Floating Homes Philippines

Project plan


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1 INTRODUCTION

All around the world floods are a growing problem. Dealing with high water levels in residential areas will be of great importance. In the Netherlands multiple organizations and companies are working daily on finding solutions. One of these is Finch Buildings which designed modular floating homes. Two years ago Pieter Ham and Joran van Schaik did their graduation research on the implementation of these houses in foreign countries, more specific in the Philippines.

Nowadays Finch Floating Homes, part of Finch Building, is founded by Pieter Ham, Jurrian Knijtijzer and Joran van Schaik together with TU Delft Global Initiative. They aim to create affordable, sustainable and typhoon proof homes for developing regions like the Philippines. The design of the houses has to be extended at some aspects, before the pilot project can be built in the summer of 2018. The research, design improvement and implementation are carried out by a multidisciplinary team of 6 Civil Engineering master students.

Figure 1 Design of floating homes

2 PROBLEM

The pilot project will be located in the area of Macabebe, the Philippines. It is situated in the Pampanga Delta adjacent to the Manila Bay. The area of Macabebe has to cope with daily flooding, caused by the river and the sea. Groundwater is pumped and used for local industry, causing land subsidence which worsens the problems. Where once rice fields were the main source of income, these fields are now filled with brackish water and turned into fishponds. However, the fish in these ponds can escape in the case of a large flood where the water level rises above the dikes of the fishponds. On top of all this, typhoons strike the region regularly. Due to climate change and the ongoing ground subsidence the problems won't lessen, so affordable, floating, sustainable and typhoon proof homes would be a solution. The current housing backlog results in a high demand for these affordable, safe and healthy homes.

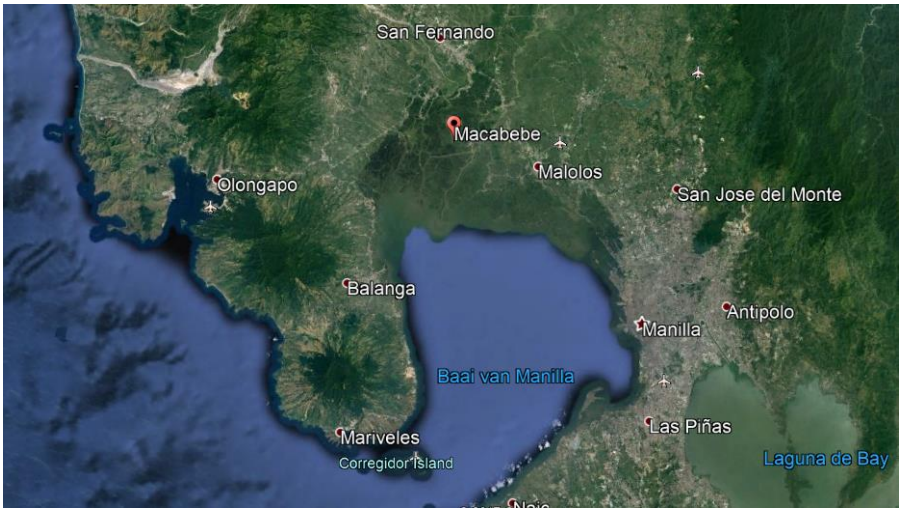


Figure 2 Location of Macabebe, the Philippines

Figure 3 Effects of land subsidence

3 GOAL

The goal of this Multidisciplinary Project is to improve the current design for the pilot project on several levels. These are the structural aspects, water management, a logistical plan and the analysis of the flooding effects on the floating structure. The structural aspects are all related to the homes themselves. From the timber parts to the connections between them. Water management focuses on drink water catchment and sustainable sanitary. The logistical plan entails the construction process of a floating home where material and workforce are brought in locally/regionally to reduce costs and provide information for the community to eventually build and sustain the homes without external help.

4 OBJECTIVE

This is the first Multidisciplinary Project team to follow up on the research performed by Finch Floating Homes. The objectives of this project are expanding their research, investigating unanswered questions, and increasing local awareness about the project. This project team includes students with different specializations than Finch Floating Homes. With their knowledge they could improve the design in their respective field. On the other hand, the project team is very multidisciplinary which has to be used to fit all the individual research and adaptations into the overall design. During this process the local community has to be involved to end up with a suitable design for them. All this is done with the main objective in mind, which is improving the current design and introducing floating homes as solution for the constant floods in the Macabebe area.

Figure 4 Effects of daily floods

5 THE PROJECT TEAM

As mentioned in the previous chapters the project team consists of 6 students from different disciplines within the faculty of Civil Engineering. This is what makes the team multidisciplinary. But how are the disciplines exactly interconnected within this project?

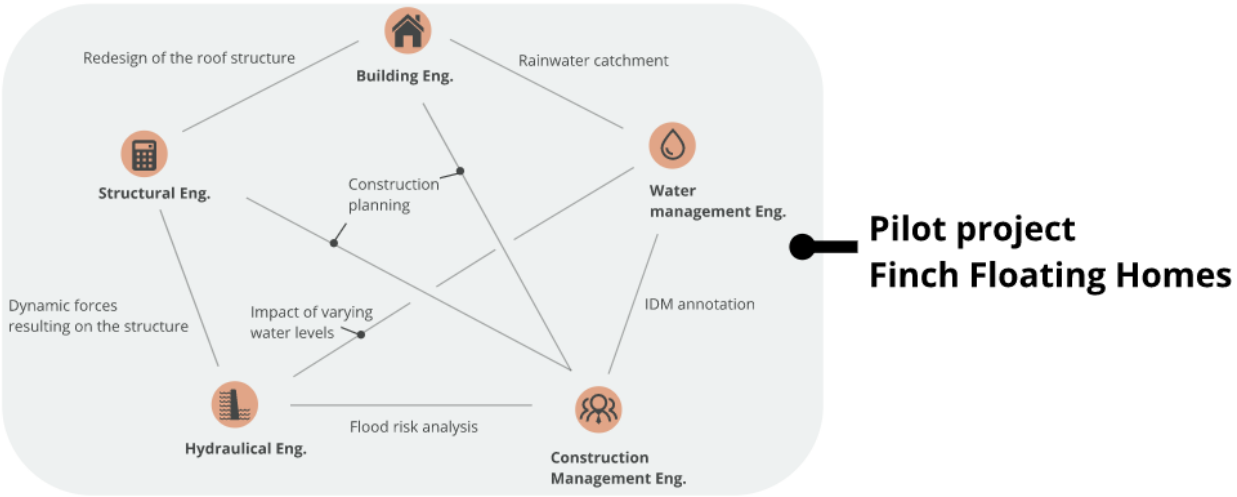


Figure 5 Interaction diagram

Figure 5 shows the interaction diagram and serves as a visual representation of the connections within the project team. While some disciplines are not directly connected there always is a bridging discipline in between the non-linked groups. This all together forms a closed web, all pushing towards the same goal of improving the current design for the pilot project.

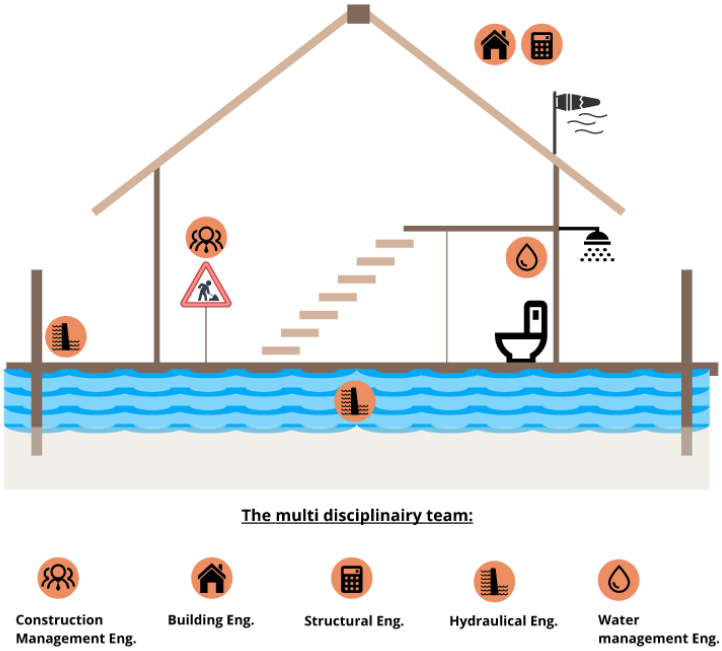


Figure 6 Visualization of to be investigated areas for the pilot project

When placing the different disciplines in the context of the pilot project figure 6 is obtained. This schematic display of the housing unit shows the target areas of each discipline within the housing unit and its surroundings. More information about what the exact plans for the different components shown in figure 6 are can be found in the appendices.

6 RESEARCH QUESTION

The research question consists of 5 sub questions, related to each discipline within the project group. With these sub questions, the main research question can be answered.

6.1 MAIN QUESTION

How can the design and development of the pilot project be improved for an optimal testing model of the floating home in Macabebe, the Philippines?

6.2 SUB QUESTIONS

- CME -

What is the most efficient construction plan for the pilot project?

- BE -

How can the roof be redesigned to assure a buildable pilot model?

- SE -

"How to design the roof structure and its connections for the Finch Floating Homes in the Philippines to have sufficient load bearing capacity, to be easy to assemble, to be affordable and to be durable?"

- HE-EFM –

What scenario results in the most dominant hydrodynamic conditions?

-HE-HS -

How can the design of the floating structure and mooring system be adjusted to the dynamic environment in a way that the disturbance from these hydrodynamic conditions is minimum?

- WM -

How can a socially accepted, sustainable and durable sanitary facility be created?

7 METHODOLOGY

The research is an extension of the existing research of Pieter Ham and Joran van Schaik and will be carried out on location by the multidisciplinary team.

7.1 EXISTING RESEARCH FINCH FLOATING HOMES

Previous research has started in 2016, when the Master thesis reports of Pieter Ham and Joran van Schaik were released. Their conducted research focusses on the design of a prefabricated amphibious structure. The main topics of research discussed are: basic structural behaviour and structural detailing, rough cost estimation and implementation of local needs. After these reports Finch Floating Homes continued the research and the design has been improved further. While the previous research covers a broad range of topics, it is also concluded that more in depth knowledge is still required in the fields of structural behaviour and cost estimation.

7.2 SCOPE

The project Floating Homes started in 2016 and in the summer of 2018 the construction of the first pilot project is planned. The design of the pilot project is made by Finch Floating Homes, but this is open to changes regarding the location and new, in-depth research. At the moment some aspects of the design are in a preliminary phase. This has to be developed into a more detailed design for the construction of

the pilot project. The scope of the multidisciplinary project is the improvement of the design of the pilot project. Focus will be on how the various parts and multidisciplinary aspects of the design can be fitted into each other, including the wishes of the local people, which is essential in this regard.

7.3 METHOD

- Elaborate on previous research and literature study

This phase is reserved for coupling the previously performed research (as performed by Finch Floating Homes) to the local situation. Connecting theory and reality will be very important to fully comprehend the magnitude and effect of the problem on the local community. A combination of literature study and site visits will result in a better understanding of the possibilities for this project.

Finch Floating Homes have already set up a solid communication network with the local university, local companies and influential figures at the location. After arriving it will be our task to invest into these relationships as they will determine the amount of local support of the project in the short and long run. For this project to be successful the importance of support from the local community may not be neglected.

- Carry out required research on-site

In this phase the required research on-site will be carried out in the Macabebe area. Each field has its own required research. The Building and Structural Engineering field will look into the local construction methods, construction instruments and materials available. Hydraulic Engineering will investigate the water level, flow velocity and wind velocity throughout. The Water Management field is interested in the current sanitary behavior of the local community. Knowledge about this behavior will be achieved through a survey among local people.

- Work out results into solutions or adaptations

After collecting the required information from the previous research, the literature study, and the research on-site, it is time to process the information and find answers and solutions to the stated research questions. At this stage we will also engage the local community by giving informative lectures and workshops about our work to those who are interested.

- Implementation into design Finch Floating Homes

The results that were found in the previous phases have to be implemented into the design of Finch Floating Homes. This design must be standardized in order to be applicable not only at the pilot location, but throughout the whole Macabebe area.

7.4 MULTIDISCIPLINARY ASPECTS

During the performance of the project all parts will be integrated into one project. In this process team members need input from other team members or will work together to improve the design. An unwanted situation could occur when team members are dependent on information provided by others. To prevent this, every individual must be sure that he or she can carry out his/her own research independently of others. This means that if information is not provided by team members, external parties, or due to lack of available resources, the individual must return to the previous research and/or make well-considered assumptions. But it must be highlighted that if extra information is needed from

team members and this is available, a short analysis must made by the involved team members. This cooperation will result in a more integrated design and improved communication within the team.

8 TIME PLANNING

In the first week of February 2018 we will travel to Macabebe, Philippines. Table 1 shows a brief overview of the time planning. The tasks listed in this table are further explained in paragraph 7.3.

Tasks / Week	1	2	3	4	5	6	7	8
Elaborate on previous research and literature study								
Carry out required research on-site								
Work out results into solutions or adaptations								
Implementation into design Finch Floating Homes								

Table 1. Time planning

9 BUDGET

To be able to do this project abroad, a preliminary budget has to be made. In the first table the expected income regarding this project can be found. The team is negotiating with several funds and sponsors, who have shown a lot of interest in the project. Besides that, personal savings will be used for daily living costs.

Income

Type	Price		Quantity		Purpose	Total
Funds						
S4S grant	€300.00	per team	1	team	Equipment	€300.00
Global initiative	€500.00	per team	1	team	Flights	€500.00
Stud Fonds	€300.00	per team	1	team	Flights	€300.00
Waterbouw Fonds	€500.00	per team	1	team	Flights	€500.00
IS Fund	€250.00	per person	6	persons	Flights	€1,500.00
Subtotal						**€3,100.00**
Compensation						
Vaccinations compensation	€50.00	per person	6	persons	Vaccination	€300.00
Health insurance compensation	€250.00	per person	6	persons	Vaccination	€1,500.00
Reisvergoeding OV (3x 91,62)	€274.86	per person	6	persons	Travel	€1,649.16
Subtotal						**€3,449.16**
Sponsoring						
Companies	€0.00	per team	1	team		€0.00
Subtotal						**€0.00**
Personal budget						
Personal savings	€1,000.00	per person	6	persons	Living	€6,000.00
Subtotal						**€6,000.00**
Total						**€12,549.16**
Total per person						**€2,091.53**

Table 2 Income

Table 3 shows the expected expenses for the project. The biggest expense will be the flight tickets to the Philippines. The funds will be used to cover these costs.

Expenses					
Product	**Price**		**Quantity**		**Total**
Travel					
Flight return tickets Amsterdam - Manila	€650,00	per person	6	persons	€3.900,00
Transport in Philippines	€150,00	per person	6	persons	€900,00
Visa and other documents	€100,00	per person	6	persons	€600,00
Subtotal					**€5.400,00**
Health care					
Vaccination hepatitus A and B (2x)	€106,00	per person	6	persons	€636,00
Vaccination DTP	€22,00	per person	6	persons	€132,00
Vaccination Typhoid	€33,00	per person	6	persons	€198,00
Vaccination Rabies (3x)	€210,00	per person	6	persons	€1.260,00
TU Delft travel insurance	€0,00	per person	6	persons	€0,00
Subtotal					**€2.226,00**
Living					
Accomodation	€450,00	per person	6	persons	€2.700,00
Food	€250,00	per person	6	persons	€1.500,00
Subtotal					**€4.200,00**
Project related					
Study/Work material	€60,00	per person	6	persons	€360,00
Subtotal					**€360,00**
Total					**€12.186,00**
Total per person					**€2.031,00**

Table 3 Expenses

10 RESULTS/CONCLUSION

The results of this multidisciplinary project have to advise on adaptations of the design to increase the success of the pilot project and minimise the risk of failure. The multidisciplinary team will address subjects which aren't investigated by Finch Floating Homes. Despite the multiple subjects which are going to be researched, the final result will form a whole; one final report with advice on design and implementation changes. The team members work together in their fields and exchange information throughout the project in order to ensure an integral output rather than separate pieces of advice. The results of this research will provide both answers for Finch Floating Homes to use during the construction of the pilot project as well as some longer-term solutions for the development of the floating homes community. Besides this, at the end of this research some new questions and possible threads on matters that will need more attention may rise. These subjects that remain open can be taken as a starting point for successive multidisciplinary groups.

Appendices

APPENDIX A: PERSONAL PROJECT PLAN DISCIPLINE CME

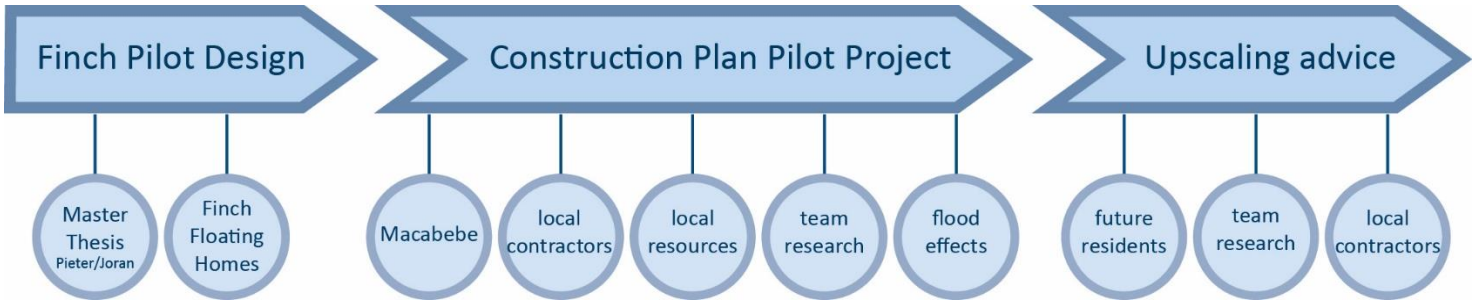
The main focus for the Construction Management and Engineering discipline is the planning and allocation of the construction phase of the pilot project. Focus will be on the efficient time scheduling of the development and construction process of one floating home, where the type of resources, resource allocation, logistics, costs and incorporation of the research of the other disciplines are included.

Research Question: *"What is the most efficient construction plan for the pilot project?"*

The challenge here is the allocation and storage of the resources. Due to the many floods and typhoon risk, the materials, tools, employees and other resources have to be carefully allocated and managed in order to prevent delays, cost overrun and waste of the resources. The consequences of a flood during the pilot project will be identified and used to create a more efficient construction plan.

Another challenge rises after the completion of the pilot project. The aim of Finch Floating Homes is to create several floating communities on multiple locations over the world. The upscaling of the project requires changes to the construction plan, since short-term and long-term planning might be different in the Philippines. The types of changes will be analysed and mapped, and can be used by Finch Floating Homes for a multi-annual plan, which continues after the pilot project with building several floating homes to floating communities and finally aims to implement multiple floating communities in the Philippines and other locations in the world. The involvement of the locals is of great importance during the pilot and the start of the upscaling, since they will need to collaborate during the construction but they will also be the future residents.

The final goal is to provide the locals and Finch Floating Homes with a report which can be used during the construction phase of the pilot project and forms the start of the construction plan for multiple floating communities throughout the world. The report will include a construction plan with the most efficient time schedule of the development of the pilot design and construction process, as well as how to incorporate the results of the research of the other team members. With this the pilot project can be constructed. Furthermore, advice will be given on the required changes regarding the upscaling of the project.



APPENDIX B: PERSONAL PROJECT PLAN DISCIPLINE BE

REDESIGN OF THE ROOF FOR THE (PILOT) PROJECT

From the initiation talks with the team of Finch Floating Homes it has shown that the roof is one of the hurdles in the current design. There are doubts about the current design of the roof, mainly regarding the connections to the housing units and the successful implementation of typhoon resilient measures. With the start of the pilot model scheduled at the beginning of the summer there needs to come more certainty about the current roof design before it can be produced.

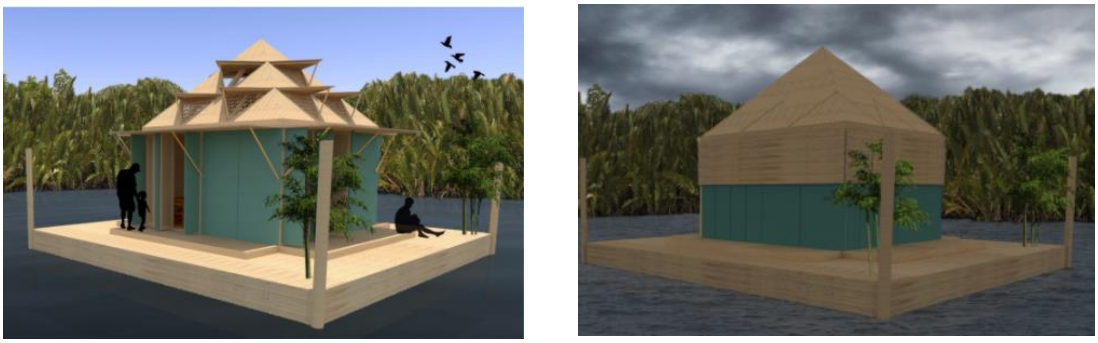


Figure 1, current design of the building with openable roof unit

Not only does the construction have to be easily buildable with the locally available tools and products, it also must be durable and preferably easy to repair. With these aspects in mind the following research question is formulated for the discipline of Building Engineering:

How can the roof be redesigned to assure a buildable pilot model?

The word buildable is key in this research question. During the time in the Philippines the design limitations will be investigated by looking interacting with local construction companies to see what is common and what is possible for constructions in the Philippines. By gaining insight in the local way of constructing a more specific solution to the structurally challenging roof construction can be found.

Redesigning the roof structure will only be successful if the different disciplines in this project work together. For the roof structure this especially means close collaboration between the disciplines of Structural Engineering and Building Engineering. Because of the large overlap between the work done it might be informative to state the specific aim of the final product regarding Building Engineering. For this discipline that will be a comprehensive construction manual.

The world's best-known manuals are those of IKEA furniture. With very basic tools and a self-explanatory construction manual everyone can transform several wooden panels in into a specific product. The power of these manuals is that they do not rely on one specific language or someone's technical skills to work. Instead they are the 'one size fits all' of construction manuals, turning a rather complicated process in nothing more than a step-by-step cartoon book. By aiming towards such a construction manual, the buildability of the roof construction for the pilot model can be assured.

APPENDIX C: PERSONAL PROJECT PLAN DISCIPLINE SE

The specialisation Structural Engineering will design the roof structure for the Finch Floating Homes together with the specialisation Building Engineering. Important aspects in the design of the roof that Structural Engineering will focus on are the optimal shape with respect to wind load and its load bearing structure, the materials used for the roof construction and the connections within the roof construction. The aim is to provide Finch Floating Homes with a design for the roof that can be implemented directly into the first pilot project, which will be built in June 2018.

The research will start with a literature study. The aim of this literature study is to find applied solutions for roof structures in typhoon areas in reference projects. This can be very innovative solutions, but also construction techniques that have been used for decades and have proved to be successful. The literature study will provide design options for both the roof shape and structure as well as the connections which can be used in the roof structure.

After this the definition phase will start, in which the requirements of the roof structure for the Finch Floating Homes will be further clarified. Key topics in these requirements will be sufficient load bearing capacity when undergoing the loading conditions present in the area, the assembly without big and expensive instruments, the availability and affordability of the elements and materials in the area and the durability of the elements and connections.

With the results of the literature study and the definition phase, the design of the roof structure can be made. By sketching an optimal design has to be found. The chosen design will be modelled with all loads imposed on the structure. The connections will be undergoing both static (dead load and live load) and dynamic loading (wind, waves, earthquakes). Finding numeric values for these loads will require further research into the Building Codes. When the numeric loads have been found, the current design of the roof structure and its connections has to be tested and dimensions will be given to the elements.

In the final phase of the design, the development phase, an assembly plan will be made. This assembly plan must be understandable for local construction workers and will prevent the chance of errors in the execution. This plan also includes an overview of suppliers of the elements in the nearby area.

The final goal is to provide Finch Floating Homes with a suitable, workable design for the roof structure, which will be implemented into the pilot project in June 2018. The research question for the specialization Structural Engineering will be:

"How to design the roof structure and its connections for the Finch Floating Homes in the Philippines to have sufficient load bearing capacity, to be easy to assemble, to be affordable and to be durable?"

APPENDIX D: PERSONAL PROJECT DISCIPLINE HE-EFM

DELFT3D MODELLING OF HYDRODYNAMIC CONDITIONS

The scope of this personal project is to map the hydrodynamic conditions for different scenarios. At first the pilot location will be researched. Does wind create significant waves? And during a typhoon? But also when a levee breaks or overflow, the flow conditions are crucial. This information is required to determine the mooring and anchoring systems, done by Ruben Frijns. Several parameters are varied to assess the sensitivity of these systems to changes in external forces.

Other locations can also be of interest. Closer to the sea the tidal forces are also a source of external forces (water level and waves). Near a river the flow conditions are dominant and likely much larger than in a fishpond. Several of these scenarios are to be studied to better map the hydrodynamic conditions of areas of interest.

Modelling will be done using Delft3D. A 2D or 3D model will be used depending on the computation time and accuracy. Note that for all categories typhoon conditions and flooding cause extreme conditions. This leads to the question:

"What scenario results in the most dominant hydrodynamic conditions?"

DELFT3D AND DATA

Delft3D requires several input data for its computations. These are for example bathymetry (incl. fishpond depth and levee height), wind speed, direction, and wave conditions. Some data can be obtained through external sources. One source is a contact at an engineering consultant office. This person could provide bathymetry and typhoon condition data. Other sources are The Philippine, Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) and The University of Philippines.

OTHER

If data is outdated, corrupted or unavailable measurements need to be done on site. Water levels and flow velocities can be measured with the smartphone app Mobile Water Management (WMW). This app allows the user to get the water level and flow velocity with the click of a button. A photo of the staff gauge is send to a central server where the image is processed and the result is send back. The accuracy for water levels is 10mm.

Of lesser importance but of interest is the mobility of sediment. An anchoring systems like poles introduce the possibility of erosion. This mechanism can be studied with some simple formulas to get an estimate of the erosion rate. Also the stability of the levees and embankments are possible topics of interest.

APPENDIX E: PERSONAL PROJECT PLAN DISCIPLINE HE-HS

The main topic of the research of the Hydraulic Structures discipline in this multidisciplinary project is the effect of the hydrodynamic conditions on the floating structure. The floating structure is exposed to waves and currents during flooding. Typhoons will amplify these phenomena adding strong winds. The motions of the structure have to be limited to ensure pleasant life in this community. Another requirement deals with the resulting forces on the foundation module and the mooring system of the floating home.

The research will start with a literature study on the existing approaches for the dynamic behaviour of floating structures. By following the course 'Motions and Loadings of Structures in Waves' a start will be made in the Netherlands. The literature about the effects of currents on floating structures has to be gathered from other academic sources. Mario will work on various scenarios which can occur at the future location of the pilot project. With the knowledge from the literature study it should be possible to translate these hydraulic scenarios into the behaviour of the floating homes during these scenarios. When the behaviour is known two important results are investigated. Firstly, the motions of the floating structure should be limited to ensure pleasant life. Which motions are acceptable during each scenario? Secondly, the behaviour of the floating structure leads to forces. The foundation module has to resist these forces, but it also has to be sure that mooring system prevents the floating structure from drifting away during the investigated scenarios. Several mooring options will come across and will be evaluated.

The final goal is to end up with an optimal floating and mooring system which can be applied into the pilot project. Several hydraulic scenarios will be analysed and used in the optimization of the foundation module and mooring system. The focus will lie on the pilot project, but it is intended that the floating and mooring system can be applied to the successive floating homes.

Research question: *"How can the design of the floating structure and mooring system be adjusted to the dynamic environment in a way that the disturbance from these hydrodynamic conditions is minimum?"*

APPENDIX F: PERSONAL PROJECT PLAN DISCIPLINE WM

Extreme flooding, earthquakes, soil depletion, unsafe housing condition are all motivations for this research. These motivations in combination with the 17 Sustainable Development Goals of the United Nations the scope of this research will focus on clean water and sanitation.

The scope of this research is to create a social accepted, sustainable and durable solution for the local inhabitants of the Finch Floating Home in Macabebe, Philippines.

The main research question will be:
"How can a socially accepted, sustainable and durable sanitary facility be created?"

The question can be split in two parts, a technical and a social part, both of these parts have their own requirements. The research will first focus on the social wishes and common habits of the local population, secondly research for the possible technical solution, at last the system has to be tested to the requirements stated at the start.

The social wishes and common habits will be retrieved through a site visit of Pieter Ham in combination of a questionnaire of the local population. This questionnaire will focus on the current situation, habits and wishes of the local inhabitants. The technical solution will result from the social study, a literature study, (local) test and reference projects.

Relationship to the Integral Design Management annotation or System Engineering.
The sanitary facility will function as a part within the community, an integrated part of the house and/or village. To design an integral system within the house the approach by Wasson to describe and allocate the attributes with their requirements.[i]

As stated in the first paragraphs above the requirements of the system come from both technical and social research within the project. Those requirements will be allocated in a capability/function tree/matrix. This will result in a total overview of the system and its key components.

[i] Wasson, Charles S. (2016), System engineering analysis, Design, and Development, Wiley & Sons Inc.