

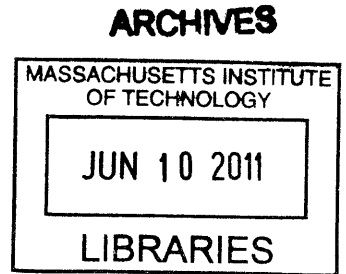
Adaptation and Adaptability; Expectant Design for Resilience in Coastal Urbanity

by

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Helsinki floods of January 2005. Photo courtesy of Mikko Rauhala.

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ABSTRACT

What is the nature of and possibility for urban resiliency through adaptation? Adaptation implies responsiveness to phenomena that are disruptive to a system's functioning; it is a willful evolution in response to changed circumstances. Adaptation occurs in cities when an event or fluctuation provokes a re-figuring towards new conditions or hazards. Considering current environmental and systemic changes in coastal post-industrial cities, this thesis explores adaptation and adaptability's form and function therein. Building on a history of adaptive design and natural hazards research, expectant design uses concepts of specificity, incrementality, participation, and phasing in design for urban adaptability. *Expectant design* employs flexible architectural and urbanistic strategies in response to climate change hazards and harbor redevelopment. Helsinki's new Kalasatama district is used as a testing ground for the development of adaptive design in coastal cities that are undergoing accelerating environmental change and demands for capacity. The design components of the adaptation armature illustrate a scheme that is incremental, flexible, expectant and public. Design arrives at an adaptation strategy that is implemented in a phased and open process, and that addresses the necessary adaptability involved in climate change adaptation strategies.

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Project Description

Systems adapt in response to changes in context or interior relationships. Historically, cities have adapted to natural disasters and environmental change, immigration, economic flux, and social and political change. This study examines the change in environmental forces bound up in climate change and harbor redevelopment. It views these alterations as stimuli for the re-designing of urban adaptability. Cities have not been designed with projected climate change in mind; the effects and scale of changing environment in coastal post-industrial cities dictate the need for a new adaptability.

The relationship of urban development and water is changing in water-proximate cities throughout the world. The altering environment due to climate change, when combined with higher demand on urban capacity, is placing densifying coastal areas in a more intense state of vulnerability. Simultaneously, as harbor spaces redevelop, high demand is put on uncertain conditions, and robust space for urban expansion and experiment is lost. A broad range of climate change and redevelopment effects impact cities globally. Coastal cities are among the most vulnerable.

Water-related environmental changes are impetus for coastal cities to re-assess themselves in a changing ecology. Cities are facing challenges in confronting increasing frequency and intensity of hydrological events coupled with sparse spatial resources. In the ex-harbor city, as industrial and production activities move elsewhere, urban structure redevelops and build-out is reached. Use of space is further concentrated, and a higher capacity increases potential damage. An attempt at adaptation must be made to preemptively design for the environmental change represented by a predicted risk of water issues. Infrastructure that anticipates new environmental hazards must be knit into existing urban fabric, with a distinct publicness to serve the surrounding urban area.

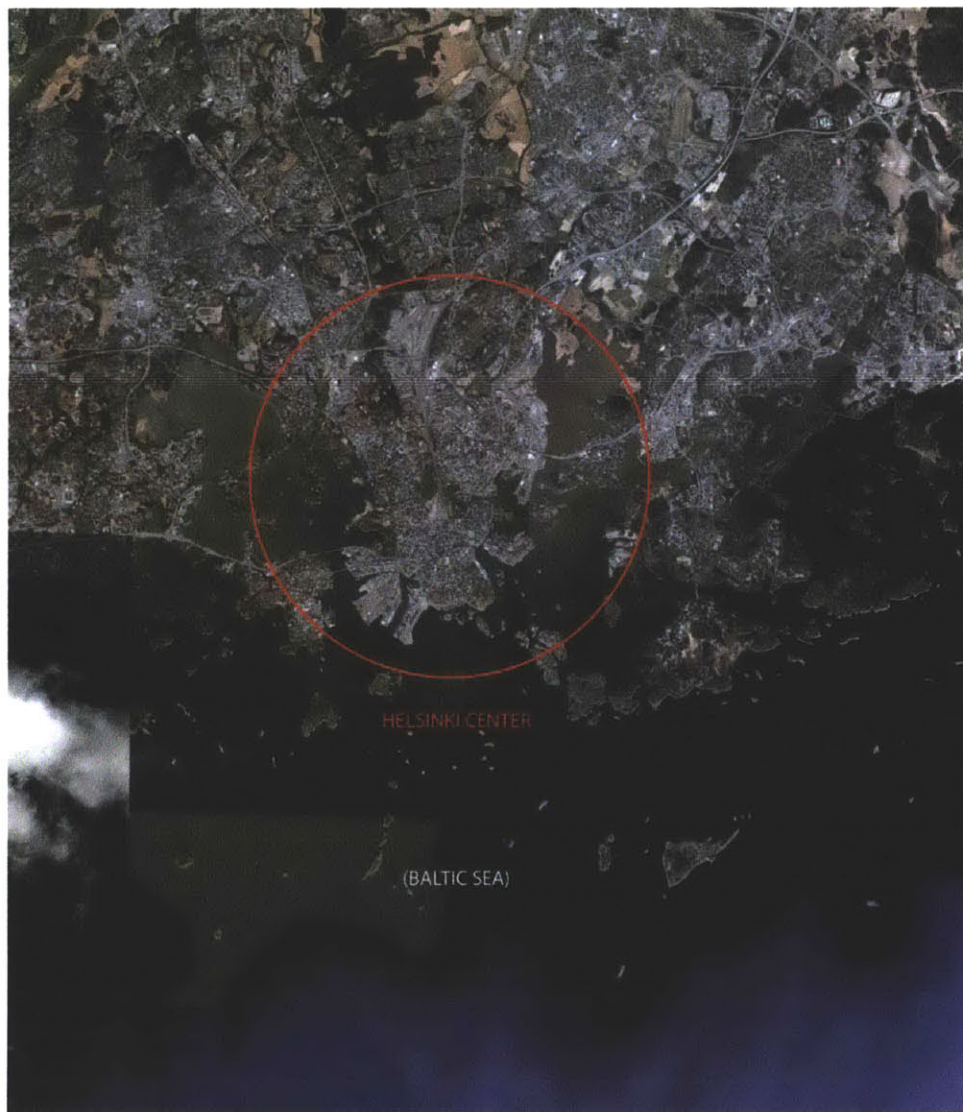
Changes in environmental conditions are a catalyst for adaptive response in cities. Similarly the shift in changing economies (away from industry and large-scale production), densifying populations, and the expansion of development to the previously industrial edge represents a departure from the set of forces that previously governed the success, failure, and form of the port city.

Cities have adapted to change in the past. Adaptability as a design preoccupation entered the discipline of architecture and urbanism in an attempt to direct cities towards being responsive and resilient. These attempts have been inconclusive. Additionally, the phenomena to be adapted to are new, and in particular climate change brings urgency to the need for cities to re-figure themselves towards changed environmental, functional, and spatial conditions.

This study will explore opportunities of design to build-in adaptability, via what will be discussed later in the text as *expectant design*. The study's design aims to allow cities to adapt through participation, incrementality, and long-term behavior change. Climate change, deindustrialization, and increased demand on capacity represent the particular circumstances to be responded to. The ex-port city possesses a typology of inherent tools, situations, and possibilities such that it may be used as a site for case study in adaptation. The design will be made with the intention of producing a pilot project. The new district of Kalasatama in Helsinki, Finland is utilized as a site for design which, if successful, would serve as a reference for a range of urban situations facing similar issues. Although the intervention will be limited to Kalasatama, this area is to be understood as a testing grounds for a study in contemporary adaptation strategies.

Helsinki is an example of a de-industrializing coastal city that is confronting environmental change and consequent risk. This Nordic capital is undergoing urban change on a scale unprecedented for the city. Extensive harbor activities are moving elsewhere and large swaths

of land in the city core have been opened for development. These areas are slated for residential and commercial uses. Development is planned to occur over the next thirty years. It must be of lasting construction in consideration of projected environmental flux, but implemented within the context of uncertainty. This large-scale redevelopment challenge together with projected environmental change posits Helsinki as an archetypal site for this study's exploration of adaptability.



The site of study, and its condition as coastal. Image: Google Earth and the author.



Location of the site city in Europe. Image: author, base map: Wikipedia user Owen Blacker.



Aerial view of Helsinki, with a coastal and deindustrializing area in the foreground and upper left. Image: Wikimedia user Pöllö (accessed May17th, 2011).

Change in Coastal Cities

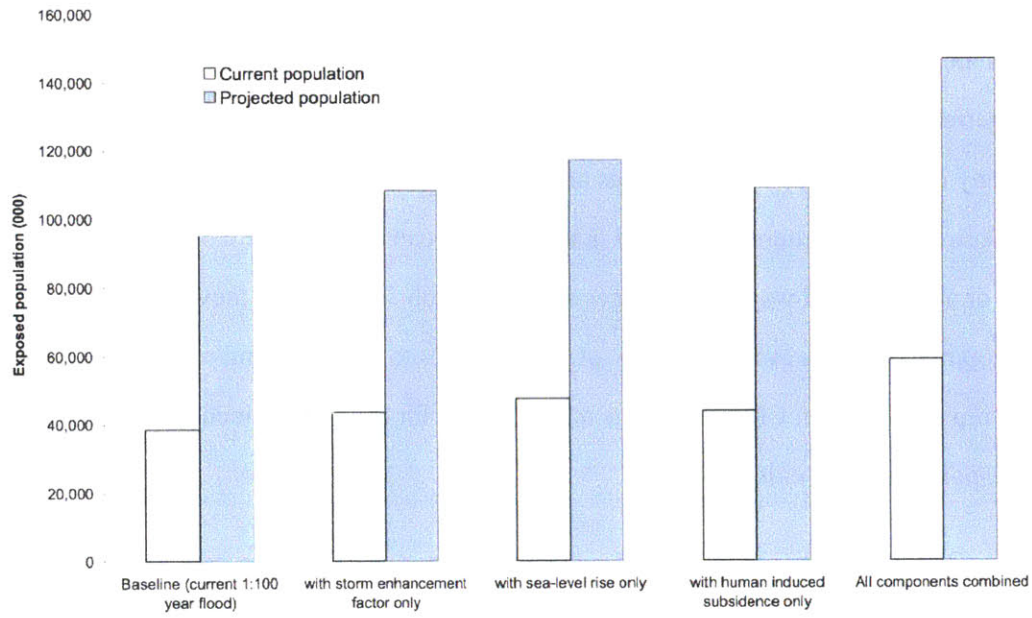
Climate change is viewed as a relevant form of environmental alteration that humanity experiences now, and will continue to contend with in the coming centuries. Climatic change and deindustrialization are explored as catalysts for adaptation. Within a broader study of adaptation through design, research concentrates on adaptation's form according to current changing realities in coastal urbanity.

Environmental Challenges in Coastal Cities

Cities near the sea have environmental issues by virtue of their siting. Ocean water can produce floods because of sea surge or water level rise due to climate change. Sea storms that degrade densely built space, infrastructure, and landscape in coastal cities are predicted to continue to grow in intensity and frequency (Pachauri, et al., 2007). The coast's edge is subject to retreat through accelerated erosion, and a weakened natural and urban structure in coastal areas is more predisposed to damage during extreme events. Deltaic areas where rivers meet seas may endure less predictable runoff events (Ibid.). Changes in groundwater levels or composition because of sea water intrusion can compromise structural integrity of some buildings and soil areas.

Urban settlement is influenced by, but also affects its surrounding marine ecosystem. Water quality can be seen as a base measure of the health of a coastal ecosystem. Runoff from coastal cities has a great influence on the diversity and abundance found in the adjacent marine habitat. Precipitation events are expected to increase with climate change (Ibid.), and runoff will increase in amount and decrease in quality due to denser settlement (Ellis, 1999). A facet of adapting cities to climate change considers their influence on contextual ecosystems. Runoff quality management in coastal cities is part of climate change planning. Climate change's acceleration of these issues acts as an impetus for reassessment of urban design's capabilities to cope with environmental problems.

A range of hard and singular technical solutions exist to address water issues. Ideally a more integrated, lasting, and engaging response to these hazards would be made while constructing a coastal city's urban form, in an attempt to build-in adaptive resiliency from the start. Many cities are, however, already built and adaptability through design must happen within an existing urban or semi-urban context, through retrofit or limited intervention. Lack of space due to the developed and dense urban form characteristic of coastal development dictates the needed



From OECD working paper "Ranking Port Cities with High Exposure and Vulnerability to Climate Extremes", 2007. Above, a comparison of impacts of individual and combined water level factors on global population exposure, based on present and future scenarios. Below, an image of 196 coastal cities with populations over 1 million in 2005. (Ibid.)



potency of designed adaptation.

Coastal cities are subject to such environmental problems as flooding, sea storms and sea level rise, coastal retreat, extreme precipitation events, groundwater-related subsidence, and salt water intrusion. Many of these environmental issues are present without the effects of an altering climate, and current weak patterns of coastal urbanity often can not mitigate damage, or does so in limited or short-sighted ways. Hard edges and narrow buffer zones (if they exist at all) in coastal development patterns limit the ability of coastal cities to negotiate and respond to their risk-relationship with the sea. Climate change adds urgency for the development of an adaptive strategy in response to these existing issues.

Coastal Cities, Risk and Spatial Challenges

By definition coastal cities, on at least one edge of their centralized areas, are bounded by water. It is estimated that 40% of the world's population lives in coastal areas, and that the population doubling rate happens in these areas faster than anywhere else (Hassan, et al., 2005). This data implies that a large population is subject to the environmental risk associated with coastal urbanity. This condition, combined with lesser spatial resources with which to cope, denotes an amplified vulnerability to the hazard of environmental change, and a lessening of readily available spatial tools.

Restrictions on growth due to geographical boundaries and the draw of development towards valuable coastlines cause water-proximate densification. Coastal areas often also constitute the older part of an urban center, and can have built fabric and infrastructure that is fragile and historically valuable. Alternatively (and as examined in this study) coastal areas are homes to industries that, through the process of de-industrialization, move elsewhere; hence new areas are available for densification and increase in built space and users. Great potential loss is possible

where city meets sea, as there is a wider exposure to a greater risk of water-related hazard.

This research focuses on coastal development within the context of deindustrialization. The movement of harbor activities outside of city centers leaves behind land for the construction of dense and fully-inhabited urban fabric. The previously industrial and lightly inhabited zones are transformed into dense, heavily used residential and mixed-use areas. As ex-harbors are coastal, their inclusion into regular urban fabric furthers coastal exposure, and constitutes the creation of increased vulnerability. Considering environmental change, the development of disused harbors is descriptive of exposure to climate change and impetus for adaptation.

Post-Port Urbanity: Common Challenges, Common Solutions?

Environmental shift poses risks to water-proximate human settlement by virtue of inherently vulnerable location. Climate change presents densely developed areas with an



Containers in Jätkäsaari coastal ex-harbor. Image :Timo Salmi.



Kalasadama post-industrial landscape. Image: author.

intensified hazard. Water-associated problems are often the most prominent and pressing effects of an altered environment that cities experience. This is evidenced by the many urban adaptation strategies that reference flooding as a primary concern (Katich, 2009).

The coastal post-port city is chosen as a typological site for urban adaptability strategies. In its circumstances are aspects of change divulgent of some of development's challenges now. A shift from industrial to urban space implies a greater accommodation of people and loss of "open" space (space of potential). A change in economy from industrial production and movement to consumption and smaller-scale commerce implies an associated shift in relationships to the adjacent sea. Coastal cities that are undergoing de-industrialization confront these problems regardless of their country or hemisphere of origin. Aspects of adaptation strategies are applicable to a variety of ex-ports, and the choice of a particular site is in attempt to ground the design in specifics of challenge rather than of place.

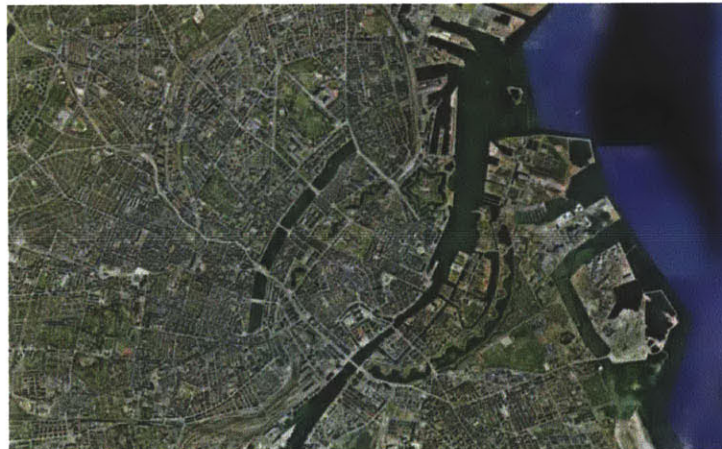
It is hypothesized that a similarity of possible adaptive solution may be found through design for a site that is viewed as typological. The site chosen for this study, Helsinki's Kalasatama, is used as a typological testing grounds to suggest adaptive solutions which are applicable in varying costal conditions. Adaptation for resiliency to water issues in post-industrial coastal cities may be addressed with common strategies and similar tools.

Within this study is an interest towards the creation of a widely applicable adaptation infrastructure and particularly in the expansion of its abilities into the public space realm. In an urban context the presence of protective infrastructural construction (such as a levee system) affects its surrounding community greatly. This effect can be positive, in the case that water infrastructure is also public infrastructure. The inclusion of programs outside of flood-protection infrastructure's engineered use becomes necessary in a densely inhabited context. The design employs a multi-functional and public infrastructure for the incremental building-in of resiliency

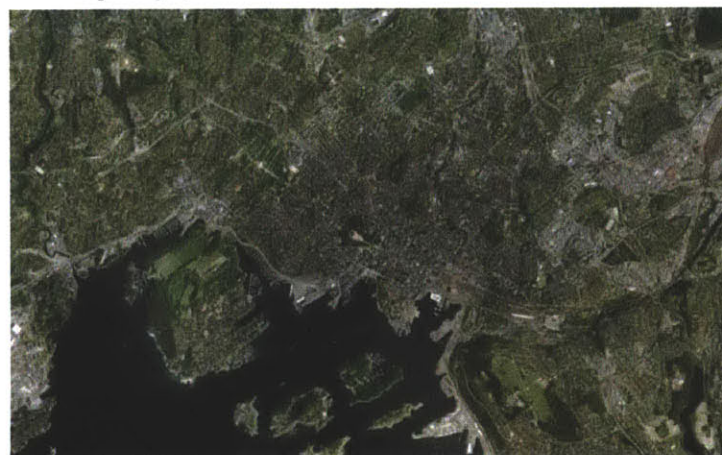
and flexibility through adaptability, appropriate for application in more than only the site chosen for the purpose of the study.



Stockholm, Sweden



Copenhagen, Denmark



Oslo, Norway

Coastal cities in the Nordic context. Images: Google Earth.

Building Resiliency to Coastal Challenges through Adaptation

As populations in coastal cities grow, spatial infrastructure is burdened with higher demands, and its tendency to thus degrade can lead to increased flood hazard. Water-proximate urbanity is presented with the dilemma of intensification of existing environmental problems with which it already struggled or failed to cope. Urban form and processes in coastal cities must reflect and respond to these conditions.

Cue may be taken from existing coastal projects as to how a resilient coast may be structured. Precedent studies of water-related urbanism inform the design work and represent a point of departure for further study in adaptive design.

Coastal urbanity faces particular challenges in respect to urban form and the environment. Water-proximity implies access to a wealth of resources, but not without risks associated with coastal environments. Dense urban areas have limitations in available spatial tools. The physical constraints of water on urban expansion coupled with dense and growing populations often lead to congestion and a tendency to build even in vulnerable areas. The conditions that these challenges, constraints, and demands create in coastal urbanity, when confronted with environmental change, necessitate new (yet retroactive) strategies for resiliency.

Urban Resiliency Strategies

In recent years, many schemes for resiliency in water-proximate cities have been created. Strategies utilize spatial and/or infrastructural, urban and/or architectural means to adjust coastal urbanity to the new and existing issues it faces.

Depending on the magnitude of risk and vulnerability, a buffer zone between city and sea may be provided for. In the best case, this is a landscaped and sloped area, helping to absorb flood water and to protect development from flooding (in particular due to extreme events). Use of this mini-flood plain as an area of brief storm water treatment is also an option. This planted surface may serve for the absorption, slowing, and filtering of rainwater runoff from adjacent development. Such a coastal water-resilient design is seen in parts of Michael Van Valkenburgh Associates' Brooklyn Bridge Park project, which proposes an adaptation strategy for Brooklyn in its confrontation with environmental change.

Space requirements for this strategy's efficacy are, however, large. Ex-harbors are often located in city centers, where land value is high and available real-estate is to be maximized for development. In this case an argument for a floodplain may be countered by the need to accommodate residents, for example, or to produce taxable land. Soil pollution is common in

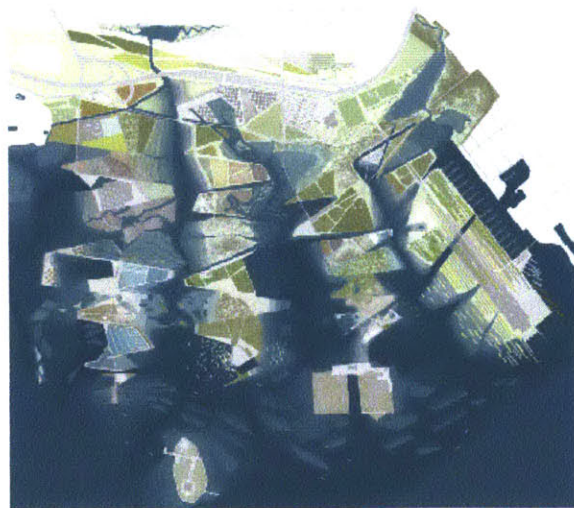
post-industrial areas, and only in the case where an area is prohibitively damaged or unbuildable because of structural instability is it feasible to introduce a area that is empty by design.

If resources and spatial need exist, it may be an imaginable solution to extend landscape into waterspace. In the case of Lewis, Tsurumaki, Lewis Architects' proposal for the *Rising Currents* Exhibition in New York's MoMA, a landscape is extended and crenelated so as to create more intermediary space between urban development and ocean water. As seen in the previously discussed strategy, this landscaped area may be used for storm water treatment as well. Polder filling in the Netherlands also utilizes land extension for the creation of further usable space.

A wide base of resources is needed to fund such a design, and it can be technically and spatially challenging. Erosion of an extended landscape can be problematic unless reinforced by costly and potentially invasive structure. The filling process itself can be very disruptive to surrounding marine ecosystems, and in the



*Michael Van Valkenburgh Associates Brooklyn Bridge Park.
Image: Michael Van Valkenburgh Associates.*



*Lewis Tsurumaki, Lewis Architects' Water Proving Ground.
Image: Lewis Tsurumaki Lewis Architects.*

delicate cases of estuaries, for example, it is not an appropriate solution.

Harbor areas are often initially built with hard, industrial edges. To add onto this with a naturalized mask of landscaping is against the history of such places. In harbor development, although hard edges do present increased risk of flood damage and urban runoff into adjacent water, in many cases it is historically and physically not a fitting adaptation strategy to modify edge conditions so as to create a filled landscape.

Elevation of an area is a flood protection option, and has been implemented in developments such as that in HafenCity, Hamburg. This particular ex-harbor area's buildings are to be constructed on seven and a half to eight meter high plinths. Elevation places the built area out of reach of a predicted flood zone, and leaves ground floors for public and nonresidential program (or parking). Some streets and other infrastructure are also elevated. This allows for a residual topography of raised spaces and ample public areas on the ground floors of buildings.

This adaptive adjustment is, however, not without large financial and time investment. The raising of entire districts (or cities) is at this time prohibitively costly in terms of resource investment. The elevation of built space does provide some protection from a predicted flood event, but in the case of HafenCity, the hazard of the everyday, storm water, is not accounted for. Criticism may be pointed towards to use of hard materials in the project, and the lack of measures taken to retain and filter rain that will inevitably fall onto the water-proximate site. As provision is not taken to adapt to changed environmental forces of increased precipitation, water quality in the adjacent river will not greatly improve on the account of the HafenCity development.

Flood Infrastructure

Water protection infrastructure is of particular interest for the study; flood walls, dams, sluices, and moveable barriers in particular are an unexploited category of flood-protection devices. Flood management projects by the Dutch group DeltaWorks show the magnitude to which such infrastructure can be built. Dams and levees are not solutions to flood hazard in themselves as they are inflexible, singular, and mono-functional, but they are specific and concentrated in their effect.

These types of proposals, although successful in some areas, lack an agenda of adaptability and flexibility. A successful adaptation strategy considers several different spatial and temporal scales, and is implementable in part as well as whole, allowing users and cities to engage and intervene with, and to change the course of, the adaptation strategy. Through neglect of public discussion and input, totalism and immediacy of implementation scale, or presentation of the plan as finished and finite, these designs fail to be flexible and adaptable, and thus prevent the possibility of long-term and situation-appropriate adaptation.



Deltaworks' Haringvliet Dam, the Netherlands. Image: www.teampolytech.com (accessed May 17th, 2011).



HafenCity's urban plan. Image: HafenCity Hamburg GmbH.



HafenCity's plinth strategy. Image: HafenCity Hamburg GmbH.

Non-Structural Adaptation

Non-structural forms of water hazard response such as regulation, warning systems, and evacuation as mentioned by Gilbert F. White in *Human Adjustment to Floods* (1945) do potentially provide more flexible solutions to flooding, but perhaps are best when used in combination with other means. Also of importance from the work of Gilbert White is the concept of the “range of choice”. This introduces a variability of commitment within adaptive response to flooding. As a non-structural adjustment, behavioral change of coastal populations towards a preparedness for water events and greater acceptance of water in everyday life would build-in flexibility to a water-proximate area. Acceptance of flooding as a possibility would motivate the siting of coastal space so that excess water could have less impact. Built space could be constructed so as to anticipate or expect changes in nearby aqueous environments. Connections to and familiarity with water could be brought into public discussion and opportunities for recreation. Water, as an environmental force, could be integrated into the fabric of city space. This type of large scale construction practice and behavioral change allows a flexible form of adaptation, but is significant and would only be feasible over a long time span. This requires a fundamentally incremental and very public approach.

Before further discussion on design for adaptability, the terms used in the study of adaptation in design will be grounded through definition. A historic look at attempts at building-in adaptability (to various versions of change) both informs the design project’s lineage and sharpens its concepts of what adaptive design, in principle, is.

Adaptation and Adaptability:

A History of Adaptation and Adaptability in Design

Past attempts at fostering adaptability through design have, as described by Hashim Sarkis, included concepts of expandability, versatility, convertibility, and fluidity (Sarkis, 2009). Adaptation for resiliency to climate change is a current form of adaptability in design. It is focused on in this study because it is a pressing incentive for the building-in of adaptive strategies in the planning and construction of cities now. The language of “adapt” as set apart from “change”, and exploration of the root and extensions of the central term provides a foundation for a historic study of adaptability in design.

Adaptation's Relevance Now: Environmental Shift

Within a greater interest towards responsiveness through design, this study focuses on the role of adaptation in reaction to the current and pressing issue of climate change. Adaptation to climate change entered as a significant and lasting language with the publishing of the 1995 *Intergovernmental Panel on Climate Change 2nd Assessment report, Working Group II: Impacts, Adaptations and Mitigation of Climate Change: Scientific-Technical Analyses* (Marufu, et al., 1995). Here the task of adaptation in the built environment is called to the reader's attention, and adaptability of a system to climate change is described as the extent to which adjustments are "possible in practices, processes, or structures of systems in response to projected or actual changes of climate" (Ibid.)

This study's connection of natural hazards research (via climate change, White's *Human Adjustment to Floods*) to adaptable design (particularly in late modernism, Team 10, Yona Friedman, N. John Habraken) is manifold. Climate change, a hazard (although arguably unnatural) presents current coastal urban situations with impetus for adaptation, in order to simplify or reduce vulnerability. A city's ability to adapt is dependent upon an inherent flexibility and potential for change; in other words, it's adaptability. Adaptability in architecture and urbanism has been pursued in the past, however, under different guises according to sociocultural and environmental conditions at the time. In the case of adaptable design in the 1950's - 1970's, adaptability was sought after as a response to the environmental change and degradation imposed on cities by the rise of mass and standardized solutions in housing (particularly that of the existenz-minimum tradition carried out by Ernst May and others). Standardization, single-use, and the associated anonymity was the environmental force to which adaptable design fought against during the period following the dissolve of the CIAM group (Risselada, et al., 2005).

These conditions were, to adaptable design at the time, as the hazard of climate change is to

cities today. The challenge that environmental change (which is for the purpose of this study, that of water) presents city's now calls again for design to propose an adaptability. Although climate change is, as standardization was, imposed by human action, its resultant effects appear within the realm of natural hazards. Thus adaptable design now confronts again the need for adaptability, but in response to a much larger, unpredictable, and less static force.

This study argues the importance of adaptability of design in climate change adaptation. Past attempts at building resiliency have failed in part due to their inflexibility and inability to change according to environment or to accept change on the part of the city or user. "Adaptability" in this thesis addresses not only the ability of an urban system to adapt, but also an adaptation strategy's ability to respond to unforeseen change in environment, and towards the changing user and his/her fluctuating needs. Issues of uncertainty in climate change, financial risk, shifts in city government and policy, and user participation contribute to the need for adaptability in climate change adaptation, and will be discussed at length later in the text.

Climate change constitutes an essential example of what is discussed in the study as "environmental forces". This alteration of the physical context of the built environment is the most prominent impetus for a re-thinking of adaptation and adaptability in urban design now. As other challenges in the physical environment have called for adaptation and adaptability in the past, climate change does now. The definition of terms and the analysis of past attempts at adaptability in design ground this study's further work in designing for adaptation.

Definitions of Terms

To adapt is to adjust so as to "make fit, as for a specific new use or situation" (Babcock Gove et al 2002). Adaptation is defined in common terms as "adjustment to environmental conditions" (Ibid.). The root word has enjoyed several associations and extensions of its meanings through

history. This study touches on key points of this language's development in order to inform an inquiry on how the contemporary usage of this term in urban design and architecture has come to be.

The language of adapt is set apart from that of change. "City" will be used as an example site where these two phenomena take place, and where they may be demonstrated not to be one in the same. Both change and adaptation have been strong mechanisms in the development and survival of cities; urbanity depends on its ability to respond to its context, both physical and structural (i.e. economy), and to renew itself from within. Diversity of actors and resources, so characteristic of urban centers, is part of what enables change and adaptation. The significance of these qualities in past attempts to build-in adaptability will be discussed later in the text. Firstly, it is of importance to the study to distinguish the difference in terms considered.

Change versus Adaptation in Cities

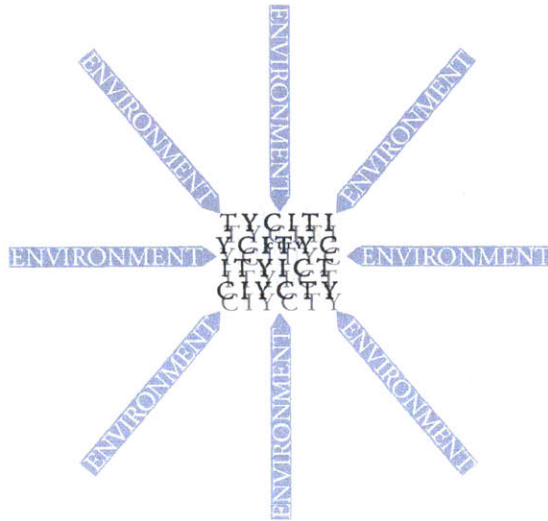
Change in cities is a difference from one state to the next, originating from agents that are part of the composition of the city. Cities survive and continue because of causal innovation and renewal. Internal mechanisms such as local capital and commerce, locomotion, and population makeup are parts of the city system are constantly updating themselves. Change that sustains and renews cities happens within these structures that comprise urbanity, and is constituted by difference from one state to the next. These systems are inwardly focused. The city is the structure that maintains their correspondence. Such systems and components are the tools for growth and change. In the research, it is noted that change as a term connotes an alteration, and does not extend to describe a reflective correspondence to a contextual system of forces. In this sense the language of change is self-referential, and does not immediately describe a causal and responsive relationship.

Adaptation of cities is in dialogue with outside forces or interior dynamics. Conditions or contextual changes that oppose the urban system, which press against the potential success of its functions, are those to which a city adjusts and thus adapts. Adaptation is a response that is made in attempt to continue relative patterns, encourage development, or maintain survival. Forces to which a city adapts are from changes in its context or interior dynamics. Environmental forces can press on urbanity from without and can be of meteorological or geological nature, in the case of natural disasters or environmental hazard. Economies, resource shortage, war or social disruption, and immigration can unbalance urban dynamics and create interiorized conditions to which cities may adapt. Forces that arise to alter urban systems so as to produce an unbalance between city and context, or disrupt relationships within urbanity, are impetus for adaptation. Climate change and redevelopment are altering forces and dynamics in coastal cities.

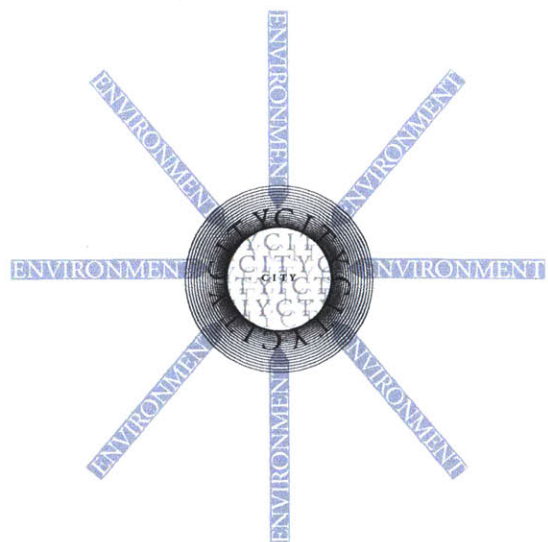
Change describes isolated difference made through tools or internal actors, whereas

CITY TYIC

Diagram: Change in cities. Image: author.



Effect of environmental forces and changes in interior dynamics in the city. Image: author.



City structure adaptation to environmental force and flux of interior dynamics. Image: author.



Limits of the Nile River floodplain, demarkated by agriculture. The adaptive use of raised topography evidences borders of previous flood barriers. Image: Flickr user "Empirically Grounded" (accessed May 17th, 2011).

adaptation is particularly linked relationship of a system that responds in a reactionary way to an environmental or dynamic shift. There is often a particular externally to this force, and can be seen as something different that from isolated change that occurs and originates from within a system. An example can be taken that the Nile river valley adapted to flooding that occurs at regular intervals whereas the innovation and proliferation of the Otis safety elevator changed New York City. (Hombberger et al., 2005)

Adaptation in Myth

The Flood Myth of the Book of Genesis describes adaptation to the extreme. In this text is a poetic epitome of human response to what is not only flux in a settlement's contextual environment, but a collapse and decimation of that system. This story is a reference for urban adaptation studies and action.

"14 Make yourself an ark of gopher wood; make rooms in the ark, and cover it inside and out with pitch. 15 This is how you are to make it: the length of the ark three hundred cubits, its breadth fifty cubits,

and its height thirty cubits. 16 Make a roof for the ark, and finish it to a cubit above; and set the door of the ark in its side; make it with lower, second, and third decks. 17 For behold, I will bring a flood of waters upon the earth, to destroy all flesh in which is the breath of life from under heaven; everything that is on the earth shall die. 18 But I will establish my covenant with you; and you shall come into the ark, you, your sons, your wife, and your sons' wives with you. 19 And of every living thing of all flesh, you shall bring two of every sort into the ark, to keep them alive with you”

“17 The flood continued forty days upon the earth; and the waters increased, and bore up the ark, and it rose high above the earth. 18 The waters prevailed and increased greatly upon the earth; and the ark floated on the face of the waters. 19 And the waters prevailed so mightily upon the earth that all the high mountains under the whole heaven were covered; 20 the waters prevailed above the mountains, covering them fifteen cubits deep. 21 And all flesh died that moved upon the earth, birds, cattle, beasts, all swarming creatures that swarm upon the earth, and every man; 22 everything on the dry land in whose nostrils was the breath of life died. 23 He blotted out every living thing that was upon the face of the ground, man and animals and creeping things and birds of the air; they were blotted out from the earth. Only Noah was left, and those that were with him in the ark.”

Dundes, 1988, quoting with permission the The Book of Genesis : From the Revised Standard Version of the Bible. Division of Christian Education of the National Council of the Churches of Christ in the USA. 1971.)

In the Bible's Flood Myth the Ark is the structure that enables the continuation of humanity and animal life. The flood is a complete and total alteration of the characters' milieu and the settlement's habitat. The context of settlement is effectively erased, and thus the complete substitution of Ark-as-city is made in adaptive response to the environmental force. Because the initial change is total, it necessitates a complete adaptation. Adaptive adjustment is embodied in the Ark: the bastion of resiliency amongst disaster. The Ark as apotheosis of adaptive action, and as an infinitely resilient space, is a primary source of inspiration for this study.

Human Adjustment to Floods



The Ark as infinitely resilient and "expectant" space. Image: Edward Hicks's "Noah's Ark", 1846. Image courtesy of the Philadelphia Museum of Art, Philadelphia.



The mound-building Kincaid Site in Massac County, Illinois. Painted by Herbert Roe, 2004.

Contemporary discussion of adaptation has its roots in natural hazards research. Adjustment to flooding was central to the founding of natural hazards research, and the study of human settlement as habitat or ecology (Hinshaw, 2006). In his 1945 PhD dissertation *Human Adjustment to Floods*, Gilbert F. White discusses the methods by which civilization and cities adapt to flooding through what he terms "adjustments" (White, 1945). These adjustments to changes in contextual water environment are as follows: " 1) land elevation, 2) flood abatement, 3) flood protection, 4) emergency measures, 5) structural adjustments, 6) land use, 7) relief, and 8) insurance." (Ibid.). These options for adjustment to the particular environmental force manifest in flooding are discussed at length in the text. White addresses the advantages and disadvantages of adopting these methods for responding to water hazard and change.

Numerous brief case studies are made within White's text of cities or communities that have adapted to flooding. White cites the practice of

mound-building by Native American tribes along the Mississippi river as a mode of protecting settled areas from the river's changing flow, as well as the temporary fashion of building houses on cedar posts in New Orleans. Relocation and reconstruction as modes of adaptation to environmental hazard along the Savannah River in South Carolina, Chicago, and various other locations are referenced in exploration of modes of adjustmental action (Ibid.).

White mentions the Flood Control Act of 1936 in the text, in a discussion of means of reinforcing responsiveness to environmental force associated with water. There are, in fact, nineteen different flood control acts. These legally binding constructs authorize the construction of flood-control technology (dams, levees, etc.) by the U.S. Army Corps of Engineers, and mandate that adaptive action be taken to response to flood risk (US Army Corps of Engineers, 1936). This is, in effect, law intended to force adaptive action through structural adjustment and posits the question of authority within the theme of adaptation.

Structural and Non-Structural Adaptation

White's discussion of *adjustments* contribute greatly to conceiving of technical and land-based aspects of an adaptation strategy. His adjustment strategies are fairly straightforward and are projects of engineers, city officials, and labor forces. The text speaks of adjustment through structured flood protection strategies, as it does as well mention non-structural changes such as regulations. It does not, however, address complex urban behavioral aspects of adaptation, nor does it discuss at length terms of program or engageable space specifically functioning so as to render a place adaptable. While White's work does not explore multi-functionality and creativity of adjustment, it is an example of adaptation study that directs its energy towards adjusting to a specific environmental or dynamic force. White embarks on the discussion of the benefits of adjustment, but does not fully arrive at the possibility of multi-functional adjustments. The proposed methods of action are somewhat heavy handed and singular, but are without ambiguity

that is often seen in attempts to respond to environmental change and hazard.

Adaptation in the Netherlands

Implementation of flood adjustment mechanisms as mentioned by White can be seen in the development of places that have a long history of living within close proximity to water hazard. Adaptation research is particularly active in the Netherlands, where both issues of changes in environmental force and interior dynamics abound. A watery and flood-prone landscape and a growing population for whom not enough space is available has led to adaptation strategies that respond to both the force of potential flood and the need to “grow” land. The construction of dams in order to drain rivers and open up polders as developable space began as early as the 11th century (Hooimeijer et al., 2005). The low, deltaic landscape, and the growing population of the Netherlands establishes an history of adaptation, particularly in relationship to water. Already by the 16th century, adaptation to flooding hazard was “perfected with the help of sluices and mills” (Ibid.)

City structures like those in Amsterdam, the Hague, or Rotterdam demonstrate the use of adaptation as a historic component of the built environment, in this case to flood hazard (Ibid.). Factors such as lack of space, an expanding population, and abundance of water in the landscape led to adaptations of the landscape like polder and coastal lowland infill. Hard and singularly-programmed adjustments such as flood walls, dikes, sluices, and pumping systems maintain the livability of cities in areas vulnerable to flooding. This particular family of adjustments and consequent development is linked to the way in which Dutch cities now confront the environmental forces of water, which is expected to grow significantly in the following centuries, due to climate change.

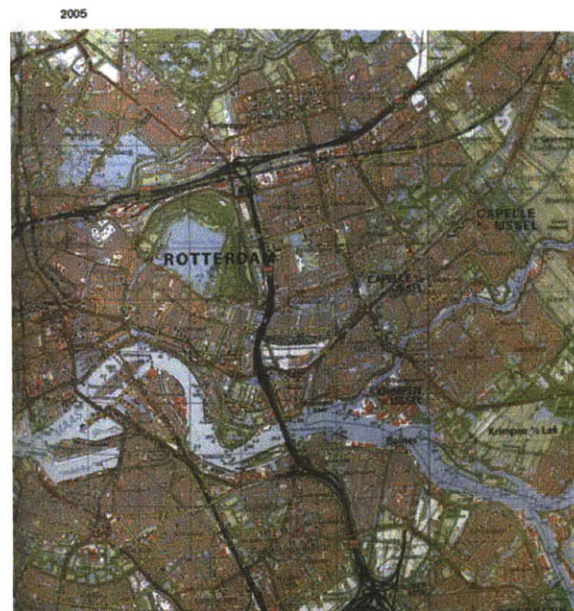
Hazard response characterized by heavy and singular interventions is described in the planning of Dutch coastal and lowland cities. Adaptive action here is, as seen in White's *Adjustments*, thus far mono-functional. Single-program adjustments are underexploited for their dormant potential as multifaceted entities, and are in this case built to fulfil infrastructural purposes only. A further iteration of such systems would be to include flexibility (to uncertainty, changed circumstances, etc.) throughout implementation processes, as well as to make publicly engage-able the infrastructure itself.

Designing to Foster Adaptability

Flood infrastructure and adjustment is made with the intention of adapting a settlement to an external force. Adaptation is a process of response of a system to an external force or interior dynamic; this response is made as a means of preservation or proliferation of that system. A similar but alternative stance towards adaptation is taken from the viewpoint of the user, in his/her ability to adapt a system



Polder infill in Rotterdam shown through historical map comparison (1850 above and 2005, below). A method of adaptation, which proves maladaptive in the context of altered conditions such as climate change. Images: Uitgeverij Sun.



(urban space) to her/himself. To say that a place (a city for example) is adaptive is to describe it as resilient and able to receive and react to change. As a quality that can be integrated into a design this is termed as adaptability: the ability of a system or element to adapt. Adaptability of city space has been a recurring theme in urban design, with a particular lineage beginning during late modernism.

Design that is oriented towards adaptability arose first as a strong theme in the work of Alison and Peter Smithson and was adopted by members and associates of Team 10 (Risselada et al., 2005). Alternative incarnations of adaptability in design were to be born contemporaneously and subsequently, as seen in the ideas of Yona Friedman (Lebesque, 1999), N. J. Habraken, and consequent development of “open” housing in the Dutch tradition (Frans van der Werf, 1993).

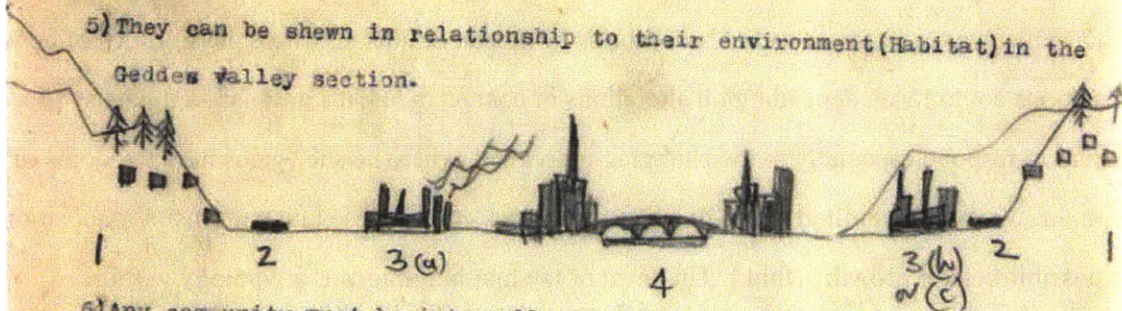
A.P. Smithson, Team 10

Adaptability entered architecture and urbanism thought through work of the Smithsons and Team 10. Already in 1954, the Doorn Manifesto mentions the term “habitat” (A. Smithson, 1954). This language comes with the associations of growth and change; concepts so fundamental in the ideas and work of Team 10. Habitat implies a responsive, evolving relationship of parts to whole, and of systems to forces. For a habitat to continue life, it must adapt itself to a changing context or internal relationships. “Habitat” references a system in which adaptability is inherent. The use of this term foreshadows the importance of designing for responsive relationships to a changing milieu in the work of Team 10.

" HABITAT "

SMITHSONS

- 1) It is useless to consider the house except as a part of a community owing to the interaction of these on each other.
- 2) We should not waste our time codifying the elements of the house until the other relationship has been crystallised.
- 3) "Habitat" is concerned with the particular house in the particular type of community.
- 4) Communities are the same everywhere.
 - 1) detached house - farm.
 - 2) Village.
 - 3) Towns of various sorts (Industrial)
(Admin.)
(Special.)
 - 4) Cities (multi functional).



- 6) Any community must be internally convenient - have ease of circulation, in consequence whatever type of transport are available, density must increase as population increases, i.e. (1) is least dense (4) is most dense.
- 7) We must therefore study the dwelling and the groupings that are necessary to produce convenient communities at various points on the valley section.
- 8) The appropriateness of any solution may lie in the field of architectural invention rather than social anthropology.

Team 10's Doorn Manifesto. The title of "Habitat" is revealing of Team 10's design aspirations towards growth and change.
Image courtesy of NAI Publishers.

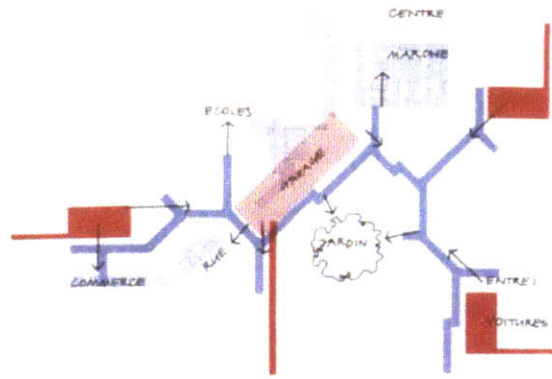
Team 10 regarded accommodating “the phenomenon of total life” as a primary task of design (Bakema, Carré Bleu 1961, as quoted by A. Smithson, 1966). Architecture was to respond to changes of its inhabitants through time, both on a life and daily scale. Projects like Toulouse Le Mirail of Candilis, Josic, and Woods use a patterning of housing types in an attempt to compose a flexible residential system that offers possibilities for the single, couple, or family inhabitant. The formal development of this particular project grows from what the group termed the “stem” (Candilis, 1980). In its form this connotes a live, growing, changing entity. The intention of such design is to provide for changes and alterations through time, especially in regards to program and association.

So-called “Mat-buildings” (A. Smithson, 1974) were particular habitats for adaptive potential to root. They were seen more as fields or fabrics by Alison Smithson, where possibilities of new interactions could form, depending on alterations in context dynamics or inhabitant needs. The mat was to respond especially to the changing individual, where he/she “gains new freedoms of action through a new shuffled order, based on interconnections, close knit patterns of association and possibilities for growth” (Ibid.). The form of the mat-building was a typology within the Team 10 language that worked to answer the need for a reflectivity of the user in his/her surrounding architecture. Ideas of freedom of the user for the creation of new uses and meanings in urban spaces was a founding ideal of the group, and a particular issue in Alison Smithson’s writing.

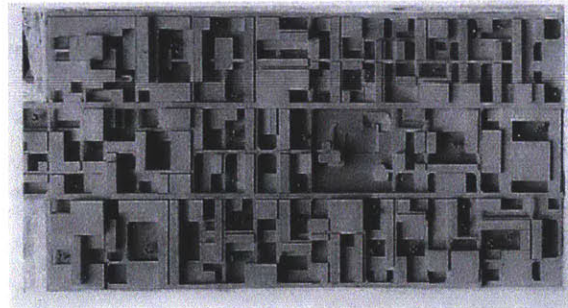
In building typologies typical of the group, such as the mat-building, the employment of a loosely structured patterning of neutral or repeating forms in generating architectural and urban form can be seen. This process was to generate spaces that performed as templates for the user and uses to imprint themselves, and the loose structure was to provide support for growth and change that, according to the group, was so vital to the survival and success of built space.

The residual and public space of Team 10's architecture intended to balance the designed space with the open field, and to thus extend an invitation for other uses and associations. In this structured openness, however, grew a no-man's land where it became unclear to what was one supposed to react. Instead was a homogeneity that lacked moments of intensity which might otherwise lend the design's legibility and consequently the imagination of its potential use.

Inhabiting the courtyards of Candilis, Josic, and Woods's Freie Universität Berlin, one notes the importance of repetition of nondescript elements in the design, as seen in other Team 10 public space schemes. This patterning communicates itself almost as a stage set would, providing a platform for anything, which in view of the current use of the buildings' courtyards, is often interpreted as nothing. It is perhaps the scale at which the change-responsive scheme for the project was executed, but the perception of potential adaptation inherent in the project's spaces does not communicate itself with the immediacy and clarity with which it was perhaps intended.



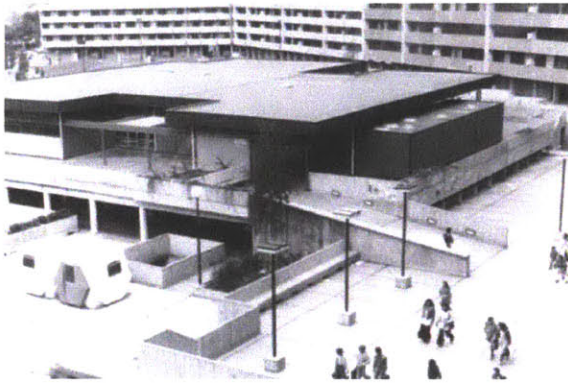
"Stem" concept sketch by Candilis, Josic, and Woods', showing Toulouse Le Mirail's formal relationship to program, circulation, and public space.



Candilis, Josic, Woods Berlin Free University courtyard structure. Images: NAI Publishers (above) and Wikipedia user Torinberl (below).



This desired flexibility towards and responsiveness to change in the work of Team 10's members brought adaptability to the fore in the discussion of architecture and urbanism in the late 1950's and beyond. A major debt is owed to the bravery with which the designs and writings of the group approached the topic of adapting and changing in a discipline that was founded on a quest for permanence.



The public spaces of Toulouse Le Mirail, consisting of open space or low-rise freestanding buildings and pavilions. Programs such as shopping centers or schools were built in the public spaces. Images: NAI Publishers.

It may, however, be analyzed the degree to which these projects succeeded in actually being adaptable. Focusing on the public spaces in the designs of Team 10, a pattern in the literal and figurative sense can be seen. Spaces are structured using a somewhat randomly inhabited grid scheme, and are made of hard finishes. The public spaces are left open, but often with a neutral spatial gesture meant to engage the open space. These focal points in the design fail to activate the field within which they occur, nor to provide spatial hierarchy. Again, analogies can be drawn with the nature of these spaces to that of a stage set. Open, yet structured, hard, and in worst cases hostile in their absences (of texture, readability, and apparent effect of life or use) the public



spaces of this era that so wished to host “freedoms of action” (Ibid.) remained unchanged.

Spatial Finality

What prevented the designs of Team 10 from achieving an adaptive dialog with growth and change, and from inviting public participation and adapting to community needs? Why were these platforms for action not adopted and taken advantage of by their communities? Questions that warrant further investigation may be addressed by discussing the “finality” of the spaces of Team 10. Their consequence and value to the designers as grounds for collective interaction and community participation perhaps led to their being designed fully. This completion, in combination with the intended program and consequent openness, hard surfaces, and patterning that was so often employed for formal generation, leads to an impression of finality and thus sterility.

Should some of the spatial aspects have been left less smooth, less closed, less predictable, while simultaneously being less ambiguous, the designs could have taken on much in terms of adaptive potential, and perhaps would have invited more warmly the inhabitants’ and users’ engagement. There is additionally a lack of specificity to the adaptive capacity of the Team 10 designs. Openness abounds in an aim of flexibility, but a description of to what a design might want to adapt (in terms of a spatial or dynamic force) is not pronounced.

Naturally, in an architectural scheme, why should spaces be left undesigned, unfinished? The role of the architect has traditionally been to draw and build how objects and spaces should be. Designing is to designate use, material, and enclosure to construct a space. When working with an aim towards adaptability, particularly in response to needs and desires of the user, an alternative viewpoint on the finished construct may be taken, and will be discussed further in this study’s chapter on design.

Infill and Open Design

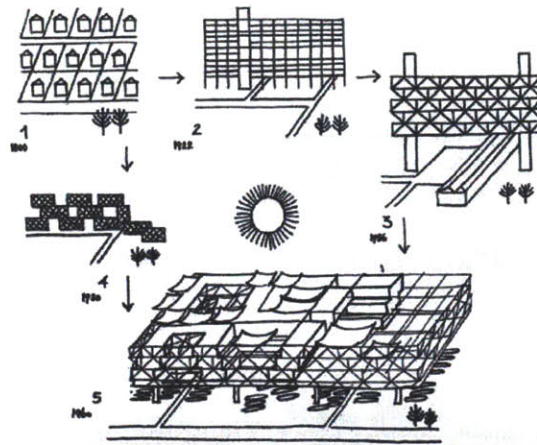
Infill design formed a direct and radical approach to user participation in the design of built space and a changed role for the architect. It defined an attempt at adaptability towards the environment and changing dynamics of the user. Yona Friedman's 1956 presentation of "Manifeste de l'architecture mobile" at the CIAM conference in Dubrovnik marked a major moment in adaptive design history (Lebesque, 1999). This work, along with Friedman's La Ville Spatiale, promoted the establishment of concepts of inhabitant-assisted construction (both physical and programmatic) in the modern architectural and urbanistic conversation. L'Architecture Mobile was comprised of "a system of construction that allows the occupants to determine the design of their own dwellings" (Ibid.). This concept was enabled by La Ville Spatiale, that employed a supportive infrastructural infill system very similar to a concept described by N. J. Habraken in *Supports: An Alternative to Mass Housing* (Originally published in Dutch in 1962). The ideas developed and depicted by Friedman in these central works aimed to integrate adaptability to the user's needs and preferences into everyday design, by way of the user's own participation in planning and construction.

In the work of Yona Friedman (and others mentioned later in the text) the engagement of the user in both designing and constructing architecture was in part an attempt at building-in adaptability. Infrastructure-supported infill or an adaptable kit-of-parts design, in their reliance on the user to complete or bring to life the design, denote participation of the inhabitant as a central concept. Adaptability was to be fostered by a dynamic and productive relationship with the user, who was assumed capable of inputting his/her own needs and preferences (interior dynamics) into the work and understanding the implications thereof. The user was also given the responsibility of acting as an interlocutor between the end product (building, furniture) and environmental forces of the project's context. This is seen on several scales in Friedman's work, from the Paris Spatial to the 1991 Chairs with Rings (Lebesque, 1999). A distinct openness in design and a desire for

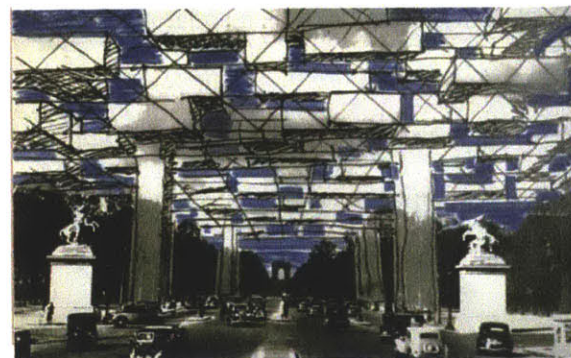
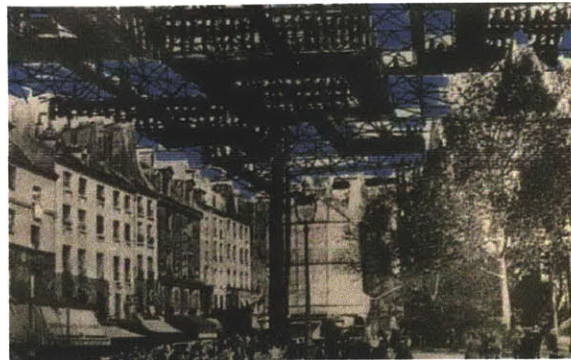
interpretation is felt in Friedman's work, as well as others who invoked the infill.

As a reflection of Friedman's political stance in design, in some projects the concept of infill architecture took on the meaning of "Self-Help" design, as the act of building would allow the user to construct his own shelter, tailoring it to his needs and establishing his independence through its construction (Ibid.). This is seen in such projects as the 1982 Communication Centre of Scientific Knowledge for Self-Reliance. In this and other projects, manuals for construction and spatial / programmatic layout were devised by Friedman. These were to be given to communities as adaptable texts that would assist them in initiating and developing projects. More so than the infill design and support structure, these manuals were to give the user both the freedom and knowledge he/she needed to construct a dwelling catered to her/his needs and environment.

Flexibility and adaptability in design as a response to the dynamic of the user and place is a theme in Friedman's work. Throughout his



Illustrations of Yona Friedman's 1956 L'Architecture Mobile. Image: NAI Publishers.



Images from Yona Friedman's 1959 Paris Spatial. Images: NAI Publishers.

career, his writings and projects developed adaptive design via user participation. In the use of instructions and kits of parts, an attempt was made through engagement to allow a customization of the design to the user, and to thus bring his/her independence through designing. An overall structure (or manual) was given, and the completion of the project is up to the needs of the user and the particulars of the environment. This was a monumental turn in architecture at the time, as it constituted a shift of the role and presence of the architect, as well as that of the inhabitant, in an attempt at making space that is adaptable.

N. J. Habraken's 1962 *Supports: An Alternative to Mass Housing* brought to life (and lively discussion) similar ideas of infrastructure, infill, and adaptability via user participation. The work systematically opposes the rigidity, finality, and inability of mass housing popular at the time to satisfy the needs and desires of its inhabitants (Habraken, English translation, 1972). The "Support" system is proposed as an alternative, and in its theoretical and formal implications, is similar to Friedman's *Villes Spatiales*. In Habraken's support city, platforms were to be physically and conceptually constructed as a means of enabling inhabitants to choose and construct their own housing, according to preferences, resources, and contextual forces. Again, this is a demonstration of architecture as originating from the architect only in its support and coercion of the user into the role of designer him/herself. For the success and implementation of the design, participation is mandatory. The project itself is never quite finished, as the inhabitants are offered the opportunity to update (and adapt) the architecture as their own dynamic and contextual forces change. The aim of *Supports* is, as in Friedman's constructs and manuals, the creation of an open, adaptable system that would, in its advantages that would be obvious to all, supplant architecture processes as they were known at the time (Ibid.).

Limitations of the Infill

Though the infill and open design concept does engage the dynamic system of the user, and

implies him/her as interpreter of environmental forces, are the architectural themes central in Friedman and Habraken's work the end to a search for adaptability in design? An inquiry into the components of this design theory may yield hints as to whether the work of these architects and their associates was adaptable.

The patterned systems resultant of both infill design and the structures of Team 10 constituted a kit of parts, and although those tools do have various interpretations, they are in essence finite. Interpretation of a manual or fill-in of the infill necessitate the adoption of a language, and that is of the architect and of the design. In the case that this language is incomplete and insufficient for the design task, use, or user at hand, success can not be expected within the constructs of the infill system. Similarly, if the infill or manual system's language (formal, material, and literal) is incomprehensible to the user, the adaptability of the design is reduced.

Relative success and adaptability of the infill design also depends on the willingness and abilities of the user. Whether or not the end



Drager Molenkruis in Poppendrecht

Image of an "Open" housing project, drawing inspiration from Habraken's discussion of infill. Image: Uitgeverij 010.

product interprets fully the user's interior dynamic or contextual environment hinges on the cognizance of the inhabitant of the tools available for use, implications of certain combinations, and his/her self- and environmental awareness. Should these aspects be limited, the design (and its adaptability) will be limited.

Infill systems utilize a narrow range of architectural intensity: that of infrastructure (support) and infill. This patterning as described in the work of Friedman and Habraken does not allow for a wide and broad spectrum of diversity in built space. Wide variability within a system and consequent diversity is part of adaptability and resiliency. "Distribution of risk" (National Research Council, 2000) as a concept in natural hazards research invokes diversity of a system as contributive to its ability to process hazard and to adapt in the case of change or disaster. An example of difference and intensity contributing to adaptability may be taken from Bangladeshi cyclone shelters, which in their comparative solidity and stability, weather climate upset much better than the average and commonplace housing. In this sense, the infill system in its lack of diversity is at fault; aside from the clear support-and-dependent relationship, a wide variety of spatial and functional qualities arising from hierarchy and difference is not present. Thus restriction is placed on the growth, ability to change, legibility, and variability of the infill.

Difference, Hierarchy, and Patterns

Patterning and homogeneity as seen in the aforementioned designed attempts at adaptability curtail the ability of a design to respond and be responded to. A hierarchy of space is part of the legibility of architecture and the city. It is as well an organizing force for space and program. Intensities in space and city fabric create difference and variety. This allows a space's and city's legibility. This is an opening for the interpretation of the user and allows him/her to apply new meaning to space and its use. If this variation and intensity does not exist, a space is illegible and participation of the inhabitant can not take primary steps.

Diversity of space is an aspect of adaptation as well as of distribution of change. Multifacetedness is an aspect of confronting external forces so as to spread exposure not evenly and equally among all but in a dispersed and varied manner. Should an environmental condition change, an assorted and nonhomogeneous system or space interprets that force in a mixed way and with multiple levels and intensities of affect, rather than being levelled as a non-diverse pattern would. Within a system designed for adaptability the example of the cyclone shelter should be made manifest. This is, however, lacking in the concepts of the infill.

In addition to varying intensity, specificity must be present for adaptability. Infill projects such the Samarkand, Uzbekistan (Friedman) are patterned structures that seek to be nondescript and functional supports that enable a variety of uses and adaptations. These are patterns of spaces or structure that offer a homogenous basis for development; this even spread and neutrality does not by default imply adaptability. These spaces can indeed house various programs, as can a nondescript hangar.

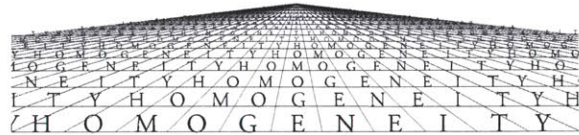


Diagram: Homogeneity as limitation to a system's ability to adapt. Diversity of resiliency does not exist, and thus evenly spread change decimates. Image: author.

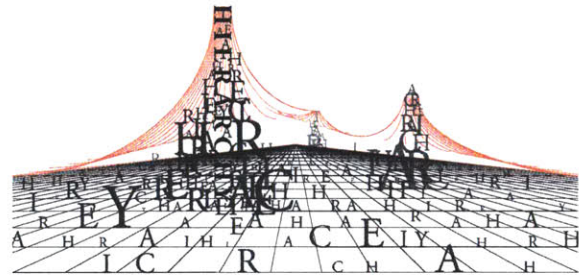


Diagram: Hierarchy. Creating intensities and diversity, hierarchy expands a system's ability to adapt. Varied spaces accept and react to change in a range of ways. After an alteration, partial systems remain to seed adaptation. Image: author.

Non-specificity does explicitly provide “openness”. Openness does contribute to adaptability, but is not in itself conclusive. An adaptive space must allow for specialization and hierarchy, and thus levy its construction towards some specific outside force to which it adapts. In an attempt to make way for the needs of any user or changed environment, both the infill tradition and concepts of Team 10 curtail the ability of their designs to react to the specificities that are present in dynamic or environmental flux. Instead of fostering distinct adaptability the architecture implies a nondescript openness.

Interpretation and Participation

The infill tradition vies for variability to spring forth from the participation of the individual. This is without a deep investigation into the nature of design interpretation. How can a user be best be involved in participation, and how can a designer communicate intent? The user-as-participant and designer relationship is a critical point in adaptive design. The designer should provide the sharpening of tools with which the inhabitant is to work, as well as imply a scaling out so as to enable the user to view him or herself within a greater system.

A theme in the works examined is the central importance of the individual. His/her experience, interpretation, and expectation of a space is central in designing for adaptability. Participation transfers partial responsibility of the success of an urban or architectural project to the inhabitant. A range is seen within the study from architecture that invites and depends upon the inhabitant to complete it (as in N. J. Habraken) to the importance of human presence in the role of a space’s activation (Team 10).

The faculty of interpretation and expectation should be, however, more deeply examined. Space can indeed, in the mind of the inhabitant, take on new meaning through his or her previous experiences and projections as to what future experiences should be. This faculty is a major

dynamic in adaptive design. To what degree can the inhabitant alter a space, or what must be present physically and in programmatic relationships to foster or initiate the dialog of user with space? *Expectant design* explores the facility of the user's expectations of spatial interventions so as to engage and activate her or his participation.

The power with which expectation influences a stance and engages space so as to alter it has not been fully exploited in existing attempts at adaptive design. Adaptation in cities must be framed in an alternative way so as to consider of the expectation of the user (individual or city), his/her heuristic structure, and must function to activate association and engagement. This facet constitutes a central strand of the design study.

Multiple Use, Multiple Meaning

In addition to participation, multiplicity has been a concept important to adaptive design. The past attempts mentioned utilize multiplicity as a tool for adjustment to change. Characteristics of multi-functionality and multi-meaning in a design allow the potential for multiple designs to be bound up in one. Within this is the aim of flexibility of an object or system to change and be adaptable.

In architecture's recent history the willingness of built space to encompass many uses and many incarnations (characteristics that contribute to adaptability) has had several moments of development, some of which have been mentioned thus far. Archigram's designs such as the Walking City were reflections of the desire of architecture to interpret change and to be able to react and adapt. The Walking City was to, through its movable nature, have multiple faces and an inherent multiplicity of possible dialogs with its changing context and user. The Fun Palace of Cedric Price, whose "ultimate goal was a building capable of change in response to the wishes of users" (Canadian Centre for Architecture web site, accessed May 17th, 2011) demonstrated the

dreams of architecture at the time, of a multiplicity utopia that created adaptability and infinite flexibility (Hughes, et al., 2000). These projects and others were not realized because in part because of their utopian nature, but they were nevertheless influential on realized constructions.

The Paris Pompidou Centre by Renzo Piano and Richard Rogers is a built example of an architecture that desires to address multiplicity. Designed in 1971, the Centre is in its primary program an art museum, but its essence is in the desire for adaptability to change. The building's goal of flexibility dictates not only its spatial qualities but also the arrangement of its technical systems, which are placed on the exterior so as to free up spatial ability for change on the building's interior. Upon entering the building, one has the sense of transient, fluctuating program as is felt in railway stations or public squares. The goal of loading the building with multiple potentialities results in a viscerally sensible absence. This void as a space for the inhabitant to enter via the insertion of his or her own interpretation is a facet of adaptability in design, but as an independent quality can result in the perception of ambiguity and absence.

Adaptable Architecture as Surface

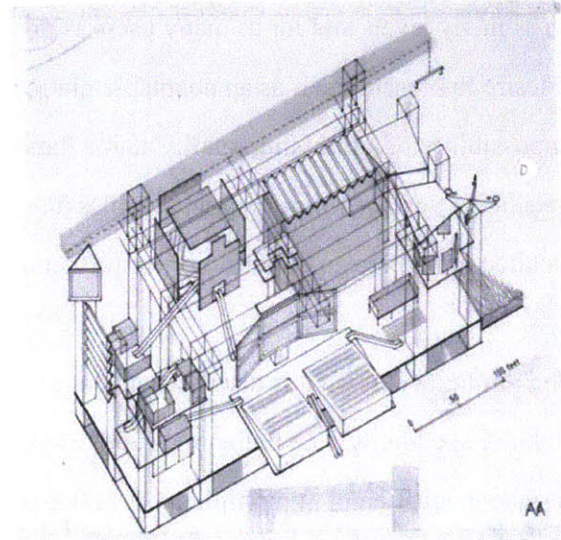
Design that attempts to foster multi-functionality and a variety of interpretations is inextricably tied to the concept of adaptability of the design by the user. This loading of potential can, as in the case of the Pompidou Centre, be to a fault. Similar processes of overload resulting in absence can be seen in more recent architecture. The desire of architecture to incorporate a plethora of potential functional interactions has, in recent years, become a dominant presence in contemporary design.

With the proliferation of performative and parametric design, and digital fabrication technologies, the surface as an architectural strategy in itself became imbued with potential formal incarnations, uses, and user interpretations. The work of Gilles Deleuze (in particular *The*

Fold: Leibniz and the Baroque) is of noted influence in this design modality. Through the work of Greg Lynn, Farshid Moussavi, et al., the multi-use, multi-meaning surface became the receiver of the desire for adaptability in design. What is produced is an architecture that, in its attempt to address a multiplicity of potential uses, is rendered as a system of fluctuating and ambiguous surfaces.

MoMA PS1 Young Architects Program (YAP) competitions for the courtyard space are particularly revealing of this moment in architecture history. SHoP Architects' project for the competition, *Dunescape* (2000), is an example of multifunctional design that intends "to provide a variety of ways" of use and inhabitancy (www.shoparc.com/, accessed May 17th, 2011). William O'Brien Junior's entry for the 2010 competition proposes a similarly adaptable surface:

The installation is conceptualized as a terrain—a continuous and varied landscape—which resists rigid typological classification. Rather, through formal and compositional metamorphosis, the terrain enfolds a spectrum of diverse, yet correlated landscape



Cedric Price's Fun Palace. A strong inspiration for the Pimpidou center. Image: Canadian Centre for Architecture.



The Pompidou Centre's externalization of systems in an attempt to free up and neutralize the interior, in preparation for multiple uses. Image: Edal Anton Lefrov.

characteristics. (www.wojr.org, accessed May 17th 2011)

The PS1 competition itself, in its call for a flexible spatial concept that is engaging or fitting on as many levels and for as many users as possible, speaks of the shift in architecture towards a desire to present itself as an adaptable platform for anything. Equivocation results from the impossibility of addressing totality, and a flattening of the built space to an overloaded and undulating surface for projection signifies a pre-emptive conclusion in the adaptability of architecture where an opportunity for further development instead lies.

The limitations in what is discussed as the overloaded surface lie in overabundance of input and non-specificity. The flattening of otherwise spatial relationships into the performativity of a surface in an attempt at multiplicity is at the expense of the encumbrance and non-specificity of the architecture. As noted in the discussion of previous design moments, specific relationships to environment or dynamics is needed in the fostering of a system towards adaptability.

Primary concerns of design for adaptability in cities now involve climate change and correlative water problems. An urgency is felt to address these issues in urban form, as demonstrated by the numerous Climate Change Adaptation Strategies that discuss flooding as a primary concern and motivator of urban design and planning reform. In the case of existing urban form, structural adjustments may placate turbulent and rising water for a moment, but have not been accepted as a lasting solution for adaptation to climate change. Softer approaches via landscape as a functional topography have been called on in several designs as a mitigator of flooding and storm water, but are not conclusive in themselves. Adaptive design incorporates lessons learned from a history study of adaptable design, and attempts to bring adaptation further through the adaptability of implementation.

Further Development

This selective historical study of adaptation and adaptability in architecture, urbanism, and flood infrastructure reveals goals of growth and change, user participation, expansion and development, patterning and redundancy, neutrality of space, and multiplicity of possible use. The design research of this thesis will respond to these findings with concepts of specificity, multi-layeredness, time-sensitivity, and user decision making. Incrementally, flexibility, and publicness are particular aims of the design that is made in anticipation of specific environmental events and user expectations.

Adaptable Design and Climate Change

The role of adaptable design in contemporary discussion now is related to climate change, and the creation of a medium for adaptation to growth and change in the environment. This calls for the flexibility of cities towards external forces such as water. Adaptable design in previous iterations (as discussed) has attempted to provide flexibility according to the inhabitant, program, or contextual urban flux. In this sense the designs have responded to engagement brought about by human intervention: the theoretical user. Adaptability in design in relationship to environmental hazard transfers the user as catalyst from the human realm to the sphere of ecology. Shift in environment becomes a stimulating element in adaptability, and adaptable design responds to the growth and change in environmental milieu. Adaptability in design is towards the necessary adaptation to environmental flux.

The design work is focused on fostering the adaptability of a coastal city to climate change's effects on water. Adaptation in the site is through adaptability of the design to water hazard and to the user, and thus design allows flexibility of the area to its environment. Design's creation of flexibility is also to address public needs. Adaptability of public space allows the user to enter

into the process of climate change adaptation, to add his/her/its role as catalyzing agent to that of environmental change in the formation of the neighborhood's environmental stance and qualities.

Expectant Design: Adaptation through Adaptability



Adaptive infrastructure is Expectant, having the ability to react to fluctuation of contextual forces, and as well possessing latent or suspended characteristics and possibilities. Image: author.



Temporary use as inspiration for Expectant Design. Helsinki NGO Dodo's container gardening as a temporary use in Kalasatama. Image: author.



Flood infrastructure as inspiration for Expectant Design. Oosterscheldekering (Eastern Scheldt) storm surge barrier in the Netherlands. Image: Vladimír Šiman.

Expectant Design

Adaptable design has been developed with the changing desire or the user in mind, and adaptation infrastructure has reflected an anticipated change in environment. This describes a theme of expectation in design. White's aforementioned *Adjustments*, the adaptation to flooding hazard through infrastructure as seen in many Dutch cities, and past attempts at building-in flexibility in architecture and urbanism inspire this exploration of design that is *expectant*. Temporary public use, in its flexibility and anticipation of participation illustrates an aspect of what is defined for the purpose of this study as *Expectant Design*. Flood infrastructure, in its role as protective construction expectant of a force, demonstrates as well a facet of expectant Design.

The flood wall itself exists for the purpose of an expected or projected force, but is unfortunately passive during the time that its infrastructural role is not called upon. It is a construction with dormant qualities and abilities, which become present according to environmental shifts. Flood infrastructure does also have many present and dormant negative or maladaptive characteristics, such as causing ecosystem degradation and loss of water connection as a valuable urban amenity. For this reason flood infrastructure such as a flood wall system is an inappropriate solution to issues of water quantity in urban areas, where demand on space is high and losses such as connection to the coast can not be afforded. Its expectant quality does, however, contribute to the proposed form of adaptation in this study.

While one facet of coastal ex-harbor development is exposure to hazards and the necessary consideration of risk, which is often realized in structural flood adjustments, harbor redevelopment also implies the loss of unused and "potentially exploitable" space (de Solà-Morales, 1995). Industrial areas, while they may be officially closed to the public, are sections of urban structure that are dormant in their capacity. As deharborization occurs, valuable and often needed land in city centers is made open for development. Built space is, by pattern of

economics and development, to occupy this land in the maximum capacity possible. Not only is the flexible, expandable zone of the harbor lost, but its new pattern is a totalizing, dense, and finite one. Future inhabitants of these areas are left without space for their imprint or intervention, and public participation and engagement is not afforded.

In this vein inspiration is taken from Ignasi de Solà-Morales's use of the term "expectant" in his discussion of the terrain vague (de Solà-Morales, 1995). Adaptive infrastructure is by nature designated as expectant, having the ability to react to fluctuation of contextual forces, and as well possessing latent or suspended characteristics and possibilities. Expectant design explores the potential of such elements as flood adjustment structures to maintain infrastructural purpose (as do examples given by White and in Dutch cities), while the sense of expectancy is made also spatial, programmatic, participatory, and public. The adaptive spaces or elements explored in the research thus far are loaded with potential. Expectant design explores the capacity of an adaptive strategy to be also pregnant with meaning and association for the user, and containing of a layering of use relative to a specific dialogue with fluctuating environmental forces and interior dynamics. It is at its foundation to be incremental, time-sensitive, and flexible; it is a search for, in other words, adaptation that is adaptable.



Expectant Design as incremental, flexible, modular, public, and participatory. Image: author.



Expectant Design as a time sensitive intersection of flexible public space and infrastructure. Image: author.

Design Inquiry. Importance of Pilot Study and Specifics of Site and Context

“The dynamic raises questions of responsibility for causing climate change and highlights the duty of those responsible and able to assist adaptation by those who are vulnerable and who have little capacity to adapt to climate change, for which they are not responsible.”
(Adger, et al., 2006)

The Importance of Pilot Studies, and “Fairness” in Climate Change Adaptation

Effects of climate change are not equally distributed globally. Greater vulnerability and hence need to adapt exist in some areas more than others. The Kalasatama ex-harbor development in Helsinki has been chosen as the site for a pilot study in adaptive design. One might ask: “Why chose a stable capital city of a welfare state in the global north for a climate change adaptation study, when other areas are at greater risk and thus have a more urgent need for action?” Could not energies be better spent addressing more desperate situations?

Areas at great risk for climate change issues, particularly in the global south, are more vulnerable in part because of “unequal distribution of wealth, capacity, and power” (Ibid.). These aspects contribute to a place’s vulnerability to environmental hazards, but they have a greater influence on the ability of that area to respond in adaptation. If a country is politically, financially, and socially unstable, its ability and resources available for adaptive action are severely limited. In their text, *Fairness in Adaptation to Climate Change*, the authors discuss at great length the role of responsibility in climate change adaptation. Both causal and moral responsibility enter the text in regards to the relationship between developed and developing countries and the causes, effects, and need for experimentation in adaptation to an altering environment.

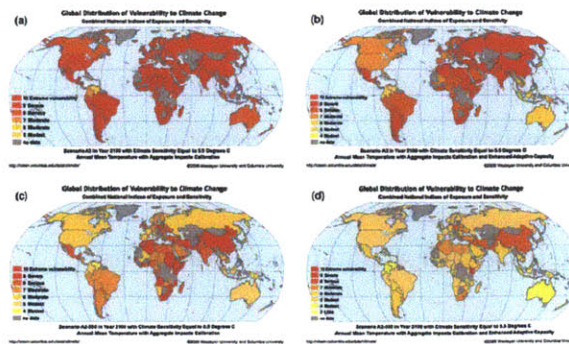
The choice of a pilot site in a developed country in which basic needs of citizens are answered through universal health care, education, and financial assistance where needed, but where emissions are high reflects the responsibility-response dynamic as noted in the aforementioned text. Climate change adaptation being a fairly new field, requires trial and error to find solutions that work. The importance of pilot studies in this newly born area of research is high. Developed countries have greater resources available for experimentation, and in the event an adaptive strategy fails, magnitude of risk is perhaps not so great and thus consequences for failure are lower. In places where stability, resources, and constituency exist, the causal and

moral responsibility (Ibid.) for exploration of adaptation strategies falls.

The ex-harbor is chosen as the site condition in that it has particular conditions, risks, and tools inherent for action. This limitation of project context is so as to create specificity towards the development of a typology that is appropriate for ex-industrial conditions or those otherwise containing the developed / disused dichotomy and in a water-sensitive position.

Helsinki as Pilot Site

This ratio of risk to resources influences the choice of Helsinki as the setting for a study on flood risk and storm water-issue adaptation. This coastal city is in an insecure position relative to climate change's predicted effects, but it is not in such peril as other urban areas on water. Helsinki has a significant constituency on climate change and the need for action, and has designated a fair amount of resources to research in planning and policy on the topic. Physical action on this basis is limited thus far, but it is a hope that this condition changes in the next years. Finland



IPCC cites geographical distribution of vulnerability in 2100 with and without mitigation along an SRES A2 emissions scenario with a climate sensitivity of 5.5°C. (a) portrays vulnerability with a static representation of current adaptive capacity. (b) shows vulnerability with enhanced adaptive capacity worldwide. (c) displays the geographical implications of mitigation designed to cap effective atmospheric concentrations of greenhouse gases at 550 ppm. (d) offers a portrait of the combined complementary effects of mitigation to the same 550 ppm concentration limit and enhanced adaptive capacity. Source: Yohe et al., 2006b.

Government budget appropriations or outlays for R&D (GBAORD) in 2011

	R&D funding € million	Share of R&D funding, %	Nominal change from 2010, %	Real change from 2010, %
R&D funding total	2 065,0	100,0	3,8	2,1
Main administrative branches (ministries)				
Ministry of Education and Culture	945,6	45,8	9,1	7,3
Ministry of Employment and the Economy	746,2	36,1	-2,2	-3,9
Ministry of Social Affairs and Health	142,9	6,9	9,3	7,5
Ministry of Agriculture and Forestry	95,1	4,6	-2,6	-4,2
Funding organisations				
TEKES	590,3	28,6	-3,4	-5,0
Universities	555,7	26,9	9,8	7,9
Academy of Finland	349,9	16,9	9,8	8,0
Government research institutes	301,9	14,6	2,1	0,4
Other R&D funding	227,2	11,0	4,2	2,5
University central hospitals	40,0	1,9	0,0	-1,7

Total research and design funding in the state budget of Finland, 2011. Source: Statistics Finland.

having been the first country to draft a national climate change adaptation plan, and naming flooding and excess water as a primary problem associated with an altering environment, its capital city is an excellent candidate for the study of adaptation to water-related risks.

Helsinki and Adaptation to Water Risk

Helsinki has a long coastline, and much of the city's development over the past century has occurred on peninsulas, islands, or in areas that have been filled in with earth. The majority of built area is in dialog with the sea in some form, and some areas are low-lying or unstable because of fill processes. The city conducted a flood-risk survey and has consequently drafted a flood emergency plan which includes several dams and some minimum ground floor height requirements (Helsinki City Planning Department, 2008). In 2005 Helsinki experienced a flood that inundated areas of the city, most notably its Market Square, and water issues in the city center were brought more actively into public discussion. Shortly before and increasingly so after this event, climate change researchers have called for action in the city's urban plan, to accommodate and prepare for flooding due to increased precipitation and sea storms.

The city center has seen its port activities moved elsewhere, and large tracts of coastal land have been opened up for development. These areas, as they are coastal and thus exposed to the effects of a changing climate on the sea, should be planned in a way so as to respond to risks associated with their position as well as the number of buildings and people they are slated to accommodate. Much analysis has taken place in the scientific community on the vulnerability of the ex-harbors, and the planning process still allows time for the integration of an adaptation strategy both for hazards of the everyday (storm water) and the occasional disaster (inundation).

Kalatatama

Kalatatama is one such area that is being rezoned for residential and commercial development. It is located on the eastern edge of the city center, has a peninsula cut by a channel in its south, and a broad area of clay soil and fill in its north. The development is planned to begin construction by the end of this year. A master plan exists but detailed plans are limited at this time. The public spaces and nature of the district's coastal edges is yet to be firmly determined. A localized climate change prediction has been completed for the area (Wahlgren, 2008), as has a study on sea level rise (Kahma, 2009). Knowledge resources exist and thus risk is known. City planning has taken the initiative to incorporate a lowest-ground floor-height standard, but other strategies of flood hazard mitigation and storm water management are yet to be fully integrated. Because of its siting, stage of planning, and resources, Kalatatama district is a model for the study of water-risk responsive adaptation through design in Helsinki, and has been chosen as the project site.



Areas of major redevelopment in Helsinki city center (above), and the overall master plan (below). Images: City of Helsinki City Planning Department.



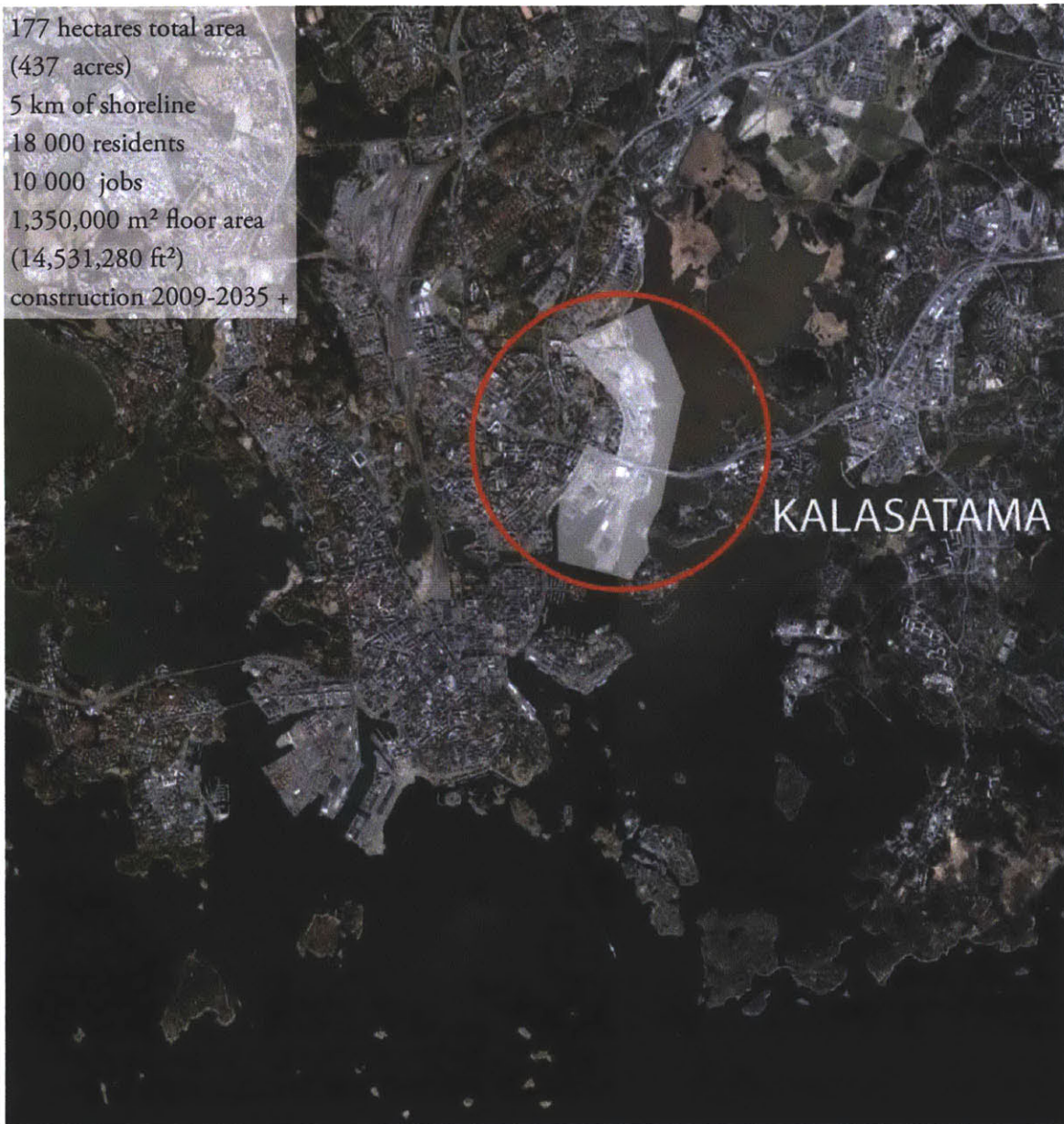
Site Specifics

Kalasadama is owned by the city of Helsinki and is thus being planned by the City Planning Department. The city would naturally like a large return on the land, and to provide as much space for housing and commercial uses as possible. As stated in the 2002 Helsinki Master Plan (for an illustration, see previous page), maintaining a dense urban core while providing palatable and accessible environment and architectural options is a priority in Helsinki development. Thus the coastal site's ground space is maximized; in most areas development is planned to extend to the coastline's edge. This path of planning does, however, not bode well for flooding risks and storm water runoff issues. Public spaces in the master plan are primarily for limited recreational uses of the site's inhabitants and do not so far have a definitive environmentally contributive function. Other green spaces that are present (for example: courtyards) are underbuilt with infrastructure, and the surfaces' absorptive capacities that would otherwise contribute to the minimization of water issues are limited.

Constituency and Resources

Helsinki's climate change risk has been brought into discussion in the scientific, political, and public realm in Finland. Several research programs have explored the risks of extreme weather events that are predicted to increase with environmental alterations (for example, the ISTO group, <http://www.mmm.fi/ISTO/eng>, accessed May 17th, 2011). Sea level, precipitation, temperature changes, wind, and general storminess has been projected to increase into the following century and correlative effects have been analyzed in habitat and biodiversity factors, agriculture, economy, social factors, politic, and immigration (Veikko, et al., 2005). Calls have been made for mitigative and adaptive research, and policy and planning fields have been very active in preparing protocols. The extensive climate change information available that has been compiled by Finnish groups and institutions is indicative of the means and capabilities the nation

177 hectares total area
(437 acres)
5 km of shoreline
18 000 residents
10 000 jobs
1,350,000 m² floor area
(14,531,280 ft²)
construction 2009-2035 +



Kalasatama as the project site. Image: Google Earth and the author. Data: City of Helsinki City planning Department.

has to take steps to analyze risk and vulnerability.

Risk, Resources, Formulation for Action

Flood vulnerabilities and storm water issues in Helsinki are lower when compared to some coastal and deltaic regions. The capabilities and interest for action are, however, high. Considering these aspects alongside the magnitude of development and change planned for Helsinki's city center in the next 30 years, action should be taken to build resiliency into the city's urban plan. This should be done using the available resources, despite a risk that is globally speaking comparatively lower. As a large presence in the world in welfare and design politics, the country and capital city has the opportunity to act as a model for adaptation. Districts such as Kalasatama may serve as pilot sites for innovation in water-issue management. An urban design that takes into consideration concepts of resiliency and preparedness may be, once constructed, a powerful reference and source of inspiration for places whose cities have more exaggerated water issues but sadly fewer resources for adaptive solution experiment.

Policy and Current Conditions

Strategic studies and policies has thus far been the primary response of Finland to its recognized vulnerability. Widespread change in the course of physical planning (particularly in regards to existing city structure) is less apparent. Climate change hazard in Helsinki and Finland generally is marked by excess water risk, particularly relative to densely developed areas. An adaptation plan that would aid in minimizing exposure to this hazard would require a spatial and functional manifestation within an already established urban plan. The Helsinki City Planning Department discusses flood risk and storm water in its public documents, but visible strategies can not yet be directly sensed in coastal district master and detailed plans. Recommendations for a lowest ground floor height above sea level have been taken into account in some coastal neighborhoods

such as Ruoholahti, however, visible, strategic, district-wide flood and storm water resiliency plans are not detectable in city's coastal development decisions. The newer coastal neighborhood of Arabianranta does contain a sea-side park that may function as a modest flood plain in extreme weather events, but this element is resultant of geotechnical issues of the underlying soil rather than a singular move towards adaptive and resilient city design.

The city planning administration has compiled (either within city departments or by contracted researchers) both a storm water strategy and a flood strategy. These documents provide information on water-related risks and vulnerabilities, and recommendations as to what actions should be taken by the city and its residents.

The Helsinki City Storm Water Strategy (*Helsingin Kaupungin Hulevesistrategia*) was published in 2008 by the City Streets and Parks Department. This strategy calls for the utilization of rainwater (for example in parks and green spaces), and for the treatment of storm water on-site whenever possible. Citing the increased precipitation that climate change is projected to generate, sea level rise and its impediment of storm water processes (especially in low-lying areas), and the storm water overflow events the city has seen in recent years, the document calls for a revision of current storm water practices. In particular it aims for the prevention of negative effects caused by flooding, preservation of the local and regional drainage and groundwater, minimization of hazardous substances in storm water, and the use of storm water as a resource.

The storm water strategy proposes methods of reaching the aforementioned goals, most interestingly to this project the treatment of storm water in an open, visible, and organic system. Green infrastructure does seem to be on the rise in Helsinki, as evidenced by the storm water strategy as well as the increased interest in community gardens for agriculture (see Helsinki NGO Dodo, www.dodo.org/, access May 17th, 2011). Despite the goals and methods set out by the storm water strategy, action in the planning of coastal Helsinki has yet to provide examples of

this document's recommendations.

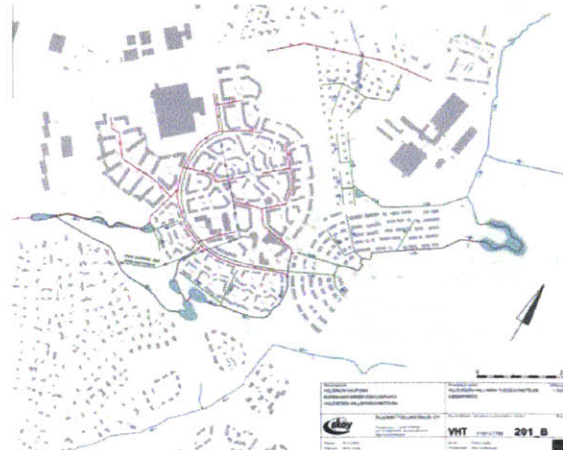
The city center currently has about 250 kilometres of combined sewer systems, and much of this is located in the older parts of the city, where space is dear and retrofit would be disruptive and costly. Storm water issues in such areas present significant challenges. In newer construction, an opportunity exists to address storm water through hard infrastructure, but developing neighborhoods such as the study's site will be served by combined sewer - storm water systems as well.

The City Economic and Development Centre is currently, however, considering the possibility of the use of such open, visible, and organic infrastructure for the treatment of storm water in the Kalasatama development. Part of this study's research, which will be discussed at further length later in the text, has been in open collaboration with this city department towards the design of a public and organic storm water treatment strategy in Kalasatama's central park.

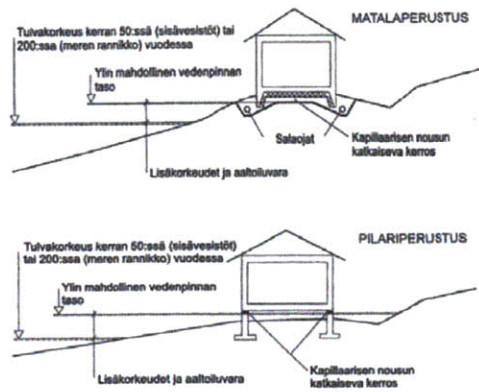
A reference for sustainable storm water



A sample of policy literature reviewed in the research. From top left: Helsinki City Flood Strategy, Helsinki City Storm Water Strategy (both courtesy of City Planning), FINADAPT study (courtesy of the Finnish Environment Institute), and Finland's National Strategy for Adaptation to Climate Change (courtesy of the Ministry of Agriculture and Forestry).



Kuninkaantammi Storm Water Pilot Project plan. Image courtesy of Skol Design ltd., and City of Helsinki Economic and Planning Centre.



Excerpt from Helsinki City Flood Strategy, illustrating the lowest building height recommendation. Image courtesy of Skol Design ltd., and City of Helsinki Economic and Planning Centre.



Construction in Arabiaranta, during a flood event. Image courtesy of Simo Haanpää.

treatment is being generated in the Helsinki metropolitan area. Although this project does not lie within the city center where storm water issues intensify, and is not coastal, the Kuninkaantammi storm water pilot project (“Kuninkaantammi hulevesien pilottihanke”), will, once constructed, serve as a reference for integrated storm water management in the Finnish context.

The Helsinki City Flood Strategy was published in 2008 (*Helsingin Kaupungin Tulvastrategia*). This document outlines the risk areas in Helsinki that are vulnerable to flooding. Flooding is focused on particularly as resultant from surface water (specifically from sea floods). Areas at risk of inundation in the Helsinki city center are identified in maps. The study concludes with identification of a lowest inhabitable floor height recommendation for new buildings.

Additionally a *Preliminary Study: Locating of Flooding Targets (Tulvakohteiden Määrittely Esiselvitys)* was published in 2007. This study illustrates through maps a 100 and 200 year flood plain in the city, and areas of high

risk. The maps are revealing of the site area's vulnerability. The probability of frequencies are, however, without thorough consideration of climate change and thus may not be taken into account in a way that will prove lasting into the later part of this century.

The lowest building height recommendation mentioned in the flood strategy addresses only new space, and that which is continuously inhabited. This recommendation does not address public or open spaces, nor does it provide suggestion for existing built space in the city fabric. Furthermore it may not reflect sea water levels as they will be in 50 or 100 years' time. In discussion with researchers at the Finnish Meteorological Institute, it was gleaned that sea level may potentially surpass this recommended height.

The lowest-height recommendation has been taken into account into such coastal neighborhoods as Arabianranta. Here, sea flooding is less of a threat as in Kalasatama, as the area lies further in from the open sea area and is somewhat more protected. In visiting this neighborhood, it is notable how hidden this consideration for flooding is. The architecturalization of risk is concealed, and thus an open dialog (on the environmental issues and changes in the area) with residents and the general public is not initiated through the architecture.

Visibility of environmental hazard and change is of great importance in beginning an open and public discussion on the topic of the city environment and its challenges. This consideration has influenced the design process and collaboration with stakeholders greatly, and will be discussed later in the text.

Current research and policy in Finland encompasses climate change strategies as well. *Finland's National Strategy for Climate Change Adaptation* was published by the Ministry of Agriculture and Forestry in 2005. To this author's knowledge, this document has been a first of its kind in national policy globally (<http://www.eea.europa.eu/themes/climate/national-adaptation->



Construction in Arabiannanta, in consideration of lowest-inhabitable-floor height recommendation. This architecturalization of the flood plain remains invisible to the onlooker, and is a missed opportunity for communication of environmental issues through built space. Image courtesy of the author.



strategies, accessed May 17th, 2011). The national adaptation strategy was followed by a flowering of research on climate change vulnerabilities, adaptation, and mitigation. Adaptive capacity was reviewed in the 2004-2005 study *Assessing the Adaptive Capacity of the Finnish Environment and Society Under a Changing Climate (FINADAPT)*, published by the Finnish Environment Institute in 2007. Review of the adaptation strategy's efficacy came in the 2009 *Evaluation of the Implementation of Finland's National Strategy for Adaptation to Climate Change*, published by the Finnish Meteorological Institute.

Climate change adaptation research in Finland between 2006 - 2010 was made in part through the *Climate Change Adaptation Research Programme (ISTO)* project group (<http://www.mmm.fi/en/index/frontpage/adaption/isto.html>, accessed May 17th, 2011) and research continues in part through the 2011-2014 project family *Finnish Research Programme on Climate Change (FICCA 2011–2014)* (<http://www.aka.fi/Tiedostot/Tiedostot/FICCA/FICCA%20Programme%20Memorandum.pdf>, accessed May 17th, 2011). These documents and project groups represent a portion of

climate change research and policy in Finland. National studies and policies have led to more localized investigation. The Helsinki Region Environmental Services' (HSY) project *Julia 2030, Climate Change in the Helsinki Region - Mitigation and Adaptation* focuses the city towards minimizing its emissions and increasing adaptive capacity (www.hsy.fi/julia2030/en/, accessed May 17th, 2011). This project, like many others associated with climate change research in Finland, is funded by the EU LIFE + program.

Adaptation strategies in Finland discuss vulnerabilities and focus mainly on mitigation, while implying that further study is needed to explore adaptation measures and capacity. This wealth of information implies a broad capacity for research and action towards, as well as interest in, issues of climate change in Finland.

Research regarding these projects and policies reveals the scientific and policy communities as stakeholders in climate change adaptation in Helsinki. As this work is in part publicly funded and in an effort to raise awareness of the environment that city residents value, it also implies the role of the general public. Research is geared primarily towards policy makers, but also toward those who act as stewards of the physical environment, such as City Planning and Development.

Stakeholders

There are many actors and stakeholders that are involved in the future of Kalasatama, and some of the input from these parties has influenced the state of development thus far. Plans for Kalasatama at the time of this study reflect the preferences and requirements of the city's housing and commercial spaces, the current topical condition of the site, and a desire to gain maximum return for an investment on the part of the city. Helsinki is in need of housing, in particular larger flats and more varied residential options. These factors contribute to a dense form of the planned development. Although some parks do exist in the surrounding area, this density is

largely a continuation of the city fabric. As actors in the site, the city administration, urban form, economy, and prospective renters/buyers are inclined as stakeholders towards a full development of the area, in order to provide maximum amount and variation of housing, produce high economic return, and to connect to the surrounding city structure. These factors and stakeholders are reflected in the plans for Kalasatama, from the build-out up to the water's edge, to the underground parking for all but one block (to accommodate cars typically owned by residents of larger flats). Public spaces are thus residual, and of a very urban character.

The research and science community holds a view of how coastal areas in Helsinki such as Kalasatama should be developed. Environmental research scientists such as Irmeli Wahlgren, in the project "Climate Change in Urban Planning" (from Finland's Environment Cluster Research Programme, Finland's National Strategy for Adaptation to Climate Change) states the study's production goal as "recommendations of practical procedures and means for taking climate change into account in urban planning and impact assessment." (presentation, www.gsf.fi/projects/astra/sites/download/Tampere_Wahlgren.pdf, accessed May 17th, 2011). The general intention of the project is to "promote adaptation to and control of climate change in urban planning and thereby reduce damages caused by floods and storms as well as reduce greenhouse gas emissions." (Ibid.).

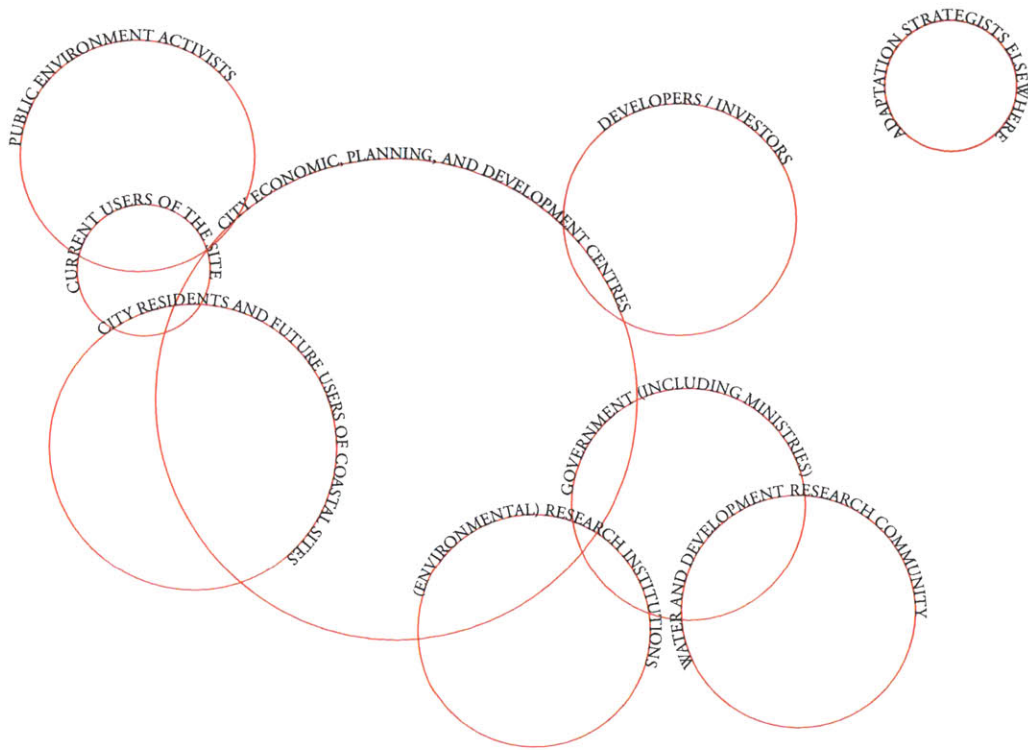
This describes a detectable common sentiment among the environmental research community in Helsinki. Projects like EXTREMES I (2004 – 2005) and II (2006 – 2008), and EXTREFLOOD look at the likelihood and impact of extreme events (particularly flooding) due to increase because of climate change. A call is made for "Climate awareness in planning" (Ibid.), and development of such projects as the Climate Change Community Response Portal (CCCRP) evidences this. Currently being codeveloped by the Finnish Meteorological Institute, Finnish Environment Institute, and Aalto University's Centre for Regional Studies, CCCRP is a project that will, when finished, provide a resource portal for regional and local climate change

information. The project's goal is to "raise awareness about global climate change and its implications for Finland" (www.ymparisto.fi/default.asp?node=24714&lan=en, accessed May 17th, 2011) and to provide a information source for policy makers and planners to refer to, in order to promote climate-informed decision making and planning. Additionally, important papers like "The Challenge of Climate Change Adaptation in Urban Planning" (Peltonen, L., Haanpää, S. and Lehtonen, S. 2005. FINADAPT Working Paper 13, Finnish Environment Institute Mimeographs 343, Helsinki, 44 pp.) published by Finnish research constituencies highlights the discussion of environmental change in the planning process.

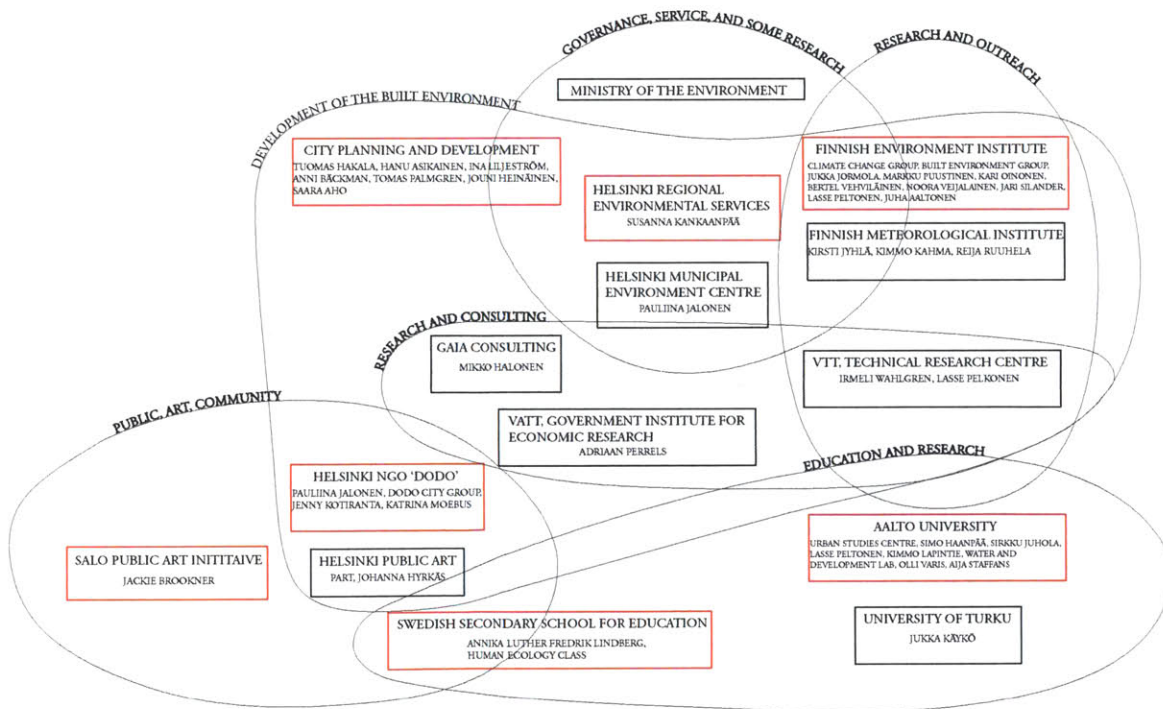
The city administration and planning has engaged the research community on these topics, although the institutions that implement plans and those that supply research remain more or less separate. The City of Helsinki City Planning Department's prerogative is towards the overall quality and efficiency of the built environment, although flood and storm water strategies have been published on the part of the city. These studies have been made in reaction to growing interest in, and need for the consideration of water and environmental issues.

City residents seem to value the city environment, and environmental issues. This is reflected by public support of sustainable strategies such as a multi-tiered recycling system, use and support of mass transit (there is, however, a dearth of bicycle lanes), and the existence of a transit mapping system that reports carbon emissions produced according to transit choice. Additionally, wide use of landscaped public spaces (playgrounds, parks, playing fields) and natural areas near the city demonstrate the value of open space and connection to nature held by the city inhabitants.

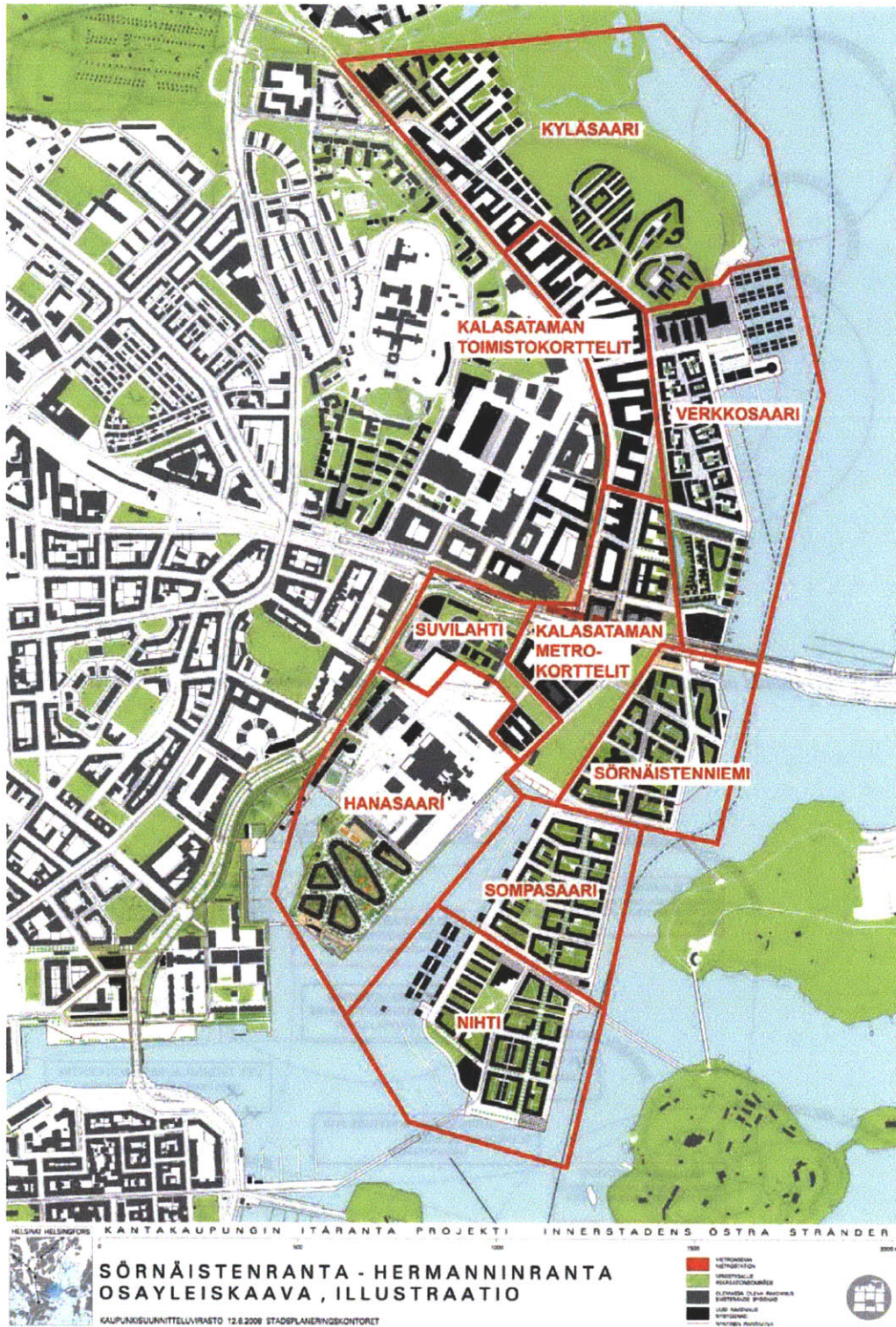
The environmental issue of climate change does seem to be of concern, and example can be taken from the amount of media attention given to the hottest day on record (<http://www.hs.fi/english/article/How+about+that+weather+huh/1135259411466>, accessed May 17th, 2011),



Stakeholder groups involved in Helsinki city coastal developments, with varying spheres of influence and degrees of involvement. Image: author.



Stakeholder group map. Names are interviewees, labels in red boxes are current or potential collaborators. Image: author.



Planned development of the thesis's site Kalasatama. Image courtesy of the City of Helsinki Planning Department.

which was experienced during the summer of 2010. Climate change adversely affects water quality in the city's surrounding sea in part through the increased growth of algae. Public beaches are popular among Helsinki residents, as is general water recreation. Climate change effects this public space amenity. Changes in the presence of blue-green algae is watched by those hoping to swim during the summertime, and reports are published daily by the Finnish Environment Institute (<http://www.environment.fi/default.asp?contentid=365983&lan=EN>, accessed May 17th, 2011).

In connection to environmental concerns, ecological and urban trends are being taken up by city residents, such as urban gardening. This is in large part enabled by the Helsinki NGO Dodo's recent actions. Dodo, also a stakeholder in the outcome of Kalasatama, has organized several community gardens throughout the city, including in the project site. The NGO has been involved with local artists and designers, in developing temporary program in Kalasatama that has a public and ecological agenda. The organization would like to see this type of modifiable and open public use of Kalasatama continue during and after construction.

Exploration of the stakeholders involved in Kalasatama gives a broader picture of the context within which a successful adaptation strategy must operate. An appropriate strategy is possible in part through knowledge of the state of research in regards to climate change adaptation, as well as a picture of stakeholders.

Research Partnerships in Helsinki

This thesis began with in-depth study of climate change research and city development in Helsinki. The author is grateful to the financial support provided by the 2010 Schlossman Research Award, which enabled a focused period of research on-site in Helsinki during the summer of 2010. Without this assistance this aspect of the project would not have been possible.

Research was made during the summer of 2010 and following months leading up to the project completion within the context of a guest researchership in the climate change group at this Finnish Environment Institute (SYKE). The depth of research, as well as many aspects of the thesis's design owe themselves greatly to the openness, generosity, and interest of this institution towards the author's project (see acknowledgments). Work space at SYKE provided a base for project development. Research support opened up many opportunities for further study, interviews, and collaborations. Feedback given in interviews and presentations provided material for further development of the project. The support of SYKE has brought the thesis to a different level, and the role of this institution in the project's development is significant.

Research included policy review of the many initiatives taken on the part of the local, regional, and national actors (both of public and private institutions) in the climate change and development discussion in Finland. Literature review provided a basis for the many interviews that the author held with various experts and stakeholders. These interviews provided further insight into the current state of research, policy and development in Helsinki. To mention a few, the author met with researchers from such institutions as the Finnish Environment Institute, Finnish Meteorological Institute, Helsinki Region Environmental Services Centre, City of Helsinki Planning Department, City of Helsinki Economic and Planning Centre, VATT Government Institute for Economic Research, VTT Technical Research Centre of Finland, and researchers from the Urban Studies Centre and Water and Development group at Aalto University. Interviews allowed for the pinning down of the precise tools and resources available, and the problems to be addressed.

Contact with researchers also led to informal collaboration. The research has been active within the Finnish Environment Institute, and groups there have been a source of information and feedback on the project.

Informal collaboration was established with the City of Helsinki Planning and Development Centre. Initial meetings brought to light the in-process nature of planning in Kalasatama. This openness of planning as well as the Centre towards collaboration was very influential in the choice of Kalasatama as the thesis site. Presentations at the Centre and the discussions following were a mechanism of development for the design.

Presentation and discussion with the local NGO Dodo, which is active in regards to city environmental issues and in public and temporary action in the area of Kalasatama, led to further incorporation of current issues of the public, environment, and flexibility towards the user. Presentation with NGO members and its “Dodo City Group” brought in many new ideas as well as a possibility for future collaboration in realization of parts of the project’s design.

Work in the education community provided insight into the view of climate change issues in the younger groups in Helsinki. On the suggestion of contacts at SYKE and the Swedish Secondary School for Education, the author taught a workshop session on climate change adaptation in Helsinki. The students had developed projects to address environmental issues in the city associated with climate change, and demonstrated a passion towards finding both an adaptive and mitigative solution.

Collaboration with stakeholders rose out of the initial research but also from a sense that a bridge needed to be made between climate change research and action in Helsinki. Extensive resources and interest existed on the part of the scientific community and some of those involved in planning towards climate change vulnerabilities and potential policy and action, but a disconnect exists between the groups that compile and synthesize information, and those who influence physical change. In the project’s foundation it was felt that more could be done to bridge these stakeholder groups.

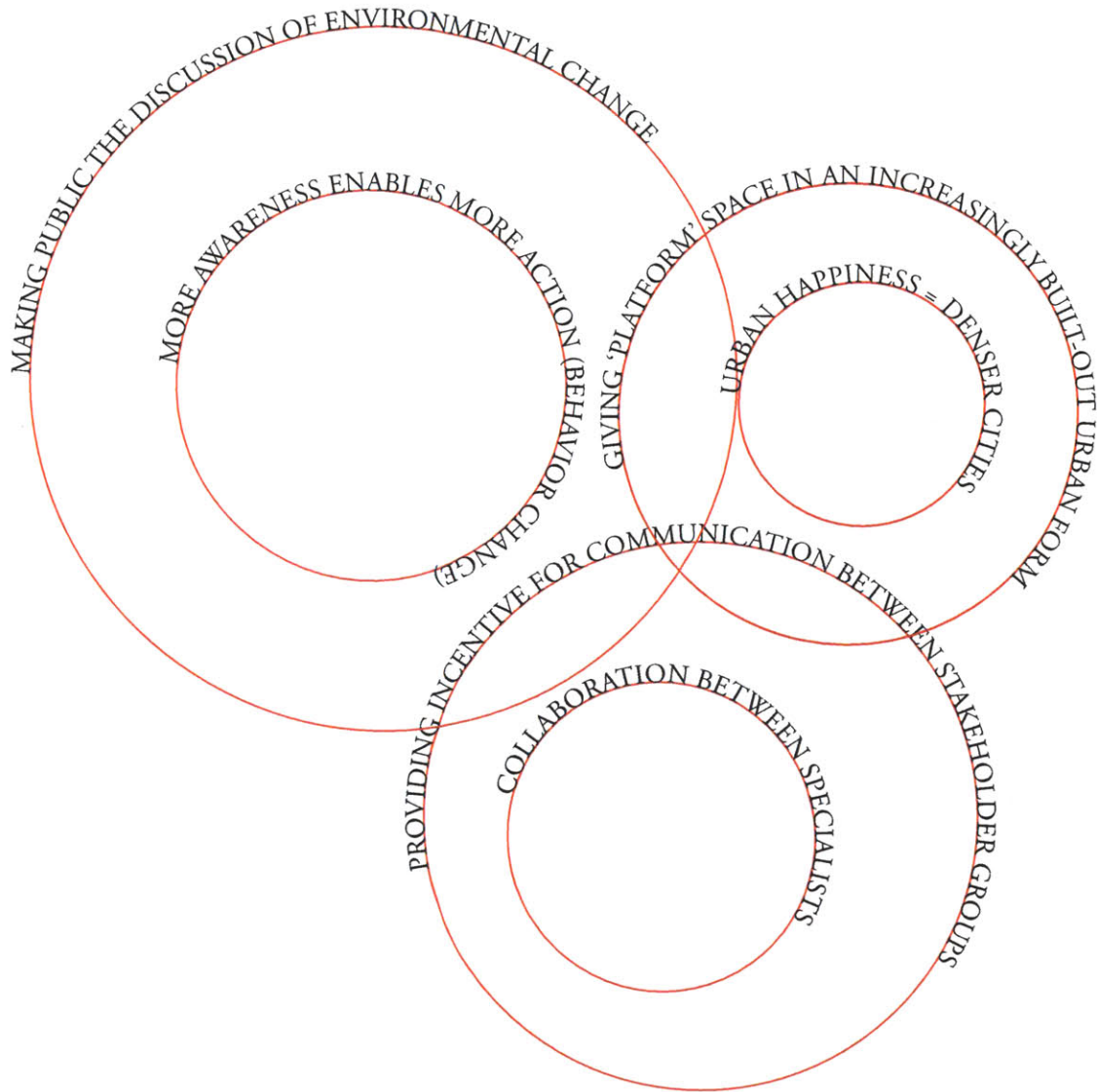
Additional to the bridging of research and development stakeholder groups, it also became a goal of the project to address the thought that a more open and publicly engaging version of climate change adaptation should be made available to the city. “Publicness” of such environmental infrastructure would raise awareness of climate issues, open dialog between the research, planning and public community, and hopefully lend the possibility of a more active role to the city inhabitants in adaptation decision making. This factor influenced the research and development methodology, the design itself, and the mediums through which the design is presented.

A primary goal of the development processes and design work of this thesis was towards the bridging of gaps between research and development communities and processes. Additionally, the research led the project to aim for involvement and engagement of the public as a user through both research and design action, and through the medium of design communication. Using a graphic language to accommodate city planners, designers, and the general public, and in consideration of the research done by the scientific community, the thesis aims to create an image for the physical implementation of adaptation research. This is in the hope of bringing into the discussion of large-scale development, risk, and uncertainty, a suggestion for a very feasible, reasonable, imaginable and imaginative adaptation strategy.

Considering the many factors, stakeholders, and challenges that contribute to Kalasatama’s development, vulnerability, and stance on environmental change, an adaptation strategy must give audience and benefit to several forces. Through collaboration, an investigation has been made into opportunities to engage several actors and issues in one design. Design aims to offer incentives and flexibility towards the site pressures, users, researchers, and developers. In consideration of the factors of several involved parties, uncertainty of environmental forces and change, large physical and time scale involved, and magnitude of investment necessary for adaptation, design arrives at the strategy of flexibility, engagement, publicness, and

incrementalization.

Challenges of Adaptation; Responding with Incentives and Incremental Strategies



The design responds to challenges of adaptation through incentives. Participation as an incentive plays a role in the implementation process. The diagram illustrates the goals and benefits of participation as an adaptation incentive. Image: author.

Challenges of Adaptation and Adaptability in an Urban Context

Space is important in city centers. As in many coastal cities, Helsinki's peninsular core is spatially limited by water. In recent years, it has expanded (and sprawled) to the north, in part due to boundaries provided by the sea and a rapidly growing population. In regards to expansion of built space in the center, questioning the validity of development in flood-prone areas, as Gilbert F. White discusses in his work, would forfeit some of the city's most valuable real estate. This would also compromise urban density, as new development would need to occur in satellite areas. Because of density and lack of space, building resiliency to water issues in Helsinki on a large scale is not a readily available option; strategies that are of a distinctly urban character are necessitated in the case of adaptation there, as in many other coastal post-industrial cities.

Small, integrated, and flexible adaptive design solutions nevertheless require space away from fillable urban fabric. Coastal areas, courtyards, streetscapes, and open and park spaces are all potential platforms for a functioning network of elements that help to manage water issues, while simultaneously serving as public spaces that build awareness of environmental issues. These areas are also potential moments of community involvement and participation. An investment and commitment needs to be made on the part of the city to fund, plan, and support such a strategy. Considering that open spaces for storm and flood water management subtract from build-able land, incentive for the city must be sought. Openings in or additions to the city fabric for adaptive infrastructure must be planned so as to have such a high value in themselves and for the surrounding property, that the initial and added benefit of adjustment outweighs the costs, to use Whitean terms (1945).

Incentivization

Creating a dual value of functionality and amenity in a resiliency network so as to incentivize its support is a major task of expectant design. The combination of adaptive infrastructure and adaptable public space, implemented in an incremental manner, incentivizes city investment. Infrastructure constitutes the creation of a protective system that guards investments. Public space guarantees a benefit of the infrastructural investment to the surrounding community, increasing real estate interest and value, and thus benefitting the city and residents. Public space also provides a means of raising awareness of environmental issues, further benefitting design in its implementation process, as well as public support of city government decisions. Incrementality allows the slow, gradual implementation of an adaptation strategy, providing opportunities for feedback on the reception and efficacy of different stages of the design, as well as in progressive changes in the environment. Incrementality is particularly feasible in the context of uncertainty and required investment associated with climate change. This study explores methods of incrementalizing and programming adaptive spaces as a means of incentivizing city investment and community involvement and participation.

Perception of Risk, Probability, and Magnitude of Action

Climate change considerations in urban planning is approached with trepidation in part because of uncertainty associated with model projections. Despite this, when viewed in 100 year blocks of time, potential damage is largest in the case that no action is taken. Reviewing risks of flood issues in coastal development require acceptance of an extended timescale. In the short term, small scale flooding and storm water issues may be consistently problematic (high probability), and large-scale inundation (lower probability) is on the magnitude of a 50 or 100 year storm, and would cause significant damage in a densely planned coastal district. Adaptive spaces need to answer risks of the everyday associated with storm water, as well as to address the greater

capacity needed to adapt to an inundation hazard. Storm water is a frequent problem in coastal areas, whereas deluge may be predicted to occur a few times in a longer time period. Considering both these lower-impact / higher frequency and high-impact / lower probability events, a range of capacity must be built into water-responsive spaces.

Could a city like Helsinki approach investment in adaptation to low-impact high-probability events rather than rare catastrophe more easily? Could it be more likely to gain support when planning and designing in an incremental manner for several scales of events? It could be more justified to invest towards resiliency that would be more often needed, and would require a lesser capacity. It may perhaps also be that city governments are more likely to address risks that are every day and without much uncertainty, rather than to use greater resources towards adapting to a nevertheless larger risk outright. It is also more palatable to take a chance on a smaller-scale projects that contribute to a larger scheme that is realizable over a long time span, where designs can act as experiment grounds to test out strategies. Additionally, design of adaptive infrastructure that is multi-functioning enables the more facile acceptance of a strategy by a city government and inhabitants, and infrastructure may serve both protective and public uses.

This project's adaptation scheme builds-in resiliency into a development at risk, and that is not in a position to question its validity of site. The adaptive strategy is not only a protection scheme, but also a spatial and programmatic amenity. It is a public and city testing grounds for adaptation and flexible use. A central aim of the design research is to incentivize implementation of an adaptation strategy on the part of the city. Part of incentivization is the navigation of risk and uncertainty, and part is the benefit and feasibility of implementation. An urban strategy that is correlative to both high-frequency, low-impact risks and high-impact, low-frequency events, while maintaining a use and form valuable to the public and to the city fabric addresses these factors. A strategy that is realizable in parts, allowing time for feedback, also incentivizes investment from the city. These factors act as means of justifying a loss of constructible, taxable,

inhabitable space, and the introduction of adaptation infrastructure.

Adaptive and Adaptable Infrastructure

Infrastructure intended to provide defence against flooding such as flood walls is often invoked as a first option in adaptive adjustment, and is also often utilized as a last resort. The hardness and singularity of this type of solution is disadvantageous, and is discussed at greater length in the study's section on adaptation's history. When employed in a dense city center, such infrastructure, like landscape, must have more than one use and possible interpretation. It must justify its existence in the urban fabric with the inclusion of several layers of function and association.

Urban adaptive strategies and infrastructure must be designed as an amenity to their surrounding inhabitants. An example may be taken from the Delft Institute of Technology's research on *Creative Flood Protection* (Steinberg, 2007). Here a call is made for the expansion of flood protection's program into the public use realm. This study and others made within the Section of Hydraulic Engineering at the Delft University of Technology evidences the need for flood protection in dense and valuable areas, and for a particularly multiple and urban character in further adaptive strategies.

New adaptation strategies must consist of several layers; rendering them protective and infrastructural for the catastrophic event, managerial of everyday hazards and change, and usable and adaptable for public action and city experiment. The design work attempts to navigate these goals. Adaptation is to be open and flexible, expectant of the user and changes in the environment, and incremental and changeable in implementation.

Design

Adaptive Design

Adaptation describes a responsive relationship of adjustment to forces that influences the thriving or continuation of a system. A designed adaptation in an urban environment is towards a dialog between the contextual or dynamic change and a corresponding adjustment through the design. Adaptation and adaptability in urban design requires a distinct recognition of the feedback cycle, and the components and nature of change as a catalyzing agent. Adaptation involves specificity, rather than ambiguity resulting from an over-multiplicity. Adaptability is not bound up solely in the flexibility of patterns or abundance of potential. Nor is it entirely embodied by the blank canvas or infrastructural platform. These are, however, aspects of elements that contribute to the overall ability of a system to adapt. This design study describes adaptable and adaptive design as expectant design; this concerns particularities of the conditions of climate change, coastal position, and harbor redevelopment. Central to this study's adaptation strategy are concepts of incrementality, phasing, flexibility, participation, and publicness.

Adaptation and Adaptability as Expectant Design

Expectant design is the conceptual driver for the development of the site strategy. This involves phasing and incrementality, anticipation of the forces (environmental and dynamic) in the site, as well as the expectations and propensities of the user (individual, group, and city). Expectant design is engaging, flexible, time-sensitive, and incremental. Through this as a generating principle, the design work is towards an adaptation of the site that is, through time and circumstance, and by different users, made adaptable.

A Short Note on Research Processes

Initial research involved a deep investigation of environmental and urban planning issues in Helsinki, and development of loose collaborations. Literature, project and policy review, and many interviews with experts and stakeholders were in large part facilitated by the author's (aforementioned) position as a guest researcher at the Finnish Environment Institute (SYKE). On-site research allowed for a view into the current conditions, policies, and stakeholders in the site.

Development Analysis

As discussed, Kalasatama development is to be dense and complete in its effect. Planned buildings leave little space for a coastal zone and/or flexible program areas. This speaks of the demand placed on the area, but is at the expense of a buffer area for environmental forces, and zone for the public to engage and enter in a creative way. Similarly, the water as an amenity is not fully exploited. Zoning on the site describes the residential, commercial, and service areas and central park space. Harbor areas are zoned as such, and regulation here is not descriptive of active public space. The neighborhood center, organized around the metro stop, is the primary commercial space and contains aspects of civic activity as well. Kalasatama central park is the main and largest area in the southern site designated for public recreation, and there are thus many prospective users for the area. In the developments north is a flood plain, whose soil is unstable and polluted. Portions of this area have been zoned for development, and are planned to be built on. The coastline along the site is zoned for a walking path, but it is thus far without detailed plan. One senses that some areas, such as those in the north and along the water, could be inserted with a public space program, and this consideration has largely directed the design. Some water areas are zoned as build-able space, for residential use. Zoning analysis takes these areas into account, as they encounter either hazard or heavy public use.

Site Analysis

Kalasadama is characterized by its history as a harbor and its long coastline. As much of its land consists of fill, it contains remains and refuse from industrial processes. The coastline's formal characteristics are in majority those of constructed land, and some areas of soil are very unstable. Edges in the south are of a hard and industrial character, and water depth in these areas is as great as 9.3 meters. In the north, where residual fill processes are more predominant, edge conditions are soft, fluctuating, and prone to flooding. View from the coast is towards islands (some built and some unbuilt), the city center, and water activity. Helsinki's river Vantaa empties into the sea just north of the site, where further residential development has recently taken place. At current, Kalasadama is characterized by water, its industrial history, workshops, temporary public events, empty northern area, and (in winter) its role as a snow storage area.

In its coastal position, Kalasadama is subject to water hazard. 100- and 200-year flood plain covers a larger portion of the site, particularly in the north (Finnish Consulting Group, "Tulvakohteiden Määrittely" study for Helsinki City Building Inspection Office, 2007). Precipitation will increase on site, by a projected fifteen percent by 2080 (Wahlgren et al., 2008). This will lead to higher runoff, and the increase in the area's built space and traffic will decrease storm water's quality as it flows towards the sea. A study on water nutrient load describes the current development's effect on the nearby water area, and this will increase with a rise in rain and traffic (Nurmi, 2001). Because of Kalasadama's industrial past and the composition of much of its land as fill, soil pollution also exists. In the northern flood plain, this is a particular problem, and the pollution is present in most of the site, with intense areas to be remediated.

Water is the primary hazard on site, and its long coast exposes much of future development to the sea. Adaptation to water thus involves a large spatial extent. In the current plan of the site, the dense nature of the development restrains the widespread use of soft infrastructure such as

landscape or open space for water management and adaptation. Additionally, this build-out does not leave behind spaces for public intervention such as temporary use. This comment could be said for much of the Helsinki area, as the city center is widely developed and built up. The need for flexible and participatory space is seen in the temporary programs and events planned on Kalasatama since its use as a harbor ended.

Flexible Public Space in Cities

A common loss of urban living is the ability to alter and engage with outdoor space, with exceptions made in the case that one breaks social and legal conventions, making unofficial interventions such as graffiti. Alterable open space, with a public and collective agenda (in part via temporary use allowing space for preferences of several users), gives the opportunity to sense (albeit fleeting) ownership of city space, outside of the home or office. Discussion of “creative spaces” (Lehtovuori, Havik, 2009) describes this desire of city dwellers, and the possibility for this to be a collective act. Foucault’s *Heterotopia* speaks to the mysteriousness of spaces that are not defined, and thus open, as does de Sola Morales *Terrain Vague*. This alterable and adaptable space is needed in the city, and especially in response to hazard and redevelopment. It is the place where awareness can be brought up, and engagement of the environment on the part of user can take place. In the design this engageable space is made through time, through an incremental and flexible strategy.

Incremental and Public Design

Adaptation to large and uncertain hazard, and at the high cost of investment, must happen at several stages. The city needs a place for strategy testing, and which communicates also to public engagement for awareness and experiment. The incremental process in expectant design engages the city and users in the testing of strategies, while providing evidence of adaptation’s need, via

the marking of environmental change. Design is made to be partial, and potentially fragmentary, with the intent of provoking awareness, participation, and intervention on the part of the city and public. Incrementally also allows the city to approach uncertainty and large investment more easily. Small investment can initially be made, and further adaptation investment can be made after a design has, in reception and efficacy, proven itself. The project's adaptation is made through this flexible and expectant design; it anticipates the user, the change of the environment, and uncertainty. The incremental beginnings of expectant design plant the seeds of an overall adaptation, while engaging users and the city in an aggregatory, incremental process.

Expectations and Experience

By considering design sites as experiences, potential questions, propensities, and needs of both user and environment can be brought to influence the expectant design placed there. This creates a specificity to the nature of participation. It is an invitation to continue a thought or process. This specificity yet openness, along with the nature of change in the environment, is the design's assurance of literal and conceptual continuation. The engagement of expectation, experience, and environmental force is the design's manual for continuation.

Adaptation as Behavioral Change

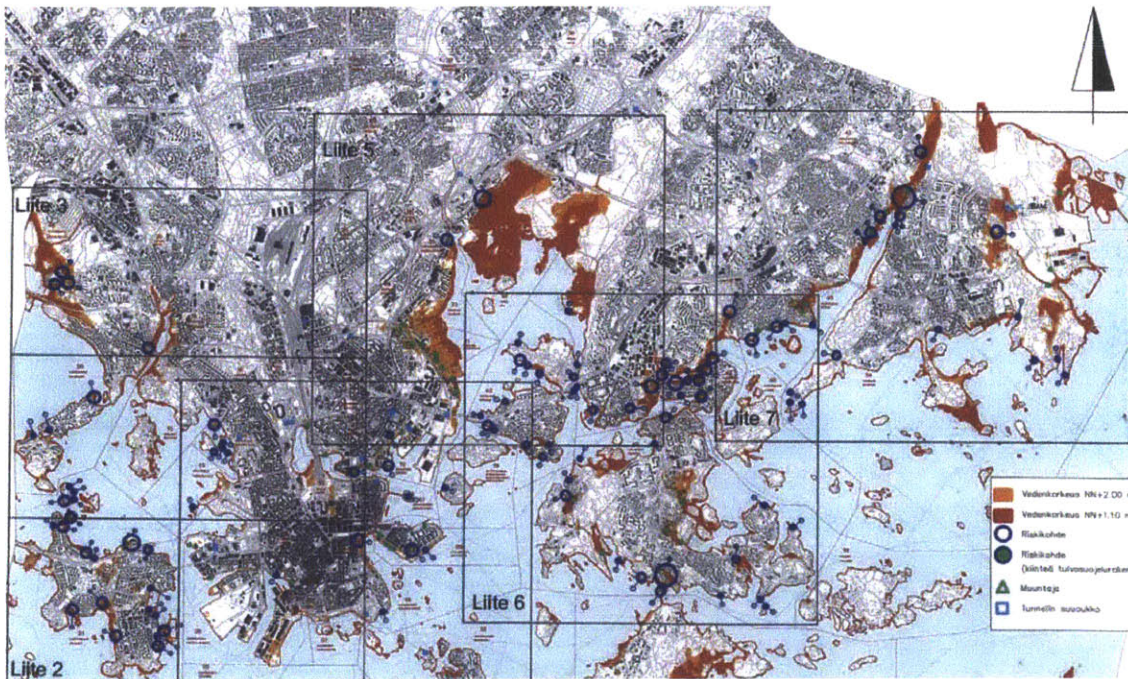
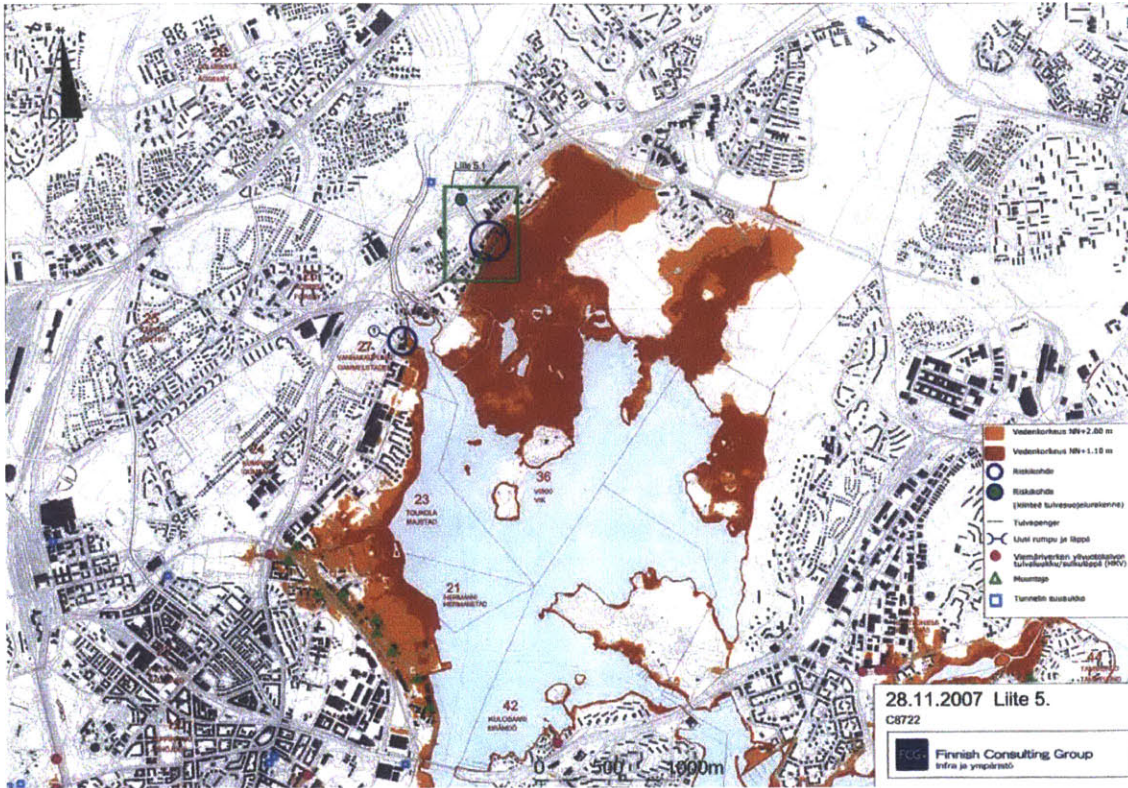
Research, precedent study, stakeholder engagement, and initial design has revealed the large role that behavioral change plays in adaptation. It is a process that happens slowly, in behavior generally but also construction practices, infrastructure construction, transportation, space use, and urban patterns. Associated with change in behavior is awareness, discussion, action, testing, and proof. This also implies the need for a distinct publicness, and a design strategy that provides feedback. For adaptation through behavior change, design offers itself as a platform for the slow shift brought about by awareness, involvement, testing, and evidence. In adapting through

behavior change to the hazard of water, design brings users closer to and in contact with water, gradually introducing it as an element in daily life. This is present in the design's use of water as space able to be built on and experienced, and an element expected in the city fabric.

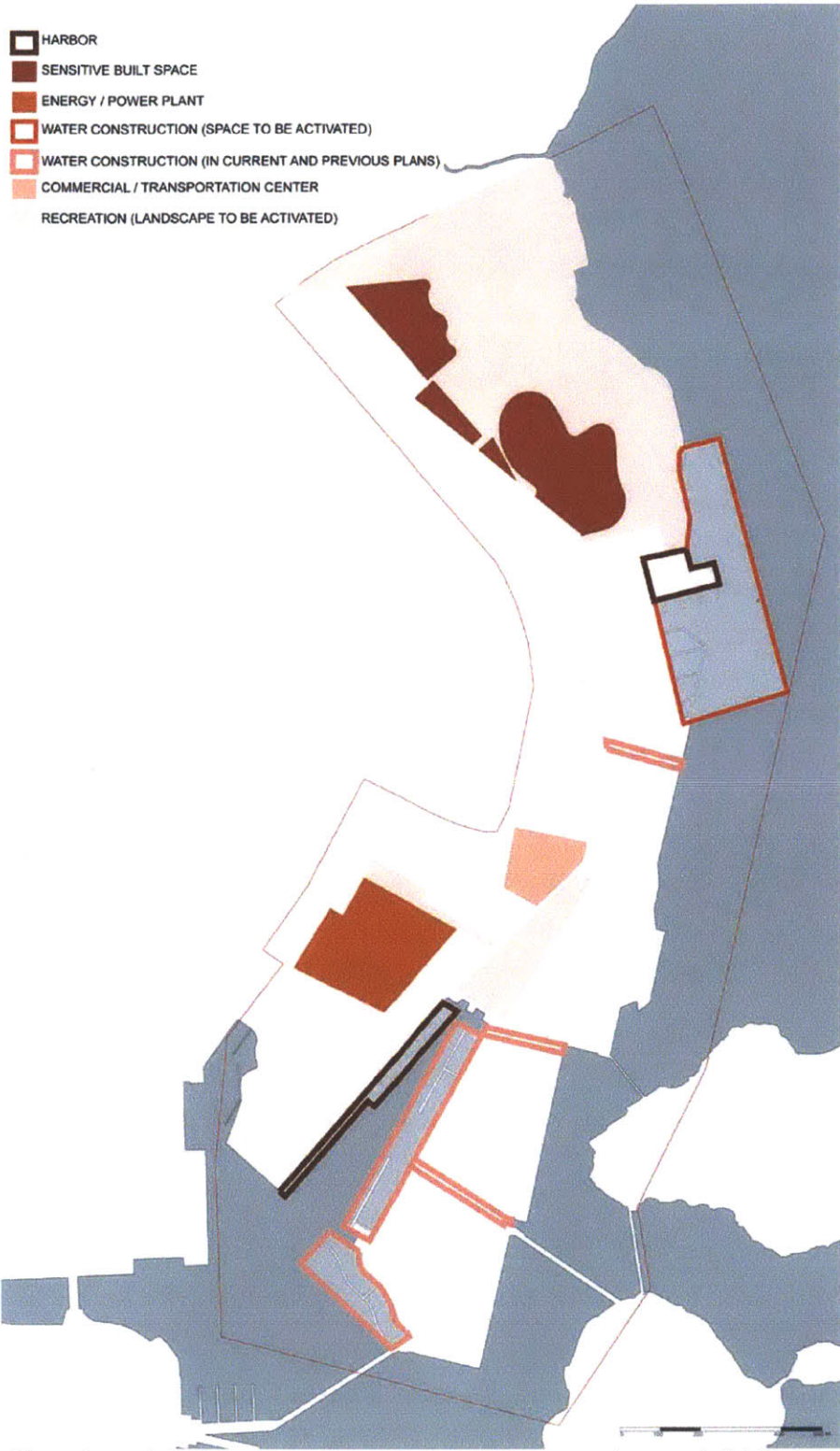
The design zone and elements act as indicators of environmental change. Processes of coastal shift and periodic floods are marked on the design through its use of borders (paths/zones) and horizons (fixed or floating). Design registers the importance of adaptation, the magnitude of intervention needed, and reaffirms the project's reason for being. Indication contributes to awareness and motivates action. The design anticipates, expects, and registers the change in the site's environmental milieu.

Armature of Adaptation and Adaptability

Design occurs within a zone, is identified by areas of hazard (flooding) and planned or likely public spaces (central park, site edge). This is the adaptation armature. Exact placement of interventions is in many cases (i.e. boats) indefinite and flexible, and thus physical presentation is approximate. Design is described initially in its total effect, and secondarily through its components. The components are to illustrate new guidelines for an adapted relationship of city to water.

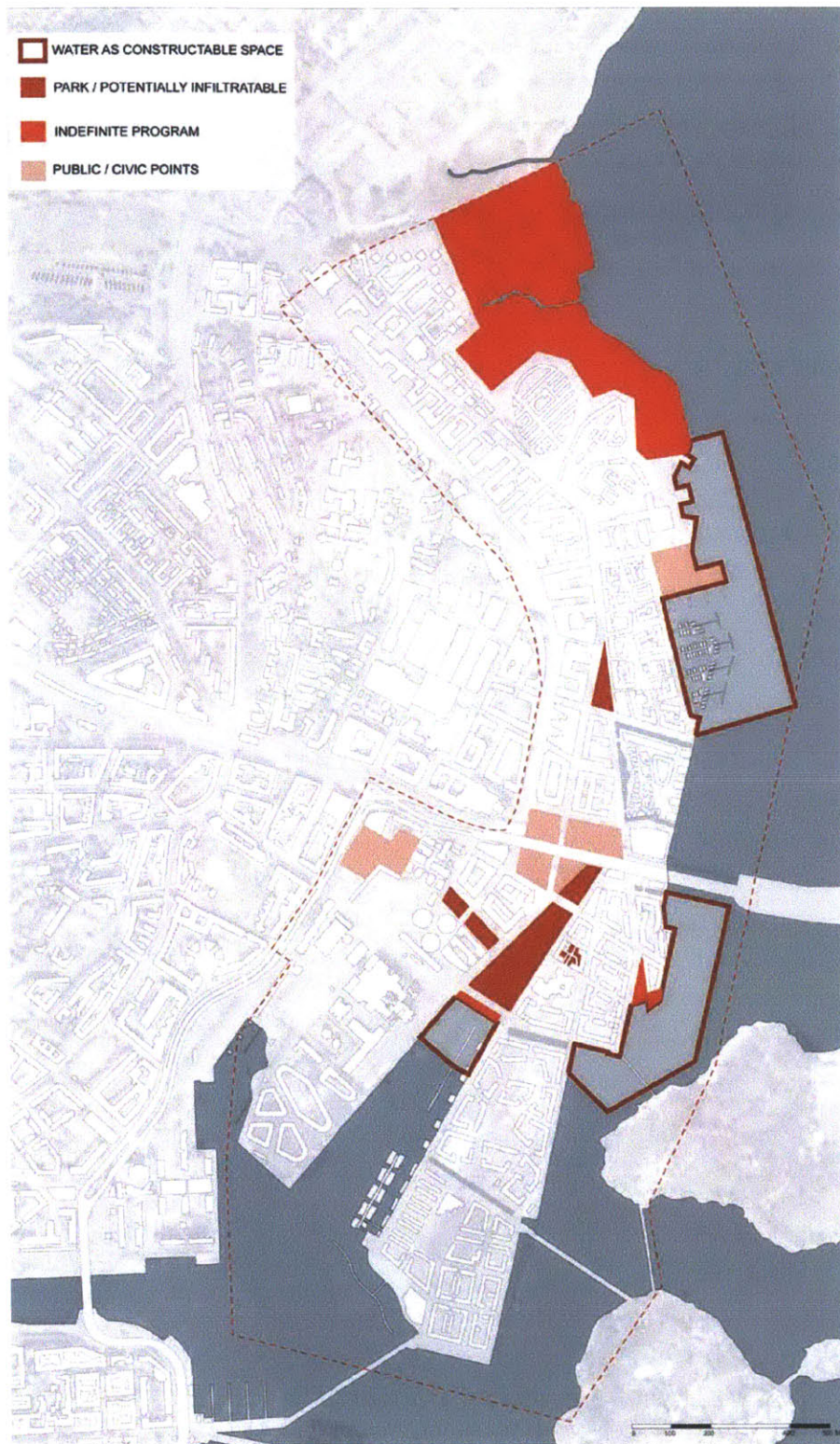


Flood Maps Courtesy of Finnish Consulting Group, "Tulvakohteiden Määrittely" study for Helsinki City Building Inspection Office, 2007. The top map shows the 100- (in red) and 200- (in orange) year flood plain in the north of Kalasatama, and below in the city center generally. Blue circle indicate built space at high risk, green triangles locate existing transformers, and blue squares correlate to tunnel entrances.



Site zoning analysis relative to environmental hazard, public space, and water as buildable space.

Image: author.



Development plan analysis illustrating areas of interest in accordance with the study's focus on water, hazard, and public space. Image: author.



Map of hazards in Kalasatama. Data sourced from Finnish Consulting Group, "Tulvakohteiden Määrittely" study for Helsinki City Building Inspection Office, 2007, and personal communication with collaborators at the Economic and Planning Centre. Image: author.

Primary question of overall research:

“How can coastal cities adapt to water issues associated with climate change? How can public space and engagement be used towards this end?”

Strategies for Kalasatama’s public spaces such as the central park, water areas, and northern flood plain explore these questions.

Design scenarios are to be **incremental and flexible** in nature, and sited within a **coastal and park zone** in Kalasatama.

ADAPTATION ARMATURE



Design armature and elements in the site. Armature describes a zone of water proximity, hazard, and public space. Image: author.

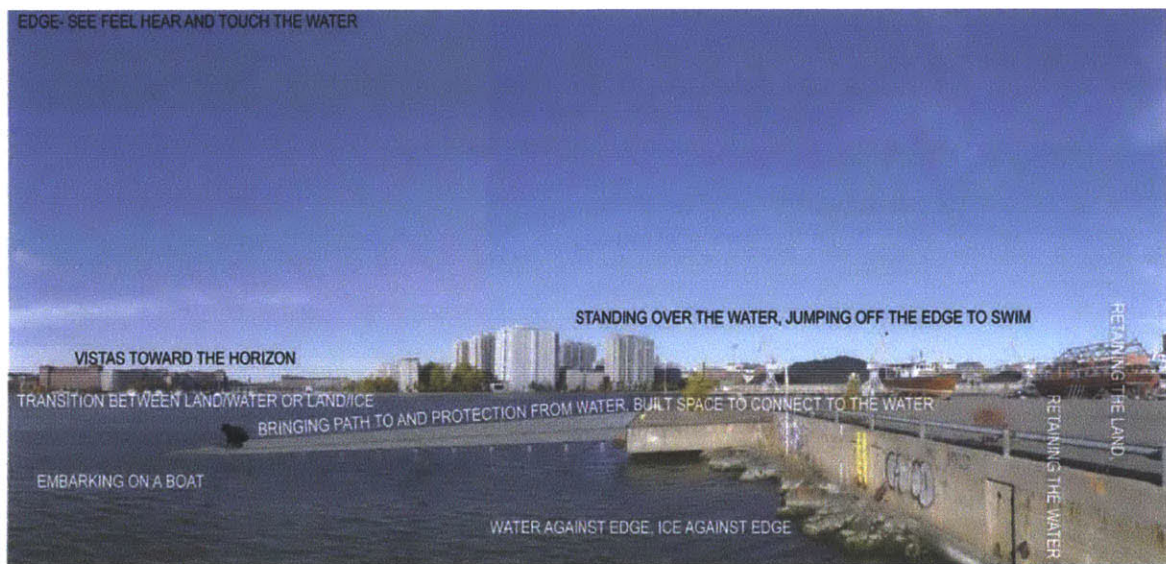
Design zone is identified by areas of hazard (flooding) and planned or likely public spaces (central park, site edge).

In this coastal and public area, design strategies work according to existing conditions:

- edge
- water
- parks
- floodplain

Design inquiry asks:

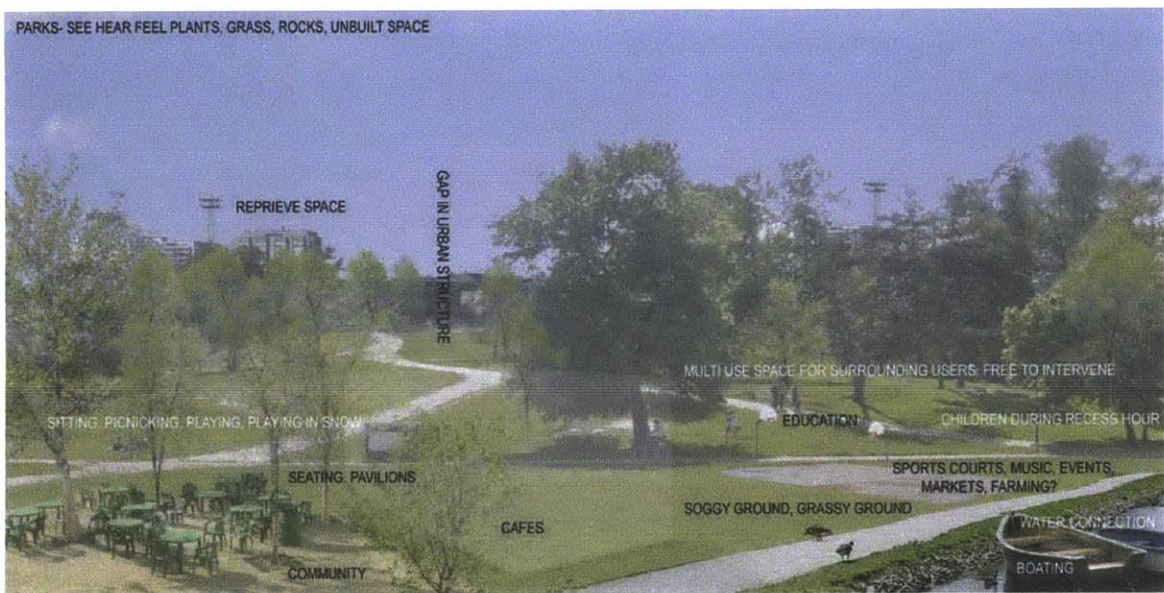
What are the expectations of a visitor to these spaces?



Experiential Expectations of Coastal Areas and Public Space: Edge. Image: author.



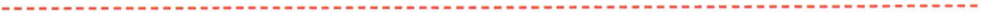
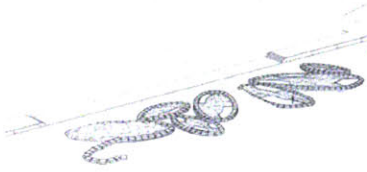
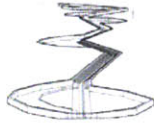
Experiential Expectations of Coastal Areas and Public Space: Water. Image: author.



Experiential Expectations of Coastal Areas and Public Space: Park. Image: author.



Experiential Expectations of Coastal Areas and Public Space: Open / Unused Space in Floodplain. Image: author.



----- -Channel / Flood Terrace

] Water Treatment

----- -Floating Ecology 'Islands'

----- -Fortifiable Public Path

] Flood Protection / -Zoning

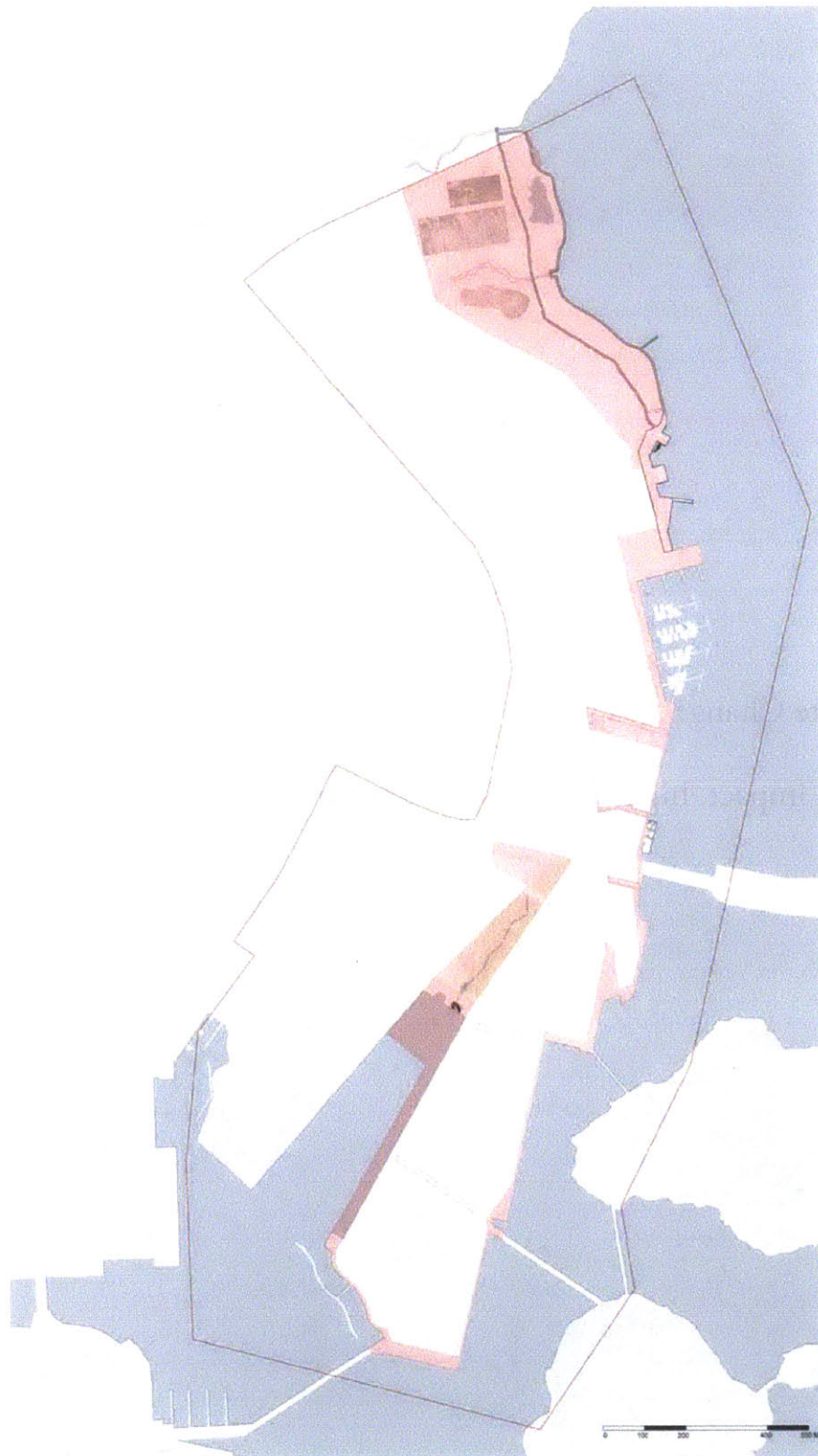
----- -Flood Zone Public Buildings 'Field Houses'

----- -Piers

] Water Access / Flexible Public
Space

----- -Floating Public Spaces 'Boats'

Components of Design. Images by the author.



Phase 1. Implementation is a slowly phased process, according to environmental change, city and user decision, and the experimental nature of the adaptation strategy. Design zone is shown in red. Image: author.

Design on site and phasing strategy



***Phase 2.** Public path strategy expands to the south. Central park processes storm water. Floating ecologies intercept runoff. Floating public spaces provide flexible public space. Flexible piers expand into the water. Image: author.*

Climate Change Adaptation confronts uncertainty, risk of large scale impact, high cost of adaptation, and a long time scale.

Adaptation schemes that propose immediate and total action are not feasible in the face of uncertainty, risk (finance related), and slow processes of environmental change coupled (sometimes) with short lived policy and government initiatives.



Phase 3. Public path expands, and is fortified in the north. Central park flood terrace expands. Floating ecologies multiply. Floating public spaces (boats) multiply and house various programs.
Image: author.

Adaptation should allow cities several decision opportunities, the time to see the impacts of those decisions, and to choose from a spectrum of commitment. *Expectant design* anticipates options a city / user may want to choose from, and the forces that cause him / her / it to initiate decisive action. **Expectant design allows an adaptable adaptation strategy.**



*Phase 4. Public path and piers expand. Fortification continues in the north. Flood terraces multiply. Floating ecologies multiply. Boats expand and are used for various public program.
Image: author.*

Adaptation must be incremental, and a gradual process by which the city adapts its coastal sites, using materials that are modifiable / compoundable and a range of scale. Design initiates adaptive action (“plants the seeds”) using expectant and adaptable design. Concerns of both the present (uses, users, environment) and future (100-year time scale) are contributive.



Phase 5. Public path and piers continue to expand. Fortification continues in the north. Flood terraces multiply. Floating ecologies expand. Boats continue to expand and are partially converted to housing. Image: author.

The design adaptation scheme operates under the premise of probable and possible actions and expectations. It takes into account consideration of what might occur in environmental relationships through time (100 years +), possible changes in dynamic relationships, and potential expectations / desires / propensities of city and users as forming entity(-ies) of the site.



Phase 6. Public path and piers expand. Fortification continues southward and inward. Flood terraces and floating ecologies expand. Boats expand and move throughout the site. Image: author.



Phase 7. Public path and piers expand. Fortification continues southward and inward. Flood terraces and floating ecologies expand. Boats expand and begin to be partially converted to housing (red blocks). Image: author.



Phase 8. Public path and piers expand. Fortification continues southward and inward. Central park becomes a basin. Floating ecologies expand. Boats expand and are partially converted to housing. Flooding in the north moves the coastline. Image: author.



Phase 9. Public path and piers expand. Fortification continues southward and inward. Central park expands as a basin. Floating ecologies expand and boats render the water as buildable space. Coastline in the north is moved permanently. Image: author.



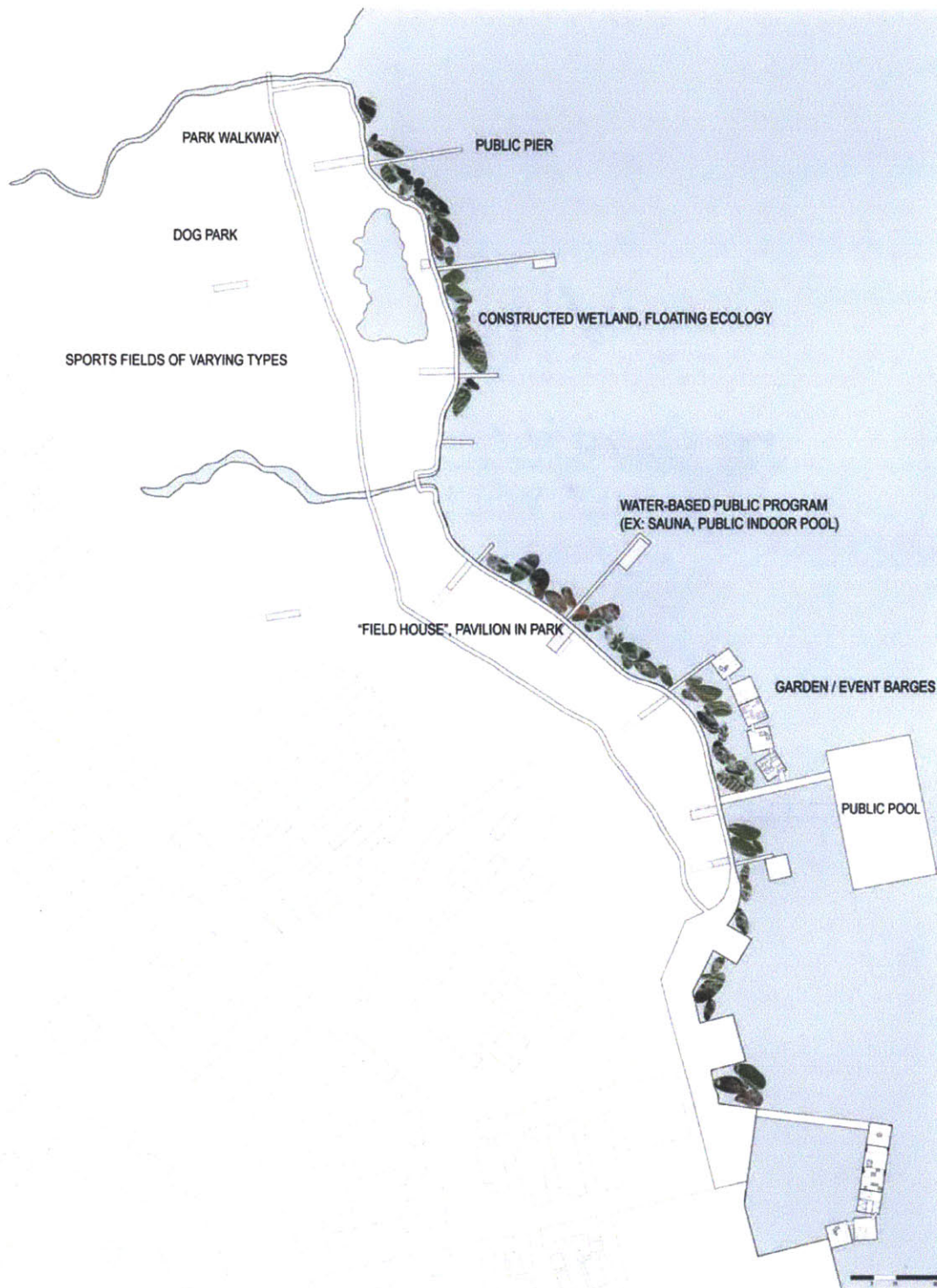
Phase 10. Public path and piers expand. Fortification continues in all areas. Buildout in water space is reached. Coastline in the north moved further inward, and built space begins water intake (in blue). Image: author.

Using existing paths on site, and connecting to Arabianranta park space plan to the north, public walks bring the visitor through the site, along the coast. These paths are fortifiable in sections; thus providing the option of coastal flood protection.

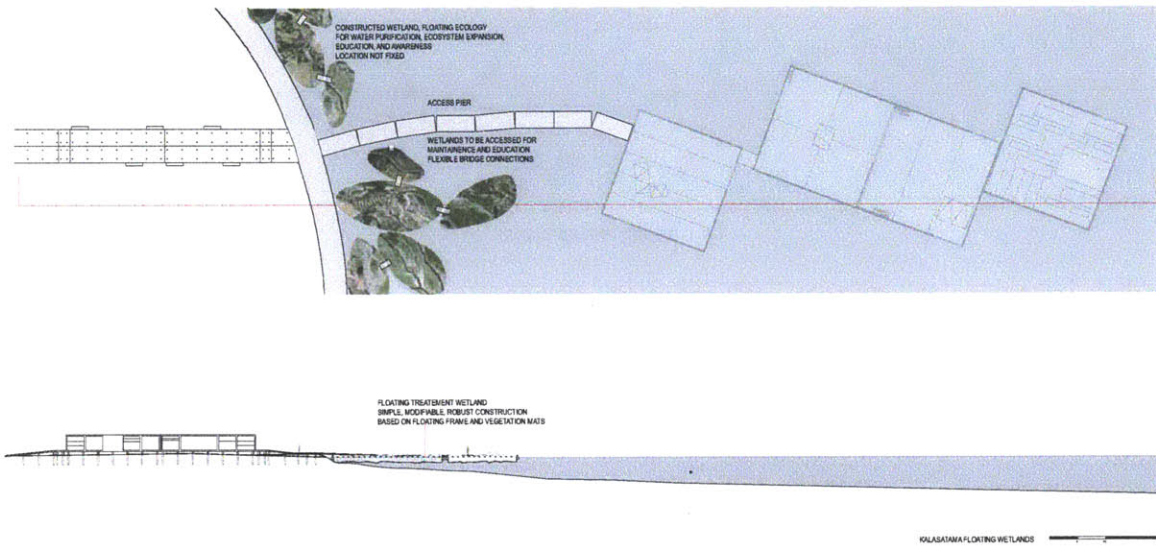
“Field houses”, or flexible public buildings, serve the park space, playing fields, and water connections. Construction is of a modular and re-used nature (example: shipping containers).

Spaces are raised on piloti to protect space from occasional floods, and to set a precedent for construction in this area. Only one or many of these houses can be built to serve the park.

Water connections and water-based program also comprise the park.



View of northern flood plain. A flexible and expectant adaptation strategy is made through the incremental components of fortifiable path, flexible piers, water-based public space, and functioning public ecologies.



Plan and section of the path and islands spaces. Images: author.

Design Zone: Northern Park (Includes Path, Piers, Field house, Islands, and Boats)

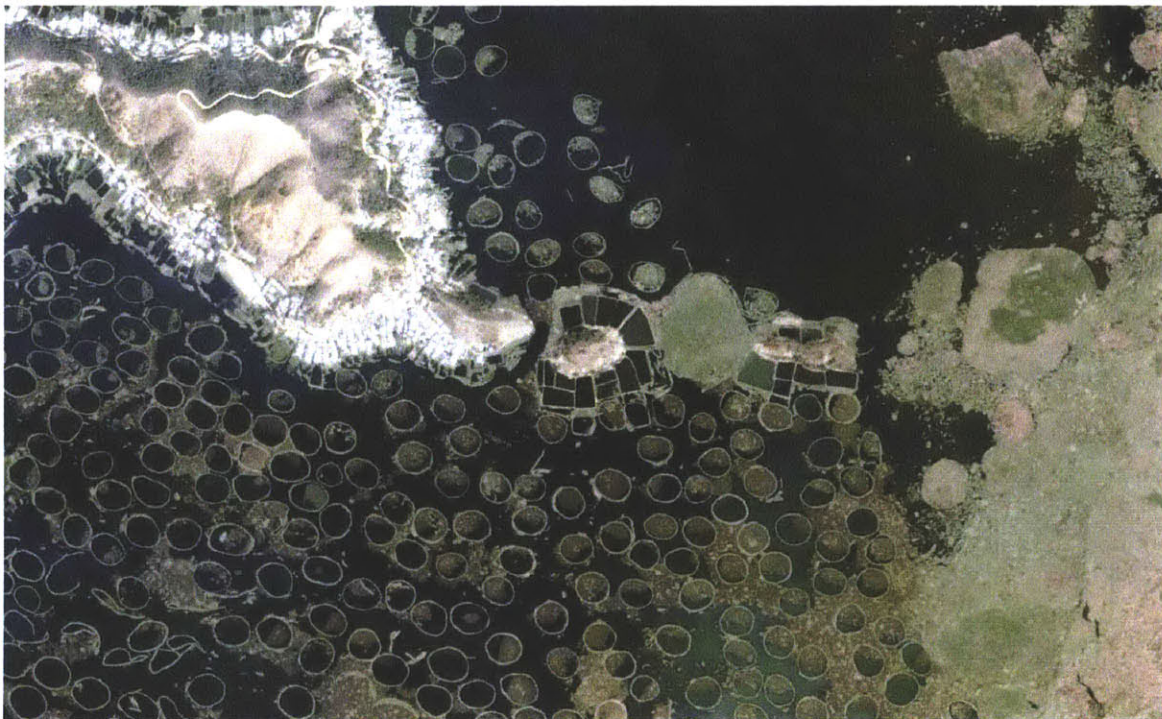
Building from existing paths, a fortifiable public walk is made in the northern flood plain. When raised, the walk is stabilized by piloti. The path is fortifiable as a flood barrier. This is possible in sections, and made through backfilling and rock armor. Partially floating and modular piers bring users from the walk into contact with water, or water-based program. “Field houses”, flexible, moveable, and modular (i.e. shipping container) spaces for public use (example: sauna) are placed on piloti, demonstrating methods of construction in the flood plain. Open space is used, for the time being (before any future development) as sports fields. Floating ecologies (“islands”) are placed at the shoreline, for water purification, habitat creation, and awareness / engagement raising.

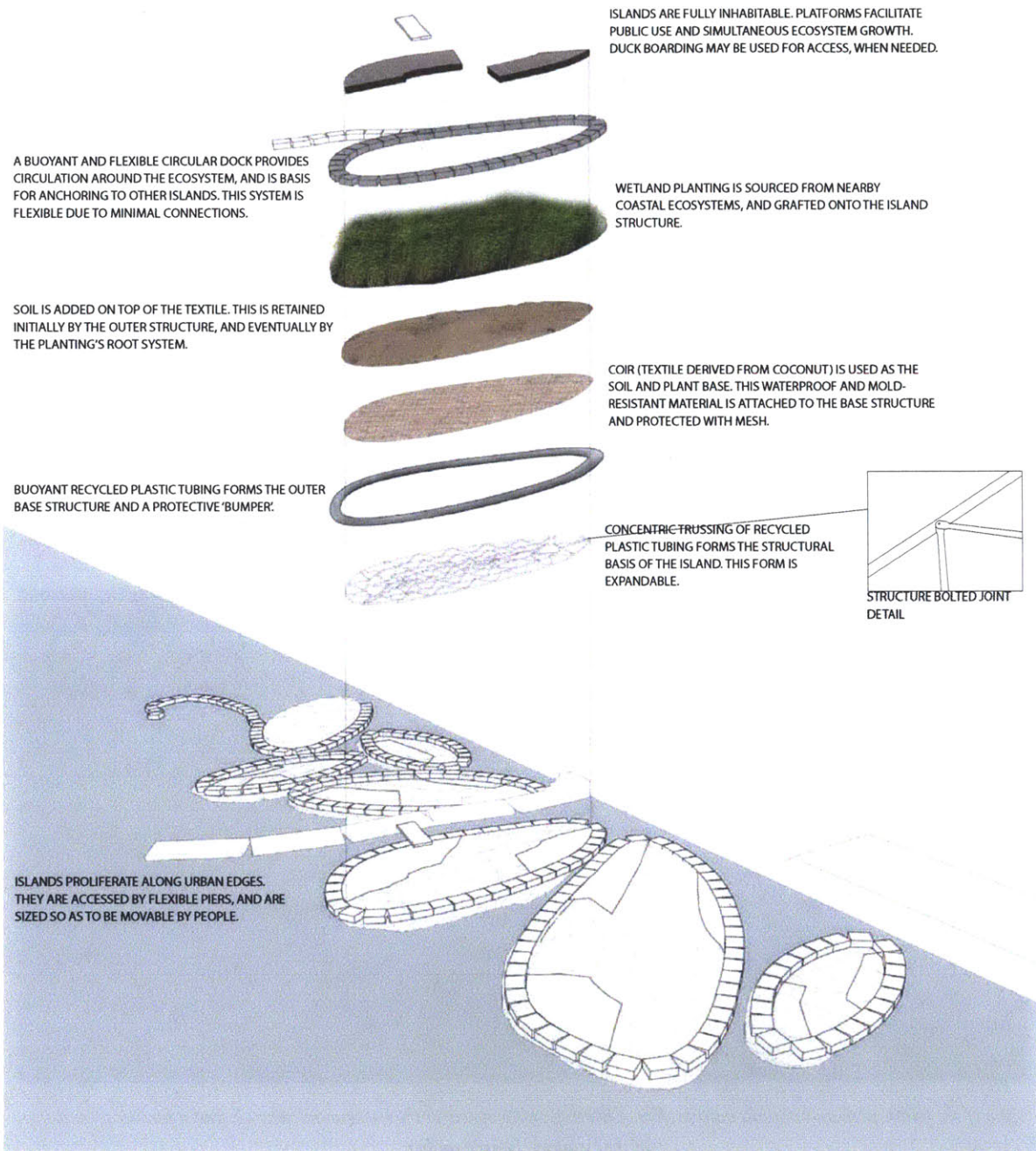
In further phases of the design, when coastal shift occurs, the path may be raised to maintain circulation through the area, while documenting the previous coastline. The path may also be fortified to maintain the current ratio of land to water space. Piers, boats, and islands multiply as they are proven effective, and shift with the water level. Field houses remain above water line, and are raised, flooded, or removed.

The site’s industrial edge takes up a similar strategy of public walk, in different materials appropriate to the harbor’s concrete edge. This scheme is, like in the northern area, fortifiable in sections, and providing of multiple connections to the water. Initially it may be partially built in materials that register effects of water splashes, waves, and rise, such as rustable metal. During flood events, open sections of this and the northern strategy reveal themselves as datums from which to view and measure waterlines and progression of floods.

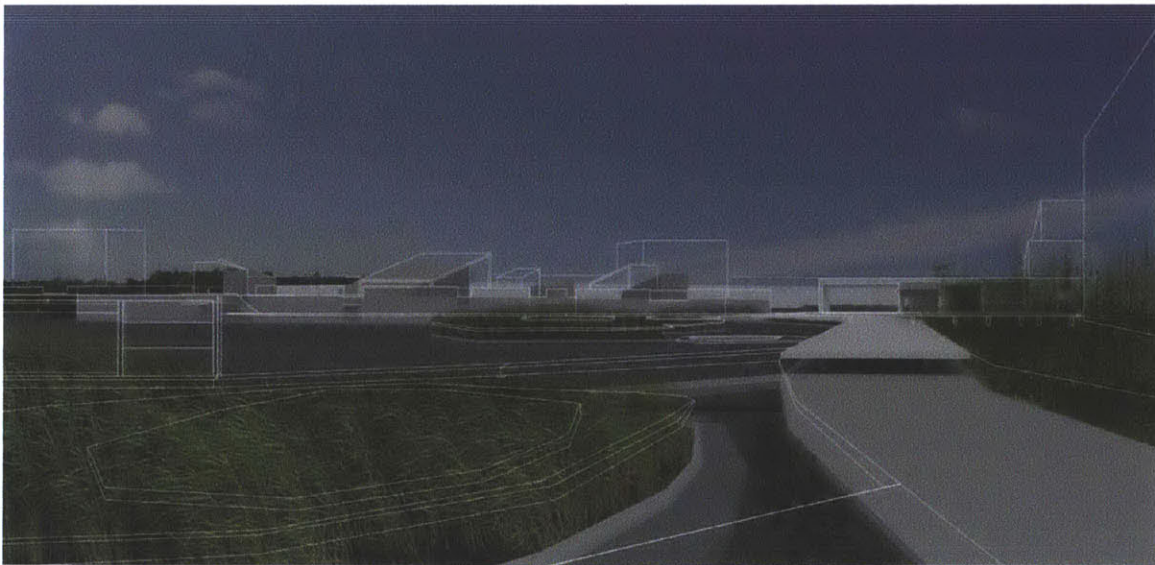
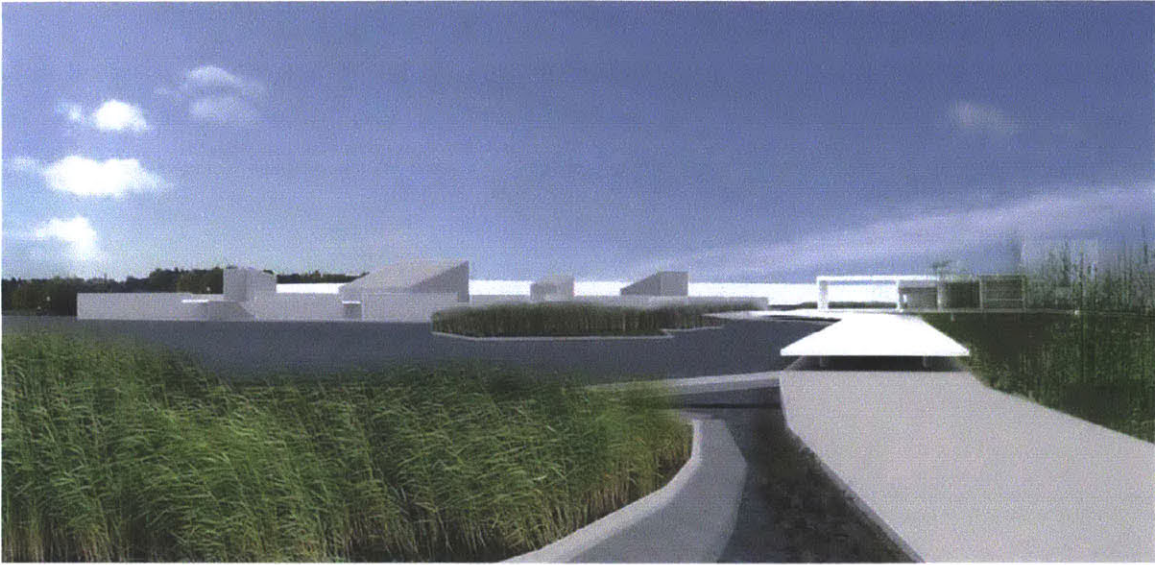


Island design References: 'Veden Taika', by artist Jackie Brookner (above). Image: www.Jackie Brookner.net (accessed May 17th 2011). 'Phumdis' in Loktak Lake, India (below). Image: Google Earth.

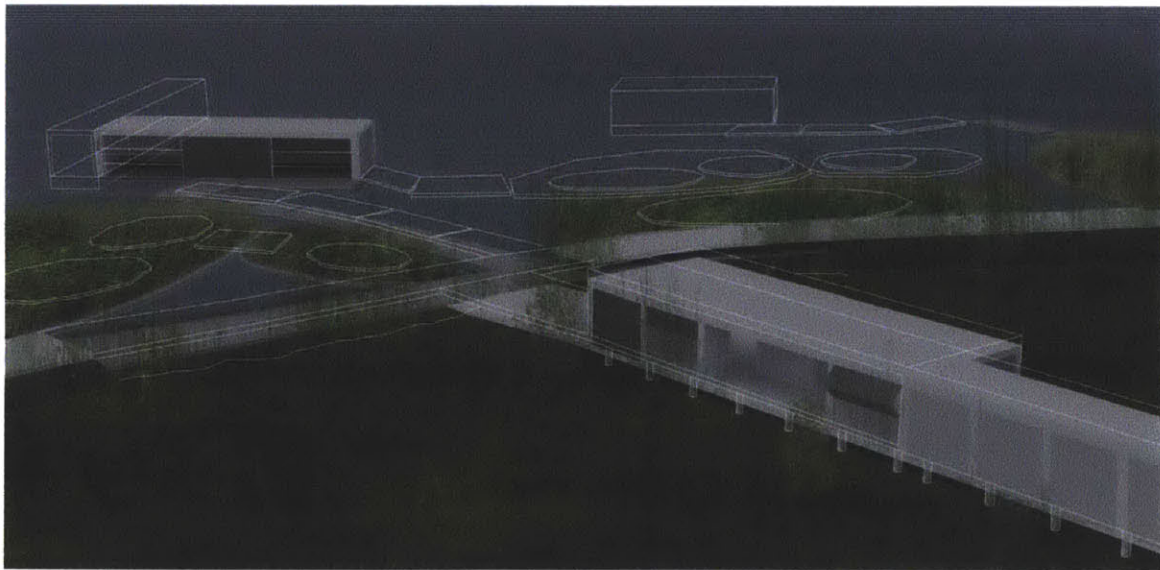
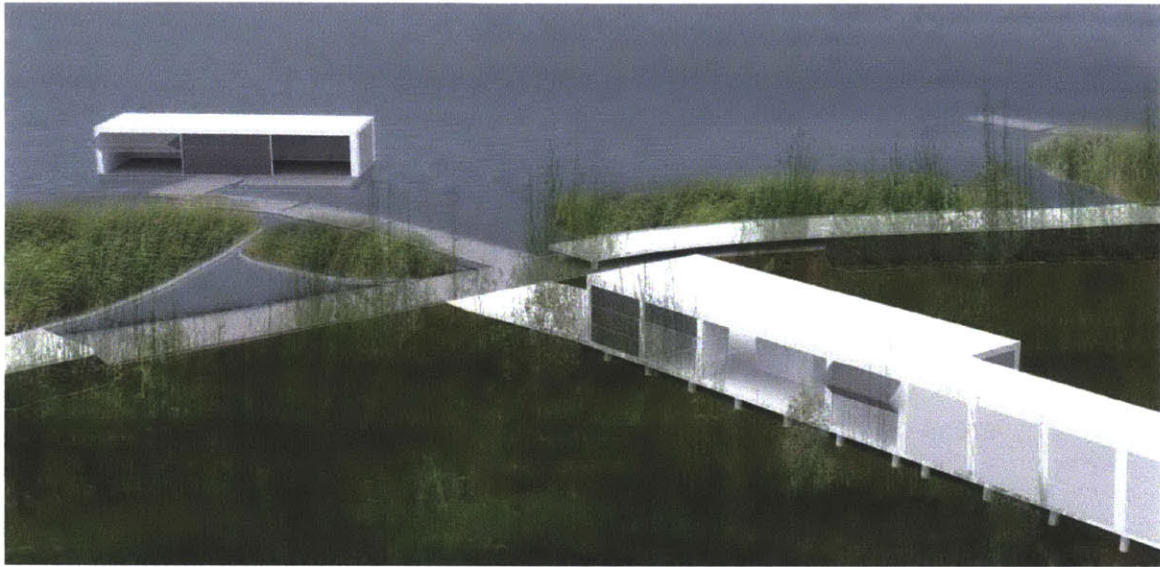




Edge Strategy: Floating Ecologies, "Islands". Diagram shows structure and construction. Image: author.

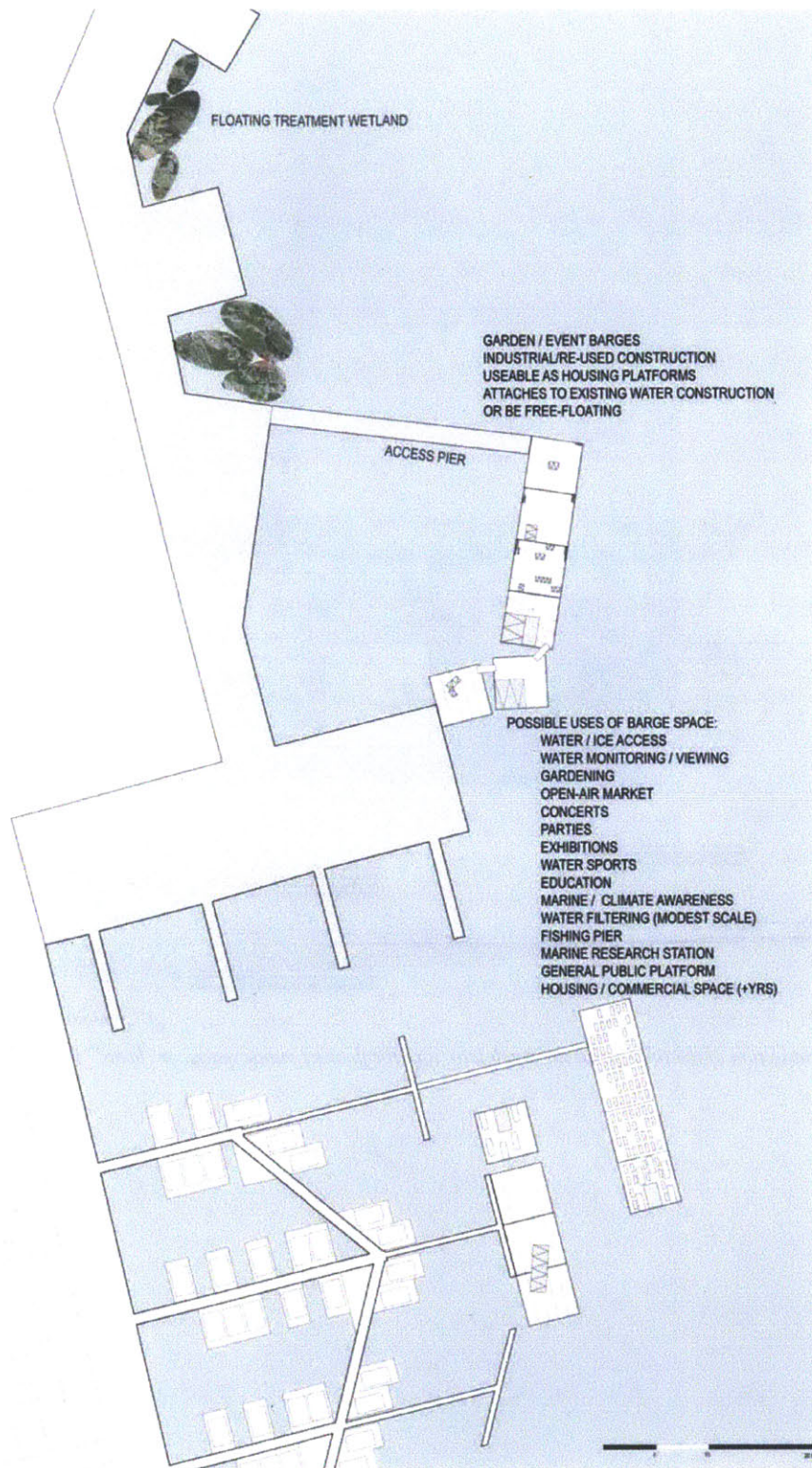


View of the public path and islands, with profiles of floating public spaces in the background (above), and a further phased step of that strategy. Images: author.

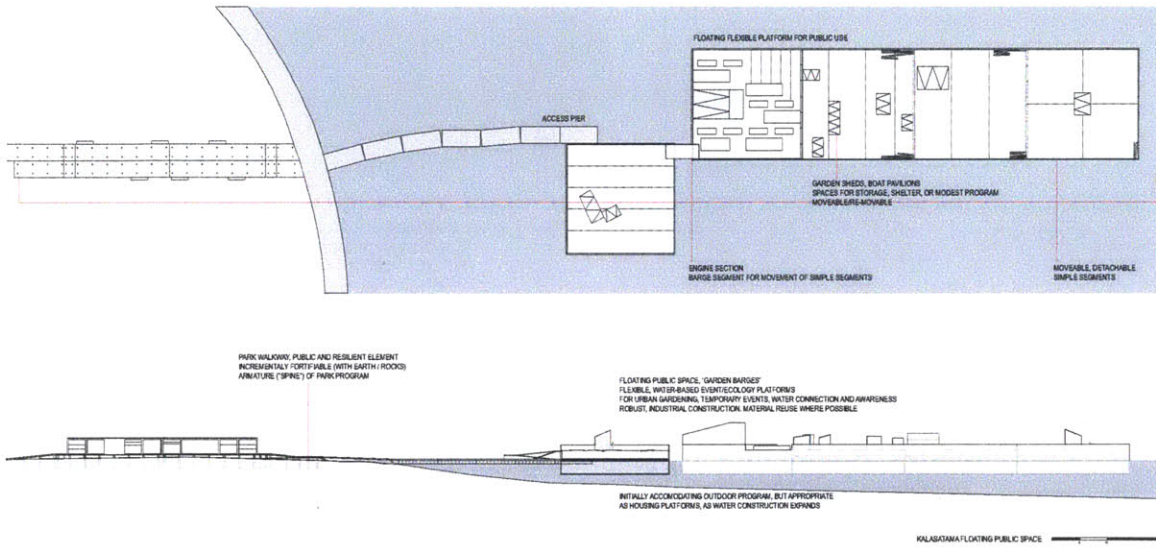


*View of the public path, islands, field house and floating public space (above), and a further phased step of that strategy (below).
Images: author.*

Floating public spaces, or “boats”, are flexible public areas on the water. Modularly built, they are of robust materials. These floating elements allow for temporary programs such as urban gardening, events, and markets. In the future they may be adopted for housing.



View of mid-site strategy. At the phase shown the fortifiable path reaches only to the harbor space. Floating houses, built by the city, gain floating garden spaces, and the harbor area gains water-based event space.



Plan and section of the site edge in the floodplain, and the floating public spaces, or “boats”. Images: author.

Design Element: Floating Public Space, “Boat”

Additional room for flexible public space is not provided in the development plan, and these areas are thus placed on water. Floating public spaces, or “boats” bring about the possibility of a platform for multiple or temporary events and uses. The boats fluctuate according to environmental and public change; their use and siting reflect shift in the site. Primary suggested program for these spaces is that of public gardening, as this has been a public space use of growing demand in the city.

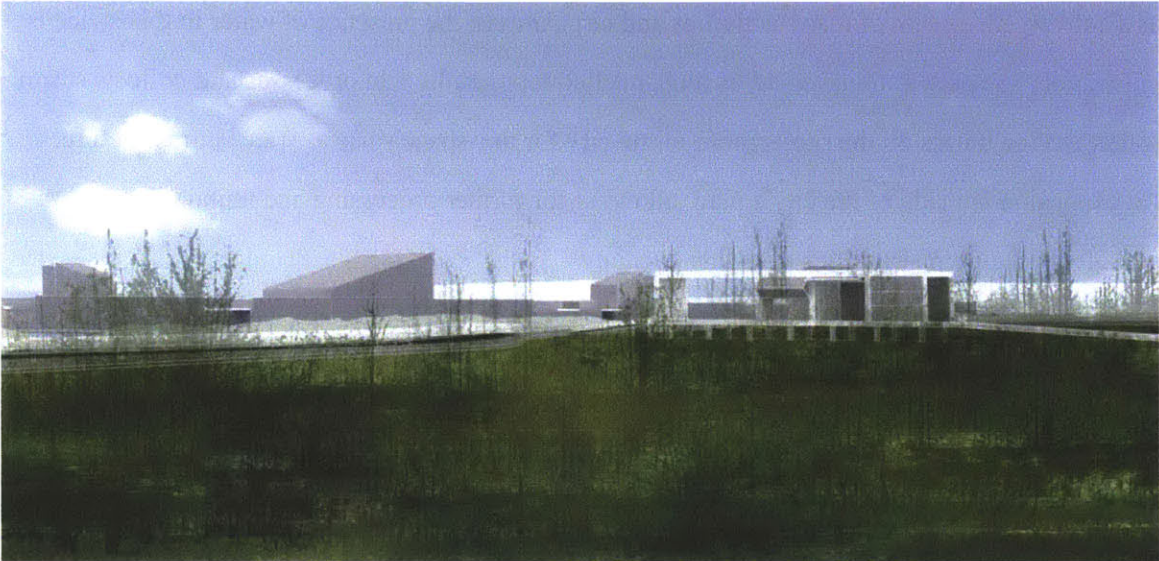
Boats are accessed by piers, and are built in flexible sections of robust material. Alternatively, they may consist of reused barges, reminiscent of the site’s harbor history. Connection to floating housing as “yards” is also possible. The boats may exist as a strategy as singular elements, or as a group of many.

Future siting of the floating public spaces may be elsewhere in the city and according to program. An example can be taken of a boat that serves as an urban garden producing edible plants, and the transfer of the boat (in harvest season) to a floating market that visits various spots in the city. Further iteration of program may involve the use of the boats as housing platform.

A primary goal of these design elements is towards adaptation through behavior change. The use of water as engageable element and buildable space brings users into closer contact with this environmental force, and intends to bring about the re-thinking of its phenomenological characteristics and associations, and the acceptance of its presence in daily life.



View of the floating public spaces ("boats"), located mid-site. The multifunctional spaces are accessed by piers and can house temporary programs such as urban agriculture. Image: author.



View of the boats in profile from the floodplain (above), and a further phased step of that strategy (below). Images: author.

Design Element: Southern Park Channel and Floating Functioning Ecologies (“Islands”)

The southern (central) park of Kalasatama is a focus of the site’s public activity. It is the largest site in the southern half of the development plan designated for public use. Because of its role as a convergence point of many activities and circulations, the presence of water in this space is influential. The park is transversed by a channelled topography that processes and collects storm water. Design builds on the preferences of the city for this space’s use as water infrastructure. An expansion is made of the city’s plan, allowing for further processing and inundation, and to provide for future possibilities of higher capacity.

The channel, when dry, functions as a public space with seating, landscaping and easy crossing. When wet, this area transforms the park into a landscaped waterfront, using storm water as an amenity to the surrounding built space. The dimensions and extent of the channel are expandable, and it functions both as a dry stream and as a lake.

Flood plain and public space “pods” attach to the channel according to city and water requirements and preferences. These areas serve to hold and infiltrate water, and to provide public space and seating. The areas are sunken -70 centimetres, and may be built singularly or as groups. Modular construction of the retaining walls provides for expandability and flexibility.

Within these spaces and the park as a whole are moveable public pavilions. Similar to the northern flood plain’s field houses, these spaces may be built of re-used modular construction (shipping containers) and are raised from the ground plain. They may be enclosed or open, and can serve a variety of programs.

At the south of the park design is water space. The slim strip of industrial edge is unclear in development plans, and a connection to the water is not organized by the city in this area. Herein

lies an opportunity to develop central water space into public space. Design extent of these elements is initially constrained due to the active harbor zone, servicing the nearby power plant, but is expandable after decommissioning of the plant. The design brings circulation to the water via flexible piers, which may be joined by a floating dock in later phases. Near the piers, storm water discharge from the development enters the sea. Constructed ecologies (“islands”) intercept this hazard, filtering the water before it disperses. This floating landscape brings about a new kind of engaging public space for the curious. Access is provided by the pierspace. The islands support human weight, and are linked to one another by ties and duck boards.

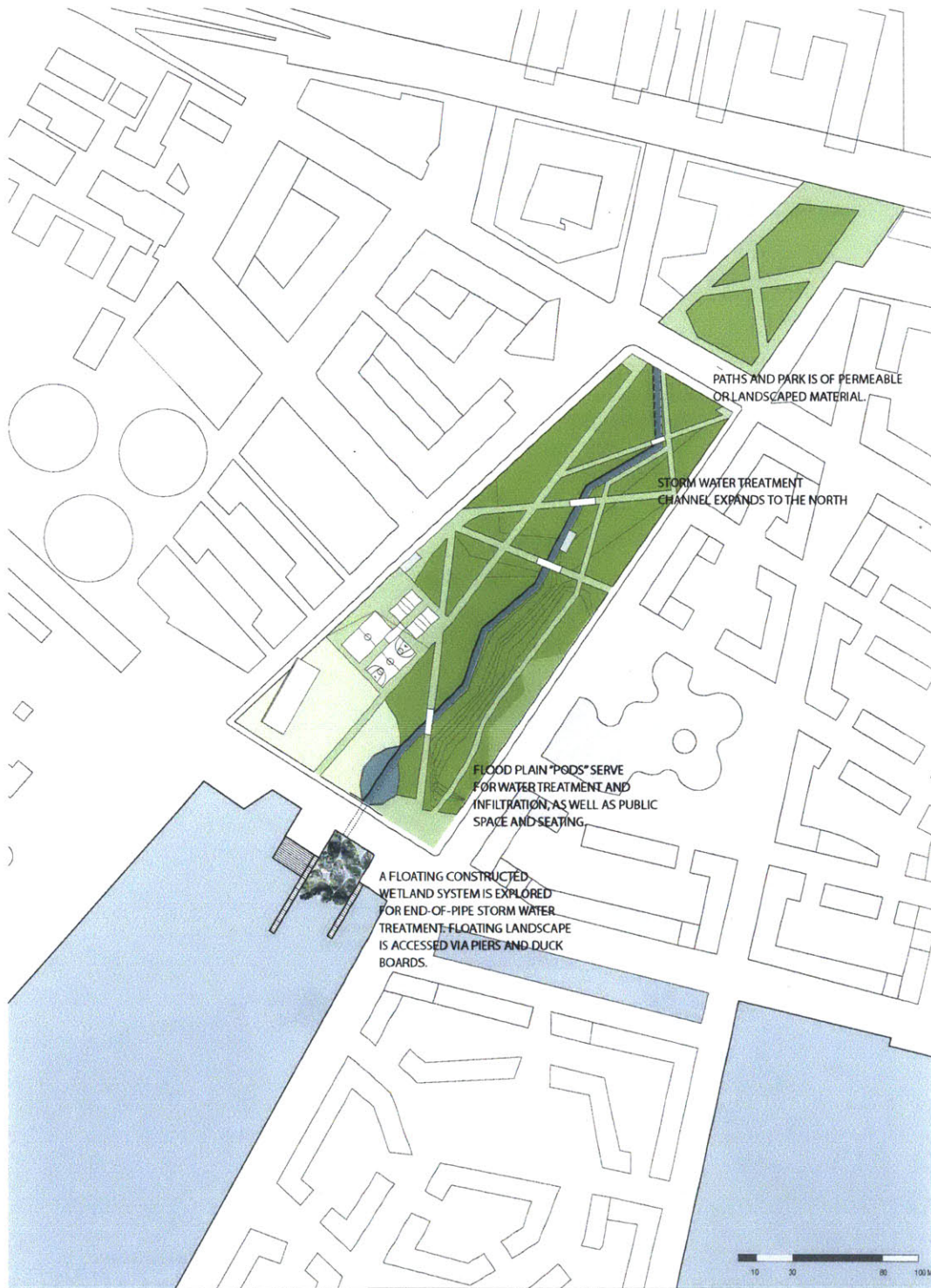
The park plan is spare and allows additions in program, built space, and landscape. The design’s role is to invite the modification of the space over time, according to environmental and user change. The park channel may be expanded, deepened, planted in, dried out, and flooded. Flood plains can be added, filled in, built in. Modular built space can be moved, re-moved, multiplied, combined, reprogrammed. Wetlands and piers can be multiplied, expanded, and moved elsewhere. Users can enter the space via reprogramming, event planning, self modifying (space’s programs and configuration), and engaging the floating ecology for experiment. Flotation also allows user the experience the water space, which is in constant flux. The city is engaged by the design in its potential for expansion and change, and in its role (the islands particularly) as a pilot project for furthering ideas of ecology in city development.

Expanding on the park's existing strategy, the storm water treatment channel extends to the north. It gains 30% of its previous area. An additional flood plain area is added in the south.

The channel edge is stepped to allow for public space / seating and easy crossing. Bridges provide additional water filtration and ease of pedestrian movement. Permeable paving and landscaping is used to infiltrate storm water from the surrounding development.

Sunken (-70 cm) flood terrace areas serve as public space "pods". These areas can contain special program, and temporary built space (modular, flexible containers. Program example: cafe).

Water is led, at the end of the channel, to an experimental floating ecology water treatment area. This zone is accessed by the public via piers.



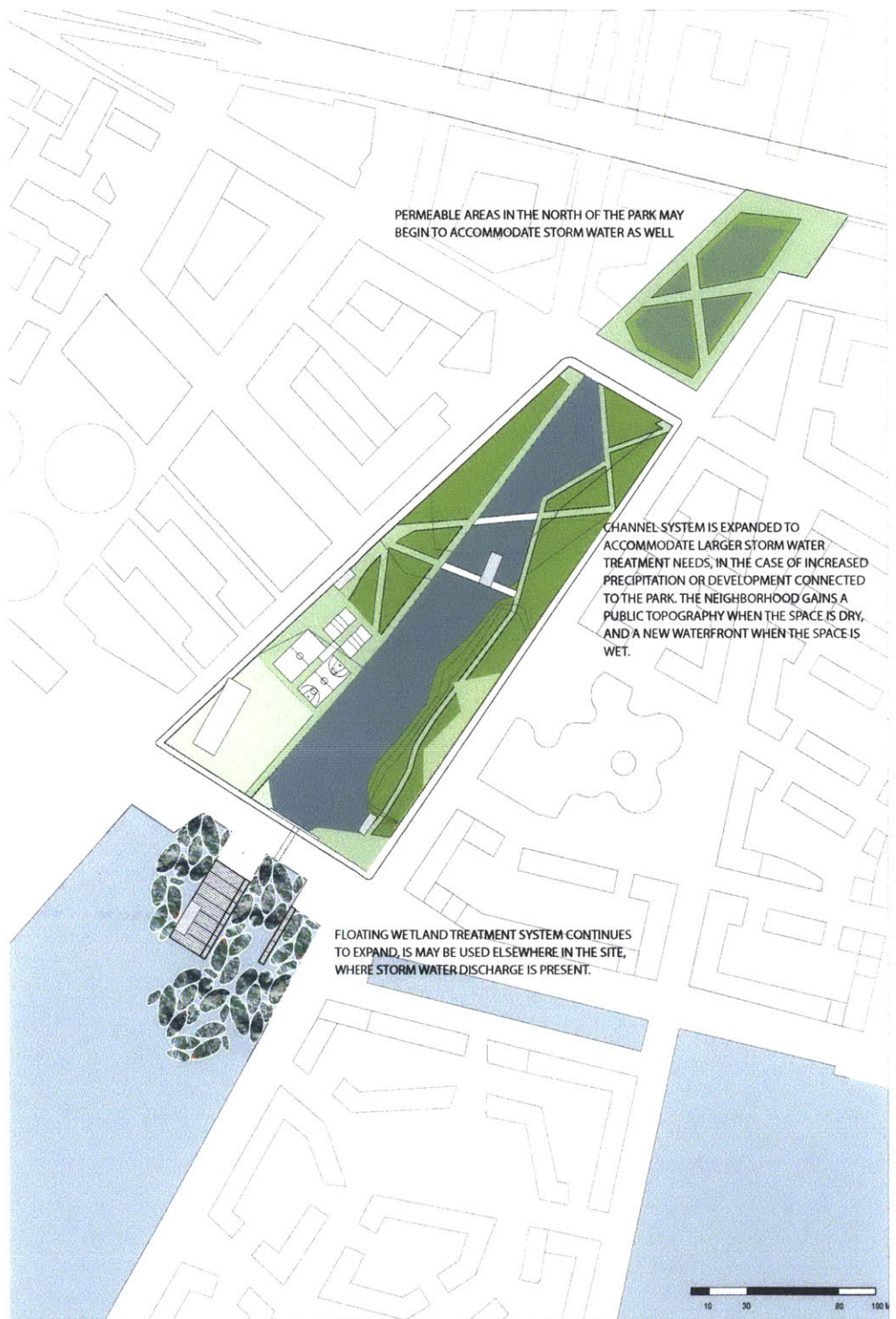
Central Park (Storm water Channel and Wetland) Strategy. Image: author.



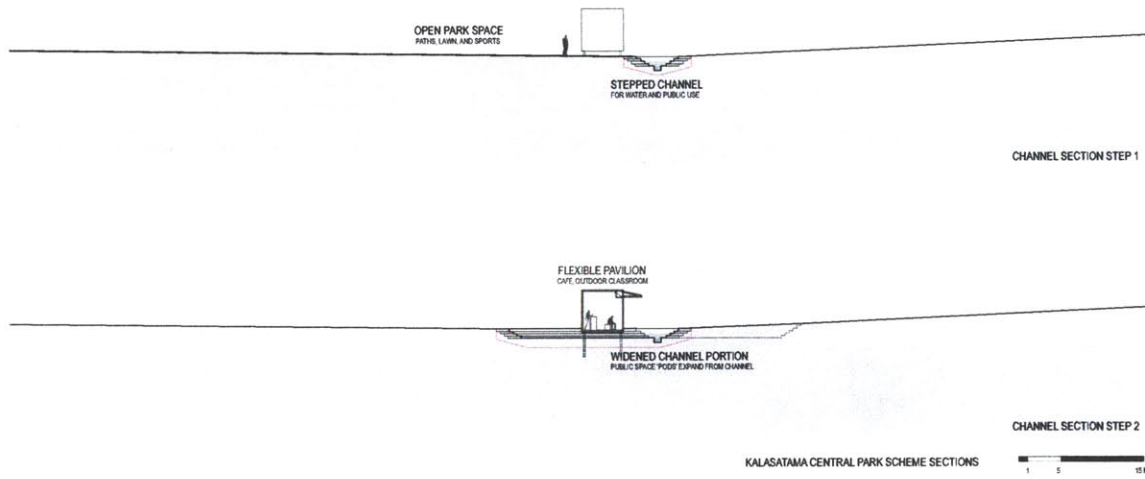
MULTIPLICATION OF FLOOD PLAIN POD STRATEGY. STORM WATER TREATMENT AND PUBLIC SPACE CAPACITY OF THE PARK IS INCREASED.

EXPANSION OF FLOATING WETLAND SYSTEM AND ADJACENT PUBLIC SPACE, WITH POTENTIAL DECOMMISSIONING OF THE POWER PLANT AND INCREASED WATER AND PUBLIC INTEREST

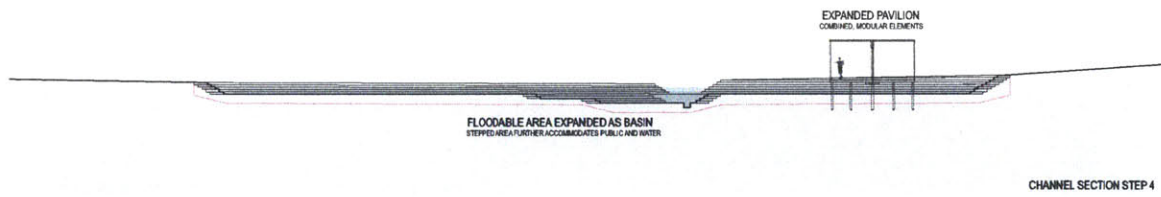
Central Park Strategy: Further Steps to Water Management. Flood terraces multiply, expanding the park's water management capacity. Floating ecologies act as both water purifiers and public space. Image: author.



The park's water capacity expands further to act as a basin for floods. The surrounding neighborhood gains a waterfront, while the nearby ecology gains more pure water. Floating ecology continues to expand. Image: author.



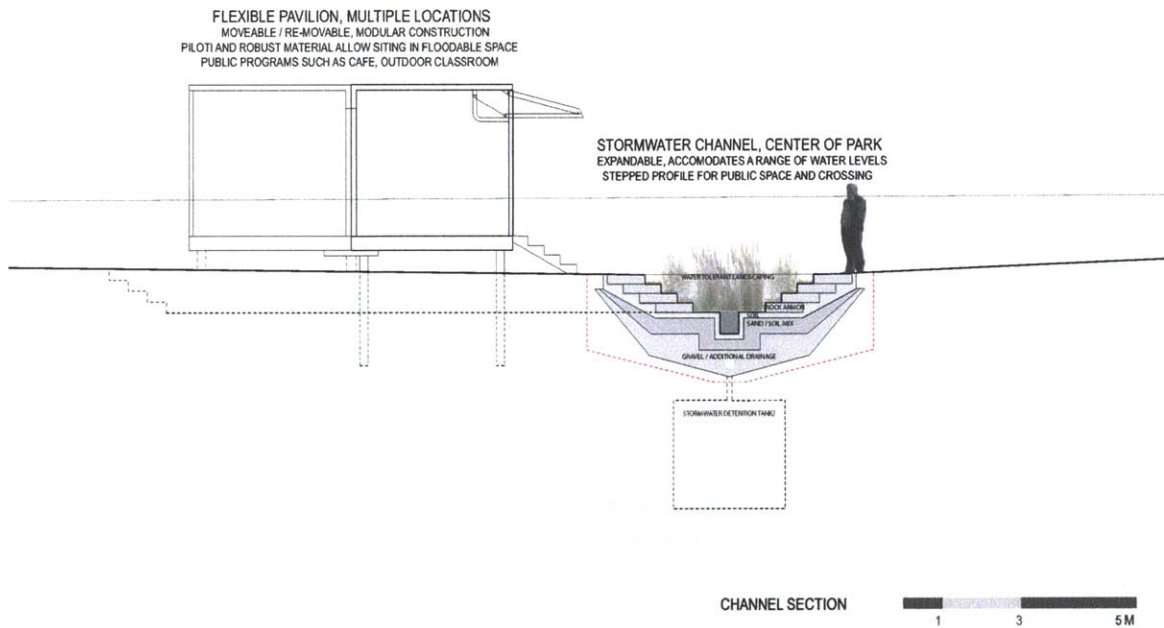
Central Park Strategy: Initial Strategy Sections. Image: author.



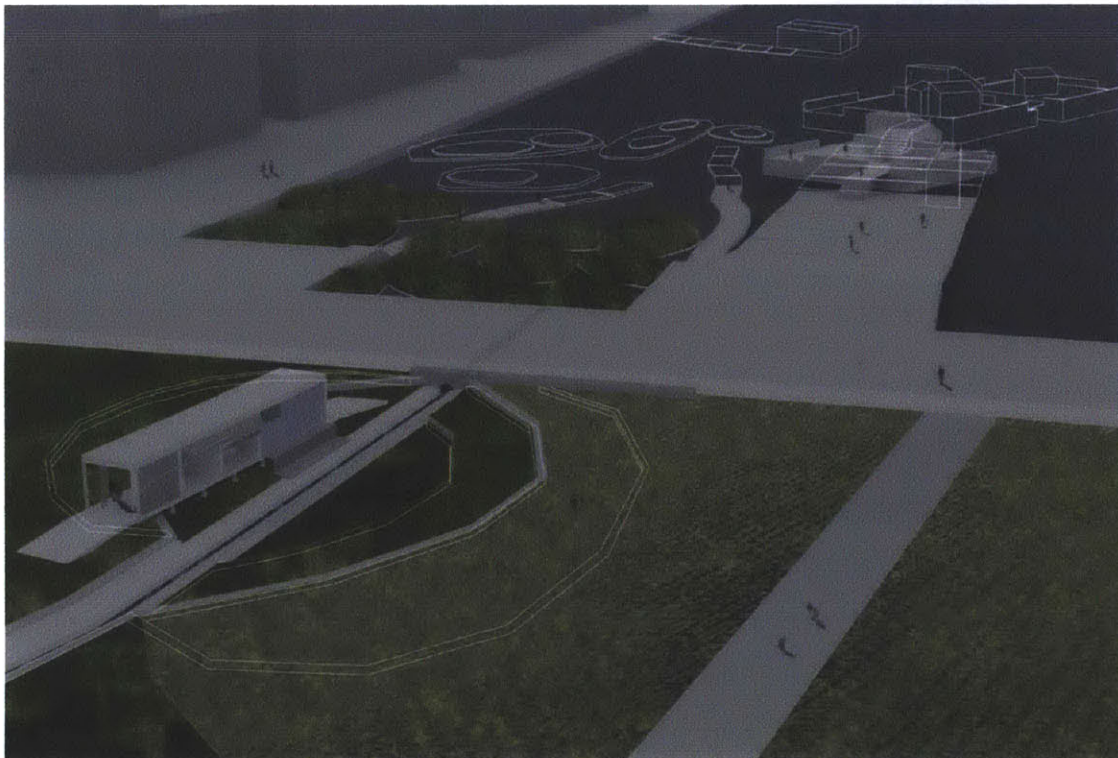
KALASATAMA CENTRAL PARK SCHEME SECTIONS



Central Park Strategy: Expanded Strategy Sections. Image: author.



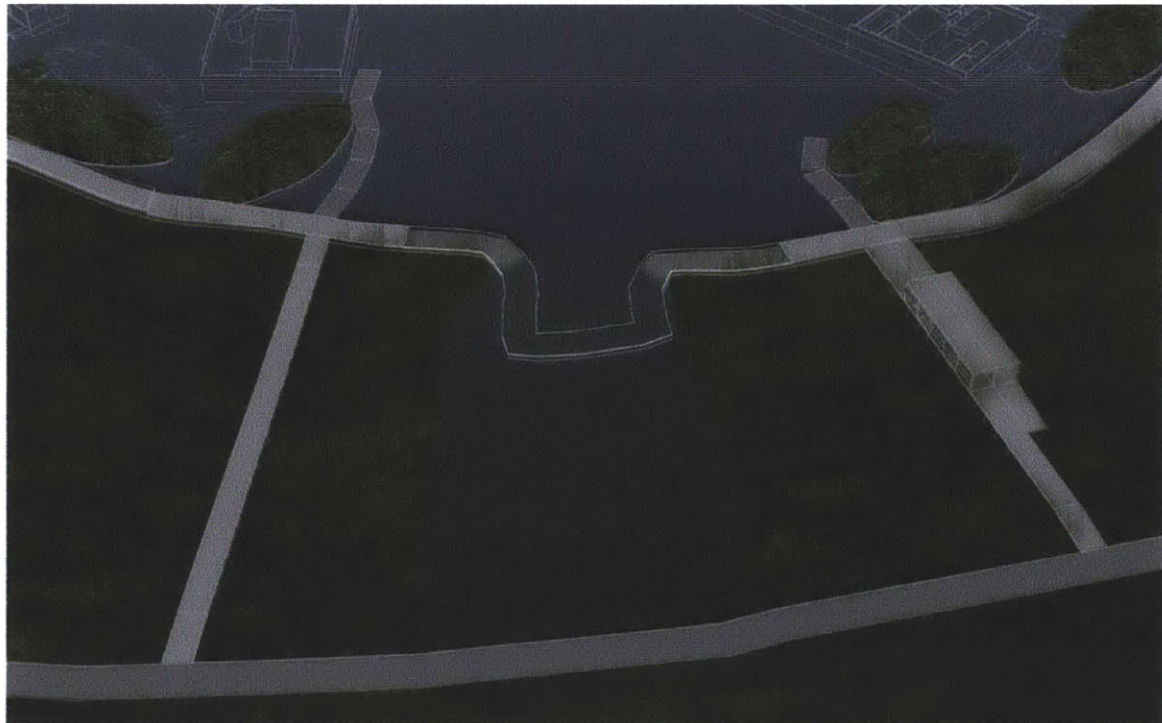
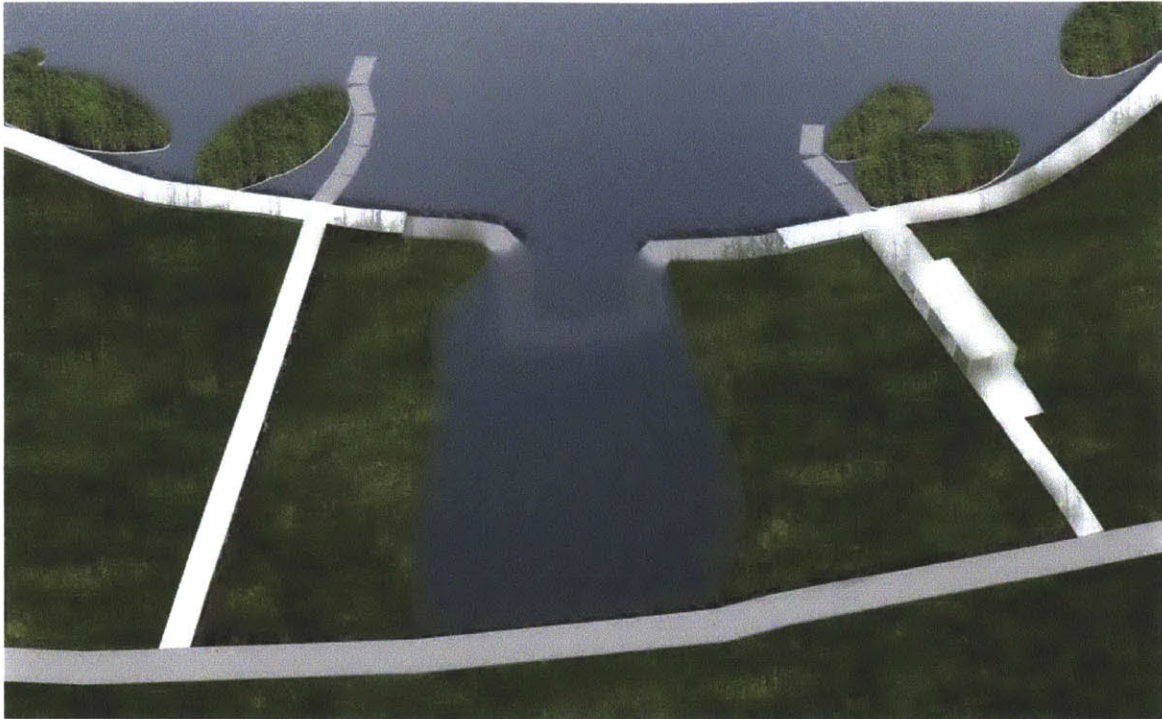
Central Park Strategy: Initial Channel Section. Image: author.



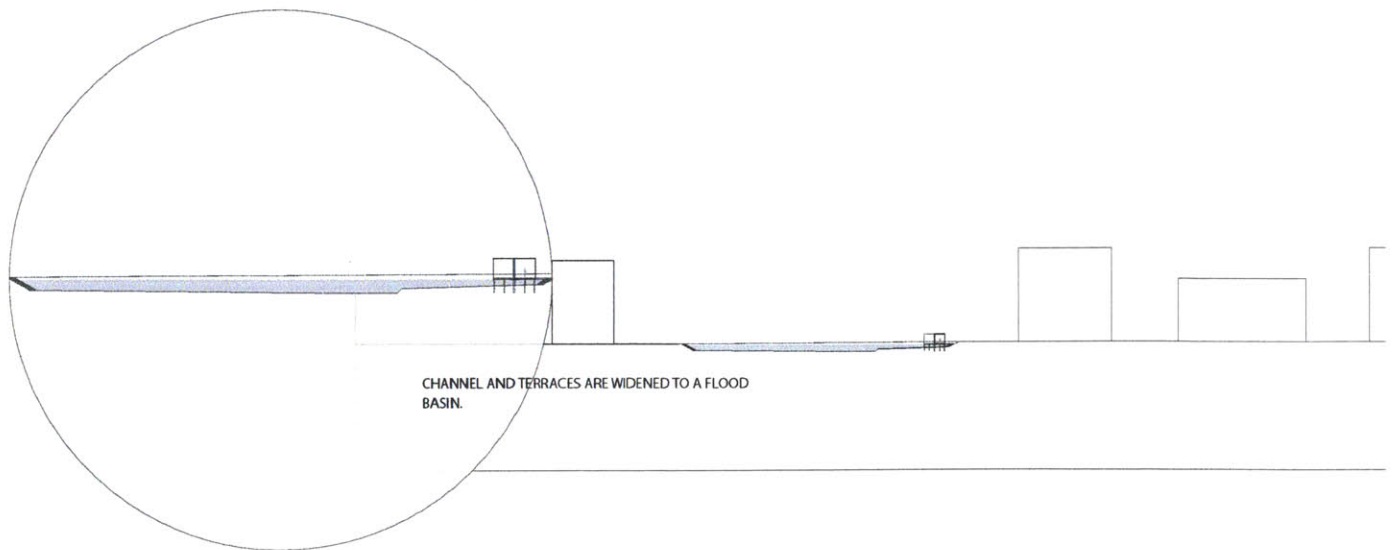
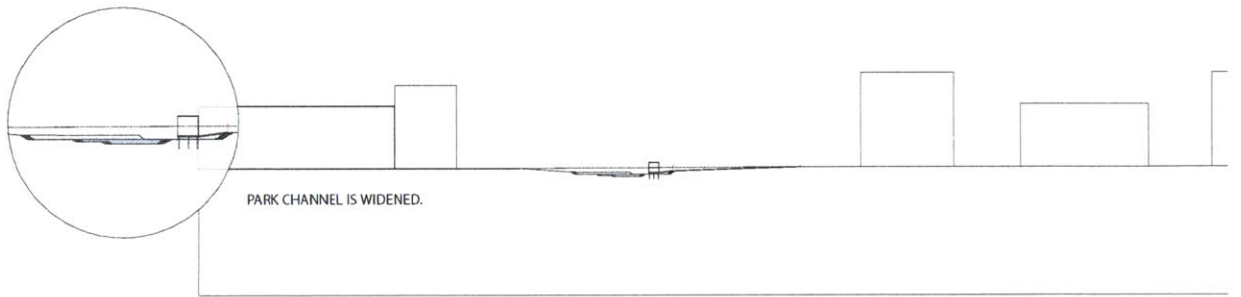
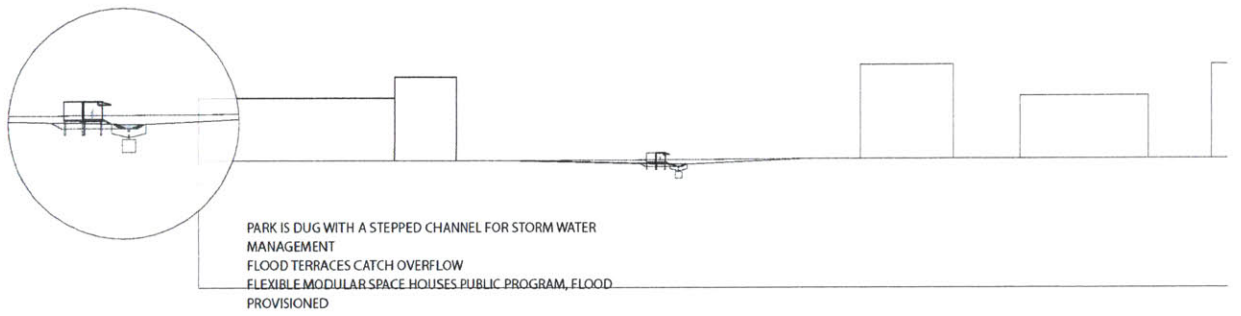
View of the park strategy looking south (above), and a further phased step of that strategy (below). Images: author.

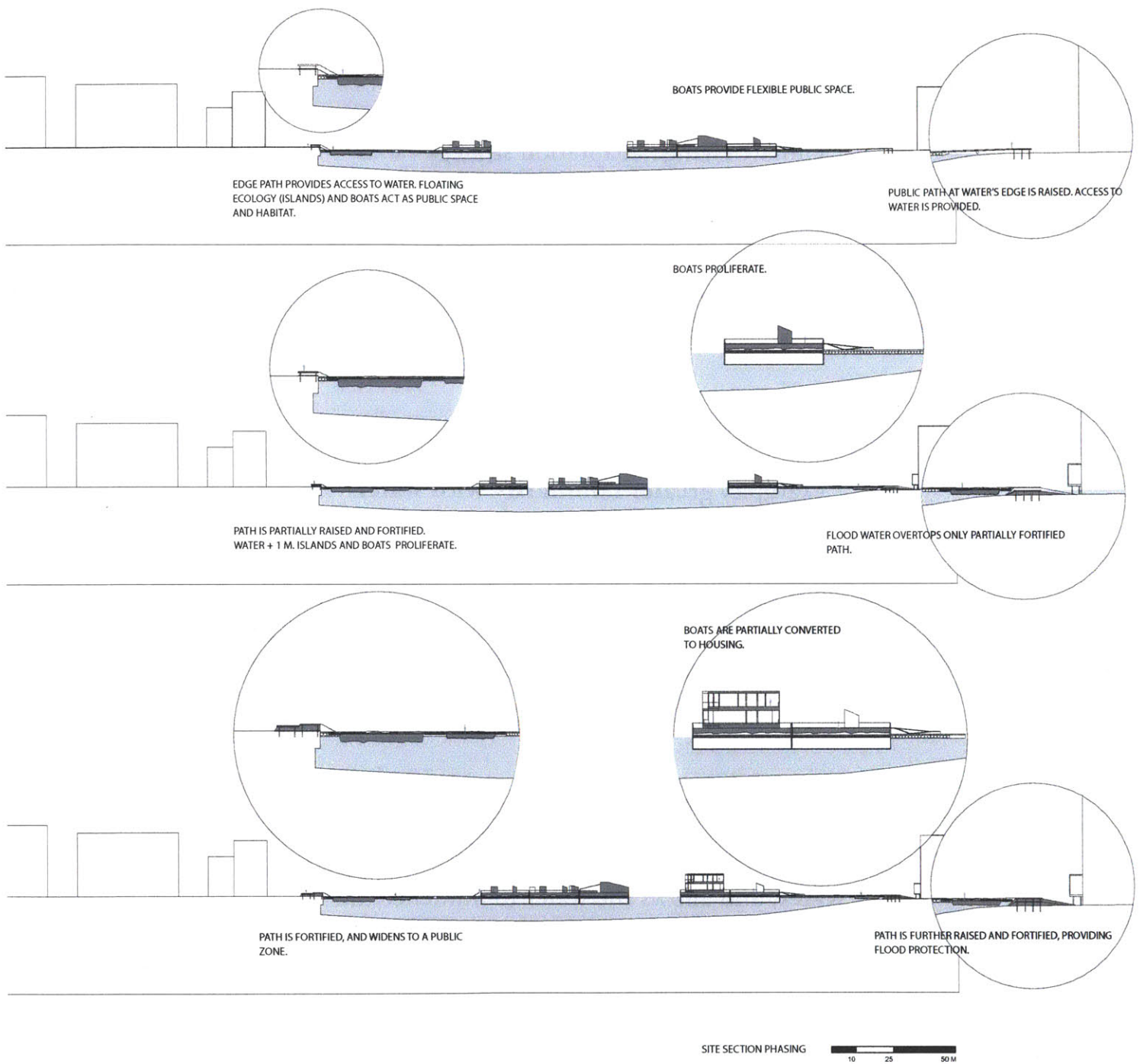


Further views of the project. View of the floodplain strategy (above), and a further phased step of that strategy (below). Images: author.



View of the public path strategy in a partially fortified stage(above), and a further phased step of that strategy (below). Images: author.



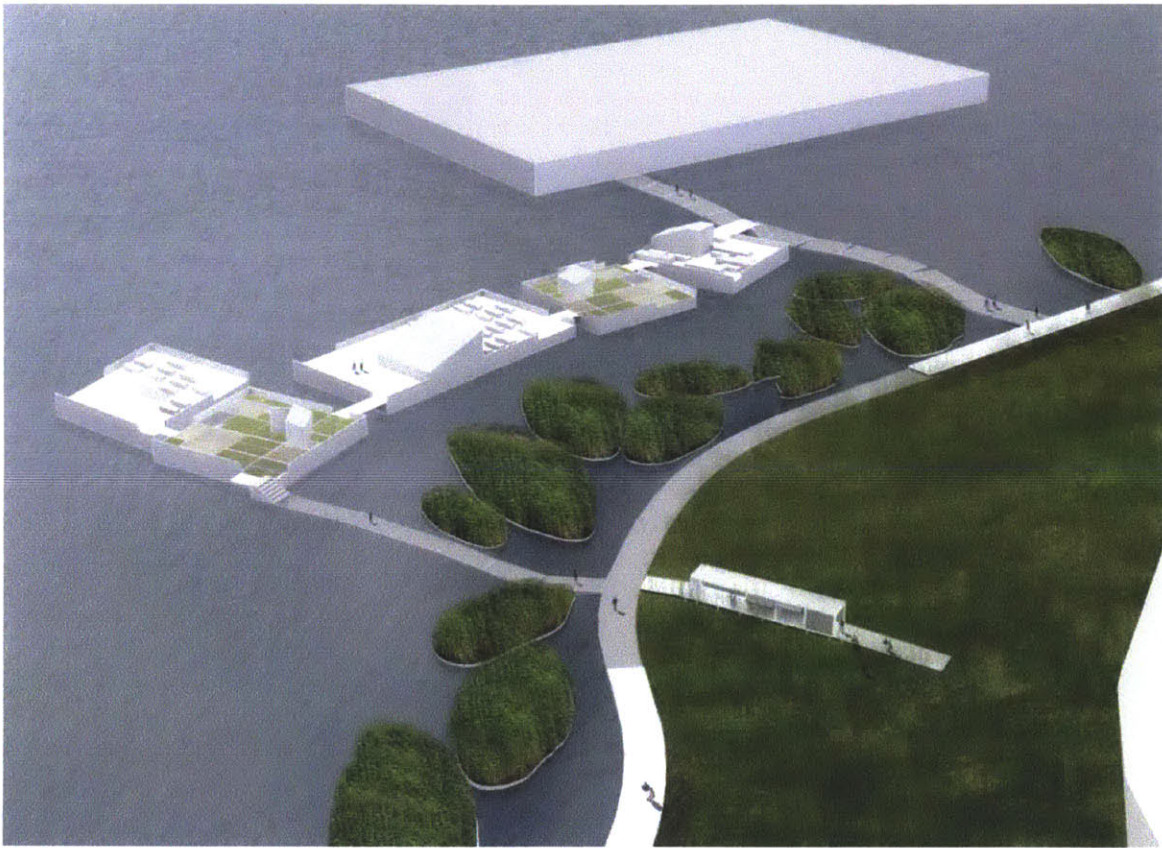


Site - Water Phasing and Relationship Change. Section shows design's response to changes in the environment. Images: author.

Publicness and physical accessibility of climate change adaptation strategy raises **awareness** of environmental issues involved.

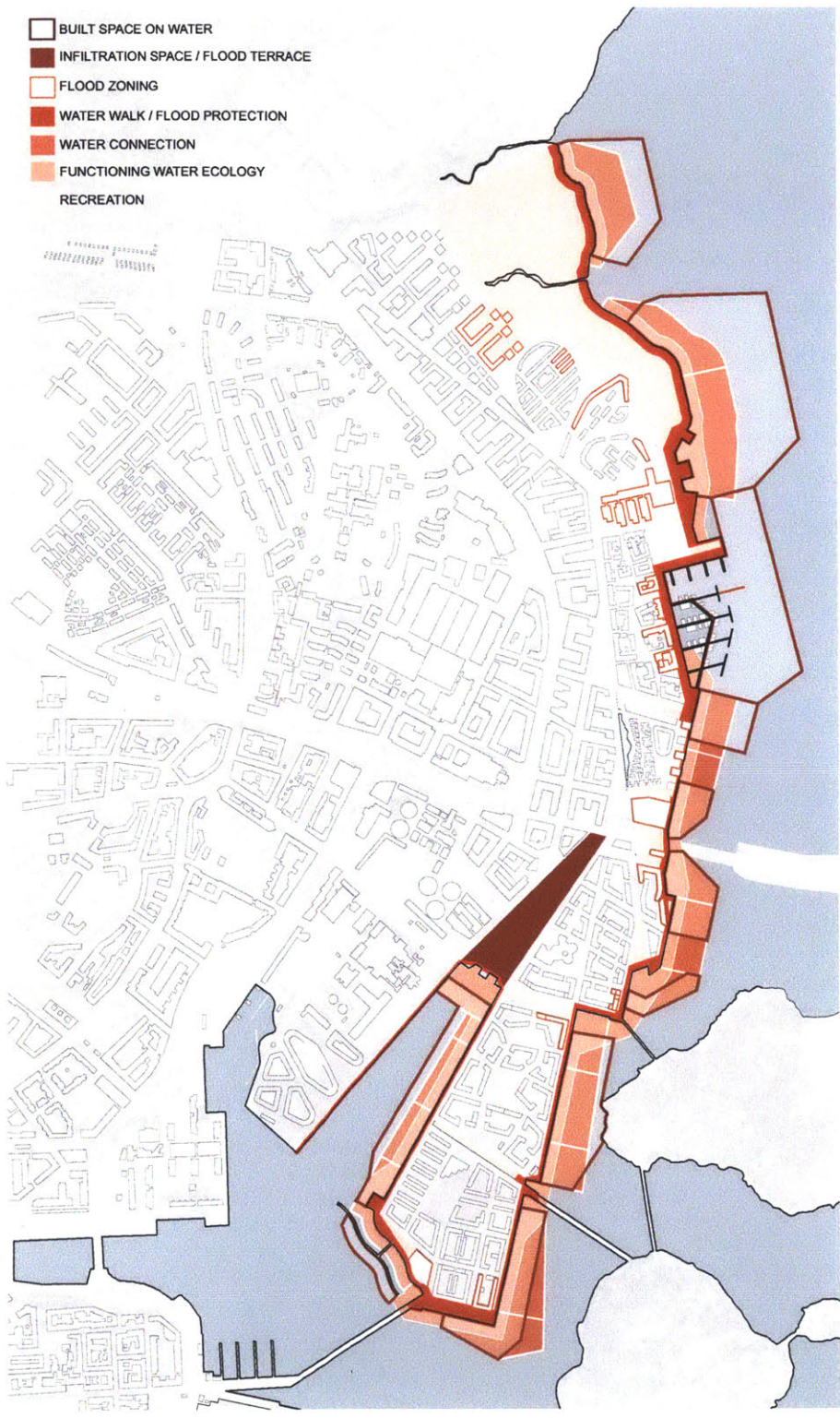
Adaptation involves behavior change; for example, **greater familiarity with water and its processes** can motivate a change in construction practices.

Design brings the public space to the water, and allows the water to influence the public space



Adaptation Strategy's public-ness as Impetus to Action. Example: Public piers allow engagement with and access to the water, bringing about ideas of water quality and use of the water as buildable / recreation space.

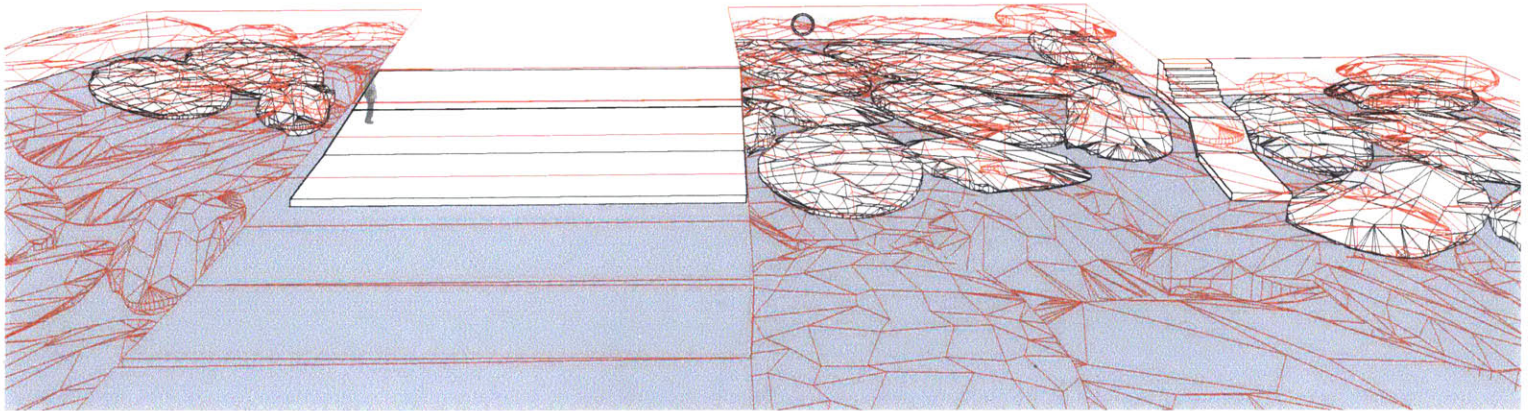
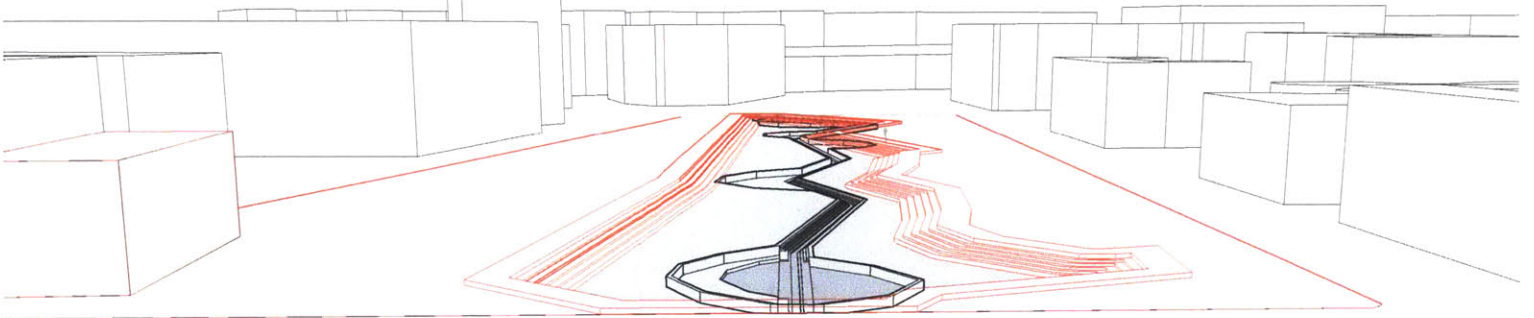
Design elements communicate **guidelines**
for a new relationship of city to water.



New site - water zoning. Image: author.

Components as Tools of Adaptation: Storm
Water Management via Landscape and
Constructed Ecology

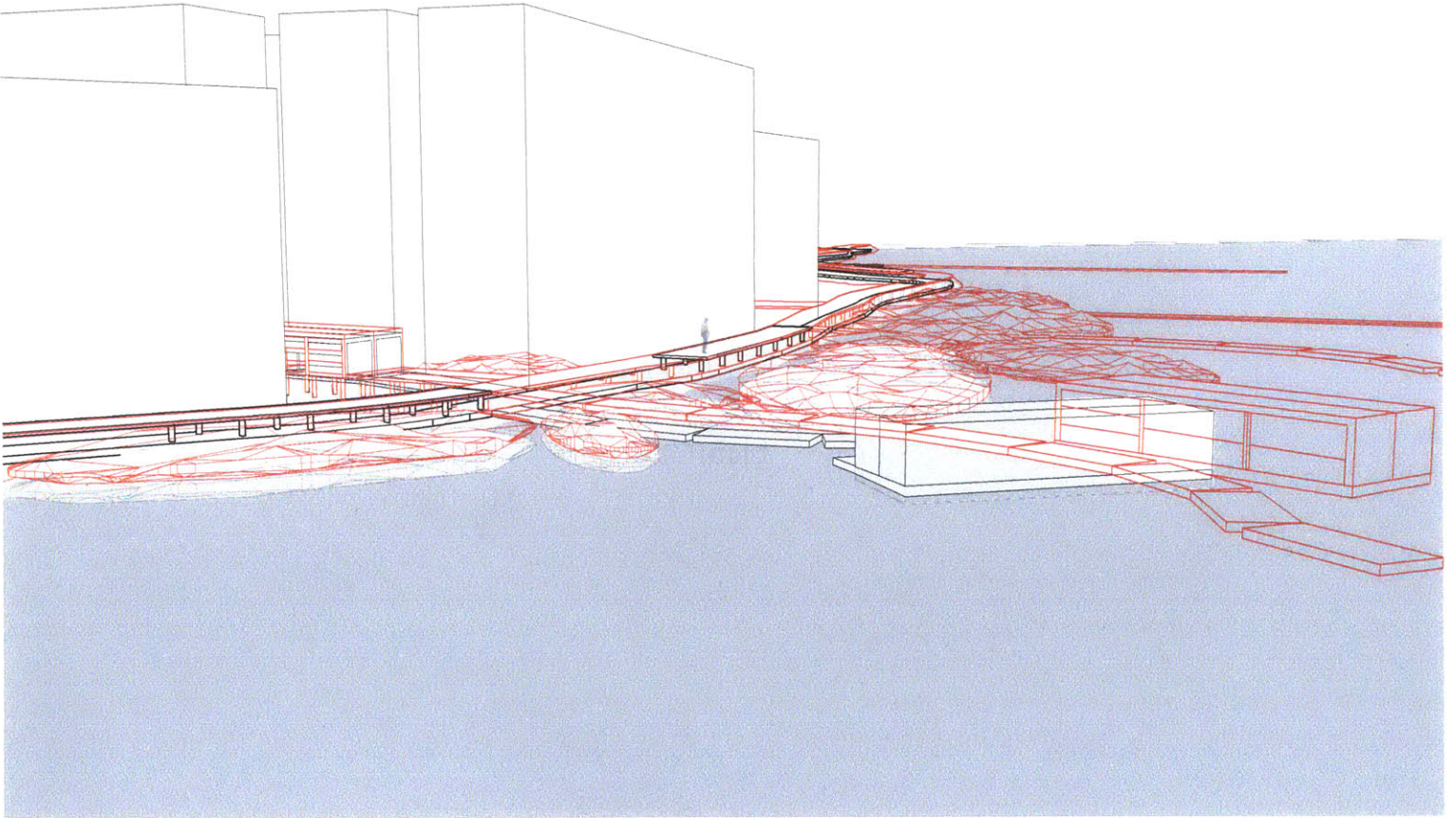
INFILTRATION SPACE / FLOOD TERRACE



Park strategy as a guideline. Image: author.

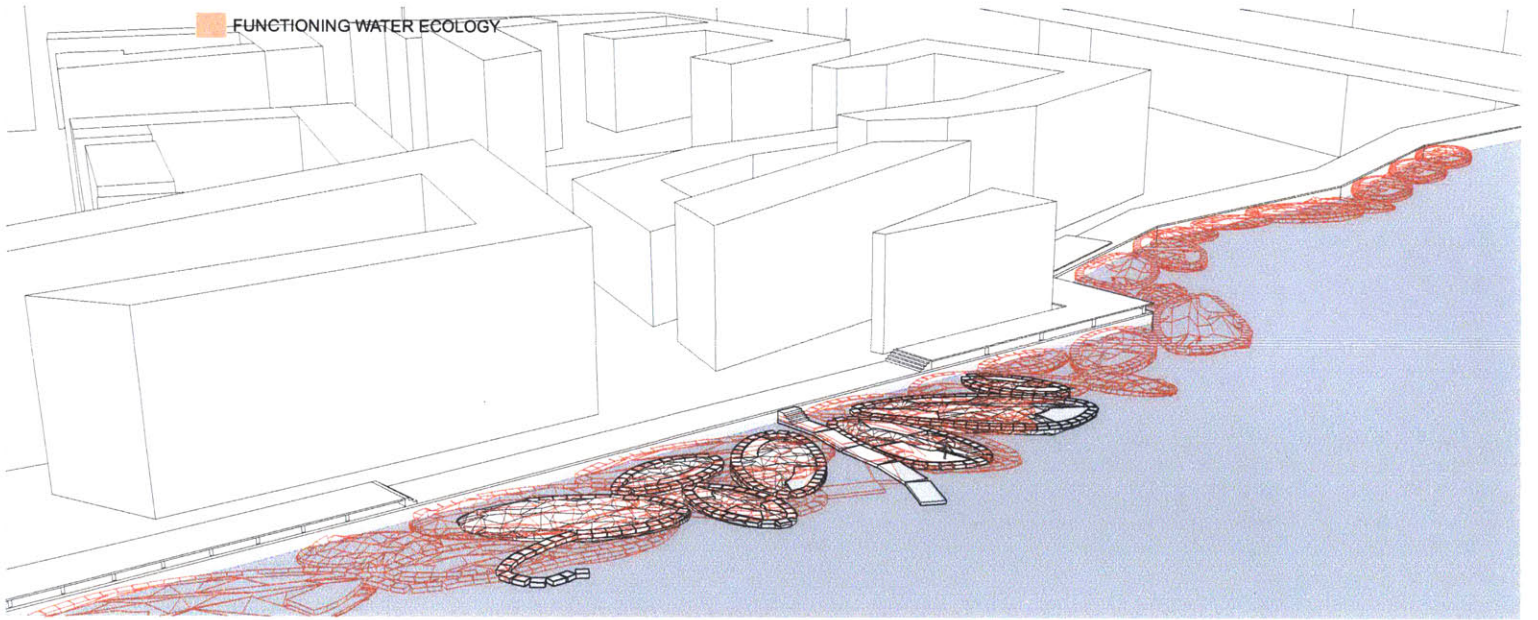
Components as Tools of Adaptation: Flood
Protection as Public Amenity

■ WATER WALK / FLOOD PROTECTION



Public path strategy as a guideline. Image: author.

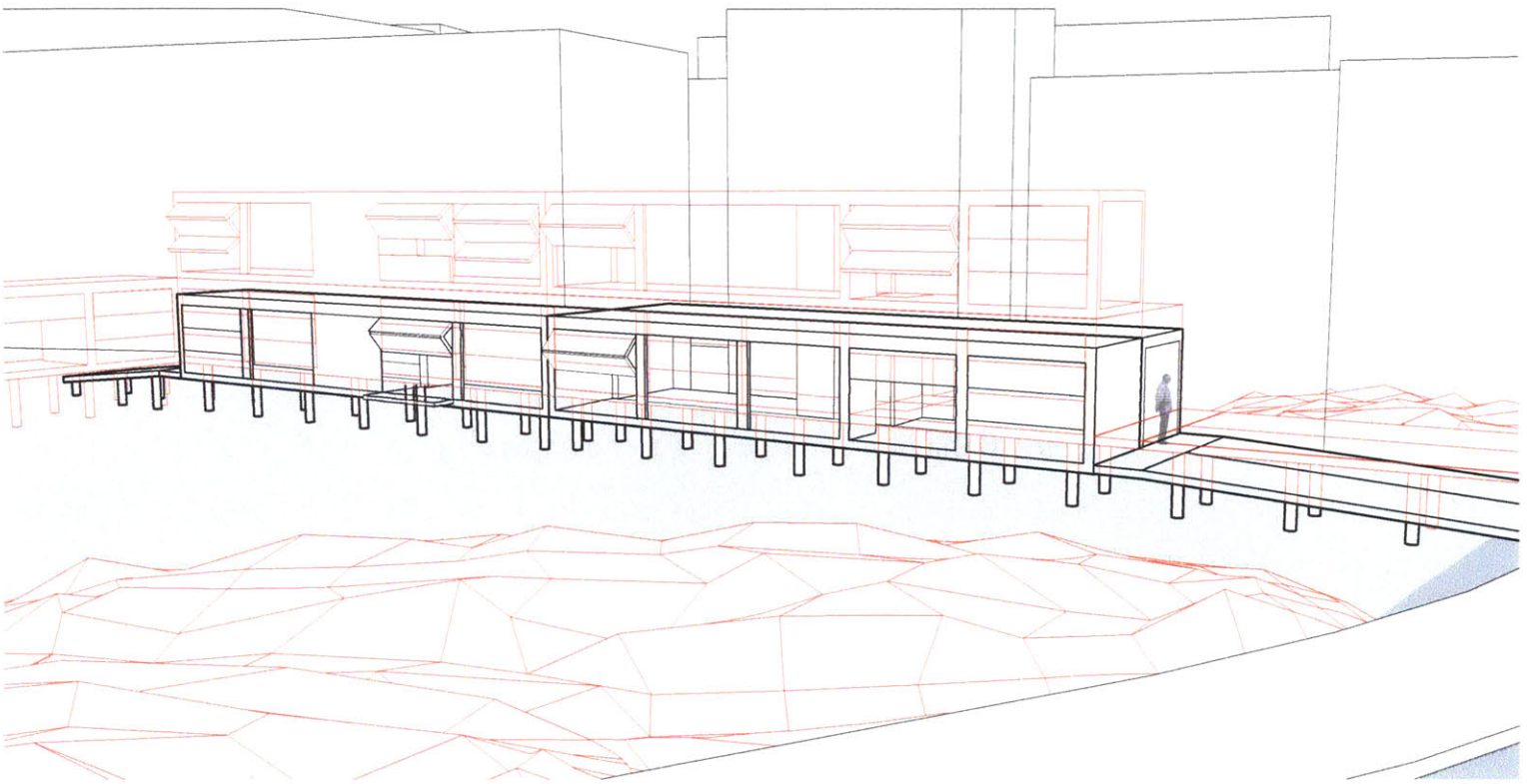
Components as Tools of Adaptation: Water
Quality Improvement as Public Space and
Habitat



Island strategy as a guideline. Image: author.

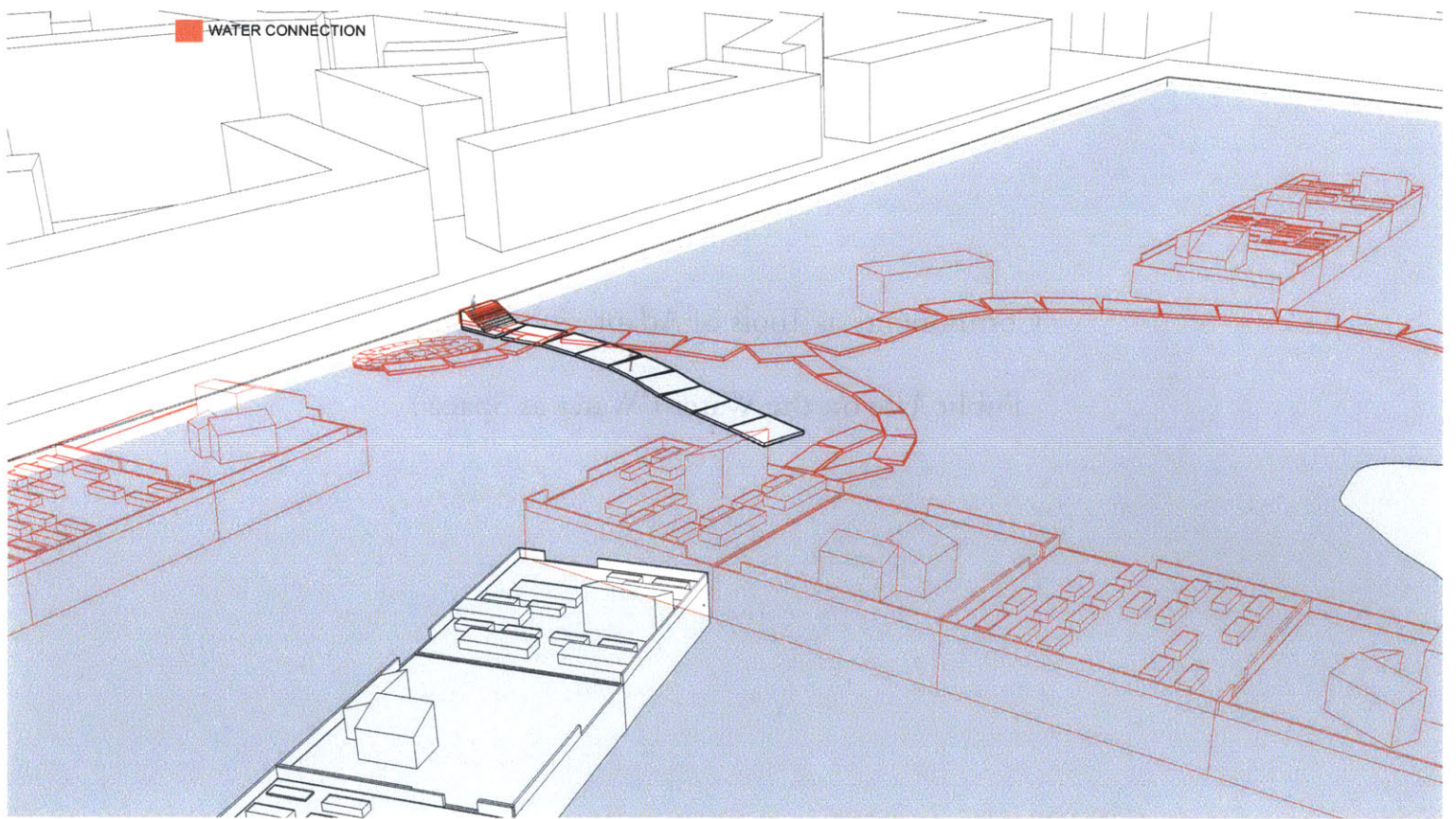
Components as Tools of Adaptation: Flood
Zone Regulation as Architectural Language
(‘Architecturalization of Risk’)

 FLOOD ZONING



Field house strategy as a guideline. Image: author.

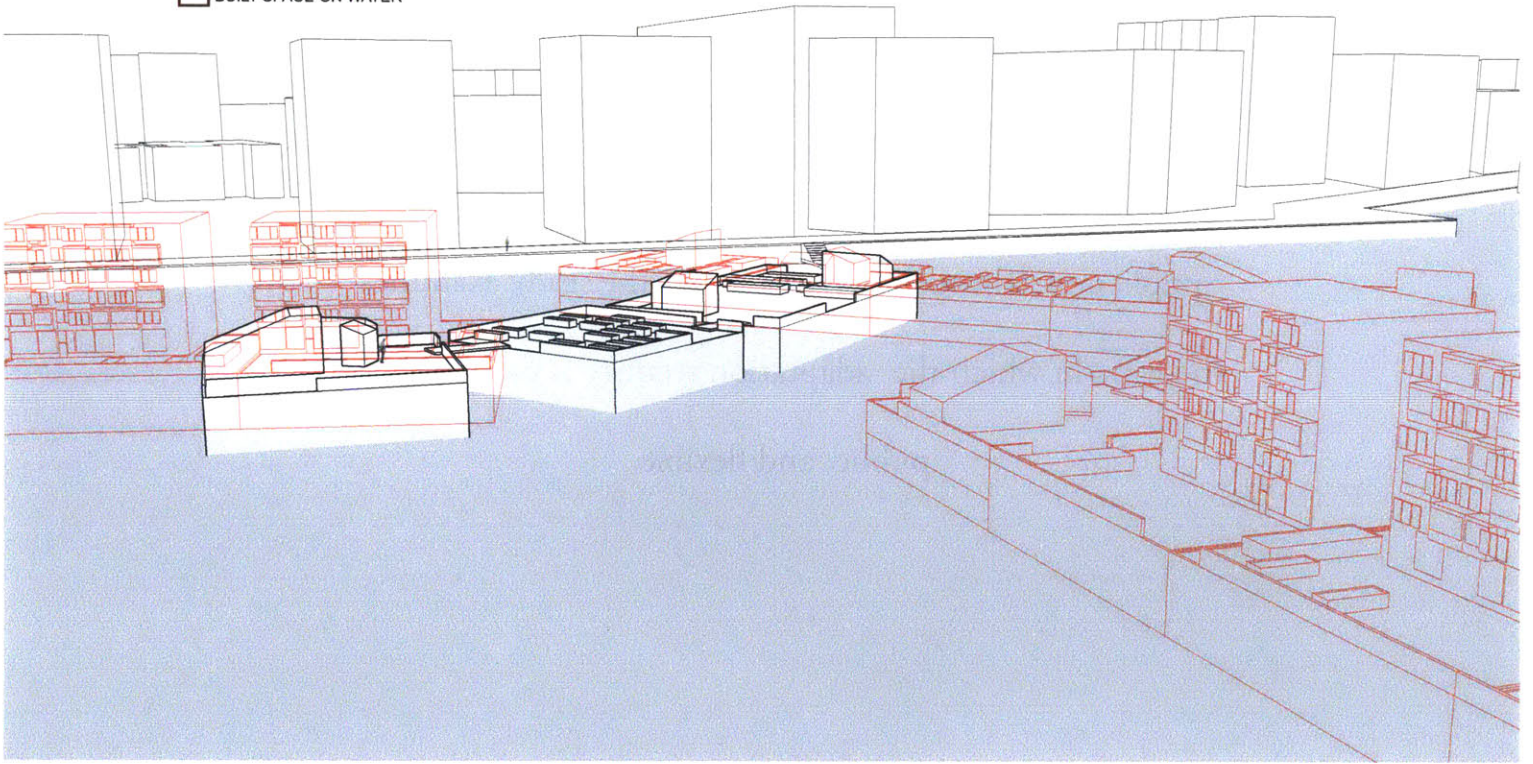
Components as Tools of Adaptation:
Flexible, Humanized Water Access ('Platform
for Behavior Change', 'Water as Space')



Pier strategy as a guideline. Image: author.

Components as Tools of Adaptation: Flexible
Public Use on the Water ('Water as Space')

□ BUILT SPACE ON WATER



Boat strategy as a guideline. Image: author.

The design process is geared towards participation and publicness. Through design analysis the study examines the ways in which the adaptation strategy is participatory, public, and flexible.

Adaptation strategy as public space

Incremental design, time / space for discussion

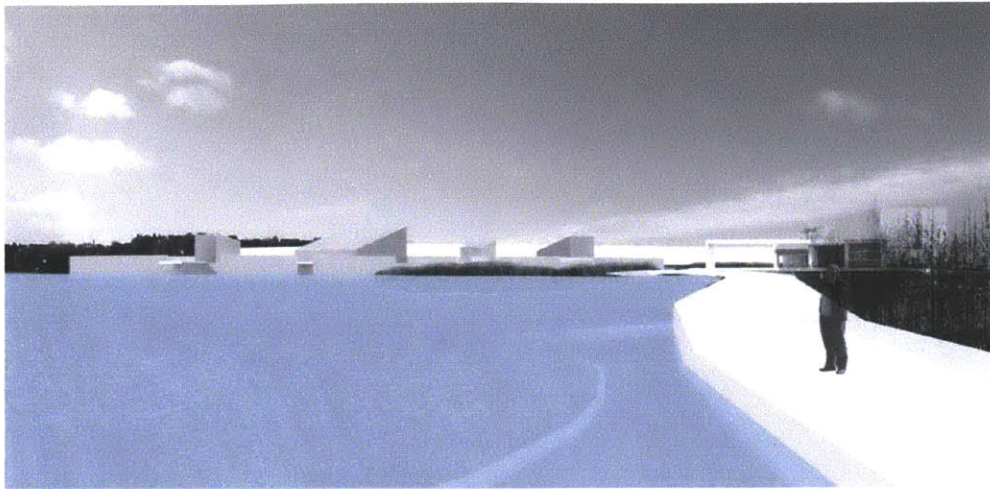
Phased development, contingent on collaboration
of stakeholders

Flexible space, temporary uses according to
community demands (In collaboration with local actors)

Visible monitoring of environmental change
(For example: flood register, floodable / water-present spaces)

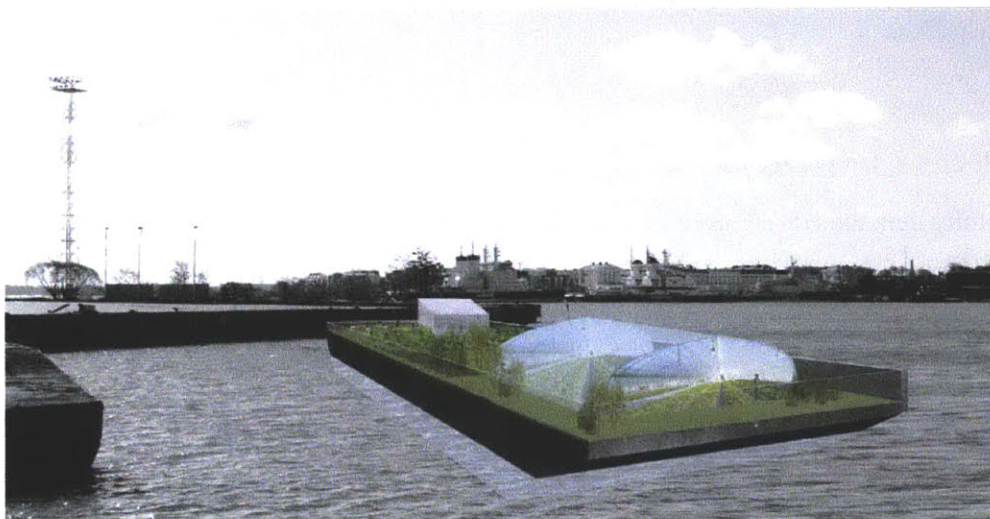
Design's mechanisms for the engagement of stakeholders and the general Public in adaptation. Image: author.

Adaptation strategy as public space



Adaptation infrastructure is also public infrastructure. Adaptation is introduced through its added benefit as civic space. The user engages it through physical experience. Example: Public walk, which is also flood protection

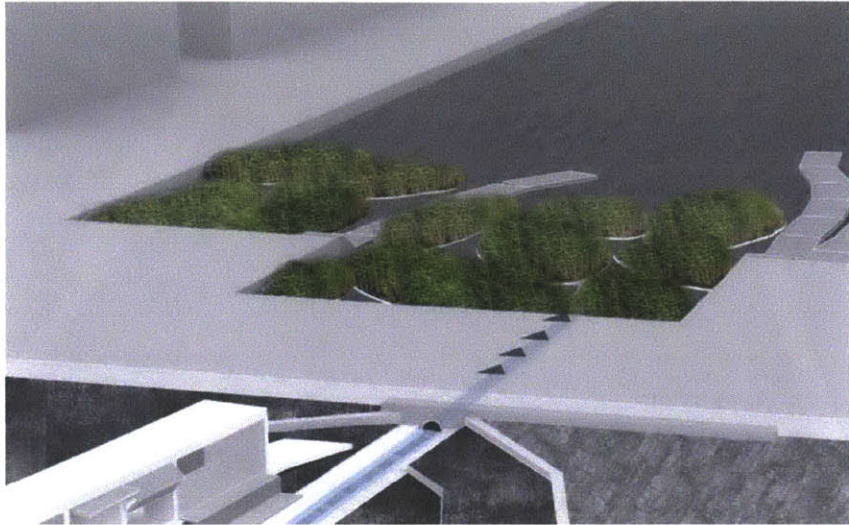
Flexible space, temporary uses



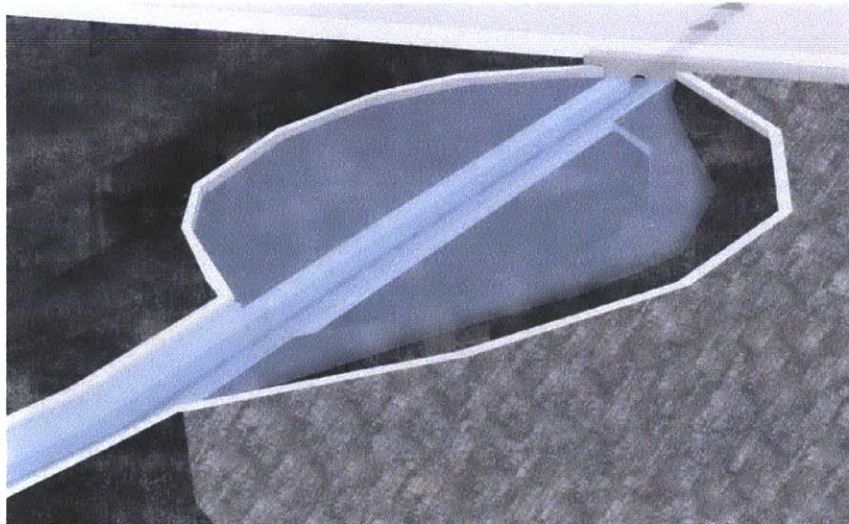
*Spaces for temporary use invite the public (and city) to modify the design for various programs. Example:
Floating public platforms, used for urban gardening*

** Programming could be coordinated through involved local parties.*

Incremental design, time / space for discussion

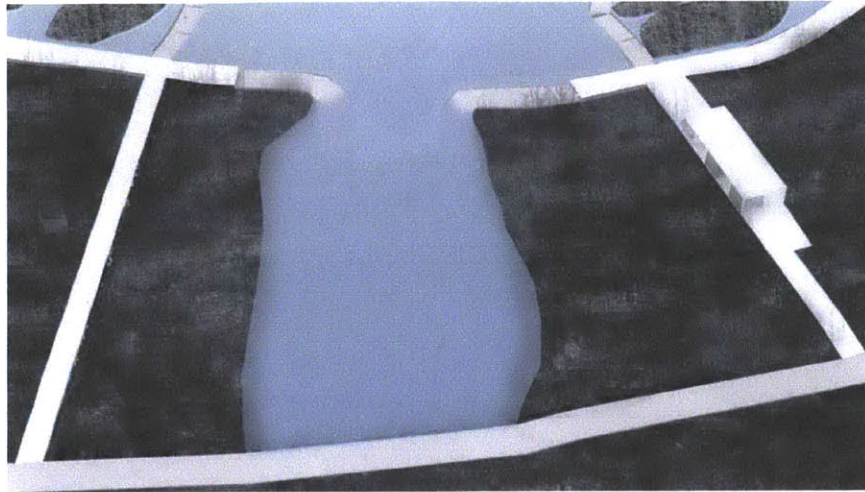


The adaptation strategy is incremental, and is built in parts over a long time period. Initial strategy elements are viewed as experimental and low-commitment; an opportunity exists for active feedback and slow decision making based on physical evidence. Example: Storm water filtration through constructed ecology

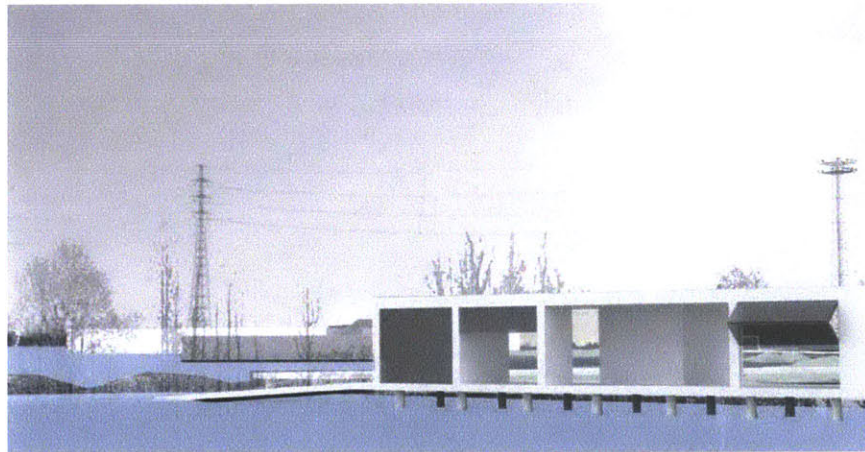


The strategy is built slowly, over several phases. Initial presentation includes minimum and maximum implementation scenarios. Further development hinges on continuation of initial collaborative relationships between stakeholders. Example: Widening of storm water channel to accommodate increased precipitation.

Visible monitoring of environmental change

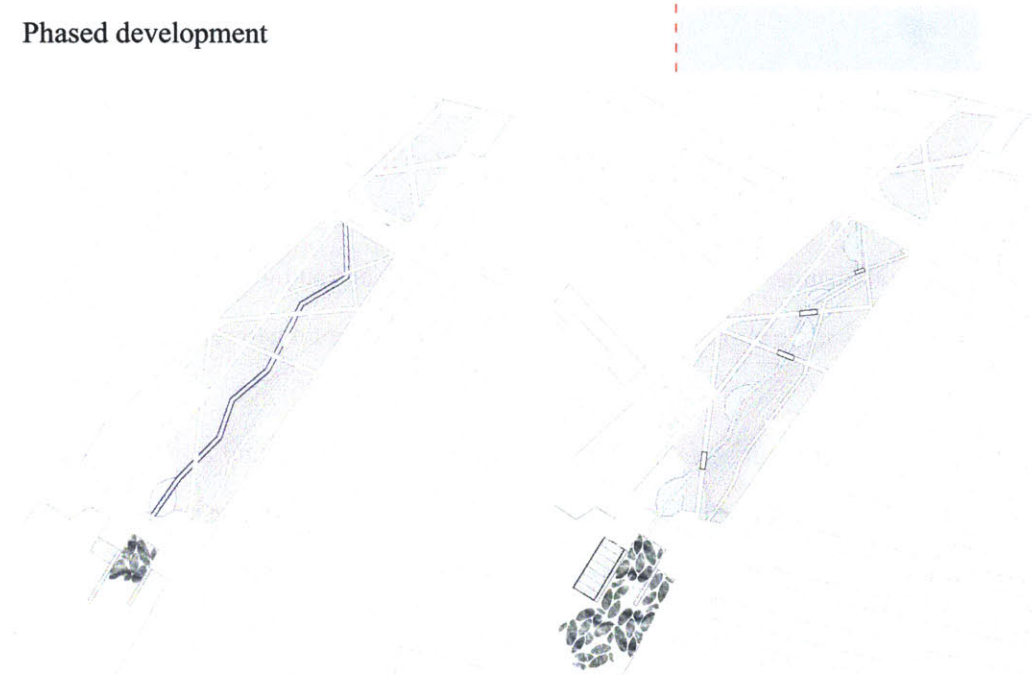


Design registers the effects of environmental change, through the use of datums and location/hazard markers. In this way the visitor can inhabit a border from which to measure environmental change. Example: Double pathways allow users to measure and visit the park when it is flooded (pathway as waterline).



Example: Buildings raised on piloti announce the flood zone, allow inhabitation and experience of flood area (buildings as waterline)

Phased development



A phased design process has many advantages. Considering uncertainty, phasing allows for a 'wait and see' approach.

Through registration of environmental change (flooding) further development is motivated; in other words, climate change's effects on the design strategy motivate further implementation of the design. Example: Park as storm water channel and floating ecosystem, phase 1, 2, and 3



Kalasadama as Testing Grounds

Design in Kalasadama is a phased, incremental, and experimental adaptation strategy. The site is a testing grounds for a coastal adaptive action plan to be applicable elsewhere in Helsinki and abroad. Public engagement brings to bear the dual nature of adaptive space; both towards environmental change, and the enabling of change by users and the city. The engaging nature of temporary use is to be embodied by the open and experimental nature of adaptation solutions.

Technical and functional aspects of the design require trial and study in-situ. A pre-phasing step would be to test condition-sensitive elements such as the wetland space. This would be particularly feasible while the overall development of Kalasadama is in-process.

Key Findings of the Research

Adaptation is a process. It should be treated as such. Incrementality, publicness, and experimental nature of an adaptation strategy is crucial. “Expectancy” of design anticipates change in environment, nature of participation, and the modification of the design itself.

Adaptation has much to do with behavior change. Hence, an adaptation strategy must be public and engaging, and a catalyst for social change; in the case of the coastal city, in regards to the social relationship to water and its processes. Design that is flexible to the user is important, but the task of design is also to bring into the realm of possibility a new flexibility on the part of the user.

In a phased design, development can't be totally controlled or dictated in the long term. However, initial presentation can include minimum and maximum scenarios and a view on possible interpretations of the strategy. Design can include mechanisms to register necessity of

further development, and its process can, from the beginning, involve the stakeholder groups in collaboration vital to adaptation's success.

Conclusion

The designed adaptation is through an flexible and dispersed strategy that is expectant and adaptable. The expectancy lies in anticipation of the user as participant, city planning as an ongoing process, and environmental change as a somewhat unpredictable force in the site. Initial research found that adaptation to hazards and issues in coastal sites like Kalasatama require urban scales and long time spans, and that they confront uncertainty, financial risk and policy challenges. This motivated the incremental, flexible, and participatory nature of the design. Building on the history of adaptable design, the strategy is open, time-sensitive and phased, providing opportunities for feedback from both user and environment. Specificity is maintained in the designed openness, as it addresses specifically the environmental hazard of water, and the users expectations via exploration of the experience of spaces and landscapes of the site.

Adaptation can be made through heavy and costly infrastructure, but this is not feasible financially or urbanistically, and is unlikely in consideration of uncertainty. Incrementality of physical intervention is central in an adaptation strategy, but behavioral change is crucial. The acclimatization to water as a inhabitable space and daily element is central in the design. Elements such as the channel and wetlands communicate this in the immediate sense, and piers and boats, in providing platforms or access for the use of the water as space, convey adaptive possibilities for the longer term. Design's goal of behavior and pattern change via a re-presentation and re-perception of water necessitates user engagement. This is conveyed through the very public nature of the armature elements, and the open process of slow, flexible implementation.

Control of human behavior is not possible through architecture. Design can, however, provide a properly equipped platform for experimentation, discussion, and decision making. It can also serve as a mechanism for the measurement of contributing factors to that decision, providing proof of change in the physical environment. Design can also engage users in becoming part of decision making, and can build awareness of issues and their consequences. Lastly, slow, incremental implementation processes can allow time for feedback from initial design elements, as well as the time and place for users and cities to engage and decide. Expectant design in the site takes up these strategies for an adaptable adaptation in response to climate change.

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