

Building with Water

Dedicated to Brenda, Max and Amy Ryan

Zoë Ryan

Building with Water

CONCEPTS | TYPOLOGY | DESIGN

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Introduction

Fluid Dynamics: Building on Water



Sandro Botticelli, "The Birth of Venus", 1485.



Caspar David Friedrich, "Wanderer above the Sea of Fog", 1818.



J. M. W. Turner, "The Slave Ship", 1840.

Water is essential to life in every form. One of the world's most valuable resources, it has been referred to as "blue oil".¹ A material that we are forever trying to preserve, conserve, clean and re-use, water is also an element we continue to fight against, barricading ourselves, for example, against rising sea levels and the threat of flood. Given the increasing emphasis on environmental approaches to living, working and playing, water has become central to discussions about new architecture and urban planning. It is, therefore, a particularly pertinent time to be discussing building on water and the many thought-provoking and experimental projects that architects, designers and engineers are initiating that aim to address these important issues in an effort to introduce new modes of thinking and practices that will radically change our relationship with this natural resource.

Water as a Symbol

The importance of water as a source and symbol of life goes without saying. Drawn to it for its life-supporting, playful and therapeutic qualities, we cannot exist without it. Although water covers about two-thirds of the earth's surface, only 3 percent of this amount is freshwater and about two-thirds of that is ice. Much of the remainder is locked underground. Therefore, a mere fraction of 1 percent of earth's water supports all life on land. It is this essential ratio of water that provides sustenance to all forms of life and is fundamental to social development. As Flemish chemist, physiologist and physician J. Baptist van Helmont wrote in his volume *Oriatrike or Physick Refined*, published posthumously in 1662, "All earth, clay, and every body that may be touched, is truly and materially the offspring of water only, and is reduced again into water, by nature and art ..."²

Water appears throughout religion, literature and art of every culture. In the religious world, water is sacrosanct – from baptisms in the river Jordan to the ritual immersion in the Ganges during religious festivals in India. Spring water is also venerated. From ancient Bath in England to the modern Floridian hot springs, this natural water source is considered beneficial to physical purification and spiritual rejuvenation. As attested by Sandro Botticelli's 1485 painting "The Birth of Venus", in which Venus rises out of the sea in a scallop-shaped shell, appearing to derive her seductive power from the water, fresh and clear water is equated with health and beauty.

Counter to the life-supporting properties of this elemental material, water can also threaten and even take life. The German Romantic painter Caspar David Friedrich (1744–1840) illustrated man's powerlessness in the face of nature in "Wanderer above the Sea of Fog" of 1818 in which a solitary man looks out over a vast rough sea. Two decades later, J. M. W. Turner portrayed the dangers of the sea in "The Slave Ship", painted in 1840, in addition to making a marked political commentary on the practice of slavery. More recently installation artists such as Olafur Eliasson have turned to urban waterways as a source of inspiration and discovery in an effort to further awareness of the inherent relationship between water and the built environment. In 2008 he created "The New York City Waterfalls". Three falls consisting of approximately 27 to 36 metre-high scaffolding poles were installed in sites along the East River, viewable from Lower Manhattan. Torrents of water pumped up from the East River cascaded down the structures to thunderous effect. Like many of Eliasson's projects, the falls encouraged exploration of the water's edge and illustrated the power of this natural waterway, its constantly changing state and its presence in the city.



Trevi Fountain, Rome, Italy, 1762.

Water in Public Spaces

The consideration of some historical examples of interactions with this natural resource help us to fully understand our relationship with water. Charles Moore credits the city of Rome as the first to fully explore the potential for new relationships between the built environment and water with projects such as the Trevi Fountain in Rome, completed in 1762 and designed by architect Nicola Salvi. The Greek God Oceanus stands strong at the centre of a triumphal arch guarding the well, as the mythic protector of the sea and a godfather to the Greek pantheon. The circulation of the water cascading from above, collecting in the basin below and then shooting back up stands as a powerful metaphor of the natural cycle of life. As Moore notes, "All around, water splashes, foams, churns, spits, caresses stone reefs, and, at night, its luminous sparkles dance on the façades of neighbouring stone walls, windows and medieval arcades. The Trevi is the ultimate joining of water and architecture."³ Fountains have since come to characterize many of the most famous gathering spaces from the Champs Élysées (1724) in Paris and London's Trafalgar Square (1845), to Chicago's Grant Park (1901).

Fountains continue to revitalize public spaces. In France, the Floodable Square in Bordeaux, situated on the Quai de la Douane has been surprising unsuspecting passers-by since its completion in 2006. Designed by landscape architects Atelier R and water feature designers JML, a shallow pool of water periodically floods the plaza and then recedes, disappearing within minutes, without a trace. Known for the Buckingham Fountain (1927), one of the largest in the world, Chicago's Grant Park is now also home to the Crown Fountain. An altogether different experience, this fountain, designed by Spanish artist Jaume Plensa and installed in 2004, is one of the most popular outdoor

attractions in the city's downtown area. Located in Millennium Park, adjacent to the Chicago Art Institute, the water feature attracts scores of adults and children. Water cascades down the media walls that flank either side of the plaza, creating a shallow pool suitable for paddling. The faces of 2,000 Chicago residents animate the media walls. At sporadic intervals, water shoots out of the mouths of the faces to the delight, and at times dismay, of unaware pedestrians.

Revitalizing the Waterfront

Urban waterfronts have become fertile areas for urban planning and redevelopment as a key part of rebuilding healthy cities. Throughout history, canals, rivers, lakes, seas and oceans forming an edge to or bisecting urban metropolises have determined the topographical character of urban areas. Used for defense, trade, transportation, industry and recreation, these bodies of water often provided a reason for founding a city in the first place and have come to define these cities and play a major role in their lively and unique characters.

The most significant event to affect cities was the development of mercantile cities such as New York, London, Rotterdam, Chicago, Lisbon, Rio de Janeiro and Cape Town into industrial ports in the 19th century. As steam-powered boats transported goods faster and in larger quantities to ports globally, many of the world's urban waterfronts took on an industrial character with warehouses, docks and wooden piers. In addition to the potential hazards of machinery from heavy industry, these areas of intense activity suffered from high levels of pollution, making them uninhabitable as well as unsuitable for recreational activities. A disconnect grew between the waterfront and the social, cultural and environmental life of the city.

Olafur Eliasson, "The New York City Waterfalls" (artist rendering), an installation of four man-made waterfalls in New York, USA, 2008.

Floodable Square, Bordeaux, France, Atelier R and JML, 2006.

Crown Fountain, Chicago, Illinois, USA, Jaume Plensa, 2004.





Georges Seurat, "A Sunday on La Grande Jatte", 1884–1886.

Brighton Pier in Brighton, Sussex, England, opened in 1899. The pier continues to be one of the city's most popular tourist attractions.

As a contrast to these conditions, retreats on the waterfront located within easy reach of the city became fashionable as weekend destinations for city dwellers. In Georges Seurat's now well-known painting from 1884–1886, "A Sunday on La Grande Jatte", he depicts the popularity of an island in the river Seine on the outskirts of Paris for fishing, boating, picnicking and promenading. Across Northern Europe seaside resorts developed in response to changing lifestyles and increased leisure time for working families. Brighton on the southern coast of England, built under Royal supervision, introduced an architectural language that was to be replicated across Europe as a model for future resorts. With majestic architecture, boulevards and seaside promenades, the city also became famed for its 525-metre-long pier, opened in 1823, which continues to offer attractions such as a Ferris wheel. In 1841 the first railway line to Brighton extended the town's reach of influence beyond the local area. Working class families from cities such as London could now make the day trip. In the second half of the 19th century, other cities followed suit including Coney Island near New York and Atlantic City, New Jersey, in the United States and Monte Carlo in Europe, which became famous for their boardwalks, amusement centres and casinos.

The perception of our industrial waterfronts altered significantly in the second half of the 20th century as a response to containerization. As the shipping industry moved the bulk of its activities to the outskirts of cities for economic and logistical imperatives, vast areas of port and port-related buildings and spaces were left abandoned in urban regions worldwide. Marred by toxic waste, these areas quickly fell into disuse and were left abandoned. Artist Gordon Matta-Clark famously explored Manhattan's post-industrial waterfront in the mid-

1970s in works such as "Day's End/Pier 52", in which he cut a crescent-shaped aperture into the wall of a warehouse on a pier at Gansevoort Street. His action opened up unexpected views across the Hudson River and prompted rediscovery of this largely forgotten area of the city.

The outlook of cities changed significantly in the latter part of the century. No longer driven by its industrial heritage, the social and cultural life of the city was instead fuelled by a new service-oriented economy. In response, the waterfront was rediscovered as a potential site for new residential, cultural and recreational developments anchored by the experience of being by the water, offering a combination of urban and rural qualities, as it were. As Ann Breen and Dick Rigby, co-founders of the Waterfront Center in Washington, DC, assert, urban waterfront planning and development became a "civic interest that is persuasive and powerful."⁴ Large-scale renewal projects along the waterfronts of various US-American cities such as the Inner Harbor of Baltimore, begun in the 1960s; Seattle port area, undergoing revitalization since the 1970s; the downtown waterfront of Boston, under development since the mid-1980s; and the Embarcadero in San Francisco, which was transformed following the removal of the Embarcadero Freeway, in 1991, destroyed during the Loma Prieta earthquake of 1989. These large-scale initiatives with recreational, commercial, cultural and residential venues providing new live, work, and play spaces became models for other cities. Today, new waterfront developments have come to define urban renewal projects in cities as diverse as Barcelona, Shanghai, Tokyo, Seoul, Yokohama, Liverpool, Valencia, Belfast, Dublin, Bristol, Buenos Aires, Kobe, Rijeka, Split, St. Petersburg, Djakarta, Cape Town, Amsterdam, London, Manila and Osaka.



Millennium Bridge, London, Great Britain, Foster + Partners, Arup and Sir Anthony Caro, 2000. The pedestrian bridge connects the north and south banks of the river Thames between St. Paul's Cathedral and Tate Modern.



Tate Modern, London, Herzog & de Meuron, 2000.

In the latter half of the 1990s, signature architecture, whether the adaptive re-use of former industrial buildings or innovative contemporary designs inserted into the urban frame as in the case of the Guggenheim Museum in Bilbao became popular signs and symbols of urban redevelopment. Frank Gehry's acclaimed Bilbao Guggenheim, which opened in 1997, became the linchpin in the city's area-wide revitalization. Elsewhere, projects such as Tate Modern in London by Herzog & de Meuron on the South Bank of the Thames illustrate the potential for new architecture to transform the city's edge, encouraging interaction between the city and its waterfront, and providing fresh icons with which to identity and interpret city life.

In other areas of the world, artificially constructed landscapes have inspired unprecedented relationships with water. As landscape architect Adriaan Geuze has pointed out: "Something new is that sand is being sprouted in pancake layers to form land on an extensive scale."⁵ He emphasizes leading examples in areas of Asia and the Persian Gulf. In the United Arab Emirates entire cityscapes are being developed on artificial islands that will span approximately 100 square kilometres in total. The Palm Jumeirah, the Palm Jebel Ali and the Palm Deira Islands, for example, off the coast of Dubai are the largest land reclamation projects in the world and will result in the world's largest artificial islands with more than 2,500 properties located on each. Commissioned by Sheikh Mohammed bin Rashid Al Maktoum in an effort to increase Dubai's tourism and population, the projects are part of an overriding plan for Dubai as a residential, leisure, recreational, business and commercial centre. The possibilities appear endless for new developments. However, critics call attention to the challenge to create architectural responses that are ecologically and environmentally



Architecture in Coney Island, Brooklyn, New York, USA. From 1829 on, Coney Island became a beach resort for well-to-do city dwellers.



Gordon Matta-Clark, installation "Day's End/Pier 52" (exterior with ice), 1975.

sustainable and that respond to current social and political situations, ensuring their longevity beyond their rapid construction. The world waits in anticipation for the completion of these ambitious schemes; their long-term viability and ecological soundness is yet to be assessed.

Although the nature of the waterfront provides a unique realm for development, entailing social, recreational and environmental benefits as well as serving political and economic interests, the potential for synergy between the built environment and water is not something achieved through a simplistic approach, but a complex and integrated process, requiring mindful strategies, a substantial investment of time, money and above all research and design development. Once determined, however, it also calls for continuous reassessment.

Flood Threats and Responses

As recent history has reminded us, our natural weather systems make clear the dramatic reality of living with water, whether there is too much or too little of that precious resource. The threat of rapidly melting glaciers and the extreme droughts in many parts of the world emphasize the intrinsic relationship between water and the built environment, as do natural disasters as diverse as the flooding in Mozambique due to heavy rains in January 2008; the series of tsunamis triggered in 2004 by an earthquake off the coast of Sumatra, Indonesia that killed more than 225,000 people in eleven countries; and the severe destruction and human tragedy that was the result of Hurricane Katrina when the levees burst in Louisiana causing extensive flooding along the Gulf Coast of the United States in August 2005.

These examples are just some of the recent disasters that accentuate the manifold connections between water and the built environment. Architects, designers and associated professionals worldwide are responding to these threats in their design work. This work has been the centrepiece of numerous biennales, expositions and conferences centred on the topic of water.⁶

In 2008, the US-based History Channel ran a competition for the "City of the Future", and invited architects to submit proposals for what cities might look like 100 years from now. Architecture Research Office from New York presented perhaps the bleakest outlook, proposing that in 2106 intense flooding due to rising sea levels caused by the loss of the earth's polar ice caps will make some of our most familiar urban conurbations unrecognizable. They foresee Manhattan transformed by a new grid of live, work and play spaces built above ground and powered by solar energy that will weave in and out of existing skyscrapers, replacing the existing streetscape that will lie deep under water.

No less critical was the scheme from Chicago-based UrbanLab, an architecture and urban design office, which looked at the potential scarcity of our natural water resources due to increased demands. Sarah Dunn and Martin Felsen, the studio's founders, developed plans for a new water system for their hometown that sets an example of water re-use for the world. They envision a self-contained system that draws water from Lake Michigan, disperses it for use through "Eco-Boulevards" and then returns it to its source via a natural treatment system. The duo note that the Eco-Boulevards will function as "green infrastructure", "cleaning and carrying water" but also housing



The Palm Islands are artificial islands in United Arab Emirates, on which commercial and residential buildings are currently being constructed.



In 2008, Mozambique suffered severe flooding, displacing some 100,000 people.



Hurricane Katrina which hit the Gulf Coast in 2005, was one of the costliest and deadliest hurricanes in United States history, causing damage to thousands of properties and destroying major infrastructure.



Flood conditions during the aftermath of Hurricane Katrina. The most severe loss of life and property damage occurred in New Orleans, Louisiana, which flooded due to failure of the levee system.



Architecture Research Office's proposal for the "City of the Future" focused on inserting a series of "vanes" or new types of mixed-use buildings into Manhattan, replacing the existing streetscape, which they predict will eventually lie deep under water. Luminescent evaporation towers located around the periphery of the city would be used to refine enough water to meet all of the city's needs.



A detail view of the interconnected "vane" system of new buildings. The project proposed that the skin or membrane structure covering the multi-level buildings could collect solar energy to supply power and could be opened to the wind to ventilate individual units or whole corridors.



- Lake
- Existing parks
- Development
- Brownfields
- Eco-Boulevard
- Eco-Buildings
- Transit

Diagrammatic plans (top 2030, bottom 2060) of a system of Eco-Boulevards, a concept for Chicago by UrbanLab, 2008. Open green space spread throughout the city stitches together historic ethnic and economic boundaries and creates gathering and play spaces as well as community gardens.

"diverse landscape elements including wetlands, prairies, walk/bike trails, open green space, recreation space, marshes, gardens, farms, etc." The proposal places the environmental and ecological imperatives of the built environment at the forefront of new water-related schemes, in addition to the social and cultural life of the city. UrbanLab are currently developing their scheme as part of a region-wide initiative spearheaded by the City of Chicago.

What has become clear is that man's impact on the environment from continuous development and industrial waste has had enormous negative effects, resulting in a landscape too taxed to heal in times of environmental disaster. Following the 2004 tsunami in the Indian Ocean, for example, researchers concluded that areas lined with coastal forests, especially mangroves, were less damaged by the severe weather conditions than areas not buffered by this naturally grown vegetation. Studies conducted by the M.S. Swaminathan Foundation in Chennai, India, conclude that in the five countries most affected by the tsunami – Indonesia, Sri Lanka, India, Thailand and the Maldives – human activities had reduced the area of mangroves by 26 percent between 1980 and 2000. The study also reveals that mangroves, in addition to protecting areas from severe weather and erosion, entail benefits such as enhanced fishing and forestry production that manmade fortifications do not provide.⁷

Neil Burgess, a conservation specialist working with the World Wildlife Fund, draws a correlation between "the degradation of the wetlands in Louisiana", which he asserts "almost certainly increased Hurricane Katrina's destructive powers" and the destruction of mangroves in countries such as India.⁸



Plan view of a concept by Diana Balmori, 2008, for a new terraced river edge, floating walkways and floating islands that will allow for inhabitation of the Mississippi River and provide greater connections between St. Louis, Missouri, USA, and its waterfront as part of new redevelopment plans for the city.

The Mississippi River in the New Orleans region is home to the largest port in the nation and one-quarter to one-third of oil and gas used in the nation is either generated or shipped through the north central Gulf. It is estimated that since the 1930s, 4,000 square kilometres of wetlands have been lost and another 4,000 square kilometres could be lost in the next 40 years, increasing the risk of innumerable damage in the future. In response, this highly trafficked section of the Mississippi is the focus of numerous studies aimed at restoring the area's depleted marshland, due to coastal erosion and poisonous chemical run-off from heavy oil and gas industries, as a natural wall of defense to reduce future hurricane risks.

Diana Balmori, a landscape architect engaged in projects along the Mississippi River, notes that historically, the "issue of water has been fraught with issues of control." She is currently working on developing alternative approaches that work with water rather than against it. "We want to re-envision treatments for our water's edges and introduce new rational and philosophical bodies of thought based on different ways of working with water that can help diminish the damage done by the force of water during adverse weather conditions, as well provide new opportunities for engaging with water."

Balmori calls for a rethinking of the waterfront, "beyond the picturesque."⁹ Her New York-based studio is radically redefining the practice of building on water with a heightened sensitivity to the flows of this natural resource. Currently working in St. Louis on a scheme to forge greater connections between a site in front of Eero Saarinen's St. Louis Arch, the city of St. Louis, and the Mississippi River, her team is tackling the the landscape as if it were architecture through built structures in



Diana Balmori's proposal for new waterfront development in St. Louis, Missouri, includes a series of sweeping walkways that will ramp over the water to seamlessly connect the islands to the mainland.

the form of floating islands, tethered to the land, that rise and fall with the changing height of the level of the water. Outfitted with facilities for boating and ice-skating, and other activities such as dining, the islands are designed with devices meant to specifically address Mississippi currents and cycles. At high water levels, the floating islands are accessible via pontoon walkways, while others are planned so they can be submerged with water. When the river levels drop, the walkways come to rest at ground level, ensuring connections between the islands and riverfront are preserved. Balmori credits the system with making use of "the dynamism of the shifting water levels."¹⁰ In addition, she notes the use of new technologies: working with the naval architecture firm of Consulmar, for example, they developed a structure made from triangular-shaped framework with pockets that can hold vegetation, which can support and shelter aquatic plants, in turn helping to clean the water and providing protected areas for river-life.

Current plans for the New York-New Jersey Upper Bay, an area spanning the entire New York City waterfront from lower Manhattan to the northern reaches on both the east and west sides of the city, also include the creation of a resilient coastline with an archipelago of islands and reefs, tidal marshes, and parks. An interdisciplinary team led by structural engineer Guy Nordenson, a professor at Princeton University, that includes New York-based Architecture Research Office and Catherine Seavitt Studio, is currently working on research for the New York-New Jersey Upper Bay, funded by the Fellows of the American Institute of Architects' Latrobe Prize. The complex coastline of the Upper Bay is laden with challenges based on changes in climate, as well as evolving social and environmental patterns, stemming from the transformation of this once



A proposal for the New York-New Jersey Upper Bay in New York, USA, by a team led by Guy Nordenson aims to transform this area of formerly industrial coastline into living and recreational space. The manifold approach includes the creation of islands in the Upper Bay made from landfill with tidal marshes, piers, parks and new building developments.

industrial waterfront to more recreational use. At the crux of their extensive strategy is the city's evolving relationship with water, given the rapid rise in sea levels, which they predict will dramatically impact local infrastructures, ecosystems and coastal communities by 2050. Rather than proposing traditional engineering fortifications such as seawalls and bulkheads, the team envisions a more flexible approach that includes: the creation of islands in the Upper Bay made from landfills created from excavated matter dredged from the bottom of the bay, a coastline that combines tidal marshes, piers, parks and new developments; and finally a new zoning procedure that would allow for public-private partnerships to be formed to drive the developments, which could evolve over time in response to changing needs, whether environmental, social or cultural. Ultimately, the team's strategy, mapped out in a 400-page document, is conceived as a flexible yet comprehensive vision that not only addresses individual environmental, technical and economic aspects but is driven by a desire to enhance the overall quality of life of the city. In keeping with contemporary thinking and practice, the team's "soft approach" is based on layering programmes such as housing and parks or fresh water storage, urban farms and wetland aquaculture. It aims to not only manage existing conditions but encourage new developments as well as support the ecological revitalization of the harbour area. "Ultimately, we envision the Upper Bay as a new regional centre", says ARO principal Adam Yarinsky. "The concept combines nature, commerce, culture and recreation into a kind of Central Park of the 21st century."¹¹

Architect Stanley Allen, an advisor for the New York-New Jersey Upper Bay project and Dean of the School of Architecture at Princeton University, is also engaged in several waterfront



An aerial view of the proposed plan for the New York-New Jersey Upper Bay. The design was structured around creating an environment that could evolve over time, addressing changing ecological, technical and economic issues.

projects that aim to resolve issues of flood protection. These include a scheme for a 1-kilometre section of Taipei, which faces the river Danshui and is also bordered by the river Keelung. In 2008, Allen's Brooklyn-based studio was invited by the Taipei City government to generate ideas for this waterfront site and an adjacent parking garage. The challenge was to re-connect the site – currently occupied by parking lots and other sub-standard uses – back to the city, and to provide public access to the water at the western terminus of the city's east-west axis. The main hurdle of the project was an existing 8.6-metre flood wall that borders the two river systems in Taipei, and provides the main source of defense against flooding from the river during typhoon season. The volatile condition of this waterfront, which experiences severe weather patterns annually, limits the plant life to native species from the area that can withstand and thrive in these adverse conditions. The river Danshui is host to one of the most important mangrove forests in Taiwan, which has inspired Allen to propose instating a mangrove forest along the stretch of waterfront covered by his project.

After initially conceptualizing a series of proposals to bridge over the land where it is at its highest points, out of the reach of tidal flooding, or over the wall when protection from flooding is required and the wall is needed, with various landscape components, the designers came up with the idea of working with the wall itself: transforming it in section to allow seamless access and reshaping it at the water's edge with a serpentine form that pushes out at certain points, extending the city out to the water, and retracts inwards at other points, drawing the water closer to the land. "By pushing and pulling the wall in and out at various places, we could work with this obstacle, maintaining the equivalent flood protection but developing the