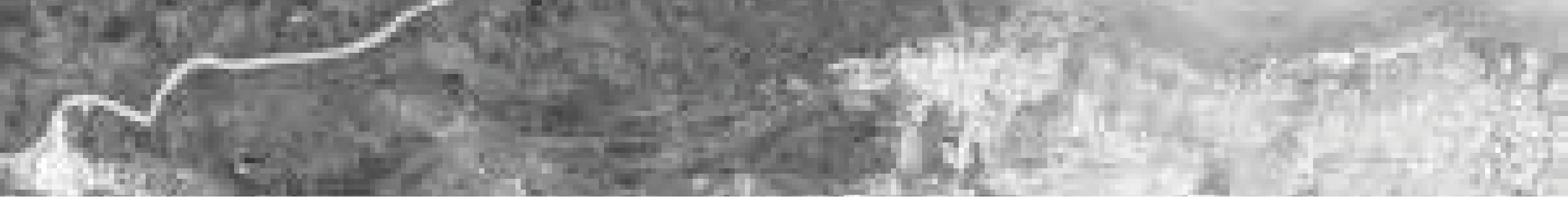

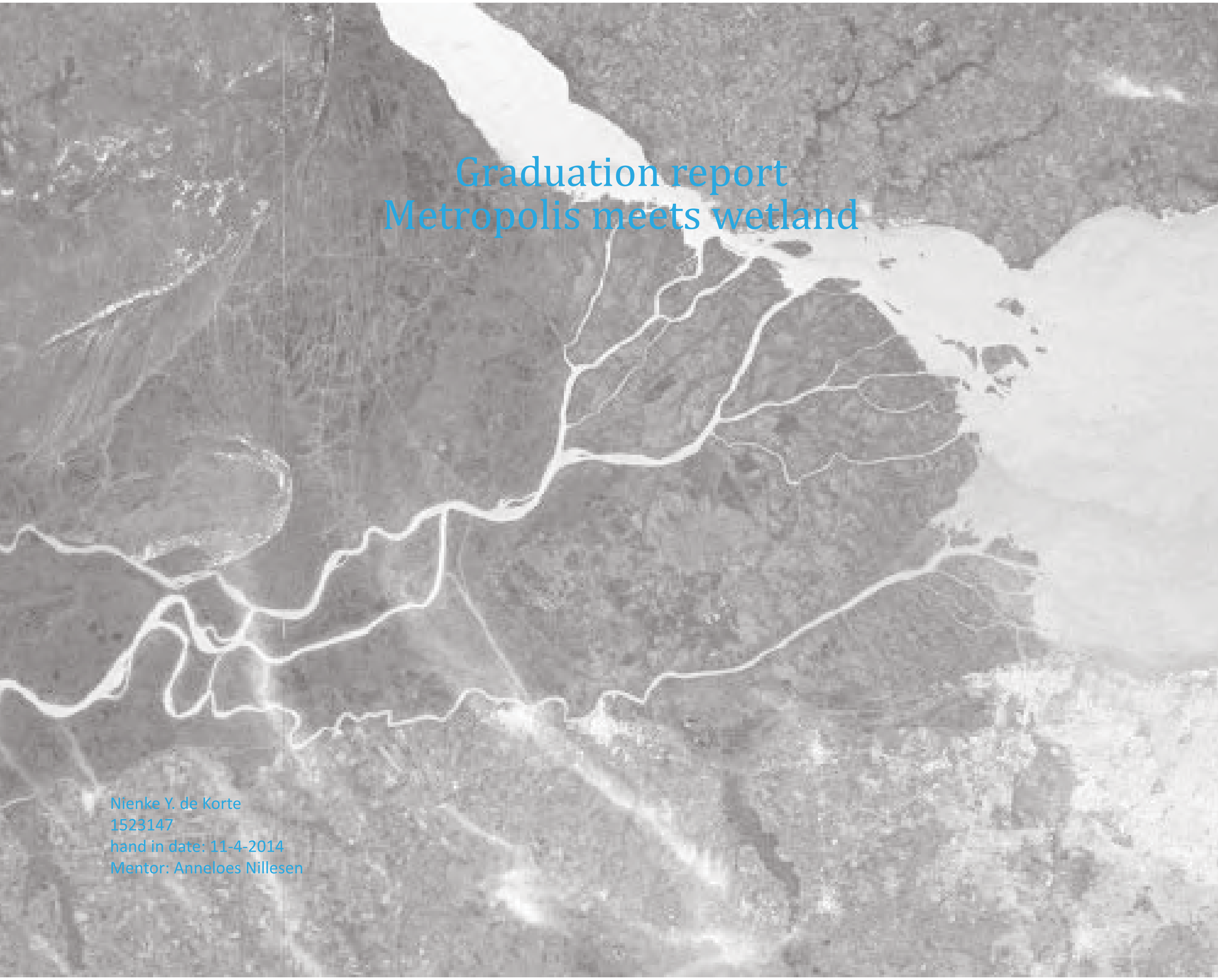

Graduation report
Metropolis meets wetland

Nienke Y. de Korte
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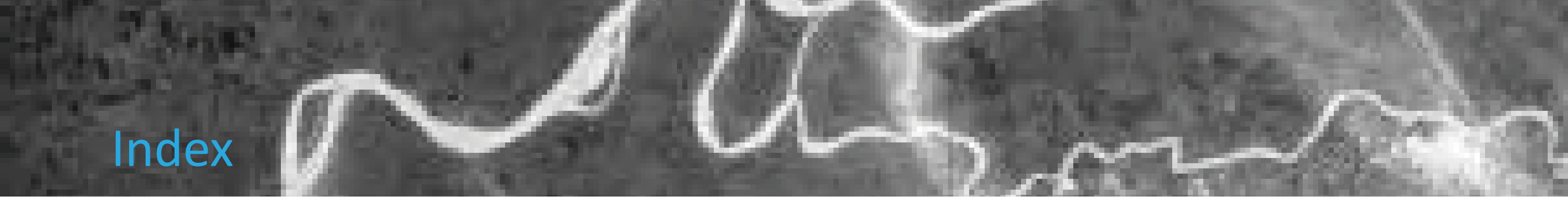
hand in date: 11-4-2014
Mentor: Anneloes Nillesen



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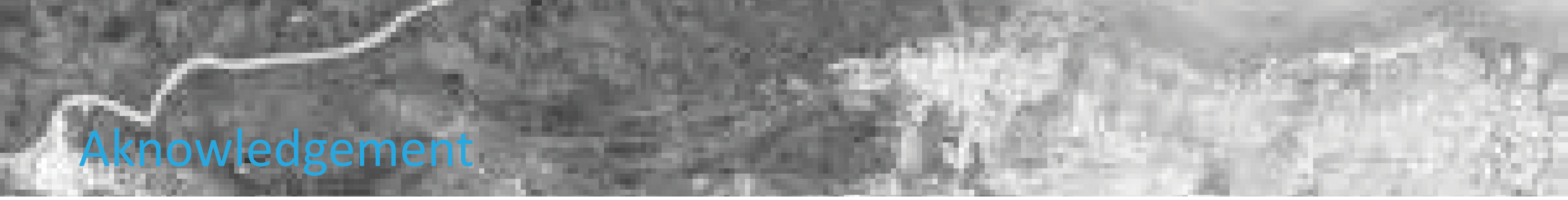
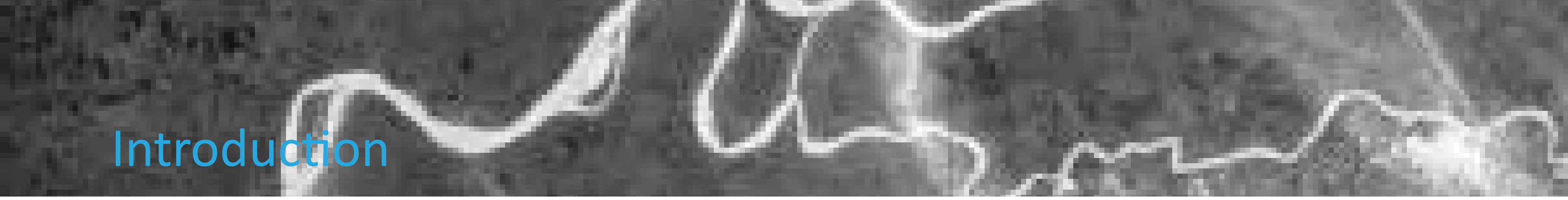


Aknowledgement

Here by I like to express my gratitude to my mentors Anneloes Nillesen, Maarten Meijs and Diego Sepulveda Caroma for leading me through my graduation process.



Introduction

This graduation report is part of the Delta Interventions Msc4 and focuses on my process done during the graduation process of the delta intervention studio. In this studio students are free to choose their own fascination / subject in relation to flood risk design or designing with water.

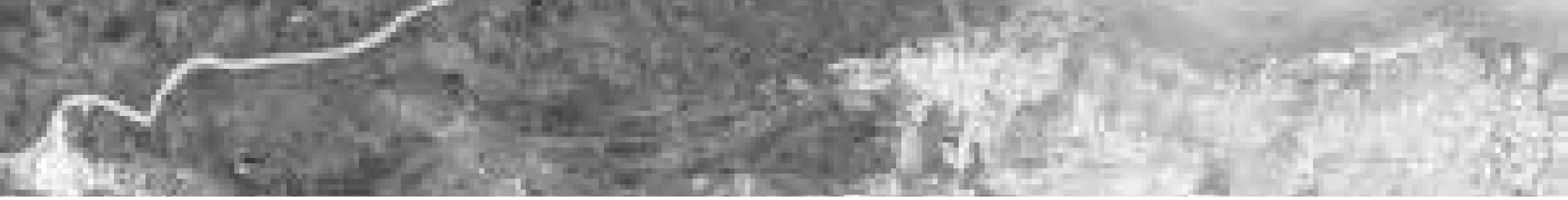
Within the Delta Interventions studio there is a strong link in between research and design. From the research and analyses we will derive insights of aspects related to flood risk into tools relevant for water related design.

This report is a research report in which the debate and flood risk task in the Parana delta of Argentina is discussed by research and reflections of the own design, case studies and literature. Insight in the topic of flood risk and its relation to aesthetic and technical / functional requirements for the architectural design brief is showed. Besides an overview of architectural design tools addressing aspects of aesthetics / technical / functional requirements of flood risk is discussed.

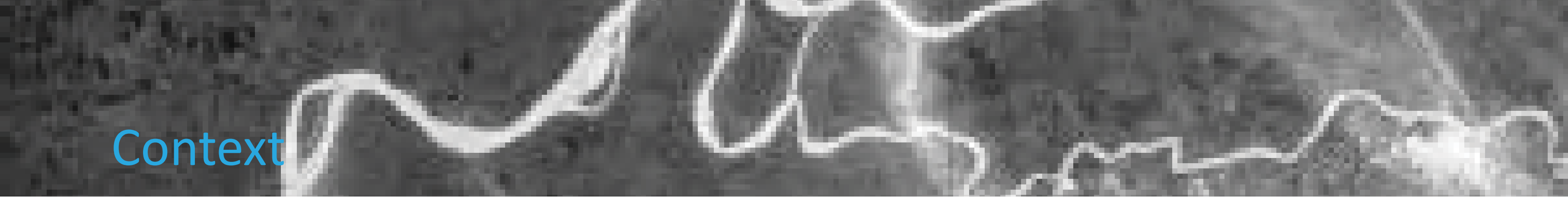
(text partly out the course base of Course AR3A160 Aspects of water-related design)

The methodology used in this report are Case study analyses, Research by design and research by literature study.

The report consists out different parts, all addressing other specific design issues. The major part of my process is showed in this report



1. Context



Context

Many coastlines of many countries over the world consist of Deltas. These Deltas are a useful vain of transportation. At the water front of the delta different functions are situated, harbours, industry and dwelling in the form of shanty towns and communities for people with a higher income. The whole waterline is a scope of different atmospheres because of the different stakeholders with their different needs. A delta which stands in this this position is the Tigre delta of Argentina. The Parana delta is one of the biggest deltas in the world as showed in fig. 1. In fig. 3 is showed that this Parana delta is located between Argentina, Uruguay and Brazil. The location chosen for the project is the coastal area of the Parana delta and the Argentine side. The coastal area reaches from Rosario to Buenos Aires as can be seen in fig.3.

The Tigre delta is the lower delta of the Parana delta which is the intercontinental transportation route from the amazon to through the border of Uruguay and Argentina to the Atlantic. For this the area is an important economical part of South America.

Metropolisation of the Parana Coastline

My interest are these parts of the delta coastline where new communities are built due to the metropolisation of the Parana delta coastline. 75% of the population of Argentina lives in this coastal area. In the upcoming 50 years the population will even increase with 150%, see fig.2 This has to do with the economical movement in Argentina.

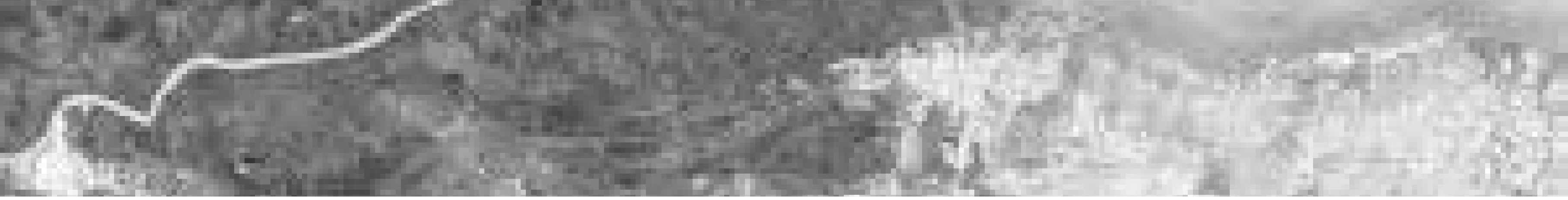
Because of the change of livestock holding to cultivating soybeans in the pampas area, many farmers leave their land and move to the metropolitan area of Buenos Aires and Rosario to find a job in other sectors. This economic movement, which important source of the metropolisation of the Parana delta Coastline. Migrants moving from areas with a lack of economic opportunities to the metropolitan area. They occupy the cheap, free land and built their own settlements, fig. 4. These new communities from the lower middle class, have to cope with bad living conditions. The areas where they settle are mostly part of the floodplain area of the Parana Delta which might be dangerous during heavy rainfall and harsh South-East winds. The people built their houses with local material and do not take the flood risks into account. With the result that during a flood the houses will flood and the people will lose their belongings. For that I think it is very important to come with a housing prototype which is affordable for the lower middle class which solve these problems of hygiene, economic possibilities and flood risk.

Communities

The last years many gated communities are built at the coastline of the Parana delta of Argentina. Building in communities has its positive sides. I see a community as a group of people which feel responsible for each other's wellbeing. For that I understand the concept of the gated community. The inhabitants of the gated community share some facilities such as sport or recreational areas. Besides the gate and the security guards of this community provides safety for all the inhabitants of the community. But I think that gated communities increase the segmentation of cities because with their fences they separate different part of a city from each other as said in the Final Booklet of the Tigre delta made by the studio of Global Housing. With that they separate the interaction of the different group of people which might increase several problems between these different classes of people. I do not agree that is the perfect way of designing a community. In the research I made about communities appendix 1, I separate different types of communities in gated communities, communities formed by routing, communities formed by a cluster, communities which share a semi-public space and communities which share a collective space. The idea of this categorization is that all these communities are formed by a common aspect. Because of this common aspects people will feel responsible for that aspect and with that they will feel more responsible for each other.

The counter side of these communities is that these communities are mostly built at reclaimed land. For that they changed the natural layer of the Parana delta. With dams, dikes and increasing the land with sand, new land is made. These gated communities ignore the natural system of the delta which may occurs problems for the ecological system of the delta. During a flood the water of the delta's rivers might not have enough space because of reclaims of the land. For that the river will get out of its slopes and the urban settlements will flood. The flood might be even worse than without the dams and the dikes because the water can't get out of this closed area.

Other counter is bad access to and from the different communities but also the access to and from the delta. Gated communities and informal settlements exclude public access. Some of these gated communities have their own water protection in form of a dam or wall. But instead of protection this only occurs more risks. A walled gated community will be more at risk when the water level reach the height of the wall and floods the enclosed area. The whole enclosed area will have more damage than without wall because the water can't leave. (E.C.



wall because the water can't leave. (E.C. Penning-Roswell, 1996) Besides dams might protect a part of the area, but it will increase problems in other parts of the delta. An example of this has to do with the Itaipu dam, fig. 8. This is a hydroelectric dam which regulate the water stream of the Parana River. But the ecological and hydrological system of the delta needs these floods and streams to function optimal (R.C. Volpe, 2013) Because of the draught and leak of water, there is more erosion in the area which damage the ecological environment. Besides many fish and mammal species and plants depends on the dynamics of the waters of the delta. The dam provides energy but brings a lot of other ecological and environmental risks with it.

According to Fabricante twenty-tree new urban settlements such as gated communities, residential and touristic projects end extension of the urban environment are build or planned between Buenos Aires and Rosario. This pictures the scale of development in this metropolitan area and with that need of planning and design of the new built projects. Now we come at a second problem, the management of the Parana delta. Because the management of the Parana delta includes many different stakeholders, from private till governmental with all their own responsibilities, the management of this Parana delta is rather complex. This is also the reason why there is such a bad management for this area. The definition and public awareness of the flood risk is ignored due to the lack of information provided by the governments, which makes the people vulnerable for the hazards. The planning of the flood affected areas gets political. Local landowners, industrialists and other stakeholders will dominate these discussion. The problem in this area is the bad regulation

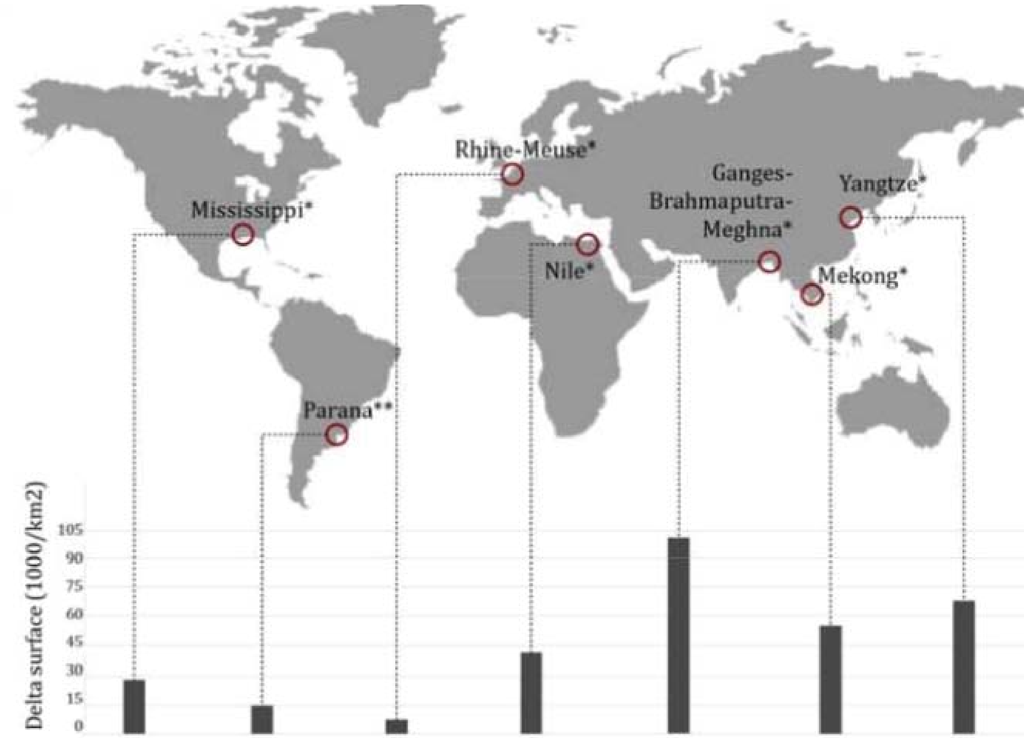


fig. 1., Deltas, Delta Alliance (unknown)

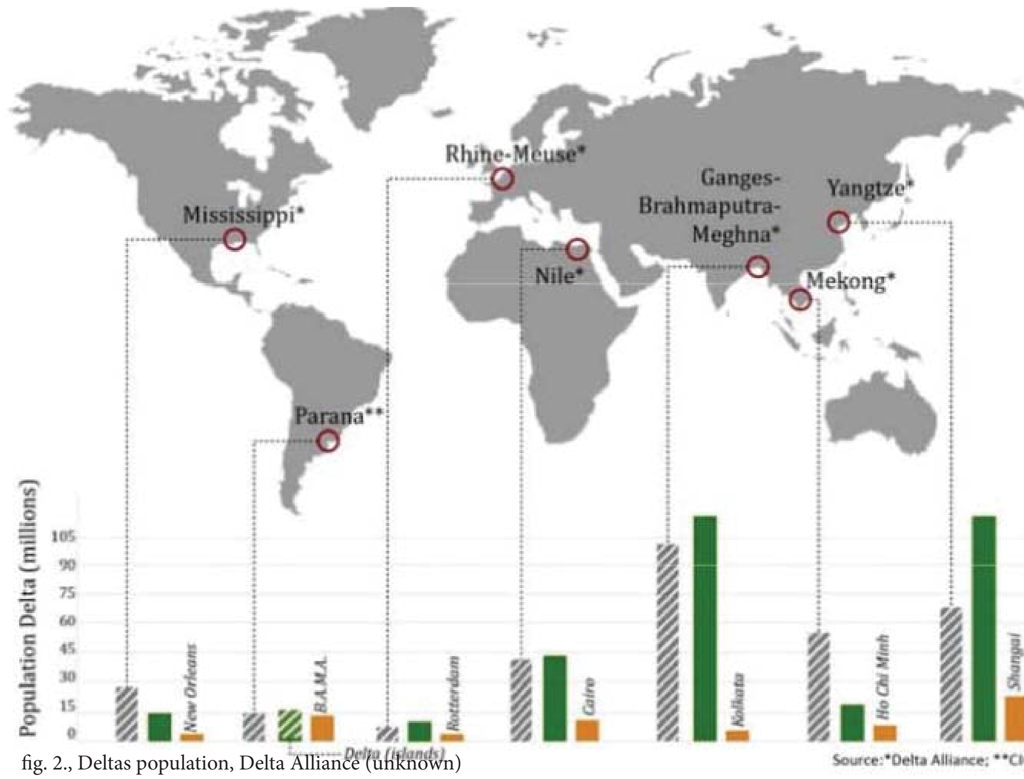
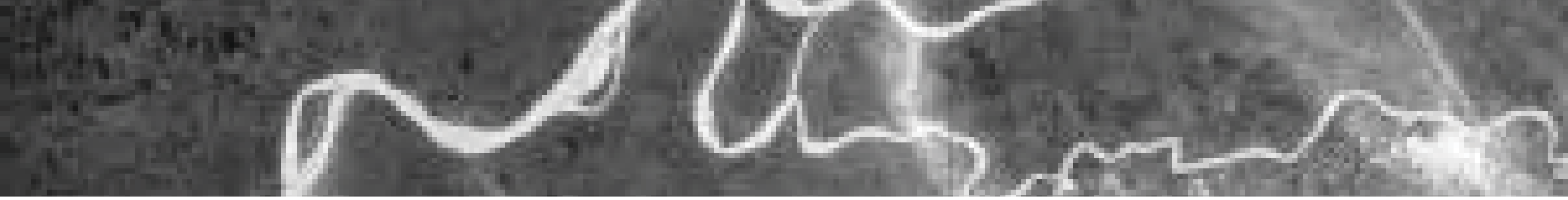


fig. 2., Deltas population, Delta Alliance (unknown)



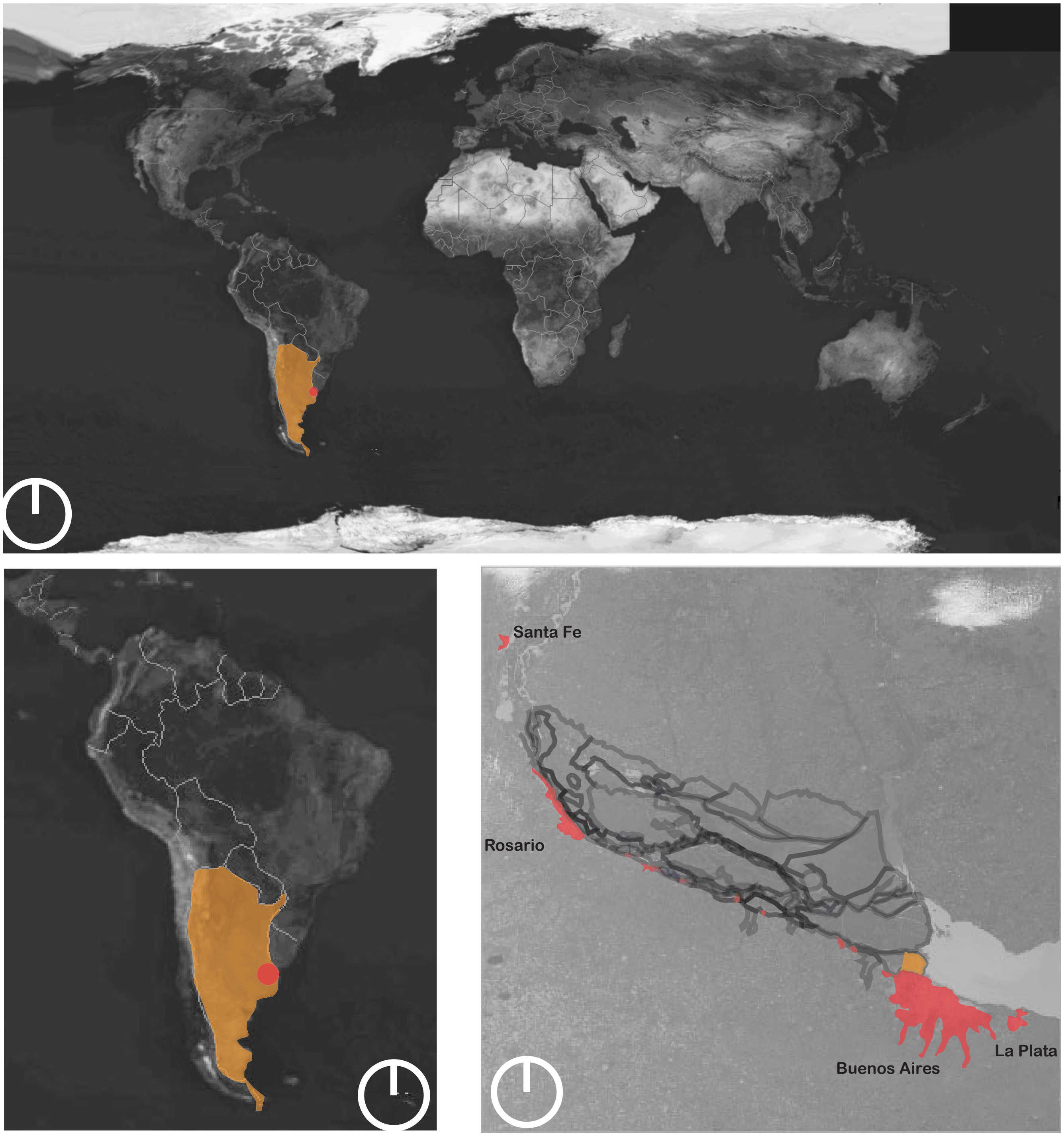
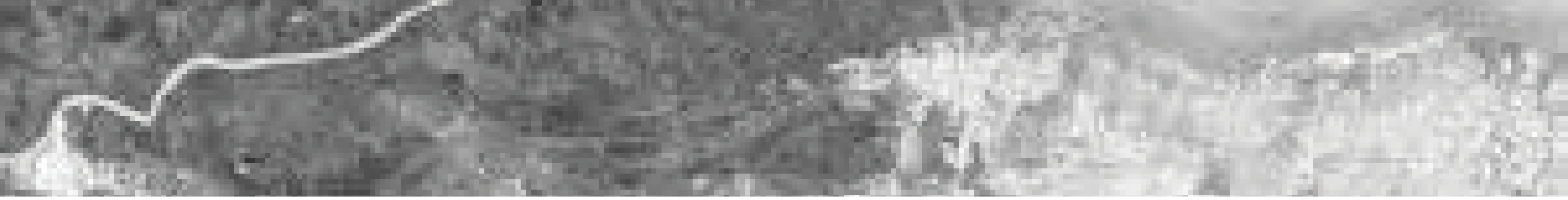


fig. 3., Location, Own work (2014)



between the stakeholders of the area. Many stakeholders are involved and there is not an overarching community which is in charge of the wellness of the delta environments. That means that the delta is not taken care of and not only the ecological system is in danger but also the belongings and lives of many people living in this area (E.C. Penning-Roswell, 1996That means that the delta is not taken care of and not only the ecological system is in danger but also the belongings and lives of many people living in this area (E.C. Penning-Roswell, 1996).

For that I think a good start for the planning of all these new urban settlements will be an integral management system of strategies for this delta between the different stakeholders. In that way you explore the diverse interest within a common delta plan and can research divine a type of housing development in this specific delta.

These gated communities are mainly build for the higher income class of Argentina. As said before, there is a demand for social housing for the migrants of the lower middle class.

Vunerability

The Parana delta is a vulnerable, growing delta. This means that due to sedimentation of the river new land is formed in the Rio de la Plata. This new land will reach Buenos Aires within 80 years (it grows 50 till 100 meters a years), fig. 9. This means new possible opportunities for the use of this lands. The Parana delta is a dynamic natural environment. It changes because of the dynamics of the changing meander of the rivers and the sedimentation. This new land means new opportunities for living in the delta and its coastal area. At the moment, as said before, the coastal area is closed by the informal settlements and gated communities. No connection to the delta

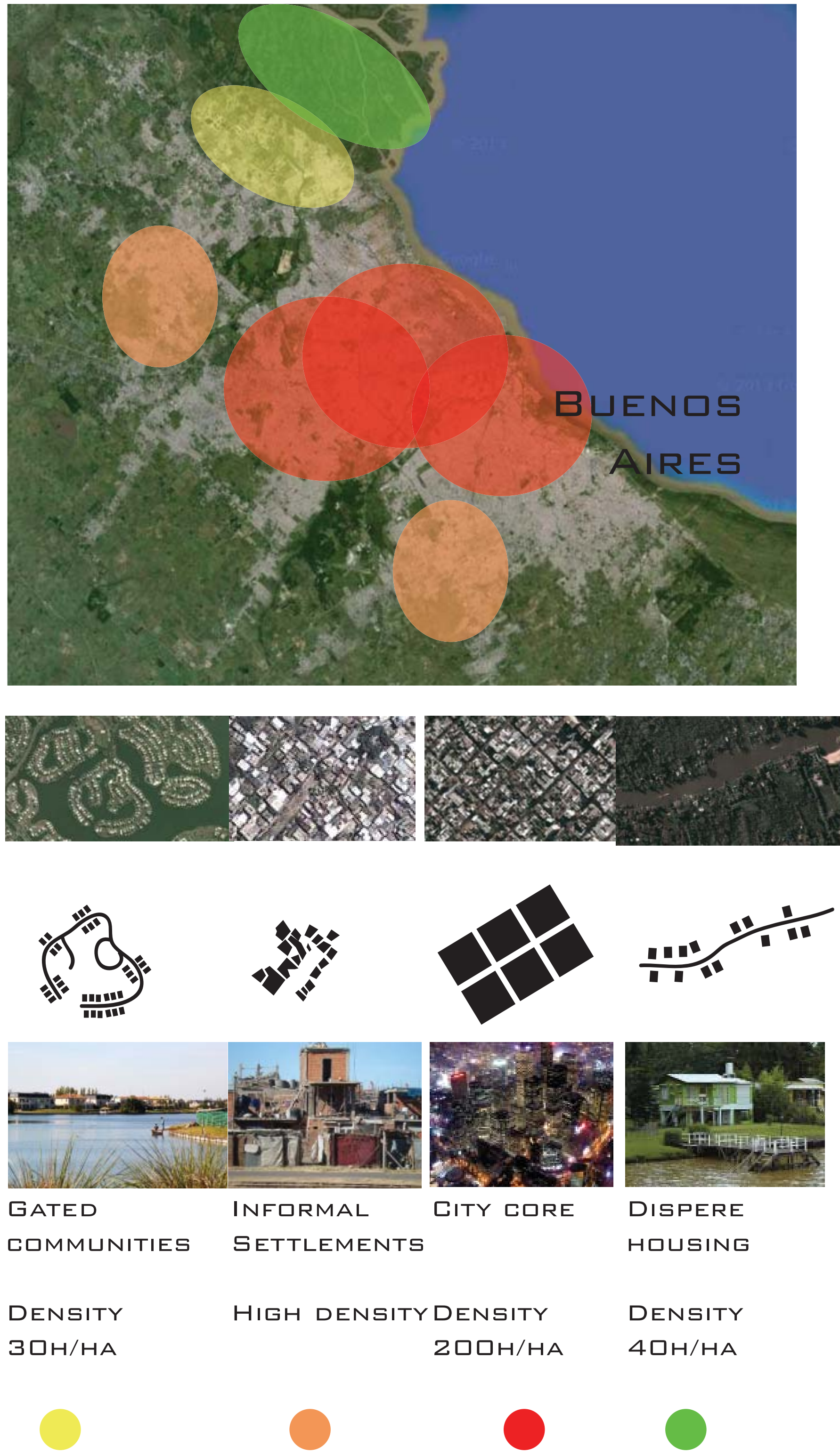
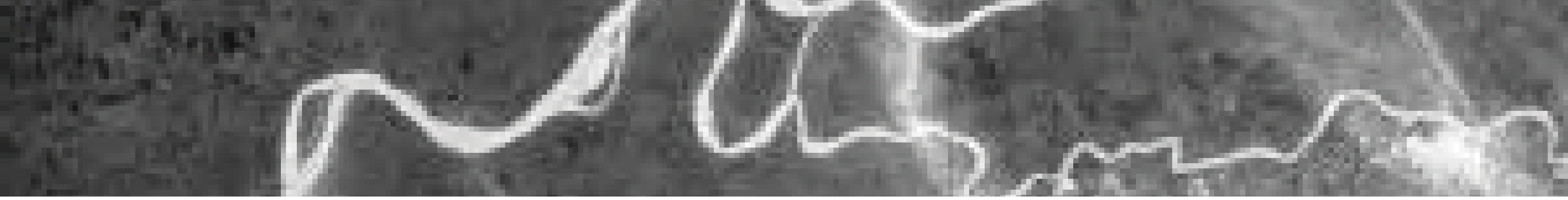


fig. 4., Settlements, Own work, (2013)



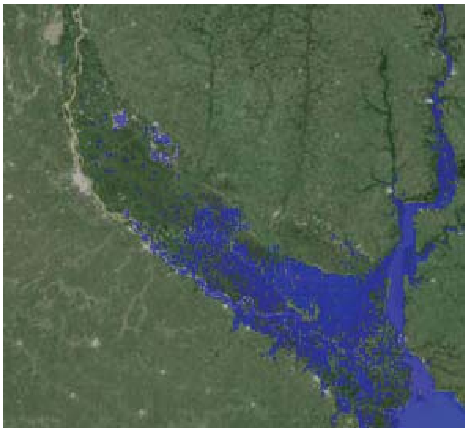
is provided. If the delta has to be a part of new living opportunities, this disconnection has to be solved first.

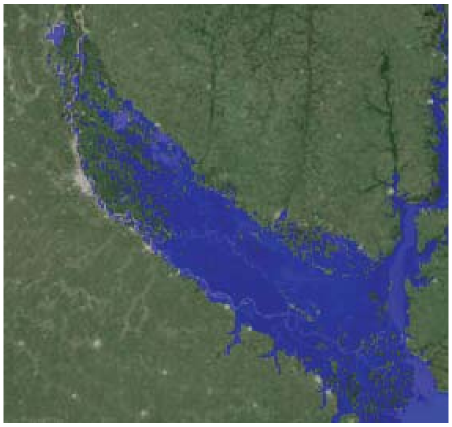
Floods

Floods occur frequently in this area (M. Iriondo, 2004) Because of heavy rain fall and the Sudestadas, south eastern winds, the water level increases with almost two meters in a hour (ABBA, 2009). Big parts of the delta flood because of this, as can be seen in fig.5 and fig. 6. and fig.7.

Importance ecological system of Parana delta

The lower Parana delta is a wetland of 17.500km2 fully consisting out of fresh water. The floods from the Parana Rivers, the Uruguay Rivers, the local rainfall and the storm surges from Rio de la Plata dominate the hydrological regime of this area. These flood pulses are the most important for the ecological system of the Parana delta. This delta is the habitat of a rich biodiversity and has many ecological functions fig. 12. First the delta is a flood buffer during the floods pulses. Besides the delta functions as a water purification system, heavy metals, nitrogen recycling, degradation of organic compounds is all done by the delta which function like a big kidney as Rodrigo Castro Volpe likes to describe in his master thesis. The third service of the delta is its primary productivity of vegetal biomass (made out of CO_2, which is one of the sources of the global warming) and carbon storage. As said the delta is the habitat for many species, such as fishes, bees used for apiculture and native forests. At last the delta is used for other activities fishing, hunting, forestry and cattle ranging are the main activities in this lower delta. But the activities of the man are a threats to these ecological functions. Infrastructural works such as dams, dikes, waterways and roads influences the water velocity





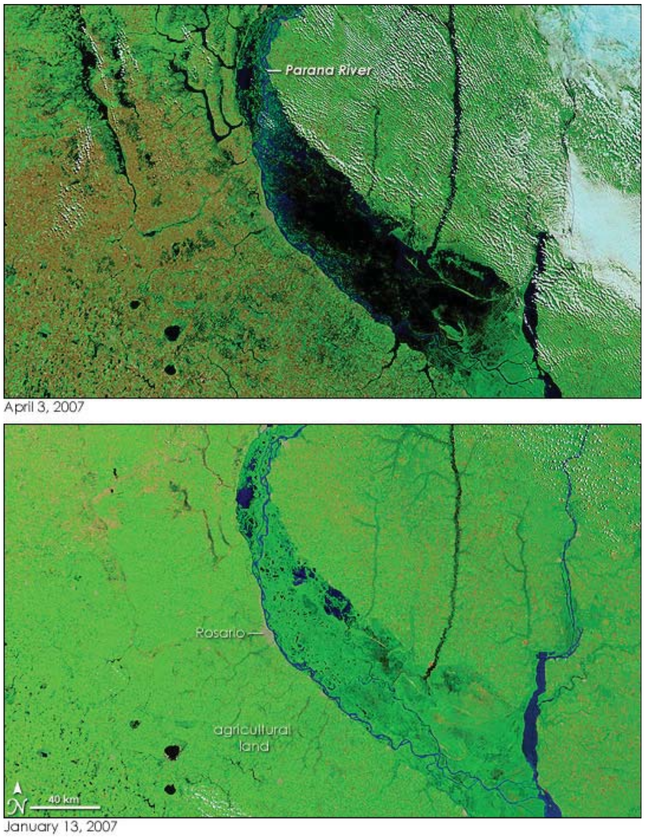
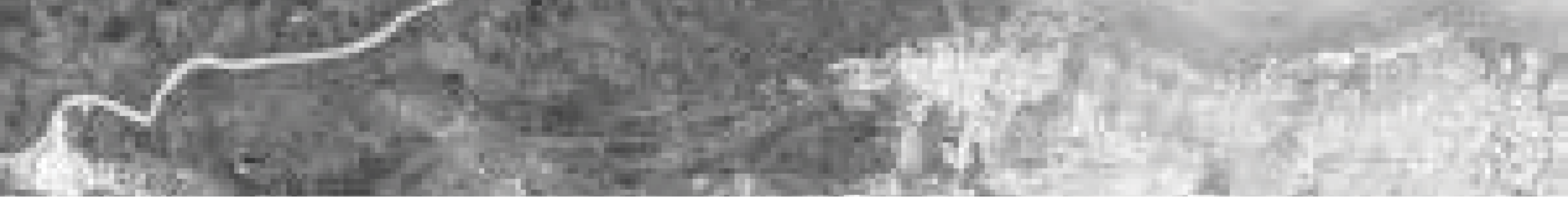
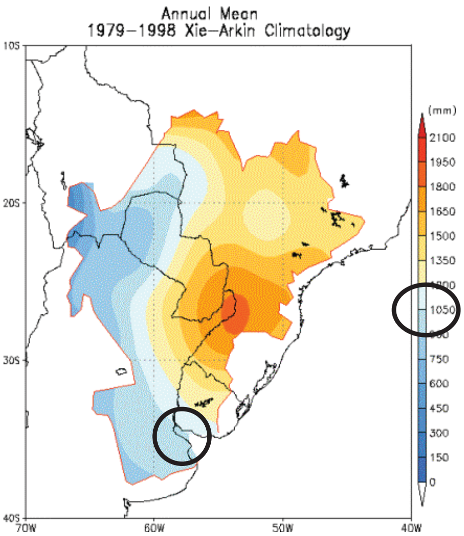
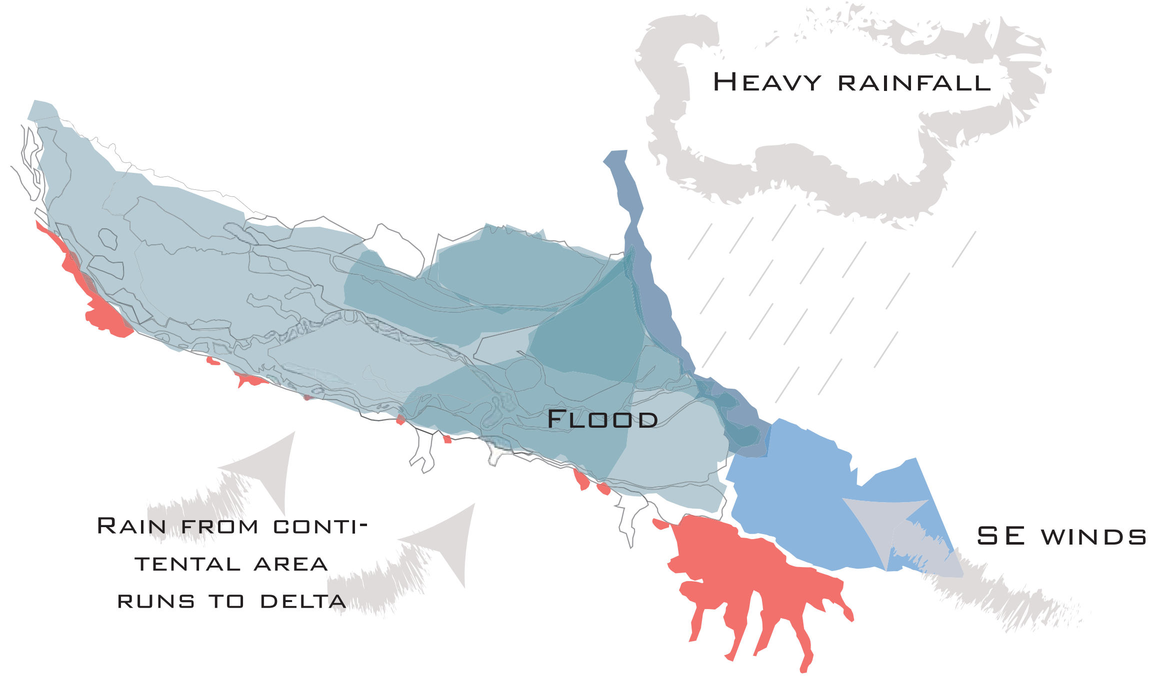


Fig. 5. Floodplain Parana delta, NASA, (2007)





ANNUAL-MEAN PRECIPITATION IN THE PLATA BASIN FROM XIE&ARKIN.



The flood risk of the delta is because of the high amount of rainwater, some 1207 mm with a maximum of 1984 mm and a minimum of 197 mm which is quite high.

Timing of floods

Inter annual floods - 17-8 year cycle floods and ENSO (every 100 year)

In Buenos Aires difficult to predict precision location flood by rain--> intense rainstorm and Sudestadas (overflow drainage system) --> Combination is maximum risk hypothesis

fig. 6., Own work, (2014)

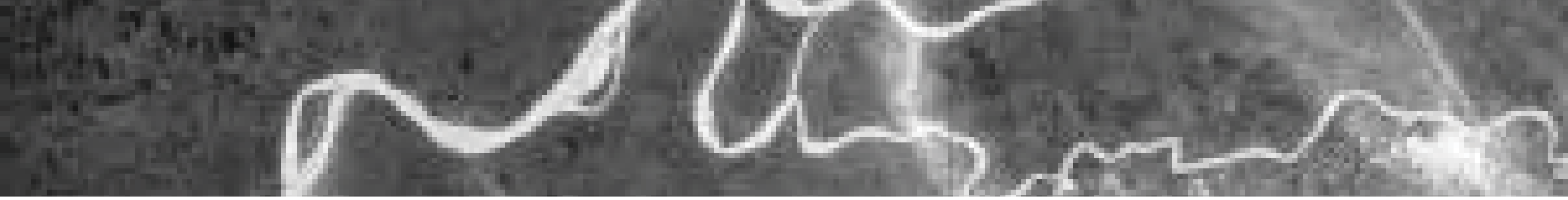
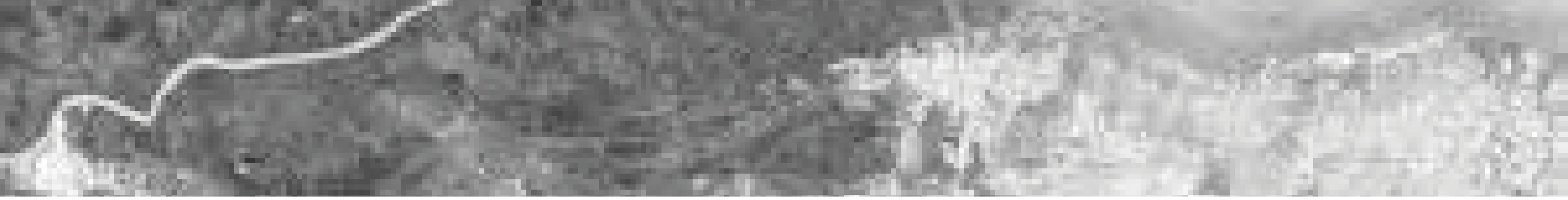


fig. 7.1., flood risk 1, Chaco, (2013)

fig. 7.2., Enrique Marcarian/Reuters, (2013)

fig. 7.3., EFE, (2013)



and the sediment transport by the river. The erosion and the drainage system of the wetlands are affected by this infrastructural works. Another threat is the pollution of the industries. They release the wasted water directly in the channels, this may kill many species which influence the ecological system of the delta. Also the intensification and expansion of the current wetland affects the ecological system of the delta. By draining the wetlands big parts of habitats of many species disappear.

That is why I state that this ecological system must be understood by the inhabitants of the delta and must be recognized. That also includes the importance of the integration of the importance of the delta in the building projects in these delta areas.

All by all it is important that while making communities in a delta some aspects are taken into account. The communities must be affordable for the lower middle class, there must be common facilities so the social control is guaranteed and the ecological system must be recognized and understood by the inhabitants.

Recommendation

My position in this topic is that due to the pressure at the delta landscape new communities for the lower middle class is needed in the Tigre delta and these new communities must recognize the ecological and hydrological system of the delta to be a sustainable community.

My recommendation for the design research is as follow. The research question for the graduation is:

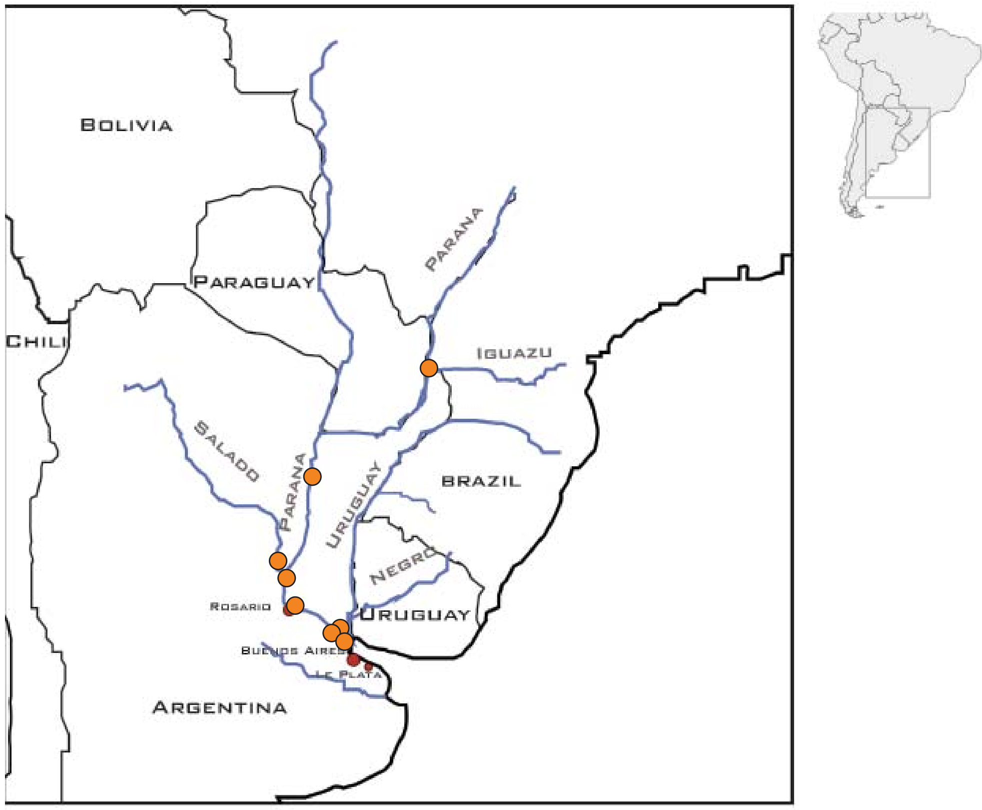
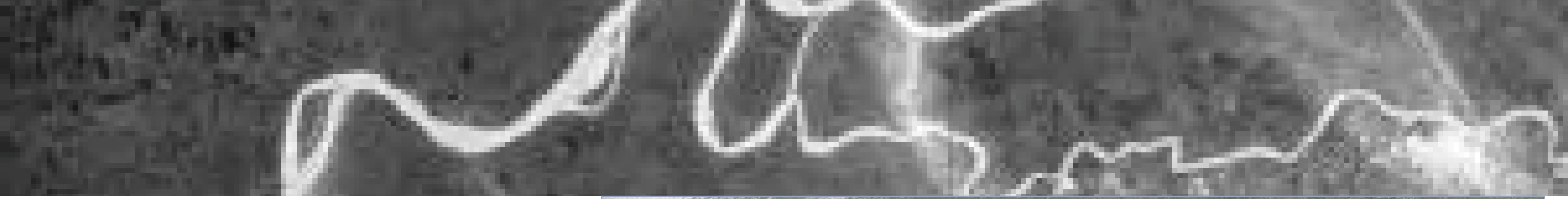


fig. 8.1., Parana delta waterworks, own work (2013)

fig. 8.2, Itaipu dam, Usmanawan68 (2014)



How to reavaluate housing for the lower middle class as a densify area in the ecological important Parana delta of Argentina as a part of the metropolisation of the coastal area between Rosario and Buenos Aires?

For that I will design affordable housing for the lower middle class. This prototype housing is a cluster of houses which forms a community of households. This prototype for a community includes common facilities which makes the habitants feel responsible and increase the social control of the community. These common facilities consists out a public building and collective and public outdoor space. Besides the public building make the area also accessible for outsiders, in this way segmentation will be minimized. This public building can diverse with each community, you can think of a school, space for manufacturing, cattle holding etc. The public outdoor area is a designed outdoor space which has as main goal to make the habitants aware of the ecological dynamics of the delta.

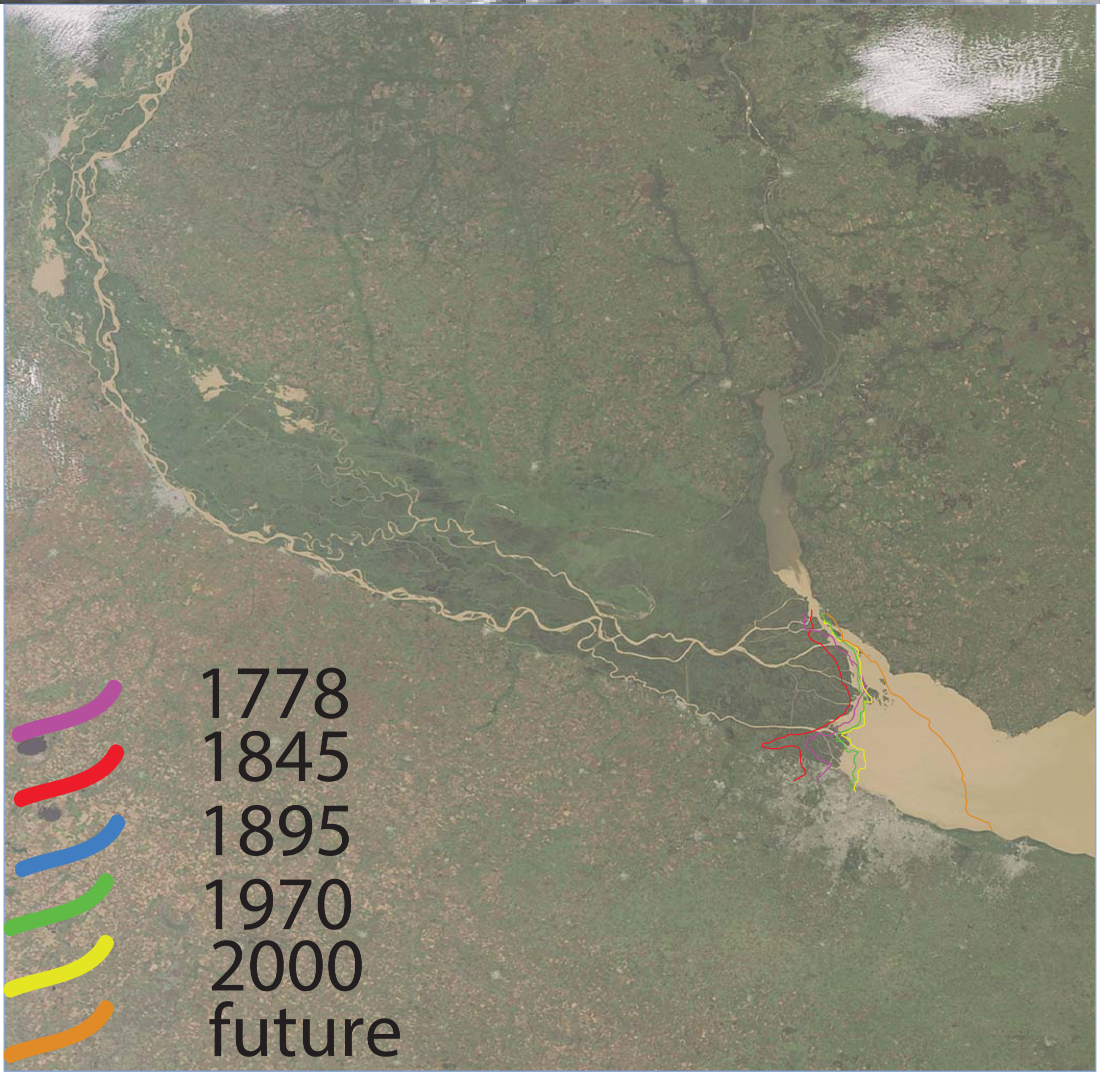
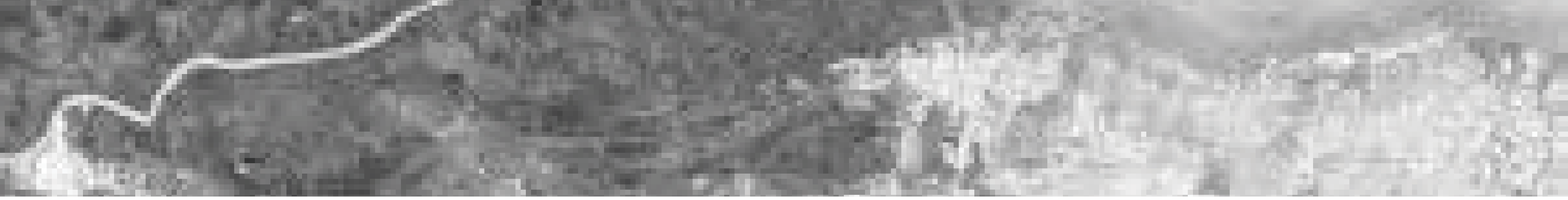


fig. 9. Growing delta, Own work, (2014)

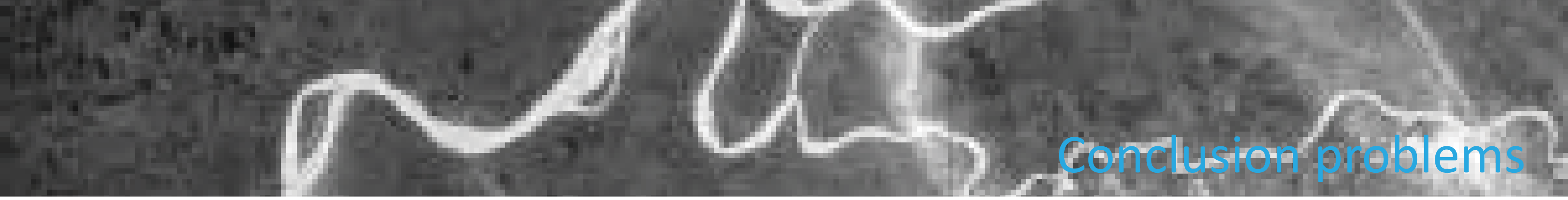
The prototype dwelling will cover the primary needs of a household, there will be space left over which people can fill in by their special needs. In this way the living conditions are much better than in a shanty town, and the people might change their property during time as wished. To come with a proper design I used sketches, models and animation models from sketch-up. In this way I researched the possibilities of the form and the space these forms left for expansion. Besides the communities must adapt and recognize the changes of the delta in the different part of the delta with their different environments. These different environments must be explored, for that I researched with help of the Wetland



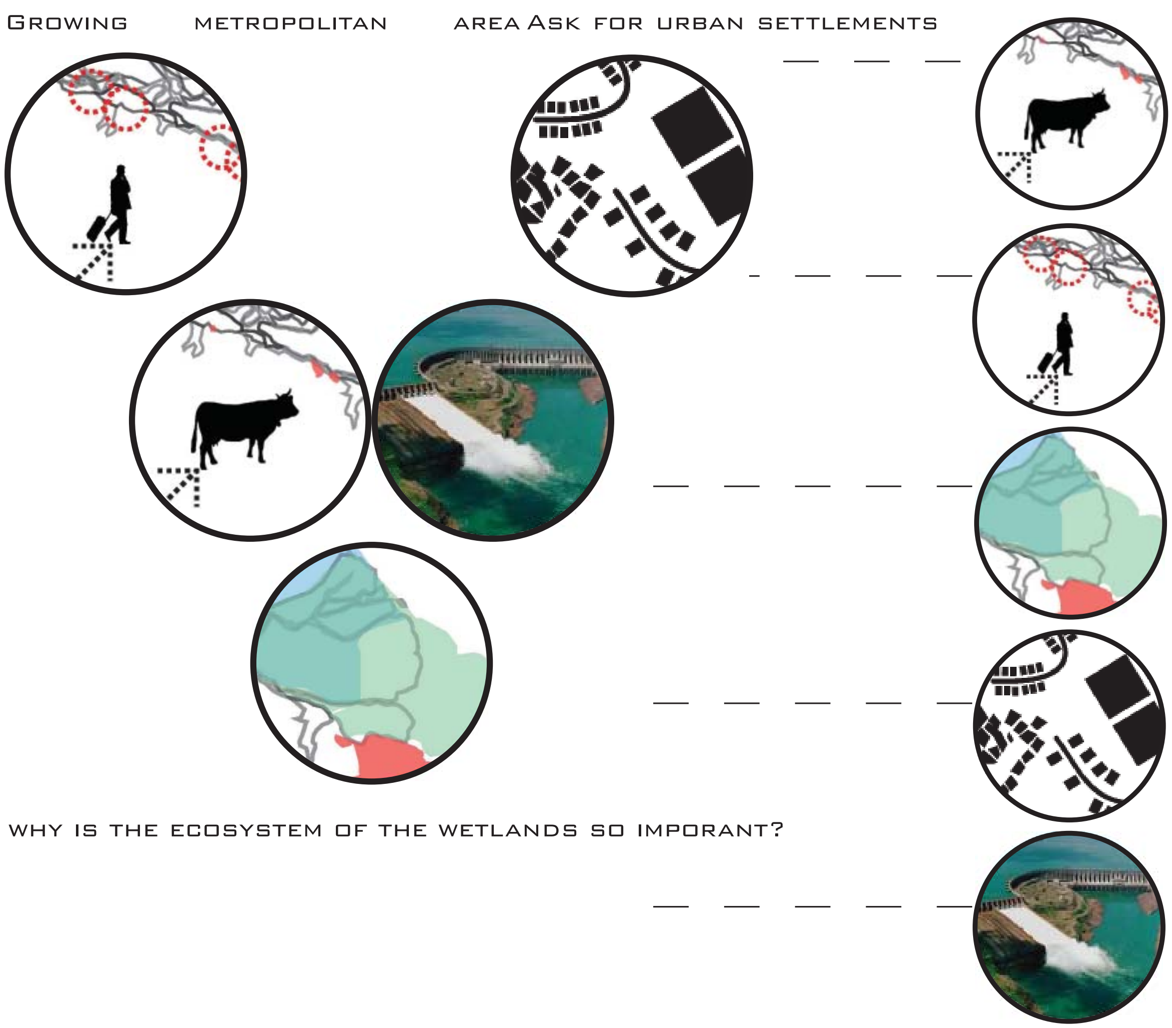
society of Argentina. With them I found out what to take into account while building in these different parts of the delta. The houses may not flood during heavy rainfall and south-east winds from the Rio de la Plata. For this research about differetn building prototypes is done and can be found in the following chapters. For the houses ecological materials will be used. Research of the possibilities of ecological materials and local materials by references is done and can be found in appendix 2. By designing the communities with ecological materials, the ecological system will be harmed less.

The connection with the continental coast is also a key factor in this system. By increasing the connection with the continental coast, the connection to and from the metropolis is provided. By making such connection possible the communities must include a harbour for their boats. Besides the communities must be connected with each other by a spatial plan. For this is will make a proposal, but since I am an architectural student I will concentrate me at the forming of the houses and the community as a whole.

For this design I have chosen a pilot location. This Pilot location is the former Peurto de Frutos and amusement park. This location is located at the continental coast surrounded with urban tissue. By making the former amusement park part again of the wetlands, by reintroducing the wetlands, the people who will live in this location will be made aware of the ecological system and its importance. The houses built their have to cope with these changes of the wetland and will so be a good pilot location for the housing in the delta. The houses will be test in three other location in the delta. In this way I will be sure these housing may be implemented all over the coast of the delta, as my concept suggest. In this way I also will be aware which specific parts of the communities have to be flexible in order to make it suitable for all the chosen locations. The research can be found in the analyses chapter.



Conclusion problems



Livestock movement the cattle affects the natural environment of the delta. Their faeces produces soil and water pollution. Besides, the soil of the slopes get loose because of the grazing. This occurs erosion at the river slopes, which at itself may occur flooding of the wetlands.

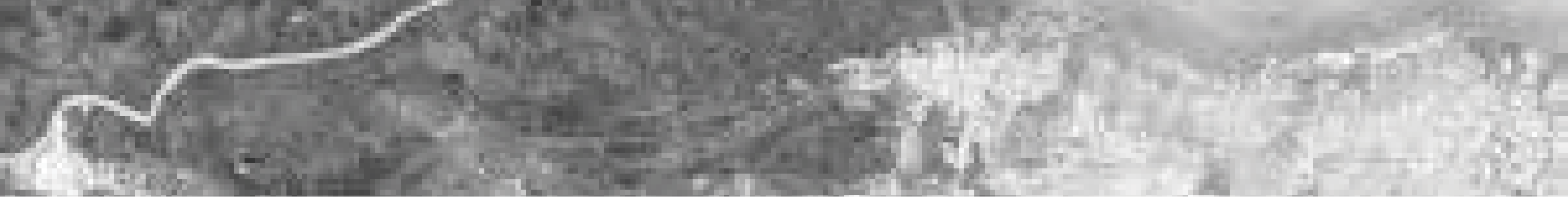
Economic movement the population at the border of the Parana delta is increasing. Buenos Aires and Rosario are still growing. Also new settlement are built.

Flood pulse Tides of the Rio de la Plata, Flood of the Parana-, Gualeguay-, and Uruguay river and Local precipitations are the sources of the floods of the wetlands of the Parana Delta

Urban settlements new, none plan urban settlement are built in the Parana delta. Because of the reclamation of the land, the water in the wetlands can't flow. The flood pulse of the wetlands is the most important and most biological productive feature of the ecosystem of the wetlands

Dams at the higher delta destroy aquatic habitat and is the source of flooding of 100.000 HA of land.

fig. 10., Diagram problem statement, Own work (2014)



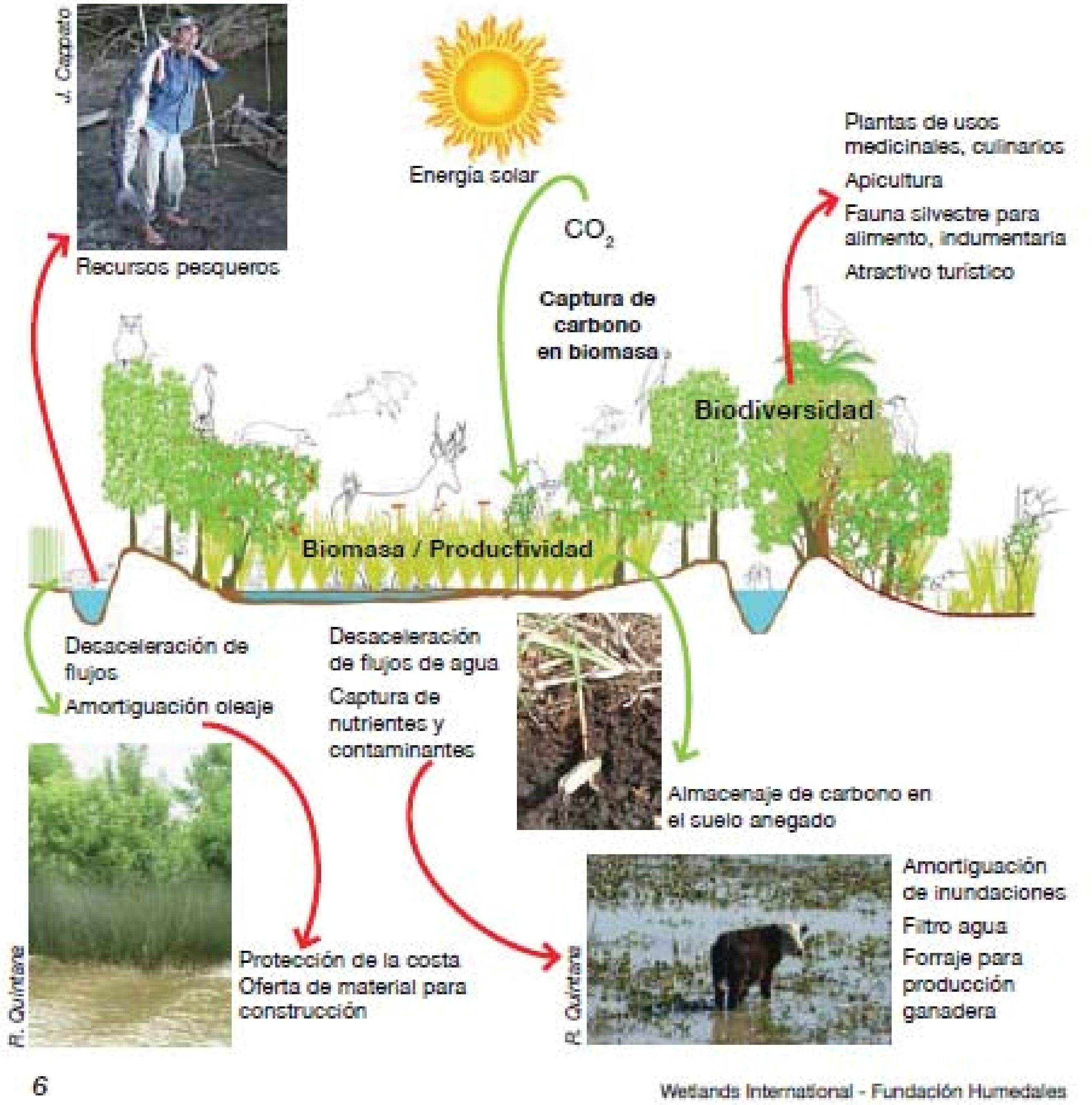
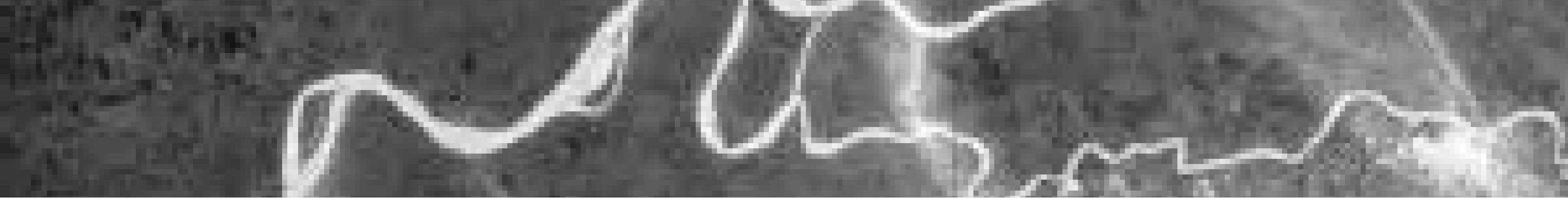


fig. 11., Diagram ecological importance, wetland international (2008)



2. Position, Aim and Research Question

Position & Aim

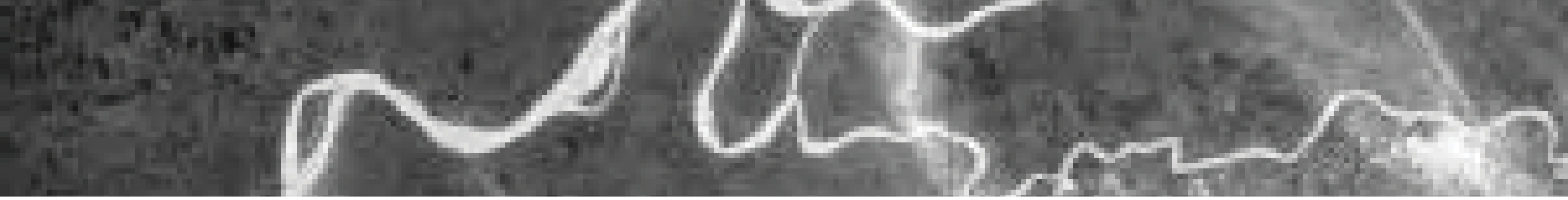
My position responds to the pressure of the delta coastline. It focalizes on the needs of the lower middle class. Under this perspective new communities must recognize the ecological system of the delta to be a sustainable community. Within the consideration of the re-accessibility of the coastal areas and of the connectivity with the metropolis.

By making people aware of the dynamics of the ecological system people will respect this natural environment more, they will feel responsible for its wellbeing.

By giving people power over their own houses, by make it possible to expand it if wished, people will indicate their self with their living environment which makes them more responsible for this environment. In this way the community will be a liveable area with social control. Which will make the location a safe and healthy place to live.

Research question

How to revaluate housing for the lower middle class as a densify area in the ecological important Parana delta of Argentina as a part of the metropolisation of the coastal area between Rosario and Buenos Aires?



3. Analyses

The assignment

For this report four different waterscapes with their own characteristics are described. A case study design is implemented in these waterscapes to describe the influences of the water and flood characteristics. Different aspects of the design will be transformed as such that it will be adjusted to these different waterscapes. The delta waterscapes used for this assignment are the continental coastal area, coastal area of the inner delta, the new land by sedimentation of the river and the coastal area of Rio de la Plata, see fig. 4.1

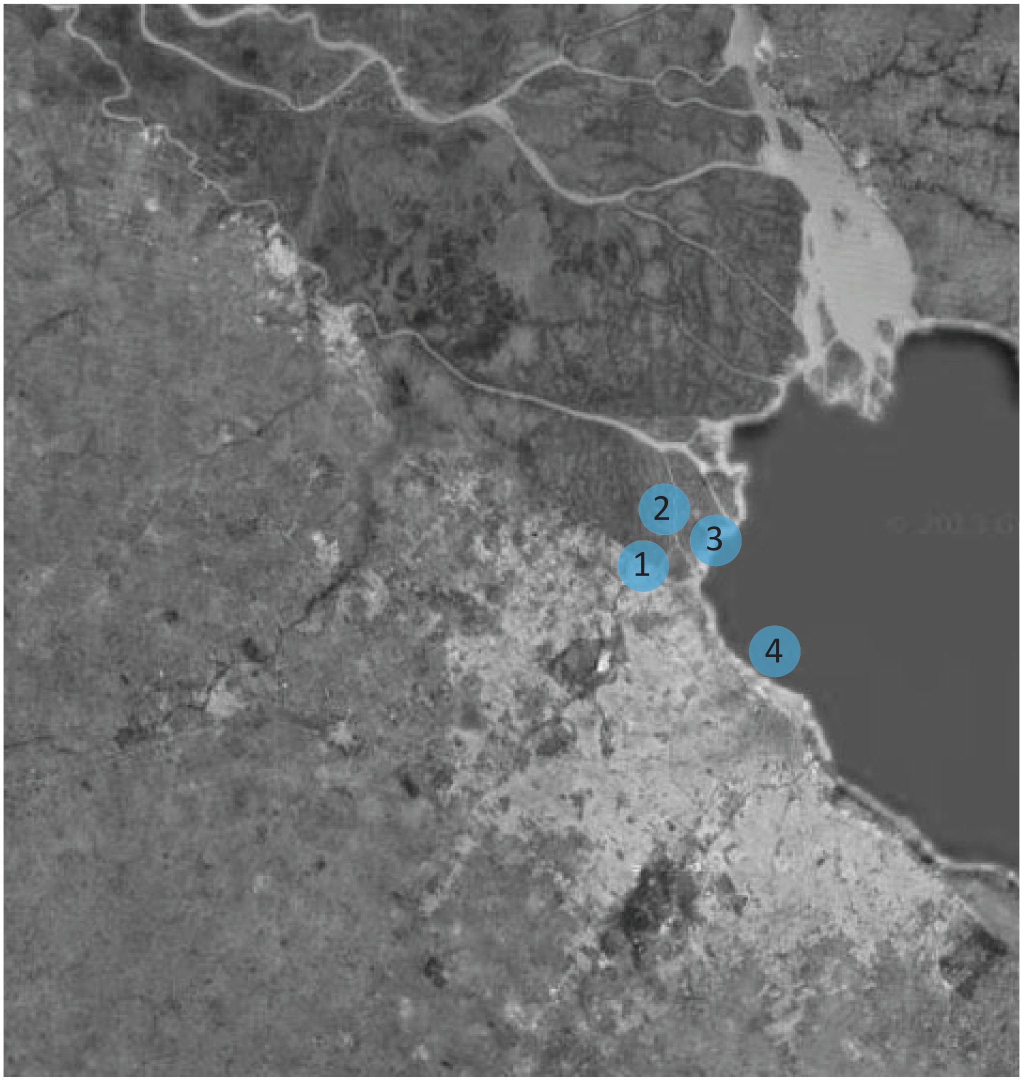


Fig. 3.1 The waterscapes, Nienke de Korte, (2014), underlayer: google maps, (2014)

Chosen design

The chosen design is a social housing project called Quinta Monroy located in Iquique, in the north of Chile. In this project the affordability of the houses were the leading topic. The Chilean government asked the architectural bureau of Elemental to redevelop the illegally used Quinta Monroy area of 5,000sqm and host the same 100 families in there. This didn't not work out but they still made a nice, expandable design for this side.

After a short analyses, which partly can be seen in fig. 3.3. the conclusion of this building is as following.

The construction of the house is of prefabricated concrete blocks, fig. 3.2. A building block consist out of five dwellings. Each dwelling is half built, that will say that the owners can expand their houses to a dwelling twice as big. The connection to the upper dwellings are by a stair in front of the building.

This design is used in the rest of the report to reflect the needs of building in different waterscapes

Fig. 3.2. Quinta Monroy, Cristóbal Palma , (2004)

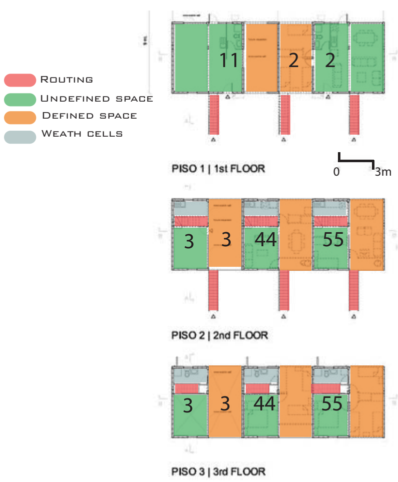


Fig. 3.3. Functions Quinta Monroy, Nienke de Korte , (2014)

The different waterscapes of the Parana Delta

Coastal area of the Parana Delta

The first waterscape is the coastal area of the Parana delta. This specific place is located in the municipality of Tigre, in the north west of Buenos Aires.

This area is part of the Rio Lujan. This river is mainly used for small transport and recreation. It is also the river that gives access to and from the delta and Buenos Aires. These transport boats originate small waves but are not of a big impact.

Because of heavy rainfall and south eastern winds flooding occur in this area. The water level can increase with almost two meters an hour. This means that this coastal area will flood. Besides the drainage system of the city flows through this area. This increases the flood risk. Also parts of this area are closed by gated communities and dams, this moves and increases the flood risk to other coastal areas. fig. 3.4.

Fig. 3.4. Floodplain coastal area, Nienke de Korte, (2014)

Coastal area versus chosen object

To reflect on this situation, the chosen design must replace a part of the urban context at the coastal area. In this case the impact of a major flood in this area with the chosen architectural object is showed in fig. 4.2.

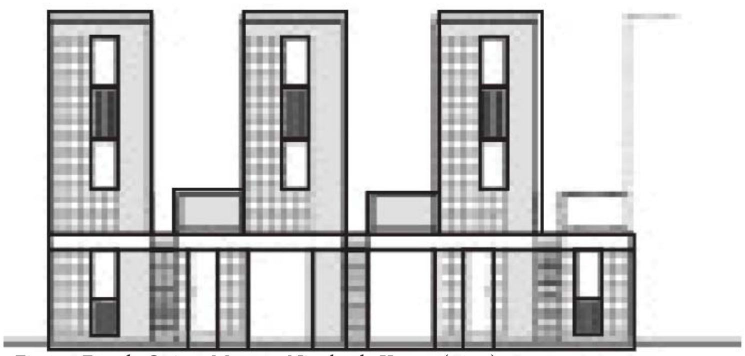


Fig.3.5. Facade Quinta Monroy, Nienke de Korte , (2014), underlayer: elemental, (2003)

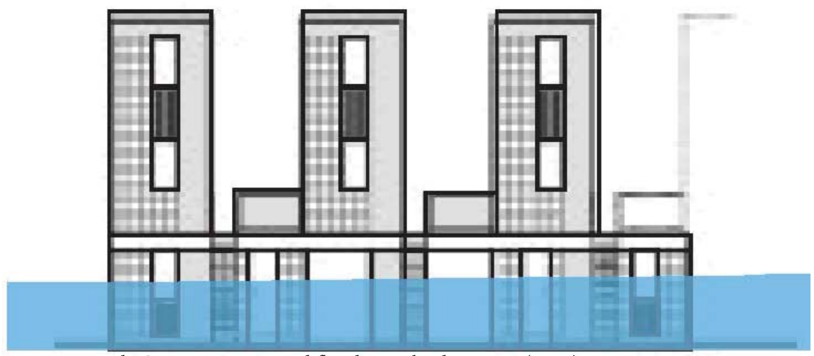


Fig.3.6. Facade Quinta Monroy and flood, Nienke de Korte , (2014), underlayer: elemental, (2003)

Problem statement

In fig. 3.5. can be seen that the dwellings at the ground floor will flood during a major flood in this location. this means that 2/5 of he whole area cant be used during a flood. This same amount of households will lose their belongings in a flood. Because these floodings occure frequently, a sollution must be found.

Goal

The design must change in a way people are safe in their house during a flood and will not be harmed by the rising water, fig.3.6. The construction of the house and its materialisation must be off use in this water environment. Besides the access of the building will change. Here for a solution has to be found as well.

Conclusion Problem statement

In this area the following challenges are found by implementing the architectonical object in this delta environment.

1

Increasing water level by two meters during heavy rainfall a south-eastern winds

2

The drainage system of the city will flow through this area.

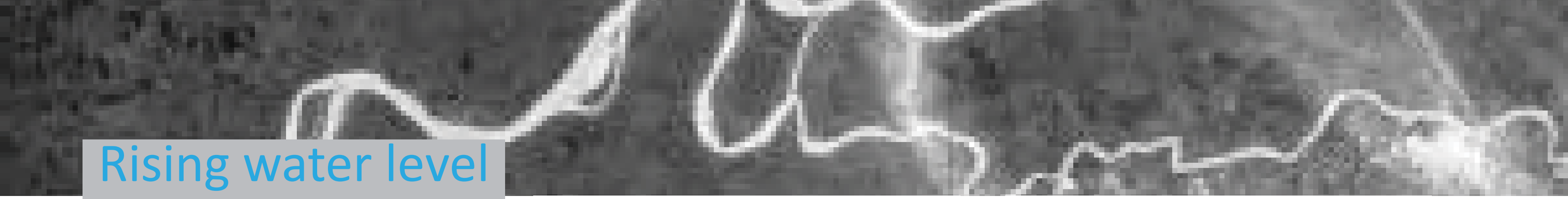
To adapt the dwelling to the rising water levels several technological and architectonical solutions are possible. In the upcoming slides these solutions are described.

3

Human implementations such as dams and walled comunitiees increases the flood risk in other parts of the coastal area

Main problem

All of these problems have as out coming the rising water levels. In this case the houses must be adapt this water levels during a flood.



Rising water level versus architectonical object

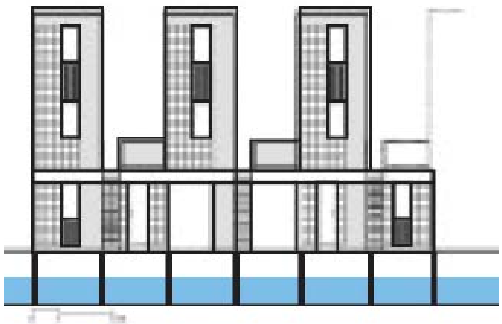


Fig.3.7. Houses lifted by poles, Nienke de Korte, (2014)

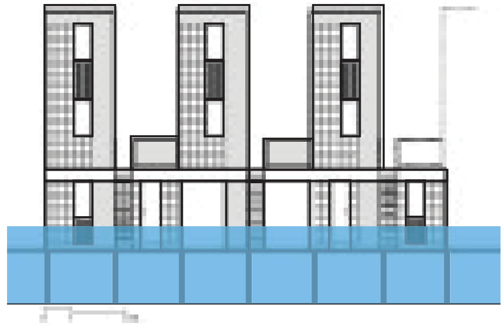


Fig.3.8. Houses lifted by poles major flood, Nienke de Korte, (2014)

Fig.3.9. Houses lifted with stairs, Nienke de Korte, (2014)

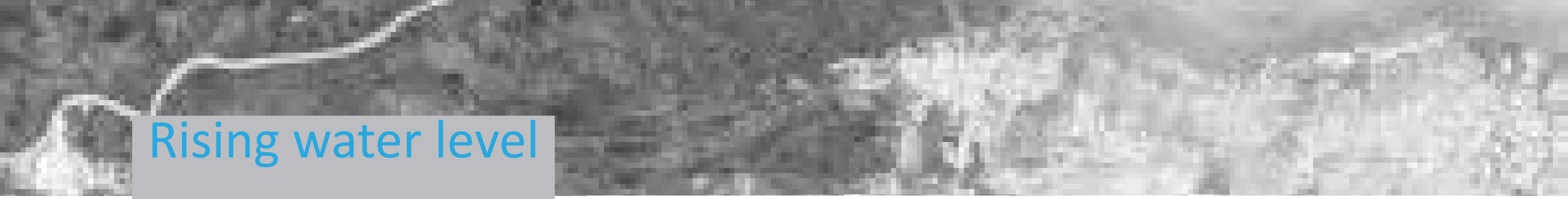
Fig.3.10. Houses lifted and slope, Nienke de Korte, (2014)

Fig.3.11. Connection environment, Nienke de Korte, (2014)

Lifting the house by poles

By lifting the house by poles the houses rise above the maximum water level, fig.3.7. This is a static solution, that means that if the water level will rise even more, the house cannot adapt this higher level, fig. 3.8.
For the access of the houses stairs are needed, this makes the access more difficult, fig.3.9. A solution might be a lifted street along the area which can be reached by a slope, fig.3.10.

By lifting the house they get another architectonical character. By rising the houses views under the houses are possible and with that connection with the environment as can be seen in fig.3.11. These areas can be used if there is no flood by the people as a shade area on hot days. But with a high density of these kind of houses these area might pauperized and not a nice place to be.



Rising water level versus architectonical object

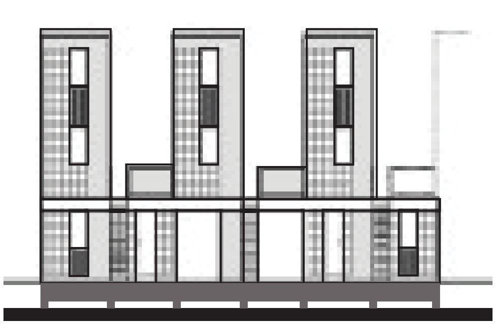


Fig.3.12. Amphibious, Nienke de Korte, (2014)

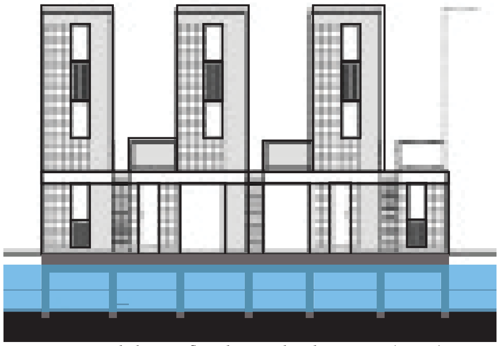


Fig3.13. Amphibious flood, Nienke de Korte, (2014)

Fig. 4.16. Materials

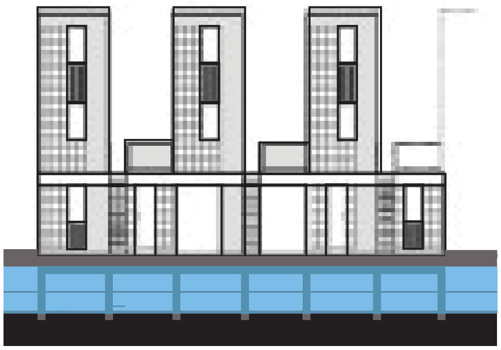


Fig.3.14. Amphibious path, Nienke de Korte, (2014)

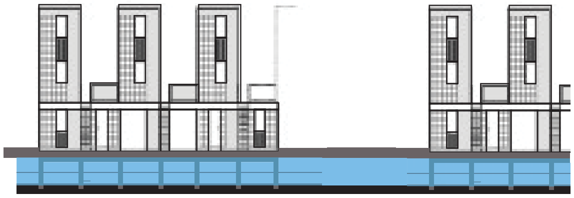
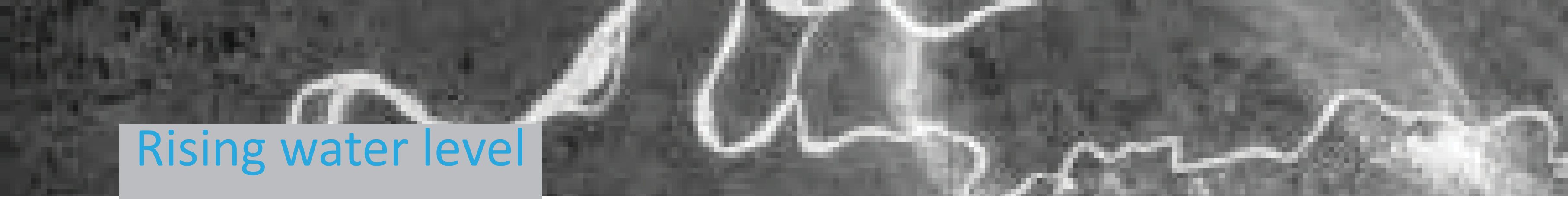


Fig.3.15. Amphibious platform, Nienke de Korte, (2014)

Amphibious housing

By making the houses amphibious they will rise with the water if there is a flood, fig.3.14. and fig.3.15. The houses always be lifted from the ground because of the foundation. It is possible to let the foundation sink into the ground but this might fill itself with durt during a flood and occure problems. The foundation of these houses (taken the chosen object as example) will be 1.2 meters high. This is because of the weight of the object by for example using light materials such as wood, bamboo or plastic, fig.3.16., this foundation might me thinner and an easier access will be possible. During a flood the access is only possible by boat or a floating/amphibious path. It is also possible to make big amphibious platforms, fig.4.15. In this case areas around the houses are accessible as well during a flood.



Rising water level versus architectonical object

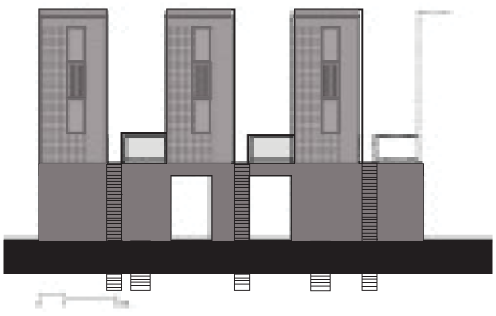


Fig.3.17. solid first floor, Nienke de Korte, (2014)

Fig.3.18. new acces ground floor Nienke de Korte, (2014)

Fig.3.19. New plan, Nienke de Korte, (2014)

If the facade openings are excluded from the ground floor facade, the access to the ground floor must be provided from the first floor. In this diagram, fig. 4.17. and fig. 4.18., I implemented a closed entrance. In either cases of having the access at the first floor, the houses at the first floor will lose space to expand their houses.

A possibility is to have all the houses, and with that the entrances at the first floor. In that case the ground floor can be used as possible expansion area and will me accessible by an indoor stair. In this case the whole floor plan of the design must change, fig. x. is an example of this change. The building has a gallery at the first floor. In this case all the access to the houses are at the first floor.

Solid houses/changing materials

It is also possible to make the dwelling waterproof by excluding facade openings until a height of 2.5 meters. The materialisation must be waterproof, is said must not be affected by the water of a flood.
The architectonical object is of concrete. Strong concretes are not harmed by water. But if it is porous, it will be affected by the water. Besides the steel reinforcement in the concrete will oxidize and loose its strength

It is important in this case that the materialisation of the building is cladded or impregnated with a waterproof material. The access of the house automatically will move to the first floor. This makes the access to the ground floor impossible without changing the whole concept and floor plan of this object. The most important change in this case is the aesthetic of the ground floor what will not have openings and be of a solid material and the infill of the floor plan as such that the dwellings at the first floor are accessible during flood as well. An indication can be seen in fig. 3.19.

The different waterscapes of the Parana Delta

The inner part of the lower Parana Delta

This part is directly influenced by the tides of the Rio de la Plata River. This tides can reach 3 meters during the Sudestadas (strong south eastern winds and heavy rainfall) the islands are stable and are the habitat of many species. As can been seen in the section in fig. 3.20 the islands are surrounded by a small hill with different trees. In the inner part of the island is lower and mainly covered by reed. These monospecific groupings of reed eventually will form solid floating parts which can be used as refugees for species during a flood.

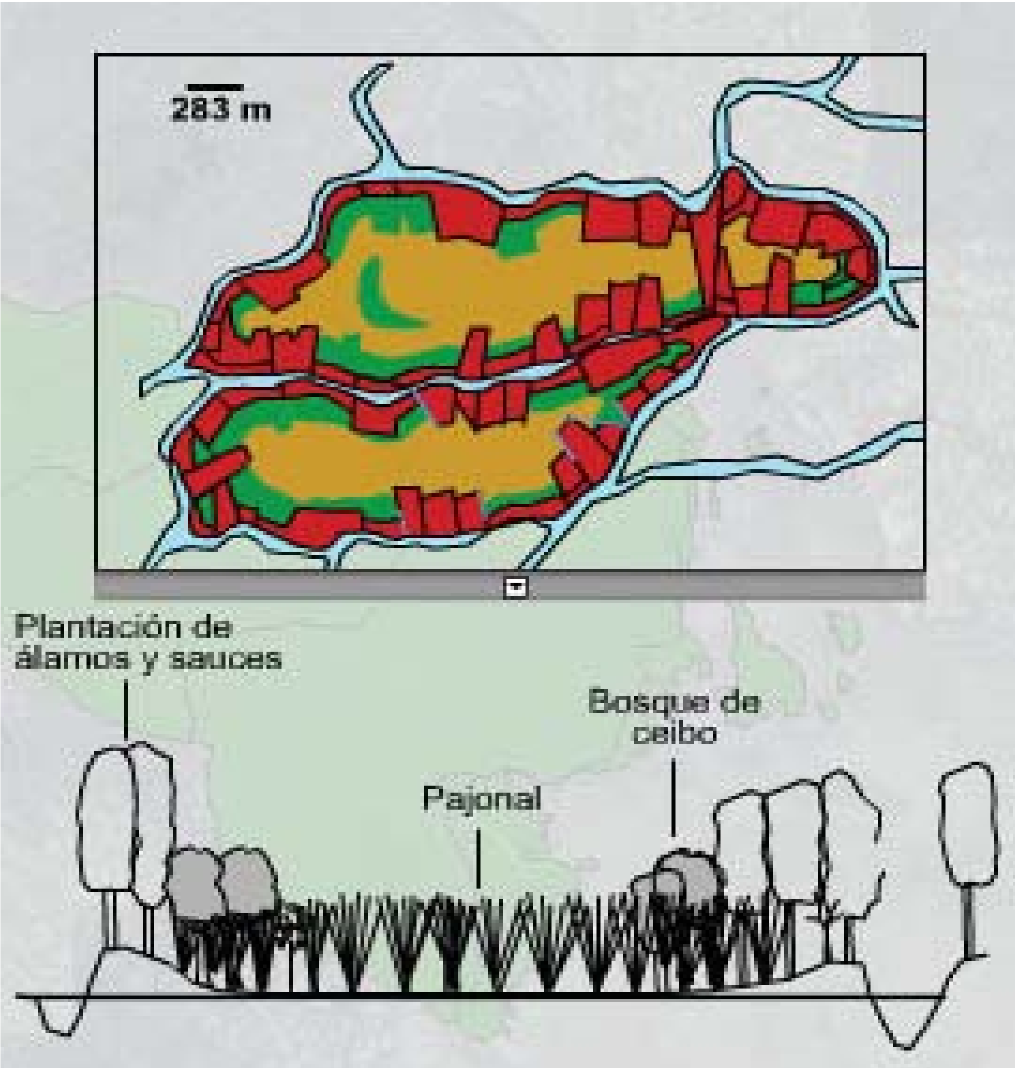


Fig.3.20. Inner delta, AABA , (2008),

Inner Delta versus chosen object

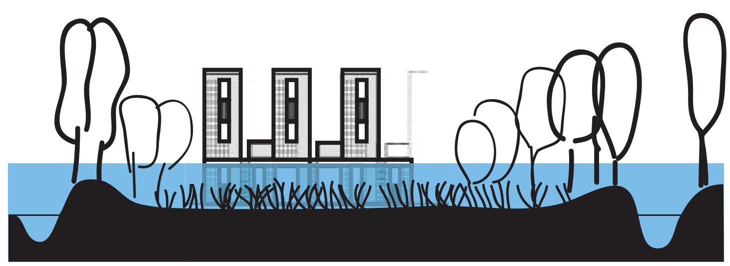


Fig. 3.21. New plan, Nienke de Korte, (2014)

Problem statement

In fig.3.21. can be seen that the dwellings at the ground floor will flood during a major flood in this location. This means that 2/5 of the whole area can't be used during a flood. This same amount of households will lose their belongings in a flood. Because these flooding occur frequently, a solution must be found.

Goal

The design must change in a way people are safe in their house during a flood and will not be harmed by the rising water. The construction of the house and its materialisation must be off use in this water environment. Besides the access of the building will change. Here for a solution has to be found as well.

Conclusion Problem statement

In this area the following challenges are found by implementing the architectonical object in this delta environment.

1

Increasing water level by three meters during heavy rainfall a south-eastern winds

2

But this area also has a natural opportunity, the use of the monospecific groups of reed as a floating foundation

To adapt the dwelling to the rising water levels several technological and architectonical solutions are possible. In the upcoming slides these solutions are described. The use of poles and amphibious housing already is described at pages 11till 13. In this case the natural foundation of reed is researched and described.

Main problem

All of these problems have as out coming the rising water levels with three meters. In this case the houses must be adapt this water levels during a flood.

Natural environment possible can be used as water protection.

Inner delta versus architectonical object

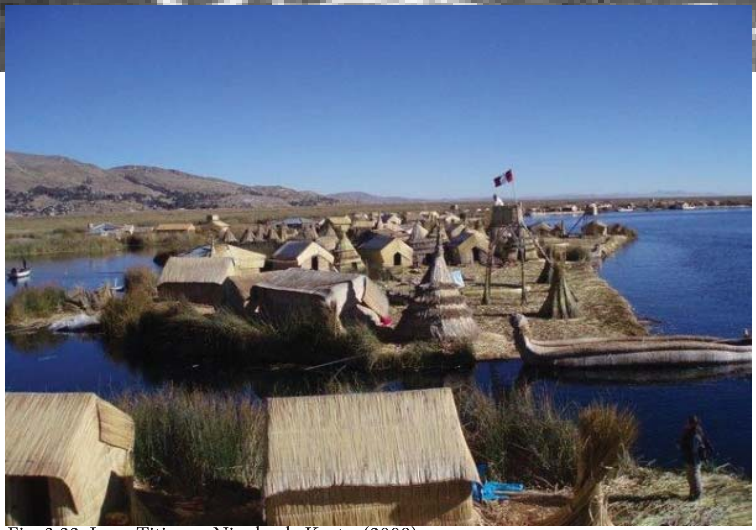


Fig. 3.22. Lago Titicaca, Nienke de Korte, (2008)

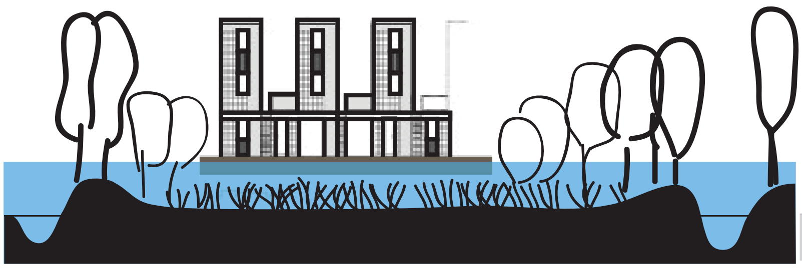


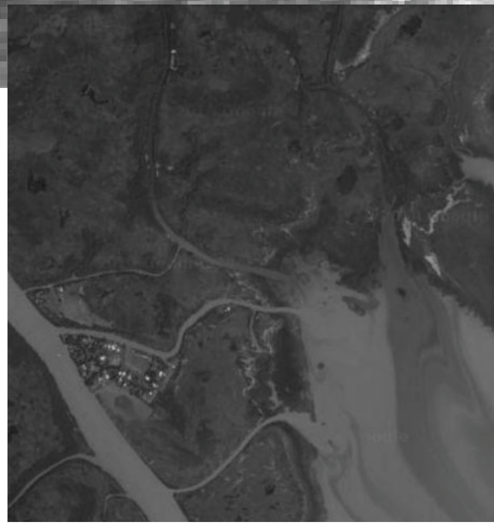
Fig.3.23. Foundation of reed, Nienke de Korte, (2014)

Fig.3.24 Cradle to Cradle, Nienke de Korte, (2014)

Use of natural environment as flooding defence

The monospecific groups of reed can be used as an amphibious/floating foundation. This is not a new, for example in Peru they are using the reed as a floating foundation at the lake, lago titicaca as seen in fig.3.22. In this case the object has to be very light weighted. That can be done by using other materials than the concrete. The problem with using reed as floating foundation is, that it rots easily. The owners of the house have to repute reed all the time at the foundation since the reed beneath the foundation rots away. At the other hand, this kind of foundation is really affordable and of no harm for the environment. It fits beautifully in the concept of cradle to cradle. fig.3.24

The different waterscapes of the Parana Delta



the new land/ young islands

This part is directly influenced by the tides of the Rio de la Plata River. This tides can reach 3 meters during the Sudestadas (strong south eastern winds and heavy rainfall). In fig.3.25 the section of this area is showed. The difference with fig.3.23 is clear, in fig.3.25 this area is covered by depositions of mud by the river and the so called young islands which are growing in front of the existing delta islands. In this section the intense processes of the succession of ecological change that triggers the replacement of species that are linked to the expansion of the delta emerged or submerged, extending from the bottom of the estuary are recorded.

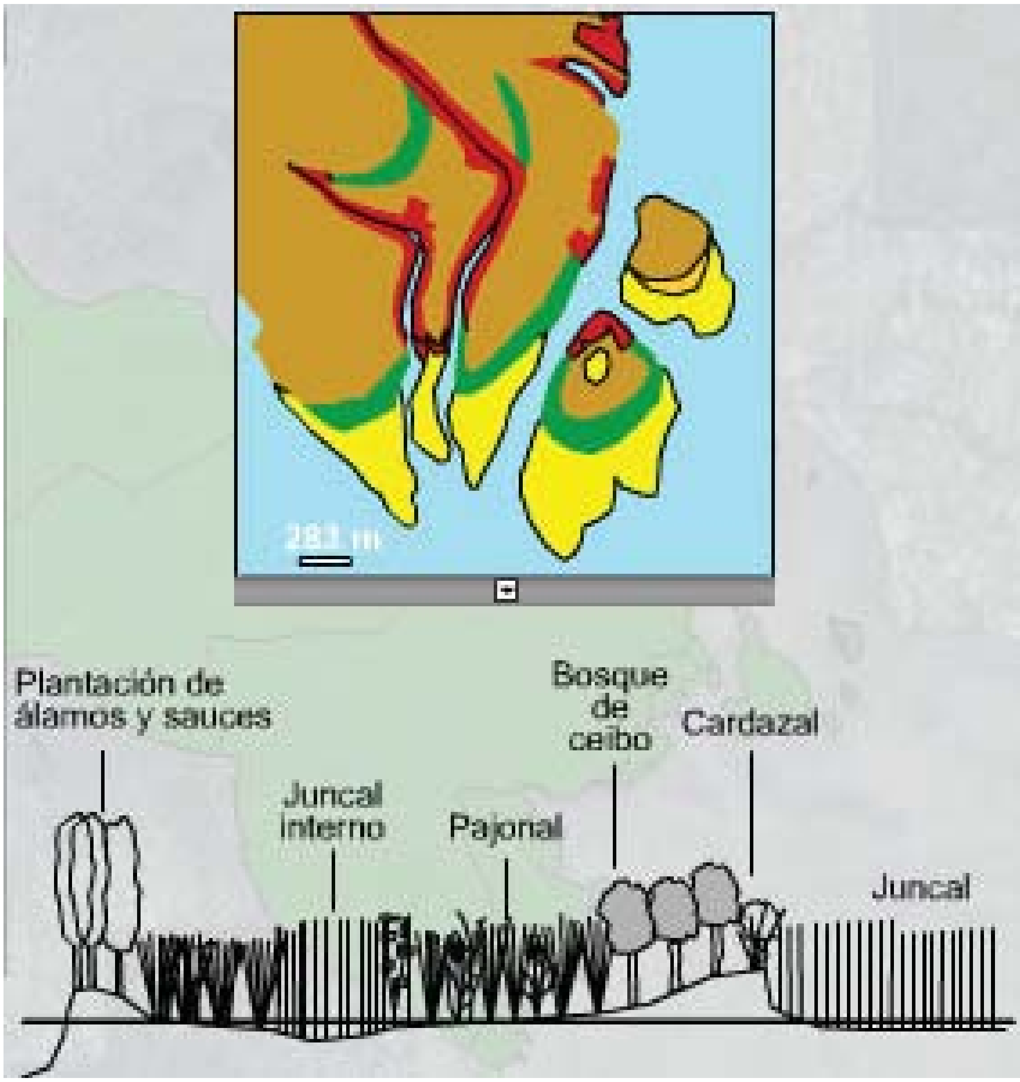


Fig.3.25. Young delta, AABA, (2008)

Young Delta versus chosen object

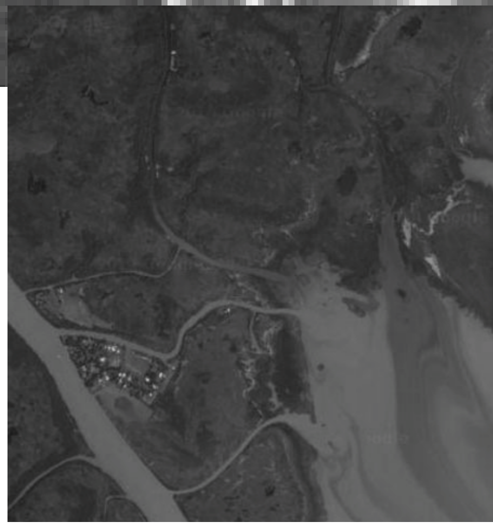


Fig.3.26 Situation young delta, Nienke de Korte, (2014)

Fig.3.27. Situation flood young delta, Nienke de Korte, (2014)

Problem statement

In fig.3.26 and fig.3.27. can be seen that the dwellings in this delta waterscape will flood up to the first floor due to the rise of three meter during a major flood.

Goal

The design must change in a way people are safe in their house during a flood and will not be harmed by the rising water. The construction of the house and its materialisation must be off use in this water environment. Besides the access of the building will change. Here for a solution has to be found as well.

Conclusion Problem statement

In this area the following challenges are found by implementing the architectonical object in this delta environment.

1

Increasing water level by three meters during heavy rainfall and south-eastern winds

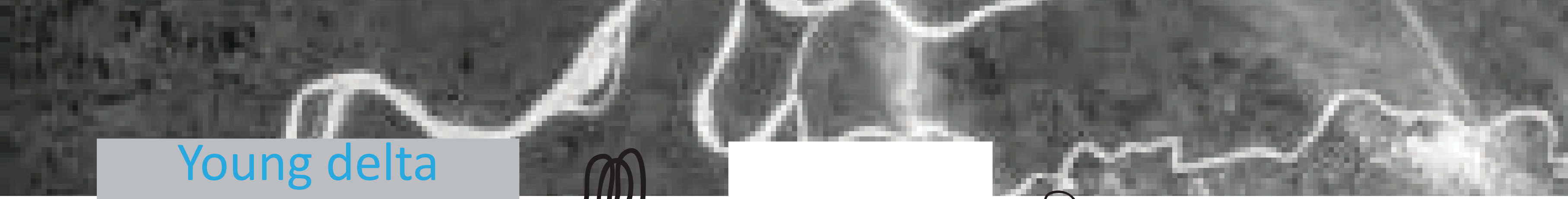
2

The environment is a dynamic area because of the environmental changes because of the still ongoing sedimentation. The ground is not settled yet. This makes building in this environment a challenge.

To adapt the dwelling to the rising water levels several technological and architectonical solutions are possible. In the upcoming slides these solutions are described. The use of poles and amphibious housing already is described at pages x till x. In this case how to cope with the changeable soil is the question.

Main problem

The rising water level and the dynamics of the soil of the wetlands are the main challenges of this waterscape environment.



Young delta versus architectonical object

Fig.3.28. Foundation principle, Nienke de Korte, (2014)

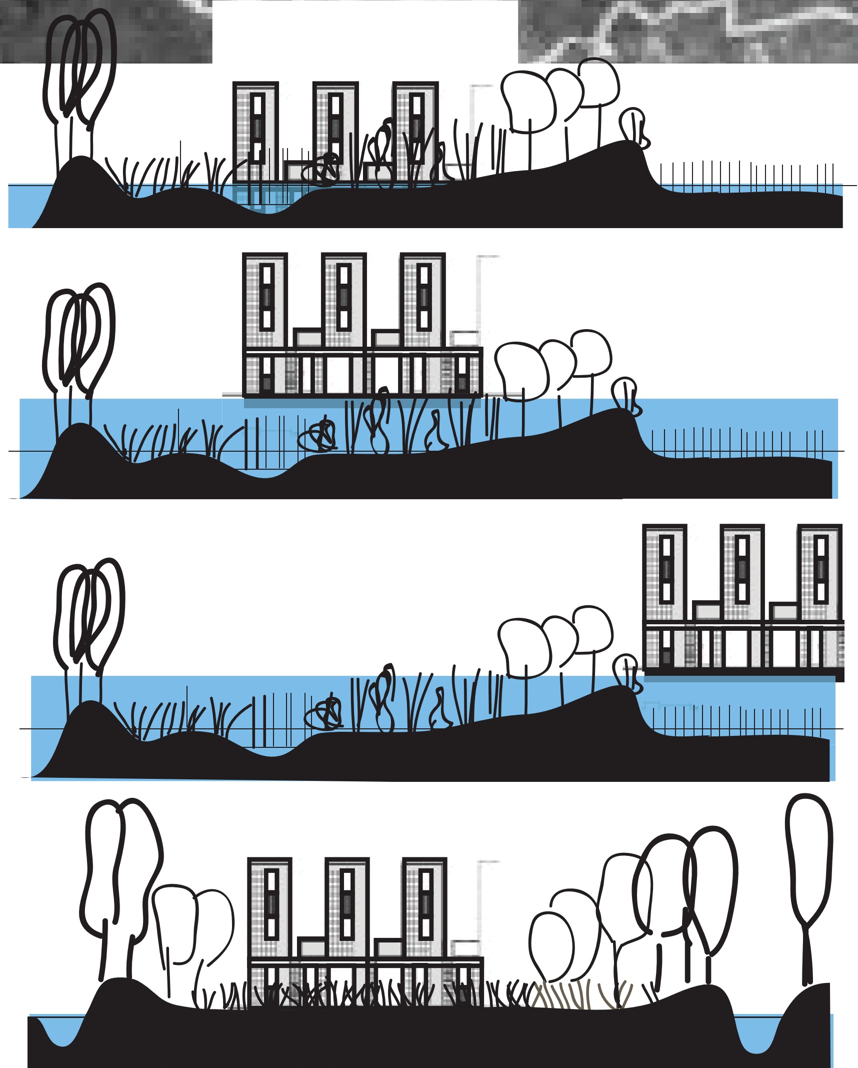


Fig.3.29. moveable houses, Nienke de Korte, (2014)

Lifting the house by poles ad amphibious housing

Two possible solutions to cope with the changeable and not yet settled soil, is to build at poles or to build with an amphibious structure. The foundation has to reach the deeper, settled soil to avoid the structure to bent over if the water level in the ground changes. Probably an even more convincing way of building in this environment are moveable houses, fig.3.28. In this environment these houses should be made as such that they are moveable over water since there are no roads but just waterways. In this case the foundation of these houses must be moveable or replaceable as well. Because for amphibious houses the object must be lifted from the ground a little to let the rising water get under the building the floating foundation must be designed as such that the water can get underneath it. in fig.3.29 an idea is showed how the poles are integrated with the foundation. By using springs the in this poles the foundation will be equally levelled all the times.

The different waterscapes of the Parana Delta

the coastal area of Rio de la Plata

The fourth waterscape is the coastal area of Rio de la Plata, in front of the capital of Argentina, Buenos Aires.

This area is located in Rio de la Plata. This mouth of the Parana delta will end in the Atlantic Ocean. Here the Sudestadas winds are the most intensive winds and can reach up to 75 to 90km/h. The result is the increase and decrease of the water level and flooding of the coastal area of Buenos Aires. Winds of 20 to 50 km/h can increase and decrease the water level by 1 meter. The Pampean winds (winds from the southwest) do have the same effect. Besides the tides of the Atlantic Ocean influence the water level of Rio de la Plata. But this is influenced by the winds. 67% of the time the water level amplitude is between 0.3 and 1.29m, however with intense winds this can decrease to 4.06 and increase to 4.16 meters.

In this area there are waves with an amplitude of not more than one meter. The highest waves, at the outer part of the river are 0.6 meters. In the inner part the wave's reaches 0.3 meters. The winds that originate the highest waves are coming from the east (from the pampas) the waves with the least impact are coming from the east-southeast.

This strong winds and fluctuating water levels influence the design.

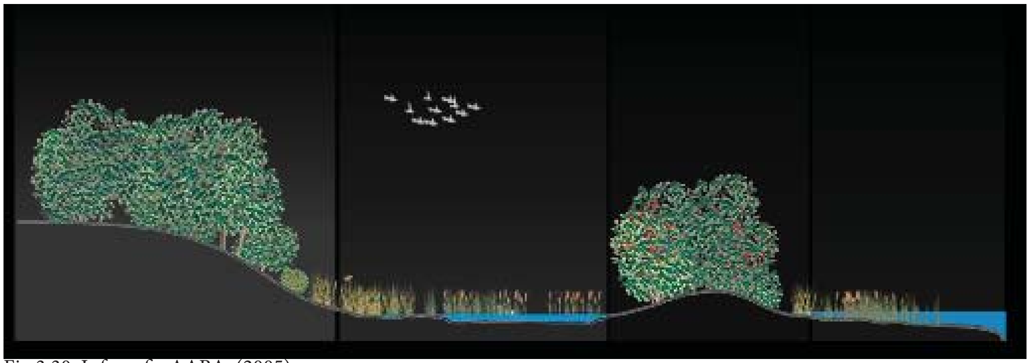


Fig.3.30. Infografia AABA, (2005)

Coastal are Rio de la Plata versus chosen object

Fig.3.40. Situation coastal area Rio de la Plata, Nienke de Korte, (2014)

Fig.3.41. Flood situation coastal area of Rio de la Plata, Nienke de Korte, (2014)

Problem statement

In fig.3.40. can be seen that this waterscape is a wetland within normal circumstances covered by water pools. The dwellings must adapt this existing water. Besides strong winds originate waves and high water levels, fig.3.41.

Goal

The design must change in a way that the dwelling in the normal weather circumstances can live with the existing water. During heavy winds and rain the people must be safe in their house. The construction of the house and its materialisation must be off use in this water environment. Besides the access of the building will change. Here for a solution has to be found.

Conclusion Problem statement

In this area the following challenges are found by implementing the architectonical object in this delta environment.

1

The wind impact of the Sudestadas which can reach 90km/h are of an impact in this environment.

2

The wave impact is a topic that have to be take into account. The tidal waves are in between .3 till 0.6 meters, but waves originated by strong winds can reach 4 meters.

In this case it possibly is better to put the houses higher at shore. The water levels in this waterscape increases big time and in combination with the waves a floating foundation at this small scale would not hold against it. Building at poles would be a solution but already is settled out in the pages before. In this case the chosen object is seen as a solid building at the shore of the waterscape and the changes to make are explained.

Main problem

The strong winds and the waves.

Coastal area Rio de la Plata versus architectonical object

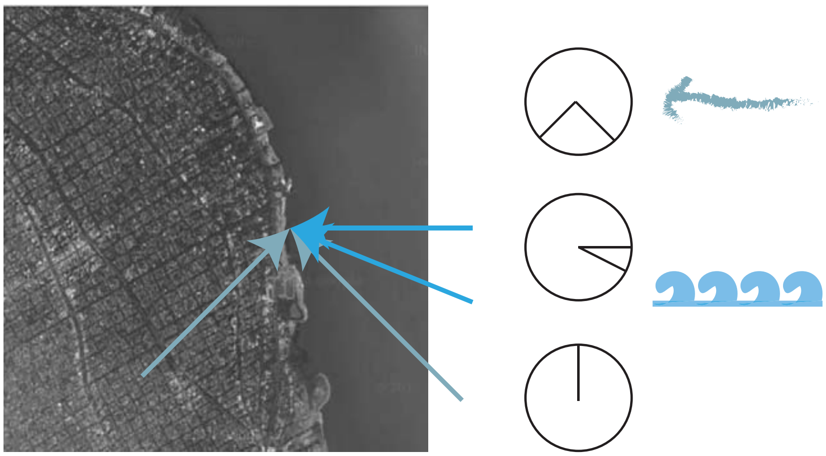


Fig.3.42. Wind and waves, Nienke de Korte, (2014)

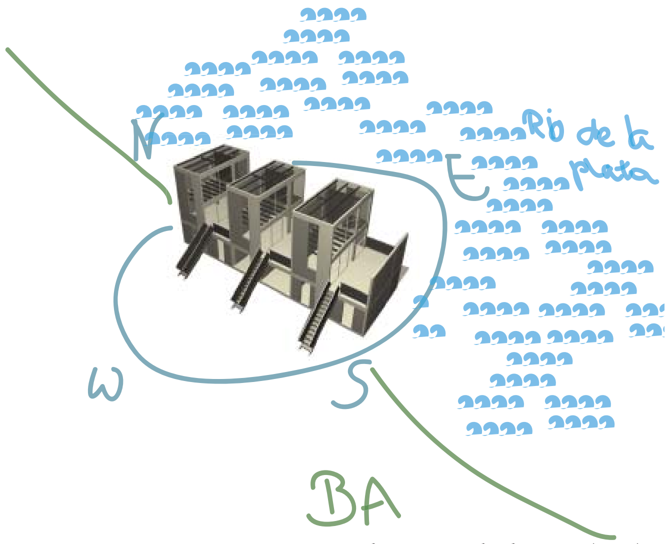


Fig.3.43. orientation houses, Nienke de Korte, (2014)

Change the facade

To make this object water and wind proof some changes has to be made. First the orientation of the building makes sense in this environment. The strongest winds come from the southwest and the south east, the biggest waves come from the east and the east south-east, fig.3.42. To protect the houses as much as possible for the winds and waves, the facade must have as less as possible openings in these orientations, or the openings well during these strong impacts. The shore is situated at the west. Looking at the design, the front of the building better faces the west to make a better connection and to protect the people from waves and winds when they enter their houses. In this case the backside of the building faces the strong winds and waves and will be a more closed facade to protect the interior for the winds and waves, fig.3.43. In fig.3.46. the Torqueay house is showed. Here the facade is protected by total closed facades to protect it for storms. The existing materialisation of the chosen object, concrete does fit in this scene.

At the other hand this side of the building has a nice view over the Rio de la Plata. A solution might be to make openings in the facade but make an implementation that closes these openings very well during waves and winds.

Strong winds and waves versus architectonical object

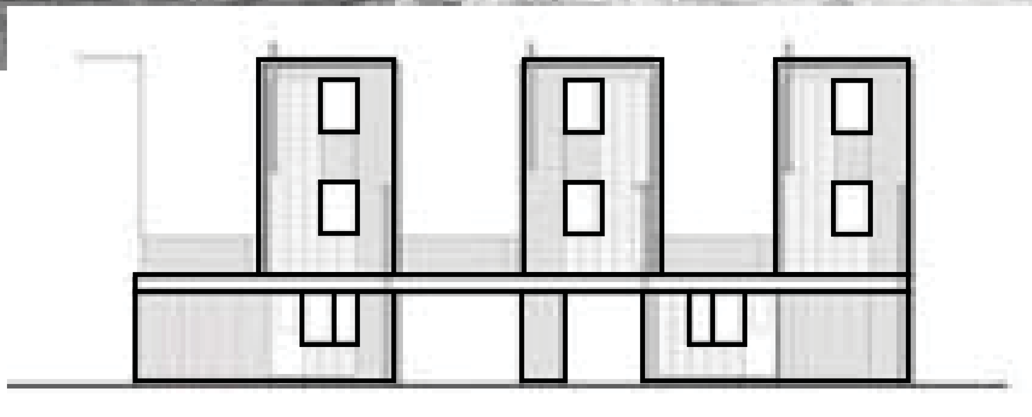


Fig.3.44. Current back facade, Nienke de Korte, (2014)

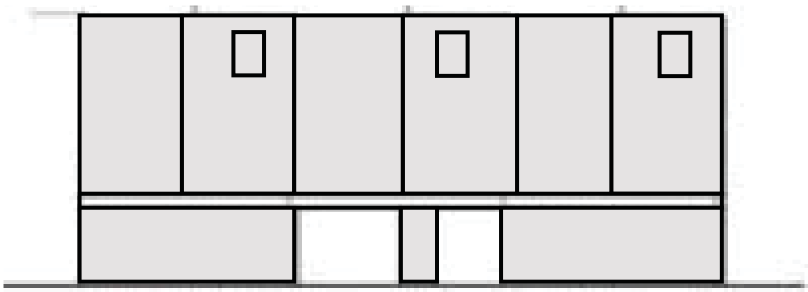


Fig.3.45. Closed facade, Nienke de Korte, (2014)

An example of this is showed in fig.3.47. In the Feanor Cottage moveable panels are used. Because the facade has to cope with winds and water, the materialisation of the building must be strong and water and windproof. In the Feanor cottage these panels are made of perforated metal screens. In this case there is still a view from the inside out but the cottage is protected against winds and rain. These two sollutions are implemented in the design in fig.3.45. and fig.3.48.

Fig.3.46. Torquay house, Derek Swalwell, (2012)

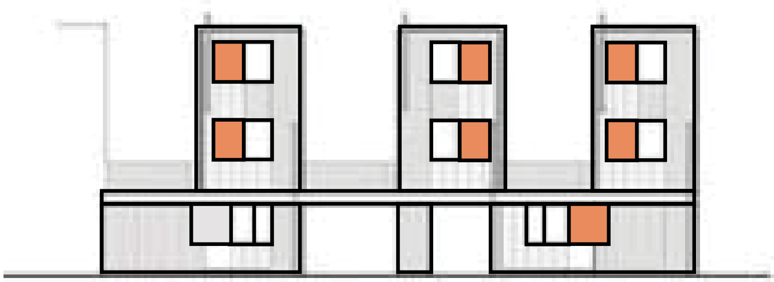
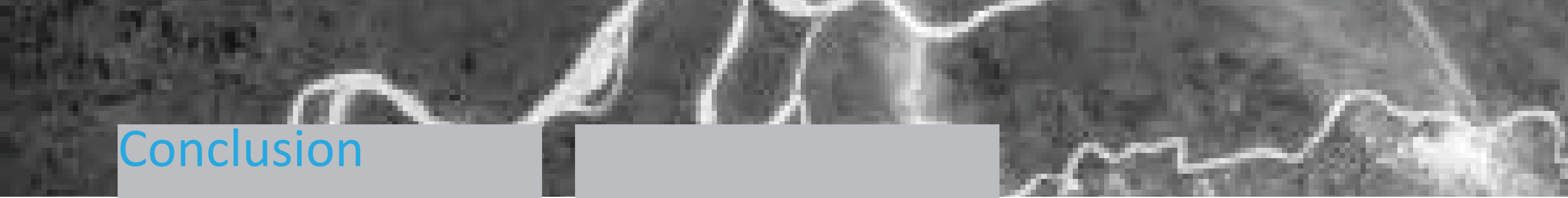


Fig.3.48. Facade Panels, Nienke de Korte, (2014)

Fig.3.47. Feanor hay cottage, freshome, (2012)



Conclusion

1

In this report four different waterscapes are described, the coastal continantal area, the inner delta, the young delta and the coastal area of Rio de la plata.

2

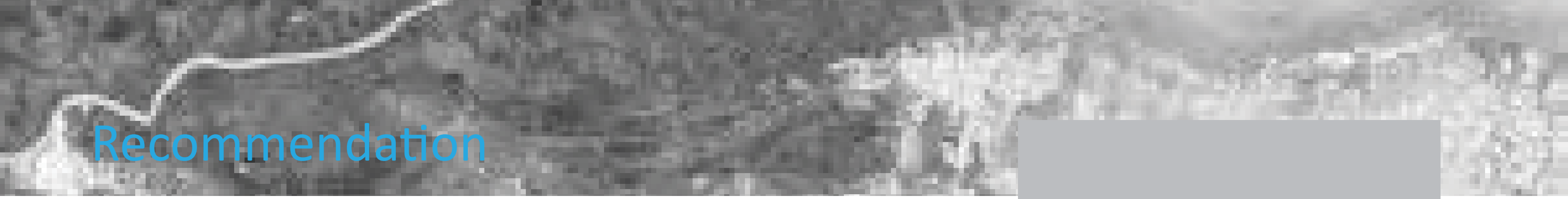
Different problems were stated in these waterscapes such as rising water level, dynamic changeable environment and the strong winds and waves.

3

Several solutions to adapt the chosen object are given. Most stated solutions in this report are putting the object at poles or make it amphibious, change the facade by leaving out facade openings or .protect these openings by screens.

4

By the changes of this chosed object also suggestion are made for the materialisation and the acces of the building to adapt it even more o the different waterscapes.



Recommendation

When building in a waterscape it is important to analyse the characteristics of the waterscape and the characteristics of the water during an environmental change such as a flood. As can be seen in this report, the four different waterscapes diverse even they are all part of one delta system. No part of a delta is the same, that means that none design in such a delta can be the same without good research and analyses.

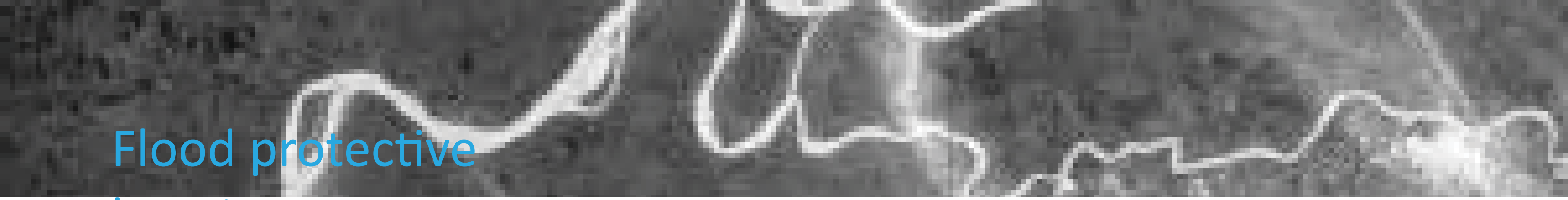
To reduce the costs of loses by flooding I recommend that new built urban tissue in this delta will be well considered. The risk of the changeable environment of water, soil and strong climatological changes, can be reduced by designing with take these changes into account. The outcome will be flexible objects which can adapt these changes. This can partly been done by building the objects on studs or to make them floating or amphibious, all depending on the specific delta waterscape with their own challenges.

For this delta specific I recommend to build amphibious and demountable objects. This because this environments knows a lot of changes by the characteristics of being a growing delta and because of the heavy rainfalls that occurs floods. In this first case it might be necessary to move the building to another location. In the second case the house must adapt the rising water that can be done by an amphibious structure.

In the chapter research typologies litlle more research is done about different typologies. Not only the building type but also the materialisation is of importance. Water proof material must be used for these parts of the object which are in connection with the water to make the live spam of the object longer and the objects more sustainable.

And because of the heavy winds and rainfalls the facade opening are a design challenge as well. They must be protected against the elements to make the object a safe living environment.

The waterscape of a delta is a dynamic environment and with that designing in such an environment is a challenge for every designer.



Flood protective housing

This part discuss the possible water management strategies in a dynamic delta environment. The delta is an economic, ecological and hydrological important area which has to deal with many problems due to the human hand (Volpe, 2013). Because a delta is a dynamic water area with risks of flooding, it is important that the inhabitants are protected against flooding. People from the lower middle class still built their houses at the coast of the delta because these areas are mostly unused and cheap land because of the risks of these areas. It is important that these people get aware of the risk of this area and live in a safe environment. That is why in this chapter the different water management strategies and prototypes of water resistant housing is researched. The research question of this chapter is:

In what ways housing can be designed as water resistible housing in a dynamic water environment?

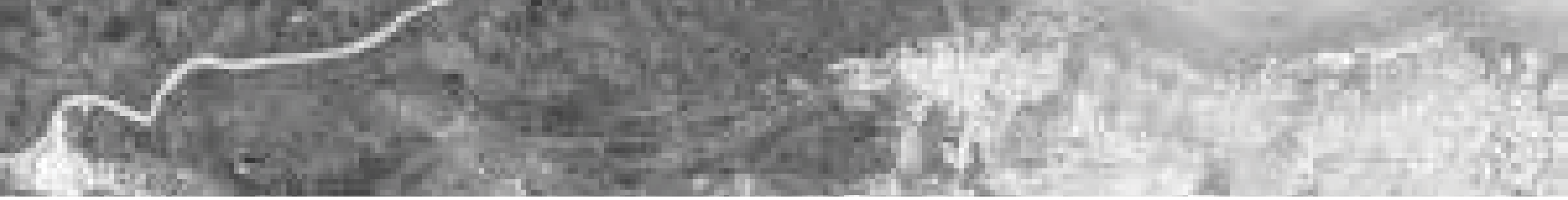
This question is answered in the upcoming sections. First a brief explanation of the effects of a delta by using journals of delta experts, like Volpe, Baigun, Fabricante and Kandus. The second section discuss the ways of water management also supported by literature of Bowker. The third section discuss the different water resistant prototype housing such as pillar houses, floating houses and amphibious housing. Here for literature from experts such as Boo, Mongkonkerd, Hirunsalee, Kanegae and Denpaiboon is used, besides references of build prototypes are discussed. The literature of these chapters and the reference projects is be compared and put in conclusion.

2 The delta environment

Many deltas are used for agriculture, water transport, industry, recreational and residential use. Because of this the ecological system of the delta is disturbed, problems in a delta are the pollution of the water, the infrastructure such as dams and levees and the privatization of the coast. These elements are the reason the ecological end hydrological systems of the wetlands are in danger (Volpe, 2013). There still is a high demand for housing for the lower middle class in these areas. But living in a delta area might be a risk. A delta is a changing natural environment due to the changes of the water streams and the seasons. Because of the segmentation of the rivers new land is created and because of the erosion land disappears. These are the causes of the consequently change of the delta environment. Besides the delta is a wetland. These wetlands are exposed to tides and floods caused by heavy rainfall and strong winds out of the ocean and river streams. (Fabricante et al., 2012) This means that building in such an environment might be a risk. While building in a wetland you have to take the change of the water and the soil into account. Nevertheless, so far these risk are not taken into account in the built environment of many coastal areas of wetlands. Mostly the urbanization of the coastal wetlands is done by the habitants themselves. The housing are slums and not suitable for floods. Other communities construct dams and levees, which just makes more risks of flooding as be explained in section 3.

3 Water management

The Dutch, are coping with flood risk since 1000 before Christ. They built dams and dikes, made levees and windmills to pump out the water to create land. But these interventions might not always be the solution to control the water and its flood risk. As said in the introduction, these control of the water is bad for the hydrology and the ecology of the delta. The delta is the natural habitat of many species. It is also a water purification system (Baigun et al., 2008). Nevertheless people want to live in a safe environment, protected by the possible floods. In this chapter a view of the possible ways of water management is explained.



3.2 Flood preventing management
At a bigger scale flood management is done by constructing dams and dikes. These dams and dikes keep water out of the land. In this way people can live safely at dry land. A great example of that is the Afsluitdijk in the Netherlands. This dike, part of the Waterwerken, separates the North Sea with the inner land of the Netherlands. With this dike, the land will not flood during a storm. Excluding the water from the natural delta also has side effects. By keeping out the water, the ecology and the hydrology of the natural environment change drastically. With that the natural habitat of many species is lost.

3.3 Temporary water management
Besides the infrastructural way of flood preventions, there are other ways to protect housing for floods. In her article "Making properties more resistible to floods", Bowker describes several ways of flood protection. She describes the sandbag as the traditional way of flood protection (Bowker, 2000). These sandbags are placed at the façade openings to stop the water from entering the building. The sandbags are not sustainable, they are not reusable ant they can leak. Besides they are very heavy. Bowker categorizes local protection in three sectors; temporary and demountable barriers, removable barriers and materials and techniques that minimise damage from floodwater. These categories are based on the relation of the route of the flood water or of the property itself.

3.4 Temporary and demountable barriers
Examples of temporary barriers are filled container with permeable or impermeable liner, air- or water- filled tube, free standing flood barrier, flood barrier with frame, panel barrier with frame and panel barrier with rigid lengths. Temporary defences can be used to add height to existing barriers or to protect small communities during a flood. Demountable barriers need more time to be installed so they can only be used if there is sufficient warning time. It consists out of light weight metal profiles supported by posts.

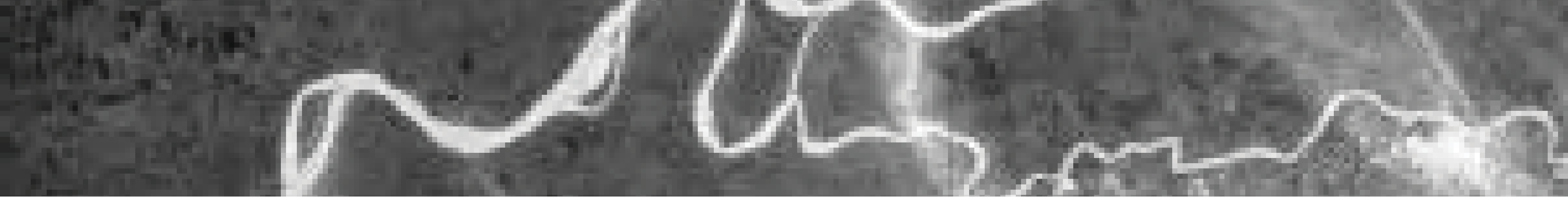
Removable barriers seal the properties doors, windows and airbricks. Examples of these barriers are flood boards and airbricks which are used for all façade openings such as doorways en window openings. These walls have enough strength to protect the property for floods up to 9 meters. But they are only of use if the boards are intact and if the water cannot enter the house through the floor or drainage system.

3.5 Architectural influences
More integrated flood protection in architecture might be external walls made out of flood resistible materials such as solid masonry, cavity walls, timber framed walls and half timer framed walls. Water-resistant coatings and paints help prevent for flood as well. The coating should be placed 500mm abode the expected level of flooding.

4 Architectural typologies

As might be clear, flood occurs a lot of damage in properties. In an architectural point of view, a better way than protect the property with temporary water management or dams and dikes, which sometimes even are the source of flooding, is to create housing which are flood proof. This part discuss three types of so seen flood proof buildings; pillar housing, floating housing and amphibious housing and compare these prototypes with a solid building, fig. 4.49

4.1 Pillar housing
These housing, protected by flood by lifting them with pillars, is an ancient way of building. In many areas all over the world people try to protect their property by living in pillar housing. In the research made by Mongkonkerd, Hirunsalee, Kanegae and Denpaiboon, the damage made by flood in Thailand by pillar housing, one storey housing and two storey housing are compared by the average



time and the damage of the physical structure of these three housing types. It happened to be that the pillar housing suffered the less of the flood in these three categories (Mongkonkerd et al., 2012). Pillar housing is a suitable building type in a flood zone. But, in the case of global warming, the water level rise even more in the upcoming years. Pillar houses are aligned with a certain water level, in the future this level might even be higher, than the pillars are not high enough and the house shall flood. So in the short term this architectonical typology is a good solution for flooding, but at the long term it might not be sufficient. fig. 4.49.

4.2 Floating housing

A second architectonical typology of flood resistant housing might be a floating house. This typology, originally built by people from the lower classes (Rijcken, 2005) such in Vietnam, Peru etc., now is also seen as a possible solution for flooding (Boo, 2005). During a flood the floating house rises with the water level. This might make floating housing suitable for flood risk areas. Nevertheless this flood proof typology also has its counters. The platform used for floating is minimal one meter under the water. When the topping gets heavier, the deck sinks even more. When you are building in an area with shallow waters the deck might rest on the soil. If this soil is non uniform, the deck might crack and the construction might sink. Deeper waters are needed when using floating housing (Boo, 2005) Rijcken states that if you make floating islands instead of floating houses the deck is unsinkable (if made by Styrofoam foundation), there is more outdoor space and it is more stable (Rijcken, 2005) It is also recommended that the construction of the building is as light as possible, for that wooden construction is recommended. Besides the constructive side of floating housing, floating housing also might occur problems as planning permissions, mortgages and insurances while floating housing possibly are no part of the real estate. Many countries, where among the Netherlands, do not have clear administrative options for living on the water. This makes the new innovative way of living visibly more difficult (Boo, 2005).

4.3 Amphibious housing

The third described option for a prototype in this paper is amphibious housing. The construction of this kind of housing is founded with pillars which works like a car antenna (fig. 4.50). During a flood the deck under the house is lifted up by the water, the antenna like pillars keeps the construction in place. When the water level reduces, the house gets down with the water level. In this way the is protected for flooding and will not break, like a floating house, when it touches soil. This is a suitable solution for flood risk areas. A nice reference are the Maasbommel houses by Dura Vermeer Architects (fig.4.51). A possible counter is that the houses are founded and because of that not moveable.

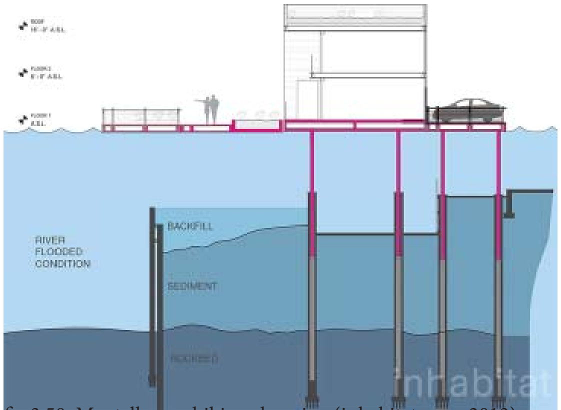


fig.3.50, Mantella amphibious housing (inhabitat.com, 2013)

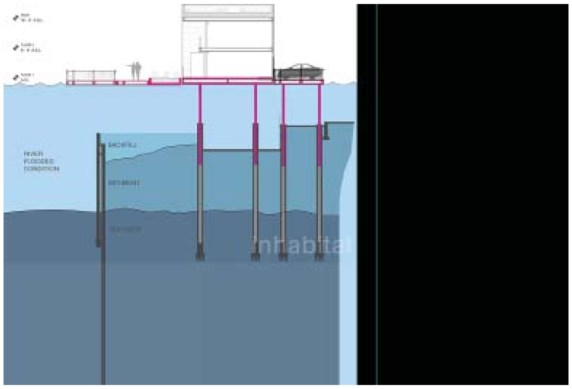


fig.3.51, Maasbommel (friederike de Raat, 2007)

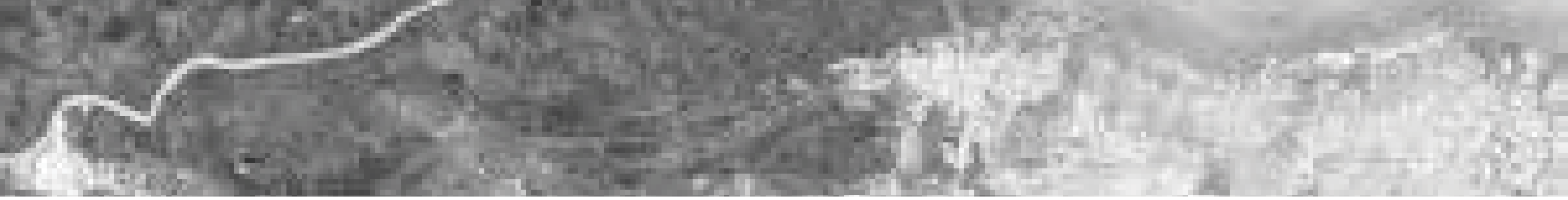
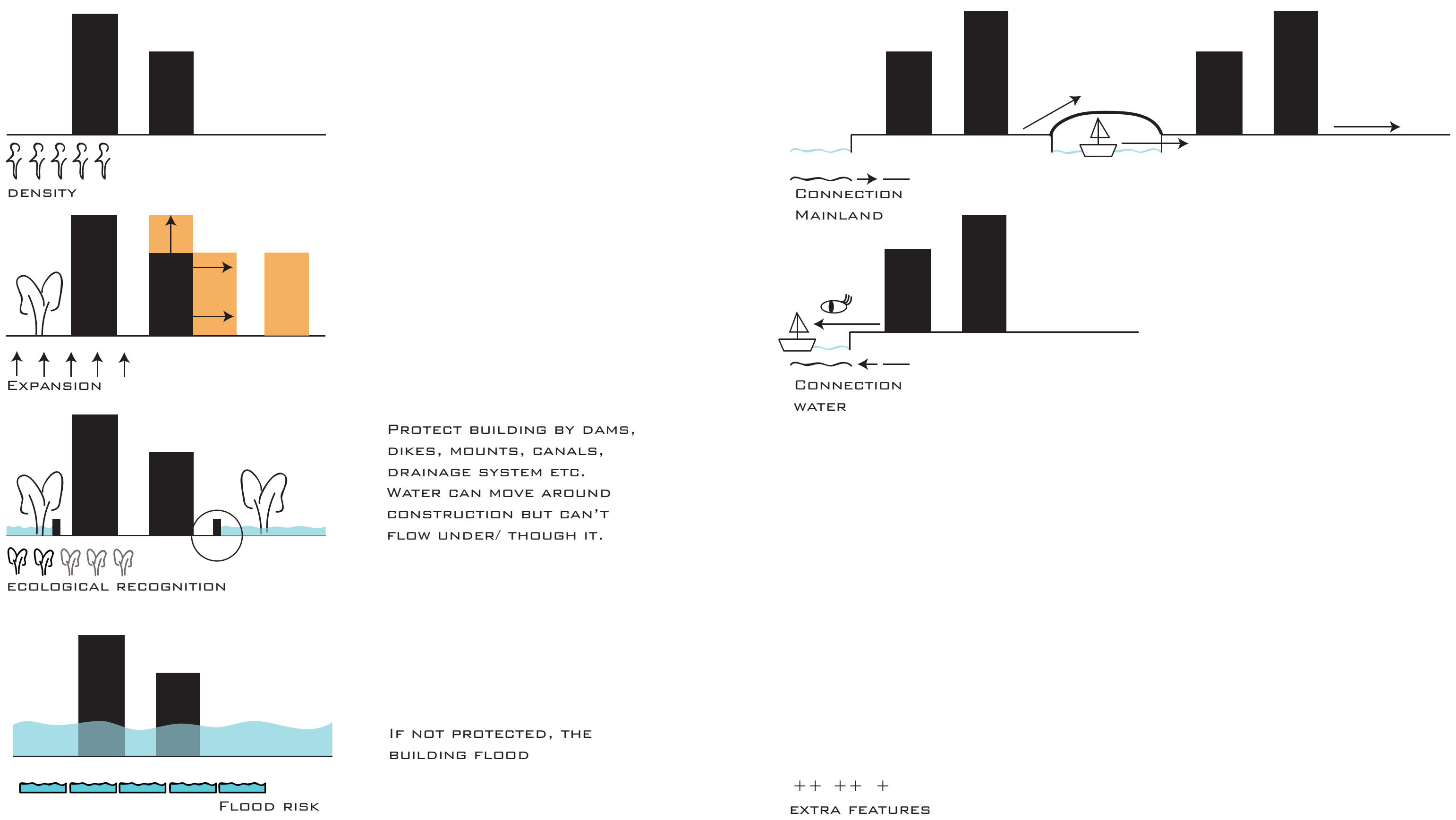
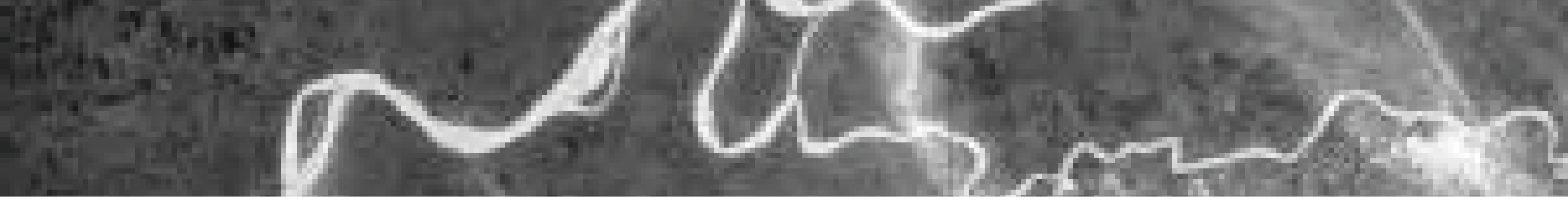


fig. 3.49, Nienke de Korte, (2014)

The solid building can be a construction that has the possibility to be high and increase with that the density of the area (more people per sq can live, if the building is a tower of more floors). It is also relatively easy to expand because of its subsoil.
But this kind of buildings are quiet vunerable to flooding. During a major flood the first floors can be destroyd by water becasue there is no protection against the water. This can be solved by dams, dikes and some architectonical implementations. The problem with protection with dams, dikes is the influence this has at the ecoligcal system as explained in chapter 1.

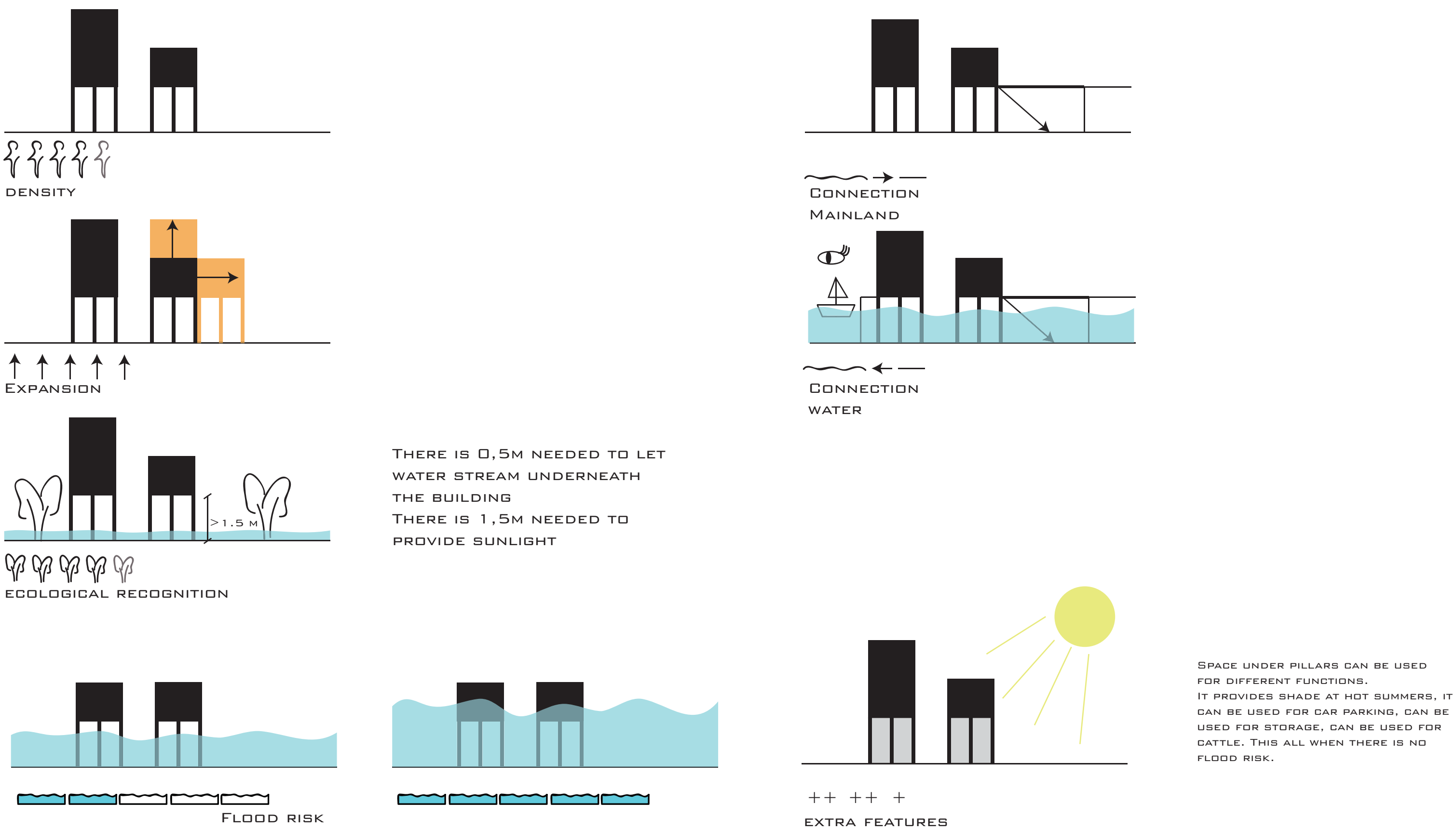
Solid building

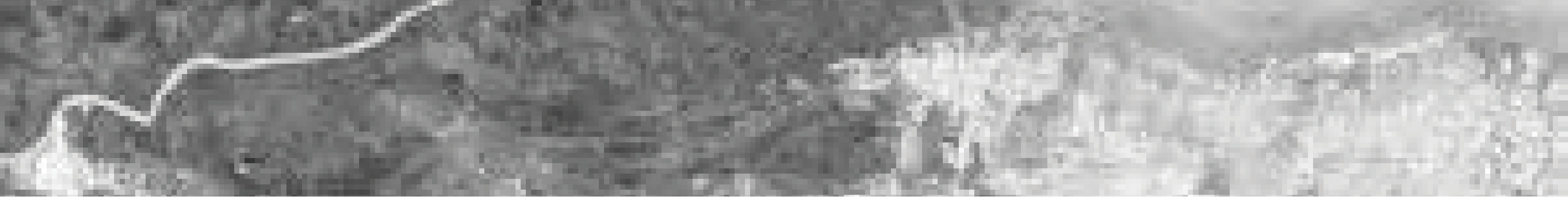




The pillar building has as features that it is elevated. That means that during a flood the water will not reach the living area of the building. The owners will be safe. But it cannot adapt possible higher water levels, since the water level will rise the upcoming years, this kind of building is not perse the most sustainable solution for a flood risk area.
The possibilities of expansion is high. As can be seen in many informal settlements were pillar building are used, the houses can be expanded by the owners them self, fig. x. A problem is the connection with the mainland, this always must be done by stairs or an elevated road. An extra feature of the pillar building is the shaded area under the building. These areas can be used for livestock, family reunions etc, if no flood occurs.

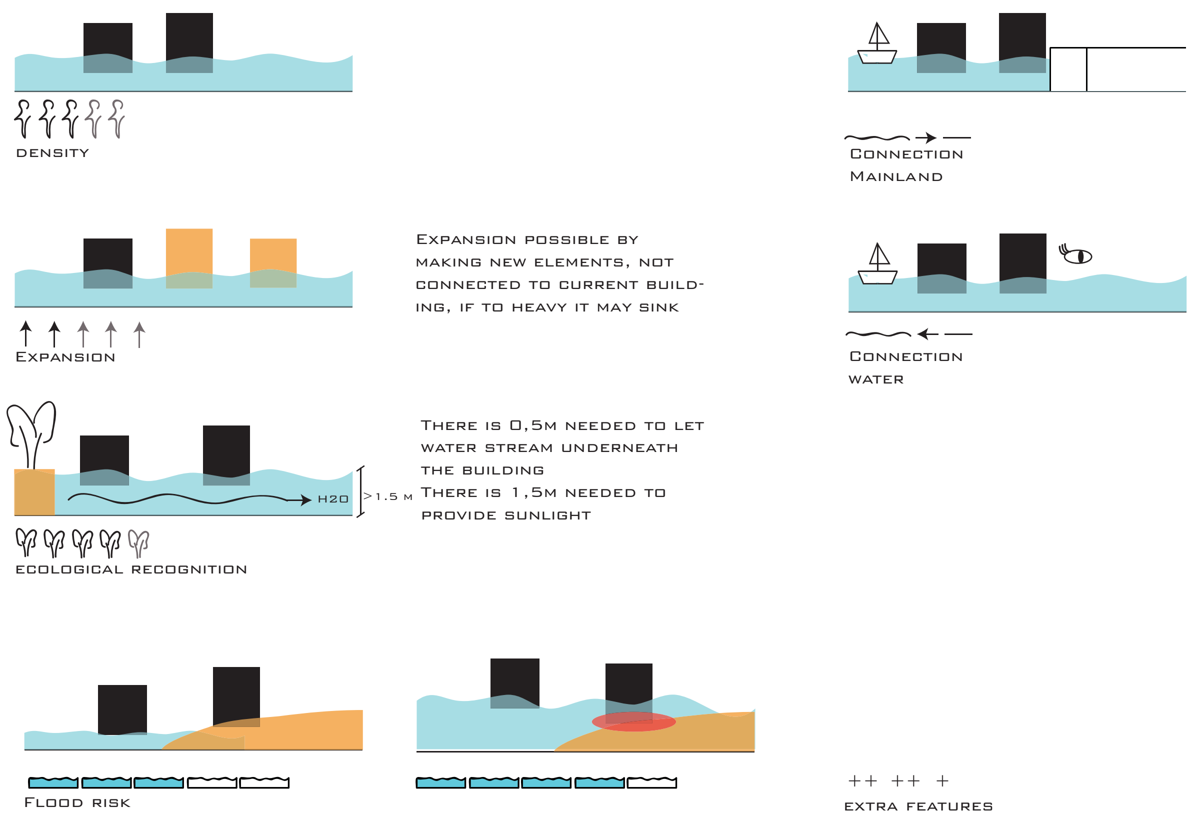
Pillar building

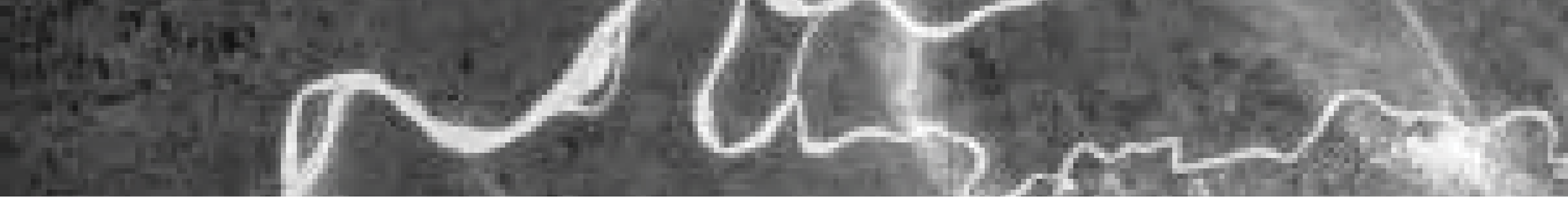




The floating building is made to be used at water. It looks like the best solution in a water scape area. It sure is if the water is always there. Since the waterscape of a delta is dynamic, sometimes with flooding sometimes with a lack of water, a floating building might have some problems. If the deck of a floating building gets in connection with soil, it might break. This damage the buoyancy of this building, it will sink than during a flooding. At the other hand, it does not obstruct the hydrological system if situated in a 100% waterscape.

Floating building

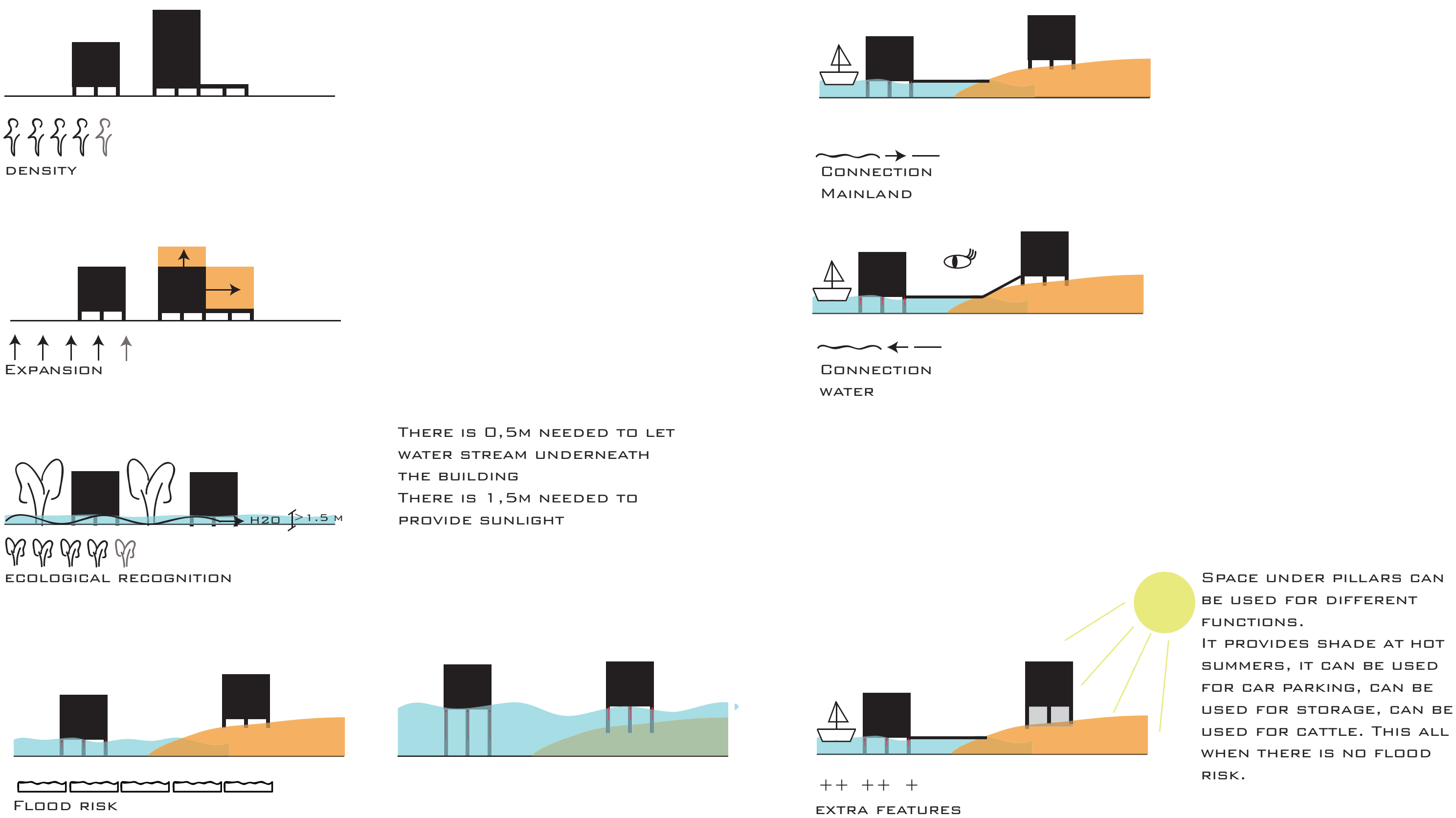


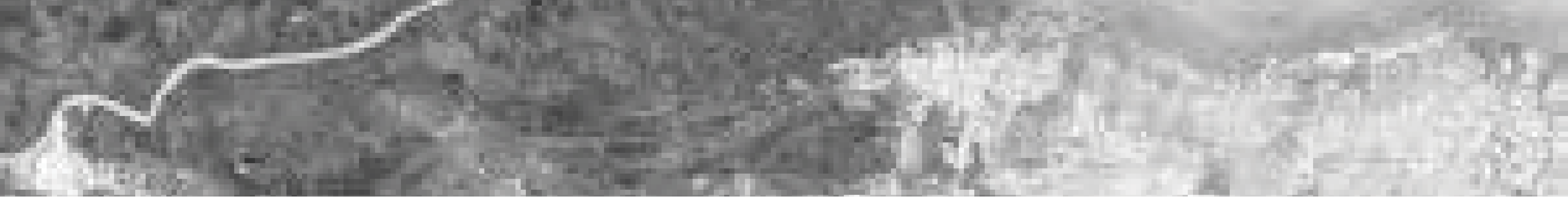


The amphibious building prototype is a flexible prototype. The concept of this kind of buildings is that it is built at mainland but during a flood will float. This can be done because of the construction underneath the building. This construction is made of a deck that will float on water. This construction is founded to the land so it will not drift away during a flood. The feature of this kind of construction is that it can adapt any water level, considering the stability element of the construction to be high enough.

In this way water always can flow wherever it wants to go and will not be obstructed by the object. Besides the connection to the mainland but also to the water is high because of its ability to adapt the water level. The environment can change around the object without the object being harmed or destructed. This kind of prototype suits in the dynamic environment of a delta.

Amphibious building





Conclusions
A delta is a dynamic environment due to ecological and hydrological system and the input of the human. Notwithstanding the possible flood risk, the housing demand is high in these wetland areas. There are several ways of protecting the living environment such as flood preventing management by dams and dikes, temporary water management such as sandbags and barriers and architectural influences such as sandbags in the door openings. Another way of protecting is to make the residents flood proof. Three prototypes are described in this paper; pillar houses, floating houses and amphibious houses. In figure 3.52. These three prototypes plus a solid building to compare with are compared with each other. As can be noticed in this image the pillar houses are suitable for flood areas, but they are aligned with a certain maximum water level, if this maximum water level rises, the pillar houses flood anyway. The second prototype is the floating housing, this prototype is also suitable for a flooding area but if the water level reduces or the water is shallow, the deck touches the soil and it might break. The third option is amphibious housing. These houses are founded and have an antenna like construction which provides the rising water level to push the house up. In this way the house goes up and down with the changing water level. This last prototype likes to be the most suitable flood proof prototype in a dynamic water environment.

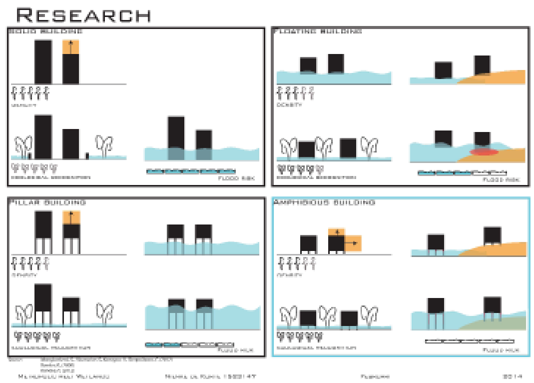
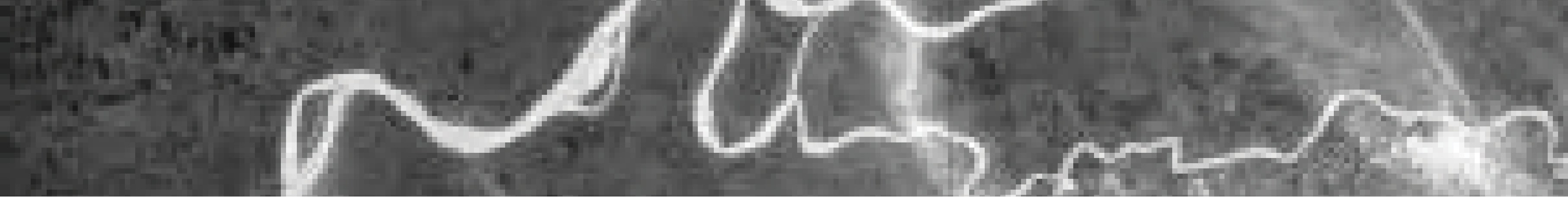
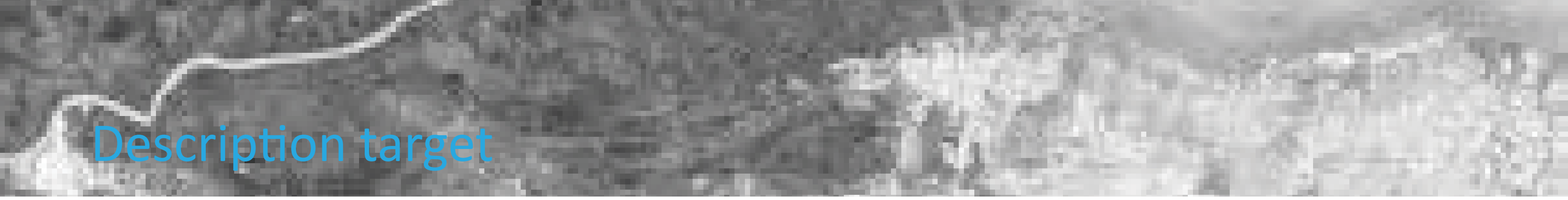


Fig. 3.52. Research conclusion building prototypes, (Own work, 2013)

Recommendations
As an architect it is my duty to make suitable housing according to the social aspects but also according to the environmental aspects. In my graduation project I design a dynamic prototype for social housing at the Parana delta coast of Argentina which must be implemented in different parts of the delta with their different demands. They also have to cope with possible flood risk due to heavy rainfall and flooding of the rivers. This dynamic environment demands for dynamic housing. This chapter described the different possibilities of water protection, as an architect my recommendation is to integrate the flood protection in the architectural design. This kind of flood protection is not the leading topic of my project. Because the design is a prototype which must be implemented in water but also in dynamic environments (example: River buffer zones), the floating housing is not suitable for my project. The deck might break in more shallow waters. Pillar housing is a good alternative because they are above the water level. But I recommend the amphibious housing. This housing typology adapt more changes of the water because they level with the water heights. Besides this kind of housing do not harm the ecological system since they do not depend on the soil of the location but are lifted from the soil by the antenna like construction. At last this housing typology is better accessible than the pillar houses because they are connected to the ground, less stairs are needed to enter the houses which might reduce the costs of this typology and makes these typology suitable for different functions



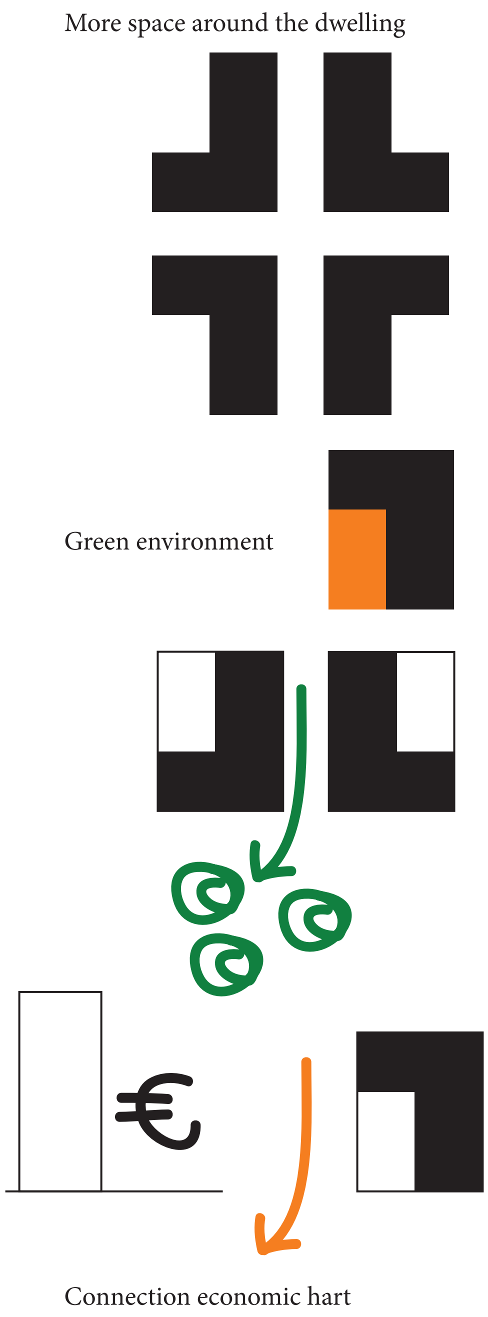
4. Target group



Description target group

The target group of this project is the lower middle class of the society of Argentina.

The history of this class starts in the 19th century and beginning of the 20th century. Immigrants of Europe, mainly Italian, German and Spanish, tried to find their luck in Argentina. They settled in small and unhygienic housing. In this time a cooperation, Hogar de Obrero, started to build more hygienic and comfortable social housing. After a hundred years and many changes in the society and density of Buenos Aires, there is a new demand for social housing for the lower middle class because of the economic movement. People from others parts, mainly the pampas, move to the metropolis belt at the coastal area of the Parana delta to start a new living. In the current situation a majority of these people live in informal settlements. These kind of communities are known as unsafe and unhygienic, such as the housing in the beginning of the 19th century. That is why there is a demand of hygienic, affordable and safe social housing for this social group.
The community of my design are suitable for small families and starters from the lower middle class. Communal aspect is important in the design to increase the social control of the community.
The houses in the community are also attractive for the middle class and even the credit class because of the open space around the dwellings, the possibility of expansion and the good connection to the metropolis and the delta, see fig.x. By selling a part of the houses to these middle and credit classes, the housing for the lower middle class can be financed. This mixture of classes will stimulate the economic value of the area. In the design I will concentrate on the housing for the lower middle class.



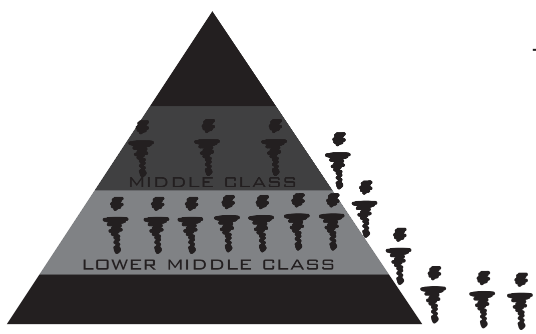
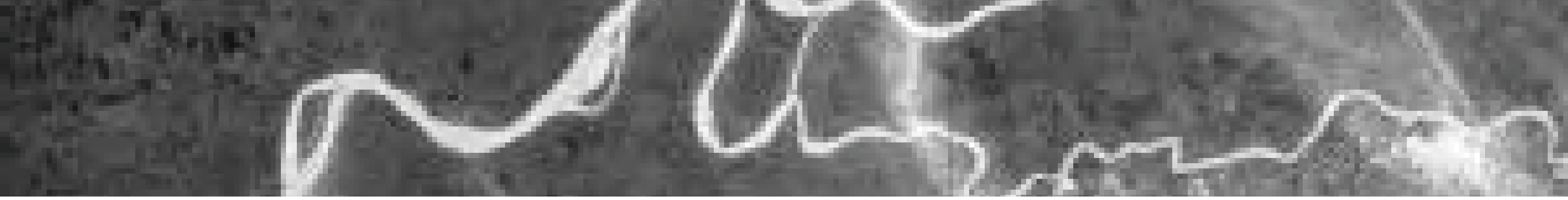
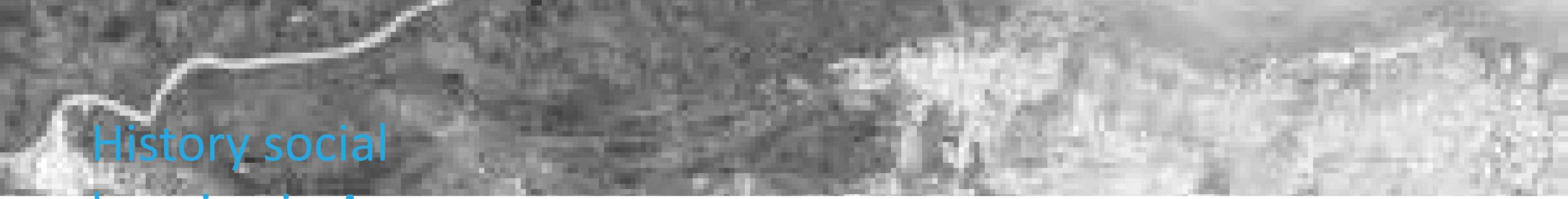


fig. 4.1, attractiveness living in delta, own work, (2014)



5. Social housing in Argentina



History social housing in Argen-tina

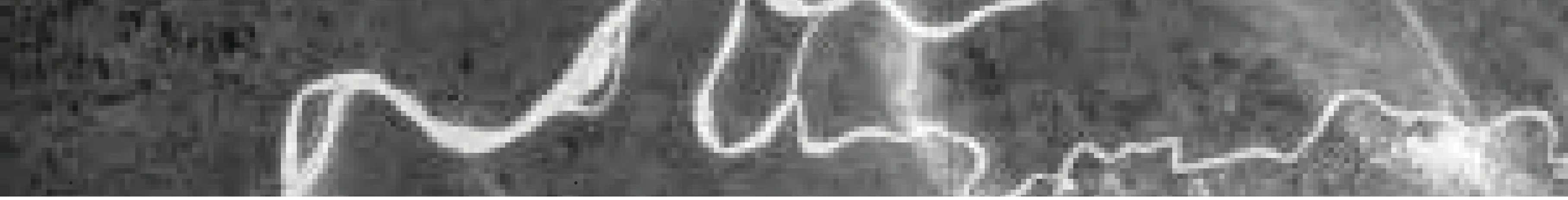
Social housing in Argentina is a topic of the past100 years in Argentina. The middle 19th century and the beginning of the 20th century, there was a big immigration to Argentina from out Europe. This European movement increased the size of the Buenos Aires Capital rapidly. In this time. This immigration was the basis of the cultural forming of Argentina. With that different cooperation's started, included the in 1902 founded El Hogar Obrero., which is a cooperation for housing. In the first years they build different social houses. The cooperation El Hogar Obrero tackled a social problem; hundred thousand persons lived in unhygienic housing. The cooperation wanted to change this. Justo, Repetto, Gimenez y Dickman were doctors were part of the cooperation and were aware of the problems of these settlements. People lived in rooms of 4x4meters with their whole family. The rooms were badly ventilated and insulated. People, lived, cooked and slept in the same area. In 1907 tenants broke a strike. They refused to pay their rent. The social governable party considered this arguments of the tenants because they saw that these protest influenced the productivity of the labours. They concluded that more houses were needed. But the opposition did not agreed. However it happened to be a topic in the parliament. In 1910 el Hogar Obrero started to build several social housing projects. They did not only change the quantitative deficit, but also the transformation of popular housing, especially the sanitation. The upcoming years the cooperation build many more social housing. They were diverse in prototype of renting, from 1948 they started to sell the apartments. They also started to build complete neighborhoods of apartment buildings and collective buildings, with commune routings and functions. At 1991 the cooperation build over 5300 houses. The crisis, just before the First World War, affected the building grow.

There used to be a discussion in the cooperation about the prototype of the wished social housing. A part idealized the individual housing surrounded by green, meanwhile the opposite preferred collective housing because this would be the solution for the economic grow. In an interview of an owner of an individual houses she tells that the dormitories an in compared with the living room and kitchen are quiet big, see fig.x. She does not really agree with the floor plan. The value of these houses is the neighborhood where everyone knows each other, also thanks to the communal origin of the social cooperation.

But in between 1913 and 1955 the collective house was the mainly build prototype. In contrast to the individual houses, the collective houses used the ground in its maximum. The collective houses proposed to increase the living conditions of the houses. Another characteristic of these kind of houses are the communal areas such as reunion areas, educative, cultural social and sport areas, which were designed as part of the community. The apartments are situated in a building block, more families can be placed in this way, which is good for the finance. The discussion about the individual houses and collective houses were a big topic in these times. Both typologies, as described before, have cons and pros.

In my opinion the individual houses have a nicer atmosphere. The owners feel more responsible for their houses because they can identify themselves with their house. Besides the green environment is positive. At the other side the communal areas of the collective houses connect the dwellers with each other. This also is important for a community. Interaction with inmates increases the social control and the safety of an area.

During time the cooperation changed, the function, hygiene and comfort were the leading topics of the social housing. Also the treatment of the communal areas changed and got



more important. The interaction of familiar and social was used in different scales in the building environment. The routings now also needed to be used as social and meeting areas. In this way social control is formed. The changes are also visual in the floor plan. The dormitory got smaller which made it possible to make another dorm so the adults and the kids could sleep separately. Besides the kitchen got bigger.

Routing and communal spaces

In general the collective houses are integrated with great areas of green and communal functions at different levels, from the urban scale to the domestic scale. Many inner spaces are integrated in the collective housing design which are used for interaction of the owners. The equipped communal spaces increase the connection with the neighborhood.

Present collective housing

Talking about the current collective housing means analyzing the interaction between the many actors and circumstances that surrounded the construction, administrative management, the maintenance and the appropriation of the owners. Constructively speaking the problems of the social housing are affected by the complexity and the high costs which the conservation of the quasi centenarians demand.

After a building break in the 80's of approximately 17 years because of the economic and political crisis in Argentina, there is a new generation of collective housing. A multifamily totally industrialized house was the new prototype for the middle and higher class. But this did not came off the ground. Again a break of almost 20 years started. Now a days the demand for housing is a current issue that affects hundred thousands of families in the metropolis area of Argentina. It's said that the current situation, in a different and diverse scheme, is similar to the situation in 1905 (R. Dunowics & F. Villaveiran, 2013).

That means that there is a demand for a reformed social housing typology that answers the demands of the modern lower middle class of Argentina.

Case study

To get a better impression about social housing in South America, I have done two case studies. The conclusions of this case study can be found in fig. x. I concentrated at the initial floor space and the budget of social housing in South America. Thanks to this case study I got an impression about the possibilities for my own design

VILLA VERDE, ELEMENTAL
CONSTITUCIÓN, CHILE

BUDGET: ? US $204 /SQM
484 HOUSES + 3 COMMUNITY CENTERS
SITE: 85,000 M2

TYPE 1
INITIAL AREA: 56.44 M2, 11526 US $
FINAL AREA: 64.90 M2, 13260 US $
TYPE 2:
INITIAL AREA: 56.88 M2, 11628 US $
FINAL AREA: 85.10 M2, 17340 US $
COMMUNITY CENTER: 95.90 M2, 19584 US $
37% MINIMUM OF GROUND BUILD
48% MAXIMUM OF GROUND BUILD

57 HOUSES PER HECTARE
FOR PROTOTYPE:
INITIAL AREA: 54 M2
FINAL AREA: 90 M2
COMMUNITY CENTRE: 180 M2

QUINTA MONROY, ELEMENTAL
IQUIQUE, CHILE

BUDGET: US $204 /SQM
UNITS: 93 HOUSES
SITE: 5000 M2
CONSTRUCTED AREA: 3500 M2

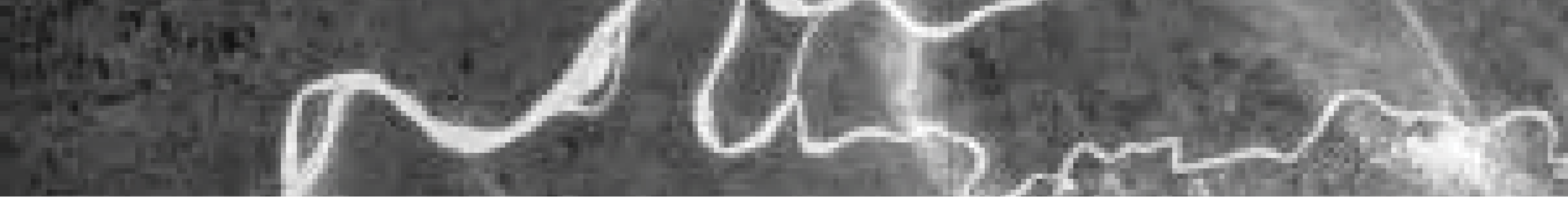
INITIAL AREA HOUSE : 36 M2, 7344 US $
FINAL AREA HOUSE: 70 M2, 14280 US $

INITIAL AREA APARTMENT: 25 M2, 5100 US $
FINAL AREA APARTMENT: 72 M2, 14688 US $

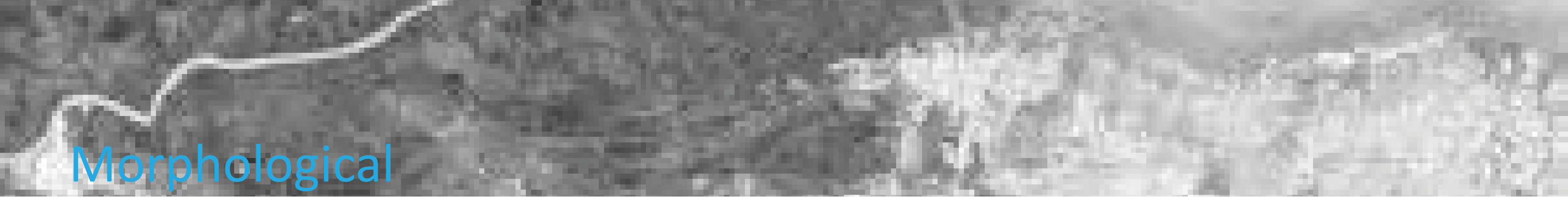
70% OF GROUND BUILD

186 HOUSES PER HECTARE

BUDGET: US $204 /SQM
40 HOUSES PER HECTARE



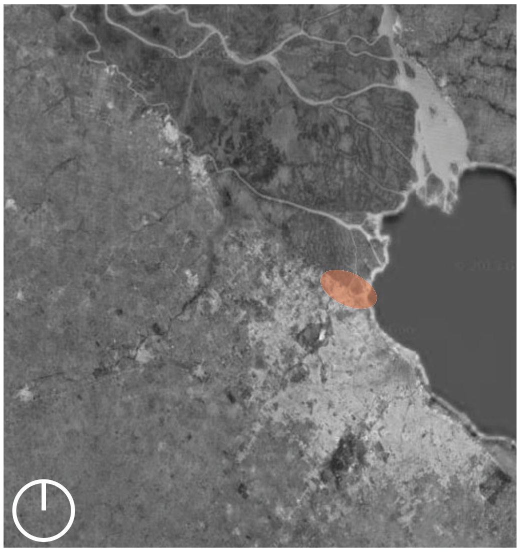
6. Spatial Concept

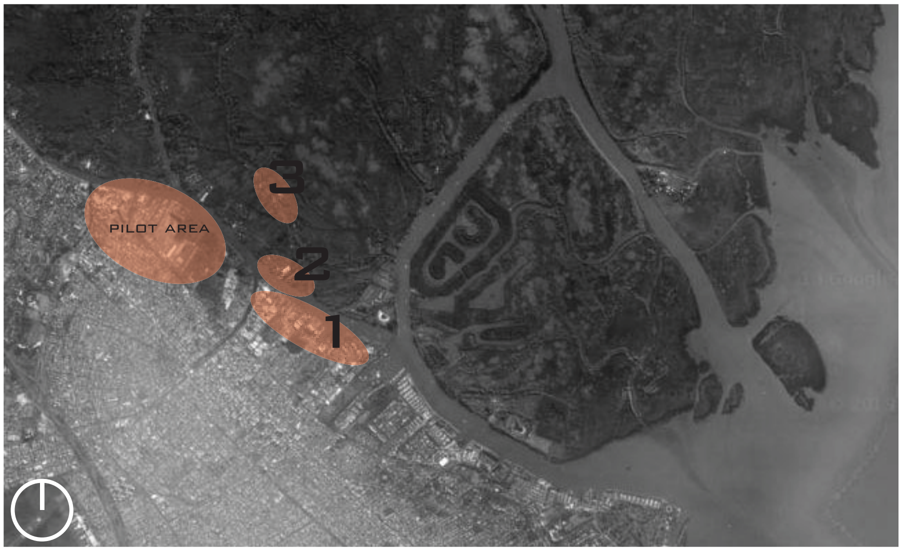


Morphological Analyses

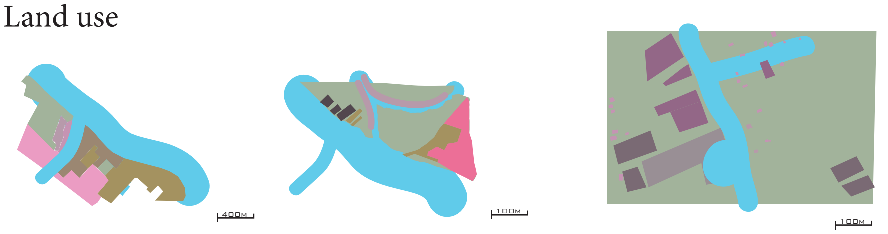
Before making a spatial concept the location has to be understood. In the chapter before an analyses of the location has been done. This chapter will focus a little more ate the different waterscapes in the lower Parana delta. For that three areas are chosen and analysed for land use, accessibility. This are the continental coast, the delta coast and the inner delta coast see fig. 6.1.

fig. 6.1 land use different location lower parana delta, Own work, (2014)





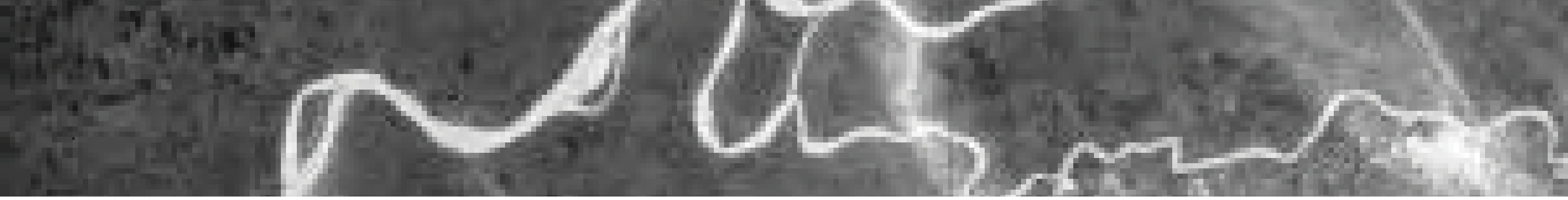
Land use



1
Continental coast

2
Delta coast

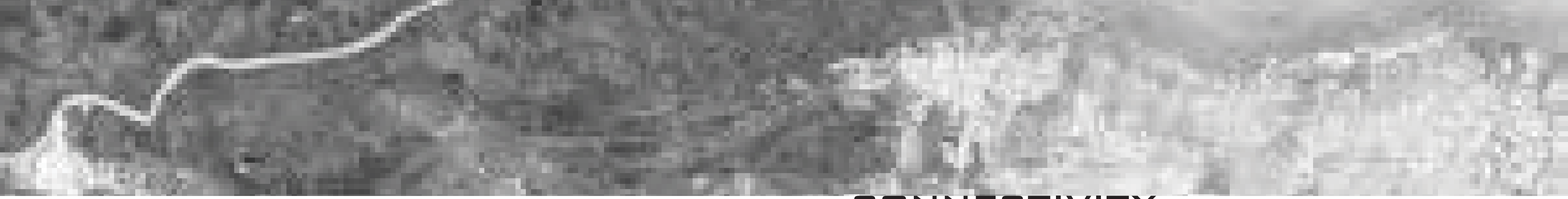
3
Inner Delta coast



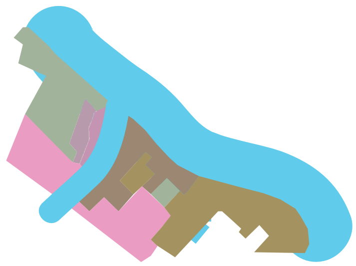
The vulnerability of the ecological system of the wetlands is high at every part of the wetland. At the continental coast because of the pollution and the erosion. In the inner land because of the erosion but also because of the sedimentation.

The land use at the continental coast is mainly part of informal settlements, gated communities and industry. This is the reason that the coastal area is not accessible for public. Because of that there is a bad connection to and from the delta. In the scope of the high pressure at this coastal area this bad connection to the delta has to change to create new sustainable living environments by using the delta as a new sort of living environment.

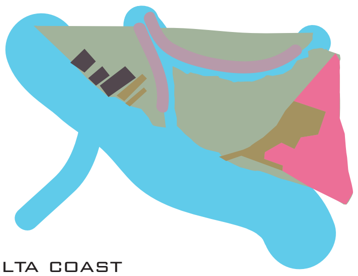
The prototype communities I will design must be the start of a renewed communal system which can be implemented in the delta. The land use of these communities are of a high importance. The connection to and from the delta is one of the most important design strategies in this design.



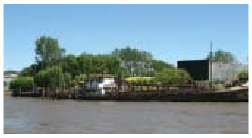
LAND USE



CONTINENTAL COAST 400M



DELTA COAST 100M



INTER DELTA COAST 100M

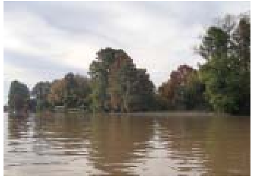
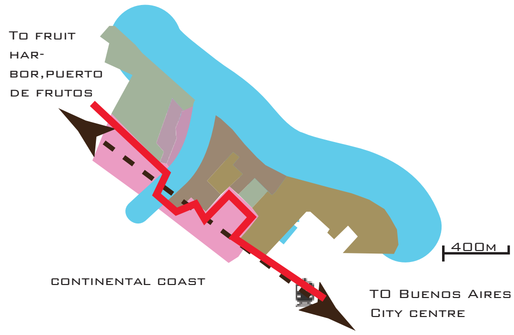


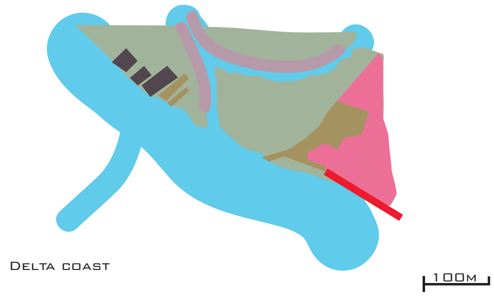
fig. 6.2 land use and connectivity different location lower parana delta, Own work, (2014)

CONNECTIVITY



Continental area

Bad connection from and to delta



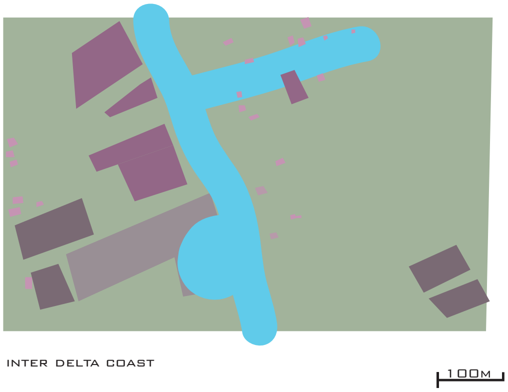
Coastal area

Bad connection from and to metropolis

Better connection in the delta

Gated communities disturbs this accessibility

Connection by boat.



Inner delta coast

Good connectivity from the inter delta and the water

Bad connection from and to metropolis

Pilot location

The chosen pilot location for the design id the former Puerto de frutos and amusement park. In fig.6.3. is showed how the land is used in this area in the current situation.

Land use

As can be seen in the image, the coastal area is completely privatized and because of this inaccessible for the public, such as in many of the coastal areas of the Parana delta.

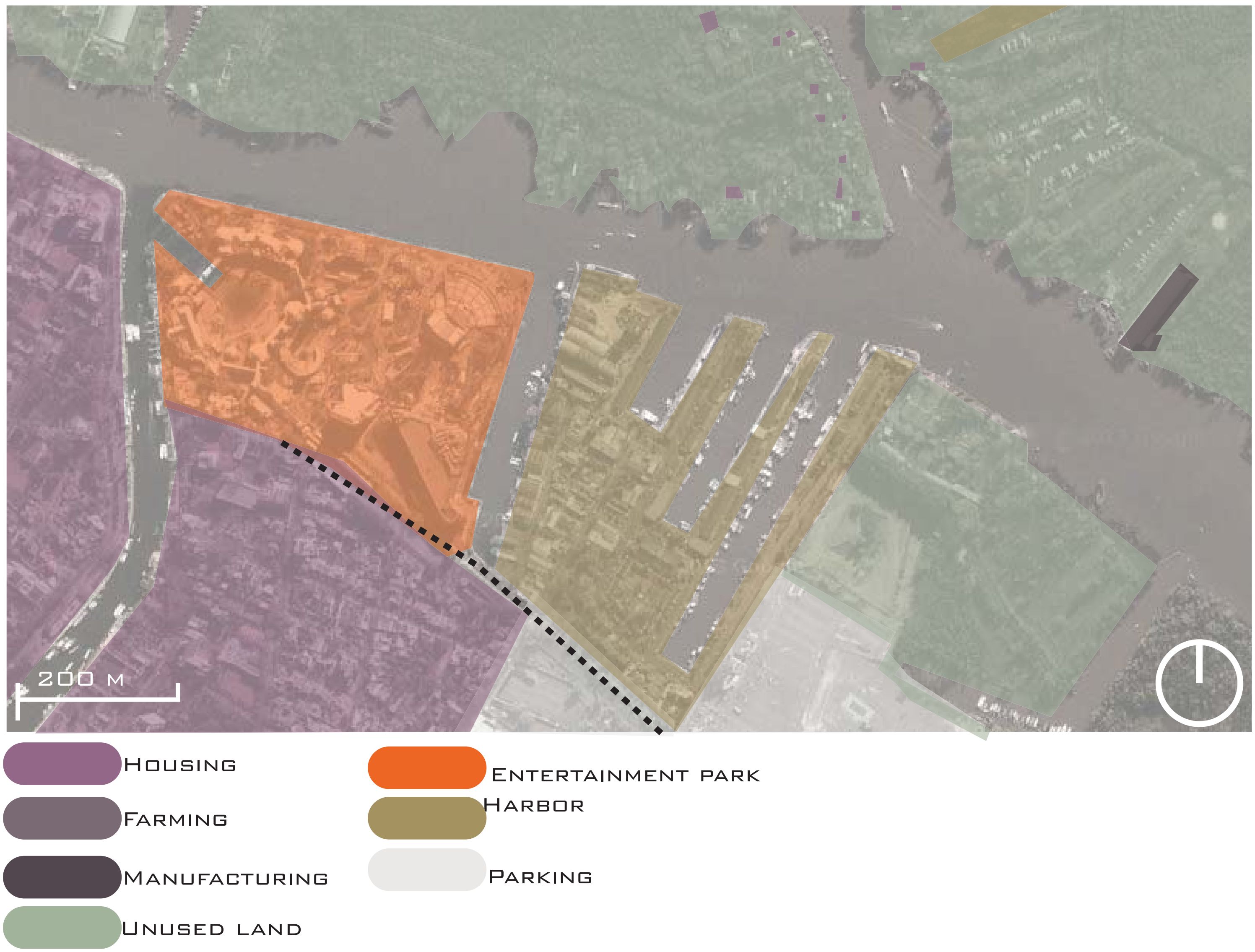
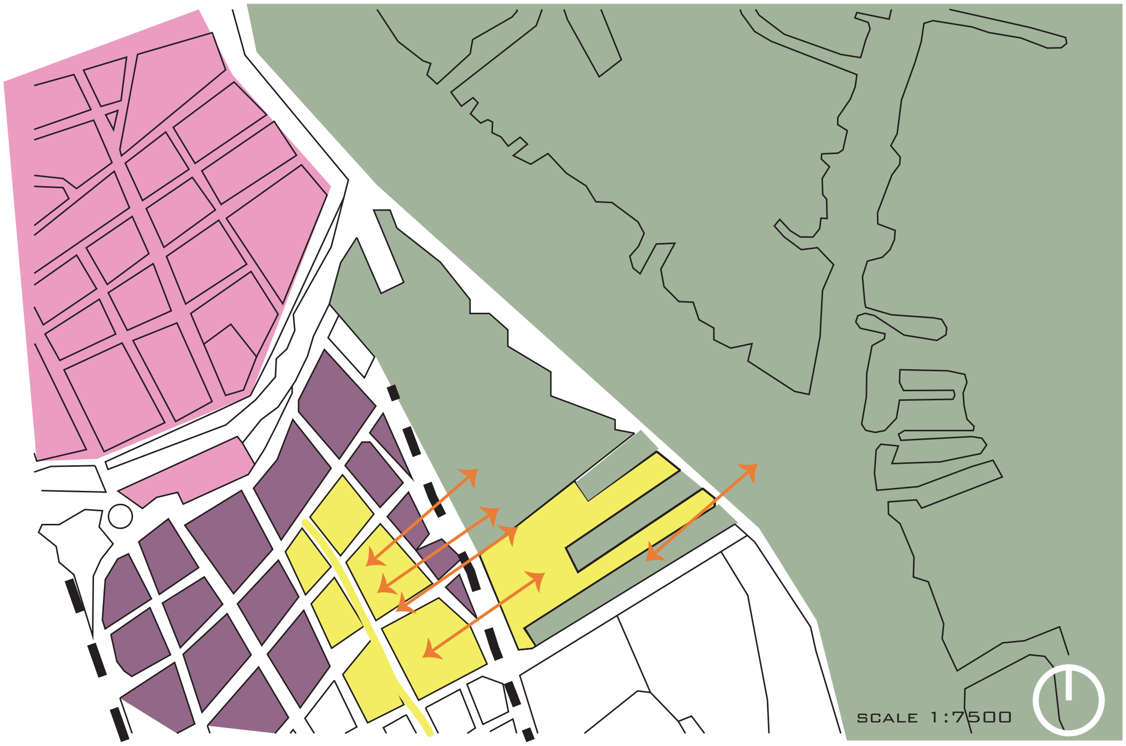


fig. 6.3 Chosen location land use analyses. Own work. (2014)

Economic value

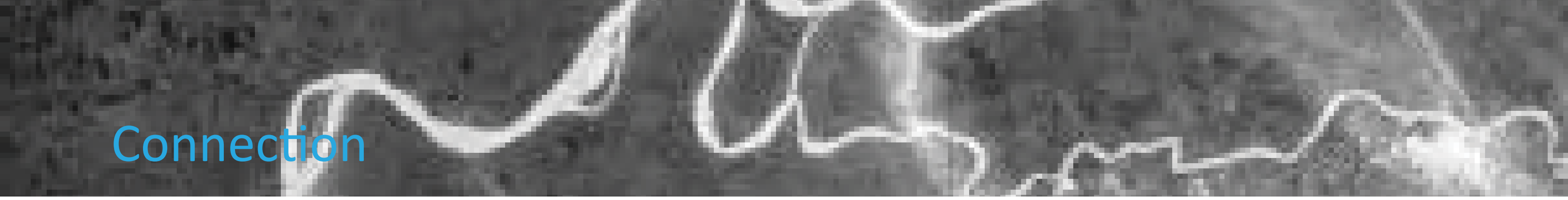
As can be seen in fig6.4. the chosen pilot area is in a mixed area of a rundown area of the lower middle class, recreational area of the high class, area of touristic and with that economic value also thanks to Puerto de frutos. The new development of this area can be a katalysator not only to redevelop the chosen area but also the surrounded rundown area.



Flavio Pigazzi, (2009)

Mauricio, (2005)

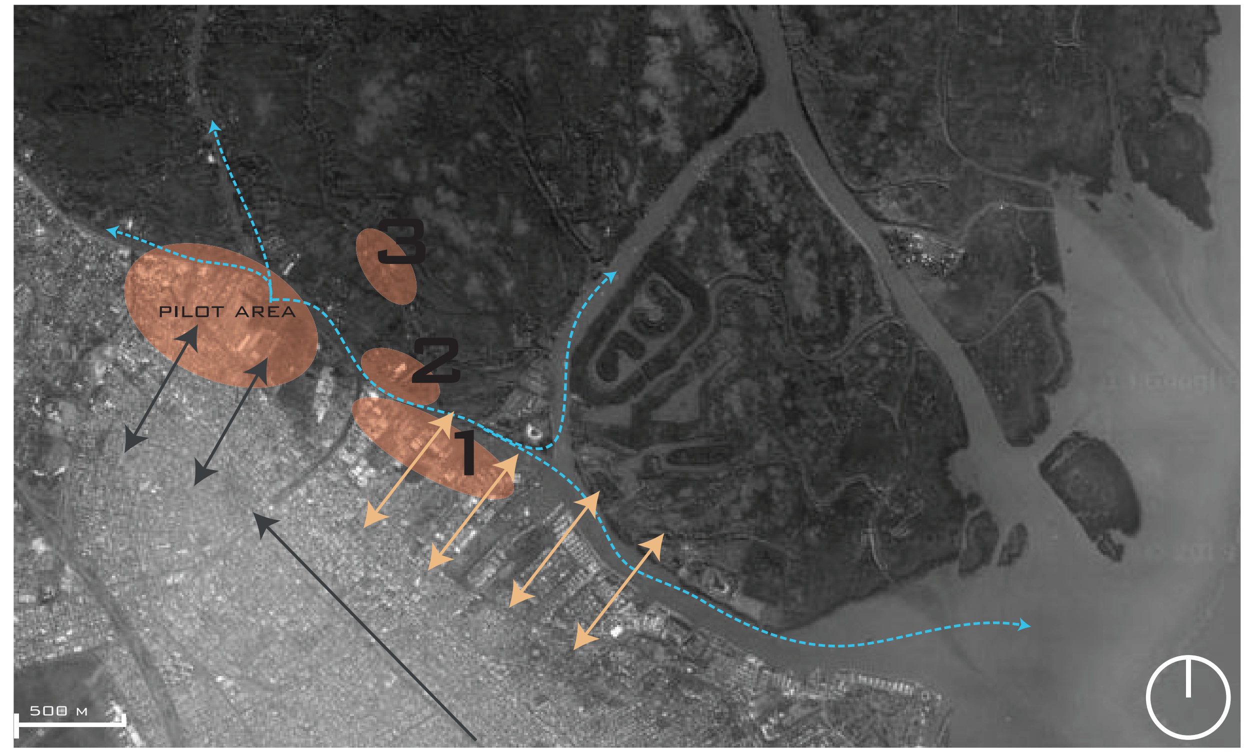
fig. 6.4 Economic value analyses, Own work, (2014)



Connection

The check areas chosen in the Delta are only accessible by boat.

Space for harbour is needed in the community. At the bigger scale, a network of public transport might be an option. In this way the waterways will be less grounded, and the ecologic system less affected by the boats



IJBURG, THE NETHERLANDS, PRIVATE LANDING FOR BOAT, (2013)

LITTLE HARBOR, NOVAVEST, ALKMAAR (2013)

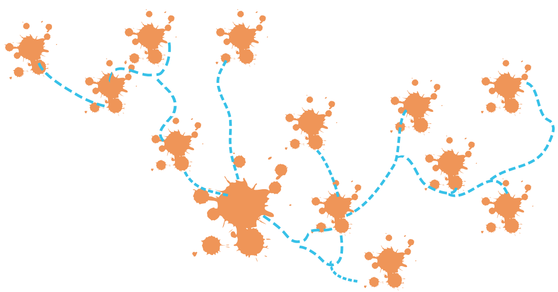


fig. 6.5 Connection analyses, Own work, (2014)

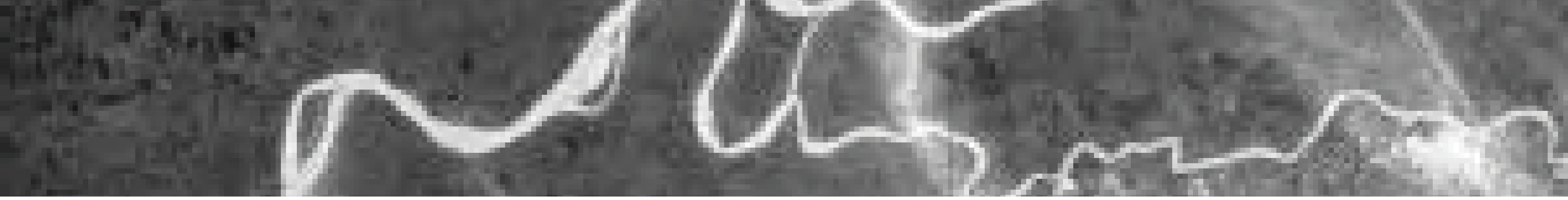
Concept

By integrating the delta system into the urban system several known problems of the area are counteracted. This new urban system of integrating the delta system and the urban system gives the coastal area more value.

The spatial concept is to open up the coastal area to reintroduce connection to and from the delta and reduce the pressure, occurred by the gated communities and informal settlements, at this coastal area. For this the wetlands will be reintroduced in the urban structure, see fig.6.6. Nature has many appealing aspects. Nature has the ability to create an atmosphere. A green environment gives the atmosphere of serenity and relaxing, besides this kind of environments are appealing for family's to come together and passing time together. Nature in urban tissue also has a positive effect on its environment. The environment gets more appealing because of the effect of the trees and plants.

Also by making the urban tissue in the coast less dense, I counteract at the missing permeability of the coastal area. The coastal area now is a flood plain that can adapt huge amount of water during heavy rainfall.
There is a high risk of flooding in this area this makes it important that run of water coming from the city, can be absorbed in the soil. The underground of the city mainly consists out concrete or other hard materials, these materials do not have a high permeability. This means the water can sink into the soil and will decrease the flood. By keeping the underground natural soil, water can be adapted by this soil. The water level decreases.
The coastal area of the Parana delta needs to be a buffer zone for the run of water from the city to decrease the risks in these areas. That is why in my concept the natural layer will be left intact so the permeability of the area is as high as possible. Fig. 6.7.

fig. 6.6 Reintroducing wetland in urban tissue, Own work, (2014)



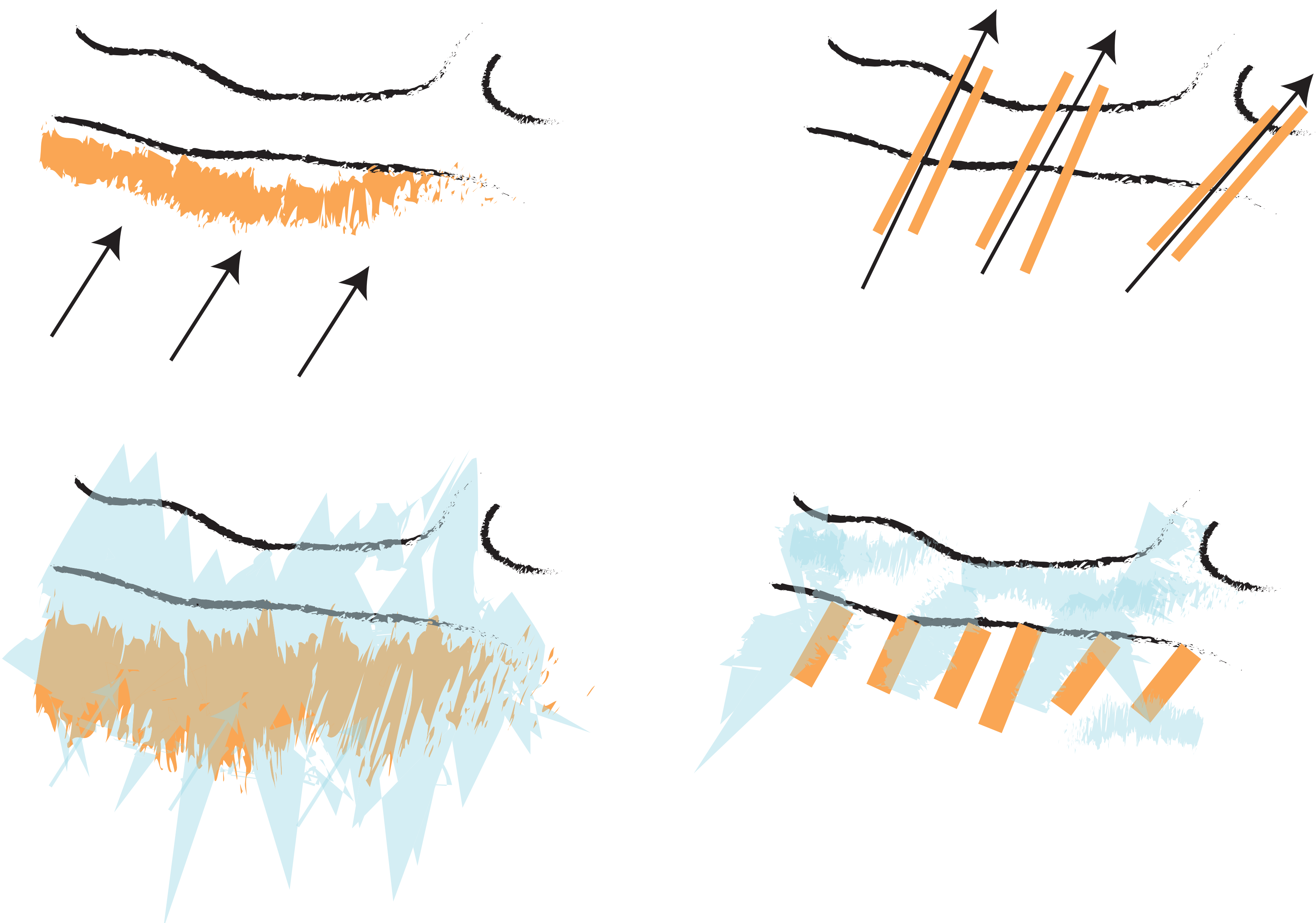
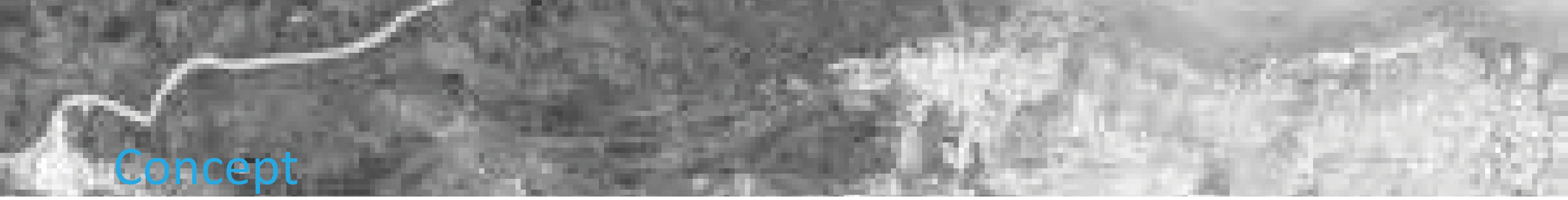


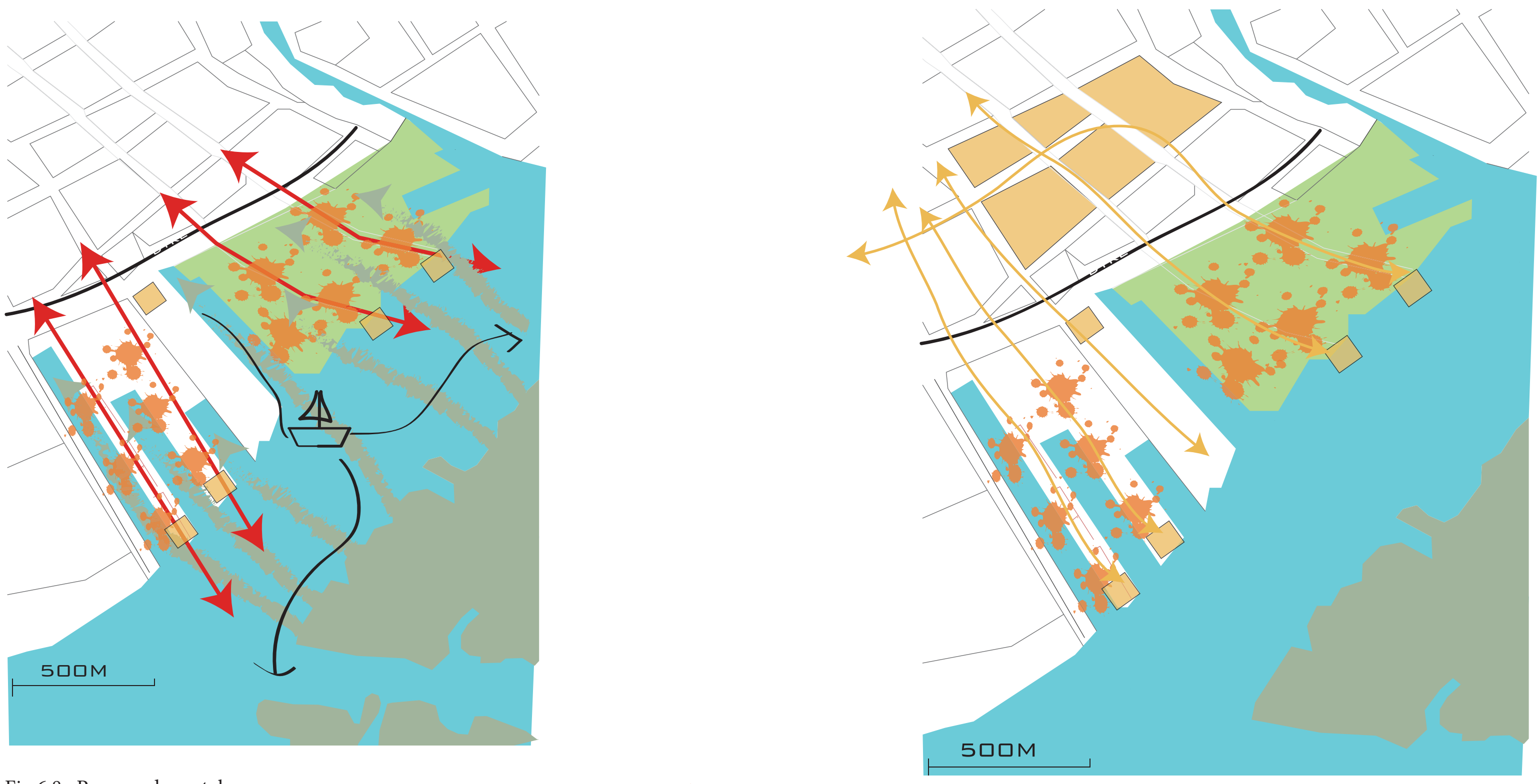
Fig.6.7., Pressured coastal area, new connection, flood risk and lower density, Own work, (2014)



Concept

Penetrating the closed coast of the delta will give re found access to and from the delta and gives new opportunities for living, see fig.6.8. By connecting the new routings to the existing routings, good connections are provided. The area will be attractive because of its natural character and because of its public areas. Besides this area is the hop on hop of to and from the delta by boat.

By making the routing to the coast attractive by a public building and public areas, people will enter the area and will be physically connected to the delta system and its dynamics. Because of its attraction, people from the metropolis and tourists will visit this area. This is also good for the economic value of the area



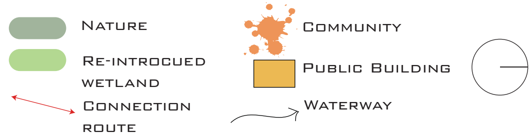


Fig.6.8., Pressured coastal area, new connection, flood risk and lower density, Own work(2014)

As can been seen in the figure at the left, above the natural layer and the existing urban tissue and routing, a new urban structure is placed at the coastal areas which make connection to and from the delta possible by its open structure and public accessibility. Besides the nature will be reintroduces in this coastal area/ altogether new routing are formed for the connection to and from the delta.

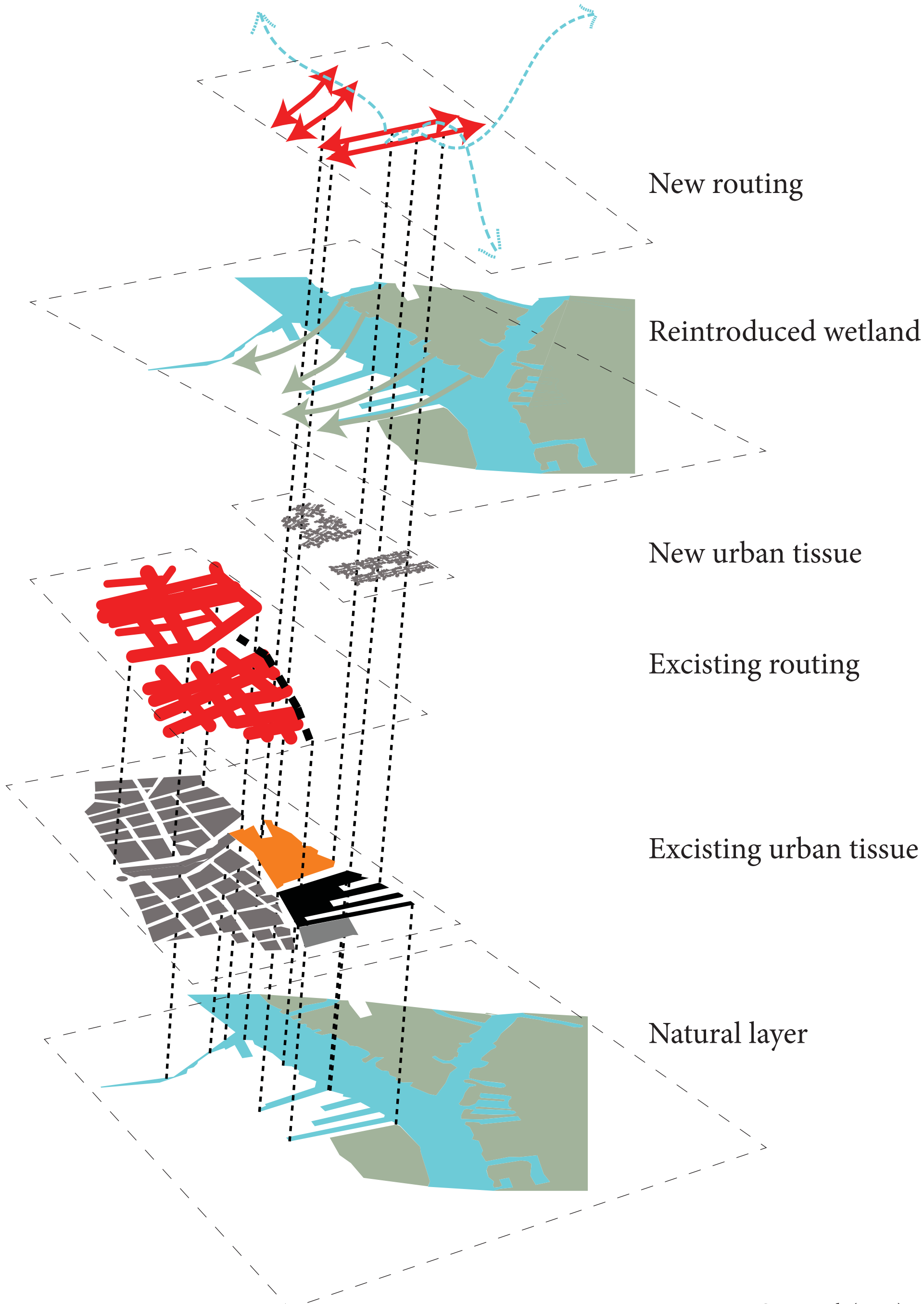
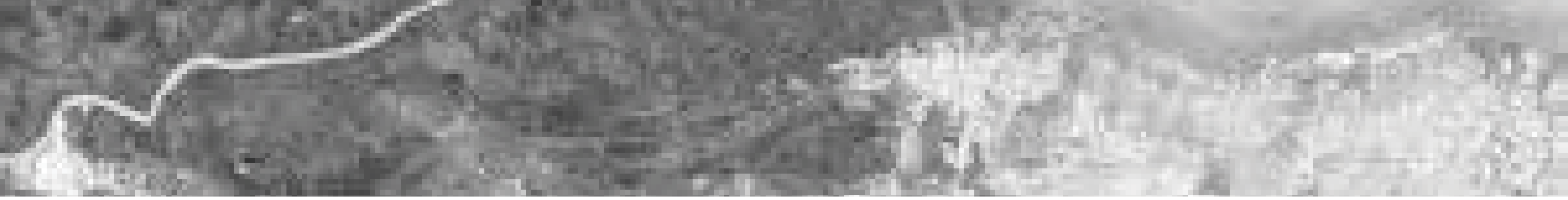
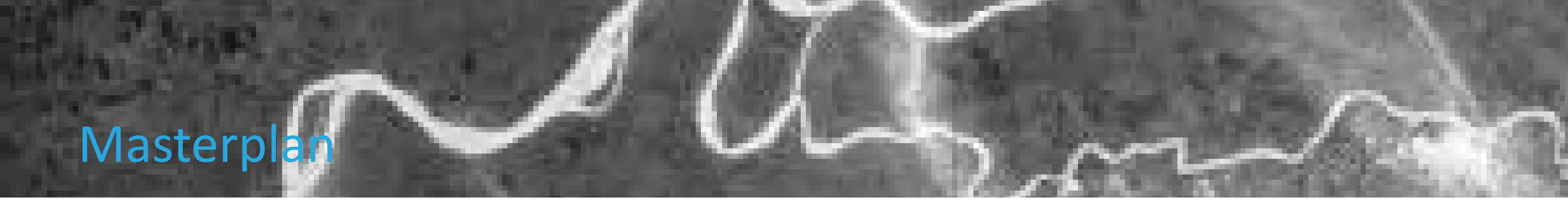


Fig.6.9., Layers, Own work,(2014)



7. Masterplan

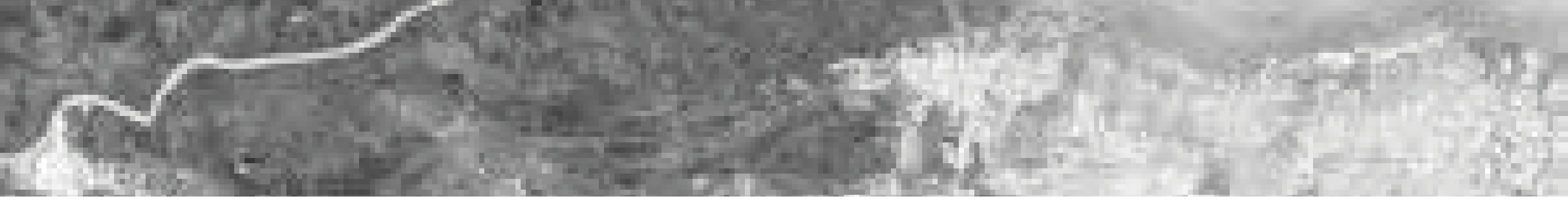


Masterplan

The pilot location is the former Puerto de frutos and amusement park in the municipality of Tigre, fg.7.1. This area is the hop on hop of to and from the delta, for that this is a perfect location to start this renewed community prototype. This area can be the start to open up the coastal area and be an example for the rest of the coastline to introduce these kind of open coastlines.

In fig.7.2 the master plan for this area is showed. This master plan has a density of 56 houses a hectare. The density is medium high, this to increase the permeability of the areas. In the current amusement park the nature is reintroduced as in the former Puerto de frutos the docks are maintained. Besides there is space left for a harbour to make the connection to and from the delta by boat. At the waterfront place is reserved for recreational fishing.

Fig.7.1., Pilot locarion, Own work, (2014)



Land use

- Area introduce urban in nature

- Area introduce nature in urban

- Dike with parking facilities

- Harbor--> hop on hop of to and from delta
Distribution center recyclable materials for use in communities

Economic

- Accessible for public

- Public building as attraction in area

Connectivity

-Public route connects developed area by community with the delta

-Harbor provides connection to and from delta

Fig.7.2., Masterplan, Own work, (2014)

Strategy

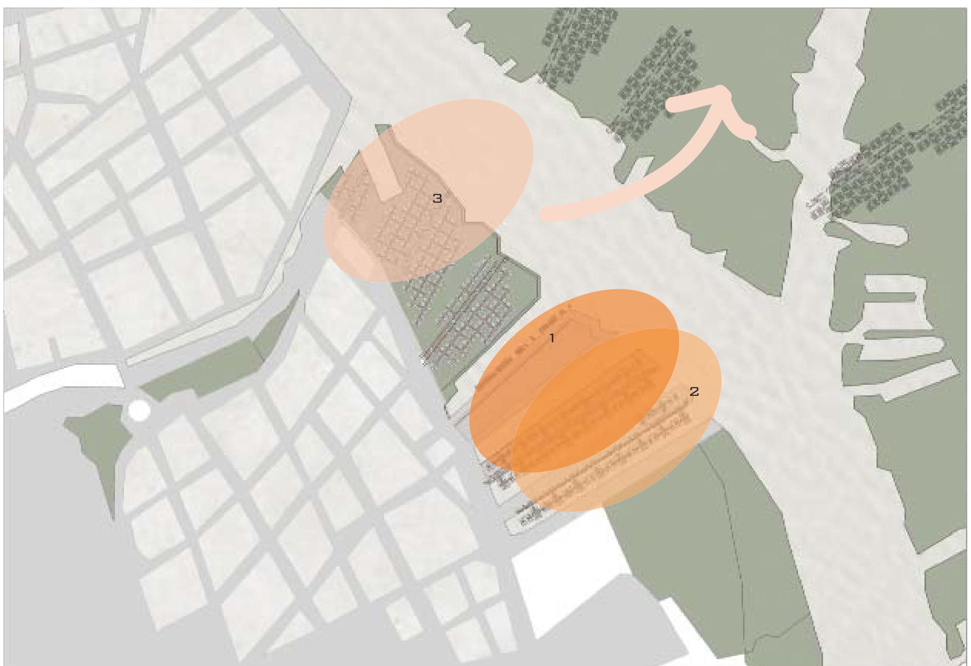


Fig.7.3., Expansion and axpnsion strategy, Own work, (2014)

To make this plan as reasonable as possible it is important to make a strategy for the development of the area. That is why I made a strategy for this pilot location. fig. 7.3
Fase 1:

Developing the harbour. This will increase the economic value of the area and makes this area an attraction point of the city of Buenos Aires. Besides this will provide the access to and from the delta which is important in my concept.

fase 2:

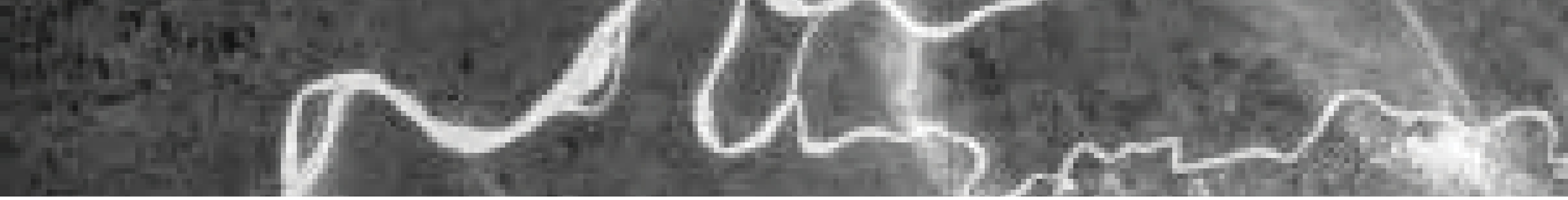
Developing houses for the higher middle class. The money provided from this project will be used in fase 3.

Fase 3:

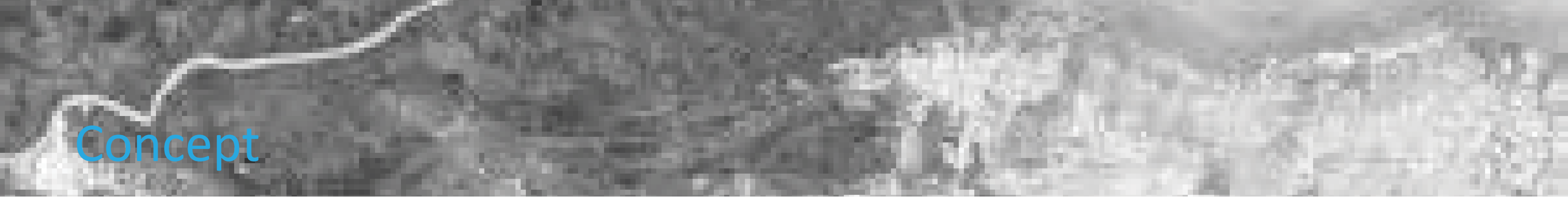
In this stadium the houses for the lower middle class will be built with the money from fase 2.

fase 4:

In fase for the prototypes will expand into the delta. A new generation of living in the delta will start.



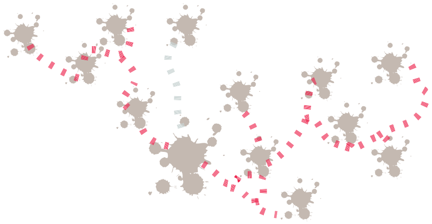
8. Architectonic Concept



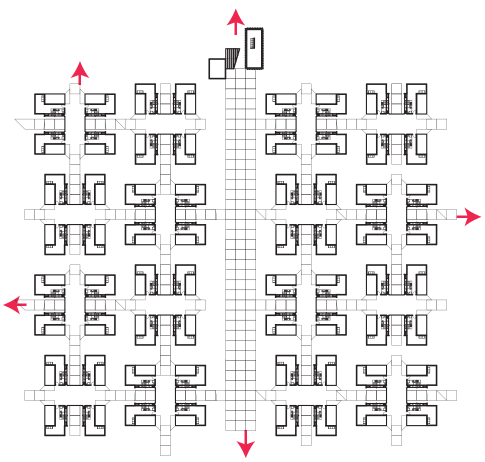
Concept

The first topic of this project is the possibility of expansion, see fig. 8.1. Expansion in regional, communal and building scale. The project is that of a communal prototype, which also must be implemented in other parts of the delta region.
At communal scale the community must have the opportunity to grow. For that a structure which can adapt expansion must be found. And at building scale the expansion also is integrated by free area where the owners can expand their houses as wished.

Regional scale



Communal scale



Building scale

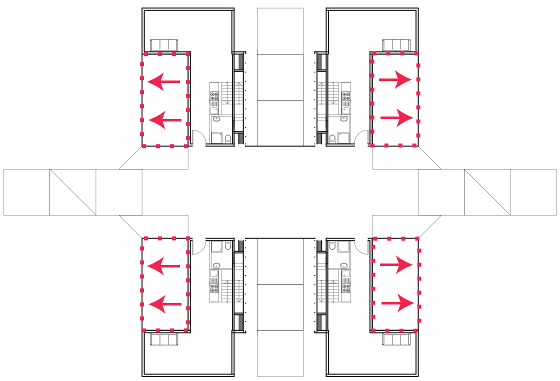
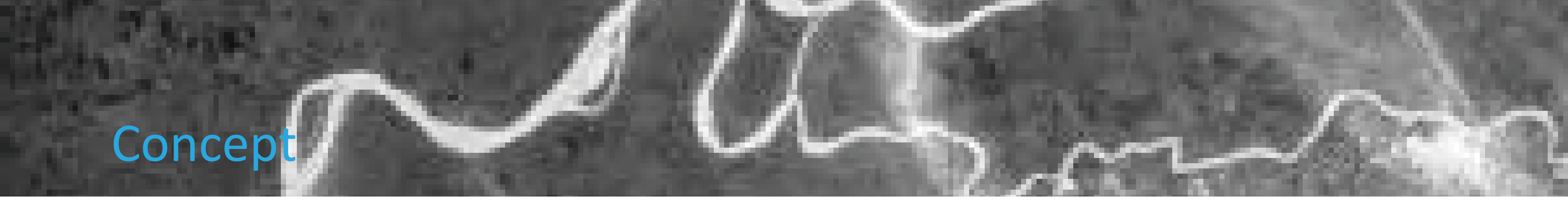


Fig.8.1., Concept expansion, Own work, (2014)



Concept

The second topic is the awareness of the dynamics of the delta, see fig. 8.2. In my opinion it is important to make the people aware of the dynamics of the delta. By making people aware of the changes of the hydrological system, people will notice the consequences of rising water and the changes of the environment. By making them aware the people will respect these dynamics more and will feel responsible for the wellbeing of the delta system. The people will be made aware of these changes by architectonical interventions in the communal spatial plan.

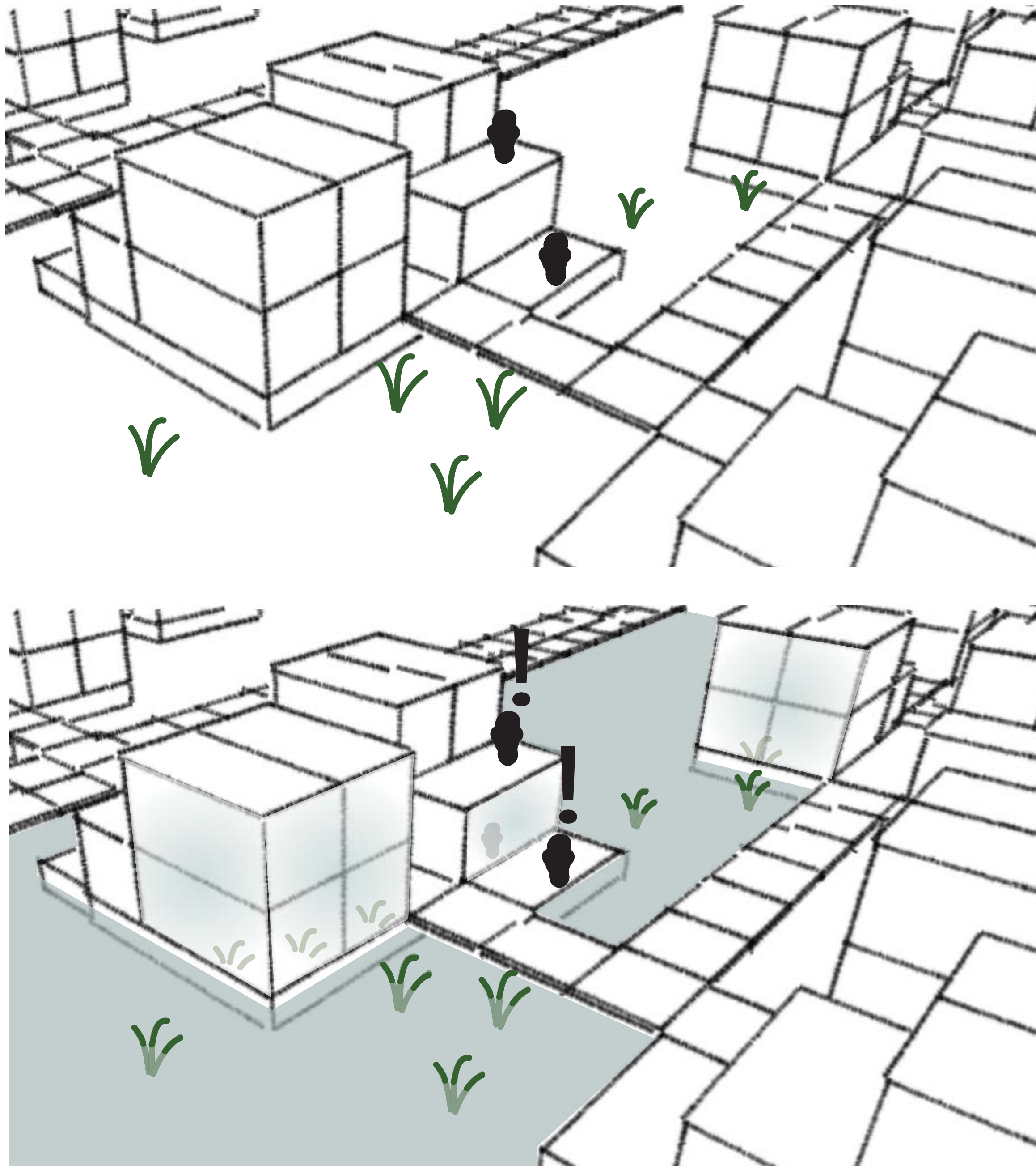
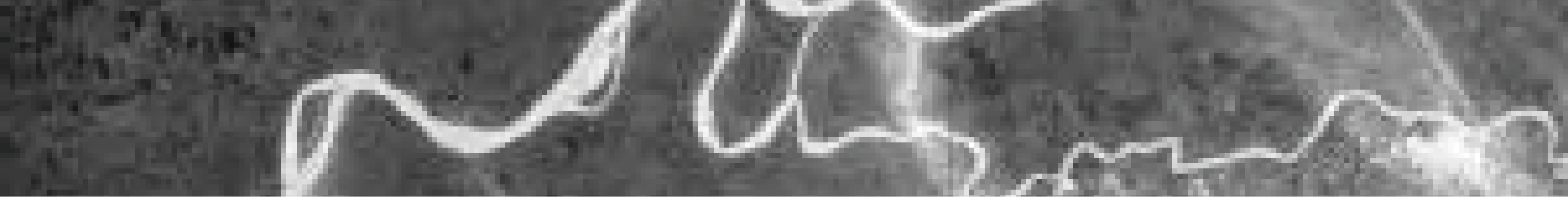


Fig.8.2., Concept awareness of the dynamics of the delta, Own work, (2014)

The third topic is the use of recycled and local materials as facade and construction elements. By using recycled materials the waste in the delta will be removed and will get a new purpose as a facade element. The waste are plastic bottles and cans. Besides local materials, such as bamboo will be used to decrease the costs of the buildings and make these houses affordable for the lower middle class. The research done for useable materials can be found in appendix 2. The chosen materials are showed in fig 8.3

Fig.8.3., Materialisation, Own work, (2014)



9. Design

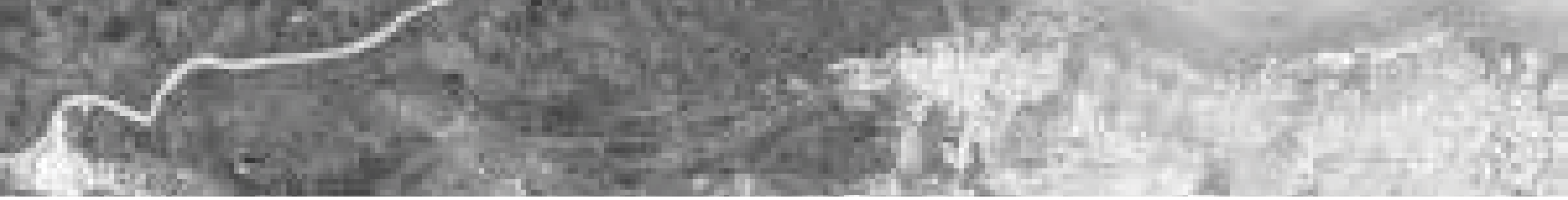
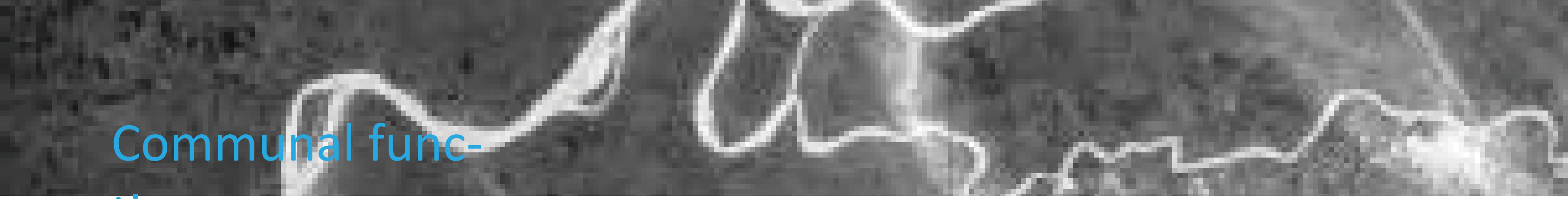


Fig.9.1., Community, Own work, (2014)



Communal functions

Social housing

Built in cluster per four houses. one house floorplan in 54 square meter (indoor and outdoor area)

A cluster plus communal area is 288 square meters

The amount of clusters at a public route can variate, for the design I used eight clusters of four houses

Public route

Th public route concist out of two parts. One part has a connective function, it connects the urban tissue with the delta, It is a straight road for pedestrians only accesable for cars in a emergency situation.
At both sides of this road a stroke of water related elements are designed. These elements are seen as small outdoor livingrooms were people meet and interact with their enviroment.

fig.9.2.

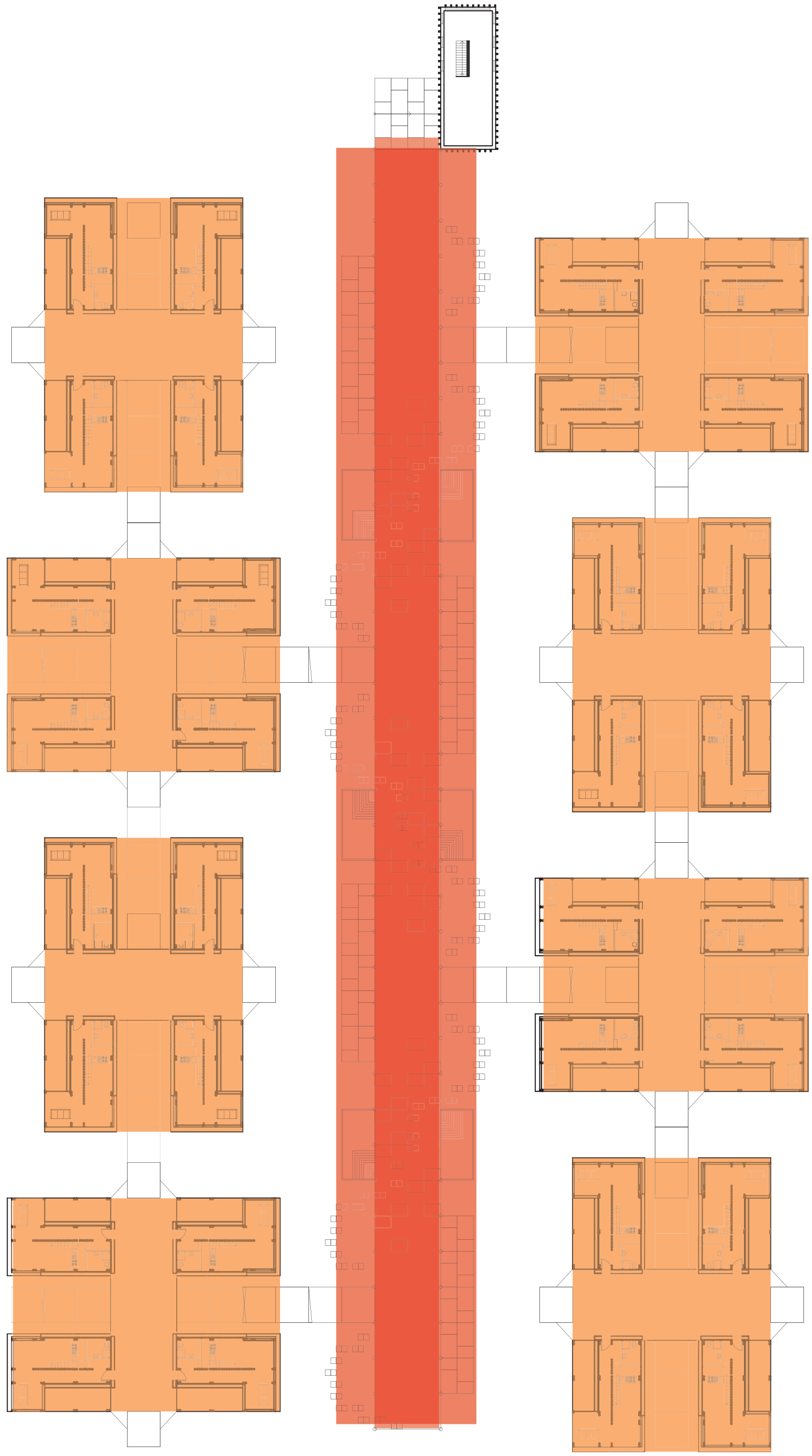
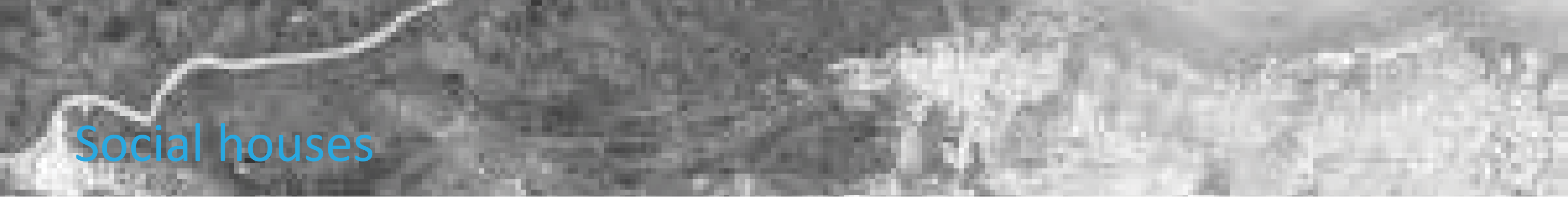


Fig.9.2., Functions community, Own work, (2014)



Social houses

As explained in the chapters before, I have chosen to work with an amphibious construction because of it character of adapting rising water during a flood see fig9.3.

In this case people are not harmed by rising water, neither are their houses and belongings.

The houses are sustainable because it can adapt a possible higher water level than expected at the first place.

Changes of the environment are visible when the houses rise with the water level, this makes people aware of these changes.

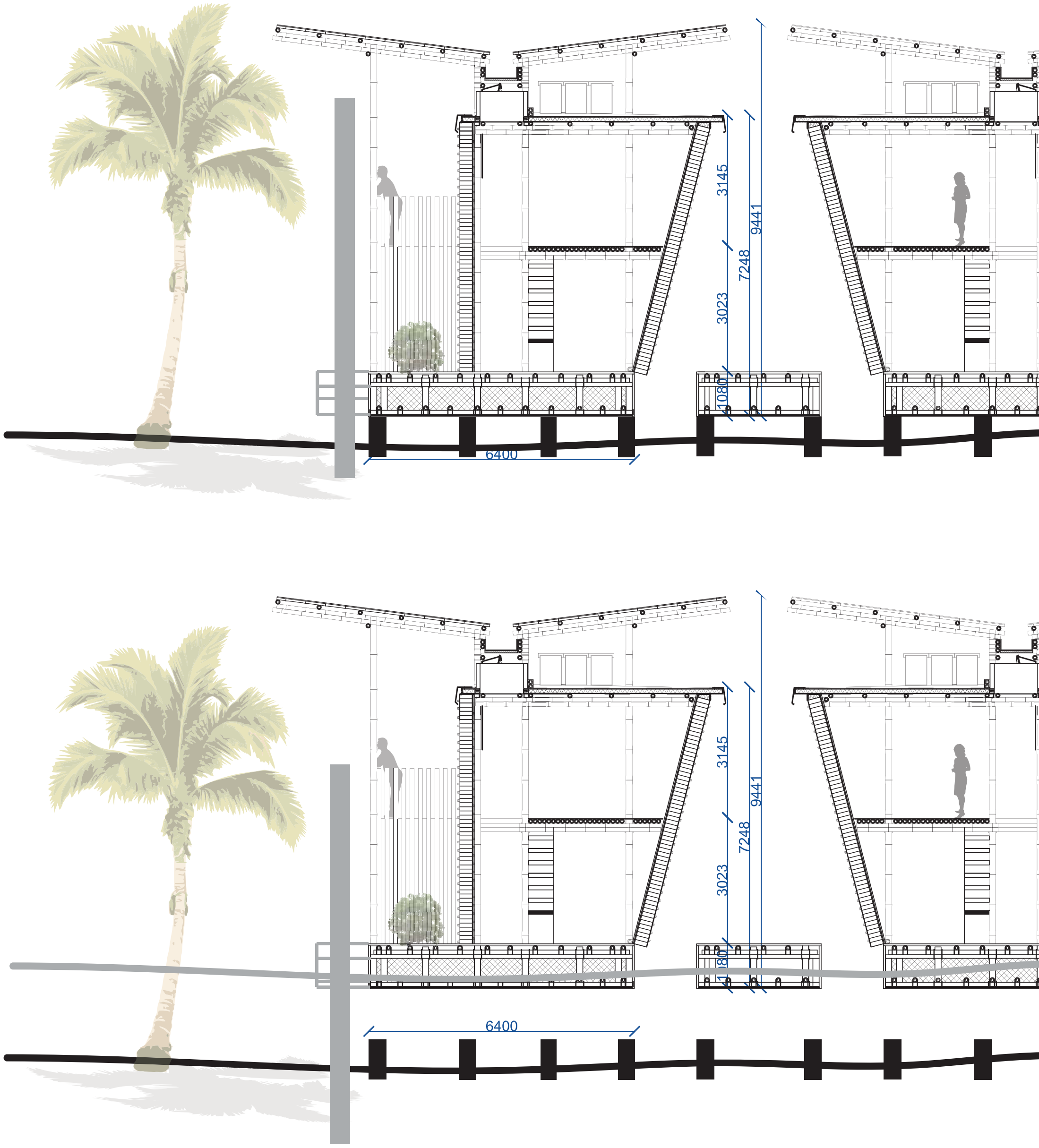
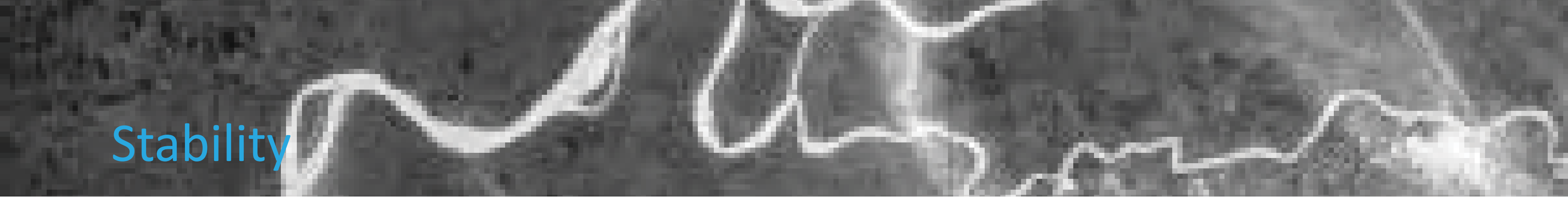


Fig.9.3., Amphbious houses, Own work, (2014)



Stability

By clustering the dwelling per couple and connect them with the routing in between, the stability of the dwelling is occurred. The different parts are connected with a ridged connection.

Make gardens with a max and minimum amount of weight. During construction of expansion the garden will be demolished and that weight will replaced by the weight of the construction.

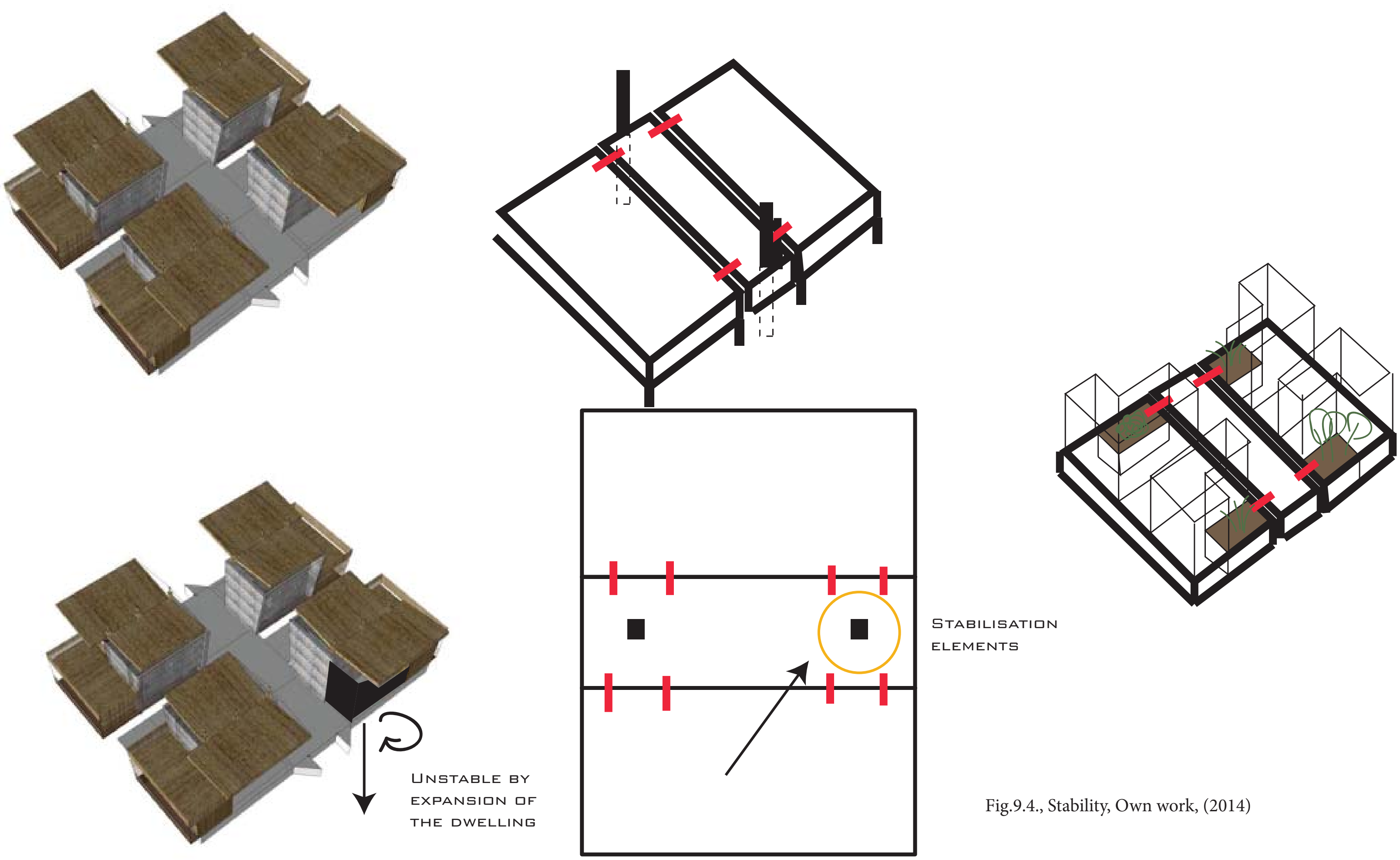


Fig.9.4., Stability, Own work, (2014)

Stability

The structure of the floating foundation is made of bamboo and chicken wire. The bamboo are connected by tires. This is a rigid but also a cheap solution.
Bamboo is a light material, which makes it suitable as floating object. The bamboo needs to be impregnated against the water.
The bamboo structure will be filled with packed Pet bottles. These can be collected in the environment. This cleans the environment as well. It is important that the bottles are sealed with a lid and packed firmly together to optimize the buoyancy.
Off course water can still entre the structure and reduce the buoyancy, but a cheap solution
The bamboo is connects by bamboo connection stick and with tires. These are cheap solutions and also light solutions.

Source: The Lift House, Prithula Prosun, Waterloo, Ontario, Canada, 2011

Communal area

The communal area is formed by a cluster of four houses and its reed field which are used as water purification system. It works like a courtyard for different households, see fig. 9.5. In this area neighbours and neighbour children come together to play and to have conversation.

Interior space

This picture also shows the interior space of the houses. The hall connects the communal outdoor area with the interior of the house and makes a connection with the natural environment at the backside of the houses. This is strengthen by the use of the same material as in the outdoor space and with the sightlines of the hall. The back facade is showed in fig. x.. In this figure you see that the facade is totally open able. Because of this there is a strong connection with the interior and exterior. The facade elements are horizontally open so they also work as sunshades.

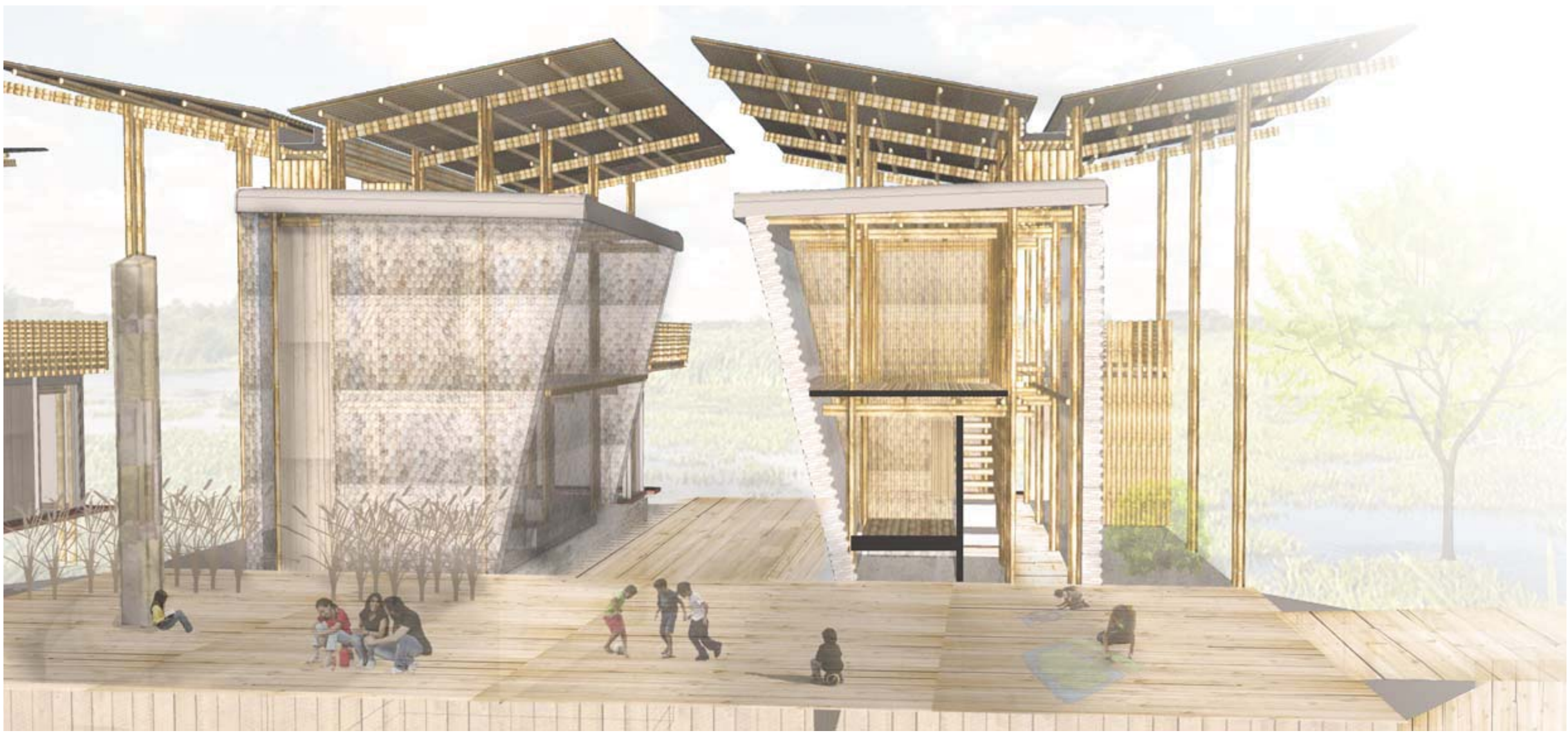


Fig. 9.5. Communal area and interior space, Own work, 2014

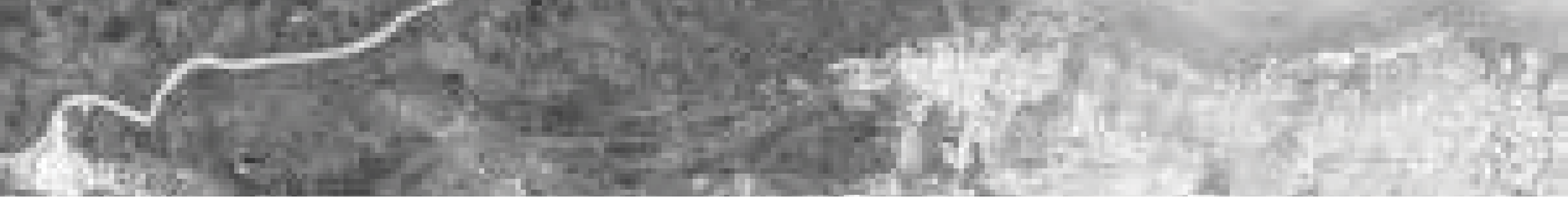


Fig.9.6. Connection interior exterior, Own work, 2014

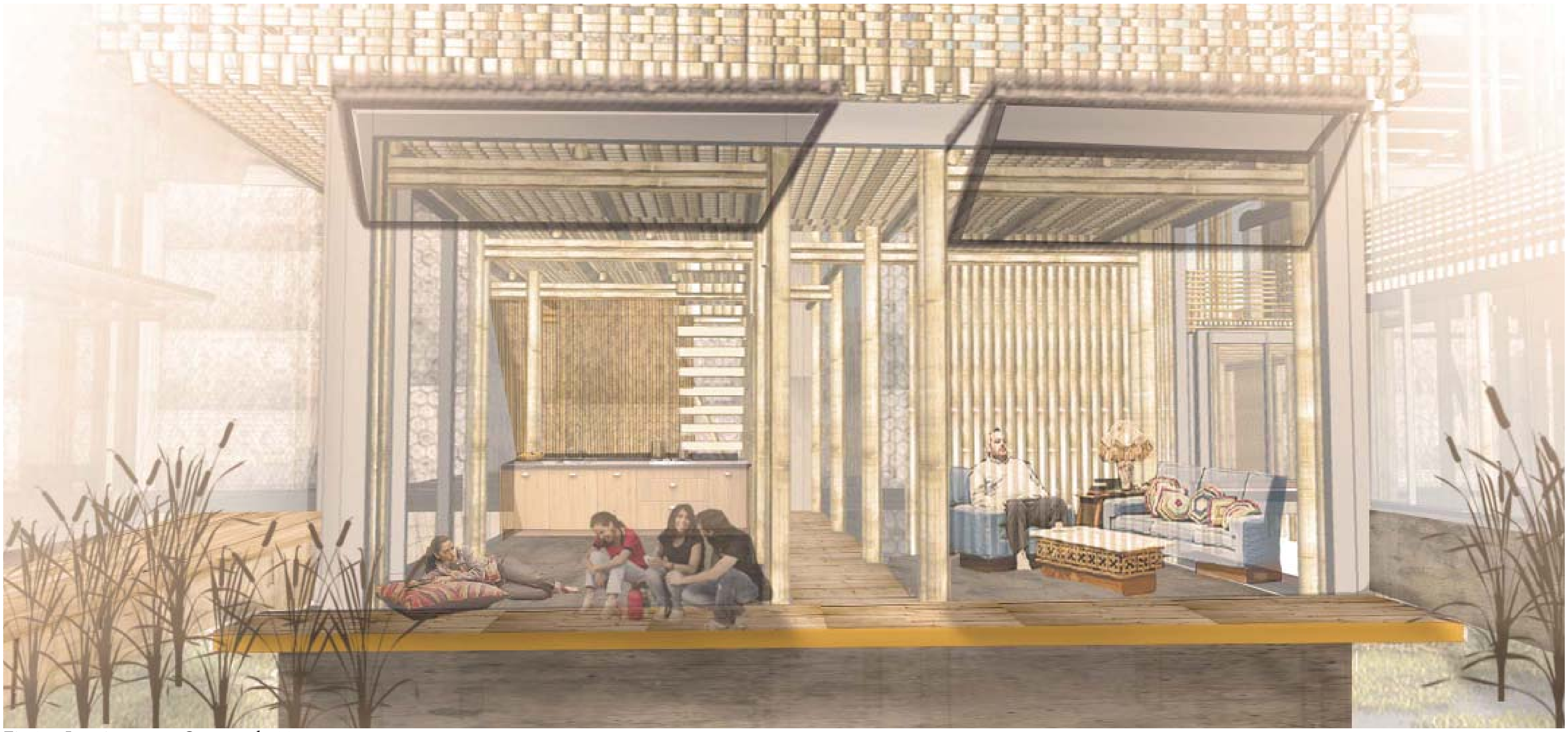


Fig.9.7. Interior space, Own work, 2014

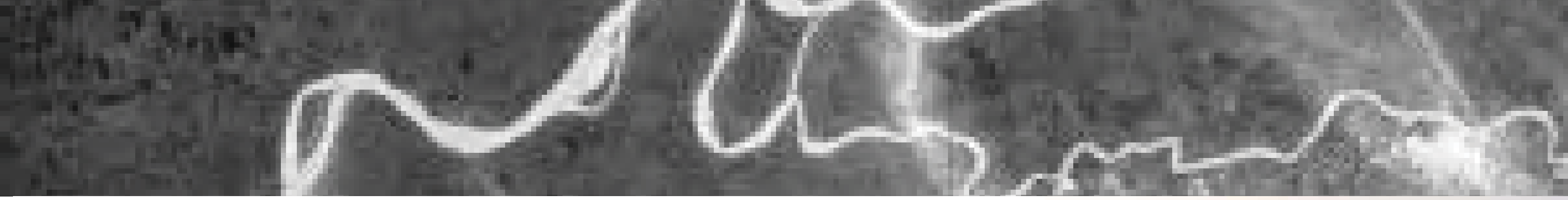
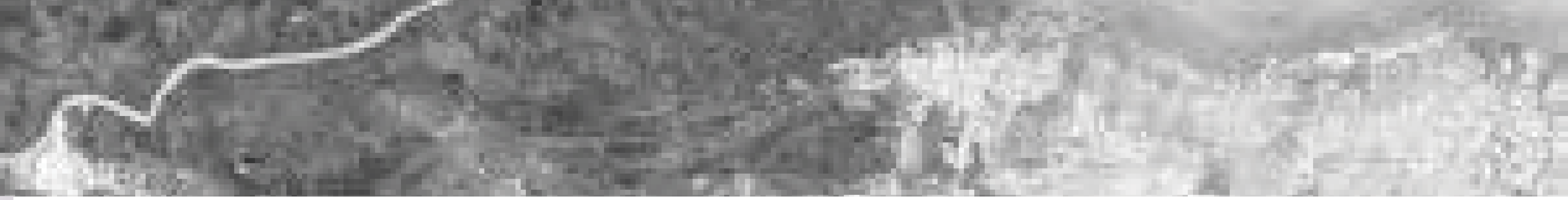
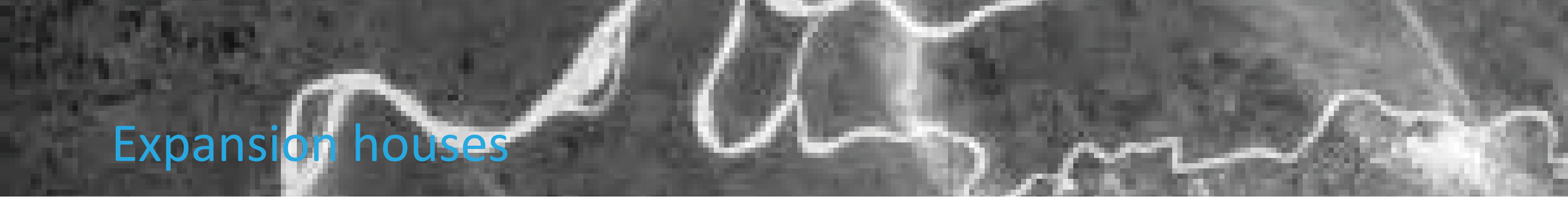


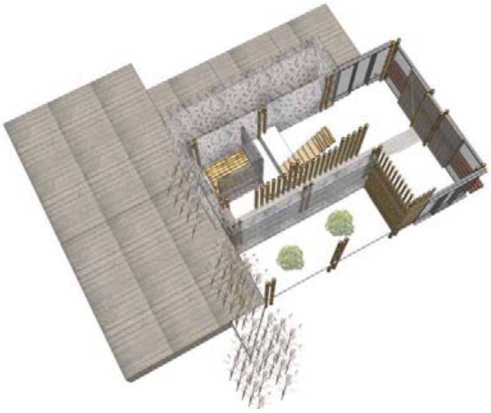
Fig.9.8., Community impression, Own work, (2014)

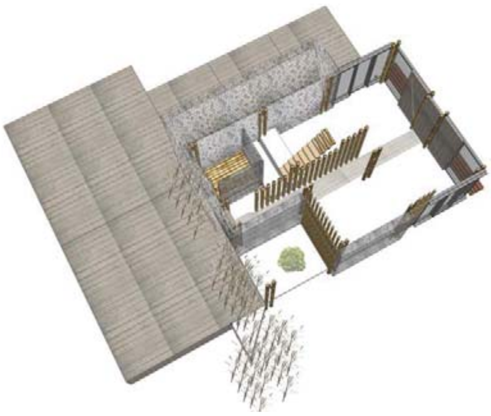




Expansion houses

One of the important topics of the design is the possibility of expansion. The idea is that people can expand their houses as wished. Possible reasons for this is a grow of the family, grow of economy, wish for commercial activity, wish to rent a part of their property to another. In fig. 9.9. and fig.9.10 possible expansion timetable is showed for a growing family. The figure also indicates the costs of this expansion.



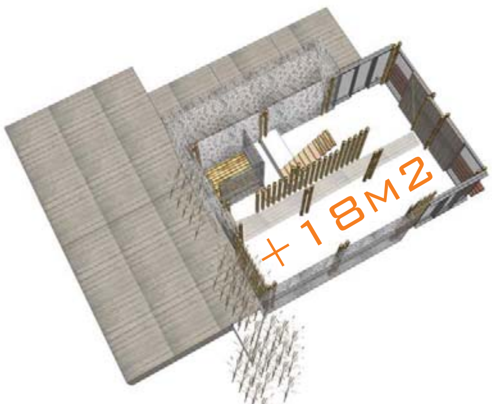


Costs

1 m2 facade pollibrick= 51 dollar sqm

1 m2 facde/floor bamboo = 50 dollar sqm

Totaal= 1350 dollar for 27sqm



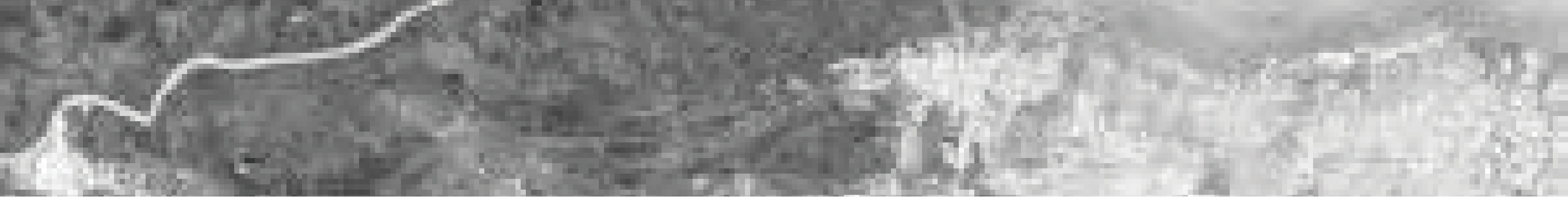
Costs

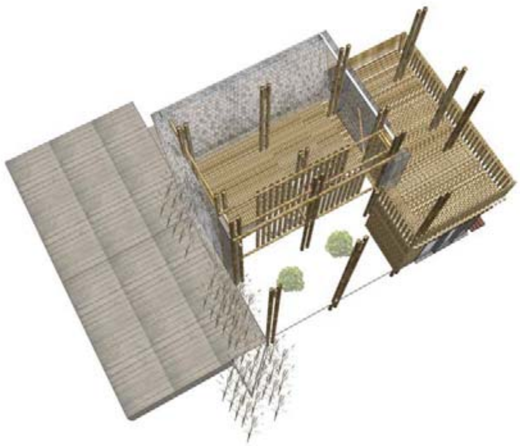
1 m2 facade pollibrick= 51 dollar sqm

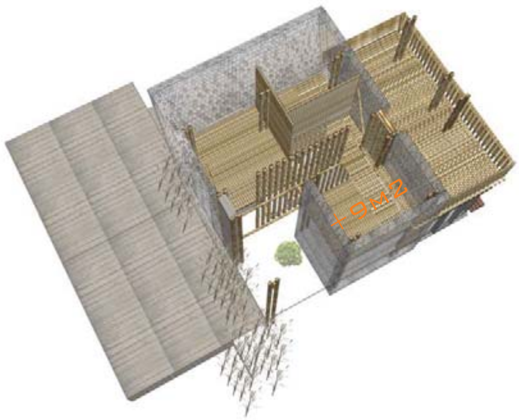
1 m2 facde/floor bamboo = 50 dollar sqm

Totaal= 2250 dollar for 45sqm

Fig.9.9., Expansion first floor, Own work, (2014)





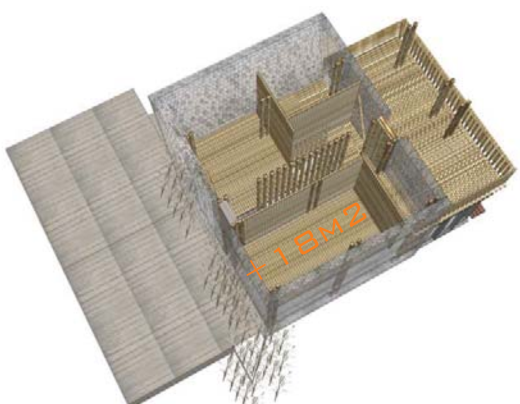


Costs

1 m2 facade pollibrick= 51 dollar sqm

1 m2 facde/floor bamboo = 50 dollar sqm

Totaal= 3150 dollar for 63 sqm



Costs

1 m2 facade pollibrick= 51 dollar sqm

1 m2 facde/floor bamboo = 50 dollar sqm

Totaal= 3600 dollar for 72 sqm

Fig.9.10., Expansion second floor, Own work, (2014)

Materialisation expansion

It is important the people them self's can expand their houses. For that the materials used must be easy to mount and inexpensive. That is why I have chosen to make a catalogue of possible to be used facade elements. These elements can exist out of bamboo panels, Polli-brick panels in different colours or open glass panels, fig.x. Owners can choose the materialisation as wished, in this way they will identify them self with their house and feel more responsible for it and the community of which it is part of. In this way the community will get its own character, formed by the inhabitants, such has happened in La Boca, an outstanding neighbourhood of Buenos Aires were the facades are characterized by the different colour facade elements, fig. 9.11.
'La Boca was the first port in the city. The neighbourhood appeared and developed as a neighbourhood of sailors. Therefore, La Boca was a region of immigrants, mostly Genoese, arrived between 1880 and 1930. The outfall of the river was the natural refuge to vessels which had arrived in Buenos Aires. There was great movement of seamen and traders. The land was low and swampy and that is why the houses were of wood, built on pilots.

The origin of various colours is related to leftovers of paint that the sailors brought to their homes. As there was enough money to buy ink and the quantity was limited to paint the entire house the same colour, is used to the last drop of ink that could. The houses had just been painted in various colours, each window a different colour, the door of another colour and the walls of various colours
(Colors and history of La Boca - Caminito Argentina, R. Donask, (2009)

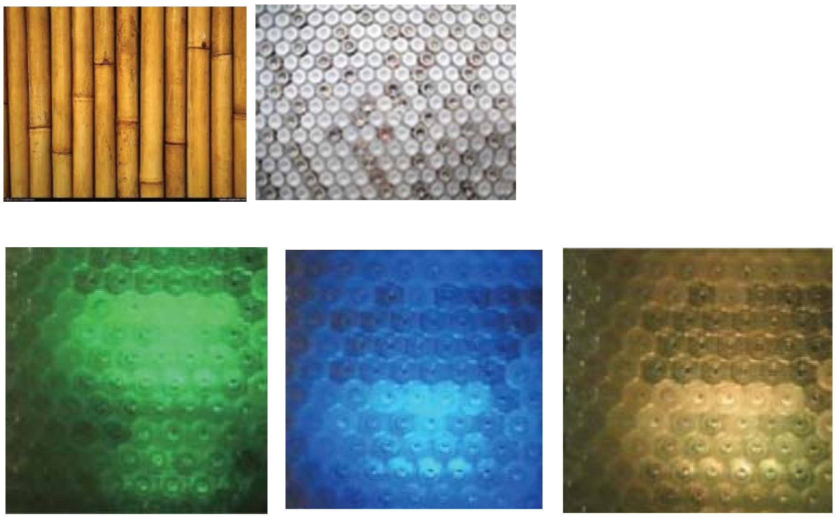
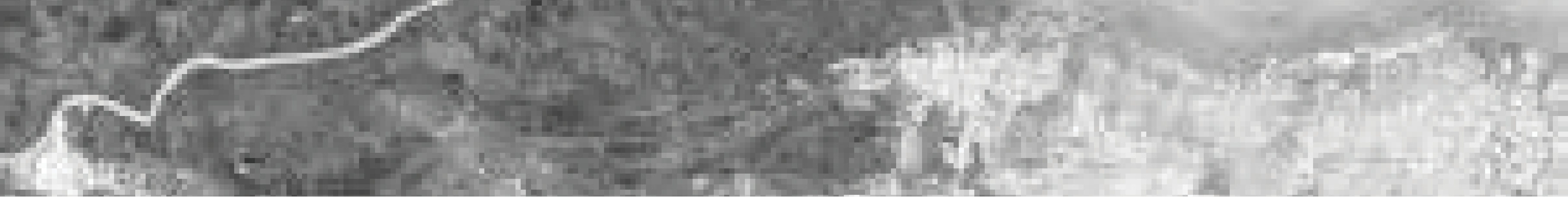


Fig.9.11., Coloured facades, Own work, (2014)



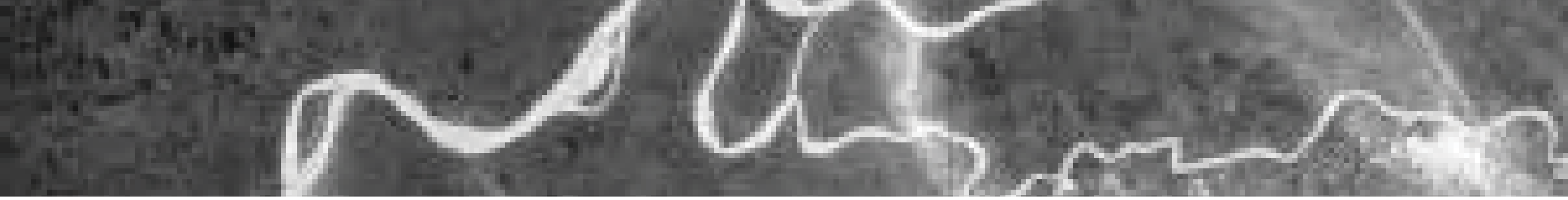
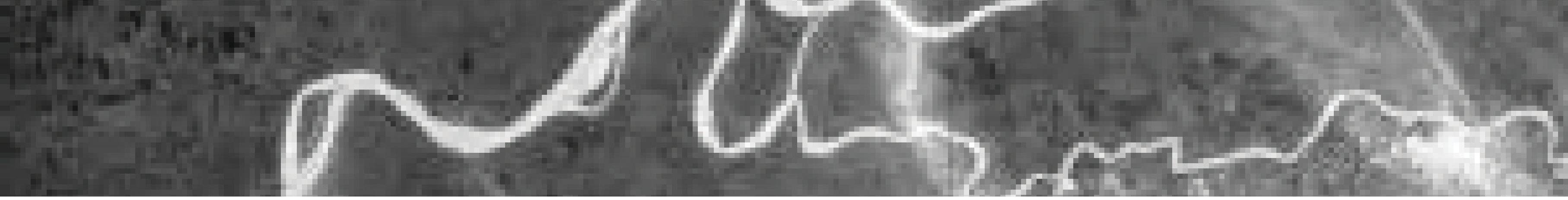


Fig.9.12., Possible expansions, Own work, (2014)

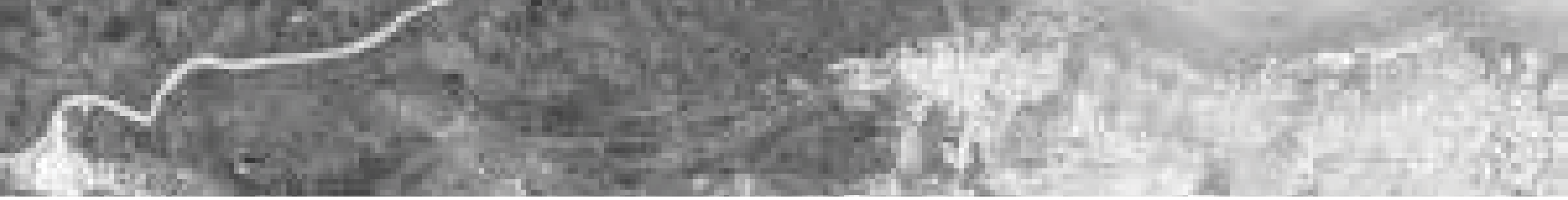


10. Communal area

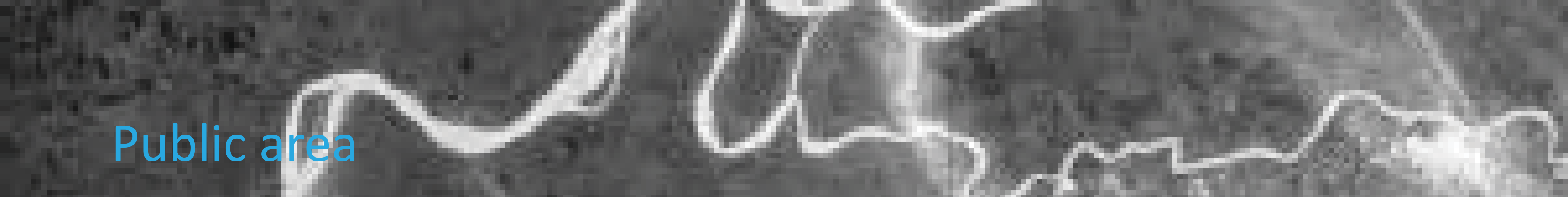
Communal area

The communal area is an important part of the design. In this communal area neighbours of a cluster of four houses share facilities such as water storage system. This is also an area where they can interact with each other and where their children can play. This area also will be used as pass way for neighbours of other clusters. This makes these areas lively. Because of the connection between the neighbours, there is a high social control that makes this area also safe to live. Fig. 10 gives an impression of the communal area.

Fig.10., Communal area, Own work, (2014)



11. Public Area



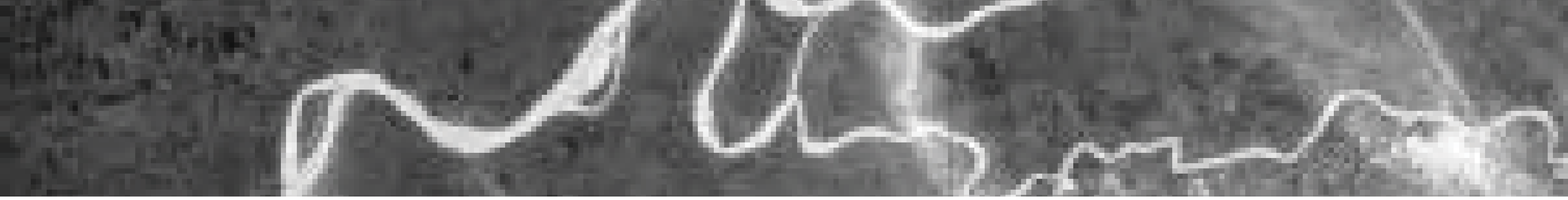
Public area

The public area is the main routing of the community. This area consist out a routing with at both sides water related elements. These elements will be explained further on in the report. The public routing is shielded by vertical elements which strengthen the sightlines to the end of the routing were the open delta lies. The focus to this point is important in the concept because I want to make the people aware of the importance and the dynamics of the delta, this only can be done if the focus point is at the delta. These vertical elements have a second function; the stability of the amphibious path. They are designed as such that they also provide shadow at the path and surrounded elements. The vertical poles are cladded with recycled cans. They will reflect the sun and water and they also change of color after connection with the water. So after a flood, the water level can be seen at these oxidized cans. This also shows the changes of the environment. The vertical elements continue in the facade of the public building at the end of the route. This building is placed aside so the view to the delta from the routing is not blocked. The vertical elements continue in the facade as a gesture to the dynamics of the delta, fig.11.1. The entrance of the building is situated at the first floor. A stairs leads to this floor. The building itself is founded, that means that during a flood the water will go up along the façade. That is the reason why the entrance is at a higher level. The stairs is always accessible, even with a high water level. In this case the public building is an informative centre about the delta and the amphibious houses. Because the function might change during time, the building has an open floor plan, see fig.11.2. At the first level glass is implemented in the façade, this to give a vision over the delta, also when the water level rises. The other side is made out pf concrete. This concrete en the cladded vertical elements will change colour during time. This shows the changes of the environment such as the vertical elements of the routing, see fig.11.3. The first floor consists out of Polli brick and glass even as the second floor to make the areas light and with a lot of view to the environment.

Argentine people, in comparison with most Dutch people, are used to spent time outside their houses with family and friends. It is common to hang around at the street and parks, have a mate together and talk about the daily live. For me it was important to design outdoor areas in the community for the people to make it possible to have this interaction with each other. The elements at the sides of the public routing are steppingstones, sitting blocks and an element to stand in. All these elements give a different experience. These elements can be seen as small living rooms were people can come together and experience the environment in different ways.

The separation between public and communal/private part of the community is done by placing a small obstructive element in the path to the more private zone. The obstruction is done by lowering the walking path and placing an object. By lowering the walking path people will notice that from that point something is changing. The obstructive element forces people to go through a small hatch. They have to zig zag between this hatches. This also indicates that this area is not for public access. To give these hatches an even more private appearance, I integrated mailboxes in the hatches. This shows that you are entering an area where people live, and with that a private area. Because of this intervention, people will not enter this area if they are not intended to. In this way public and communal/private are separated. Fig. 11.4 amd fig 11.5 show these intervention.

Fig.11.1., Impression public building, Own work, (2014)



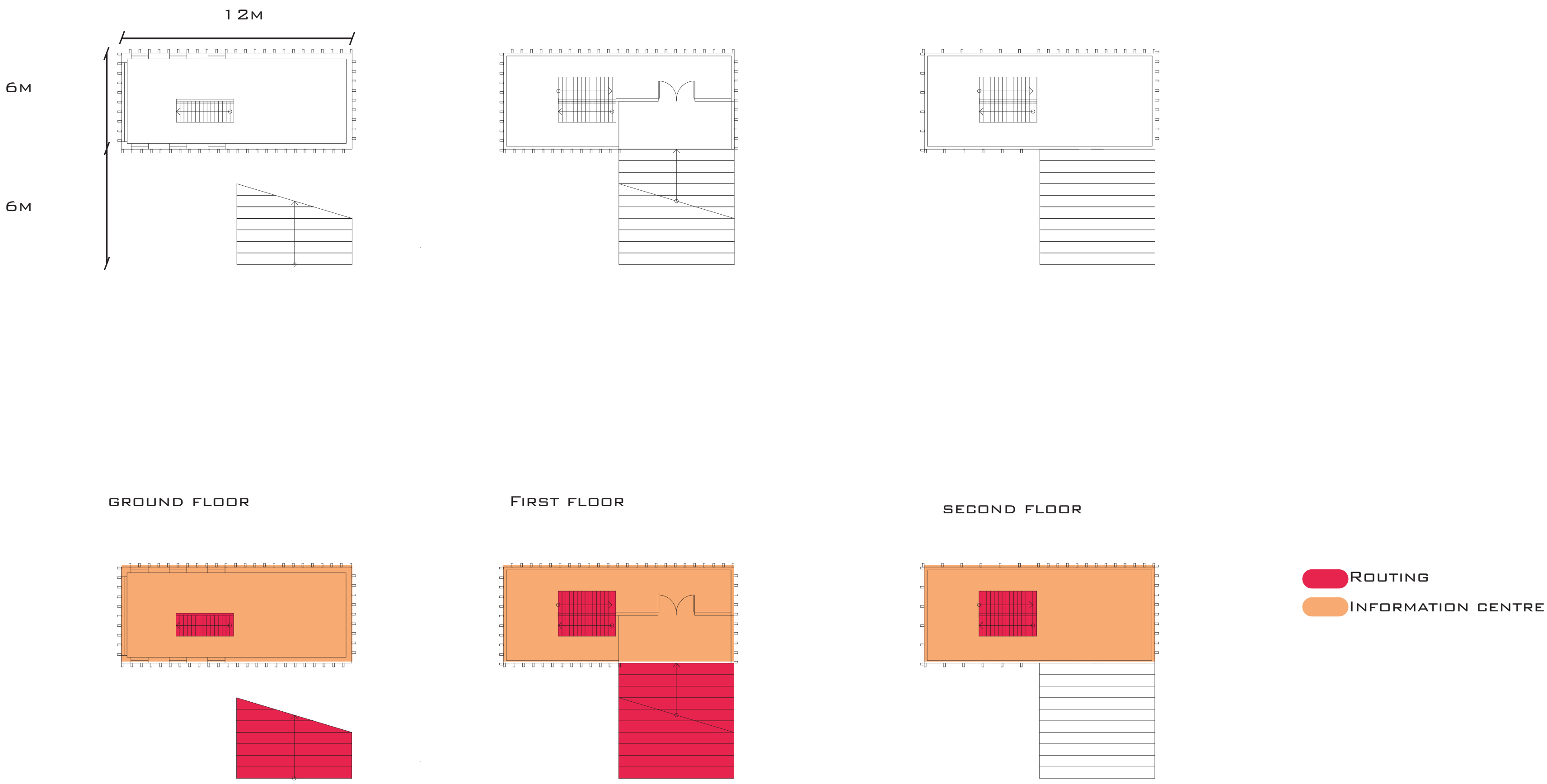
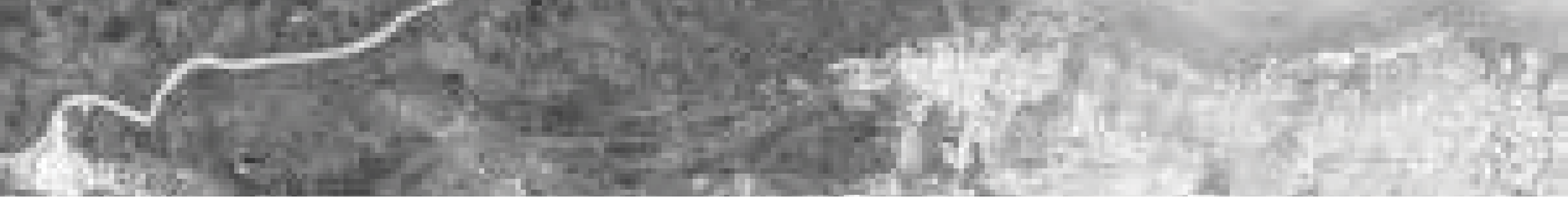


Fig.11.2., Floorplan public building, Own work, (2014)



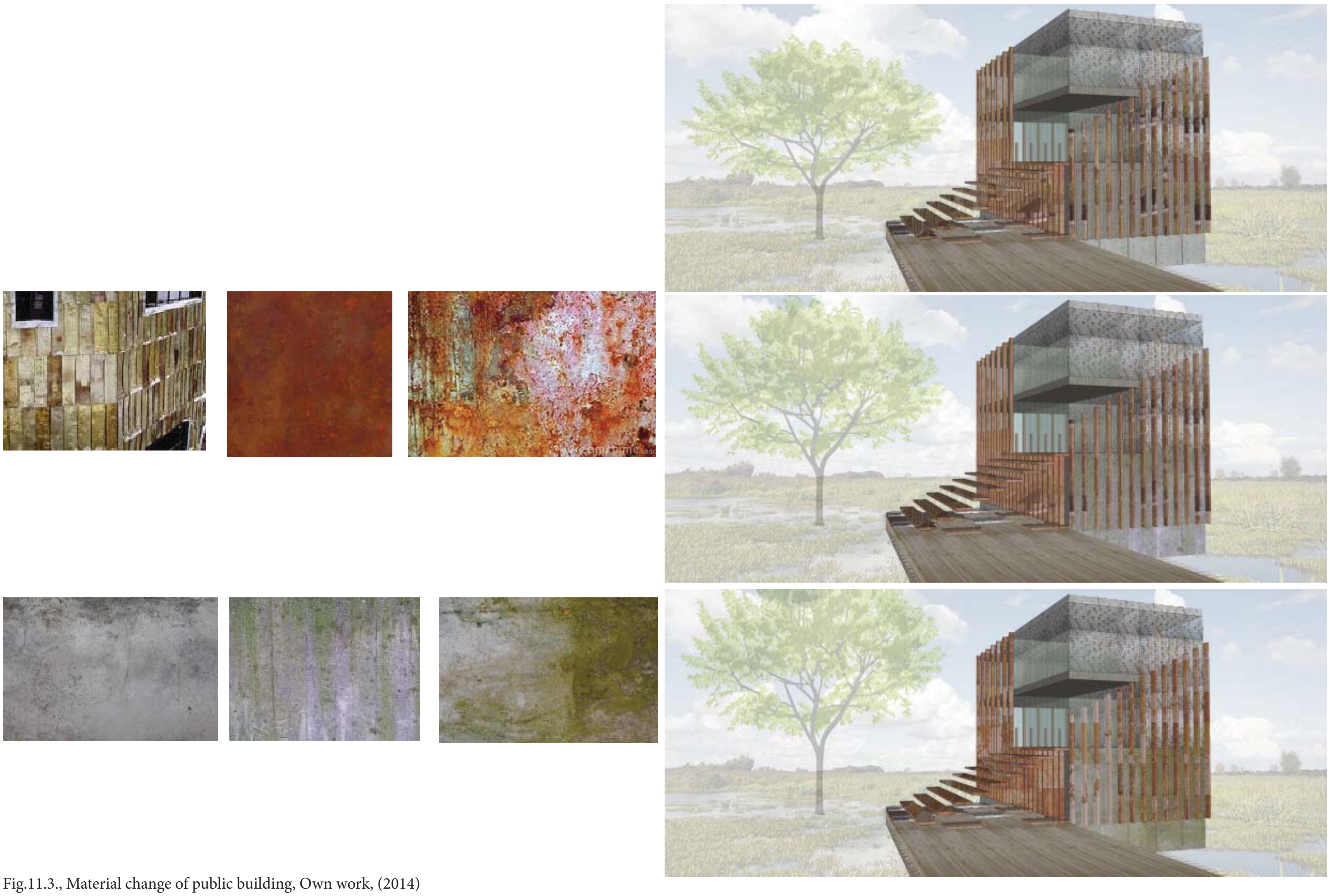


Fig.11.3., Material change of public building, Own work, (2014)

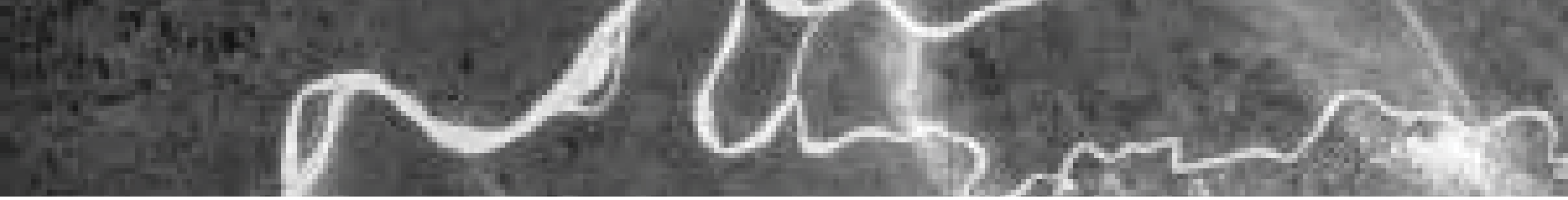



Fig.11.4., From public to communal, Own work, (2014)

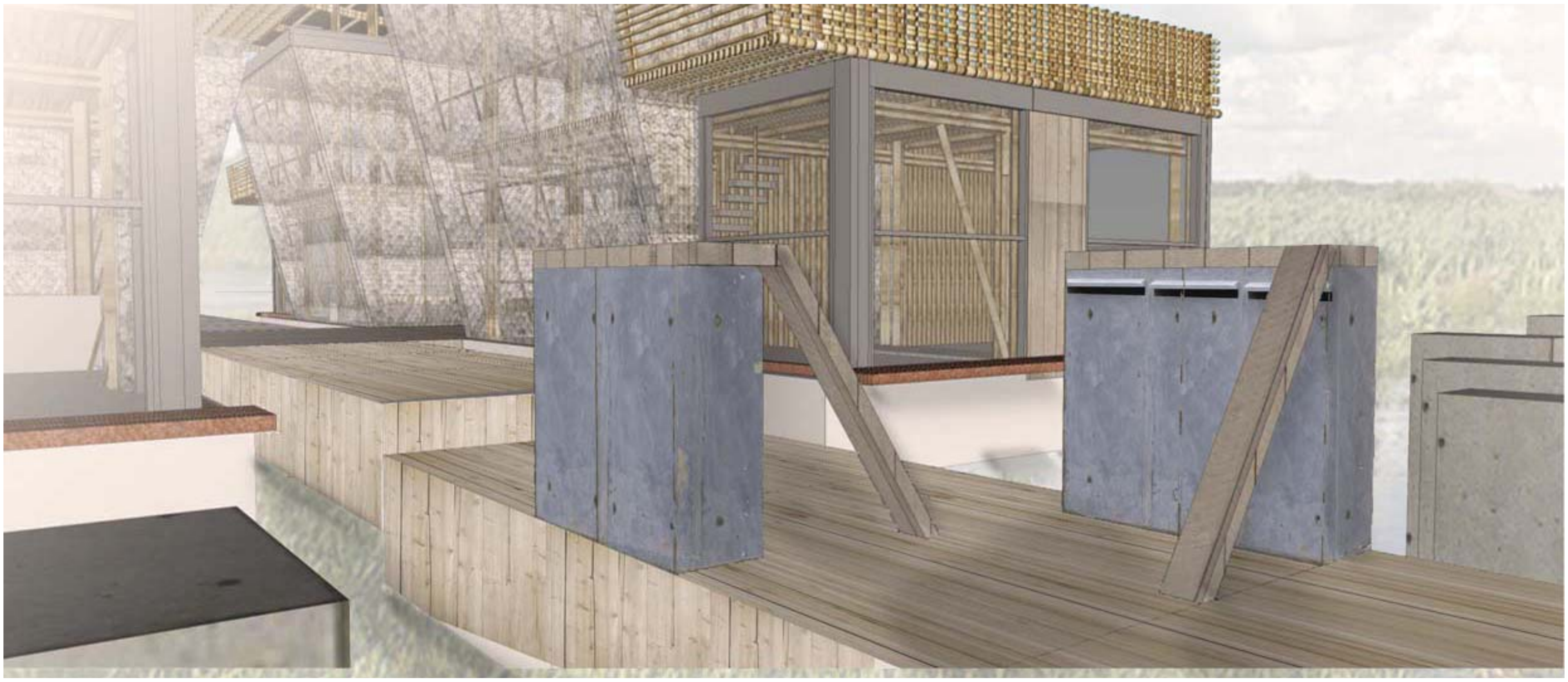


Fig.11.5., From public to communal elements, Own work, (2014)

Public area
Blocks

These blocks are part of the public area. The purpose of these blocks is to give people the opportunity to come together and spent time together is the delta environment. The second purpose of these blocks is to make people aware of the dynamics and changes of the environment. A part of the blocks, the blocks made out bamboo mesh, are founded to the ground while the Pollibrick blocks are amphibious. During change of water level the blocks move relatively to each other. In this way the small compartments were the people mead change and the visitors will be aware of these changes and with that be aware of the changes of the environment. Also because of these different levels the sightlines change. All together this area is a subtle way to be dynamics of the delta.

Fig.11.6., Blocks, Own work, (2014)

Public area
Stan-in

The second element of the public area is the stand in. In this area people can take in their environment in quiet. The element is founded to the ground so during water level changes, the horizon of the visitor change as well. In the figures at the right the changes are showed.

Fig.11.6., Stand-in, Own work, (2014)

Public area
Steppingstones

The last element are the steppingstones. This element is more an active way of being part of the delta environment. By changes of the delta, some stones are not accessible anymore, this make people aware of these changes. Besides after a high water level the steppingstones are not accessible at all, also for the safety. In the figure at the right these changes are demonstrated.

Fig.11.7., Stepping stones, Own work, (2014)

Public area
Night vision

The illuminated elements provide a safe and nice place to stay even during an evening.

Fig.11.8., Night vision, Own work, (2014)

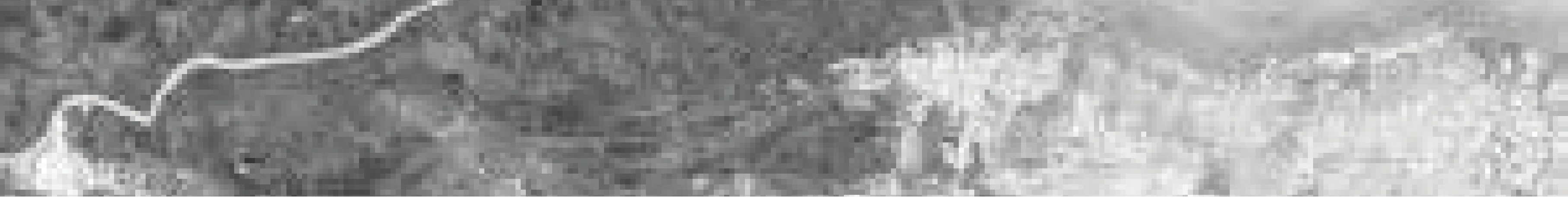
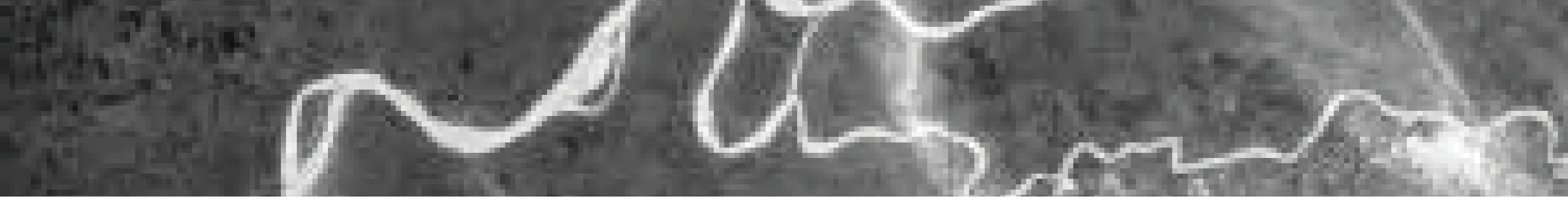


Fig.11.9., Night vision 2, Own work, (2014)



12. Climate technical concept

Introduction

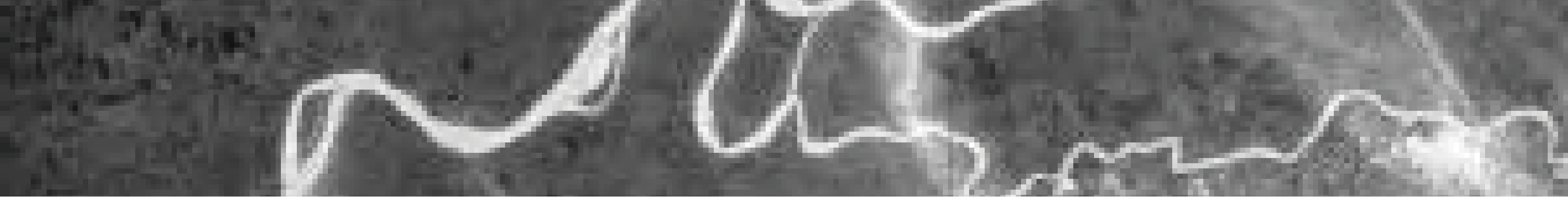
In this chapter the climatological concept is addressed. There is an explanation of the natural ventilation system of the social houses and the self-sufficient of the buildings by the storage and purification of rainwater and the energy supply by solar collection. Besides the process of the influences of the climate at the design is pointed out.

Climate lower Parana delta

The climate of the Lower Parana delta can be described as following; the summers are hot and often muggy. The daily temperatures are between 18 and 22 degrees. In the night this drops to 16-20 degrees. During summer there are heatwaves in which the temperature can reach the 40 degrees. Thunderstorms are well known in this period and they bring cooler weather and rain. Also the southern winds bring cooler air in the hot summer months. In the winter the temperature is in between the 13 and 18 degrees and at night 3 to 7 degrees. But because of the humid weather the temperature appears to be colder. Precipitation ranges from 1000mm to 1400mm. The peaks are in late spring/early summer and late summer/early fall.

Because of the hot summers the climatological design of the dwellings is important. I started the design with the concept of a tropical roof. The first roof has an insulated function while the upper roof keeps out the direct heat of the sun. The gap in between the two roofs stimulates air to flow through which cools down the roof. The warm air in the interior moves upwards, which increases thermal draft; cooler air from the outside flows in the interior and pushes the warm air upwards. This warm air has to leave the house, which is why a gap is made in the first roof. In this way the warm air is drafted away and cool air is drafted inside the building. The outdoor air will be cooled by the presence of the water. The water has a lower temperature than the outdoor temperature, in this way the air cools down and the thermal draft increases (how bigger the difference between the inner and exterior temperature, how stronger the thermal draft) fig. 12.1.

At page x-x the process of designing an object which is designed to use natural ventilation is showed. During this process I designed different ways of stimulating the thermal draft.



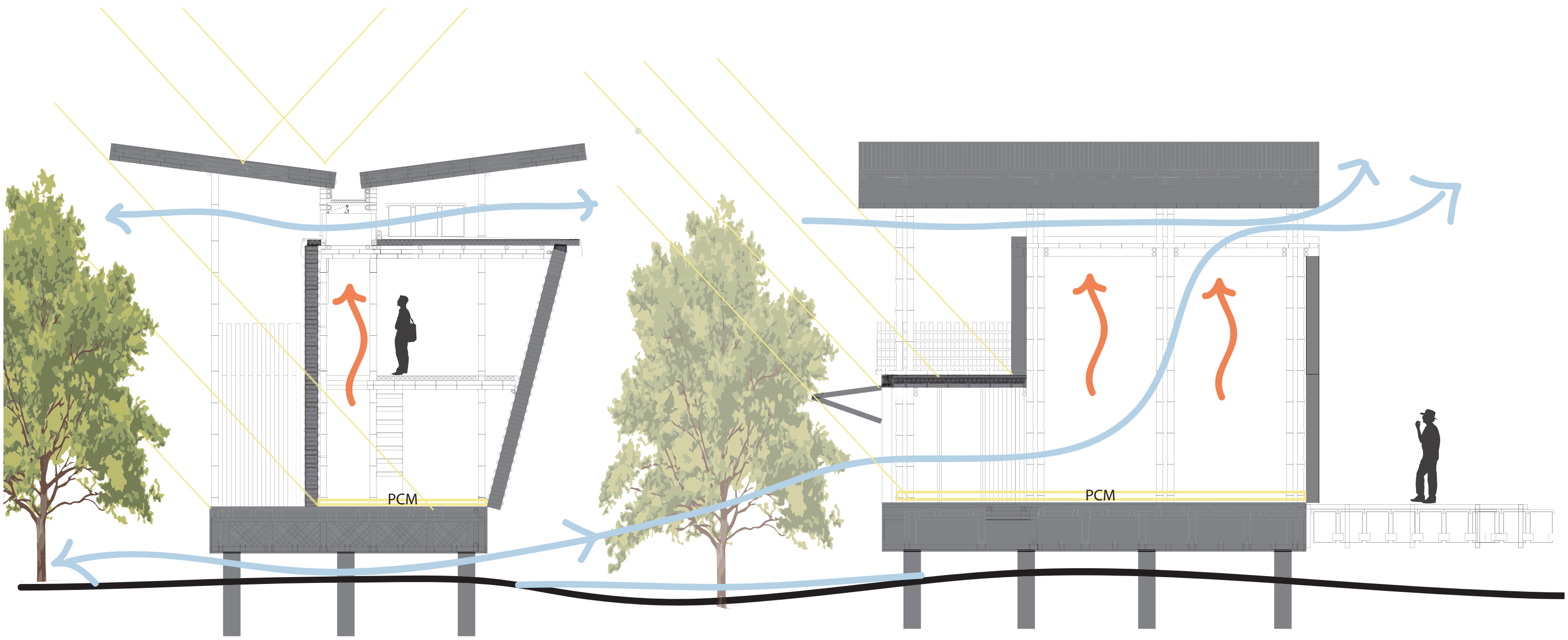
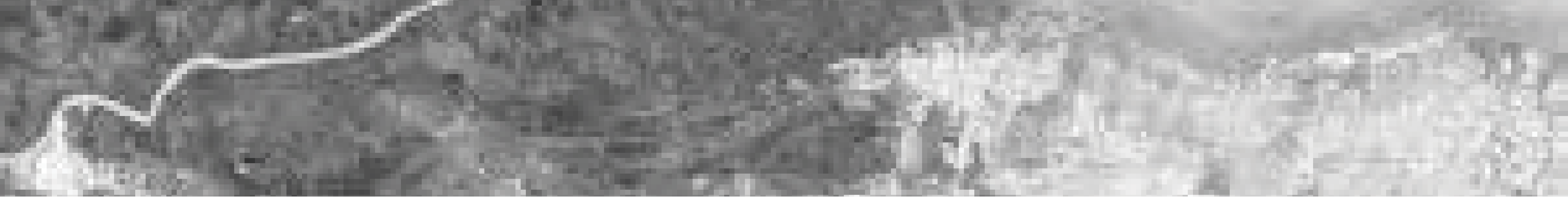


Fig.12.1., Ventilation scheme summer, Own work, (2014)



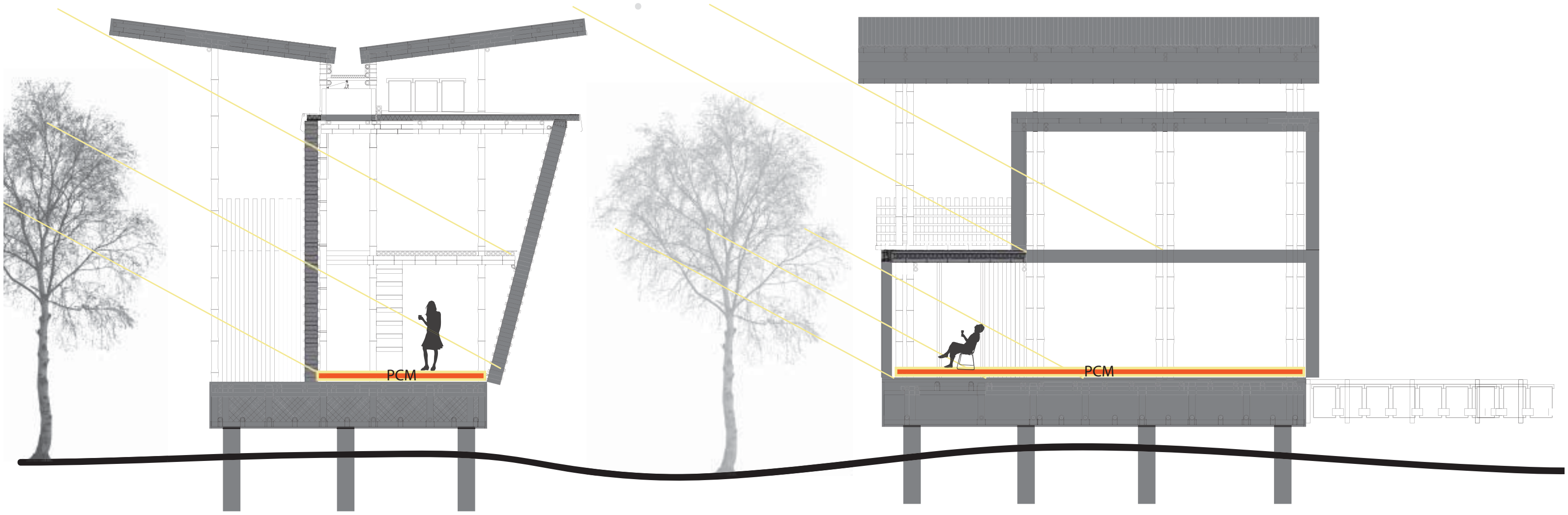


Fig.12.2., Ventilation scheme winter, Own work, (2014)

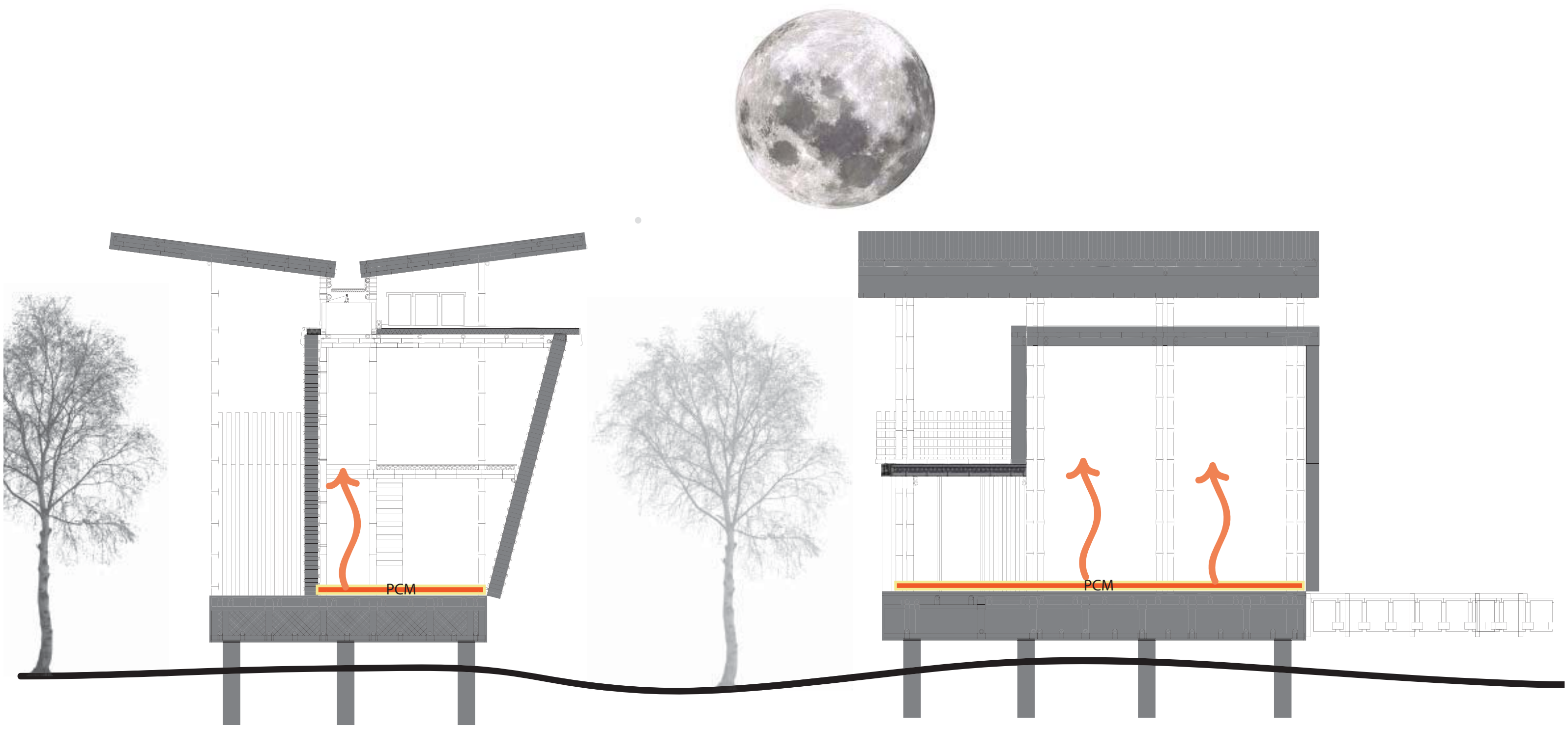
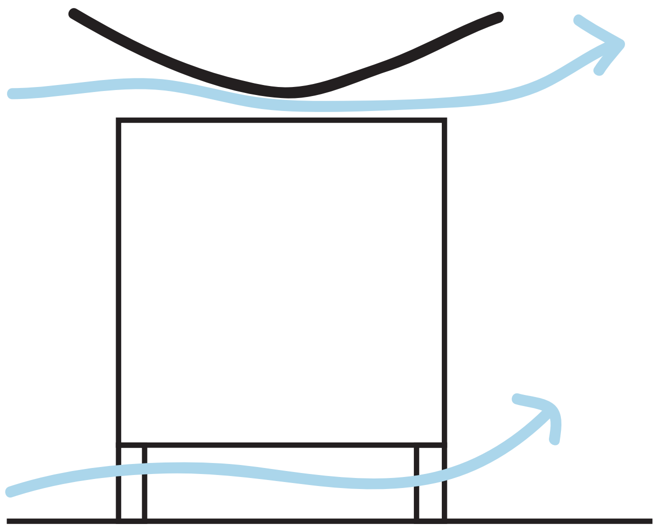


Fig.12.3., Ventilation scheme winter night, Own work, (2014)

Climatological design proces



Optimal ventilation in the summer can be provided by a tropical roof and ventilation under the floor by lifting the house.

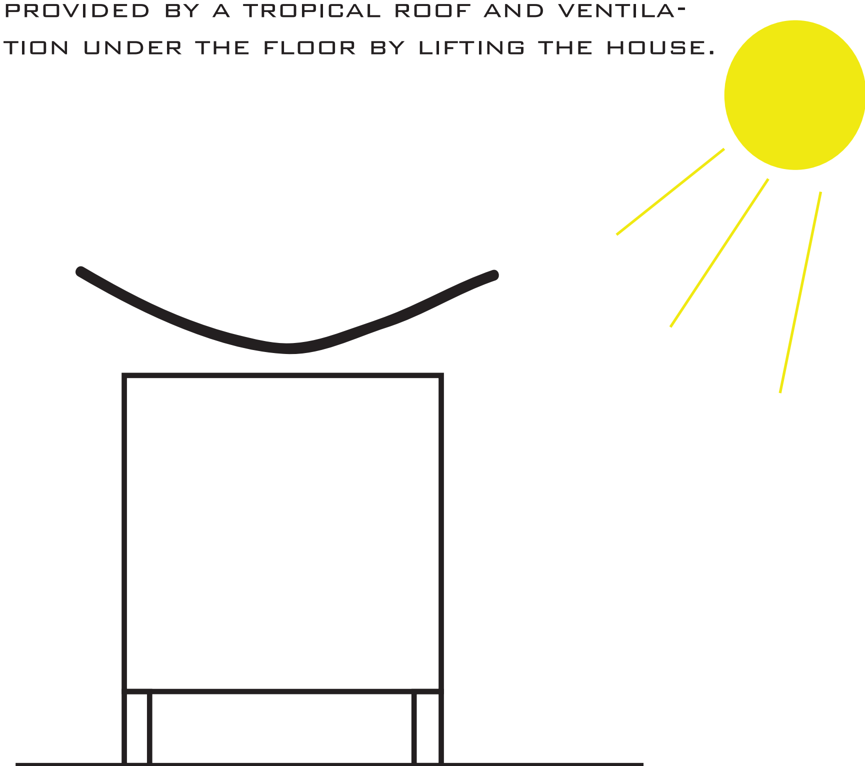
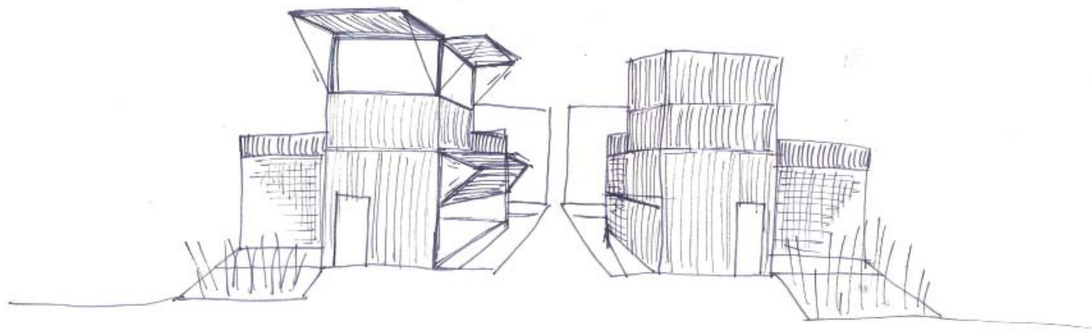


Fig.12.4., Ventilation scheme abstract, Own work, (2014)

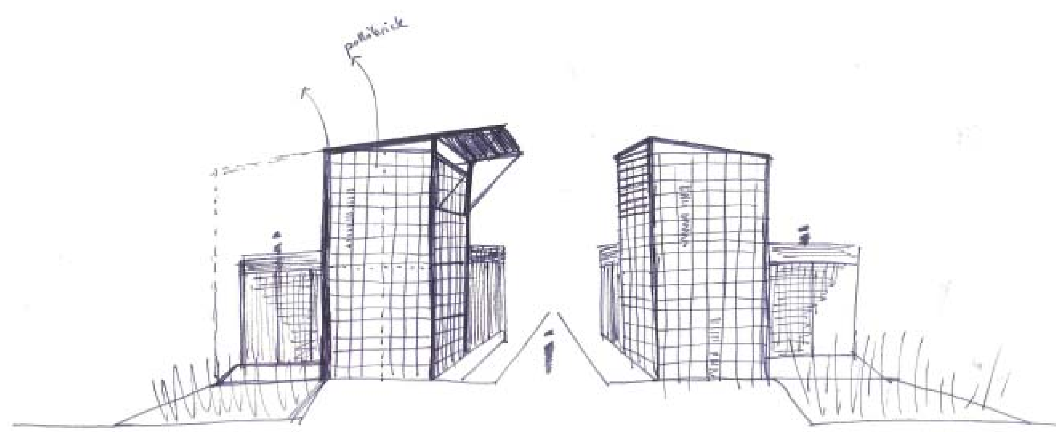
In summer it can be very warm, the design must have implemented a solar systems to keep the sun out.

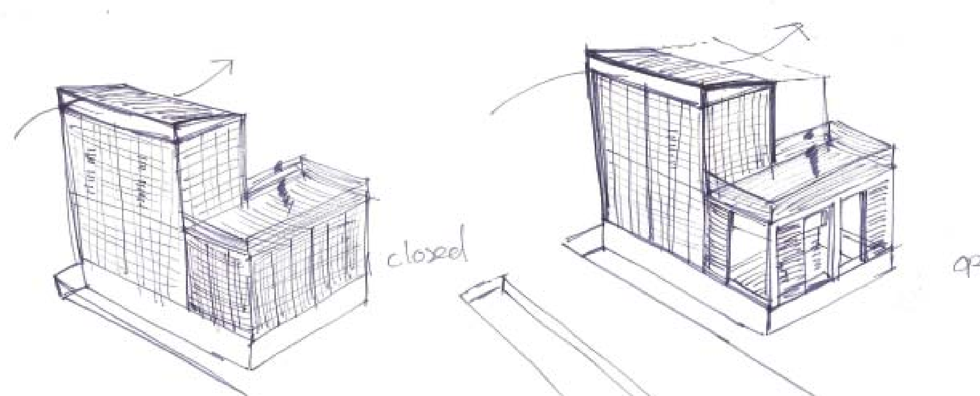
Climatological design proces

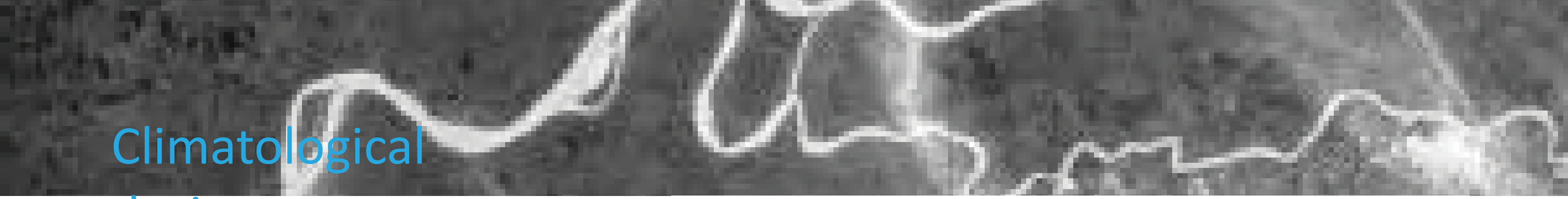
In this first sketch the dynamics are visible in the openable facade elements. in the same times this provides shade and natural ventilation.
Contra:
In winter the object will not have daylight because of the closed facade, (profiding and openable elements and large glass panels the construction would be to expensive.



In this second sketch the roof is lifted a little so warm air from the building can escape. In this sketch also openable elements are used for shading and extra ventilation. This time moving elements are part of the facade. This is also a costly sollution.

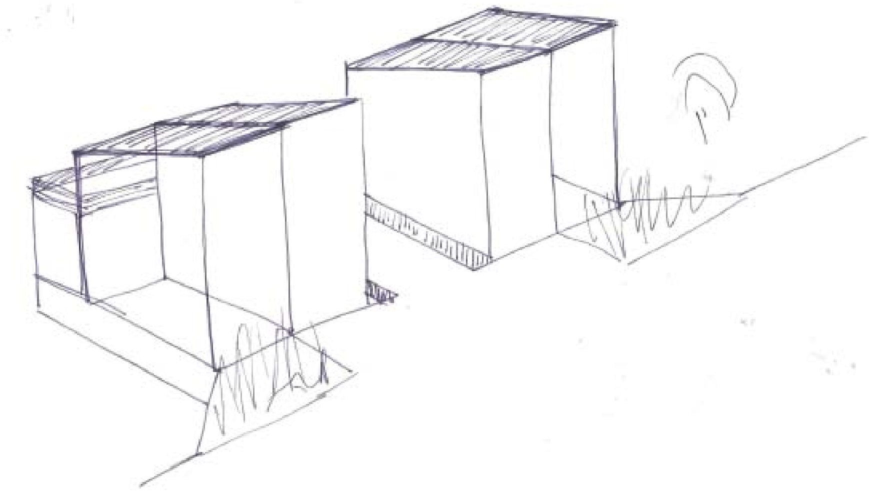




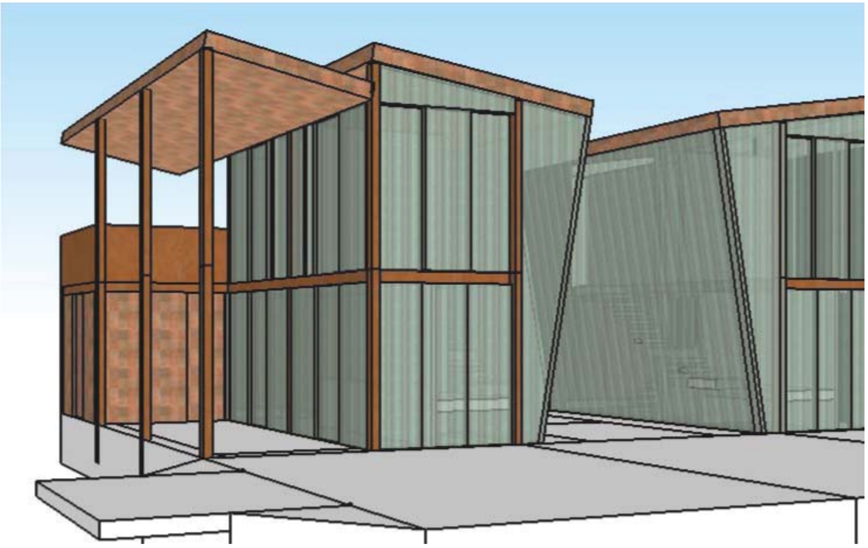


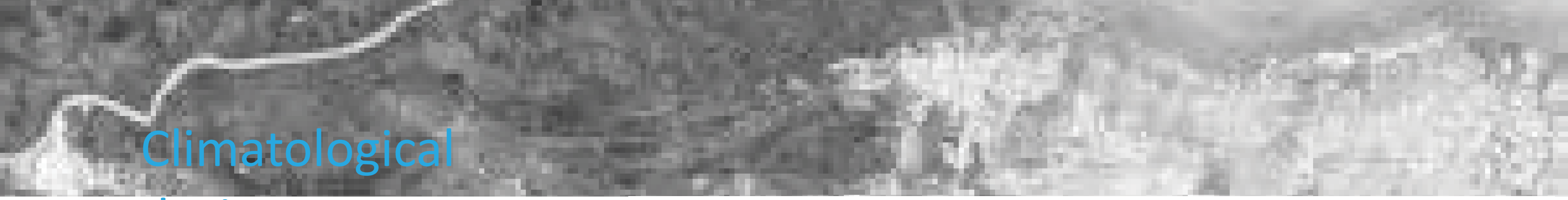
Climatological design proces

In this thirth sketch an other way of designing a roof as a tropical roof was tested. In this case focussing on water storage. By rotating the roof it will have a slope which will lead the water wo one point where it wil be collected. Nevertheless it was not as functional for a tropical roof.



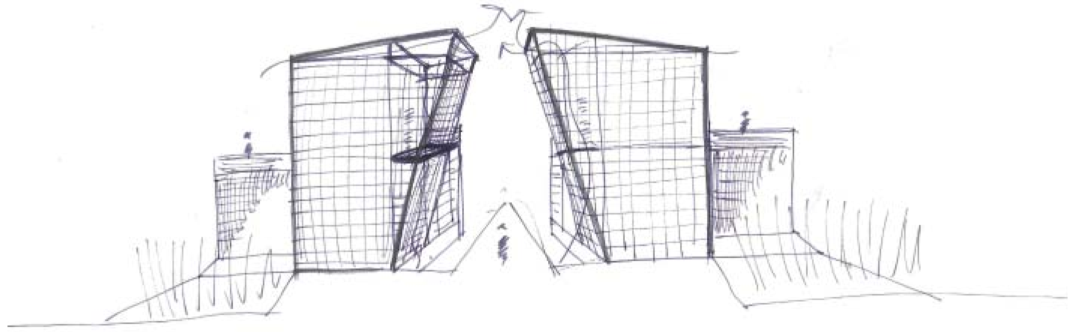
In this fourth sketch the form of the roof also changed. In this case the room provided because of the overhelling wall, creates a buffer-zone in which natural ventilation takes place. After talking this trough with the mentors the conclusion was that probaply the roof does not really work as a tropical roof but will even block the natural flow of air.

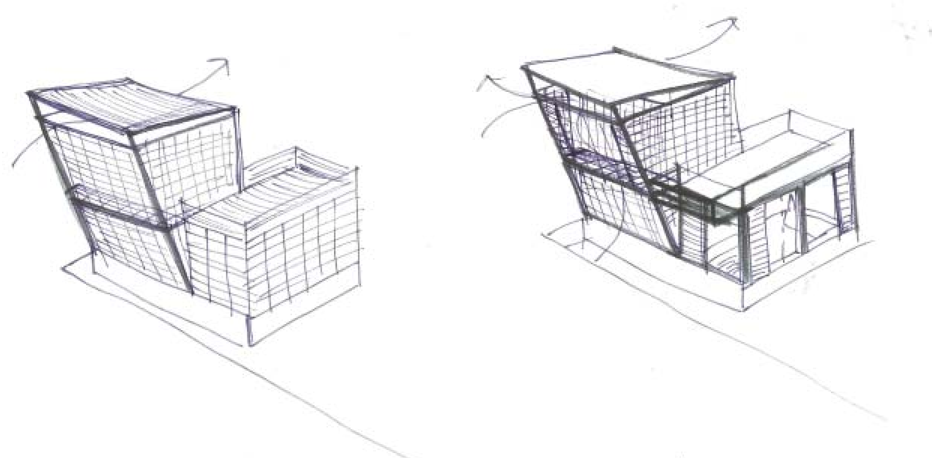




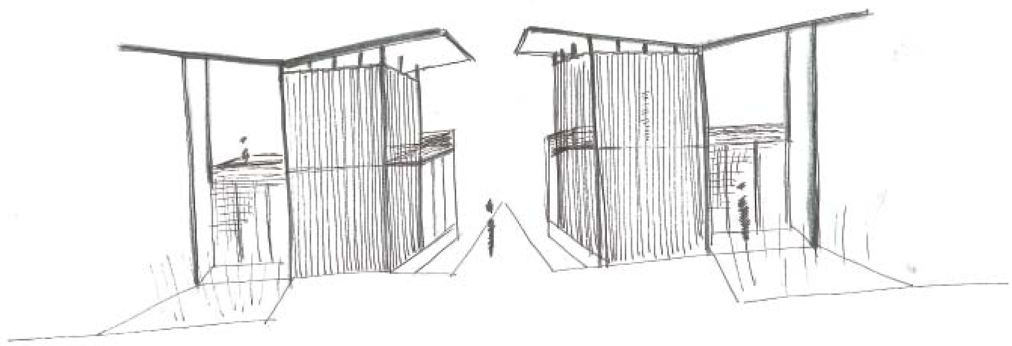
Climatological design proces

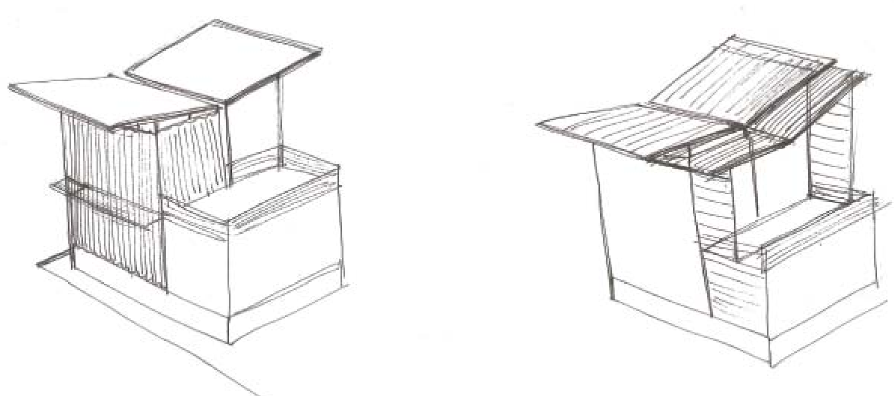
In this fith sketch a combination between the lifted roof and the helles wall is made. I this case the in between space is a outdoor space and the helled wall is more a aesthetic choice.

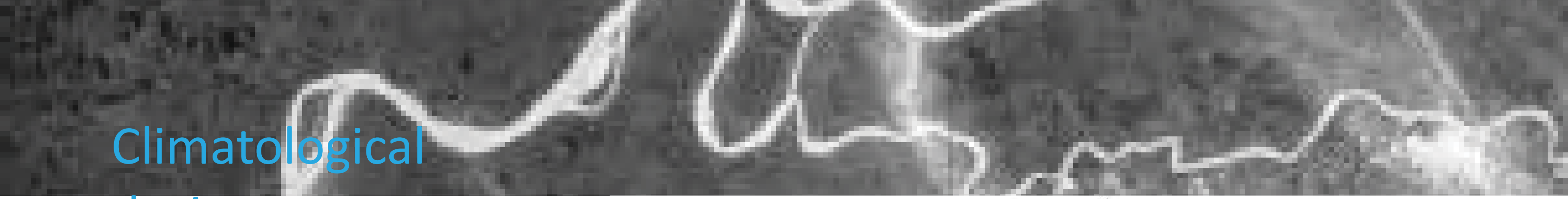




In this sixth sketch the tropical roof is reitroduced in the design. This because in this way people do not have to construct the secod part of the roof by them selfs if they want to expand their house. besides it is usefull for shade and collecting rainwater.



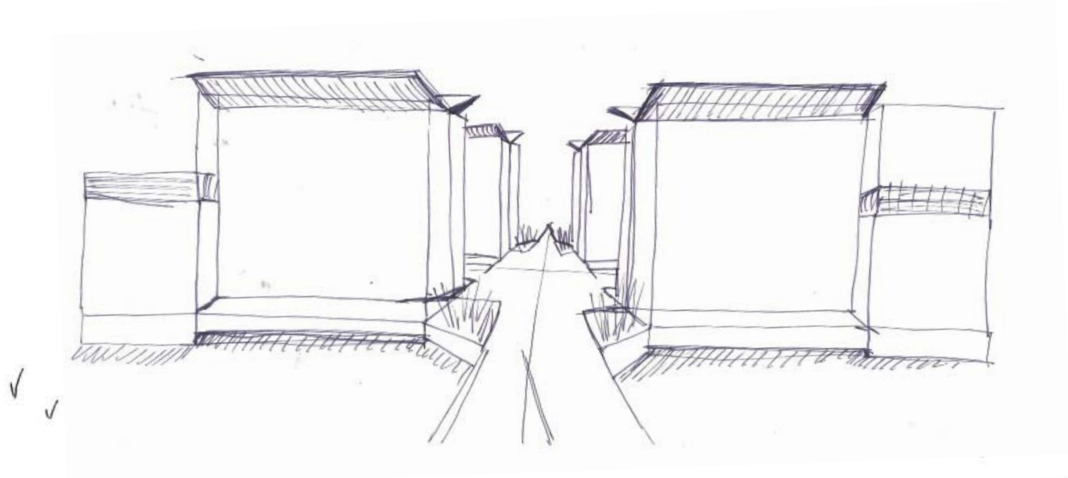


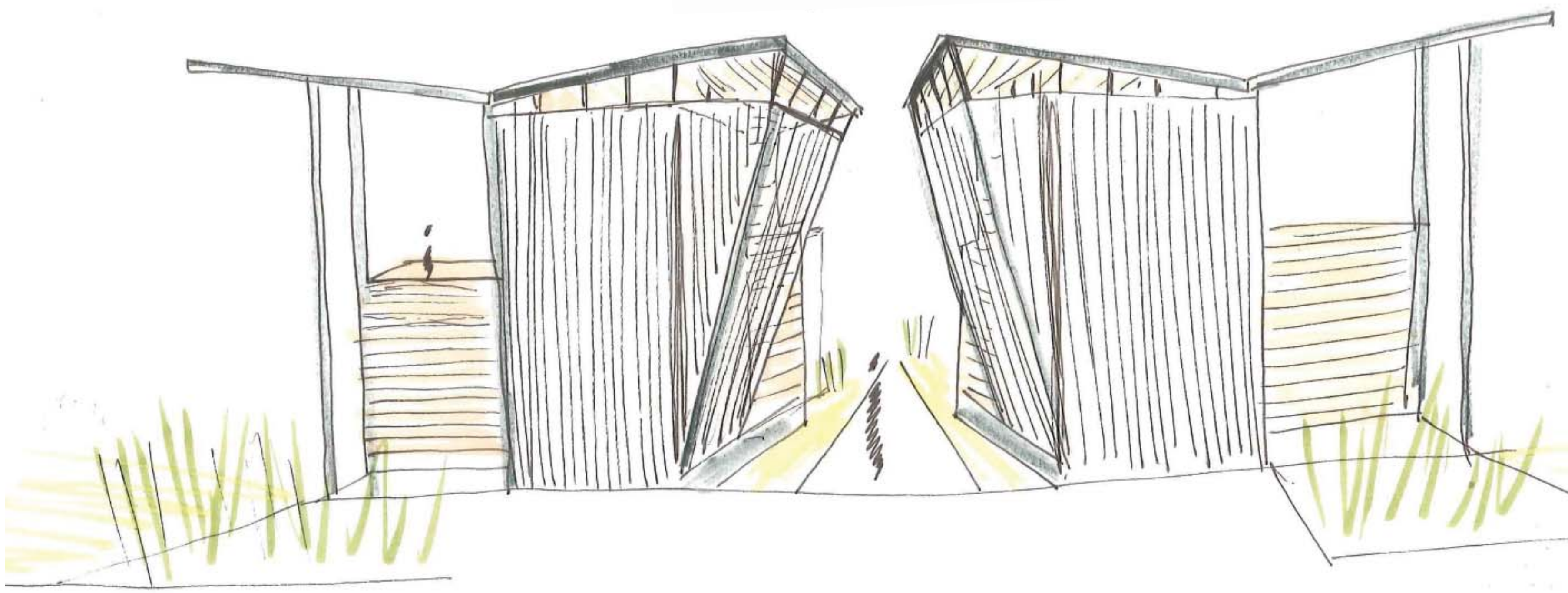


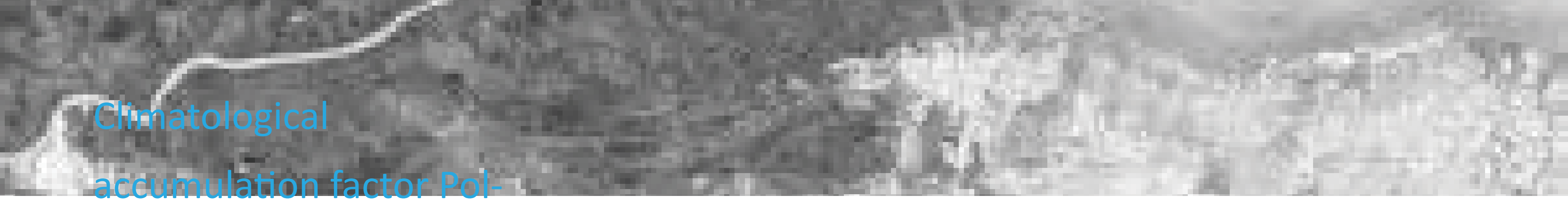
Climatological design proces

In this seventh sketch diagonal lines of the overhelling wall is brought back in the design. this because diagonal lines emphazise the view lines of the walking paths through the delta and makes the people more aware of their environment.

In this eight sketch, the tropical roof as a whole is intergtaed int he design even as the overhelling wall. In this case the overhelling wall is used as extra floorspace and it brings shade in the exterior area. From out this design the project elaborated as can be ssen at page x.







Climatological accumulation factor Polli-brick

The design had to be tested if the heat load in the summer and the heat loss in the winter were acceptable. Here for I used calculation made with a spreadsheet provided for the course BK4050. These sheets can be found in appendix 3.
The first step was to calculate the warmth accumulation factor of the Polli brick and the time needed to warm the Polli brick element. The following calculations are done:

Accumulation factor Polli brick

Rpollibrick= 12
d= 0,02m
λ = d/R
0,02/12= 0,002
This is a respectively low lambda factor

Accumulation:
Qpollibrick=ρ*c*d*DeltaT
ρ= 0,91 kg/m^3
c= 1470 J/KG K
DeltaT= 15
C=0,91*1470=1337,7 KJ/M3K
Q=0,91*1470*0,002*15= 40,131 MJ/m2

d= 0,3m
λlucht= 0,024
This is a respectively low lambda factor
By using a parafine with a melting point of 25 degrees, means that the material turns solid and releases warmth as the temperature drops warmth as the temperature drops under the 20 degrees. It will melt and capture heat above the 25 degrees. An inner temperature of 25 degrees in Argentina in summer is acceptable if there is enough ventilation. The parafine used need to have a melting point in between the 20 and 25 degrees. The concrete floor panels will be impregnated with parafine. In fig.x can be seen that the addition of parafine doubles the heat storage capacity, in this case concrete blocks were used for a test.

Qlucht=ρ*c*d*deltaT
ρ= 1,29 kg/m^3
c= 1 J/KG/K
d= 0,3
⊠T= 15
Q=1,29*1*0,3*15= 5,81 MJ/m2

c= 1 J/KG/K
d= 0,3
DeltaT= 15
Q=1,29*1*0,3*15= 5,81 MJ/m2

Qtotaal= 5,81+40,131= 45,941= 46 MJ/m^2
Thermische capaciteit= C
C = (ρ × c × d) / 1000 kJ/(m2K)
C=1,29*1*0,3= 0,387 KJ/M3K
Delta = ρ × c × d × (1,5 × d / λ)
= 1,26*1*0,3*(1,5*0,3/0,024)= 7,08 sec. om Q te leveren aan lucht

Conclusion:
Polli brick is a weak warmth accumulator (the combination of the polytheen and air is not sufficient), it does not store heat.
By integrating a gas with a high accumulation factor into the Polli bricks, the accumulation of these bricks will be probably get higher. But this means a reduction of the translucent of the bricks and the system will get highly complicated, which will cost more as well. This is not the best solution for this design. Other ways to store heat is by PCM's. At page x this Phase change materials are explained and the choice of use in the design as well.

Climatological

Heat load

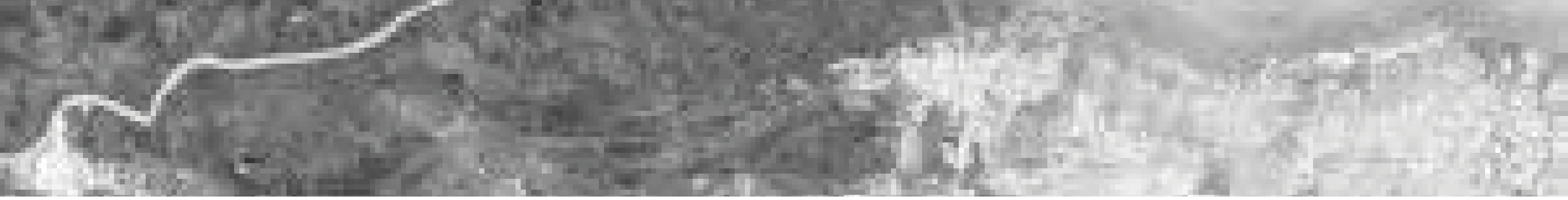
The second step were the calculations of the heat load and loss of the building. In the sheets used, appendix 1, the following result were found.

The building consist out two parts, a Polli brick part and a partly glass part. the heat gain in the Polli brick part during day is 5151W for one floor, the Polli brick side has 2 floors, so the heat gain will be calculated as 5151*1,5= 7726.5W , but the glass part has a heat loss of 2250W. This means an overall heat gain of 5476.5W at day time. In winter that is positive, the warmth can be stored in a PCM and released if it cools down during night. In summer this means that the temperature inside is quiet high. Ventilation is needed. Following the sheet (1*glass part and 2*pollibrick part):
2*1,83m3/s + 1,36m3/s= 5,02 m3/s
Air is needed to ventilate the house. In this fase the gaps in the roof are essential for the ventilation. Warm air elevates, so the warm air wants to leave the roof. The gaps in the roof makes this possible. fig.12.5.
The following calculation shows the size needed for this gap to ventilate. With natural ventilation the needed amount of outside air for cooling is:

A=totaal luchtvolume(m3/s)/1

A= 5,02 m2

The gap in the roof is > 5,02 meter



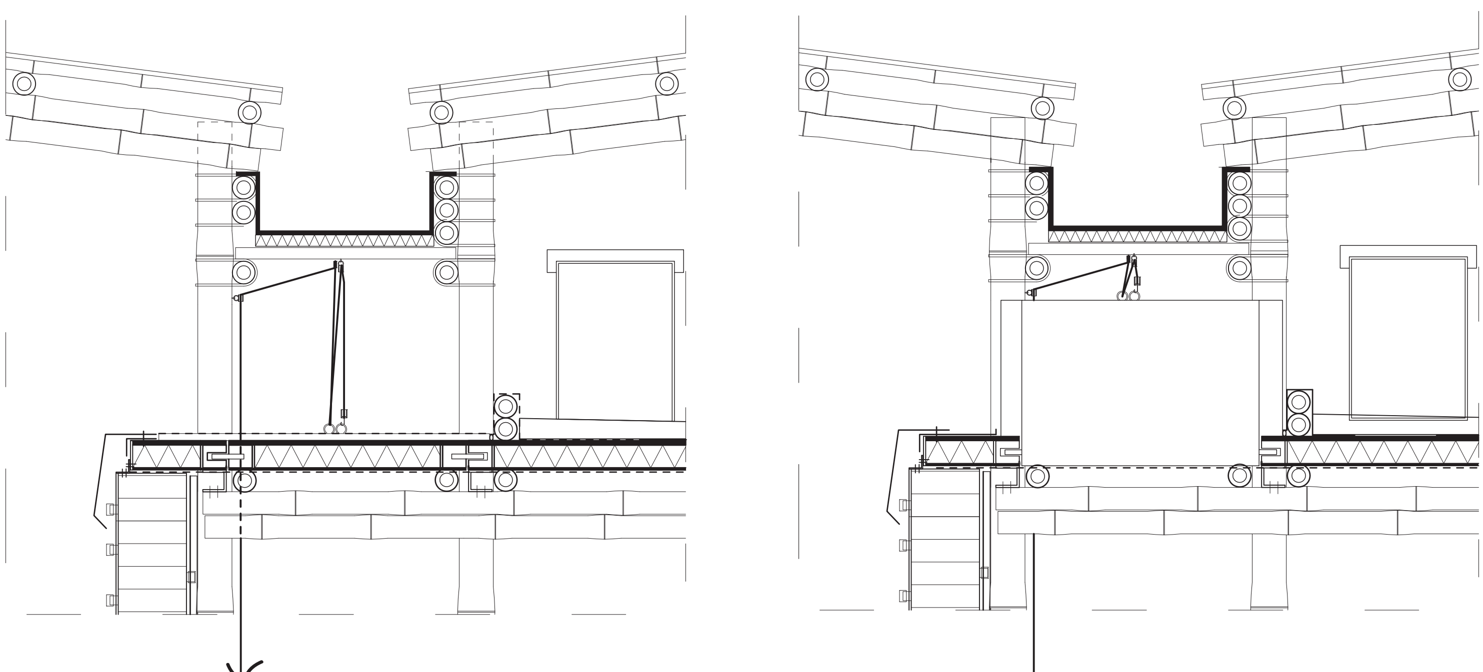


Fig.12.5., Ventilation gaps in roof, Own work, (2014)

Sun shade facade elements

Because the heat gain of the building are quiet high, solutions to keep the sun out are essential. One solution of the design are the sunshade elements at the glass part of the building. Cooler exterior air (the air is cooled by the water of the environment) has to enter the houses. For that a part of the facade can be totally opened. These facade elements also has a sunshade function. They open horizontally instead of vertically, by folding the element as can be seen in figure x. In this way the sun cannot enter the interior of the houses. The interior is covered in shade which makes this area cooler that the sunny exterior.
In winter these facade elements are closed. The sun can enter directly the houses and will warm up the interior. In this way Sun radiation in summer degrees when in winter the sun radiation is gained

Heat storage in PCM

In the winter it is wished to keep the warmth inside to come to a comfortable interior climate. The first step is to decrease the thermal "lack" of the roof. Gaps were made to draft of the warm air in summer but in the winter you need to keep this warm air inside. That is why panels are made in the roof construction which can close of the gaps see fig.12.4. These panels are insulated and decrease the thermal leakage as much as possible. The second step is to collect warmth and store this warmth. Here for also the PCM floor elements are of use. The sun is lower in the winter. The doors in the facade are closed in winter so the sun shade function of these door panels are not of use which means the sun will enter directly the floor elements in the houses. The warmth of the sun radiation will be stored in the PCM and will be released when the interior temperature gets below an x degrees.

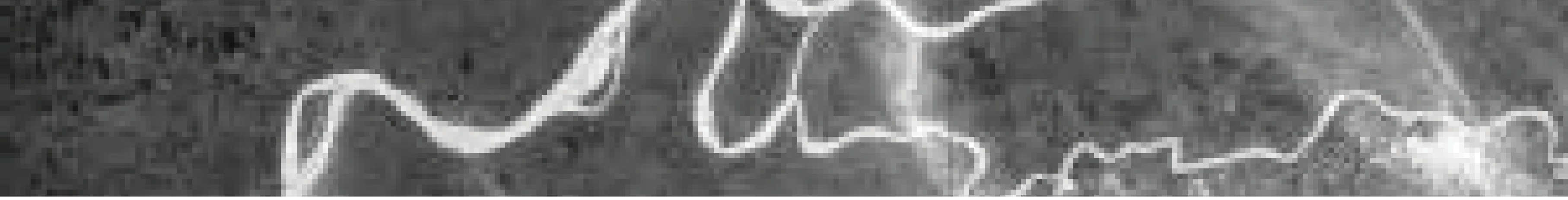
PCM is short for phase changeable materials. Chemical bonds are used to storage and release heat by changing from solid to liquid and the other way around. PCM's have melting point between 20 and 32 degrees. This can be lowered by editing calcium carbonate. The material changes at an x degrees, during this process it absorbs the heat from the area, and this area will cool down during this process. If the areas temperature drops, because of change of season or day and night, the material changes to get solid again and releases the stored heat to its environment. In this way heat storage during summer/ day will released during night,/ winter, fig,12.2 and fig. 12.3 (V.V. Tyagi & D.Buddhi, 2005)
This use of PCM's is a passive system, without the use of mechanical systems. I have chosen this to decrease the costs of energy and material. Several materials can be used as PCM in the floor. The top layer of the floor is a concrete layer of 5cm. This at itself can storage heat by warmth accumulation. The heat storage in this layer can be increased by editing a parfine mixture in the concrete top layer. (V.V. Tyagi & D.Buddhi, 2005) The PCM material needs to have a melting point in the rage of the interior temperature, so in between 20 and 35 degrees. By using a parafine with a melting point of 25 degrees, means that the material turns solid and releases warmth as the temperature drops under the 20 degrees. It will melt and capture heat above the 25 degrees. An inner temperature of 25 degrees in Argentina in summer is exeptable if there is enough ventilation. The parafine used need to have a melting point in between the 20 and 25 degrees. The concrete floor panels will be impregnated with parafine.
In fig.x can be seen that the addition of parafine doubles the heat storage capacity, in this case concrete blocks were used for a test.

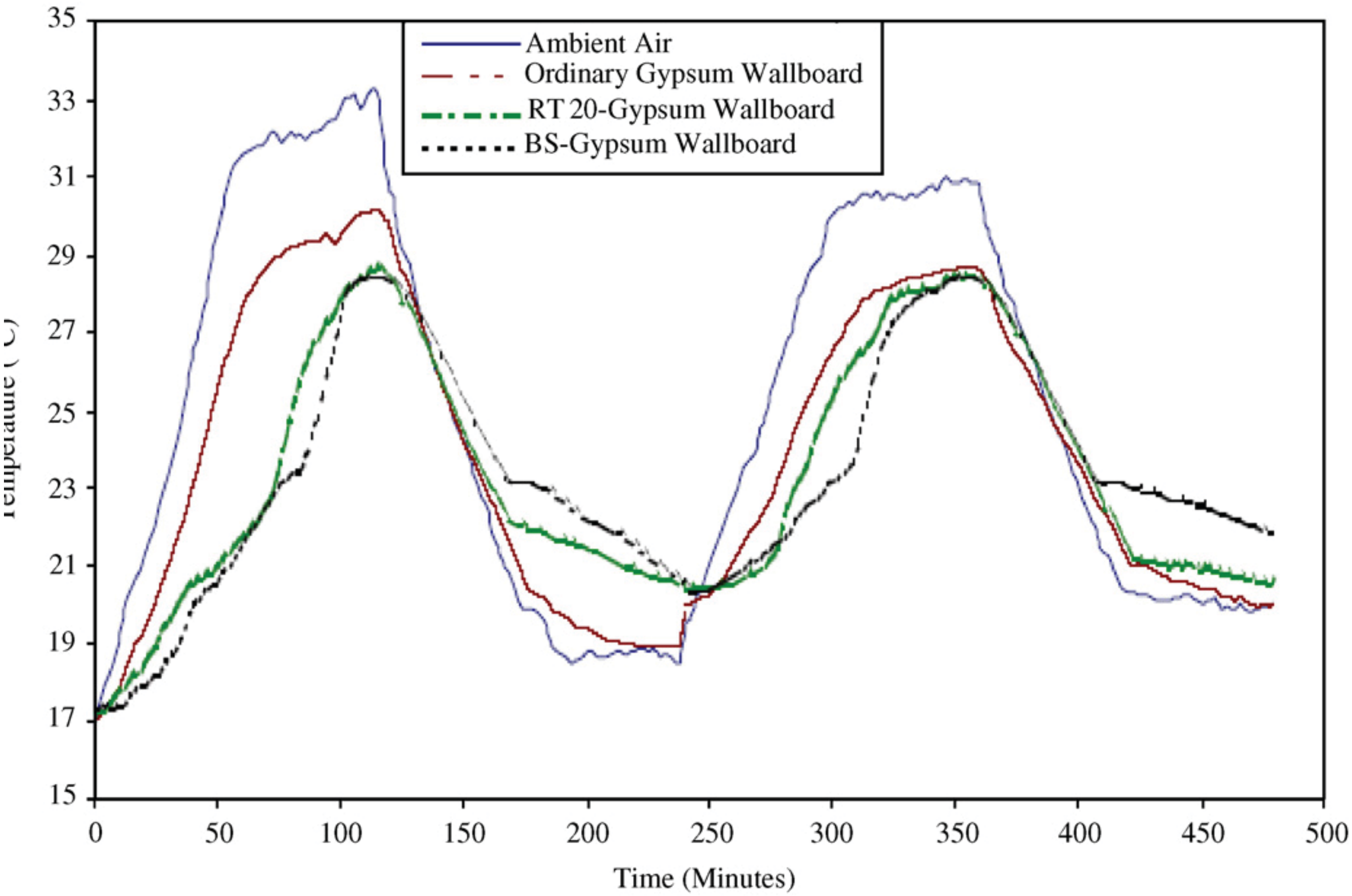
In fig.12.6 a test is showed of two gypsum wallboards impregnated with a PCM. Two wallboard samples with dimensions 100x100x10mm were impregnated with paraffin (23.2% in weight of RT20) and BS (22% in weight of BS). These wallboard were compared with a control board of gypsum without a PCM. The test was done by forcing warm (30–33) and cold (17–20) air over the same side of the board for thermal cycling tests and are presented in fig.x. This is just one of the many test results done. The PCM was completely melted and frozen. The results of these tow PCM'S show that tthere was no tendency for the PCM to migrate in the wallboard. Neither was a sensible deterioration of thermal energy storage capacity. (Khudhair A, et al. 2003)

What this figures demonstrates for my design is that a with parafine impregnated floor will have positive effects for the interior climate. This kind of parafine is low-cost but will have good results. The use of the PCM impregnated floorboards will storage heat during day which in summer will cool down the interior and in winter this warmth will released by a temperature dropping. In this way, the interior will be warm even during colder outdoor temperatures.

The climate control of this design is as such that during the warm humid summer, the interior space of the houses are cooled by natural ventilation by water cooled air drafting through open able windows, a gap in the roof for thermal draft and a tropical roof which reduces solar radiation through the roof. Besides the horizontal open able facade elements work as a sunshades and will exclude the sunrays' to enter the interior. The interior of the house will be bathing in shadow at the glass side. At last the PCM in the floor has an influence at the indoor interior by its capacity of storing heat.

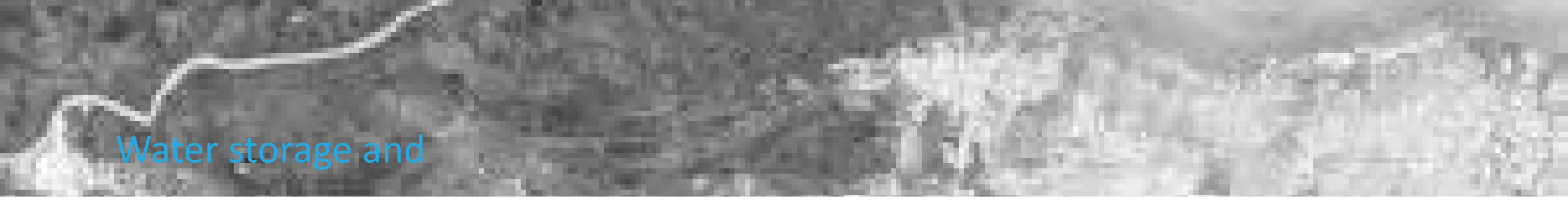
In winter the sunshades are down, that means the solar rays will warm up the interior space. The solar energy will be stored in the PCM coated floor. The PCM will release this energy if the temperature drops under the melting point of the PCM. This can be seen in fig. 12.2 and fig. 12.3.





The type of the block	A	A	A	R	R
PCM	BS	P	P	P	P
% PCM in block	5.6	8.4	8.4	3.9	3.9
Temperature range (°C)	15–25	22–60	45–60	22–60	45–60
Storable sensible heat in blocks (kJ)	1428	5337	2107	7451	2941
Storable sensible heat in PCM (kJ)	233	1136	449	705	278
Storable latent heat in PCM (kJ)	977	2771	2082	1718	1291
Total storable heat (kJ)	2638	9244	4638	9874	4510
Total storable heat/storable sensible heat in block	1.9	1.7	2.2	1.3	1.5

Fig.12.6., Calcualted heat storage values for various PCM-Block combinations, Lee et al., 2000



Water storage and purrifiction system

Another aspects of the social houses is their self-sufficiency. Because this design is a pilot for a community which has to be implemented in all the parts of the delta, even parts without electricity or water supply, it is important that they are self-sufficient.

The roof of the houses are formed in a way that they can collect water. In fig x the cycles is showed. Rainwater is collected by the roof and stored in drums at the roof. A part of this water will be heated by the sun in a water heating system at the roof. This warm water is collected and stored for use. The cold and warm water enters the houses for use in the bathroom and kitchen. The grey water leaves the houses and enters the water purification system. This system consist out a bed of reed. Reed has the ability to purification water. Grey water enters a pipe in which the roots of the reed are growing. The water get cleaned and drips out the pipe, passes some soil layers and this clean water streams to the collector. This water collector is in the communal area of the community. With a water pump this water can pumps to the roof if there is a lack of water in a household. An overflow of water will leave the system by pipes. In this way the water will be refreshed naturally. Only clean water will leave this system so the environment will not be harmed by human waist.

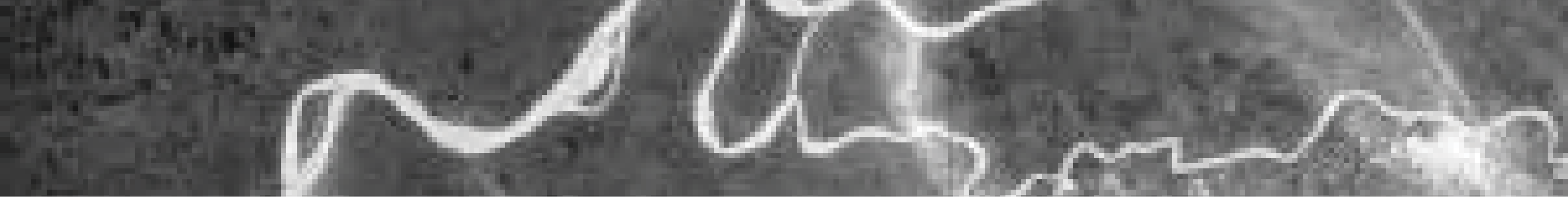
The needed size of the reed bed is adopted from the article at foodforest.com. For a household of 2 person they calculated with the following. They assume that a household of 2 a 3 person use 300 litres of water daily. Assuming that rain water is used also for hot water. They design a 1650liter water tank which give a retention time of 5,5 days in primary treatment. Citation from the article:
"'Sizing of reed bed
Using the TPlugflow modelP as endorsed by the US Environment Protection Agency and allowing for local SA conditions the following formula and values were adopted:
Flow (cubic metres/day) X BOD of inflow
Area of bed = BOD of outflow________
Temperature Constant X bed s porosity X depth of water
Where:
- Depth of water 0.5 metre
- Porosity of gravel in bed 40%
- Biological Oxygen Deficit (or Demand) of inflow 300
- Biological Oxygen Deficit of outflow from bed 20
- Temperature average of 15 degrees C gives a Constant of 0.473
- Flow 0.3 cu metre/day (300 litres)

Therefore the Area of the reed bed must be 8.52 square metres
Using a width of 1.2 metres length = area/width
The length of the bed must be at least 7.1 metres.

Using modules of 2.4 metres length, three modules give a reed bed length of 7.2 metres which is thus adopted.

The volume of this reed bed will give a retention time of a fortnight, well over double the retention time required by many reed bed designers in Australia. A pump sump will be at the exit end of the reed bed fitted with a submersible pump and irrigation piping to the woodlot.'

These are calculation following the rules in Australia, there are no guidelines for this kind of systems in Argentina that is why I used these guidelines.
Concluded can be said that the reed bed per household must be 8,5 square meters. The reed bed in the design is 9 square meters, with the guidelines used this is sufficient.



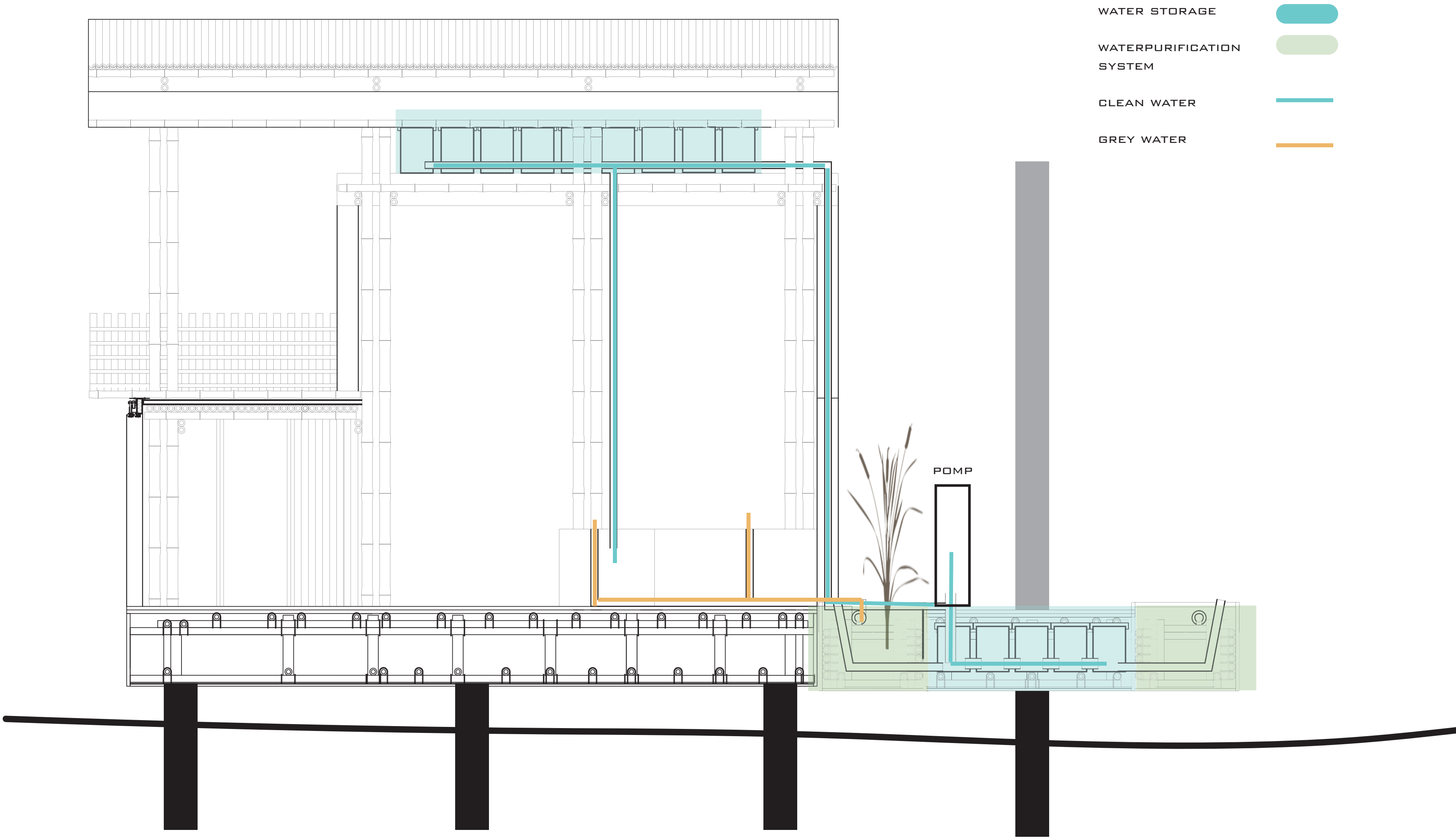
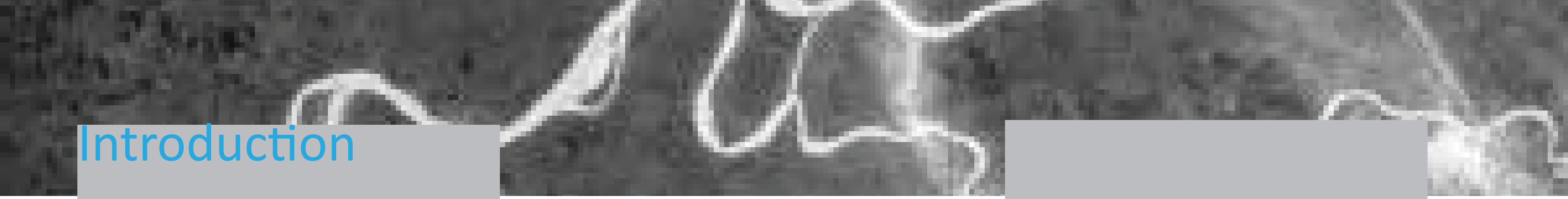


Fig.12.7., Water purification system, Own work, (2014)

13. Constructive aspects



Introduction

In this chapter the building with bamboo is pointed out. Bamboo is the main constructive material of the dwellings designed in this graduation project.

First the characteristics of bamboo are explained. Next the possible joints used by building with bamboo are pointed out at last an explanation follows with the chosen technique for the design is described.

Characteristics of building with bamboo

Suitable bamboo species

There is a wide and diverse range of bamboo species. Some of them are applicable for construction. Bamboo Guadua Angustifolia, found in the Parana Delta is such a bamboo (M. Brea, A.F. Zucol, 2007)

Competiveness Bamboo

Bamboo is a cheap material, compare with wood. J.J.A. Janssen states in his report that bamboo costs 1,5 US Dollars for a 8 meter culm. Calculated this will be 105 US Dollars per cubic meter. Because of its hollowness the efficiency of the bamboo is 1.9 higher than wood. So competitive seeing the wooden beam cant cost more than 105*1,9=55 dollars per cubic meter. But wooden beams costs a lot more Janssen states.

Harvesting bamboo

Harvesting bamboo needs special care. If done wrong the plant wills stop growing or will even die. A clean cut is essential. This can be done by using a chainsaw. (B. Byrnes, 2009) in this way the diameter will get bigger and will get taller.
Fun fact: In the lower Parana delta the Tigre municipality started a project to learn people how to harvest bamboo to maximize the commercial and environmental appeal.

Competiveness Bamboo

Bamboo is a cheap material, in compared to wood. J.J.A. Janssen states in his report that bamboo costs 1,5 US Dollars for a 8 meter culm. Calculated this will be 105 US Dollars per cubic meter. Because of its hollowness the effeteness of the bamboo is 1.9 higher than wood. So competitive seeing the wooden beam cant cost more than 105*1,9=55 dollars per cubic meter. But wooden beams costs a lot more Janssen state..

Stress

In fig.13.1 the stress failure diagram is showed of concrete, bamboo/wood and steel. In short, how wider the diagram how bigger the rage of failure of the material. This means that bamboo and wood has a big uncertainty. Concluding from this outcomes steel looks more economical for construction than wood/bamboo. However, in the case of hurricanes, strong winds and earthquake, the stresses multiply. In such circumstances the values of steel will get in the failure area, but timber and wood would not. Steel constructions suffer more than timber and wood, if built with care. The "failure "of the stress of bamboo is not a real failure as such. Because of its elasticity, bamboo after deformation will return in this current state. So after deformation by an earthquake of heavy winds, the structure, even if slightly damaged, will return in current state. The damaged parts can be replaced eventually.

Besides bamboo, after steel, has a high strength and stiffness, in other words is resistant against deformation. This also makes this material suitable for hurricane and earthquake sensible areas.
The Parana delta suffers from strong winds, heavy rainfall and also earthquakes. Bamboo, with its constructive characteristics described here for, is a suitable material for this area.
(J.J.A. Janssen, 1999)

Durability bamboo

The natural durability of bamboo is very low if not preserved. The live span of untreated bamboo is:
1-3 years in the open in contact with soil
4-6 years under cover and free from contact of soil
10-15 years under very good storage conditions. (J.J.A. Janssen, 1999)
Some point are useful to increase the natural state of the bamboo.
- Harvesting in the season when starch content is low
- Dry storage, of the soil
- By construction keep the bamboo free from water

Preservation is needed to increase the lifespan of the bamboo. The outer skin of bamboo has a high silica content, this keeps water out and prevents insect but also makes it difficult to preserve the material. The inside has a waxy layer which also makes preservation difficult. The only way to preserve bamboo is through conductive vessels. These vessels close within 24 hours after harvesting.

There is a traditional and a chemical way of preservation of bamboo. Traditional ways are curing, smoking, soaking and seasoning and lime washing. In large scale project, such as my design, chemical treatment is unavoidable. Cheap and affective ways are with a boron- based fertilizer. Once mixed with starch and sugar of the bamboo there is no waste at all and it can be used as a fertilizer.

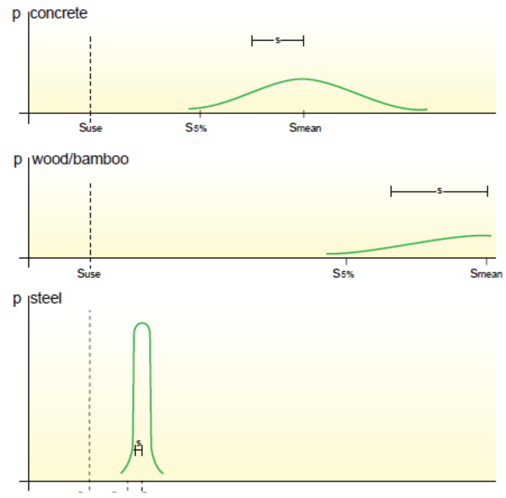


fig.13.1., 7654321Detail 7

Two ways of fertilizers are used; modified Boucherie treatment and dip-diffusion. The first one has to be done directly after harvesting. The chemicals are pressed in to the culm. The vessels absorb the chemicals. The second treatment dips the culms in a bath of chemicals so it passes the culm by diffusion.

Calculation of a beam

To make the right choise fot the measurements for the beams some calculations have been made with help of the report of J.J.A. Janssen.

Calculations bamboo deformation

Formulas:
$F=(5*q*L^{4}/)(384*EI)$
Or
$F=(F*L^{3})/(48*EI)$

$E= 20000\ N/mm^{2}$
$P=3,14$
$I= 0,40A^{2}$
$D=150mm$

Deformation acceptes= 1/3 spam
Spam = 3m
Deformation accepted = 1 cm

$I=0,03D^{4}$
$A=0,26D^{2}$
$S=D/(3*L)\ (N/mm^{2})$
$S= 150/(3*3)= 17,7\ N/mm^{2}$

Deformation:

$10*3^{2}*16,7/\ 150= 10,02\ mm = 1cm$
$M=16,7*181442=3030081\ Nmm$
$Q=**M/L^{2}= 2,7\ N/mm$

Diameter of 150 mm is ok for a beam

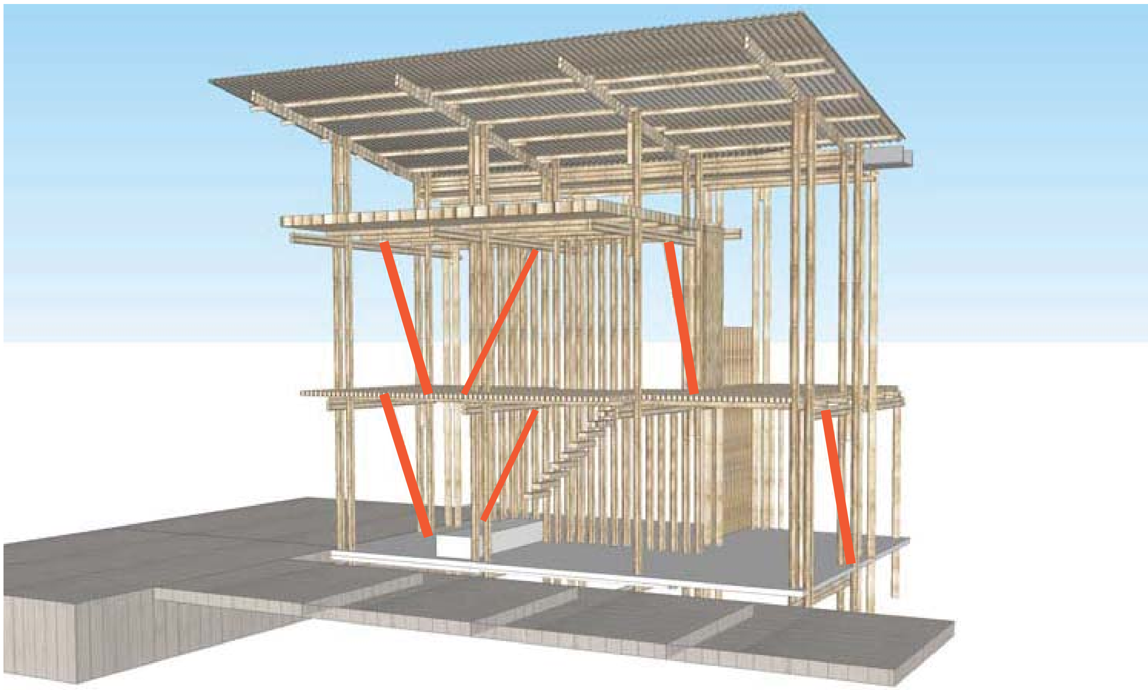


Fig.13.2.,Construction forces remittance, Own work, (2014)

Used Joints bamboo construction

Because of its round form, the approach of jointing bamboo is different than rectangular constructive elements. Bamboo has a high strength, even though, it is susceptible for crushing and splitting if the characteristics of the bamboo are not known. By using nails, pegs and notches the strength of the bamboo can reduce drastically. Therefore it is important to know how to deal with this material. In this part different joints used for bamboo are pointed out with its con's and pro's.

Under the traditional joints the following joints are known according to wikispace which got his information from J.J.A. Janssen.

Double butt bent joint

This joint consist out of two bamboo elements. One part is cut out and bent around the second bamboo element. It is hold together with wires or ropes, see fig. 13.3.
Because of the cutting the bamboo looses strength and it requires precise manufacturing. At the other hand it is a low cost solution and it has a smoother joint and doesn't need a complicated lashing technique.

Friction-tight rope connection

This joint consist out of two bamboo elements hold together with wires or ropes, see fig. 13.4.
It requires precise manufacturing. At the other hand it is a low cost solution and it has a smoother joint and doesn't need a complicated lash-ing technique.

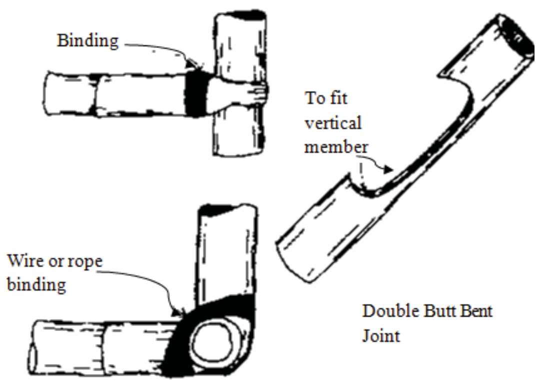


fig.13.3., wikispace, (2002)

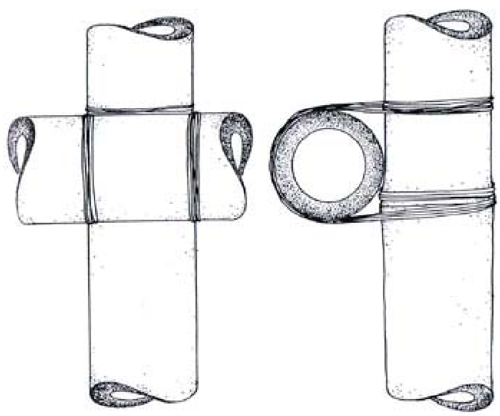


fig.13.4., Plemenka Supic, (1937)

Plug-in/ bolt connection

This technique uses the interlocking of a third element to contain their strength. Thus joint is mainly used in combination with a rope.
The used bolts have to adapt and transfer the tractive and comprehensive forces.
In this case holes must be made in the bamboo. The holes in the vertical element must be bigger for the wooden or bamboo pin. In this pin a wedge is interlocked to strengthen the connection. For extra strength rope can be used.
This technique gives smoother connections and it doesn’t need complicated lashing techniques. Besides it can stand big forces. But the holes reduces the strength of the bamboo and might be weak in the vertical direction. It also needs more manufacturing techniques such as drilling etc. (Jansen, J., 2002)

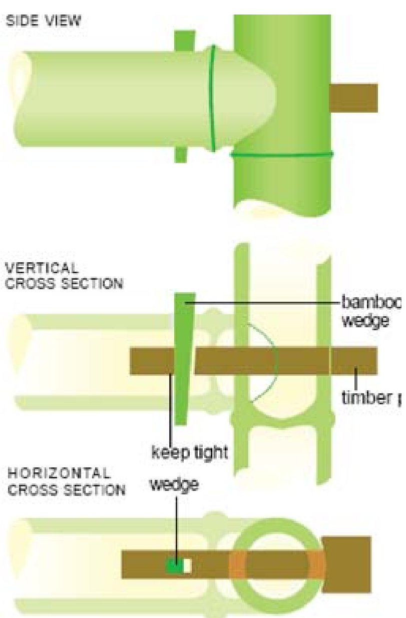


fig.13.5., Dukelberg, (1987)

Positive fitting connection

In this technique the extra wedge is cutted or rope is used to keep the interlocked bamboo in tis place. This technique can be combined with the plug-in and lashing technique.
Here the appereance of the joint are more appealing. It can also reduces the costs of bamboo poles when making combined connections for example with rope.
Nevertheless this technique askes for highley skilled manufacturing techniques and the holes in the poles reduces the strenght of the bamboo.

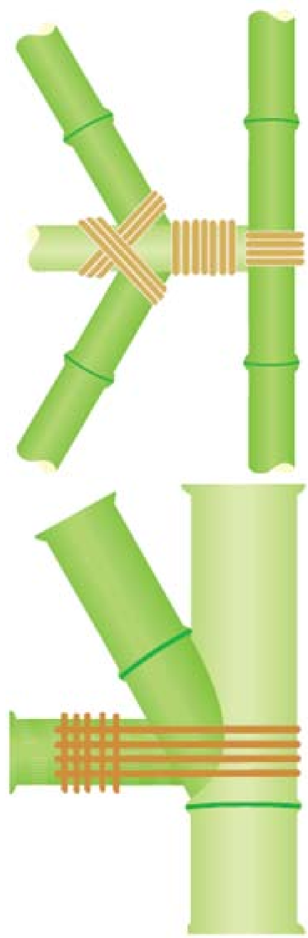


Fig.13.6.,Jansen, J., (1981)

Interlocking connections

These kind of connections are done by integrating glue or shedding connection with the bamboo. Wood core connections but also steel anchor techniques are known. The wood core is most used. Many inner wood parts are can be applied depending on the demands of the connection.
This kind of connections can be used under more circumstances and the connection are normally stronger than other connections. No other joint techniques such as nails are needed. But this kind of connection are more costly and it requires precise manufacturing skills and equipment.

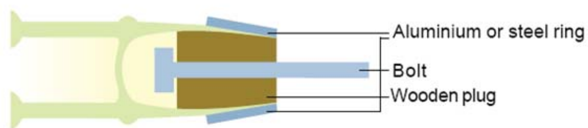


fig. 13.7., Jansen, J., (1981)

fig. 13.8., Renzo Piano, (1997)

Choise of joints

Natural materials

In my graduation design it is important that the design is affordable. So learning from local and traditional techniques is important. In the pages here for different joint techniques are explained. Because of the affordances of the design and the need of easy to make joints I have chosen for the second, the friction tight rope connection. In this chapter different manners of friction tight rope joints are described and discussed.
All grated by easiness to make, strength and sustainability of quality and time.

Natural materials used as rope are cocos/sago palm fibre, bast, strips of bamboo and rattan.
To strenghten the connection green strips of green bamboo are weathered and rapped around the connection area. While drying these strips shorten. That's how the connection can be made stronger.
These kind of natural materials are vulnerable for moistening, rotting and insects and because of this not highley sustainable. These elements have to be impregnated to protect them for these elements

The location of the graduation project is a delta and with that exposed to water and insects. These kind of joint can be used if protected against the moisture and insects.
Jaap Overal tested three different kinds of natural materials as joints for bamboo during his graduation project for building technology; sisal rope, hemp rope and flax and resin composite.
This last one happens to be the strongest joint, according his report. Besides it is a smooth joint which makes it aesthetical more appealing. At the other hand it needs more manufacturing time.
This kind of joint is used a lot by bikes, see fig. 13.10.

Fig.13.9., Overal, J., 2011

fig.13.10., Leeds, J., 2011

Industrial materials

Industrial materials are iron wire and plastic tapes and ropes. Plastic tapes and ropes can turn brittle during time. Besides the sustainability the plastic tape is not directly a nice aesthetic choice. The rope can form very nice looking joints, fig.13.12. and fig13.14. Another way is to use the iron wires, they are vulnerable to oxidation and which can make them weak. But it is an economic solution because of the labouring time to make them and the cheap materialisation, fig. 13.13. Also the joints are very minimum, which make the construction look like having no joints at all and strengthen the visual effect of a very light construction.
Better is to use galvanized steel as a wire. This has a longer lifespan that iron wire.

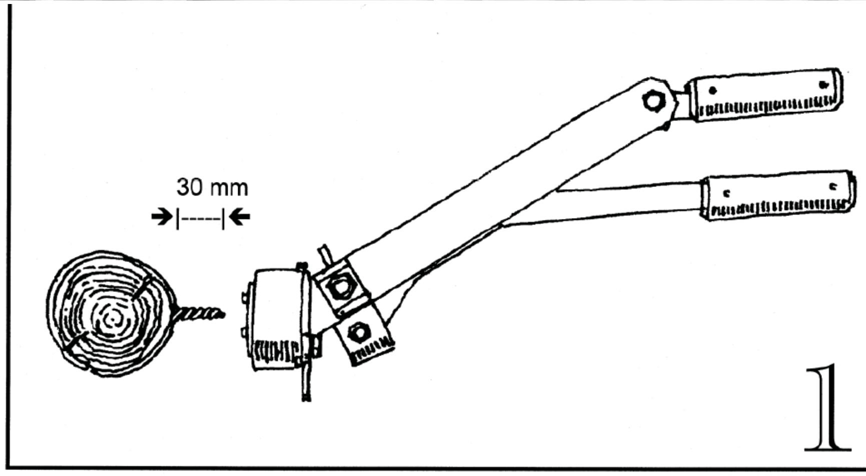
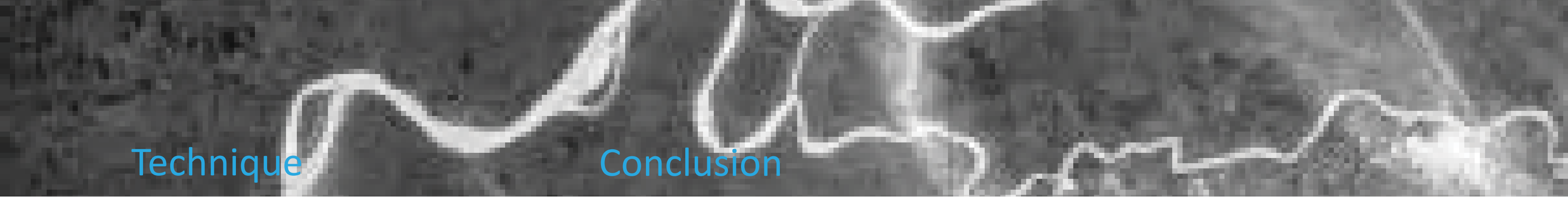


fig.13.11., The wire lacing tool, dr. P. Huybers (1999)

Fig.13.12., Mason lane farm, B. Meinhofd, (2009)

Fig.13.13., Japanese noodle restaurant, DSA+s, (2010)



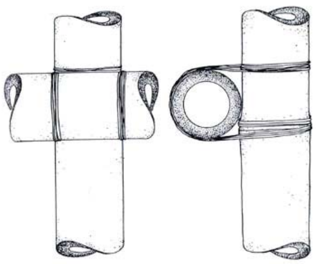
Technique

The Delft wiring lacing tool is a tool that provided strong joint of wire, see fig. 13.11. In this way the wire joints are very tight and with that strong and a good choice for a constructive joint. (dr. P. Huybers, 1999)
The tool easily to made, affordable and easy to handle, it fits perfectly in my concept.

Conclusion

For my design the affordances, and the easy way of manufacturing the joints is really important. Besides the materialisation of the joint must resist humid and insects. That is why have chosen to use galvanized steel wire. (anping, 2014). By using the Delft Wiring Lacing tool, strong joints can be made easily. In fig.13.14. can be seen how the facade is built and what kind of costs are possible to make.

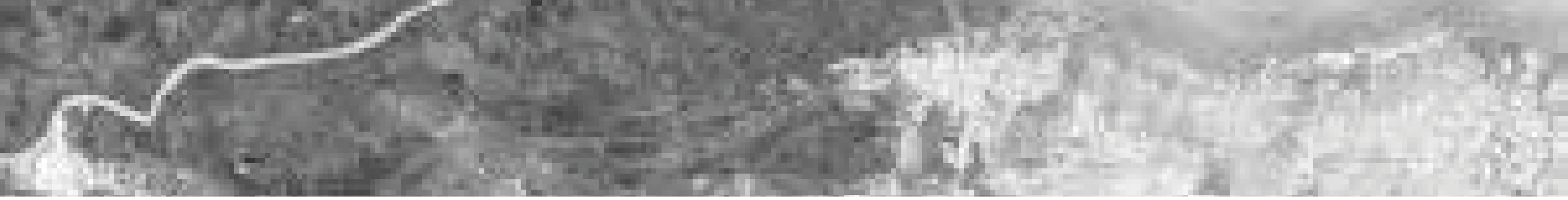
Fig.13.14., facade prototype houses, Own work, (2014)



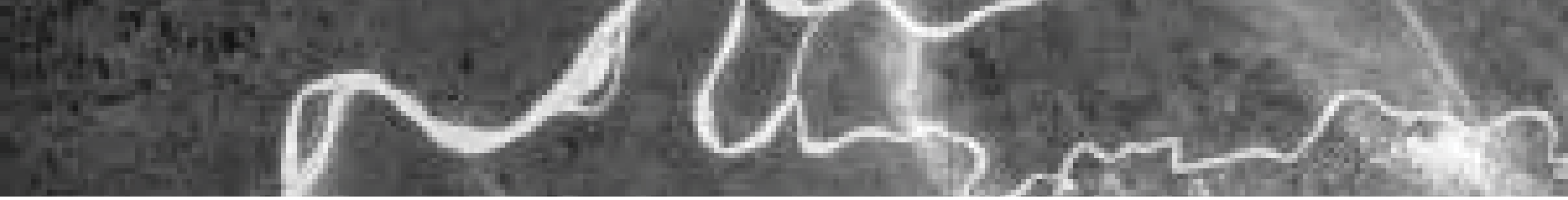
Plemenka Supic, (1937)

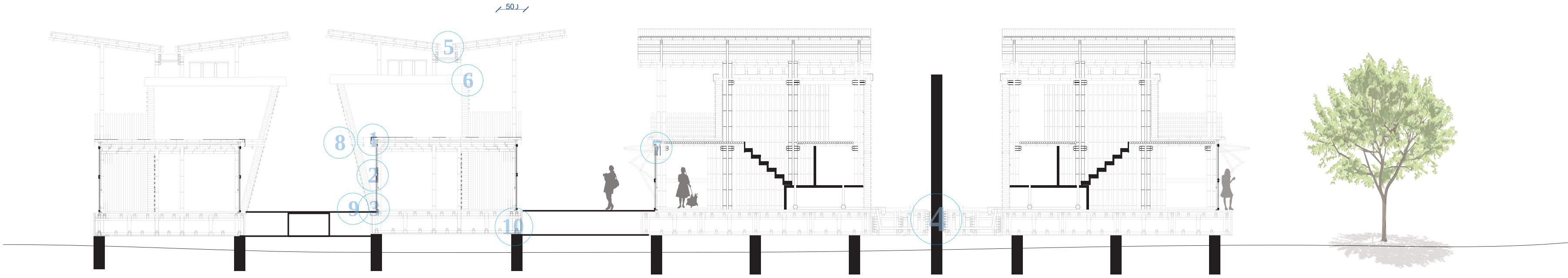
Joint with rattan lashing (Dunkelberg 1985)

Brian (2013)



14. Details




5
6
8
1
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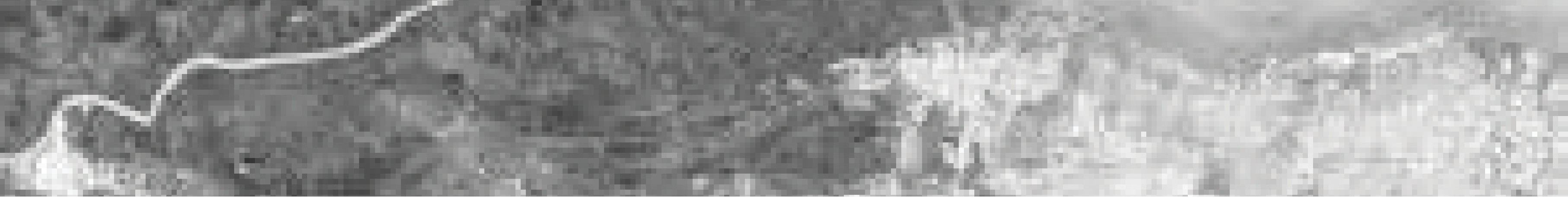
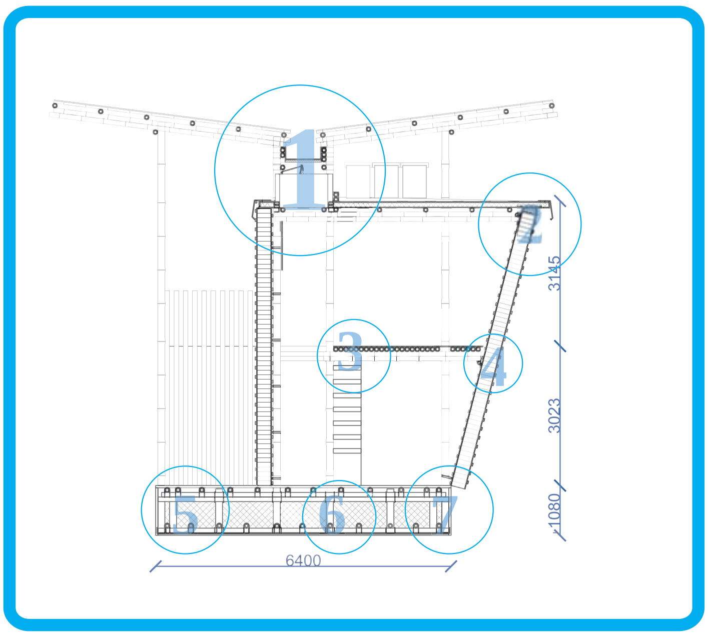
4




1
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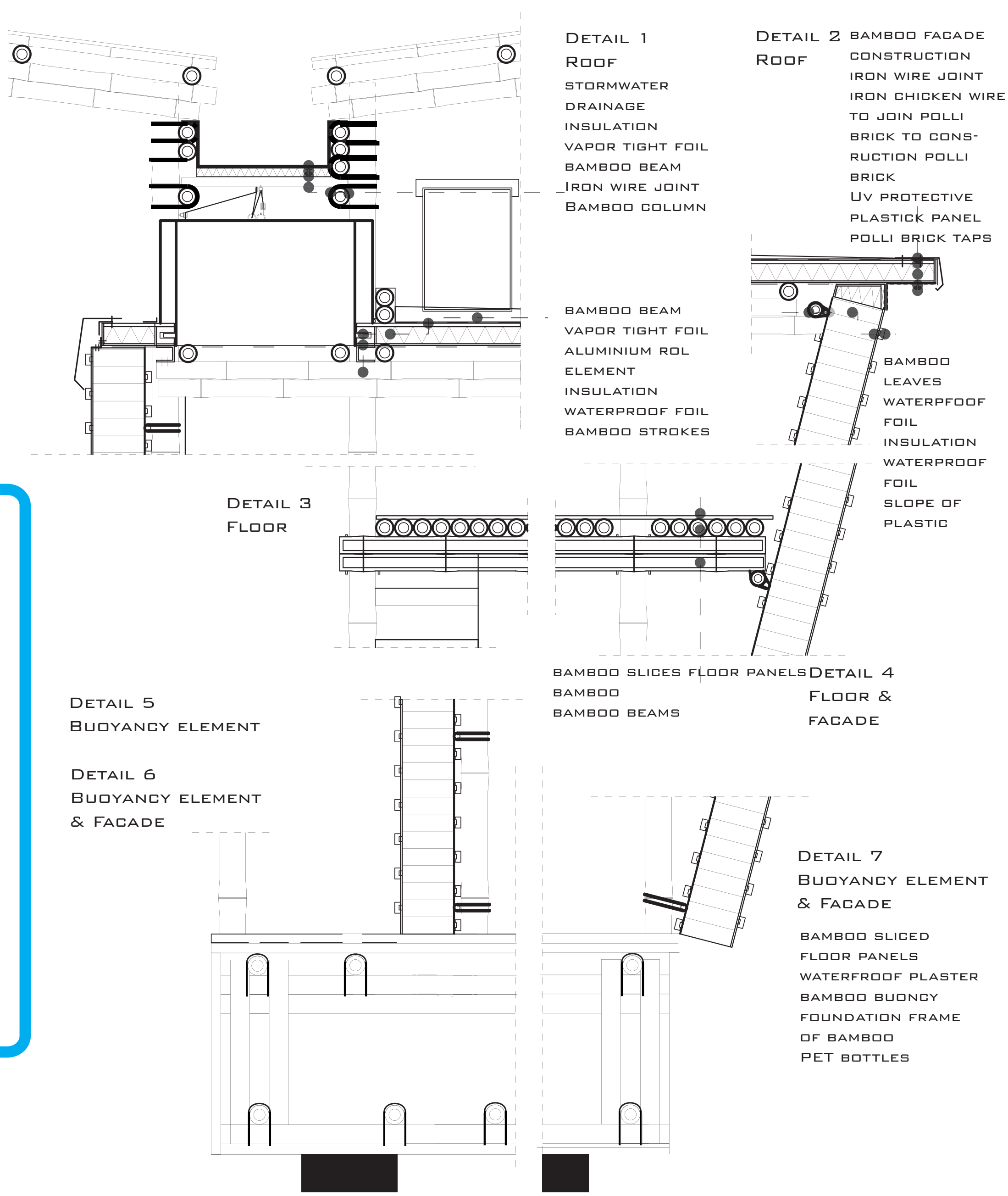
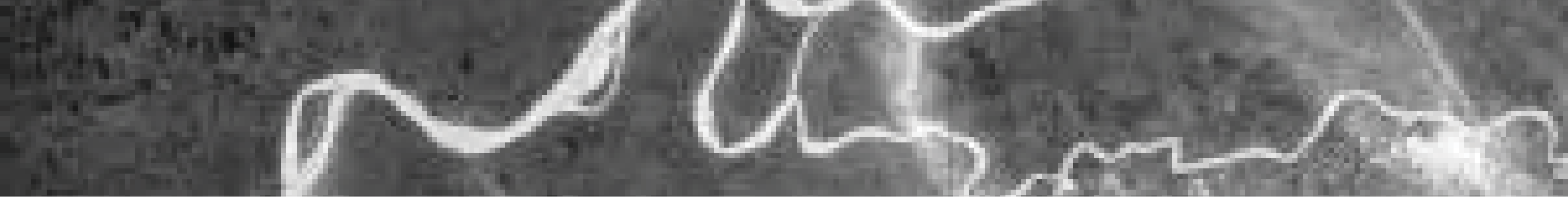

Detail 1
Roof
stormwater
drainage
insulation
vapor tight foil
bamboo beam
Iron wire joint
Bamboo column
bamboo beam
vapor tight foil
aluminium rol
element
insulation
waterproof foil
bamboo strokes
Detail 2
Roof
bamboo facade
construction
iron wire joint
iron chicken wire
to join polli
brick to cons-
ruction polli
brick
Uv protective
plastick panel
polli brick taps
bamboo
leaves
waterpfoof
foil
insulation
waterproof
foil
slope of
plastic
Detail 3
Floor
bamboo slices floor panels
bamboo
bamboo beams
Detail 4
Floor &
facade
Detail 5
Buoyancy element
Detail 6
Buoyancy element
& Facade
Detail 7
Buoyancy element
& Facade
bamboo sliced
floor panels
waterproof plaster
bamboo buoncy
foundation frame
of bamboo
PET bottles



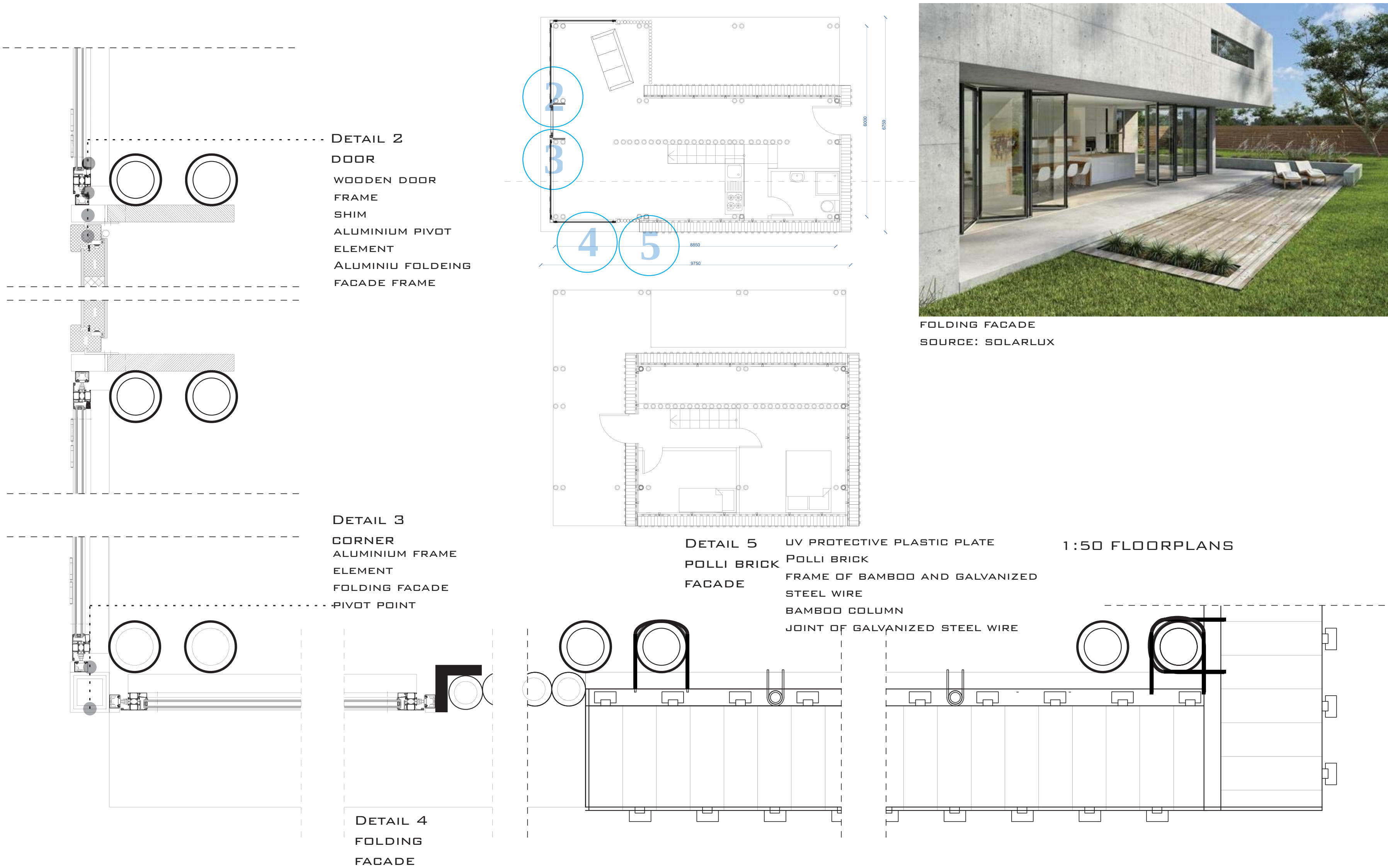
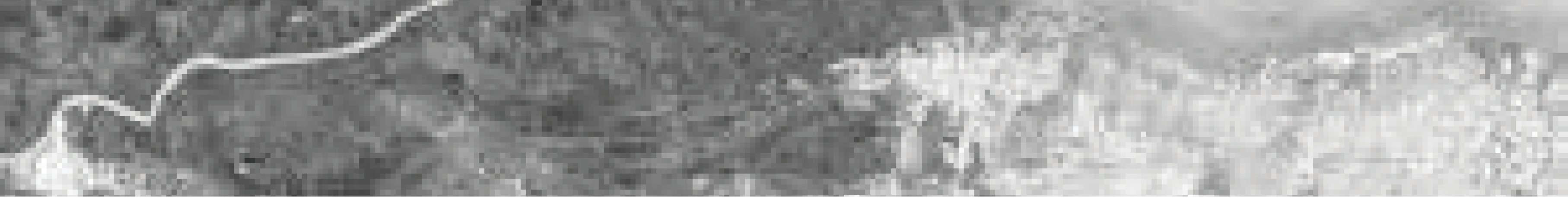
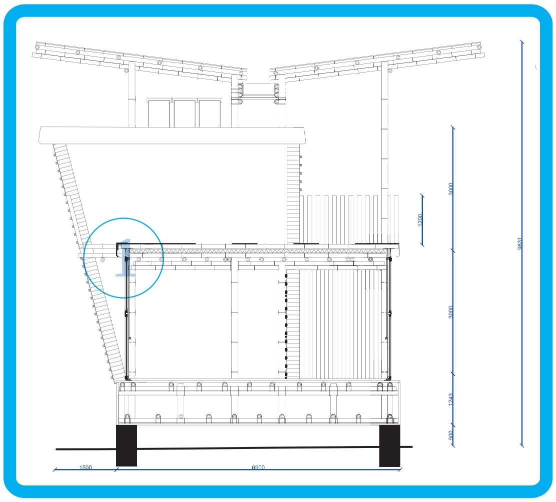
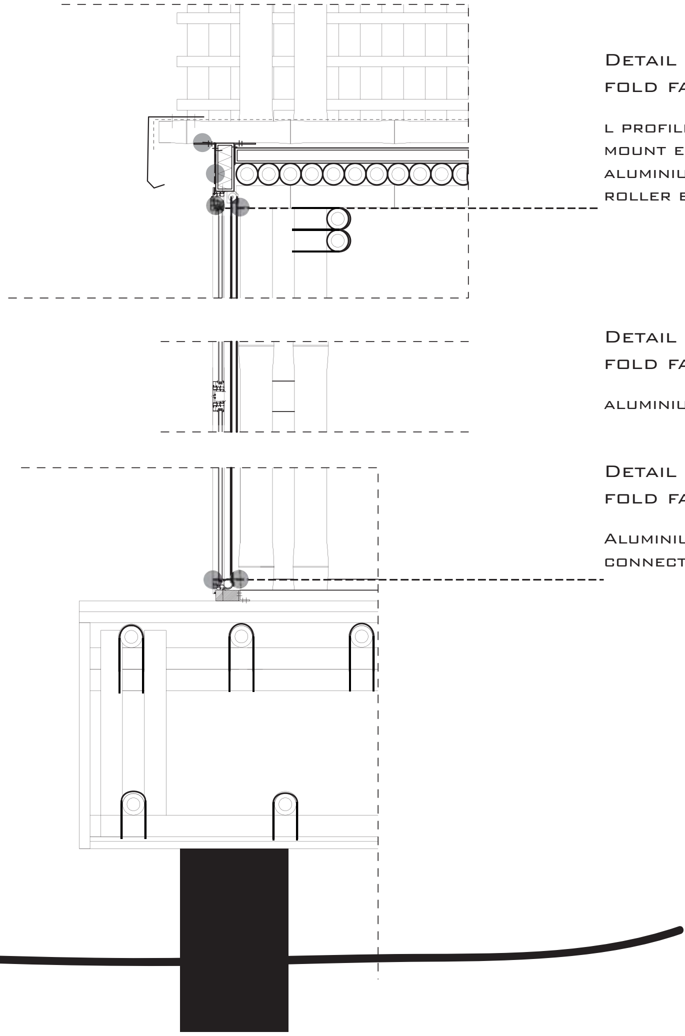


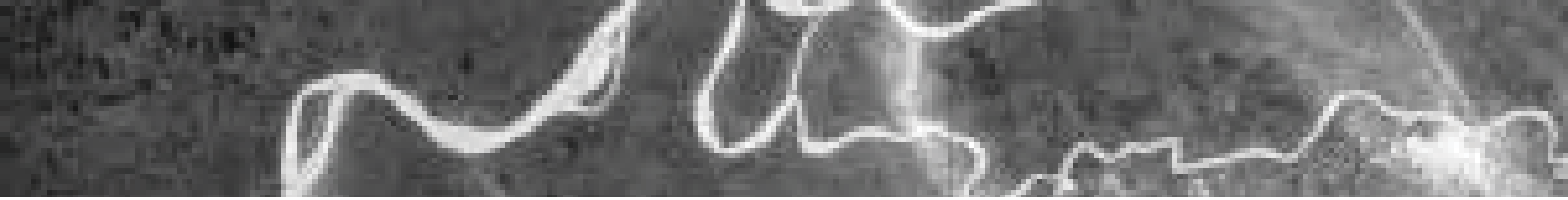
Fig.14.2., Details, Own work, (2014)



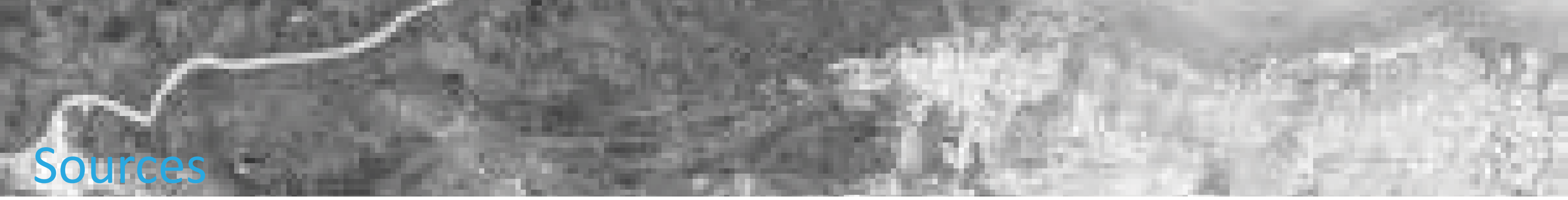




1:10 VERTICAL DETAILS



15. Sources



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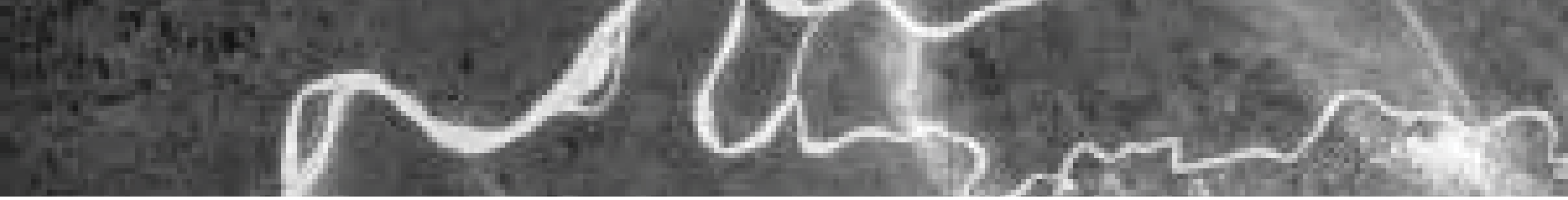
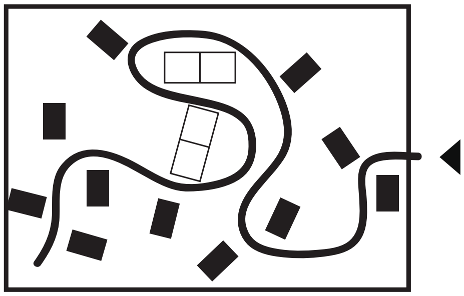


16. Appendix

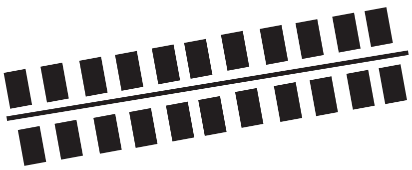
Appendix 1



Group of household which are connected because they share facilities, such as sport facilities. There is a hard border in the form of a fence and a gate protected by guards.

Arises when walthy people like to live in a safe area. Goverment or minicipality is in charge in such projects.

Marcela Valente



Community formed by routing, for example a road. (this is common in villages)

These kind of communitys are mostley houses built by the owners them selfs a side of a road.

Bakkeveen

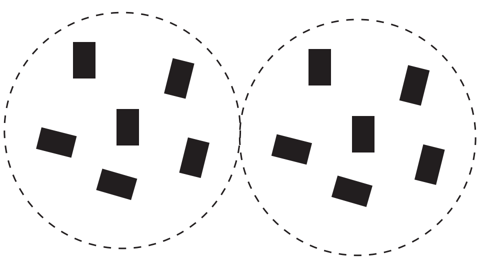
Community formed by a U-block. The people live in a block building where they share some facilities such as elevators and a seme public outdoor space.

Blocks are mostley govermental/municipal projects.

Steelvliethof

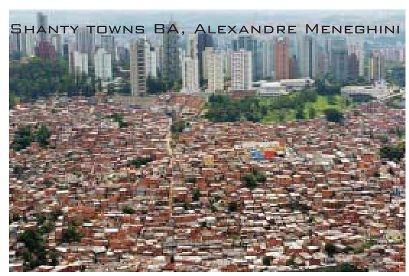
Community formed by a block. The people live in a block building where they share some facilities such as elevators and a collective outdoor space.

Blocks are mostley govermental/municipal projects.

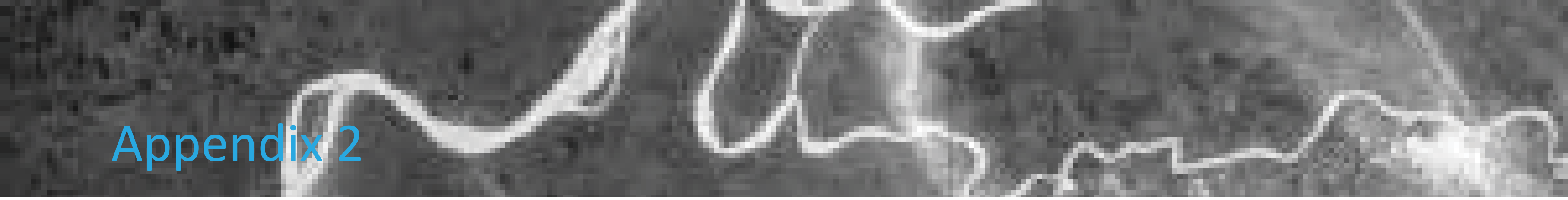


Community formed by typology. Typologys are formed by culture, income, buildingtype etc. These kind of communities excist mostley in the form of shanty towns.

These informal settlements are made by the owners them selfs. No rules or regulations are made. This provides it self in unhealthy living environments.

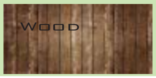
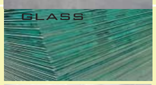
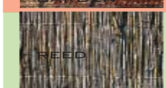


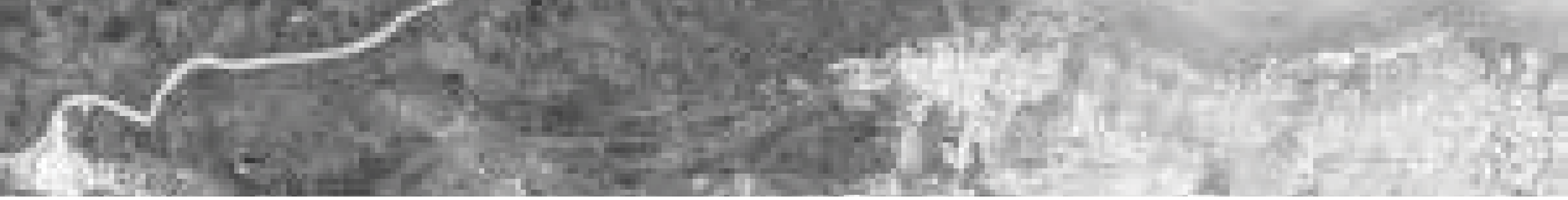
Shanty towns BA, Alexandre Meneghini



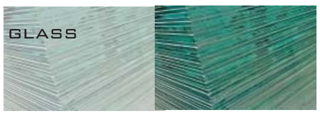
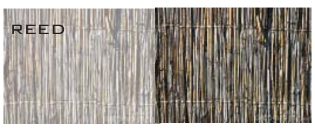
Appendix 2

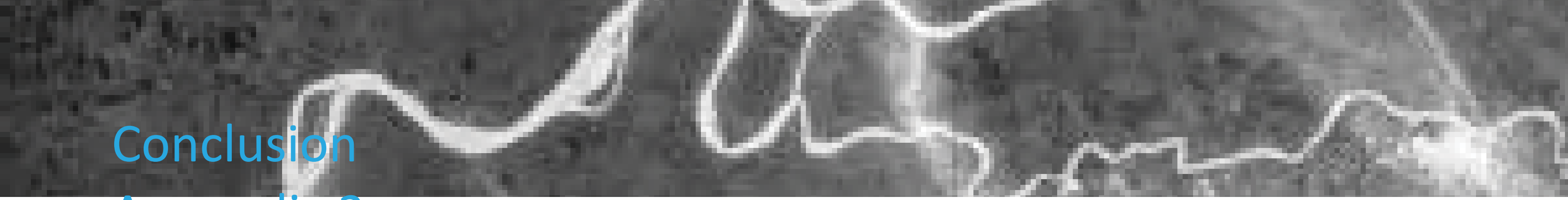
Material Catalogue

Material	Water/ rain impact	Impact of pests (rats, mouses)	Luminous transmittance	Thermal conductivity	Recyclable	Weight (kg/m3)	Constructive material	Using for
 Wood			No	0,12 W/m*K	if not impregnated; yes	700-1100 kg/m3	Yes	Construction facade
 Concrete			No	0,2 W/m*K	Yes	2400 kg/m3	Yes	Construction facade
 Glass			Yes	0,8 W/m*K	Yes	2500 kg/m3	Yes	windows
 Translucent plastic board			Yes	0,2 W/m*K	Yes	910 kg/m3	No	facade
 Pol-li-bricks			No	Plastic 0,2 W/m*K Air at 0: 0,024	Yes	910 kg/m3	Yes	Construction facade
 Ceramic vertical garden			No	16,6 W/(m*K)	Yes	1250 kg/m3	Yes	
 Reed			No	0,83 W/(m*K)	Yes	150 kg/m3	No	facade
 Recycled paper			No	0,18 W/(m*K)	Yes	900 kg/m3	Yes	
 wool			No	0,035 W/(m*K)	Yes	25-30 kg/m3	No	Insulation
 straw bales			No	0,83 W/(m*K)	Yes	150 kg/m3	Yes	facade
			No	0,83 W/(m*K)	Yes	1450 kg/m3	Yes	
			No	79 W/(m*K)	Yes	7860 kg/m3	Yes	facade rain protector

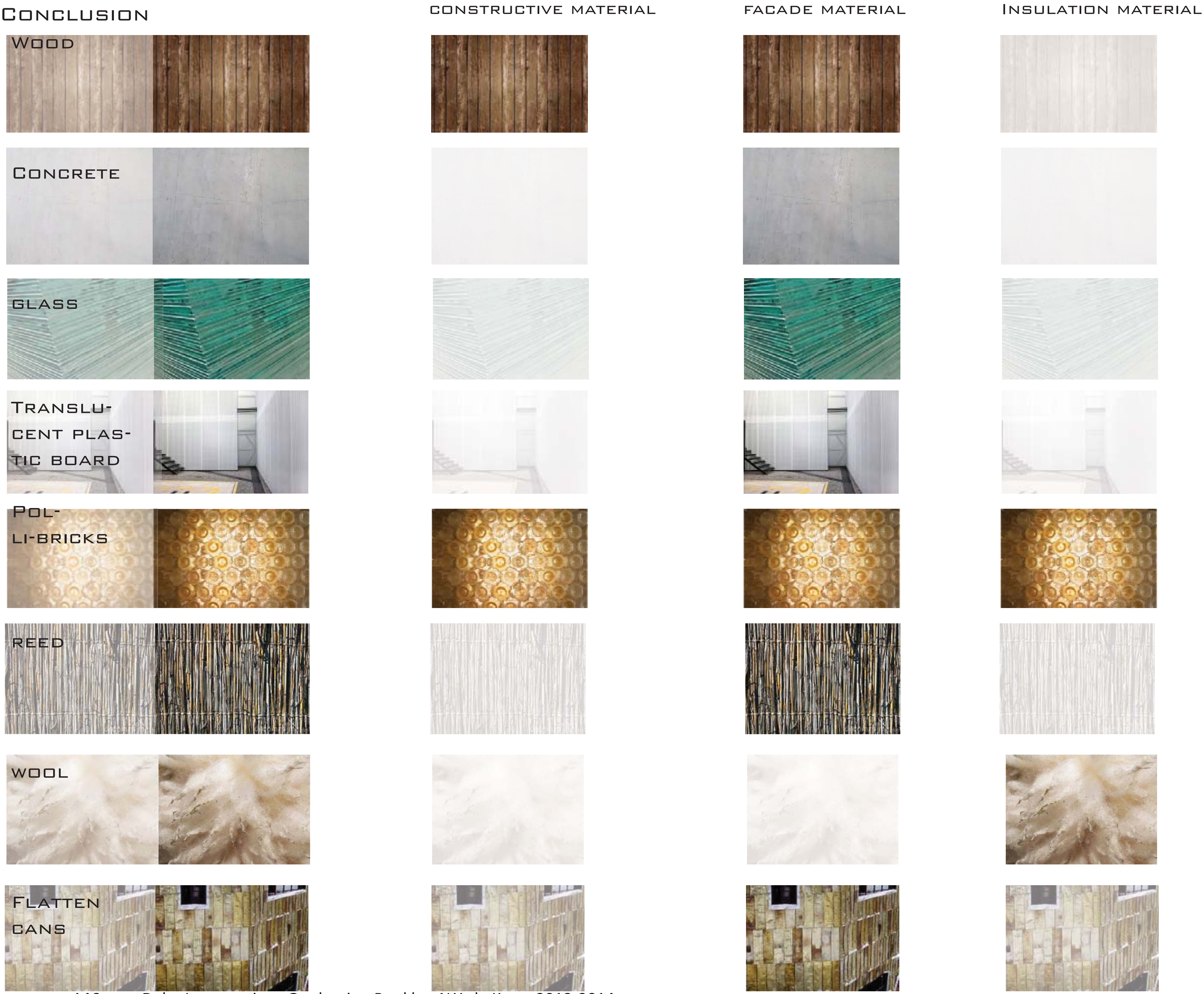


Invetarisation

Material	Luminous transmittance	Thermal conductivity	Weight (kg/m3)	Constructive material	Using for
Wood 		0,12 W/m*K	700-1100 kg/m3	Yes	Construction Facade
Concrete 		0,2 W/m*K		Yes	Facade
Glass 	Yes	0,8 W/m*K		Yes	Windows
Translucent plastic board 	Yes	0,2 W/m*K	910 kg/m3		Facade
Pol-li-bricks 		Plastick 0,2 W/m*K Air at 0: 0,024 W/m*K	910 kg/m3	Yes	Construction Facade Insulation
Reed 		0,83 W/(m*K)	150 kg/m3		Facade
Wool 		0,035 W/(m*K)	25-30 kg/m3		Insulation
Flatten cans 			7860 kg/m3	Yes	Facade



Appendix 2

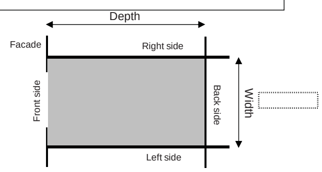

Conclusion
constructive material
facade material
Insulation material
Wood
Concrete
glass
Translu-
cent plas-
tic board
Pol-
li-bricks
reed
wool
Flatten
cans

Appendix 3

Do not leave cells empty!! Type 0 in unused cells
- Please fill in the yellow fields
- More info can be found in the Reader Klimaatinstallaties or the website www.bk.tudelft/bouwtechnologie/installaties
And translation of the symbols are stated in the table Symbols on the site

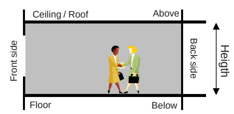
Room dimensions and orientation

Net height [meters]	3,0 m
Gross height (floor-floor) [m]	3,60 m
Window height [m]	3,0 m
Window width [m]	3,0 m
Façade / front side width [m]	6,0 m
Room depth [m]	3,0 m
Orientation (N, NE, NW, S, SE, SW, E, W)	S



Temperatures

	winter	summer
Design temperature, t, [°C]	20 C	20 C
adjacent room temperatures, if applicable		
Right side [°C]	5 C	30 C
Left side [°C]	20 C	26 C
Back side [°C]	20 C	26 C
Front side [°C]	5 C	30 C
Above [°C]	5 C	30 C
Below (floor? outside?) [°C]	20 C	26 C



Other windows, if present (only outside windows!)

right side	Right side window height [m]	3,0 m
	Right side window width [m]	1,0 m
	Orientation (N, NE, NW, S, SE, SW, E, W)	W
left side	Left side window height [m]	3,0 m
	Left side window width [m]	1,0 m
	Orientation (N, NE, NW, S, SE, SW, E, W)	E
back side	Back side window height [m]	,0 m
	Back side window width [m]	,0 m
	Orientation (N, NE, NW, S, SE, SW, E, W)	N
roof side	Roof window length [m]	,0 m
	Roof window width [m]	,0 m
	Orientation (N, NE, NW, S, SE, SW, E, W)	Horiz.

Did you fill in the numbers (and units!) correctly?
Numbers will automatically be inserted in the calculations!!
=> Proceed with "heat loss" calculations

Calculations *(no entry)*

Areas *(gross height)*		***Areas*** *(net height)*	
front side window	*A= 9,0 m2*	*front side window*	*A= 9,0 m2*
front side parapet	*A= 12,60 m2*	*front side parapet*	*A= 9,0 m2*
roof or ceiling; window excluded	*A= 18,0 m2*	*roof or ceiling; window excluded*	*A= 18,0 m2*
floor	*A= 18,0 m2*	*floor*	*A= 18,0 m2*
right side wall; window excluded	*A= 7,80 m2*	*right side wall; window excluded*	*A= 6,0 m2*
left side wall; window excluded	*A= 7,80 m2*	*left side wall; window excluded*	*A= 6,0 m2*
whole sidewall	*A= 10,80 m2*	*whole sidewall*	*A= 9,0 m2*
backside wall: window excluded	*A= 21,60 m2*	*backside wall: window excluded*	*A= 18,0 m2*
front and back side; whole façade	*A= 21,60 m2*	*front and back side; whole façade*	*A= 18,0 m2*
window (right), if present	*A= 3,0 m2*	*window (right), if present*	*A= 3,0 m2*
window (left), if present	*A= 3,0 m2*	*window (left), if present*	*A= 3,0 m2*
window (back), if present	*A= ,0 m2*	*window (back), if present*	*A= ,0 m2*
window (roof), if present	*A= ,0 m2*	*window (roof), if present*	*A= ,0 m2*
total window area	*A= 15,0 m2*	*total window area*	*A= 15,0 m2*

room volume

net height x floor area	*54,0 m3*

percentage of windows *(with respect to gross wall area)*		***percentage of windows*** *(with respect to net wall area)*	
of façade	*42%*	*of façade*	*50%*
of right side wall	*28%*	*of right side wall*	*33%*
of left side wall	*28%*	*of left side wall*	*33%*
of back side wall	*0%*	*of back side wall*	*0%*
of roof/ ceiling	*0%*	*of roof/ ceiling*	*0%*
of total wall area	*23%*	*of total wall area*	*28%*

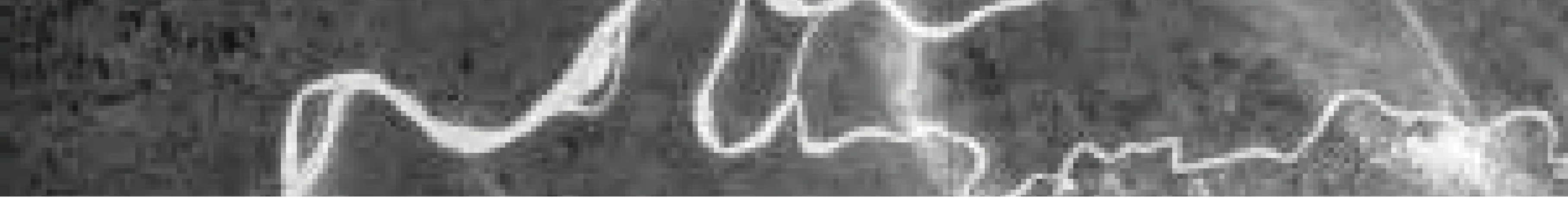
Δt with respect to adjacent rooms and surroundings

	winter	*summer*
window (inside-outside)	*15 K*	*-10 K*
parapet (inside-outside)	*15 K*	*-10 K*
roof or ceiling	*15 K*	*-10 K*
floor	*K*	*-6 K*
right side wall	*15 K*	*-10 K*
left side wall	*K*	*-6 K*
back side wall	*K*	*-6 K*
inside air-outside air	*15 K*	*15 K*

max, min values

width or depth of room, largest value	*6,0 m*
width or depth of room, smallest value	*3,0 m*

steady figures	*winter*	*summer*
outside temperature, t_e [°C]	5 C	5 C



ROUGH HEAT LOSS CALCULATION, Φw (stationary method)

Please fill in the yellow fields

	more info	more info			
	e	**U**	**A**	**Δt**	**Φ_{tr}**
transmission	[-]	[W/m² K]	[m²]	[K]	[W]
Window (front)	1,26	5,1	9	15	865
Paparet	1,05	1,2	12,6	15	238
Ceiling or Roof	1,05	1,2	18	15	340
Floor	1,05	1,2	18	0	0
Wall, right side	1,26	5,1	7,8	15	750
Wall, left side	1,26	5,1	7,8	0	0
Wall, back side	1,00	0,083	21,6	0	0
by other windows, if present					
Window, right side	1,26	5,1	3	15	288
Window, left side	1,26	5,1	3	0	0
Window, back side	1,26	5,1	0	0	0
Window, roof/ceiling	1,26	5,1	0	15	0
				$\Sigma(\Phi_{tr})$	2481 W
				$\Phi_{opw} = 0.5 \times \Phi_{tr}$	1241 W

	more info	more info			
	$q_{v,inf/vent}$	**ρ**	**c**	**$\Delta t_{in,\,out}$**	**$\Phi_{inf,vent}$**
Outdoor air flow	[m³/s]	[kg/m³]	[J/kg K]	[K]	[J/s] = [W]
infiltration	,0014	1,2	1000	15	25
ventilation	,0014	1,2	1000	15	25
				Max(Φ_{inf})	25 W

overall heat loss, $\Phi_w = \Phi_{tr} + \Phi_{opw} + \Phi_{inf,vent}$ **3747 W**

Characteristic numbers - building services

Specific heat loss	$\Phi_{w,spec} = \Phi_w / A_{vloer}$ =	208 W/m²
Air exchange rate of outdoor air	$n_{inf/vent} = (q_{v,inf/vent} * 3600) / V$ =	0 time/ hour

With air heating

volumetric airflow required for heating

with high supply $\Delta t_{toe,afv} < 20$ K	$q_{v,\Phi w} = \Phi_w / (\rho\ c\ \Delta t)$ =	0,16 m³/s	562 m3/h
with low supply $\Delta t_{toe,afv} < 40$ K	$q_{v,\Phi w} = \Phi_w / (\rho\ c\ \Delta t)$ =	0,08 m³/s	281 m3/h

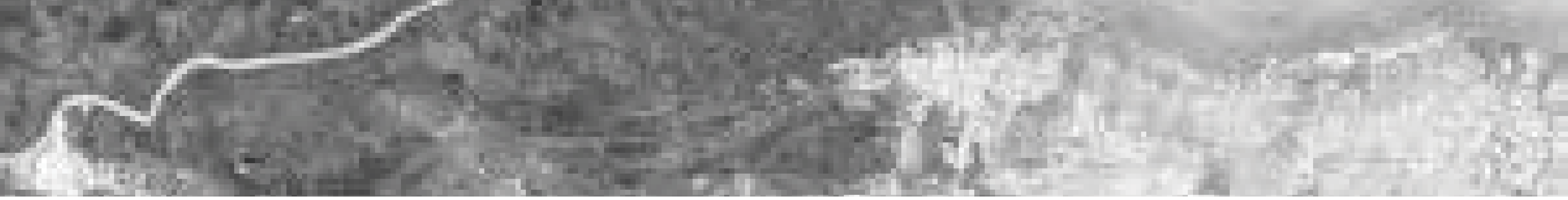
air exchange rate required for heating

with high supply	$n_{circul} = (q_{\Phi w} * 3600) / V$ =	10,4 maal /uur
with low supply	$n_{circul} = (q_{\Phi w} * 3600) / V$ =	5,2 maal /uur

Characteristic numbers - general		**% of total heat loss**	
facade area	21,60 m2	transmission through windows	30,8%
window percentage (facade)	42%	transmission through roof/ceiling	9,1%
floor area	18,0 m2	transmission through floor	0,0%
room volume	54,0 m3	infiltration	0,7%
design temperature	20 C	ventilation	0,7%
		other	58,8%

control figures - infiltration	more info	more info
utility / industrial building, minimum value $q_{v,\,inf}$		*,019 m3/s*
utility / industrial building, maximum value $q_{v,\,inf}$		*,045 m3/s*
residential building, minimum value $q_{v,\,inf}$		*,002 m3/s*
residential building, maximum value $q_{v,\,inf}$		*,135 m3/s*
	minimum value $q_{v,inf}$	*,002 m3/s*
	maximum value $q_{v,inf}$	*,135 m3/s*

control figures - ventilation:		
guideline, minimum value $q_{v,\,vent}$	*25 m3/h*	*,007 m3/s*
guideline, maximum value $q_{v,\,vent}$	*150 m3/h*	*,042 m3/s*
guideline, minimum value $q_{v,\,vent}$	*5 m3/h m2*	*,025 m3/s*
guideline, maximum value $q_{v,\,vent}$	*35 m3/h m2*	*,175 m3/s*
	minimum value $q_{v,vent}$	*,007 m3/s*
	maximum value $q_{v,vent}$	*,175 m3/s*



ROUGH COOLING LOAD CALCULATION, Φ_k (stationary method)

Please fill in the yellow fields

Slide shows on HVAC calculations

	p [-]	q_p [W] (more info)	Φ_p [W]
Heat load by people, Φ_p	2	50	100

	A_{vloer} [m²]	q [W/m²] (more info)	Φ [W]
Heat load by lighting Φ_l	18	200	200
Heat load by equipment Φ_a	18	0	0

internal load, $\Phi_i=\Phi_p+\Phi_l+\Phi_a$ 300 W (Φ_i)

sunradiation, OUTSIDE windows	orientation	time of the day [h]	z [-] (more info)	A_{raam} [m²]	ZTA [-] (more info)	q_{conv} [W/m²] (more info)	f_d [-] (more info)	$\Phi_{z,gl}$ [W] (more info)
front side window (façade)	S	16	0,22	9	0,79	310	1,00	485
outside window, right side	W	16	0,45	3	0,79	340	0,50	181
outside window, left side	E	16	0,45	3	0,79	350	0,60	224
outside window, back side	N	16	1,00	0	0,79	100	1,00	0
outside window, roof	Hori:	16	1,00	0	0,79	760	1,00	0

$\Sigma(\Phi_{z,raam})$ 890 W

$Max(\Phi_{z,raam})$ 937 W

transmission, via OUTSIDE windows	U_{raam} [W/m² K] (more info)	A_{raam} [m²]	$\Delta t_{in, out}$ [K]	$F_{tr,raam}$ [W]
front side window (façade)	1,2	9	-15	-162
outside window, right side	1,2	3	-15	-54
outside window, left side	1,2	3	-15	-54
outside window, back side	1,2	0	-15	0
outside window, roof	0	0	-15	0

$\Sigma(\Phi_{tr,raam})$ -270 W

sunload via OUTSIDE walls and roof		a [-]	A [m²]	q_w [W/m²]	$\Phi_{z,w}$ [W]
parapet (front side)	S	0,7	9	0	0
roof	Horiz.	0,7	18	6	76
outside wall, right side	W	0,7	6	25,5	107
outside wall, left side	E	0,7	6	25,5	107
outside wall, back side	N	0,7	18	25,5	321

$\Sigma(\Phi_{z,w})$ 611 W

access of outside air	$q_{v,inf}$ [m³/s] (more info)	ρ [kg/m³]	c [J/kg K]	$\Delta t_{in, out}$ [K]	Φ_{inf} [J/s] = [W]
infiltration	,0045	1,2	1000	-15	-81

more info **Φ_{inf}** -81 W

external load, $\Phi_e=\Phi_{z,gl}+\Phi_{tr,gl}+\Phi_{z,w}+\Phi_{inf}$ 1197 W (Φ_e)

rough cooling load, $\Phi_k=\Phi_i+\Phi_e$ **1497 W**

	orientation	time of the day [h] (more info)	z [-]	A_{raam} [m²]	ZTA [-]	q_{conv} [W/m²]	f_d [-] (more info)	$\Phi_{z,gl}$ [W]
front side	S	16.00	0,22	9	0,79	310	0,80	388
right side	W	16.00	0,45	3	0,79	340	1,00	363
left side	E	16.00	0,45	3	0,79	350	0,50	187
back side	N	16.00	1,00	0	0,79	100	0,90	0
roof	Horiz.	16.00	1,00	0	0,79	760	0,90	0
							$\Sigma(\Phi_{z,gl})$	937 W

	orientation	time of the day [h]	z [-]	A_{raam} [m²]	ZTA [-]	q_{conv} [W/m²]	f_d [-]	$\Phi_{z,gl}$ [W]
front side	S	9.00	0,22	9	0,79	310	0,50	242
right side	W	9.00	0,45	3	0,79	340	0,30	109
left side	E	9.00	0,45	3	0,79	350	1,00	373
back side	N	9.00	1,00	0	0,79	100	0,80	0
roof	Horiz.	9.00	1,00	0	0,79	760	0,60	0
							$\Sigma(\Phi_{z,gl})$	725 W

		[h]	z [-]	A_{raam} [m²]	ZTA [-]	q_{conv} [W/m²]	f_d [-]	$\Phi_{z,gl}$ [W]
front side	S	13.00	0,22	9	0,79	310	1,00	485
right side	W	13.00	0,45	3	0,79	340	0,50	181
left side	E	13.00	0,45	3	0,79	350	0,60	224
back side	N	13.00	1,00	0	0,79	100	1,00	0
roof	Horiz.	13.00	1,00	0	0,79	760	1,00	0
							$\Sigma(\Phi_{z,gl})$	890 W

		[h]	z [-]	A_{raam} [m²]	ZTA [-]	q_{conv} [W/m²]	f_d [-]	Φz,gl [W]
front side	S	13.00	0,22	9	0,79	310	1,00	485
right side	W	13.00	0,45	3	0,79	340	0,50	181
left side	E	13.00	0,45	3	0,79	350	0,60	224
back side	N	13.00	1,00	0	0,79	100	1,00	0
roof	Horiz.	13.00	1,00	0	0,79	760	1,00	0
							$\Sigma(\Phi_{z,gl})$	890 W

Characteristic numbers - building services:

specific cooling load $\Phi_{k,spec} = \Phi_k / A_{vloer} =$ 83 W/m²

infiltration-factor $n_{inf} = (q_{v,inf} * 3600) / V =$ 0,30 times/ hour

needed amount of air for cooling

Quantity of cooled air $\Delta t_{toe, afv}$ = 5 K $q_{v,\Phi k} = \Phi_k / (\rho\ c\ \Delta t) =$ 0,25 m³/s 898 m3/h

needed circulation factor for cooling

circulation factor for cooling $n_{circul} = (q_{v,\Phi k} * 3600) / V =$ 16,6 times/ hour

At natural ventilation: more info

needed amount of outside air for cooling $q_{spui} = \Phi_k / (\rho\ c\ \Delta t) =$ 0,42 m3/s 1497 m3/h

needed ventilation factor for natural cooling $n_{spui} = (q_{spui} * 3600) / V =$ 27,7 times/ hour

Characteristic numbers - general:

façade area	18,0 m2
Window percentage (façade)	50%
Floor area	18,0 m2
Room volume	54,0 m3
Design temperature	20 C

control figures - general

floor area per person 9, m2

% of toal cooling load

internal load	20%
heat load persons	6,7%
heat load lighting	13,4%
heat load machinery	0,0%
external load	80%
sun radiation through outside windows	62,6%
transmission through outside windows	-18,0%
sun load through outside walls and roof	40,8%
outside air supply	-5,4%

control figures - infiltration

minimum value $q_{v,inf}$	*0.2 * V / 3600*	*,003 m3/s*
maximum value $q_{v,inf}$	*0.3 * V / 3600*	*,005 m3/s*

minimum value $q_{v,inf}$ *,003 m3/s*

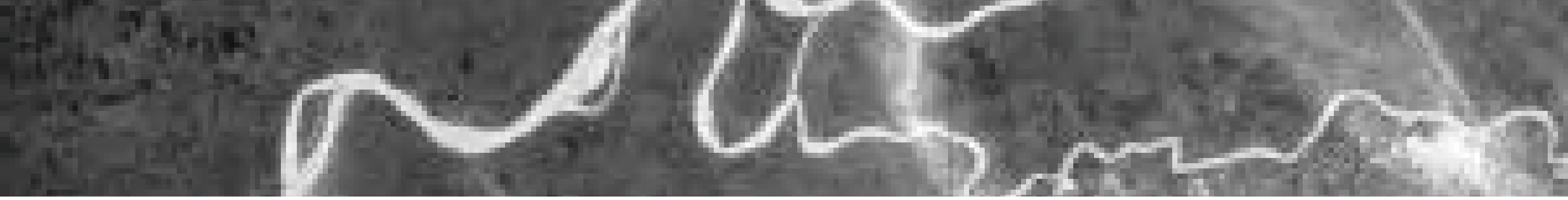
maximum value $q_{v,inf}$ *,005 m3/s*

control figures - ventilation

guideline minimum value $q_{v,vent}$	*25 m3/h*	*,007 m3/s*
guideline maximum value $q_{v,vent}$	*150 m3/h*	*,042 m3/s*
guideline minimum value $q_{v,vent}$	*5 m3/h m2*	*,025 m3/s*
guideline maximum value $q_{v,vent}$	*35 m3/h m2*	*,175 m3/s*

minimum value $q_{v,vent}$ *,007 m3/s*

maximum value $q_{v,vent}$ *,175 m3/s*

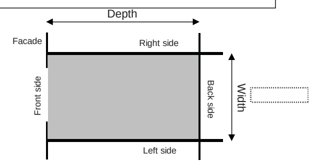


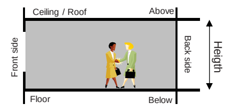
ROOM SPECIFICATIONS, INPUT FORM

Caution!
Do not leave cells empty!! Type 0 in unused cells
- Please fill in the yellow fields
- More info can be found in the Reader Klimaatinstallaties or the website www.bk.tudelft/bouwtechnologie/installaties
And translation of the symbols are stated in the table Symbols on the site

Room dimensions and orientation

Net height [meters]	3,0 m
Gross height (floor-floor) [m]	3,60 m
Window height [m]	,0 m
Window width [m]	,0 m
Façade / front side width [m]	3,0 m
Room depth [m]	6,0 m
Orientation (N, NE, NW, S, SE, SW, E, W)	S





Temperatures	winter	summer
Design temperature, t_i [°C]	20 C	26 C
adjacent room temperatures, if applicable		
Right side [°C]	5 C	5 C
Left side [°C]	5 C	5 C
Back side [°C]	20 C	26 C
Front side [°C]	5 C	5 C
Above [°C]	20 C	26 C
Below (floor? outside?) [°C]	5 C	5 C

Other windows, if present (only outside windows!)

right side	Right side window height [m]	,0 m
	Right side window width [m]	,0 m
	Orientation (N, NE, NW, S, SE, SW, E, W)	E
left side	Left side window height [m]	,0 m
	Left side window width [m]	,0 m
	Orientation (N, NE, NW, S, SE, SW, E, W)	W
back side	Back side window height [m]	,0 m
	Back side window width [m]	,0 m
	Orientation (N, NE, NW, S, SE, SW, E, W)	N
roof side	Roof window length [m]	,0 m
	Roof window width [m]	,0 m
	Orientation (N, NE, NW, S, SE, SW, E, W)	Horiz.

Did you fill in the numbers (and units!) correctly?
Numbers will automatically be inserted in the calculations!!
=> Proceed with "heat loss" calculations

Calculations *(no entry)*

Areas *(gross height)*		***Areas*** *(net height)*	
front side window	*A= 3,0 m2*	*front side window*	*A= 3,0 m2*
front side parapet	*A= 22,92 m2*	*front side parapet*	*A= 20,76 m2*
roof or ceiling; window excluded	*A= 77,76 m2*	*roof or ceiling; window excluded*	*A= 77,76 m2*
floor	*A= 77,76 m2*	*floor*	*A= 77,76 m2*
right side wall; window excluded	*A= 38,88 m2*	*right side wall; window excluded*	*A= 35,64 m2*
left side wall; window excluded	*A= 38,88 m2*	*left side wall; window excluded*	*A= 35,64 m2*
whole sidewall	*A= 38,88 m2*	*whole sidewall*	*A= 35,64 m2*
backside wall: window excluded	*A= 25,92 m2*	*backside wall: window excluded*	*A= 23,76 m2*
front and back side; whole façade	*A= 25,92 m2*	*front and back side; whole façade*	*A= 23,76 m2*
window (right), if present	*A= ,0 m2*	*window (right), if present*	*A= ,0 m2*
window (left), if present	*A= ,0 m2*	*window (left), if present*	*A= ,0 m2*
window (back), if present	*A= ,0 m2*	*window (back), if present*	*A= ,0 m2*
window (roof), if present	*A= ,0 m2*	*window (roof), if present*	*A= ,0 m2*
total window area	*A= 3,0 m2*	*total window area*	*A= 3,0 m2*

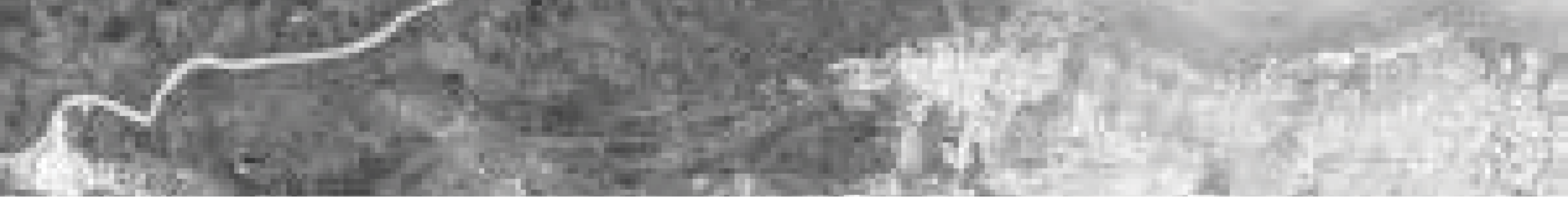
room volume
net height x floor area *256,61 m3*

percentage of windows *(with respect to gross wall area)*		***percentage of windows*** *(with respect to net wall area)*	
of façade	*12%*	*of façade*	*13%*
of right side wall	*0%*	*of right side wall*	*0%*
of left side wall	*0%*	*of left side wall*	*0%*
of back side wall	*0%*	*of back side wall*	*0%*
of roof/ ceiling	*0%*	*of roof/ ceiling*	*0%*
of total wall area	*2%*	*of total wall area*	*3%*

Δt ***with respect to adjacent rooms and surroundings***	*winter*	*summer*
window (inside-outside)	*30 K*	*-2 K*
parapet (inside-outside)	*30 K*	*-2 K*
roof or ceiling	*5 K*	*-2 K*
floor	*K*	*K*
right side wall	*K*	*K*
left side wall	*K*	*K*
back side wall	*30 K*	*-2 K*
inside air-outside air	*30 K*	*-2 K*

max, min values
width or depth of room, largest value *10,80 m*
width or depth of room, smallest value *7,20 m*

steady figures	*winter*	*summer*
outside temperature, t_e [°C]	5 C	25 C



ROUGH HEAT LOSS CALCULATION, Φw (stationary method)

Please fill in the yellow fields

transmission	e [-] (more info)	U [W/m² K] (more info)	A [m²]	Δt [K]	Φ_{tr} [W]
Window (front)	1,00	0,083	3	30	7
Paparet	1,00	0,083	22,92	30	57
Ceiling or Roof	1,05	1,2	77,76	5	490
Floor	1,05	1,2	77,76	0	0
Wall, right side	1,00	0,083	38,88	0	0
Wall, left side	1,00	0,083	38,88	0	0
Wall, back side	1,00	0,083	25,92	30	65
by other windows, if present					
Window, right side	1,00	0,083	0	0	0
Window, left side	1,00	0,083	0	0	0
Window, back side	1,00	0,083	0	30	0
Window, roof/ceiling	1,00	0,083	0	5	0
				Σ(Φ_{tr})	620 W
				Φ_{opw} = 0.5 x Φ_{tr}	310 W

Outdoor air flow	$q_{v,inf/vent}$ [m³/s] (more info)	ρ [kg/m³] (more info)	c [J/kg K]	$\Delta t_{in,\,out}$ [K]	$\Phi_{inf,vent}$ [J/s] = [W]
infiltration	,014	1,2	1000	30	504
ventilation	,014	1,2	1000	30	504
				Max(Φ_{inf})	504 W

overall heat loss, $\Phi_w = \Phi_{tr} + \Phi_{opw} + \Phi_{inf,vent}$ **1433 W**

Characteristic numbers - building services

Specific heat loss	$\Phi_{w,spec} = \Phi_w / A_{vloer}$ =	18 W/m²
Air exchange rate of outdoor air	$n_{inf/vent}$ = ($q_{v,inf/vent}$ * 3600) / V=	0 time/ hour

With air heating

volumetric airflow required for heating

with high supply $\Delta t_{toe,afv}$ < 20 K	$q_{v,\Phi w} = \Phi_w / (\rho\ c\ \Delta t)$ =	0,06 m³/s	215 m3/h
with low supply $\Delta t_{toe,afv}$ < 40 K	$q_{v,\Phi w} = \Phi_w / (\rho\ c\ \Delta t)$ =	0,03 m³/s	108 m3/h

air exchange rate required for heating

with high supply	n_{circul} = ($q_{\Phi w}$ * 3600) / V =	0,8 maal /uur
with low supply	n_{circul} = ($q_{\Phi w}$ * 3600) / V =	0,4 maal /uur

Characteristic numbers - general

facade area	25,92 m2
window percentage (facade)	12%
floor area	77,76 m2
room volume	256,61 m3
design temperature	20 C

% of total heat loss

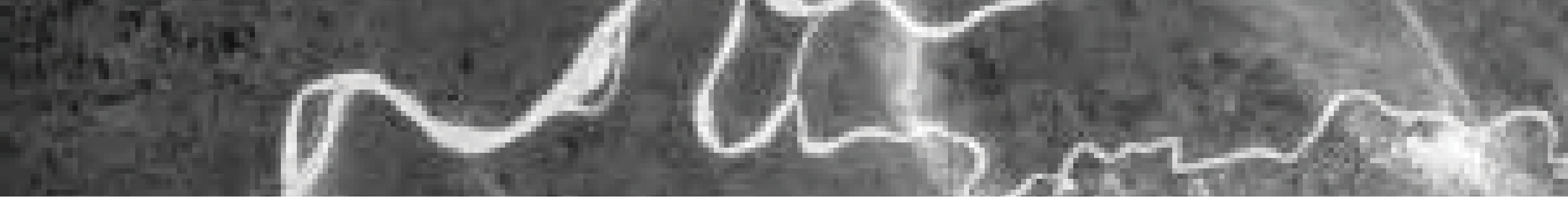
transmission through windows	0,5%
transmission through roof/ceiling	34,2%
transmission through floor	0,0%
infiltration	35,2%
ventilation	35,2%
other	-5,0%

control figures - infiltration more info more info

utility / industrial building, minimum value $q_{v,\,inf}$	*,023 m3/s*
utility / industrial building, maximum value $q_{v,\,inf}$	*,054 m3/s*
residential building, minimum value $q_{v,\,inf}$	*,007 m3/s*
residential building, maximum value $q_{v,\,inf}$	*,642 m3/s*
minimum value $q_{v,inf}$	*,007 m3/s*
maximum value $q_{v,inf}$	*,642 m3/s*

control figures - ventilation:

guideline, minimum value $q_{v,\,vent}$	*25 m3/h*	*,007 m3/s*
guideline, maximum value $q_{v,\,vent}$	*150 m3/h*	*,042 m3/s*
guideline, minimum value $q_{v,\,vent}$	*5 m3/h m2*	*,108 m3/s*
guideline, maximum value $q_{v,\,vent}$	*35 m3/h m2*	*,756 m3/s*
minimum value $q_{v,vent}$		*,007 m3/s*
maximum value $q_{v,vent}$		*,756 m3/s*



ROUGH COOLING LOAD CALCULATION, Φ_k (stationary method)

Please fill in the yellow fields

Slide shows on HVAC calculations

	p	q_p (more info)	Φ_p
	[-]	[W]	[W]
Heat load by people, Φ_p	2	50	100

	A_{vloer}	q (more info)	Φ
	[m²]	[W/m²]	[W]
Heat load by lighting Φ_l	77,76	200	200
Heat load by equipment Φ_a	77,76	0	0

internal load, $\Phi_i = \Phi_p + \Phi_l + \Phi_a$ 300 W (Φ_i)

sunradiation, OUTSIDE windows	orientation	time of the day	z (more info)	A_{raam}	ZTA (more info)	q_{conv} (more info)	f_d (more info)	$\Phi_{z,gl}$ (more info)
		[h]	[-]	[m²]	[-]	[W/m²]	[-]	[W]
front side window (façade)	S	3	1,00	3	0,60	0	1,00	0
outside window, right side	E	3	0,45	0	0,60	0	1,00	0
outside window, left side	W	3	0,45	0	0,60	0	1,00	0
outside window, back side	N	3	0,22	0	0,60	0	1,00	0
outside window, roof	Hori:	3	0,00	0	0,60	0	1,00	0

$\Sigma(\Phi_{z,raam})$ W

$Max(\Phi_{z,raam})$ W

transmission, via OUTSIDE windows	U_{raam} (more info)	A_{raam}	$\Delta t_{in, out}$	$F_{tr,raam}$
	[W/m² K]	[m²]	[K]	[W]
front side window (façade)	1,2	0	2	0
outside window, right side	0	0	2	0
outside window, left side	0	0	2	0
outside window, back side	0	0	2	0
outside window, roof	0	0	2	0

$\Sigma(\Phi_{tr,raam})$ W

sunload via OUTSIDE walls and roof		a	A	q_w	$\Phi_{z,w}$
		[-]	[m²]	[W/m²]	[W]
parapet (front side)	S	0,7	20,76	46	668
roof	Horiz.	0,7	77,76	46	2504
outside wall, right side	E	0,7	35,64	46	1148
outside wall, left side	W	0,7	35,64	46	1148
outside wall, back side	N	0,7	23,76	46	765

$\Sigma(\Phi_{z,w})$ 6233 W

access of outside air	$q_{v,inf}$ (more info)	ρ	c	$\Delta t_{in, out}$	Φ_{inf}
	[m³/s]	[kg/m³]	[J/kg K]	[K]	[J/s] = [W]
infiltration	,0214	1,2	1000	2	51

more info Φ_{inf} 51 W

external load, $\Phi_e = \Phi_{z,gl} + \Phi_{tr,gl} + \Phi_{z,w} + \Phi_{inf}$ 6284 W (Φ_e)

rough cooling load, $\Phi_k = \Phi_i + \Phi_e$ **6584 W**

		more info [h]	z [-]	A_{raam} [m²]	ZTA [-]	q_{conv} [W/m²]	f_d (more info) [-]	$\Phi_{z,gl}$ [W]
front side	S	9	1,00	3	0,60	0	0,80	0
right side	E	9	0,45	0	0,60	0	1,00	0
left side	W	9	0,45	0	0,60	0	0,30	0
back side	N	9	0,22	0	0,60	0	0,50	0
roof	Horiz.	9	0,00	0	0,60	0	0,60	0

$\Sigma(\Phi_{z,gl})$ W

	orientation	time of the day [h]	z [-]	A_{raam} [m²]	ZTA [-]	q_{conv} [W/m²]	f_d [-]	$\Phi_{z,gl}$ [W]
front side	S	16	1,00	3	0,60	0	0,90	0
right side	E	16	0,45	0	0,60	0	0,50	0
left side	W	16	0,45	0	0,60	0	1,00	0
back side	N	16	0,22	0	0,60	0	0,80	0
roof	Horiz.	16	0,00	0	0,60	0	0,90	0

$\Sigma(\Phi_{z,gl})$ W

		[h]	z [-]	A_{raam} [m²]	ZTA [-]	q_{conv} [W/m²]	f_d [-]	$\Phi_{z,gl}$ [W]
front side	S	13	1,00	3	0,60	0	1,00	0
right side	E	13	0,45	0	0,60	0	0,60	0
left side	W	13	0,45	0	0,60	0	0,50	0
back side	N	13	0,22	0	0,60	0	1,00	0
roof	Horiz.	13	0,00	0	0,60	0	1,00	0

$\Sigma(\Phi_{z,gl})$ W

		[h]	z [-]	A_{raam} [m²]	ZTA [-]	q_{conv} [W/m²]	f_d [-]	Φz,gl [W]
front side	S	13	1,00	3	0,60	0	1,00	0
right side	E	13	0,45	0	0,60	0	0,60	0
left side	W	13	0,45	0	0,60	0	0,50	0
back side	N	13	0,22	0	0,60	0	1,00	0
roof	Horiz.	13	0,00	0	0,60	0	1,00	0

$\Sigma(\Phi_{z,gl})$ W

Characteristic numbers - building services:

specific cooling load $\Phi_{k,spec} = \Phi_k / A_{vloer} =$ 85 W/m²

infiltration-factor $n_{inf} = (q_{v,inf} * 3600) / V =$ 0,30 times/ hour

needed amount of air for cooling

Quantity of cooled air $\Delta t_{toe, afv} =$ 5 K $q_{v,\Phi k} = \Phi_k / (\rho\ c\ \Delta t) =$ 01,1 m³/s 3950 m3/h

needed circulation factor for cooling

circulation factor for cooling $n_{circul} = (q_{v,\Phi k} * 3600) / V =$ 15,4 times/ hour

At natural ventilation: more info

needed amount of outside air for cooling $q_{spui} = \Phi_k / (\rho\ c\ \Delta t) =$ 01,83 m3/s 6584 m3/h

needed ventilation factor for natural cooling $n_{spui} = (q_{spui} * 3600) / V =$ 25,7 times/ hour

Characteristic numbers - general:

façade area	23,76 m2
Window percentage (façade)	13%
Floor area	77,76 m2
Room volume	256,61 m3
Design temperature	26 C

control figures - general

floor area per person 38,9 m2

% of toal cooling load

internal load	5%
heat load persons	1,5%
heat load lighting	3,0%
heat load machinery	0,0%
external load	95%
sun radiation through outside windows	0,0%
transmission through outside windows	0,0%
sun load through outside walls and roof	94,7%
outside air supply	0,8%

control figures - infiltration

minimum value $q_{v,inf}$	*0.2 * V / 3600*	*,014 m3/s*
maximum value $q_{v,inf}$	*0.3 * V / 3600*	*,021 m3/s*

minimum value $q_{v,inf}$ *,014 m3/s*

maximum value $q_{v,inf}$ *,021 m3/s*

control figures - ventilation

guideline minimum value $q_{v,vent}$	*25 m3/h*	*,007 m3/s*
guideline maximum value $q_{v,vent}$	*150 m3/h*	*,042 m3/s*
guideline minimum value $q_{v,vent}$	*5 m3/h m2*	*,108 m3/s*
guideline maximum value $q_{v,vent}$	*35 m3/h m2*	*,756 m3/s*

minimum value $q_{v,vent}$ *,007 m3/s*

maximum value $q_{v,vent}$ *,756 m3/s*