Graduation Plan (P2):

Track: Architecture

**Personal information**

<table>
<thead>
<tr>
<th>Name</th>
<th>Jiayi Huang</th>
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<tbody>
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<td>Student number</td>
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**Studio**

<table>
<thead>
<tr>
<th>Name / Theme</th>
<th>Delta Interventions</th>
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<tbody>
<tr>
<td>Teachers / tutors</td>
<td>Prof. Frits Palmboom/ Jan van de Voort</td>
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<tr>
<td>Argumentation of choice of the studio</td>
<td>Interested in Dutch Delta and its response to climate change in an architectural and urban point of view</td>
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**Graduation project**

<table>
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<tr>
<th>Title of the graduation project</th>
<th>The Water Institute</th>
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**Goal**

<table>
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<tr>
<th>Location:</th>
<th>Zeeburgereiland, Amsterdam</th>
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<tr>
<td>The posed problem,</td>
<td>The shortage of traditional water defense system such as the expense of dike maintenance, occupation of livable land, and disconnection between water and city drives me to explore another possible method apart from building dikes to ensure water safety but also regain the relation between water and city.</td>
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The location chosen for the graduation project is in the east part of Zeeburgereiland, and it is in the juncture between lake Markermeer and Amsterdam city. Built in the early 20th century, the constructed with dredged sediment coming from the IJ and the Eastern Docklands. It used to be a remote area from Amsterdam and was used as a military ground during WW2 and the West Sewage Treatment Facility in the eighties. But because of the urban expansion of Amsterdam and the development of transportation system, the position of Zeeburgereiland has changed and not it is a planned new urban district. The ambition of the project is to design a public architecture in east tip of the island to regain the relation between Lake Markermeer and Amsterdam City.

**research questions**

| How can architecture reactive the relation between | |
|--------------------------------------------------| |
and Markermeer and Amsterdam? How can architecture reactive the relation between water and architecture users?

design assignment in which these result.
The Water Institute
The Water Institute is an educational facility which focus on the sustainable use and management of water resources to support healthy and prosperous communities.

The intention of this institute is to use Amsterdam, an international port where talented scholars could gather, to deal with water related issues, especially ones happen in Ijsselmeer.

In the same time, public events would be held in the institute to raise the attention of citizens in Amsterdam to the issues mentioned above. With the increasing attention to the Ijsselmeer region, the connection between Amsterdam and Ijsselmeer is hoping to be reactivated.

In the perspective of architecture, water-related architecture will be explored to strengthen the relation between water and architecture users.

**Process**

**Method description**
The aim of research and design is to reactive the relation between Markermeer and Amsterdam, and the relation between water and architecture users. To achieve this goal, different methods will be performed:

- **Site Analysis**
  3x3x3 analysis is intended to research the historical relation between Amsterdam, the IJ, Zeeburgereiland and Ijsselmeer so as to gain the theme of the project.

  Site analysis including analysis of noise, traffic, terrain and water level are performed to find out the urban and architecture strategies to response to such circumstance.

- **Literature research**
  Literature about flood risk managements in the Netherlands, climate-adaptive architecture design, flood resilience strategies and multi-layer safety concept are reviewed and research to provide theoretical knowledge for the graduation project.

- **Theoretical writings**
  The review paper “From Flood Resistance to Flood Resilience - A Case Study of
‘Room for the River’ Project in the Netherlands” (theory paper of urbanism) is written to discover the capacity at which a resilient method can operate at and compare it with the Ijsselmeer water levels at site for feasibility.

The position paper “From “Building against Water” to “Building with Water”” (position paper of architecture) is written to explore the method to give consideration to both water safety and spatial quality in the perspective of architecture.

- **Case Studies**
  Copenhagen Harbour Bath and Maritime Youth House by BIG + JDS are studied to discover architectural method to strengthen the relation between water and inhabitants. And some educational projects are studied to see how to create an interesting spatial.

- **Design Practice**
  Design practice requires to base on the previous research methods and address relevant issues. By designing an institute where general population can be educated and provided further understanding of water-related issues, the graduation project aims at a providing a physical and visual relationship to the water while maintaining strategies that provide protection against flood damages.

### Literature and general practical preference

**Keywords:** Climate-Adaptive Architecture; Flood Risk; Flood Resilience

**Literature:**

- Physical Planning Department, City of Amsterdam. (2013). *Amsterdam, City of Water - A Vision for Water, Safety and Rainproofing.* PLAN Amsterdam magazine.

**Project:**

- Copenhagen Harbour Bath / BIG + JDS
- Maritime Youth House / PLOT = BIG + JDS
- Science and Technology Park of Itajubá (pcti), BCMF + MACH arquitetos
Reflection

The Water Institute with facilities that cater for research, study and teaching in various marine and water related fields. Facilities will not cater only to students and staff, but the general population to educate and provide further understanding of flooding. Therefore, the project aims at arousing the public attention to flood risk; increase people’s accessibility to water while using flood resilience strategy to provide protection against flood damages.

The intention of the graduation project is to design a public building function as “Water Institute” to reactive the relation between Amsterdam city and Lake Markermeer. While at the same time, the designed architectural spatial quality is to reactive the relation between water and users of this architecture.

Time planning

P1: Research & Design Assignment (Week 1.10)
Site Analysis; Research Questions; Design Assignment

P2: In-depth Research & Initial Design (Week 2.10)
Research: In-depth research of site; flood resilience strategy; case studies
Design: Site 1:1000/1:500; Architecture 1:100
Week 2.1: Evaluation of Problem Statement and Design Assignment
Week 2.2: In-depth research of the site
Week 2.3: Relevant Case Studies & Design Concept
Week 2.4: References & initial Site Plan
Week 2.5: Design Principles & Site Design: 1:1000
Week 2.6: Site Design: 1:500 & Function Diagrams of Individual Architectures
Week 2.7: Architecture Design 1:100
Week 2.8: Architecture Design 1:100
Week 2.9: hand in final Graduation Plan, prepare for P2 presentation

P3: First Complete Design Presentation (Week 3.8)
Design: Final Architecture Design: 1:100;
Detail Design: 1:20/1:5
Week 3.1: Evaluation of design and relevant research
Week 3.2-3.6: Improvement of Architecture; Detail Design; Research
Week 3.7-3.8: Theoretical research and preparation for P3 Presentation

P4: Definitive Design Presentation (Week 4.5)
Improve Design; Final Detail; Perspectives;
Presentation of research and design
Week 3.9-4.3: Final Design; Detail Design with regards to materialization; structure and climate design
Week 4.4-4.5: Final Drawings and Renderings; Models and preparation of P4 Presentation

P5: Conclusive Public Presentation of Graduation Studio (Week 4.11)
From Flood Resistance to Flood Resilience

A Case Study of ‘Room for the River’ Project in the Netherlands

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5th Graduation Lab Urbanism Conference
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Abstract
Facing rising sea levels, increasing peak discharges of the rivers and intensification of rainstorms due to climate change; the subsidence of land; development of urbanization; and the growth of population, flood risks continue to be the prime issue to the Netherlands. As the frequency and severity of floods increase, the reconsideration of current flood defense strategies is imperative. This paper reviews a new approach – “flood resilience” strategy (Bruijn K. d., 2004) – that was introduced to better deal with increasing flood risks. Different from the traditional “flood resistance” strategy (Bruijn K. d., 2004) which focus on building flood defense constructions such as dikes to prevent the land from being flooded, “flood resilience” strategy aims at reducing the damage and increasing the capacity of recovering from the flood. The Dutch “Room for the River” project which is based upon the idea of resilience would be studied to explain the necessity to develop “flood resilience” strategies. Among the series of projects to manage increasing water level by increasing river conveyance by opening up more room for the water to flow through in the national “Room for the River” project, the particular project in Nijmegen is used to demonstrate the effective outcome of increasing water safety whilst contributing to spatial quality in such projects. Finally, the paper concludes that the “Room for the River” project and relative resilience strategies indicate a transition in in the traditional strategy of strengthening dikes. Although the choice between different strategies or a combination of both varies according to particular situations, “flood resilience” strategies would continue to be researched and used more often while the traditional strategies would still be used and reinforced but may be reformed to cope with “flood resilience” strategies.

Key Words
Flood risks; Flood defense; The Netherlands; Resilience; Room for the River

1. Instruction
Situated at the northwest corner of the European continent, the Netherlands has always faced the threat of flooding from the North Sea, the Rhine and Meuse rivers. The coastline of the Netherlands is more than 400 kilometers long and about 60% of its land is flood-prone (Fig. 1). Throughout history, the Dutch people and society worked and developed solutions in response to water-related challenges. Since the 9th century, the Netherlands began to “fight against the water” by building artificial defenses and reshaping the natural coast. It
has developed a flood defense system that can protect people and the land from the risk of a flood disaster. The flood resistance strategies were efficient and successful until recently.

However, the increase of flood frequency and severity lead to reconsideration of current flood defense strategies. The focus of flood defense program gradually switches from “fighting against the water” to “working with nature” (Han Meyer, 2010). Because of climate change, the Netherlands is facing a more threatening situation from flood risks. The potential danger from rising sea levels, increasing peak discharges of the rivers and intensification of rainstorms due to climate change and the notion of increasing the quality of the natural environment lead to new strategies that could better cope with the issue.

Traditionally, flood defense of the Netherlands concentrate on flood resistance. To be more precise, defensive structures like dikes, dunes, dams, barriers and natural high grounds to prevent the country’s lowland from being flooded. However, flood risks involve not only the danger brought by the flood, but also the damage and destruction to the area after such an event. “Flood resistance”, the traditional strategy that still largely applied in Netherlands and the world, aims at reducing the probability of flooding. On the other hand, “flood resilient” strategies focus more on living with floods instead of preventing them. Such strategies rely on a flexible response to floods and a rapid recovery from such an event (De Bruijn & Klijn, 2001; Vis et al., 2001).

This paper firstly explains and discusses the concept of resilience and resistance in a flood, risk management context. By analyzing the changing flood defense strategies in the Netherlands, the paper indicates the importance of increasing the capacity of flood resilience. Following this, a review of The Dutch “Room for the River” project which is based upon the idea of resilience would be studied to explain the necessity to develop “flood resilience” strategies. The particular project in Nijmegen - Room for the River Waal – would be used to demonstrate how water safety and spatial quality could be both increased by increasing river conveyance by opening up more room for the water to flow through. Finally, the paper concludes that “Room for the River” project and relative resilience strategies indicates a transition in in the traditional strategy of strengthening dikes.
2. Flood Resistance and Flood Resilience

Flood risk can be defined as the product of probability and consequences of flooding (Hall et al. 2003). Flood defense strategies aim at reducing either one or both of probability and consequences of floods. “Flood Resistance” strategy and “flood resilience” strategy are both intent to prevent flooding but focus on two different aspects. The traditional “flood resistance” strategy focuses on flood prevention while resilience strategies focus more on living with floods instead of preventing them. Such strategies rely on a flexible response to floods and a rapid recovery from them (De Bruijn & Klijn, 2001; Vis et al., 2001).

Generally, a system’s reaction to a disturbance depends on its resistance and resilience. The resistance of a system determines which disturbances a system can withstand without reacting; its resilience determines the response to and recovery from more intense disturbances (Fig. 2). (Bruijn, 2004)

Figure 2: The relationship between reaction amplitude and disturbance severity for a resilient and a resistant system and a system that has both system characteristics [source: De Bruijn, 2004]

In the contents of flood risk management, resilience was used to explore and study the reaction of lowland river systems to flood waves. As mentioned, resistance is defined as the ability of this system to prevent floods, while resilience is defined as the ability of this system to recover from floods (Bruijn K. d., 2005). In such cases, resilience strategies for flood risk management allows potential flooding, but aims at minimizing the impacts while maximizing the capacity to recover from a possible flood. The following paper will further explain such approach by analyzing ‘Room for the River’ Project in the Netherlands which is an ongoing project using flood resilience strategy.

3. ‘Room for the River’ Project in the Netherlands

The Dutch ‘Room for the River’ project will be studied to illustrate the necessity to reconsider the traditional flood defense system and the possible advantages of resilience strategies.

The ‘Room for the River’ project was approved by the Central Government of the Netherlands in 2007 to protect four million inhabitants of the river catchment areas from high water level and create a better spatial quality in these areas. Different from traditional “flood resistance” strategy which focus on constructing and improving artificial defense infrastructures to prevent the Netherlands from being flooded, the project intents to build a safer river area with an attractive living environment.

The program is working on 39 projects along the Rhine tributaries, such as the IJssel, Waal, Lower Rhine and Lek (Fig. 4). And the goal of the project is to give more room to be able to manage higher water levels. The project intended to increase the maximum discharge capacity from 15,000 m³/sec in 2007 to 16,000 m³/sec in 2015. By the end of the project, water safety is expected to increase while the overall environmental quality will also be improved. The project will restore marshy riverine landscape to serve once again...
as natural ‘water storage’ sponges and provide biodiversity and aesthetic and recreational values (Dutch Ministry of Infrastructure and the Environment).

Figure 4: Projects of “Room for the River” [Ruimte voor de Rivier voor een veiliger en mooi rivierengebied

https://www.ruimtevoorderivier.nl/]

3.1 Reasons of the Project

Due to geographical reasons, the Netherlands has been dealing with water-related issues to protect the country from being flooded. However, its flood risk management strategy primarily relies on “flood resistance”. In order to protect the low-lying lands, multi-layers of defense system was constructed and developed. Along the main rivers and coastal areas, the “dike rings” were built as the primary defenses because these structures directly protect citizens from storm surges and river flooding. Currently, the low lands of Netherlands are divided by 53 of such dike rings. With the flood defenses, each dike-ring area could withstand a flood with a probability (‘return period’) of 1/10,000 years to 1/1,250 years and the probability is designed by the number of inhabitants and the economic value of the assets within a dike ring (Aerts, 2009).

The increasingly elevating dikes and relative infrastructures wedge the rivers and giving them less space to throw through. While at the same time, land subsidence of the land behind dikes increase the potential dangers when a flood happens. What such questionable system is facing is the increasing flood risk due to climate change. According to the most recent scenarios of the Royal Netherlands Meteorological Institute, sea level on the Southern North Sea will be 25 to 80 cm higher in 2071-2100 (averaged year 2085) than in 1981-2010. For 2100, a projection for the upper level of sea rise 100 cm. As a result, the traditional “food resistance” strategy has certain obstacles, and the continuing threat of rising sea levels, increasing peak discharges of the rivers and intensification of rainstorms due to climate change raise the pressure of reconsidering the system’s feasibility.

In the other hand, spatial quality in delta areas is paid more and more attention. The traditional flood defense system was from an engineering point of view. Since flood protection is the primary concern, the spatial quality around defense infrastructures was limited to fitting in the flood defense strategy. However, the interventions that were required to meet the protection standards have been facing growing opposition because of the negative effects on spatial quality and a renewed appreciation of cultural and environmental values (Klijn F, 2013). Nowadays, the Netherlands has switched from “fighting with nature” to “working with nature” and the consideration of making flood defenses and surrounding environments more eco-friendly and with better spatial quality is still developing.

3.2 Direct Reasons

In 1993 and 1995, extreme discharges happened in the Netherlands. In 1993, heavy rainfall caused flooding in Limburg located in southeast of the Netherlands. One fifth of Limburg was flooded because of the rainfall in France and Belgian. In 1995, widespread
flooding in Europe caused by rainfall resulted in the evacuation of 250,000 people and a million animals (Fig. 3).

Figure 3: 1995 Flooding in Netherlands [Photo source: Rijkswaterstaat]

These two floods resulted in the reconsideration of former flood defense systems. It is necessary to increase the discharge capacity of the major rivers and the former method of raising the height of dikes could not ensure long-term safety. As a result, the Dutch government began to discover possible approaches to mitigate flooding and “Room for the Rivers” project was put forward.

3.3 Methods and Examples

Lowering flood water levels by creating “room for the river” can be either achieved within the existing floodplain area by removing obstacles in the floodplain, or through deepening the riverbed or excavating the entire floodplain, or by enlarging the floodplain area by relocating embankments, creating bypasses or making detention areas (Alberts, 2009). To be more precise, the 9 approaches of the programs includes (Fig. 5):

1. Lowering flood plains
2. Removing hydraulic obstacles
3. Setting back dikes
4. Detention reservoir
5. Lateral flow channel
6. Lowering groynes
7. Deeping low flow channel
8/9. Dike reinforcement

The following paper will use the project in Nijmegen - Room for the River Waal - the biggest and most awe-inspiring of the national program to further explain how the “flood resilience” capacity and spatial quality could be improved through “Room for the River” program.

The river Waal bends sharply near the city Nijmegen and moreover, it narrows itself in the form of a bottleneck (i-Lent, 2015). To prevent inhabitants from the risk of high water and potential flood, the capacity of flood defense is necessary to be improved. However, instead of strengthening its dikes, the project intends to provide additional room for the river Waal by relocate the Lentse dike 350 meters inwards. A canal with a depth of 10 meter and a width of 200 meter is created in the new flood plain (Fig. 6). During high discharges this canal flows together with the Waal. A part of the old dike is redesigned as an island opposite the historical center of Nijmegen. This creates a unique riverside park in between the ancillary channel and river Waal, where people could experience the dynamics of the river. The islands offers unprecedented opportunities for living, working, sports and nature (Royal HaskoningDHV, 2015).
4. ‘Room for the River’ project as ‘Flood Resilience’ Strategy

The ‘Room for the River’ project indicates a changing notion on flood risk management. For centuries, the Netherlands turned its inhabitant areas back to the river while Nijmegen is now turning to face the river again. The project not only enhanced water safety by increasing discharge capacity while at the same time created incredible opportunities to the city by offering a river park, nature development and a new water front (P. Nijssen MA, 2012).

Here, instead of continuing to strengthen and enlarge the dikes so as to protect the city, the project creates an island where potential flooding is allowed but at the same time minimizes the impacts to the city protected by dikes by allowing water to flow through the additional canal and even the new island in an extreme case. As the capacity of discharge is increased by the new canal, the island has the ability to rapidly recover from the potential flood. Although the island has a possibility of flooding, it also has possibilities for recreation, culture, water and nature while the main city is safer because it is not only protected by hard defense system but also a higher discharge capacity of the water itself.

5. Conclusion

The ‘Room for the River’ project demonstrate a transition in the traditional strategy of strengthening dikes. The rising awareness of reconsideration upon flood risk management is mainly because of the increasing understanding of negative consequences of dike reinforcements which includes high investment, occupation of urban land and creating a disconnection between water and city. Nowadays, the land behind the dikes is becoming more heavily used and populated. While the growing population calls for urban expansion, the reinforcement of existing dikes limits such extension. At the same time, as the density of inhabitants is getting higher in coastal areas, a flood would have unpredictable disastrous results if it happens. Moreover, if the dikes continue to rise, the height difference between the water level and the land protected by dikes will be increase. In this case, the effects of flooding will be even greater if a flood occurs anyway (Met Andere Woorden, 2006). To merely use ‘flood resistance’ strategy by constructing and reinforcing dikes is inopportune, especially facing the growing threat from climate change. As a result, increasing the capacity of resilience in flood-prone areas is an essential
issue in flood risk management.
The switching research attention and relative policy making focus from “flood resistance” strategy to “flood resilience” strategy is not suggesting to replace the traditional defense system with the new strategy. Instead, flood risk managers can choose between different strategies, or a combination of both according to each particular circumstances. Every flood risk management system has a certain degree of resilience and resistance to cope with discharge waves. The resistance of the system decide which discharge waves are allowed to pass through the river without casing floods. However, resilience determines the capacity of such area to recover from a flood. As a result, resistance strategies aim at flood prevention and focus on designing the river in such a way that a certain design discharge can be dealt with. While in the other hand, resilience strategies aim at maximizing the consequence of a flood that break the designed discharge (Bruijn K. d., 2004). To be more precise, although “flood resilience” strategies enable the system to cope with uncertainties and allow an unexpected flood in less hazardous way, “flood resistance” strategies set protective barrier and actually set the basis of resilience strategies. Even though the choice between different strategies varies according to particular situations, one certain thing is that “flood resilience” strategies would continue to be researched and used more often while the traditional strategies would still be used and reinforced but may be reformed to cope with “flood resilience” strategies.
The ‘Room for the River’ approach is an attempt in experiencing “flood resilience” strategies in the Netherlands. It successfully found a new solution to flood risk apart from constructing artificial water barriers. Besides, increasing water safety is not the only objective in the project. Spatial quality is a supplement objective which fits in the increasing notion of more sustainable and environmental friendly urban planning. The project proved that “flood resilience” strategies are applicative and could be developed and used in cooperation with “flood resistance” strategies. The project plays an important role in a transition to integrated water management in the Netherlands where “flood resilience” capacity will be enhanced to create a safer and more livable coastal area.
Bibliography


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for river safety and urban development. A1 - EAUX ET TERRITOIRES / LAND AND WATER.


Room for the River, the Netherlands. (2015). Source: Royal HaskoningDHV.