MASTER

The Pier, a place where fresh water is celebrated
solution for the fresh water supply challenge of Istanbul, with a building for UNESCO-IHE

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Graduation report part of the graduation project Architecture, Brand and Sustainability.

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Preface

This Graduation thesis is the result of my graduation project, Architecture, Brand and Sustainability. It is the final result of my Building Engineering course at the Technical University of Eindhoven.

The goal of the graduation studio Architecture, Brand and sustainability is to design a sustainable building for a specific brand in either Istanbul or London. As an almost architect for me sustainability is something that cannot be ignored these days when designing a building. This studio gave me the opportunity to research the subject of sustainability in multiple ways and gave me a broader view on sustainability is and how it can be implemented into architecture.

I would like to thank prof. ir. J.D. (Juliette) Bekkering, J.J.P.M. (Sjef) van Hoof, dr. dipl.-ing. (Torsten) Schröder for their feedback and input during the whole project. I would also like to thank the co-students of the studio for the interesting discussions, the feedback and the good times we had during this graduation project. Finally I would like to thank my parents, sister and friends for supporting me and keeping my spirit during the difficult times.

Bert Atsma

Eindhoven, August 2016
Abstract

Architecture, brand and sustainability are the three main subjects of this report. Major brands claim that they have sustainable strategies and that their building are designed in a sustainable way but what this sustainability actually is, is unclear. How can sustainability be implemented in a meaningful way when designing a building for a brand is the question that was dealt with within this studio.

In this report this question will be researched with an building UNESCO-IHE, the department of UNESCO that does research into water related challenges around the world. The location for this project is Istanbul, a city of fourteen million people that is running out of fresh water. With a building for this brand and a technique called desalination where salt is subtracted from water to create fresh water a solution is proposed on how to deal with this challenge in the future. This led to the research question; ‘How can the desalination process be translated into architectural elements for the UNESCO-IHE Institute in Istanbul?’

Because the challenge is not only about the supply side but also has a demand side a second research question is made to be able to lower the water use of the citizens of Istanbul; ‘How can the UNESCO-IHE Institute be used to promote water as a vital element amongst the citizens of Istanbul?’

The research is divided in two different parts. Firstly research is done into the history of water in Istanbul and why the desalination process would be the next step in water supply. How the process can suit the brand and be translated into a building is researched by using different case studies. In the second part the chosen location is described and why this suits the challenge. After is described and how different aspects found in the research are translated into were water is produced and promoted.

Keywords: UNESCO-IHE, desalination, fresh water, Istanbul
# Table of Contents

Preface

Abstract

Chapter 1: Introduction

Chapter 2: Preliminary research
  2.1 Introduction
  2.2 Sustainability in Cities
  2.3 Challenges Istanbul
  2.4 Challenges London
  2.5 Comparison

Chapter 3: Sustainability
  3.1 From preliminary research to sustainability challenge
  3.2 History fresh water supply
  3.3 Current challenge
  3.4 Theories sustainable cities
  3.5 Desalination

Chapter 4: Brand
  4.1 UNESCO
  4.2 UNESCO-IHE

Chapter 5: Program
  5.1 Program Delft
  5.2 Program Istanbul

Chapter 6: Location
  6.1 Choice
  6.2 History
  6.3 Characteristics
  6.4 Golden Horn

Chapter 7: Building design
  7.1 Masterplan
  7.2 Translation of the Desalination process
  7.3 Drawings
  7.4 Visualizations

Chapter 8: Conclusion and reflection

Chapter 9: Bibliography
  9.1 Literature
  9.2 Images
1. Introduction

Flagship stores, corporate museums and headquarters of major brands claim all that they are sustainable. They all have a sustainable marketing strategies and are housed in sustainable buildings but as they all are very different there can be questioned what the meaning of sustainability actually is. In this studio, Architecture, Brand and Sustainability, a building for a major brand is designed in which sustainability is expressed in a more meaningful and comprehensive way. Hereby the vision of the brand and the location of the building play an important role.

With an annual growth rate of 3.45 percent Istanbul is the fastest growing city in the world. It grew from one million inhabitants in 1950 to almost 14.7 million in the beginning of 2016 (UN, 2014). This growth gives the city many different faces. There is a huge contrast between rich and poor, old and new, developed and underdeveloped. They now facing the difficult task of dealing with this rapid growth on the different levels of society. They not only have to ensure basic needs for the new poor citizens who hope for a better life in the city, but also have to develop themselves to be able to compete with other big cities on an economical and industrial scale. This makes Istanbul a good location for major brands to establish and expand themselves. As Istanbul wants to be able to compete with the rest of the world, challenges of sustainability that already are taken into account in more developed cities, become an important aspect to deal with.

With the selection of a brand in combination with the different challenges that the city is facing it is possible to come up with a more specific interpretation of sustainability. The challenge chosen is the lack of fresh water within the city. It is impossible for a city to compete on a global with other major cities without being able to ensure one of the basic needs. A brand that suits this challenge is UNESCO-IHE. This is a institute that conducts research into water related issues around the world. As water scarcity is still a broad subject what can be solved in many different ways, a solution that is more specific for Istanbul is used as a base for the research and the design process of this report. This lead to the following research question:

‘How can the desalination process be translated into architectural elements for the UNESCO-IHE Institute in Istanbul?’

Desalination is a process which can create fresh water from salt water. As Istanbul is surrounded by the sea this method is very suitable for the city.

But with this question only one part of the problem of the water scarcity can be solved. The desalination process will deal with the supply side of the problem. But if it would be possible to simultaneously lower the demand the problem could be solved more effectively. This is aspect where the second research question will deal with:

‘How can the UNESCO-IHE Institute be used to promote water as a vital element amongst the citizens of Istanbul?’
In the first part of the report a summary will be given about findings of the preliminary research. This formed the base for the choices that were made in the M4 project. An important part of the studio was the research into a specific challenge in Istanbul that could be addressed by a brand with a suitable program. In chapter three is described why the water scarcity challenge is chosen and how Istanbul dealt with this challenge in the past. With the approaches of Girardet and Steel, who both wrote about how cities should deal with their resources in the future, the reason for the choice of the desalination process is made clear. In the second part of this chapter different options of desalination are described.

The fourth chapter is dedicated to the brand. In the first part a short history of UNESCO and where they stand for are described. The second part is dedicated to UNESCO-IHE. Where the brand stands for, how they deal with sustainability and why they are suitable for the challenge in Istanbul will be addressed. In the fifth chapter the chosen program for the design is introduced. With case studies research is done into different buildings that deal with water related challenges but also are interesting buildings to visit.

In chapter six the location is introduced. In the final chapter the research of the previous chapters is translated into a building. With a masterplan that was made by architectural office Teget for a plot adjacent to the location, a masterplan was made for the project location. With the masterplan the exact position for the building was determined. After this the translation of the desalination process together with the social aspects of the challenge and the branding are described and the second half of chapter seven.

In the end a conclusion is given on the whole process and at the final result.
2. Challenges of sustainability in London & Istanbul
2.1 Introduction
2.2 Sustainability in cities
2.3 Challenges Istanbul
2.4 Challenges London
2.5 Comparison
2.1 Introduction

The M3 research formed the basis for the final project. In this research the two possible project locations, Istanbul and London where compared with each other. Both cities can be seen as megacities, cities with more then ten million inhabitants (UN, 2014). Sustainability is a very important topic within these cities because megacities account for a large group of the worlds inhabitants an have a great impact on the global environment.

The research was build up in three different parts. To conduct a good comparison between both cities first with the use of five different sources a broader understanding of sustainability in cities was gained. Then five different sources where used for both cities that dealt with challenges related to sustainability in that city. In the end the theories and the challenges where compared to each other.

2.2 Sustainability in cities

The conclusion of the research about sustainability in cities was that sustainability remains a difficult concept because there is not an general definition that can be used for all sustainability related challenges that both of the cities are facing. For every location with different actors, there are specific challenges related to sustainability. Most of the definitions like the Brundtland definition are oversimplifying the concept of sustainability, however some distinction can be made in the challenges that the different cities face by using the theories stated by Marcotullio (2007) and Globescan (2012). They both categorized cities in three ‘archetypal’ cities; ‘emerging cities’ with ‘brown’ challenges, ‘transitional cities’ with ‘grey’ challenges and ‘mature cities’ with ‘green’ challenges.

Emerging cities are mostly characterized by high growth rates driven by migration and natural growth. The annual growth rate of these cities is between 3.5 and six percent. The highest growth will occur in the informal settlements with no infrastructure and other services (Globescan, 2012). This uncontrolled growth in the ‘slums’ is one of the main problems in emerging megacities. Therefore the main challenge is to provide the basic needs for their inhabitants.

Transitional cities already overcame the challenge of not being able to manage rapid growth and annual growth rates are slowing down. They grow between two to three percent a year and are often located in countries that are more than 50 percent urbanized (Globescan, 2012). They also face the problems of providing the basic needs for their citizens but are better organized and have more financial resources. Besides an underdeveloped part of the city they also deal with increasing affluence which leads to new demands in quality of life (Globescan, 2012). Therefore the main challenges within these cities are related to solving negatives of contemporary industrial processes and infrastructure systems, such as water and air pollution and traffic congestion.

Mature cities are characterized by much slower growth rates than emerging and transitional cities. They grow about one percent on average per year because there is almost no migration from rural areas anymore. Because their infrastructure has
been built simultaneously with the emergence of the city they do not have to deal with these challenges anymore. They can afford themselves to focus on green challenges such as the adaptation to the consequences of climate change, social inequity and further improvements to the infrastructure of the city.

The next step in the research was to create an overview of the different sustainability challenges that London and Istanbul where facing.

The challenges that were found in the different literature matched with the theories of Marcotullio and Globescan. Istanbul can be seen as a transitional city and London as a mature city. The challenges that were found in the sources where split up in different categories and different sources were per challenge compared to each other to create an more objective view. The results for both cities are described below.
2.3 Challenges Istanbul

Istanbul is one of the fastest growing cities in the world with an annual growth rate of more than three percent. The main challenge found in the literature was how to deal with this rapid growth. This growth led to uncontrolled development of the urban structure. This resulted in a range of urban changes such as fragmentation of the urban structure and urban sprawl. The main challenges caused by these urban changes are mostly social challenges such as the social inequity and the loss of identity.

It became clear that fragmentation divided the city in areas which are well served for the wealthy inhabitants, and in areas that are unserved where the lower classes live. This is not only related to the growth of the city, but the contemporary gentrification process through the ‘Urban Renewal Act’ is a big contributor to this challenge. The old districts with their ‘finely-meshed street patterns, intricate social and micro-economic structures, their vibrant street activities and their small-scale character, are being replaced by anonymous housing projects that could be build anywhere in the world’ (Dossick, 2012, p.53). Next to the loss of identity it creates different challenges like ineffective use of infrastructure systems such as transportation ways, electricity grids, water systems and sewers.

Environmental challenges where hardly mentioned within the literature but with the rapid growth is can be expected that they also have to deal with an increasing pressure on the environment. A challenge that was mentioned and contributes to this pressure is the car use in Istanbul. The infrastructure of the city is not capable to deal with the huge amount of cars which leads to many traffic jams.

Overall could be concluded that as the city is still dealing with poor and unserved areas and such a high growth number it can be questioned if it is possible to implement aspects of sustainability within the city.
2.4 Challenges London

For London as mature city is was expected that deal with completely different challenges than Istanbul. Looking at their primary challenge that was found in the used literature this hypothesis was right. The city is mainly dealing with the effects of climate change and the contribution of the city to climate change. To reduce their impact in general they have to reduce their emissions. This will improve the quality of life in the city but also will reduce the impact of London on the global effects caused by climate change. To make major steps in this they face the difficult task to change from the old techniques where they relied on for ages to a techniques that emit less CO2 and improve quality of live. Improvements where mainly focused on updating old systems to meet the new standards.

This can be seen by water use, waste and energy supply. Water use is reduced by improving old systems, waste is not dumped anymore but burned where heat for other purposes, and energy supply still relies on existing technologies that are improved to be more sustainable. To adapt more to climate change, major shifts in technologies are needed. They should rely more on the resources that already are in the city to reduce their impact on the environment. Water from precipitation should be used, energy should be supplied locally and waste should be recycled as much as possible. Next to these prevention methods the effects of climate change are inevitable for the upcoming years. Rainwater harvesting is one example, but London should also prepare for drought and high sea levels.

Another important challenge is the future of their transportation system. Transport related challenges mainly focus on improvements of the public transport system to reduce the car use and thereby reduce their emissions. It is important that the city is easily accessible by foot or bicycle. Town centres in inner and outer London should develop higher densities and create more functions around their public transportation system which will reduce the need to travel by car in this part of London.
2.5 Comparison

Although both cities are in different phases they do share some similar challenges. Both cities have to deal with social inequity but if this challenge between the two cities is compared directly, it becomes clear that the problem takes place on a different level in Istanbul than in London. The lower class within Istanbul is still lacking in basic needs and are being marginalized and forced out of their houses, while in London it is impossible for anyone but the rich to live in the city centre due to the high housing prices. This difference in level of severity of the same challenge can also be seen in the challenge of reducing automotive transportation. Istanbul has major issues with traffic congestion, but is not really showing any incentive to reduce car use and are only making more roads, despite different research labelling this as a big issue. London has less congestion problems but wants to reduce car use to increase quality of life and make a more attractive city besides reducing travel time.

The difference between the cities is that Istanbul is facing challenges that are mostly solved already by other western cities like London. It could be questioned though if it is possible for Istanbul to use the knowledge of the history and challenges that other cities faced. By looking at the development happening in for example London now, they could already take ‘green’ issues in consideration when solving their ‘grey’ issues. Since the development of Istanbul is happening so much faster than that of other western cities, it would be a shame if they need to overhaul the actions they are making now to adjust them to the new phase they are going to face in the near future. Instead of just trying to solve their problems they could strive for a higher level altogether and ‘leapfrog’ an entire part of sustainable city development western cities had to make.
3. Sustainability challenge
3.1 From preliminary research to sustainability challenge
3.2 History water supply Istanbul
3.3 Current challenge
3.4 Theories Sustainable cities
3.5 Desalination
3.1 From preliminary research to sustainability challenge

As stated before the preliminary research was the base for the choice of the sustainability challenge that will be addressed in this report. After the preliminary research was finished from a personal interest, more research has been done into the environmental challenges. The main reason for this was with the current way of development the city probably will ‘collapse’ in the near future. The city is lacking a good infrastructure system as it all is build as a reaction on the uncontrolled expansions of the city. Instead of reacting on the growth a stable basis with primary needs that are not only capable of dealing with the growth but also are ready for the future. As concluded in the preliminary research Istanbul should learn form cities likes London. The sustainability aspect of the different challenges that Istanbul is dealing with should become a key driver to solve these challenges.

In new found literature the environment was mentioned as a challenge that is becoming more important in the near future. One of the challenges that especially was mentioned is the lack of fresh drinking water. As this is a primary necessity for life it is very important to solve this in the near future.

3.2 History fresh water supply Istanbul

The challenge is not a new for the city. It is dealing with it since its emergence (Saatci, 2013) because the city is build on limestone which makes the reliance on groundwater impossible. Therefore the city is heavily dependant on surface water and springs in forest in the north and west of the city.

The first known water supply systems of Istanbul dated from the Roman times in second century. Two aqueducts transported water to the city. As the city grew new supply lines where build. Within the city borders the Romans made an extensive system to distribute the water. It was channelled from natural springs to reservoirs and holding tanks just outside the cities borders. From here the water was piped to cisterns, fountains bathhouses and private houses within the city. This cisterns where the solution to for hard limestone ground. They not only stored the water that was transported from the springs but they made is also possible collected water from precipitation. From the tenth century the Romans started to rely more on the cisterns because the aqueducts and transmissions lines did not function during sieges and earthquakes. They constructed many cisterns in the city so that they where less dependant on the hard to control sources outside the city (Kulturturizm, 2015).

In 1204 the Latins concurred the city and many of the Roman waterworks were destroyed. The city became once again mainly dependant on transported water. In 1453 the city was conquered by the Ottomans and they focussed on repairing and rebuilding the existing waterways. As the population grew the Ottomans enlarged the system with four new supply lines. In the next decades the system was improved several times. In principle the system that they build was the same as in Roman time but they expanded with more complex distribution chambers.
which made it possible to control the amount of water that was distributed to the cisterns and fountains within the city. During the Ottoman and Roman period fountains not only played an important role in the distribution network but also were a social element in the city.

“The Ottoman government favoured supplying public fountains rather than private homes with mains water. This made the local fountain an indispensable focal point of every neighbourhood. (...) In Istanbul, as in every Turkish city in the past, the local fountain was a hub of social intercourse”. (Kulturturizm, 2015)

Most of the transmission lines that the Ottomans build are still in use. Until the eighteenth century these line were sufficient to serve the city. In this century two new supply systems were build that should be enough to serve the city for the upcoming 300 years. In the 1970’s the first signs of the rapid growth that the city is still facing emerged and they were once again forced to expand and renovate its water supply system. In the next years dams were build in rivers to create extra reservoirs in the existing supply line. This increased the capacity but as the growth continues the demand for more fresh water and new sources continues with it.
3.3 Current challenge

The challenge that Istanbul is facing today is not only the ongoing rise of fresh water in demand caused by the rapid growth, the urbanization process is also endangering the quality of the water in the reservoirs. Before 1970 the reservoirs always were located outside the boundaries of the city. But since 1970 the city is facing the rapid growth, new uncontrolled expansions are more and more located next to the reservoirs. New highways, illegal settlements, the consequences of the second Bosporus bridge and other industrial activities are now endangering the quality of the water with their emissions (Kaya, 2013). The urbanization from the fifteenth century to 2010 can be seen in figure 3.2 till 3.8. In figure 3.9 the expected growth until the year 2045 with the third Bosporus bridge can be seen.

Besides the consequences of the urban growth, the consequences of climate change also influences the amount of water than can be supplied. The dry season is becoming longer which in the summer of 2007 resulted in water cuts. By then the water levels in the reservoirs only reached half of their normal capacity. In the summer of 2013 the water levels even dropped below twenty percent (Kaya, 2013). The government is trying to solve this challenge in two ways. Protection zones were set up around the reservoirs where only low destiny single housing is permitted to reduce the emissions that could harm the quality of the water (Kaya, 2013). But recent research shows that these laws are very week and that the urbanization probably will continue around the reservoirs in the upcoming years. (Kaya, 2013).
Their second solution is to use new rivers far beyond the boundaries of the city borders. A recent project, the Melen project, will increase Istanbul’s water capacity with a third from 750 million cubic meters to one billion cubic meters per day (Saatci, 2013). According to the minister of Forestry and Water of Turkey this will be enough to supply a projected population of 35 million in 2071 (Daily Sabah, 2014). Taking the history into account this solution will again be a temporary solution. Also the more recent challenges like the droughts indicate that circumstances have been changed which ask for different solutions than the ones in the past.

Besides the supply side there is also the demand side of the problem. If the wealth in the city will continue to rise more water will be used per capita which will enhance the scarcity. To prepare the city for the future and ensure a continuous water supply of fresh water for both sides new solutions have to be found.
fig. 3.4: Year 1950 AD
(Author, 2016. Data from 51N4E architects)

fig. 3.5: Year 1970 AD
(Author, 2016. Data from 51N4E architects)
fig. 3.6: Year 1990 AD  
(Author, 2016. Data from 51N4E architects)

6,500,000

fig. 3.7: Year 2000 AD  
(Author, 2016. Data from 51N4E architects)

10,000,000
fig. 3.8: Year 2010 AD
(Author, 2016. Data from 51N4E architects)

fig. 3.9: Year 2045 AD
(Author, 2016. Data from 51N4E architects)

Legend:
- Existing highways
- New third highway
fig. 3.10: Drought in the reservoirs (Erken, 2015)

fig. 3.11: Location Melen water source (Author, 2016)
fig. 3.12: 
Inhabitants and water production 
Istanbul (Author, 2016. Data from Demirci, 2001) 

Inhabitants in millions 

Water production in $10^9$ liters/day 

Year 0 300 400 500 600 700 800 900 1000 

Roman Empire 

Dams 
Aqueducts 
Cisterns 
Natural reservoirs 
Public baths 
Fountains
3.4 Theories sustainable cities

To come up with a solution two approaches of how future cities should look like related to energy flows in the future are investigated. The first approach is the approach of regenerative cities of Herbert Girardet. The second is of Carolyn Steel who wrote in her book the hungry city about food flows within the city. It are more general of approaches of how a city should deal with energy and food, but their principles can be translated to the water scarcity challenge that Istanbul is facing.

3.4.1 Regenerative cities, Herbert Girardet

The approach of Herbert Girardet and regenerative cities was already mentioned as a promising theory in the preliminary research and will be explained further. According to Girardet (2008) the challenge for cities today is no longer to just focus on fossil fuels and renewable energy sources cities but to create cities that:

“Not just become resource-efficient and low carbon emitting, but that they positively enhance rather than undermine the ecosystem services they receive from beyond their boundaries” (Girardet 2008).

In 2007 more than half the world’s population lived in cities (UN, 2014). Despite the fact that their surface is only three or four percent of the earth’s surface they consume 80 percent of the world’s resources (Girardet 2010). Girardet states that current cities use resources without knowing where they come from. They have developed resource consumption and waste disposal habits that show little

fig. 3.13: Current relation resources and cities (Author 2016, Data Girardet, 2010)
concern for the consequences (Girardet, 2008). Resources for cities are gathered on a global scale and cities consume them without thinking where they come from. This way of living is powered by fossil fuels which are consumed at such a rate that this was of living is reaching its limits. To postpone the scarcity oil platforms are now drilling to sources located ten kilometers deep and mountains are topped to mine for coal (Girardet 2010). If these sources are depleted eventually new methods have to be found to fuel our economy.

The way cities should function and deal with their resources can be compared with the cities of the past. These cities were fed by their own hinterland and the amount of resources extracted from the land was in balance by the time the land needed to recover. This ensured an continues production of food and other resources like food. Modern cities should restore this connection with their direct environment instead of relying on the global hinterland. When for example food is produced just outside the city borders Impacts on a global scale are lowered and transportation costs are minimized. To ensure the hinterland can always provide enough resources a balance has to be found in the energy that is taken from this land and what is given back.

“The new challenge is for cities to find ways to continuously help regenerate natural systems from which they draw resources” (Girardet 2010)
To achieve this according to Girardet the ecology of natural systems should be studied. In nature outputs of one system or organism are the inputs for the other. These days outputs of a city are mostly seen as waste but they should be reused as energy for the resources that the city needs. In this was a circular metabolism is created instead of the current linear metabolism.

The hinterland should also be used as a production space for renewable energy sources. Cities become less dependent on fossil fuels and can depend more on the local produced renewable energy.

3.4.2 Hungry city, Caroline steel
The second theory or approach is of Caroline Steel who wrote the book Hungry City. Steel states that our world is shaped by food. Historically cities are formed by the availability of food. The layout of the streets and canals are initially based on the resources that were available around the city. These days basically nothing changed except the scale of how the city is supplied with food changed. Steel comes up with solutions that are comparable with and probably partly based on how Girardet envisions the future of the cities. In the first cities food was harvested outside the city, gathered in the temple of the city and from there spread to its citizens. (Steel, 2011). In the older cities that were built for the industrial revolution the public places like squares and streets were the only places where...
food was bought and sold. People who lived in a city were thereby well aware of where their food came from. After the industrial revolution a big change was visible in the way cities were supplied with food. Trains transported food into cities and people were able to transport food with their cars. Cities grew very fast and the food was not sold at markets as for example whole animals, but as little pieces in the grocery stores. Steel observed that food used to be the centre of the social core of the city, but that it has been moved to the outskirts of the city. It used to be a social event but it became anonymous. As the world started to act more on a global scale also the food production and supply system became more global. Food is produced at the other side of the world. Huge distances which lead to more emissions have to be covered before it is stored in a warehouse in the outskirts of the city and eventually in the grocery store. Consumers have no idea where the food comes from and how much energy is needed before they can buy it. Steel states that food should play a central role in our life again. As cities were developed around food in the past, food can also be used to shape cities in the future. Hereby can be thought of local food production on for example rooftops or community gardens. By making the production and growth of food visible again people will create more awareness for the food and the environmental impact on a global scale is lowered significant (Steel, 2011).
3.4.3 Solution for water scarcity in Istanbul

With the findings of the preliminary research, the history of Istanbul with their water supply and the approaches of Girardet and Steel, a solution can be found for the challenge that Istanbul is facing.

In the preliminary can be seen that London is facing the same challenge. To reduce the demand water meters will be installed in every house. Currently only 25 percent of the houses is equipped with a water meter (GLA, 2011). Also the old supply system will be updated to reduce the leakage. In the used literature of London in the preliminary research is questioned if these solutions are the best option. Bell (2013) states that the current supply system is outdated for the future of London. The conclusion of the research was that a completely new system would be a better solution to ensure a continuous water supply in the future. Water should be harvested on roofs of buildings and surface water should be collected to function as non-potable water. This is emphasized by the history that Istanbul has with the water supply. They always had to search for new sources and now with the effects of rapid growth and climate change this method probably cannot ensure a continuous supply of water in the near future.

The challenge with water in Istanbul has many similarities with the challenge that cities faced with food. Water used to be ‘harvested’ near the city but now they are forced to search for sources far outside the city. Another similarity with the theory of Steel is the changed relationship between water and the city. Water has played an important role in the history of Istanbul. The city owes its wealth to the relation they had with the sea. The Bosporus was an important trading route between the Black sea and the and the Golden Horn was a natural harbour that protected the city during wars. Just as with food the relationship with water has changed. Fountains used to play a central role in the social life and where together with cisterns and other waterworks a dominant feature in the street pattern. Today the relationship with the sea and the fresh water has been considerably altered. The city has changed from a coastal city into an inland city (Erkök 2009).

‘As this relationship has radically changed, the city now urgently needs new insights which evaluate this situation and work to redefine a place for water in the city’ (Erkök 2009, p.1)

Looking at Girardet and Steel and their vision on more local instead of global produced resources water should be also treated this way. With the current techniques it is possible to produce fresh water from sea water. Just as in the past the Bosporus and the Golden Horn can become an important resource for the city again. In this way the pressure on the nature and the reservoirs that surround Istanbul will be reduced and the city is not dependant on sources located far beyond the city. If water, and water production becomes an important feature within the city that is visible for the public it can also contribute in creating awareness for the challenge amongst the citizens.
3.5 Desalination

Producing fresh water out salt water is called desalination. To restore this connection according to Girardet the ecology of natural systems should be studied. In nature outputs of one system or organism are the inputs for the other. These days outputs of a city are mostly seen as waste but they should be reused as energy for the resources that the city needs. In this was a circular metabolism is created instead of the current linear metabolism. It is a process that constantly takes place in nature and is an essential part of the water cycle. Sea water is evaporated by the sun and salt is left behind. Water vapour form clouds that carry fresh water to land and produce rain which eventually ends up in the sea again. The first reference to this technique used by humans to fresh water was by Aristotle in 320 BCE (Baawain, et al. 2015). During the ages different techniques of desalting water where used. The technique was frequently implemented on ships that made long voyages around the world (Baawain, et al., 2015). In the 20th century desalination techniques took a major step forward as in the second world war it became on of the most important methods to supply soldiers with potable water. In the 1990 the first commercial plants were put into operation (Baawain et al., 2015). In 2014 around 1% of the world’s population is dependent on fresh water produced by desalination (GWI, 2014). As water scarcity will grow in the future more people will have to rely on sea water as a fresh water source. According to the Global Water Intelligence “seawater desalination is the only additional renewable source of freshwater available on this planet” (GWI, 2014). According to Baawain it is expected that the capacity fresh water produced by desalination will double in the next ten years (Baawain et al., 2015). The desalination plants are mostly found in the Gulf region and Australia but as the water scarcity around the world increases this it also could be a solution for countries who used to rely on precipitation and other fresh water sources.
3.5.1 Desalination techniques

Two of the most efficient technologies are thermal desalination and membrane desalination (Veolia, 2016). Besides these two methods there are also other more experimental methods that are far less efficient and will not yet be able to play a significant role in solving the fresh water scarcity in Istanbul.

1: Thermal Desalination: With this technique salt water is heated and consequently vaporizes. The vapour can be collected by condensation on a cold surface and the salt stays behind. This process is similar as the process that happens in nature, but to make it more efficient the water is heated under high pressure at different temperatures which results in fresh water. This technique accounts for 35 percent of the installed desalination capacity. A positive aspect of this technique is that it requires less maintenance and that the sea water needs little treatment before it can enter the desalination process. A negative aspect is that it takes a lot of energy to vaporize the water and therefore this technique is mostly used in area where many fossil fuels are available.

2: Membrane desalination: With this technique membranes are used to separate fresh water from salt water. A technique that uses this method is called reverse osmosis which is based on a natural process osmosis:

“Osmosis is the spontaneous net movement of solvent molecules through a semi-permeable membrane into a region of higher solute concentration, in the direction that tends to equalize the solute concentrations on the two sides” (Oxford English Dictionary, 2005)

As the name indicates the process the osmosis is reversed to increase the pressure above the osmotic pressure. In this way water is pushed through the membrane and the salt particles stay behind. Before the water is clean enough to pass the membranes it has to be pre treated. After sea water is extracted from the ocean big particles, waste and wildlife are blocked by screens. In step two of the pretreatment small particles and algae are bound together to big particles and they are removed from the water. In the last step, the filtration process the clarified water goes to layers of sand and gravel that retain the finer particles. After this process the water only contains salt particles. After it passes the membranes minerals have to be added to meet the drink water requirements.

Compared to the thermal desalination, reverse osmosis requires more work and the membranes need a lot of maintenance. The costs of membrane technologies decreased significantly which make them although the higher maintenance with a share of 60 percent of total installed capacity the main desalination technique in the world (Baawain et. al., 2015)
Thermal Desalination (Author 2016)

Osmosis (Author, 2016)

Reverse Osmosis (Author, 2016)

Reverse Osmosis Steps (Author, 2016)

1. Pre treatment
   - Removal waste and big particles
   - Algae removal and flocculation
   - Filtration

2. Reverse Osmosis
   - Salt water
   - Clean water

3. Post treatment
   - Fresh water
fig. 3.19: Desalination plant Oman, (Ventureonsite, 2015)

fig. 3.20: Desalination plant interior Singapore (Ventureonsite, 2015)
3.5.2 Advantages and disadvantages of desalination

The most clear advantage of desalination is that it can provide a continuous supply of water, as there is enough salt water available. Istanbul will become a more ‘stable’ city and which will ensure a better basis for the future.

Besides this major advantage which solves the challenge there are some disadvantages that cannot be ignored. Both processes use a lot of energy. This energy is in the current plants mostly produced by fossil fuels but with the costs of renewable energy sources reducing and the costs of fossil fuels increasing it is expected that in the future a combination of renewable energy with desalination together will become more attractive. With the theory of the regenerative city, it can be imagined that in the future energy is produced in the outskirts of the city or even in the city on a renewable way which will be able supply the city with enough energy.

Another disadvantage is the brine, the highly concentrated salt water that is the residual of both processes. Conventional plants discharge this mostly in the ocean which affects the marine live in the area. But the current plants are mostly located at remote places far outside the city. With the desalination within the city the salt could be used for other industries within the city.
4. Brand
4.1 UNESCO
4.2 UNESCO-IHE
4.1 UNESCO

4.1.1 History

The brand that is chosen to deal with the challenge of supplying Istanbul with is UNESCO-IHE, the water department of UNESCO. As it is part of UNESCO first an overview of UNESCO is given.

UNESCO can be seen as the "intellectual" department of the United Nations and stands for united Nations, Educational, Scientific and Cultural Organization. It was founded in 1945 after the world had faced two wars in one generation. Nations believed that politics and economics where not able to ensure peace in the future and therefore UNESCO was created.

“The main objective to contribute to peace and security in the world by promoting collaboration among nations through education, science, culture and communication in order to further universal respect for justice and the rule of law and for the human rights and fundamental freedoms which are affirmed for the peoples of the world, without distinction of race, sex, language or religion” (UNESCO, 2016)

Between the 195 member states UNESCO strives to build solidarity by and peace by achieving different goals. They want to make education a fundamental right and accessible for everybody, build a inter cultural understanding between nations around the world, create connections between different nations that share scientific knowledge and protect the freedom of expression.

fig. 4.1: UNESCO headquarters (UNESCO, 2016)
Today the world and the future of the world is very unstable. Not only on a political level but as read above the recent climate changes and how to react and understand these new circumstances ask for new insights. Education, scientific research and sharing knowledge have never been more important to create and holistic approach which deals which social, environmental and economical dimensions of sustainable development (UNESCO, 2016)

4.1.2 Research themes
UNESCO has seven main portfolios with which they try to achieve their goals by creating connections and sharing information between organizations that deal with aspects of these portfolios. These seven portfolios are shortly described below to create a better understanding of the broad field where UNESCO is acting in:

1. Education for the 21st century
UNESCO’s mission is to build peace, reduce poverty and drive sustainable development by using education (UNESCO, 2016). The organization believes that good quality education should be a human right. To achieve this they provide leadership creating better education and strengthen connections between different education systems around the world.

2. Fostering Freedom and Expression
UNESCO wants to improve freedom of expression within the media. They work on policies that create press freedom around the world. Journalists safety and the
right to write regardless of their ethics is an important factor that contributes to the main objective of UNESCO.

3. Protecting our Heritage and Fostering creativity
This point is probably the most common by the public, the protection of world heritage sites.

“Heritage constitutes a source of identity and cohesion for communities disrupted by bewildering change and economic instability” (UNESCO, 2016)

UNESCO build a global network that protects the world natural and cultural heritage. This includes archaeological sites but also underwater heritage collections in museums and cultural traditions. The cultural aspect is a very important aspect for sustainable development because according to UNESCO no development can be sustainable without taking culture into account. In the dialogue about future development UNESCO tries to involve these cultural traditions and values.

4. Learning to live together
Societies these days constantly change by for example refugees flows. It becomes increasingly important that these people understand each other and work together to work one of the one of the fundamental goals of UNESCO, peace. UNESCO helps people to share knowledge in the field between their member states to create a better understanding of they way societies should life together in the future.
5. Building knowledge societies
By sharing knowledge and information UNESCO believes that this can change economies and societies. They especially focus empowering the poor, connecting them to information and knowledge that UNESCO has gathered over the years.

6. One planet on ocean
The main goal of this point is to preserve diversity of life on the earth and in the oceans which is important to establish human welfare. UNESCO wants to improve the relation with the earth and the ocean and by understanding them better this can contribute to more resilient societies.

7. Science for a sustainable future
UNESCO assists countries with their investments in Science, Technology and innovation. They want to develop a structure where countries share their knowledge that they gained by creating solutions on their own specific problems. Also involvement of the public is a very important point to create a public understanding of the solutions that are implemented. This last topic also deals with water, the earth’s resources, ecosystems, biodiversity and the interaction between humans and these elements.


4.2 UNESCO-IHE
Since UNESCO is founded it has always sought collaborating with non governmental organizations, NGO's. It are organizations that have expertises within the seven main portfolios of UNESCO. These partnerships are a key to meet the global challenges on a national and regional scale.

“By joining forces with its partners UNESCO can leverage resources, expertise and competencies to promote all UNESCO’s ideals and values, to achieve common development goals, and to strengthen visibility and impact of its action” (UNESCO 2016).

One of the partnerships that they established is the relation with the International Hydraulic Engineering Institute (IHE) in Delft the Netherlands. It is the largest international graduate water institute and offers master and PHD degrees.

4.2.1 History
The institute was founded after the flooding of the Netherlands in 1953. To protect the Netherlands for future floodings the Delta plan was set up to prevent the lower parts of the Netherlands against the water from the North sea with different flood-barriers. In 1957 the ambassador of Bangladesh asked the Dutch government if it was possible to share the knowledge that they gained through the Delta plan with countries around the world that where dealing with the same kind of problems. This was established by the founding of the IHE. In that year 44 participants from 21 countries started with a first international course of hydraulic engineering. In the next decades the student number gradually increased and more different courses where taught. In 1986 the first Master of Science degrees where awarded and in 1994 the first PHD student graduated.

In 2001 the IHE becomes part of UNESCO As an research institute that has many connections around the world it fits perfect within the vision and mission of UNESCO. From this moment onwards the institute is named UNESCO-IHE. Today more than 14,500 water professionals were trained by the institute. They came from 160 different countries that are almost all in a developing or transitional phase.

4.2.2 Mission
‘UNESCO-IHE envisions a world in which people manage their water and environmental resources in a sustainable manner, and in which all sectors of society, particularly the poor, can enjoy the benefits of basic services’ (UNESCO-IHE, 2016)

They want to achieve this by educating people and expanding knowledge through research. The capacity of organizations within the water sector has to be extended to be able to spread their knowledge that can be used to lower the pressure on the environment and infrastructure in transitional and developing countries.

The institute acts as a hub that brings different partners and networks together.
It has close working relationships at a global but also at a national and regional level. Most students that study in Delft are foreign students and go back to their country of origin when they are finished. In this way the network is enlarged every year.

4.2.3 Connection with water scarcity in Istanbul

The brand can contribute to fresh water scarcity in Istanbul. Therefore the city would be a good location to open a second institute. In Delft research is done into many different themes in the field of water. This research can be used for and extended in the new location in Istanbul. As water is the main theme of the challenge and the brand, this can be used to brand the building and address the challenge not only by teaching the students but also by the building itself.
5. Program
5.1 Program Delft
5.2 Program Istanbul
5.1 Program Delft

5.1.1 Visit Delft
During this research a visit was brought to the institute in Delft. Facility manager Arno Heins gave a tour through the building and told about the different ways of education and research that are conducted within the building.

At the building there are three ways of education. Master programmes, PhD programmes and short courses. Their are four main MSc programmes that can be followed; Environmental science, urban water and Sanitation, water management and water science and engineering. The duration of each program is eighteen months. The first year consists of courses at the institute in Delft and in the second year a practical research practical research is conducted mostly at locations outside the Netherlands. At the institute there where three main study parts, the laboratories, different classrooms and an auditorium.

The PhD programme is a four year research conducted in Delft and in the researchers home country. In Delft 135 PhD researchers from around the world are brought together which leads to a unique environment where knowledge is brought together and can be shared. The themes within the research are not only based on water challenges in the global south and countries in transition, but start more and more to deal with water in an globalised world. In Delft there where many study tables where PhD’ers had their own study place.

Besides the full study programmes it is also possible to follow online and short courses. In this way water education is made more flexible and affordable for the increasing amount of students. People who follow online courses actually never visit the building. With the short course people can refresh and upgrade their knowledge. They are meant for professionals and usually have a duration of one to three weeks. These courses also make used of the different classrooms and the laboratories in the building.

Next to the educational and research areas there were many offices for the teachers and the building facility staff. Throughout the building there are different meeting points where students and teachers can have informal meetings. There is one central canteen where all the different people can meet each other. Within the building are no separate coffee corners which stimulates the canteen as being the central meeting point.
**Fig. 5.1:** Laboratory IHE Delft (Author, 2016)

**Fig. 5.2:** Auditorium IHE Delft (Author, 2016)

**Fig. 5.3:** Meeting place IHE Delft (Author, 2016)

**Fig. 5.4:** Work area PhD IHE Delft (Author, 2016)
5.2 Program Istanbul

The program for Istanbul is made more specific for research related to desalination. In Delft there are three main research themes that cover most challenges related to water within the world. The institute will have one study direction which is the future of the challenge of Istanbul. Besides a research institute it should also become a place where awareness is created for the scarcity challenge. Looking at university buildings in Istanbul they are all surrounded by big fences and have no relation with their surroundings. It is from the outside not visible at all what is happening within the buildings. To create a connection between the public and the institute is should be a building that is part of the society wherein it is located. This can be achieved by making the building a point in the neighbourhood that is not only accessible for the students but also gives something back to the neighbourhood. With the program of Delft alone it is not possible to achieve this.

fig. 5.5: Analysis universities Istanbul (author, 2016)
5.2.1 Desalination program
To make the relation with the location and society stronger the actual desalination process is added to the building. This can become the showcase of the institute where the future of fresh water production is made visible for the public. The institute also can benefit of this because it can be seen as an extra laboratory where their research can be tested. This process will be the connection between the visitors and the Institute. Of the most productive desalination methods described in chapter three reverse osmosis is the most suitable to show to the public. In this process especially in the pre-treatment of the water the different steps can be made clearly visible. When visitors pass by the different steps they see how the water is cleaned from dirty salt water to fresh water.

The square meters of the desalination program are defined by the water use of the building itself and for the neighbourhood (Beyoglu) in which it is located. This neighbourhood houses approximately 240,000 inhabitants (Turan, 2010). An average inhabitant is uses now 250 liter water per day but as Istanbul continues to develop itself to an more mature city this could develop to almost 500 liters per day. (Dimirci, 2001). To be prepared for the future 375 liters is used a the average daily use per person.
The size of the different steps is calculated with the help of the numbers of a French water treatment company called Veolia. The UNESCO building in Delft uses 2,900,000 liter/year. As the program in Istanbul will be similar this number is also used for the new building. The neighbourhood uses 90 million liters a day which is 32850 million liters a year. The total water production therefore has to be 32852,9 million liters/year which is 3750 m³/h.

In figure 5.7 the different steps are shown with the surface area needed to produce 3750m³/h. The reverse osmosis had a very low rate per hour but this was only a small systems with several tubes. The needed space with the system of Veolia would need 2080m² to be able to process enough water. But within the surface area of the system also the monitoring systems were included, and the amount of tubes that were stacked upon each other where only five. Looking at the bigger plants the amount of tubes where the osmosis process takes places are much higher with only one monitoring area. By placing the pipes upon each other it is possible to produce the amount of water within 160 m² meter.

The size of the basin is determined by the using the size of the reservoir of water treatment company the Berenplaat in Spijkenisse, the Netherlands as a reference. This water plant is a normal water plant with a production capacity of 4m³ per second (Evides, 2015). This is 14.400 m³/h which makes this plant four times bigger then the desalination plant. Within their holding tanks it is possible to store 25 million liters of water as an emergency supply. The capacity in the building for UNESCO-IHE therefore is estimated at three million liters. As will be made clear in chapter seven the height of the basin will be six meters which result in a basin of 550 m².
**fig. 5.7: Production rate and square meters (Author, 2016 Data Veolia, 2016)**

<table>
<thead>
<tr>
<th>Step in process</th>
<th>Removal waste and big particles</th>
<th>Algae removal and flocculation</th>
<th>Filtration</th>
<th>Reverse osmosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production rate in m/h</td>
<td>- 30</td>
<td>15</td>
<td>15</td>
<td>23</td>
</tr>
<tr>
<td>Square meters in m2</td>
<td>- 120</td>
<td>250</td>
<td>400 m2 (of which 250 m2 are filters)</td>
<td>160</td>
</tr>
<tr>
<td>Total production in m3/h</td>
<td>- 3750</td>
<td>3750</td>
<td>3750</td>
<td>3750</td>
</tr>
</tbody>
</table>

**fig. 5.8: Desalination scheme with square meters (Autor 2016)**

- Pre treatment
  - Removal waste and big particles
    - Algae removal and flocculation 250 m2
  - Filtration 400 m2
- Desalination
  - Reverse osmosis 160 m2
- Post treatment
  - Basins for minerals 550m2
5.2.1 Case studies
Desalination plants are mostly located at remote places outside the city. As they are industrial buildings they are not designed to visit them. To come up with a solution to make more them more accessible for the public four different ‘buildings’ are used as a case studies that deal with water but also are, or can be an attraction for the public.

5.2.1.1 Water purification plant Berenplaat, Spijkenisse, the Netherlands
This is the biggest water purification plant of the Netherlands and its buildings are designed by Dutch Architect Wim Quist. The plant is a normal water purification plant and not public accessible but the architecture of the buildings would make it a nice place to visit. Especially the filter house where the flocculation and filtering of the water takes place is designed very well. The roof consists of the twenty concrete shells with small light strips between them. The expression of these columns makes the building much more that only a step in the purification process.
fig. 5.10: Pure functional above to functional and architectural below (Author, 2016)

fig. 5.11: Filterhouse Berenplaat, Spijkenisse, the Netherlands (Architecture guide 2015)
5.2.1.2 Storm drain Tokyo

In Tokyo, Japan lies deep beneath the ground the largest storm drain of the world. It is part of a system with different tunnels and drains that prevent Tokyo from flooding which occurs more frequently through climate change. This happens approximately seven times a year (Nagy, 2015). There are in total five tanks which are connected by six kilometres of tunnels. The main tank is 177 meters long where 59 pillars support the 25 meter high ceiling. The drain is part of an bigger system.

When the drain is not flooded it can be visited by the public. Guided tours are organized where people can learn about the mechanism of the facility and about storm prevention (Hill, 2014). It is a great example where functionality is combined with sustainability.
fig. 5.12: Flood reservoir open for public (Author, 2016)

fig. 5.14: Different use of the flooding system (Nagy 2015)
5.2.1.2 Basilica Cistern Istanbul

The Basilica Cistern is one of the few cisterns in Istanbul that was not demolished during the development of the city in the twentieth century. It was built in the 6th century and was the largest of the many cisterns that served Istanbul. Its name is derived from a huge public square in Constantinople beneath which it was built. The early cistern contained gardens and later was used to store water, to supply the first buildings of Constantinople. During the years it was improved and enlarged and a water filtration system was added.

The cistern is 138 by 65 meters and is nine meters high. The storage capacity of the cistern is 800,000 cubic litres. 336 columns support the ceiling arranged in twelve rows of 28 columns each (Staats, 2015). This strong structure of the cistern and also many other cisterns in the city where used as a base to build other buildings on.
The cistern has been used for different purposes during the years. It was originally designed as a public space for commercial, legal and artistic centres for citizens below the central plaza. It was a cool mysterious place where people could escape the daily chaos of the city (Staats, 2015). When the population of the city grew the underground basilica was used to store water. These days water is produced and stored outside the city. The cistern has become a tourist attraction where people can learn about the history and the function of the space.
5.2.1.5 Conclusion case studies.
The three examples show that buildings that were built as purification plant, flood prevention system and the cistern can also be used as an public attraction. Although the Berenplaat is not open for public the architecture of the building would make them very interesting to visit. The other two cases are not only because of their sheer size interesting to visit but also the story behind the building makes them interesting, the history of the cistern and the flood prevention of the citizens of Tokyo.

Looking at the different diagrams public and water can be combined in one building but it is either in function of it is public. As the desalination is a continuous working process is should be able to work at all times and may not be harmed by the presence of the public. The building or the environment wherein the process takes place should be designed in a way that it is attractive to visit. Architecture and sustainability should be combined. The diagram below is an addition to the diagrams of the Basilica Cistern wherein the reservoir is half in use combined with the people visiting the reservoir.

![Diagram of future scenario where public and sustainability are combined](image-url)
5.2.2 Pool

With the program of the building and the desalination plant the building is able to create awareness amongst the people and learn them about water scarcity but if to make the water part of the society again, as the fountains in the past a final programmatic element can be added.

This element not only has to become social point in the neighbourhood where water is celebrated but it also has to suit the desalination process. With a pool both can be achieved. The water in the pool can be seen as the result of the desalination process. The addition of the pool not only complements the desalination process but also attracts people who might not be interested in the process but only in the pool. With a good routing even people who are not interested awareness can be created for the fresh water challenge.

Two pools that can be used as a reference for this project are the ‘Badboot’ in Antwerp and the Pool in Berlin. They provide a great place to swim within the ‘hot’ city but also have a great connection with the water that surrounds them as the seem to float in the water. Besides the pool they both have dressing rooms and a terrace where people can relax.
5.2.3 Total program

Desalination
- Basin 550 m²
- Osmose 160 m²
- Filtration 400 m²
- Algae and Flocculation 250 m²
- Removal big particles

Institute
- Study rooms 900 m²
- Classrooms 400 m²

Pool
- Pool big 400 m²
- Pool small 100 m²
- Deck 275 m²
- Dressing rooms 150 m²

Laboratory 1400 m²
- Auditorium 300 m²
- Canteen 600 m²
- Offices 500 m²
- PhD workspace 340 m²
- Building service 280 m²
- Reception 147 m²
6. Location
6.1 Location choice

The building will be built in the neighbourhood Kasımpaşa. This is a
neighbourhood in the district Beyoğlu adjacent to the Golden Horn, located in
the heart of Istanbul. The area is part of the old harbour which played an important
economic and military role in the history of the city. As the city grew and ships
became bigger the harbour was relocated to the borders of the city. Currently
most of the harbour area is abandoned and has become an enclave within the
city. It plays no role in the daily life of the citizens anymore and is blocking the
connection between them and the Golden Horn. The theory that city has changed
from a coastal city towards an inland city is clearly visible at this location. Despite
this, it is an unique location within the city. It is very well accessible by car and
public transport and has great views towards the old city centre. By redeveloping
the site and placing a building on the site that connects people with water, the
relation between the water and the neighbourhood can be restored and the
location can become an example of how to deal with the water challenge in
Istanbul.

fig. 6.1: Location of the
project within Istanbul
(Sehirharitasi, 2016)
6.2 History

Kasimpasa is one of the oldest neighbourhoods in Istanbul that has a strong naval tradition. The shorelines of the neighbourhood have always been the harbour of Istanbul because of the perfect natural circumstances. (Erkök, 2009). In the time of the Ottomans marine ships where produced and maintained on these shores. The harbour had its peak in the 16th century. It was home of 120 ships of the navy. During the years the demand for more space grew. At the chosen location for the project there used to be a river that flew into the Golden Horn. As more land was needed for the extensions of the harbour the river was dampened. After the declination of the Ottoman empire only a small part of the harbour was kept in use were small cargo ships and ferries are being repaired.

The Turkish Naval High school was founded in 1773. They where housed in Kasimpasa in the since 19th century. Today the headquarters of the marine is based in an monumental villa at the chosen location and an old barrack is used to house the marines. The old villa was originally the seaside mansion of the Camondo family, a family of bankers that can be seen as one greatest bankers of the Ottoman empire (Tomaseli, 2012).
fig. 6.3: Project location in 1613 (Author, 2016)

fig. 6.4: Project location in 1780 (Author, 2015)

fig. 6.5: Project location in 1920 (Author, 2016)

fig. 6.6: Project location in 2016 (Author, 2016)
6.3 Characteristics

The Kasimpaşa neighbourhood is a very lively area. It has a vibrant street life and is home to the football club Kasimpaşa SK. It is a relative poor area and one of the few neighbourhoods in Istanbul that are not yet affected by the gentrification process that can be seen everywhere in Istanbul. This is a process where the urban poor are forced to move out their house because they are being replaced by mega projects like shopping malls and other commercial buildings. There is still that old vibrant street life that has been lost in other locations in the city.

It is very clear that the relation that the city once had with Golden Horn has been lost. They entire harbour area is surrounded by fences and thereby separated from the rest of the city. At the location a park has been made but even here fences form a dominant feature. The military villa and the barrack form two islands that interrupt the morphology of the neighbourhood and almost can be seen as two enclaves within the neighbourhood.
fig. 6.8: Separation between harbour and neighbourhood (Author, 2016)

Legend
- Barrier of fences

fig. 6.9: Barriers at project location (Author, 2016)
**Fig. 6.10**: Barriers at project location (Author, 2016)

**Fig. 6.11**: Headquarters
Navy villa
(Author, 2016)

**Fig. 6.12**: Barrack
(Author, 2016)
6.4 Golden Horn

The water of the Golden Horn will be the resource that will supply the city with fresh water in the future. It is an estuary of the Alibeykoy and Kagithane rivers that flow into the Bosphorus. The effects of the rapid growth have also affected this area. It used to be a piece of water that supported the thriving fisheries of Istanbul. During the rapid growth Istanbul Industrialized rapidly and the shores of the Golden Horn became an important industrial area. This toxic waste of these activities transformed the Golden Horn a dirty place within the city. In the sediments of the Horn many metals like zinc copper and lead where found. In the industrial heydays there were more than 700 industrial sites and 2000 businesses that not only polluted the Golden Horn itself but also produced a smell that was smelled in great parts of the city (Leeuwen, 2015)

In 1994 the Istanbul Metropolitan Municipality and ISKI started with the environmental rehabilitation of the area. The fish pollution was brought back from almost zero to 33 different species and the amount of bacteria was brought back from 350,000 per 100ml to 1000 per 100 ml. The estuary s now possible to play an important role in the city again. 'It has regained a lost sense of cultural identity' (Leeuwen, 2015). Although it is ready to play an important role in the city again there are, as read above, many barriers between the chosen location and the Golden Horn.
fig. 6.14: Contamination
Golden Horn (Author,
2016. Data Nelleman
and Corcoran, 2010)

fig. 6.15: Contamination
Golden Horn (Author,
2016 Data Nelleman and
Corcoran, 2010)
7. Building design
7.1 Masterplan
7.2 Translation of the desalination process
7.3 Drawings
7.4 Visualizations
7.1 Masterplan

7.1.1 Architectural office Teget

North of the project location the harbour continues in the Camıaltı and Taşkızak shipyards. This area will be transformed by architectural office Teget. During the study trip Teget was visited and architect Gökçen Erkılıç explained their approach to the location. Instead of transforming it into a park as has happened with most other locations alongside the Golden Horn, they want to preserve the historical value of the area. The site was of great value for the city. The craft of ship making was learned in the harbours and is was an social hub within the city. Today the area is abandoned but many old buildings are preserved which creates many opportunities for the future. Teget will open up the area for the public and make it part of the city again.

‘This potential set of values of the shipyards of this monumental fabric is the prime source of inspiration to the masterplan and strategies of preservation and revitalization of the site. It also bears the challenge: The site will be open to public and civil use as an urban fabric for the first time in its history with the masterplan development’ Teget (2015).

The area that they will redevelop is marked with the black line in figure 7.1. Their principles are continued in the project location which is the area with the red line. The building of the navy is for Teget and barrier were there plans end. As this is a fictive project it is possible to make the decision to move the navy to another location which makes it possible to continue Tegets masterplan. Their principles are used for the statements made new masterplan. This will create one area that is open for public and can again become an important place in the city.

The information about the area was very basic. It was possible to get their analysis of the area and the main principles that they want to apply but the actual plans are still confidential and not yet made visible for the public. Therefore it is hard to say how the actual plan will look like but with their principles is was possible to create an plan for the project location that at least on a large scale suits the plan of Teget. The figures on the next pages show these different principles and how they are interpreted and continued.
fig. 7.2: Industry at the Golden Horn (Teget, 2015)

fig. 7.3: Abandoned shipyard Golden Horn (Author, 2016)

fig. 7.4: Abandoned shipyards Golden Horn (Author, 2016)
7.1.2 Design principles

7.1.2.1 Connections with the neighbourhood

The area is surrounded with roads and high walls which are boundaries between the neighbourhood and the shipyards. According to Teget permeability of the shipyards by opening them up to the surrounding neighbourhoods is essential to connect the area with the city (Teget, 2015). These vertical connections that penetrate the shipyards are connected by a pedestrian boulevard that runs through the whole area. This boulevard is continued alongside the villa of the navy and partly through the old shipyard. The vertical connections that Teget creates are also used to connected the location of this project.
7.1.2.2 Pedestrians and public ground floor
The masterplan is made in favour for pedestrians. Besides the main pedestrian paths with the vertical connections the whole area is made accessible for pedestrians. Most buildings on the site will have a commercial ground floor that is open for the public. By doing this the area becomes more permeable and is completely accessible for the public (Teget, 2015). The project location is approached in the same way. The ground floor of the barrack will opened up and the navy villa also will be made public. This principle will also be used for the new building of UNESCO-IHE.

fig. 7.6: Pedestrians with perpendicular connections (Author, 2016)
7.1.2.3 Functions

The goal of Teget is to create an area were different classes of the society and people with different interests meet each other. Therefore are program is created with a mix of different functions (Teget, 2015). The main goal of the program is to support the open spaces such as squares, concert area’s and market places. At the project location the navy will be relocated because they do not fit in the location anymore and with the plan of Teget they will form even a greater barrier. The fences that separate the villa and the barracks of the neighbourhood will be removed and the shoreline will be opened up. The existing park will be connected to the green area that surrounds the mansion and to waters edge. The villa will be refurbished into a maritime museum and the barrack will become a market with

![Diagram of functions](Image)
apartments or student housing on the upper floors. The building for UNESCO-IHE is placed on the vertical axis alongside the old villa which will continue the axis into the water.
7.1.2.4 Vegetation
Instead of transforming the harbour in a park as has happened at other location alongside the Golden Horn, Teget uses vegetation to accentuate their main pedestrians routes. This will also be done and the projects location. The existing park will be connected to the park that surrounds the villa. In this way the green accentuates the old buildings within the area instead of becoming the dominant feature in the area.
In the image on the next page the building can be seen within the masterplan on the axis of the road above and next to the old military building.
7.2 Translation of the desalination process

The desalination scheme is used as a base for the design of the building. The different steps are placed behind each other and positioned on the pedestrian axis of the neighbourhood. The size of the steps together with the position within the masterplan determined the shape of the building. By creating a public ground floor this axis is extended into the water which will restore the connection between the neighbourhood and the water. The desalination process is located within this public ground floor which will make it visible for visitors. As a last and final step the pool is added. The desalination process is in this way ‘celebrated’ by the clean water of the pool.

For the design of the building a quote from the book Water and Architecture is used.

“Architects use materials and forms to communicate ideas. When we make places that include water in our designs, we cannot ignore the role that history and symbolism play in fortifying connections among people, water and nature” (Moore, 1994)

This is an important aspect for the design as sustainability is not only a technical challenge but also has a social aspect. The area where the desalination takes place is therefore designed with a reference to the water history of Istanbul. As written before one of the last remaining water features within the city is the Basilica cistern. By making a reference in the design to the old cistern the connection between water and the people who visit the building will become stronger.

This reference is made by using two different aspects of cistern. The first is by using the public ground floor as a base for the research institute. Cisterns created flat surfaces in the city that were used as the foundation for buildings.

This second reference is made with way the ground floor is designed. The old cistern is translated into a modern version with concrete arches instead of columns. The sizes of the different steps in the process have determined the size of the arches. Different options of how the arches could be divided were made during the design process. The first option has arches that become bigger towards the end of the process. This enhances the cleaning of the water by bringing more light into the space. Through the arches runs a footbridge on one side that allows visitors to walk over the process. In the second option a diagonal pathway was added made to make the space more interesting. In the third option the size of the different steps is used to determine the size of the arches. Each step was divided into two arches. This creates a stronger relation between the shape of the arches and the desalination process. The first option is chosen as it enhances the cleaning process by bringing more light into the space through the bigger arches. With the pathway on one side the process is more clear for the visitors than with the diagonal pathway that divides the process in to two different sides that are the same. The third option is the most direct translation of the desalination process but as the size of the first and fourth step, and of the third a fifth step are almost the same, the design indicates a repetition within the process which is not the case.
Translation of desalination scheme into building shape

**Fig. 7.10**

Desalination as a foundation with institute on top (Author, 2016)

**Fig. 7.11**

Removal waste and big particles
Algae removal and flocculation
Filtration
Reverse osmosis
Basins for minerals

Pre treatment → Desalination → Post treatment

Pool

Research Institute

Desalination → Pool
The chosen option is visible in figure 7.13, with the different steps of the desalination process. With the footbridge the different steps can be seen. This bridge is placed on this side of the process because the view on the military mansion. Visitors of the pool and the students of the institute will both use this same bridge. These two flows of people are on purpose not separated to create interaction between them. At the end the students go to institute on the first floor by using the stairs that is also a ‘tribune’ for the pool. At level -1 the dressing rooms for the pool are situated.
fig. 7.12: Option arches
(Author, 2016)
The diagonal line of the main stairs is continued into the institute and used as a key driver for the design of the institute. By continuing this line a visual connection between the pool and the institute is created. Pool visitors are able to see the research that is happening within the building. The line is accentuated by the auditorium that is placed above the main stairs.

The diagonal line is continued with the stairs of the institute. The line starts at the ground floor of the institute and ends at the roof of the building. With a glass floor at the ground floor of the institute visual connections are made between the institute and the desalination process.
7.3 Drawings

7.3.1 Sections
In the sections the separation between the two parts of the building is clearly visible. The lower part forms the base on which the institute is build. The different steps and how the size of the arches are based on these steps is visible in section BB' and CC'.

The diagonal line from the main stairs at the ground floor, that is continued into the stairs of the institute all the way to the roof of the building can be seen in section CC'. Around this main design element the building is designed which can be seen in section AA'.
7.3.2 Floorplans
Basement

Underneath the desalination process a lab is created where the desalination process is monitored and can be improved. The dressing-rooms with toilets and showers for the pool are also housed on this floor. The connection between the basement and the other floors is made by an elevator and emergency stairs.
fig. 7.22: Basement

(Author, 2016)
Ground floor

fig. 7.21: Ground floor 3d
(Author, 2016)
fig. 7.22: Ground floor

(Author, 2016)
First floor
A big atrium with the reception at the first floor provides a great view to the old mansion. The main classrooms are situated in the back of the building away from the noise of the pool. Smaller classrooms which can also be used by groups of students are situated along the east facade of the building.

fig. 7.23: First floor 3d
(Author, 2016)
fig. 7.24: Floorplan first floor (Author, 2016)
Second floor
On the second floor the auditorium is located with a foyer. The terrace in front of the auditorium will not only block the sun but also gives a great view over the Golden Horn. Also the main lab is located on this floor. It is not only accessible from the hallway but also direct from the laboratory on the first floor.

fig. 7.25: Second floor 3d
(Author, 2016)
fig. 7.26: Floorplan
second floor (Author, 2016)
Third Floor
On the third floor a PhD workspace, offices and an study area are situated.

fig. 7.27: Third floor 3d
(Author, 2016)
fig. 7.28: Floorplan third floor (Author, 2016)
Fourth floor

At the fourth floor also PhD workspaces, offices and study area are created. Above the auditorium the canteen is made with an great view over the Golden Horn. Between the foyer on the third and second floor a direct connection is made with which makes it possible to enter the canteen directly from the auditorium.
fig. 7.30: Floorplan
fourth floor (Author, 2016)
7.3.3 Facade

The facade of the building is made fully transparent which makes it possible to see the research that is conducted within the building from the outside. By making the facade of top part of the building completely of glass the contrast between the base and the top part becomes more clear. The solid base is the foundation for the light top part. But by doing this the climatological circumstances of Istanbul have to be taken into account. Therefore with a second skin the sun is blocked. This skin exits out of glass lamellae that can tilt and block the sun at different angles.

The facade of the building also creates a great opportunity to brand the water even more. An example of a building uses the facade for the same purposes is the BMW pavilion of Serie Architects in the Olympic Parc in London. This pavilion was used to brand BMW's hybrid vehicles. The building not only showed the new cars to the visitors of the Olympics but also cleaned the water of the river in which it was located. A small amount of this water was used for a waterfall that runs down the facade. This not only brands the water as a fuel for the cars but also cooled the environment through evaporation.

The facade of the building for UNESCO-IHE is also used as a branding element by cascading water over the second skin. In this way not only the process in the ground-floor and the pool will brand the importance of the water but also from the outside the water is made visible. Just as in London, the water will cool the facade and thereby the building. The evaporation of the water will also cool the surroundings of the building. This effect will be even greater with the climatological circumstances in Istanbul. This system will not be active all day but can be used when it is really hot or during special events to brand the building.

The columns and the arches play an important role in this as they will transport the water from the basement to the roof. The water is collected in a big gutter which makes it possible to reuse the water. The gutter is not only an important element in this process but also creates a clear line between the ‘foundation’ and the top part of the building.
fig. 7.32: South facade
(Author, 2016)

fig. 7.33: North facade
(Author, 2016)
fig. 7.34: West facade

(Author, 2016)
fig. 7.35: East facade
(Author, 2016)
7.3.4 Section 1:20

The section in figure 7.33 shows the principle of the facade. Water is pumped from the basement to the roof from which it runs down the facade. The cleaned water of the desalination process is used for this as this is very clean an will leave almost no traces on the facade. The columns are used to transport the water through the concrete columns into the steel columns to the roof. Here water is collected on the edge on the roof and will cascade downwards by the slope that is created. In a gutter it is collected and as it will collected dirt and salt form the facade the water is returned to the first step of the desalination process. Also rainwater that is captured on the roof will flow down into the gutter and can be added to the desalination process to produce freshwater.
7.4 Visualisations

7.4.1 Exterior
Building by night
Water facade
Water facade by night
7.4.2 interior
Entrance of the building with old military villa that will become a maritime museum according to the masterplan.
Public ground floor with the desalination process which is visible from the bridge
Desalination process
Mixing zone with the pool area and the stairs to the institute.
Main entrance with the main stairs that also is a tribune for the pool
Visualisations Interior
View towards the process from the institute
Stairs that create the diagonal sight-line with the different see connections to the process.
Smaller classrooms on the left and laboratory on the right
8. Conclusion & Reflection
8.1 Conclusion

The goal of the studio was to overcome the controversies of Brand and Sustainability within an architectural design. The building designed in this project was an research institute for the UNESCO-IHE. The sustainability challenge that was dealt with in this project was the scarcity of fresh water that Istanbul is facing. This challenge came forward during the preliminary research and after further research into this subject, the importance to solve this primary human need, became the key driver of this project. Looking at the history of Istanbul together with its geographical conditions and the theories of Girardet and Steel, desalination came forward as the technique to solve this challenge. This technique resulted into the first research question that tries integrated sustainability in the design;

’How can the desalination process be translated into architectural elements for the UNESCO-IHE Institute in Istanbul?’

During further research not only the technical aspect of the challenge but also the social aspect of the challenge, the demand side, came forward as important to ensure a continuous supply for the future. This resulted in a second research question:

’How can the UNESCO-IHE Institute be used to promote water as a vital element amongst the citizens of Istanbul?’

The building is a result of both questions. At the location in Kasimpasa the neighbourhood used to flourish due to its relation with the Golden Horn, but this relation has been lost over time. With the building and the principles of the Masterplan of Architectural office Teget the shoreline is opened and the relation with the water is restored. The shape of the building is a direct translation of the process. The different steps are placed in line which creates an pier. This pier is build in the water which makes the connection with the water even stronger. A major challenge was how to ‘translate’ a process that normally is not designed for visitors, into a building or place that is attractive for people to visit. This is achieved in different ways. The process has been made visible by placing it in the public ground floor were from a bridge that runs over the process the different steps can be seen. This ground-floor is shaped with a reference to the past by referring to the old cisterns of Istanbul. Instead of using the traditional columns concrete arches are used which are shaped by the size of the different steps. As the water becomes more clean the arches increase in size which enhances the process by bringing in more daylight. To attract people to the building at the end of the process a pool was added which can be seen as the final step of the process were the clean water is celebrated.

The different steps not only created the shape of the ground floor but also resulted in the shape of the institute that is located on the floors above the ground floor and in the basement below the process. The structure created by the arches is used for the grid of the institute. In the past the cisterns were not only used to store water but also were a good foundation in the hilly city for other buildings. This function is enhanced in the building by using different materials for the groundfloor and the institute on top. As the groundfloor is made of heavy concrete arches for the institute light transparent materials are used.
The students of the institute use the same bridge as the visitors of the pool to enter the building which will create interaction between both groups. Form the point where they separate a visual connection is made between the institute and the ground floor. In this way the visitors not only are able to see the desalination process but also the actual research. This connection became a key design element for the institute. A connection between the process and the institute is made by a glass ground floor.

The facade of the building is used to brand the water by creating a water curtain that runs down the facade. Besides being a branding feature is will also cool down the building as well as the environment through the evaporation of the water.

8.2 Reflection

It was a difficult challenge to design a building that deals with the controversies of sustainability and brand within architecture. During the graduation studio I first of all focussed on the story and the four elements, Brand, Sustainability, Program and Location. I spend many hours on how the connection between the different aspects could be made. This led to a very strong concept but I struggled with the translation of the concept into a building. By using the history of the city which also suits the brand very well, together with the desalination gave me many opportunities. The design of the groundfloor with the view on the process as the driver for the shape turned out very well but I struggled with the translation of the desalination process into the institute part. I really wanted to use the desalination process for every decision in the design. I for example tried to make floorplans that would work as a filter or with a program based on the steps in the process below. This resulted in a good translation of the process but did not lead to a good research institute. Therefore the focus was shifted in making a good section that would suit the program of the school, and within this section relations with the process where made. This led to the diagonal which created the connection between the process and the institute. The facade might have been the most challenging aspect of the design. The water that runs over the facade can be seen as a cliché solution but taking the branding aspect into account I am convinced this suits the project very well. In the end I am a satisfied with the result. During the studio I learned a lot about sustainability and its relation with architecture, a subject which I would like to learn more about in the future.
9. Bibliography
9.1 Literature

Chapter 1:

Chapter 2:

Chapter 3:
Chapter 4:

Chapter 5:

Chapter 6:
9.2 Images

**Chapter 2:**

Fig 2.2 Theory Cities


**Chapter 3:**

Fig 3.1: Basilica Cistern

Fig 3.2-3.9

Fig 3.10 Drought in current reservoirs

Fig 3.12 Inhabitants and water production Istanbul

Fig 3.19 and 3.20 Desalination plants

**Chapter 4:**

Fig 4.1-4.4 UNESCO portfolio’s

**Chapter 5:**

Fig 5.1 Removal big particles
Flocculation

Filtration

Reverse osmosis

Fig 5.9 and 5.11 Berenplaat Wim Quist

Fig 5.12 and 5.13 Storm drain tokyo

Fig 5.15 Basilica cistern, Istanbul

Fig 5.18 Pool Berlin

Fig 5.19 Badboot Antwerpen
Chapter 6:
Fig 6.1 Location

Fig 6.2 Camondo Mansion

Fig 6.13 Golden Horn in time of the Ottomans

Fig 6.14 and 6.15 Contamination Goldenhorn

Chapter 7:
Fig 7.2: Industry at the Golden Horn

fig. 7.29: BMW-Pavilion London