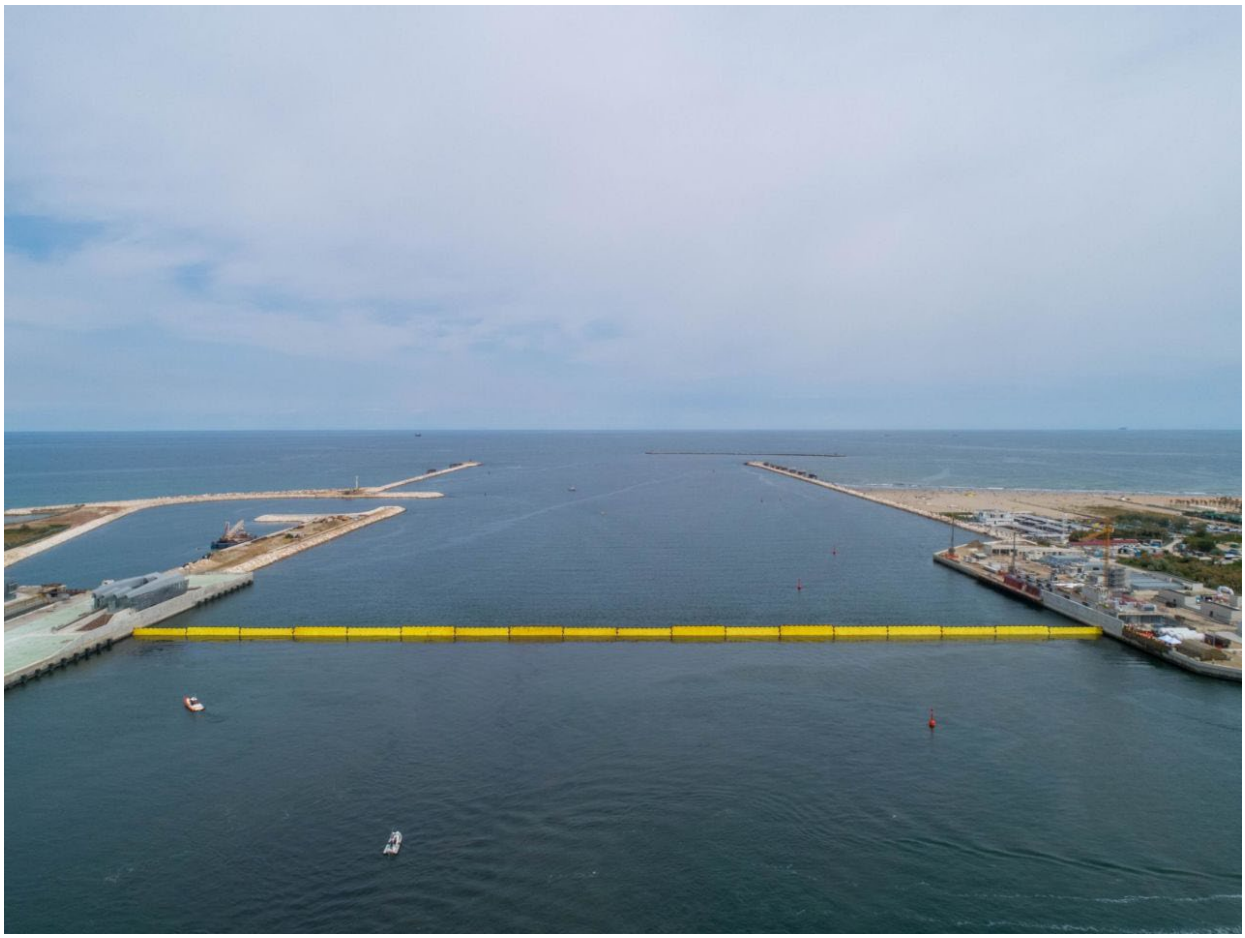

Fig. 15. View of the barrier deployed, blocking the entire waterway, MOSE Storm Barrier, Venice, Italy, 2020.

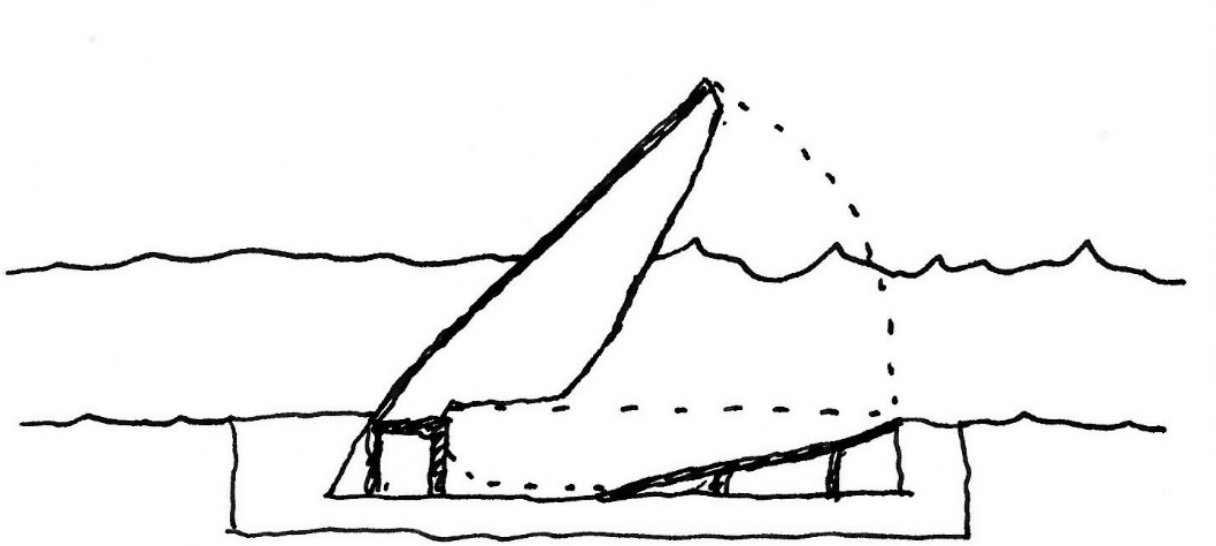

Fig. 16. Resting on the bed of the Venetian lagoon, the barrier lays dormant and out of the way when not in use, MOSE Storm Barrier, Venice, Italy, 2020.

Through city wide methods, such as bolstering the mudflats that support the island city and the creation of the MOSE storm barrier (Fig. 15), Venice has deployed the few large-scale options available. As a dense city built primarily of historic architecture, there is a lack of space for larger scale infrastructure systems. Creative solutions are required to integrate larger scale systems without disrupting the city further than the water it is trying to address. Bolstering the mud flats and the MOSE Barrier, two unusually large systems when compared to the scale of the city, are almost always hidden from view. Despite this, the MOSE Barrier still received considerable amount of criticism for its size and its questionable degree of effectiveness.[7]

The absence of large-scale solutions may also be due to complacency, as the residents of Venice have grown used to the seasonal flooding and see no need for such systems. Life in Venice continues to go on despite the flooding. Damage is repaired and new bridges are constructed. These large-scale infrastructural systems are seen as too costly and spark fear for how they may change the city. Instead, the flooding of Venice has been accepted as a fifth season, with little expectation that a solution can be engineered. As responsibility has shifted to the city as a whole for addressing the rise in sea levels, it is as if the Venetians have come to embrace this aspect of life on the water.

With the lack of large-scale, fast acting solutions, Venetian architects are left a substantial amount of responsibility in addressing the threat of rising sea levels. As the historical architecture of Venice continues to erode away, Venetian architects find themselves in a difficult situation. Is it their responsibility to preserve the architecture of Venice as a frozen moment in time? Or should the architecture change with the times? Should they continue to build up and resist the water? Or should they design the building to work with the water?

There is a divide among the architects of Venice on which is the proper path to take. As I explored the city, the sight of construction and renovation could not be missed. Both methods continue to be employed. There are architects reconstructing and restoring the original facades and details in an attempt to restore what once was.

Others, like Scarpa in the Querini Stampalia, have completely reworked the eroded historic architecture, giving way to a new form Venetian architecture.

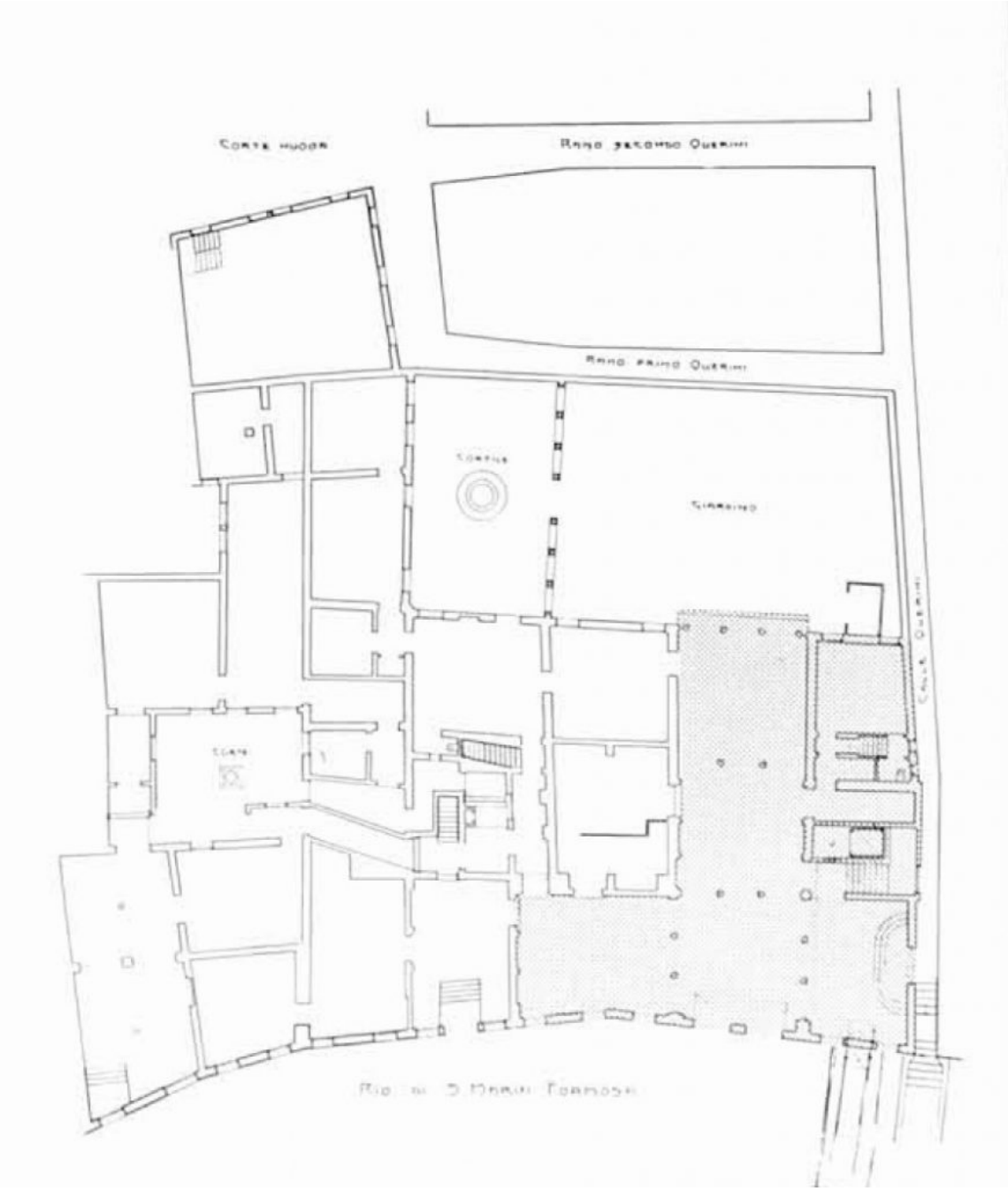

Fig. 17. The ground floor plan prior to renovation, Querini Stampalia, Venice, Italy, 1963.[8]

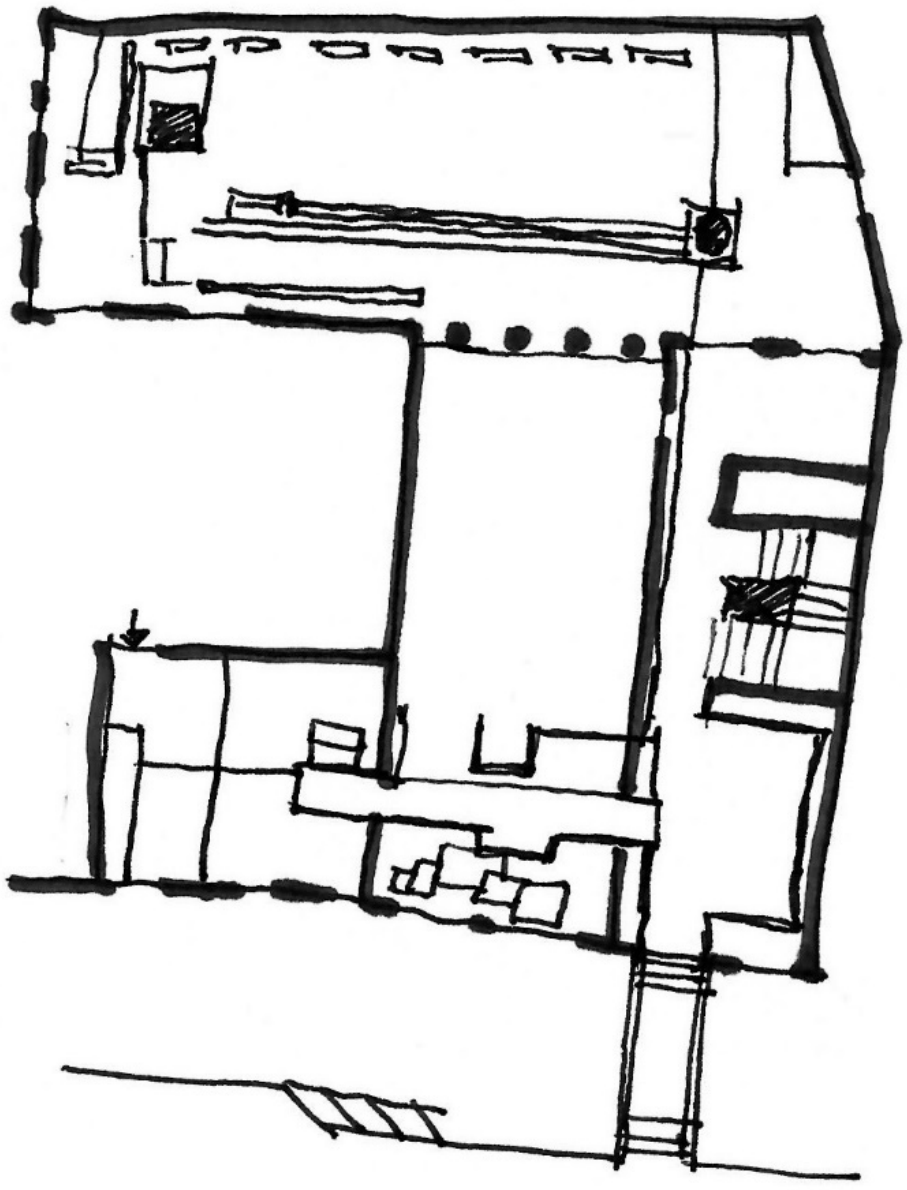

Fig. 18. The renovated ground floor plan highlights the path stormwater takes through the site, Querini Stampalia, Venice, Italy, 1963.

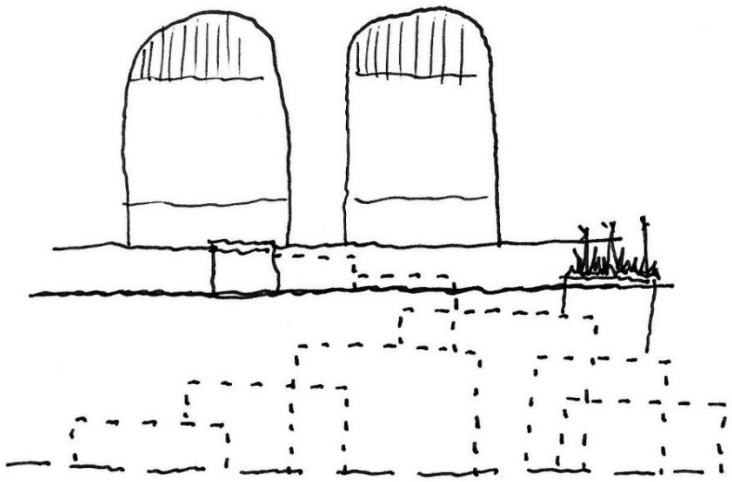

Fig. 19. View of the wide range of elevations covered by the steps, Querini Stampalia, Venice, Italy, 1963.

Fig. 20. The perimeter water channel carries water from the entrance to the rest of the site, Querini Stampalia, Venice, Italy, 1963.

Carlo Scarpa chose to take the path of change. The Querini Stampalia, like much of Venice's architecture, was being engulfed by the rising tides, while the depleting mud flats were unable to keep the historic architecture standing proudly above the water. Also, the building saw a shift in program with the introduction of the Querini Stampalia foundation that deviated from the original architect's design (Fig. 17). Thus, the Querini Stampalia could not be restored to its original design, but rather redesigned to match the changing times.

Scarpa's change came in the form of the completely reworked ground floor (Fig. 18). Water from the surrounding canals is no longer resisted, but welcomed in. A newly designed canal boat entry remains operational no matter the water level (Fig 19). Water channels flank the edges of the ground floor rooms (Fig. 20), redirecting overflow water through the altered circulation spaces to the flood gardens of the rear courtyard. The space was redesigned to include a new main lobby, altered circulation space, an exhibition space, and a reworked courtyard. These new spaces were tailored to match the new programs of the Querini Stampalia Foundation while also keeping the new water climate in mind.

With the integration of new water-based designs, a new conversation between building and water is formed. The futile resistance of the water is no more. Unlike the architects who choose to restore the erosion in Venice, the Querini Stampalia has a new stance about the water. Rather than continue to fight the relentless

water, further isolating the city, Scarpa welcomed the water in and celebrated it. The seasonal flooding is not a hardship for the Querini Stampalia but allows the building to be alive and beautiful.

Carlo Scarpa's renovation of the Querini Stampalia is a powerful example of adapting a historic building to work with the challenge of rising sea levels. As the water level changes, so does the Querini Stampalia. By adjusting building form, Scarpa took a problematic situation and turned it on its head. A building that once met the water abruptly, like much of Venice's' architecture, now gracefully blends with the water; no harsh edges are in sight. Where high waters were once seen as destructive, Scarpa's change ensures that they can now be seen as a desired quality in the architecture.

Fig. 21. View of the twin metal gates that are adorned with the dried sediment of past high tides, Querini Stampalia, Venice, Italy, 1963.

Fig. 22. View of the metal gates meeting directly with the water, Querini Stampalia, Venice, Italy, 1963.

Fig. 23. The continued erosion of concrete reveals varying levels of texture and color, Querini Stampalia, Venice, Italy, 1963.

The Querini Stampalia is able to celebrate and display the beautiful qualities of the water through its materiality. Brick and concrete hold the cast iron gate that marks the main entrance of the building (Fig. 21). Over time as the canal waters have interacted with these materials, the brick and concrete remain intact, their colors only hinting at an interaction with the water. In contrast, the iron gate has begun to wear away into the water, its metal rusting and flaking away (Fig. 22). While the materiality of the walls was chosen for permanence, the iron gates were not. In act of give and take with the water, they were chosen to draw back to the original gates of the building and surrounding architecture.[9] Inside the canal level boat entry, a unique blend of concrete was used to make up the entry steps. As the concrete has interacted with the water, the outer layer erodes away revealing the unique blend of larger stones in the mix (Fig. 23). Water has given the material a unique color blend which has helped hide the scum lines so common around the canal.

Fig. 24. The stone fountain, the main focal point of the rear courtyard, keeps water moving through the courtyard water channels, Querini Stampalia, Venice, Italy, 1963.

Fig. 25. At the end of the stone fountain sits a dry well and fountain drain where plants grow freely out of the seams, Querini Stampalia, Venice, Italy, 1963.

Fig. 26. As water reaches the dry well, it splashes out of the top while pooling at the base, Querini Stampalia, Venice, Italy, 1963.

In reworking the form of the Querini Stampalia, Carlo Scarpa also introduced the ability to grow and change with the water. Much of the architecture in Venice is unable to match the changing water. Greater levels of erosion and inundation have resulted, leaving scars as the water recedes. Bands around the canal edges remain as memories of the high waters of the past. The Querini Stampalia, however, bears these scars in a different light. Line of past high waters reach into the building, painting the steps of the boat entry. This infiltration of the water has stimulated the building and its many water-based armatures. In the form of fountains, channels, and flood gardens, these armatures celebrate the water (Fig. 24-26). Where the other architecture of Venice finds destruction and devastation, the Querini Stampalia finds beauty.

Varying levels of entry is the primary way the Querini Stampalia addresses the challenge of rising sea levels. Around Venice, as the seasonal floods take root, sandbags and other barriers are placed all around the ground floors of buildings, the last line of defense. But the Querini Stampalia remains open, still accessible and welcoming. As the water continues to rise, eventually reaching over the impromptu barriers deployed in so many buildings around Venice, the Querini Stampalia remains open and accessible but in a whole new way. As the water reaches the highest step, Scarpa's change puts the water channels to use, spreading water through each room.

Carlo Scarpa accommodated the rising water in a number of ways. Rather than completely hide these methods, Scarpa chose to put them on

display, allowing the building to stand apart from the surrounding Venetian architecture. The choice to reveal these accommodations may be due to a desire to celebrate the water. Systems like the perimeter water channels lie dormant the majority of the time, unsuspecting to the Querini Stampalia visitors. Only when the water reaches its highest level do the channels come to life. Rather than focus on the destructive nature of the overflow water, visitors see the water drawn from the walkways in beautifully designed ways. And from these channels, they see the water carried to the rear of the building where it is absorbed by the courtyard. Instead of pushing the water out of the occupied areas, Scarpa designed the rear courtyard to absorb the water in fountains and ponds.

Whether it is the reinterpretation of the surrounding culture, a shift in perspective of the flood cycle, or the integration of growth, the Querini Stampalia demonstrates how an historic site rooted in tradition can be augmented to provide shelter. Agency over the water falls to the individual architect in Venice, since each is left with answering the question of should one continue to build up and resist the water or design the building to work with the water. Carlo Scarpa reworked the Querini Stampalia to better work with the water. A multi-level canal entry, expansive ground floor channel system, and dynamic flood garden are some of the many ways in which Scarpa revived the Querini Stampalia's relation to the water. Essentially, it is the shift in perspective toward the water that allows safe and beautiful shelter along the coastline exemplified by the Querini Stampalia.

Itsukushima Shrine

Fig. 27. One of many framed views looking out on the water, Itsukushima Shrine, Hiroshima, Japan, 1168.

My journey to the Itsukushima shrine was complex. I had just arrived by bullet train to the city of Hiroshima. I found myself once again shocked at just how far I could travel by train in Japan. I boarded a local train bound for a coastal region just across the bay from the Itsukushima Shrine. The train brought me along the coast with the Island of Itsukushima constantly in view. The windows were open, and I began to smell the water. The train car was almost completely empty, a stark contrast to the trains in Tokyo. The final leg of my journey to the shrine was by ferry, which was very busy with tourists

and locals alike. As we approached, the boat began to turn, revealing the Itsukushima Shrine to those on the port side. Excitement and the shutters of cameras erupted. We were given the unique opportunity to view the shrine as it was intended, with the Torii Gate at the center marking the entrance to the Shrine.

The Itsukushima Shrine is sited on the island of Itsukushima on the Matsushima Bay. First built in 593 CE, this Shinto shrine was sited on the island because of its secrecy and difficult accessibility.[10] Built directly on the water, the shrine's wood pillars and stone bases have weathered the high and low tides, keeping the shrine standing. But as sea levels rise and water-based disasters intensify, the shrine and its connection to the water is at risk. High tides are reaching higher, affecting more of the building than was intended in its original design. Repair and restoration have become a part of the building and of experiencing the Itsukushima Shrine.

The Itsukushima Shrine is an example of an historical building designed on the water that benefits from an interconnected relationship with the water, the art of frequent repair, and the use of decay resistant materials. Because of current conditions that the original architect could not anticipate, this beautiful shrine is becoming precarious.

Japan stands alone from the other sites I visited in its conflict with rising sea levels. Unlike the other sites in this project, much of Japan is located above sea level. The challenge of rising sea levels does not appear for Japan in the form of coastal inundation.

Rather, typhoons and tsunamis level destruction across the Japanese landscape. There is a sense of fear in the costal architecture of Japan. Sudden influxes of rain and runoff trigger landslides, uproot buildings, and overrun water ways. In major metropolitan areas I had the opportunity to visit, such as Tokyo, much of the coastal architecture is elevated to establish the same ground level as the naturally high elevated sections of the city. As costal architecture is elevated to an unusually high level, the connection between architecture and the water is lost in most areas. Other than the added elevation, the water does not influence the architecture. There is no apparent style of architecture along the coast. Instead, the architecture of the city continues up until the shoreline, with an abrupt break in the landscape. This is especially exacerbated during low tide where one might think something is missing between the buildings and the water.

Fig. 28. The towering columns of the flood basin form a monumental hypostyle hall, G Cans, Kasukabe, Japan, 2006.[11]

The water management systems are also removed and hidden. Around some of the shorelines are highly integrated infrastructural systems called G-Cans. One such system is the fully underground water infrastructure project in Kasukabe, Saitama, Japan, just outside of the city of Tokyo. Consisting of five concrete silos at a height of 65 meters, they form an extensive network of tunnels and a large water tank.[12] The Japanese G-Cans in Kasukabe can remove up to 200 metric tons of water per second (Fig 28).[13]

While the Japanese G-Cans are great feats of engineering, there is also a sense of elegance and acceptance in how these systems interact with the water. Unlike the infrastructural systems in the Netherlands and Venice, the Japanese G-Cans are dry land water management infrastructural systems. They were designed to remove and temporarily store influxes of water from typhoons and tsunamis that would otherwise completely inundate the surrounding areas. By removing the excess water and preventing it from infiltrating into the ground, the G-Cans slow the sudden influx of water into the natural water system.[14] There is this dichotomy between the destructive nature of the G-Cans in use and the quiet monumental nature when patiently waiting. Unlike the infrastructure of the Netherlands and Venice, the G Cans act as more than just water management tools. Despite their intended purpose as buffers from flash flooding and landslides, they also serve as underground monuments that can be visited and explored. While the Japanese costal architecture is situated in a defensive manner, the architecture of the G-Cans is celebratory, standing as a show of force and strength.

While the G-Can water management system does not directly affect the Itsukushima Shrine, it does shape agency over the water. Agency over the water in Japan is split. In metropolitan areas like Tokyo, water management is left to the county in a similar way to that of the Netherlands. However, outside of the cities, like around the Itsukushima shrine, individual project architects have agency over the water and are responsible for water management at their site.

Fig. 29. View of shrine at low tide, Itsukushima Shrine, Hiroshima, Japan, 1168.

Unlike much of Japan, the Itsukushima Shrine was designed around a different perspective of the water. Shinto practices informed the selection of the site for the shrine. As water is highly valued and seen as sacred in Shinto beliefs, the shrine was planned out so that the water is visible throughout. Resting on wood pillars in Matsushima Bay, water surrounds the building on three sides, blurring the line between water and architecture (Fig. 29). The building can be seen as growing out of the water during high tide, with wood pillars like reeds along a shoreline. When completely still, the bright red shrine is perfectly reflected and mirrored in the water. There is no visual

buffer layer between the shrine and the water. There are also no barriers in place to block the rising water. The shrine simply rests on the water, originally designed to sit above high tide. Today with the rising water level and elevated high tides, the shrine is at the whim of the water.

Fig. 30. The Torii gate stands proudly in the water, the erosion of past high tides scaring the base, Itsukushima Shrine, Hiroshima, Japan, 1168.

The site of Itsukushima shrine was also chosen for its secrecy. When it was first built, visiting the shrine was reserved for a select few and was no easy feat.[15] Tucked into a cove of Itsukushima Island, the shrine is also well hidden, only its red torii gate giving its location away (Fig. 30). Today, visiting the site is not nearly as challenging as it once was. Regular ferry boats connect to the site each day, and a small town has grown up around the shrine. There is still a process to visit the shrine, requiring a local train and ferry to reach the island.

The shift to less secrecy, however, has affected the perceived sacrality of the architecture. As access to the shrine today has diverged from that of its original design, the uninterrupted and peaceful nature of the shrine is lost. With the exception of the early morning, the shrine is frequently overrun. Visitors can be seen throughout, even walking around the site when the water has receded during low tide. Where once a visitor was left walking the wood paths of the shrine, with only the lapping water below breaking the silence, today the qualities originally designed for are lost.

Fig. 31. Floorboards and the underlying structure are completely removed and replaced, Itsukushima Shrine, Hiroshima, Japan, 1168.

The once-beautiful site of the Itsukushima Shrine has become precarious. With the rise in sea levels, the Itsukushima Shrine has seen a shift away from the peaceful water it was originally designed around. High tides have only increased, reaching farther up the shrine’s wood pillars. At the highest tides, the water reaches through the floorboards, completely inundating the shrine (Fig. 31). During high tide, a time that was once the most revered, the shrine experiences destruction and danger. In recent years, the effects of the shrine's proximity to the water have only intensified. Erosion and damage have become a regular and predictable occurrence requiring more frequent repairs. Where columns once were the only part of the site

facing erosion, today the rising water has begun eroding away areas of the site that are difficult to repair.

Camphor wood is used to make up the wood pillars supporting the shrine. As the pillars interact directly with the water, experiencing both high and low tides, the wood is subject to frequent wear and tear. Although this wood is decay-resistant and has succeeded in keeping the shrine standing throughout its life, the increase in flooding and higher tides have begun eroding the Camphor wood faster than before. With the increase in intensity of high tides around the shrine, the cyclical drying cycle of the wood pillars has been disrupted. Rather than provide adequate time for the once-submerged columns to dry during low tide, the wood is now expected to withstand submersion over longer periods than for which it was designed.

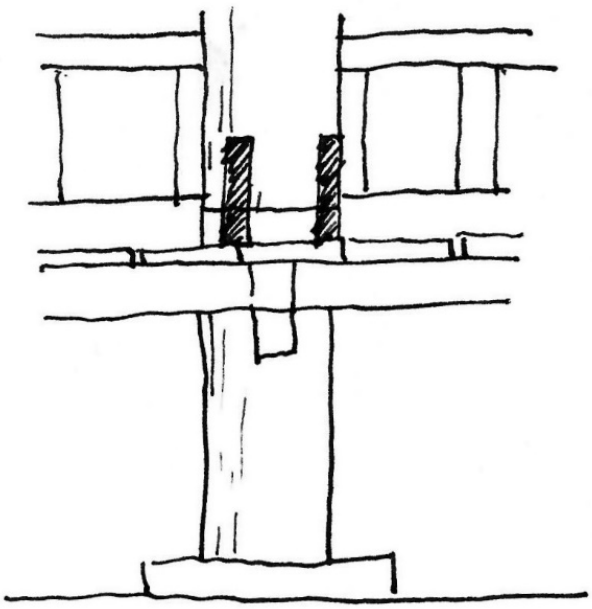

Fig. 32. The entire shrine interests the pillars which reach the water at one point, Itsukushima Shrine, Hiroshima, Japan, 1168.

Fig. 33. Craftsman hand chisel wood tabs to join the old with the new, Itsukushima Shrine, Hiroshima, Japan, 1168.

Fig. 34. Craftsman work by hand, during low tide, to splice brand new lower sections of pillars to existing upper sections, Itsukushima Shrine, Hiroshima, Japan, 1168.

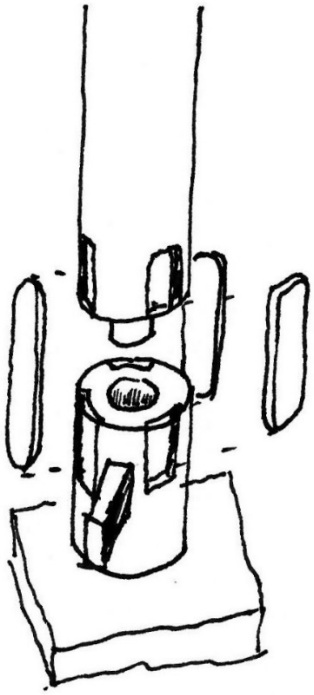

Fig. 35. The lower Wood sections exposed to regular inundation are separated from the remaining structure, Itsukushima Shrine, Hiroshima, Japan, 1168.

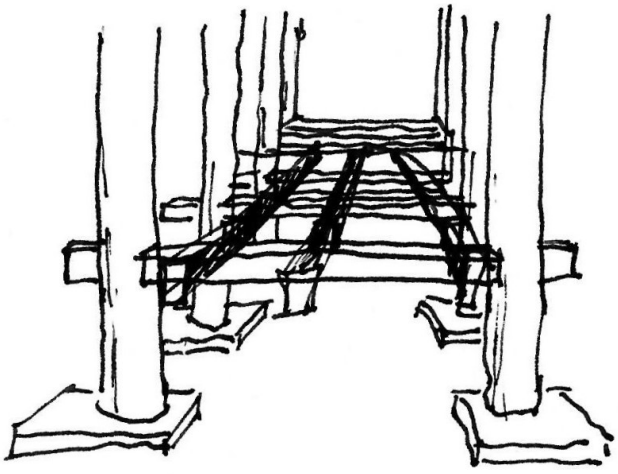

Fig. 36. The wood subfloor structure, located above the lower pillar section, is replaced more frequently with the growing high tides, Itsukushima Shrine, Hiroshima, Japan, 1168.

With the constant destruction of the shrine comes the art of rebuilding. As done in shrines throughout Japan, the Itsukushima shrine celebrates the art of rebuilding. Rather than being seen simply as a form of maintenance, rebuilding at the Itsukushima shrine is viewed as an art (Fig. 33). The craftsman are artisans in every sense of the word. They are responsible for more than just replacing damaged and waterlogged wood. Instead, they both preserve and restore what once was (Fig. 34). It is thus not surprising that the wood pillars are frequently repaired. Because the pillars are the direct connection between architecture and the water, they are continually damaged. In order to accommodate this regular wear and tear, the original design incorporated two pieces for each pillar (Fig. 32, 35). The upper portion is painted and infrequently repaired; and the lower portion is unpainted, easily removed, and frequently repaired. However, as high tides have begun reaching farther up the site, they sometimes completely inundate it.

Rising sea levels are damaging the upper painted portions of the pillars more frequently and are making repairs more frequent, more time-intensive, and more complicated. Where once only the lower sections of columns needed repair, now entire columns are replaced and repainted. Floorboards see frequent repair, and paint is often redone (Fig. 36). The regular repair and maintenance of the Itsukushima shrine is similar to that of the Ise shrine, a shrine that is regularly rebuilt. Shrine maintenance in Japan is not a new practice. Rather it is a cultural tradition that is shared by many shrines. What makes the Itsukushima shrine unique, however, is its growing need for

repair due to rising sea levels. Unlike the Ise shrine which sees regular and planned repair every twenty years, repair of the Itsukushima shrine is sporadic and heavily dependent on the water. A shrine designed to require minimal repair is now a structure at risk.

Unlike the other selected sites, the Itsukushima Shrine has seen the strongest impacts of rising sea levels. As a historic site built around a very different water climate, the shine has been forced to adjust and match the water to maintain its beauty and safety. The once beautiful water has become precarious.

Nan Madol

Fig. 37. The last fully visible island rests on a plinth, surrounded by water on all sides, Nan Madol, Pohnpei, Micronesia, 1180.

The cabin doors of the plane opened, and I was greeted by the island of Pohnpei, its tropical smell and high humidity immediately apparent. Able to hold no more than two planes, the airport was no more than a short runway and a welcoming building. I exited the plane onto the runway just off the beach and was greeted by the lush green mountains and lapping ocean. I had been up for over twenty-four hours at this point. My journey starting in Tokyo, flying straight to Guam, and then island hopping to my final destination. It was the end of the

day, the people of Pohnpei welcoming and excited for our arrival and I was ready for bed.

The following day, the journey to the Ruins of Nan Madol was no less complex. My tour guide, a local who had spent much of his adult life in the United States, navigated us through the winding roads and lush forests of the island, paying property owners to let us pass through their lands. By the time the car was parked, our journey was far from over. On a smaller island just off the main island of Pohnpei, stood our destination. The journey took us through the dense forests, as we navigated mangroves and waded through water, trying to avoid stepping on a young mangrove sprout. We began to see the architecture remaining from the ancient civilization scattered around, its basalt stone resting among the roots of mangroves. As if suddenly appearing, the large monolithic structure comes into view, its weathered basalt stones stood beautifully framed by the lush green forest. We had finally arrived, the only people for miles, with the ruins before us, ready for our exploration.

Being made up of more than 90 constructed islands, Nan Madol, often referred to as the Pacific "Atlantis", is a megalithic archaeological complex built on a reef flat.[16] The ruins are constructed with hexagonal basalt pillars and beams that are formed from the cooling of magma extrusion.[17] Inhabitation of Nan Madol dates to about AD 1 when it was used by the rulers for residential, religious, and administrative purposes.[18] Unlike the other sites I analyzed, Nan Madol is a site of ruins, no longer inhabited, and

scarcely visited. Nan Madol is an example of an ancient ruins designed on the water that benefits from the use of vernacular technology, the integration with nature, and the ability to withstand the tests of time. This results in robust structures that resisted the sea, which in turn, created an armature for mangrove and coral to grow. Nature takes shelter here even though humans no longer do.

While the ruins of Nan Madol do not serve as shelter for residents today, they do provide lessons from the past on inhabiting the coastline. Built on a coral reef flat over two thousand years ago, Nan Madol remains standing, with minor damage to the last fully visible island (Fig. 37). Rather, the surrounding nature has slowly engulfed the ruins, leaving only one island freestanding and able to be preserved. The coral reef has grown and developed around it,[19] engulfing the foundation of the ruins while acting as a natural water management infrastructure that has further strengthened and protected it from ocean-based disasters. The vernacular architecture, such as the over-engineered battered walls, interwoven stonework, and plinth foundation have kept the ruins intact. And the material use, large scale basalt stone, has resisted erosion over time.

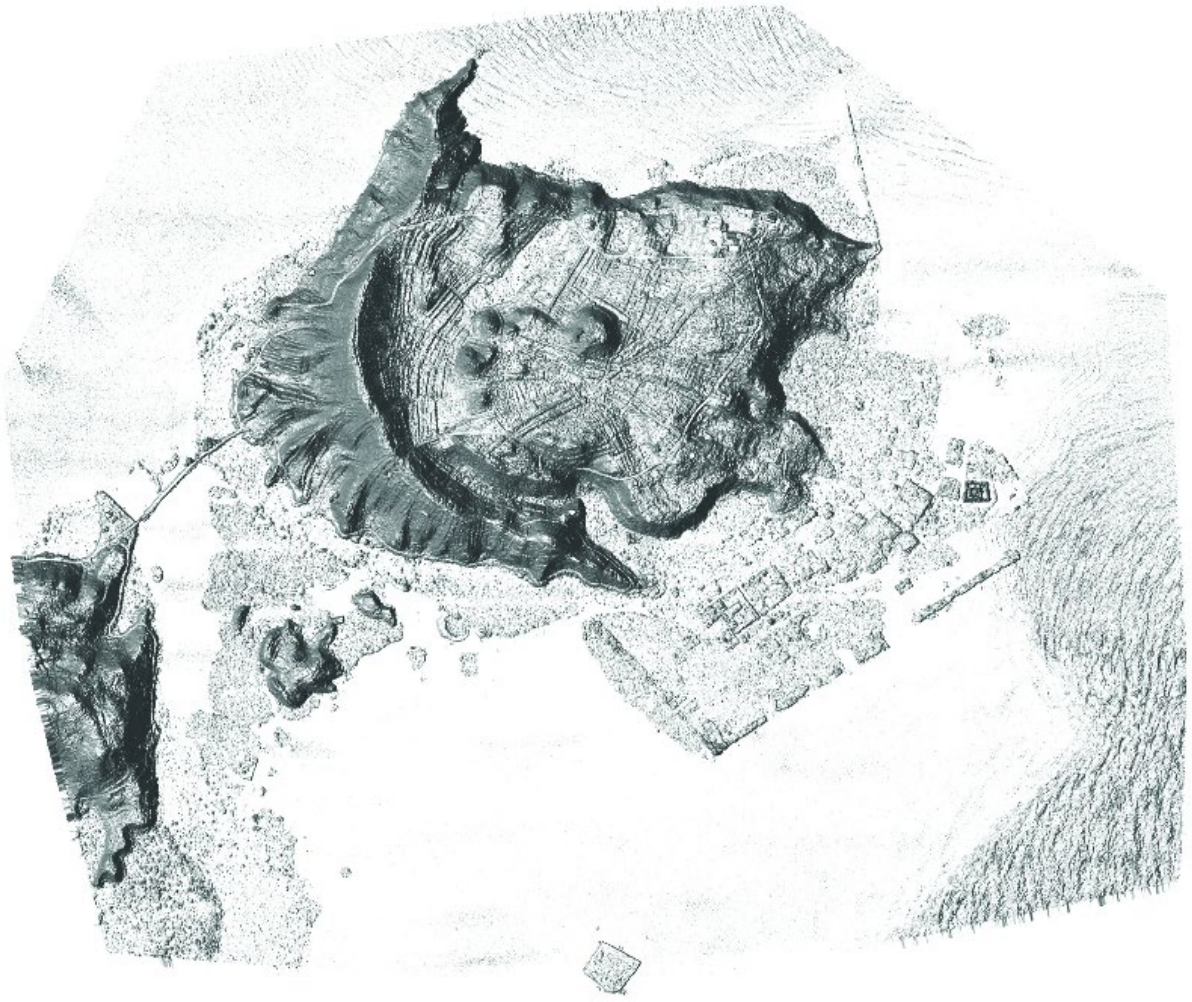

Fig. 38. Lidar scan of the ruins show the extensive area on the water that was built up by artificial islands, Nan Madol, Pohnpei, Micronesia, 1180.[20]

Fig. 39. Young mangrove trees sprout out of the coral reef flats that support the foundation of ruins, Nan Madol, Pohnpei, Micronesia, 1180.

Fig. 40. Mangrove trees plant their roots into the surrounding waterways, further strengthening the basalt stone walls of the channel, Nan Madol, Pohnpei, Micronesia, 1180.

Fig. 41. One corner of Nan Madol, directly facing the ocean, has discolored revealing a red tone to the basalt stone, Nan Madol, Pohnpei, Micronesia, 1180.

The forest has almost entirely engulfed the ruins. Through the use of Lidar scans (Fig. 38), the remaining island can still be seen, intact and undisturbed under the dense forest. While on the ground, only one island remains completely visible, the mangrove trees are still too young to reclaim it (Fig. 39). Trees of a wide variety have planted their roots blanketing the site. Pieces of the surrounding islands dot the landscape hinting at what used to be, their weathered stone standing out among the lush green forest (Fig 40-41). Centuries of sediment have been deposited further blanketing the ruins. Rather

than erode away as the water has risen, the landscape has risen, roots taking hold of sediment, and bolstering against the water.

Due to the forest having taken back some remnants from the ancient civilization, the ruins have remained undisturbed for much of its history.[21] Mangroves and other plants have taken hold of the ruins, their roots weaving in between the stonework, serving as an additional layer of solidification and protection to the aging site.[22] Acting as an armature for the mangroves, the ruins have been further strengthened by the roots. The large basalt stones are not just held into place by gravity, but also by the complex network of roots throughout the site.

Preservation and repairs have not been done on the ruins, rather they have been left to the elements.[23] The surrounding culture once considered the ruins cursed, leaving it undisturbed for much of recent history. Only recently have the ruins been visited and studied.

Fig. 42. Low stone walls with the help of Mangrove trees define interior waterways, Nan Madol, Pohnpei, Micronesia, 1180.

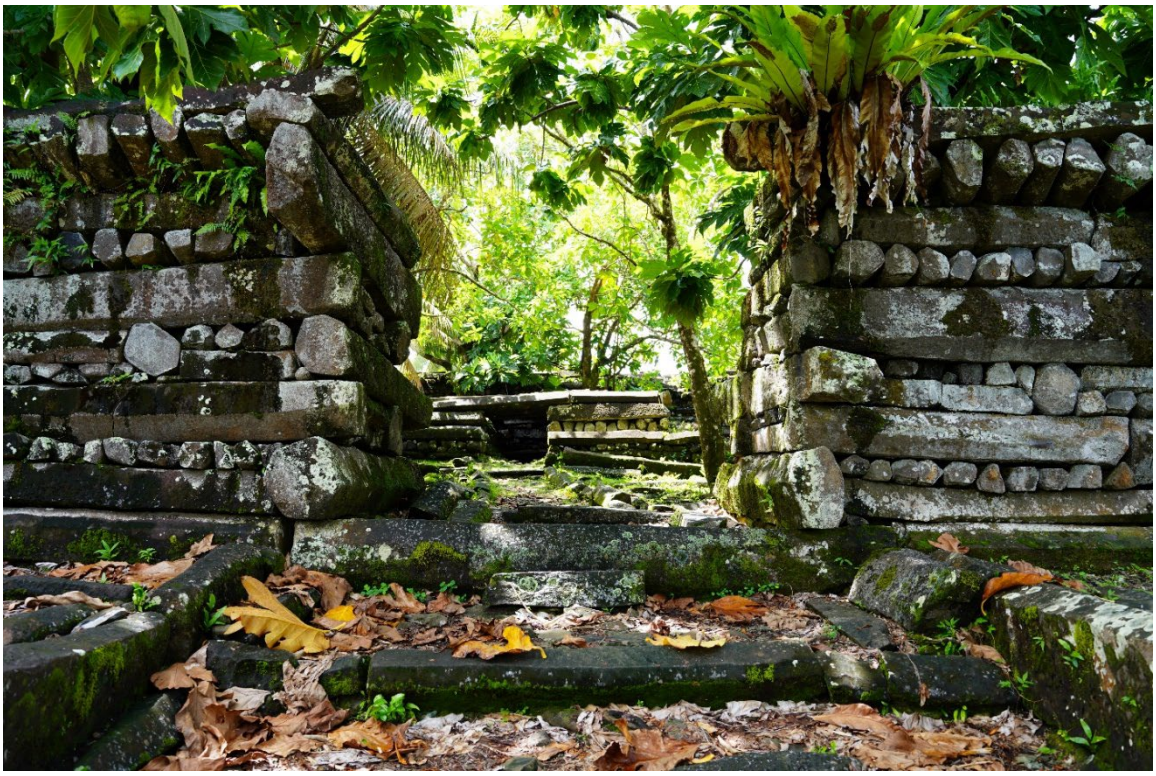

Fig. 43. The main entrance to the central courtyard remains standing, Nan Madol, Pohnpei, Micronesia, 1180.

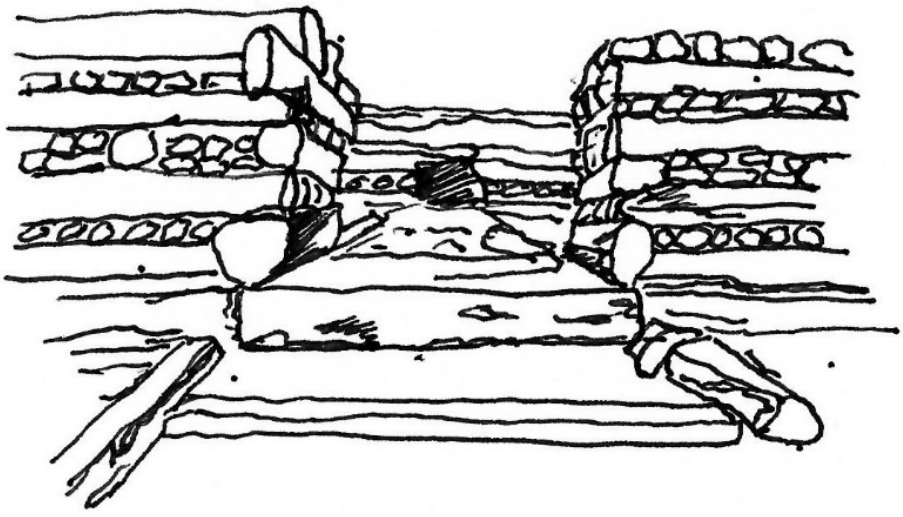

Fig. 44. The tomb, which can be seen throughout the main path, marks the terminus of the main entry path, Nan Madol, Pohnpei, Micronesia, 1180.

Fig. 45. The central tomb is shaded by the surrounding trees, Nan Madol, Pohnpei, Micronesia, 1180.

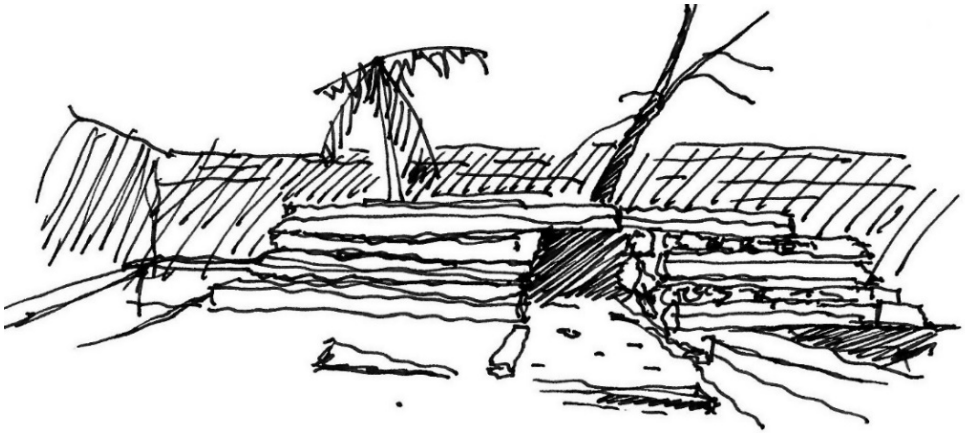

Fig. 46. Views outside of the central courtyard are limited by the towering walls which keep one’s attention on the central tomb, Nan Madol, Pohnpei, Micronesia, 1180.

Fig. 47. A stone that is believed to be carved by the original civilization has slowly eroded away, the harsh edges dulled by the continued exposure to water, Nan Madol, Pohnpei, Micronesia, 1180.

Today, Basalt stones still line the original canals built to provide navigable waterways for the ancient civilization, with their edges blurred by the forest overgrowth (Fig. 42). The layers of perimeter walls still stand proudly, their interwoven structures intact. Within one of the walls remains the primary entrance, accessible after wading through the surrounding waterway, its doorframe holding strong (Fig. 43-44). The structure located in the center of the remaining island, believed to be an ancient tomb,[24] remains visible, its stone roof supporting curious visitors (Fig. 45-46). Believed to be ceremonial artifacts carved into the ruins remain, the edges of the foot-like shape are dulled by the centuries of erosion (Fig. 47).[25] The particular use of it still remains unknown.

Fig. 48. The main path requires one to wade through the water to reach the main structure, Nan Madol, Pohnpei, Micronesia, 1180.

The ruins' connection to the water, while blurred by the surrounding forest's overgrowth, remains strong and thriving. The coral reef, a natural infrastructure layer, bridges the gap between architecture and the water, the point where the natural and manmade are in most harmony. This symbiotic relationship has helped preserve and protect the ruins from the test of time while also strengthening the coral reef by acting as a breakwater in the face of storm surges. The ruins are also broken down into layers with the foundational section seen growing out of the water. This layering of basalt battered walls separate the main structure from the foundation in the water, serving as a plinth for the structure above (Fig. 48). Pathways

raised above the water are also provided by the plinth, allowing easy access to the entire site. As the reef flats have expanded and shifted, the plinth has also adjusted, keeping the structure standing.

The dynamic site of Nan Madol has required the building to grow with it. Nan Madol has not remained stagnant over time. All aspects of site have changed. The coral reef flat foundation has grown and expanded, altering the water's interaction with the ruins. Water levels have risen, reaching farther into the site. The forest has cast a blanket of roots over the site. Plants have filled in areas not covered by stone. Despite the substantial amount of site change, the ruins remain standing, possibly even strengthened. The surrounding site has grown around the ruins like a protective shell. While the individual basalt stones have not grown, the structure as a whole has. The plant grows out from the structures, providing the ruins a greater sense of place. Rather than disrupt the natural growth of the surroundings, the ruins have acted as a substrate for further growth. Nan Madol has taken on a new image different from what the designers had previously planned for.

The ruins have transcended the designers' vision for the site. The designers of the advanced civilization responsible for Nan Madol created an ancient city on the water, its structures designed in a way that is hard to explain today. The structures were intended to be above the wild wilderness, a place of order and control.[26] Nan Madol was built as a sanctuary from the surrounding landscape, its islands standing proudly above the water and forests. Originally constructed

as a means of shelter and protection from the surrounding landscape and climate, Nan Madol has seen a complete shift away from resisting the landscape. Where it was originally designed to resist the overgrowth of the forest, now it unintentionally acts as a catalyst for growth, providing structure for the otherwise loose land. The complex collection of islands, a feat of engineering at the time, now remains a peaceful escape from the modern world. Visitors leave the familiarity of paved roads and manicured landscapes to enter a world where the architecture is integrated with the landscape, inseparable.

The original designers' plan for Nan Madol, like much of the ruin's history, is a mystery. The reason why the civilization of Nan Madol was abandoned is unknown; some speculate it was due to the loss of the royal family while others posit that a lack of resources made the islands inhabitable.[27] Despite the level of advanced engineering and planning of the site, the architecture was completely undermined by a lack of resources or the loss of royalty. The architecture of Nan Madol has outlasted its designers and outlasted its original plans. Now standing as a monument to what once was, the ruins no longer serve as shelter. Rather they serve a deeper meaning: to encourage the growth of coral while also protecting it. While not designed with the expectation of being abandoned, the ruins remain standing, continuing to withstand the tests of time.

When compared to the other selected sites of this research, Nan Madol stands alone as the only ruin. The line separating architecture and nature is blurred. The architecture and the Coral reef flats have

a symbiotic relationship. The coral acts as a natural infrastructure, protecting the ruins, while the ruins act as a substrate that encourages the coral's growth. The over engineered battered walls act as an armature for the mangrove trees. The vernacular technology employed alongside its integration with nature has allowed Nan Madol to resist the threat of rising sea levels and withstand the test of time.

Conclusion

The investigation of the four sites reveals three themes about the impact of rising sea levels on architecture along the coastline. The first theme centers on the question of agency, mainly the degree to which the architect is responsible for managing water at the site. Where the architect has no agency, seen for example in the site of Sluishuis, the architect has great license to take risk in the design. Where the architect has agency, however, the design goals of the architect must account for and may be driven by the imperative of the water conditions of the site. Thus, the original Itsukushima architects chose pillars constructed in two parts, one piece painted the other not, because the tides necessitated replacement of the unseen portions of the pillars. Rising sea levels have made the site more precarious, and restorers must contend with this design as they protect the site to ensure it continues to shelter both the faithful and the shrine's many visitors. The Sluishuis architects could build a dramatic construct jutting out onto the water, with a garage constructed below the water, because of effective water management systems beyond the site. Interestingly, with having agency over the water, Scarpa chose to intentionally allow water access to the site in Venice and incorporated the water and the impact of the tides on the building and the materials he chose. Nan Madol's origins remain a mystery, but the architecture has outlasted the original plans, and withstood centuries of erosion.

The concept of shelter is a second theme prominent throughout the four sites. In each location, architecture has also sought to provide safe shelter in the face of rising sea levels. This is shown most starkly in Nan Madol, the oldest site. There nature takes shelter even though humans no longer do. At the newest site, Sluishuis, shelter is built on land reclaimed from the sea. At the Querini Stampalia, safe shelter is achieved by admitting and redirecting the water evenly throughout the site. In each instance the architect has made accommodations with the rising sea levels to achieve the goal of safe shelter.

The final theme highlights how the architect’s response to rising sea levels transcends functionality and embodies cultural values. In the face of rising sea level, each architect's design decisions do more than just address the issue of protecting against or mitigating high water levels. Each designed beautiful, innovative, and breath-taking structures that stand apart from other architecture along the coastline for their design and not just because they are sited along the water. In so doing, their designs also embody the surrounding cultural values that further influence their designs. The dramatic structure of Sluishuis sits on the water like a ship. The below-water garage, while not necessary, reinjects a sense of conflict with the water. The Querini Stampalia takes the response to rising sea levels employed in Venice and turns it on its head. The variable height of the floors and drains allows for the seasonal flooding to be put on display. At each site, accommodations with the water have generated designs uniquely suited to the location and cultural context of the

sites. Allowing the water to flow through a building in the Netherlands would seem as preposterous and putting an underground garage in Venice; yet the designs chosen for each of these sites are celebrated for providing safe shelter that is also culturally attuned. Similarly, water is embraced in the designs at the sites in the Netherlands and Venice, although the designs vary significantly, but constant, recurring battle at a site of serenity and response. Itsukushima and Nan Madol were both designed for one thing but are in a different situation now.

Each of these sites offers potential lessons for the architect designing and building safe shelters that are both functional and beautiful. The degree of agency may provide license to the architect to take risk in placement of the building, materiality chose, and direct interaction with the water. But the imperative of design along the coastline is the integration of essential but not always visible elements of water management techniques in harmony with form to achieve architectural beauty.

Notes

1. Rebecca Lindsey, “Climate Change: Global Sea Level,” Climate.gov (National Oceanic and Atmospheric Administration, August 22, 2023), https://www.climate.gov/news-features/understanding-climate/climate-change-global-sea-level.
2. Ronald Rietveld, Erik Rietveld and David Habets, “The Tide of History: In the Dutch Battle against the North Sea, the Delta Works Are a Miracle of Hydraulic Engineering,” Architectural Review 241 (1442): 86–89. https://search-ebscohost-com.utk.idm.oclc.org/login.aspx?direct=true&db=a9h&AN=123861618&scope=site.
3. Schultz, E. 1983. “From Natural to Reclaimed Land--Land and Water Management in the Polders of the Netherlands.” Water International.
4. Rob Holmes, “The Problem with Solutions,” Places Journal, no. 2020 (July 14, 2020), https://doi.org/10.22269/200714.
5. Bennett, Catherine. 2023. “How Saving Venice’s Salt Marshes Could Keep the City from Sinking.” MIT Technology Review 126 (5): 16–17. https://search-ebscohost-com.utk.idm.oclc.org/login.aspx?direct=true&db=a9h&AN=169858630&scope=site.
6. Ibid., 16-17
7. “Sinking Venice to Be Given a Lift.” 2008. Geographical (Geographical Magazine Ltd.) 80 (6): 8. https://search-ebscohost-

com.utk.idm.oclc.org/login.aspx?direct=true&db=a9h&AN=32151069&scope=site.

8. Querini Stampalia Foundation, Previous Situation, n.d., Hidden Architecture, n.d., https://hiddenarchitecture.net/fondazione-querini-stampalia/.
9. Querini Stampalia Foundation, ""I Think I Was Born For," accessed December 20, 2024, https://www.querinistampalia.org/wp-content/uploads/2023/04/ENG_narrativo_SCARPA.pdf.
10. UNESCO World Heritage Centre, "Itsukushima Shinto Shrine," UNESCO World Heritage Centre, n.d., https://whc.unesco.org/en/list/776/.
11. The Economic Times, An Architectural Marvel, 2020, The Economic Times, 2020, https://economictimes.indiatimes.com/news/international/world-news/underground-architectural-marvel-find-out-how-tokyo-fights-back-floods/an-architectural-marvel/slideshow/78618890.cms.
12. "World-Class Underground Discharge Channel | Tech & Life | Trends in Japan | Web Japan," web-japan.org, March 2013, https://web-japan.org/trends/11_tech-life/tec130312.html.
13. Ibid.
14. Ibid.
15. UNESCO World Heritage Centre, "Itsukushima Shinto Shrine," UNESCO World Heritage Centre, n.d., https://whc.unesco.org/en/list/776/.
16. Bill Sanborn Ballinger, Lost City of Stone (Simon and Schuster, 1978).

17. Ibid.
18. Peter A, Tour of Nan Madol, interview by Joseph Hanlon, June 19, 2024.
19. Ibid.
20. CSRM Foundation, Airborne LiDAR, 2019, Airborne LiDAR Reveals a Vast Archaeological Landscape at the Nan Madol World Heritage Site, 2019, https://www.mdpi.com/2072-4292/11/18/2152#.
21. Peter A, Tour of Nan Madol, interview by Joseph Hanlon, June 19, 2024.
22. Ibid.
23. Ibid.
24. Ibid.
25. Ibid.
26. Bill Sanborn Ballinger, Lost City of Stone (Simon and Schuster, 1978).
27. Peter A, Tour of Nan Madol, interview by Joseph Hanlon, June 19, 2024.

Bibliography

All figures and images not specifically cited are the original productions of the author.

A, Peter. Tour of Nan Madol. Interview by Joseph Hanlon, June 19, 2024.

Bennett, Catherine. 2023. "How Saving Venice's Salt Marshes Could Keep the City from Sinking." *MIT Technology Review* 126 (5): 16–17. https://search-ebscohost-com.utk.idm.oclc.org/login.aspx?direct=true&db=a9h&AN=169858630&scope=site.

Bill Sanborn Ballinger. *Lost City of Stone.* Simon and Schuster, 1978.

Centre, UNESCO World Heritage. "Itsukushima Shinto Shrine." UNESCO World Heritage Centre, n.d. https://whc.unesco.org/en/list/776/.

CSRM Foundation. *Airborne LiDAR*. 2019. *Airborne LiDAR Reveals a Vast Archaeological Landscape at the Nan Madol World Heritage Site*. https://www.mdpi.com/2072-4292/11/18/2152#.

Holmes, Rob. "The Problem with Solutions." *Places Journal*, no. 2020 (July 14, 2020). https://doi.org/10.22269/200714.

Lindsey, Rebecca. "Climate Change: Global Sea Level." Climate.gov. National Oceanic and Atmospheric Administration, August 22, 2023. https://www.climate.gov/news-features/understanding-climate/climate-change-global-sea-level.

Querini Stampalia Foundation. ""I Think I Was Born For." Accessed December 20, 2024. https://www.querinistampalia.org/wp-content/uploads/2023/04/ENG_narrativo_SCARPA.pdf.

Rietveld, Ronald, Erik Rietveld, and David Habets. 2017. "The Tide of History: In the Dutch Battle against the North Sea, the Delta Works Are a Miracle of Hydraulic Engineering." *Architectural Review* 241 (1442): 86–89. https://search-ebscohost-com.utk.idm.oclc.org/login.aspx?direct=true&db=a9h&AN=123861618&scope=site.

Schultz, E. 1983. "From Natural to Reclaimed Land--Land and Water Management in the Polders of the Netherlands." *Water International*.

"Sinking Venice to Be Given a Lift." 2008. *Geographical (Geographical Magazine Ltd.)* 80 (6): 8. https://search-ebscohost-com.utk.idm.oclc.org/login.aspx?direct=true&db=a9h&AN=32151069&scope=site.

Previous Situation. n.d. *Hidden Architecture*. https://hiddenarchitecture.net/fondazione-querini-stampalia/.

The Economic Times. *An Architectural Marvel.* 2020. *The Economic Times*. https://economictimes.indiatimes.com/news/international/world-news/underground-architectural-marvel-find-out-how-tokyo-fights-back-floods/an-architectural-marvel/slideshow/78618890.cms.

web-japan.org. "World-Class Underground Discharge Channel | Tech & Life | Trends in Japan | Web Japan," March 2013. https://web-japan.org/trends/11_tech-life/tec130312.html.