FLOOD RISK ANALYSIS

EXPLOITING THE SYNERGIES BETWEEN SUSTAINABLE URBAN DRAINAGE SYSTEMS (SUDS) AND URBAN FARMING IN VĨNH YÊN CITY, VIETNAM

CONTENTS

1 INTRODUCTION

This report is part of the first output covering two sub-products: The Inception Report (output 1a) and Flood Risk Analysis Report (output 1b). This report covers the Flood Risk Analysis Report.

The Flood Risk Analysis focuses on the following:

- Stormwater and drainage system modelling
- Urban planning and potential sites for urban gardening

2 SHORT SUMMARY

The preliminary flood risk analysis shows a water flow pattern and flooding pattern, which is normal for old cities with a fully paved and densely populated city centre, less populated surroundings, and a topography leading water from the hilly sides in the periphery to the centre and ultimately the lakes system and the river.

During stormwater, water will flow on the surface and run relatively fast to low-lying areas, where barriers in roads, buildings, walls and other constructions will obstruct the water run-off, and create local floods. Even during relatively small rain events, flood events may occur locally.

The optimal solutions will be to retain and infiltrate as much water as possible in SUDS in the high-lying areas in the top of the hydraulic system, and subsequently during heavy rains lead water in water runways, channels or on-surface of cloudburst roads to the lakes system in the centre of the city, removing as many barriers for water transportation along the way. Underground pipes may help in getting water quickly to the lake recipients. These principles are applied for stormwater management in many cities around the World, including Copenhagen (Figure 1)

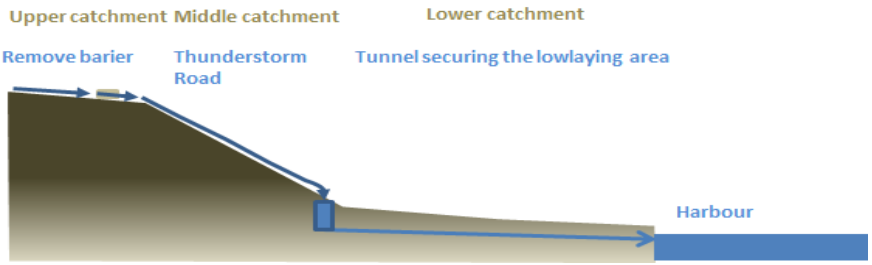


Figure 1. Principle for stomwater management in Copenhagen (NIRAS)

To identify the best solutions for Vĩnh Yên City, it recommended to:

a. Analyse Vĩnh Yên City urban plans and upcoming urban development projects, identifying possible project sites where SUDS with synergies between Green Infrastructure development, water storage, infiltration

and urban gardening, may be developed, taking into account the flood risk analysis.

b. set-up a comprehensive dynamic hydraulic model for drainage and stormwater modelling for relevant water catchment areas in Vĩnh Yên City. This will enable a prediction of the consequence of floods and the effect of SUDS scenarios and a calibration of simulated floods with observed events.

See report for further recommendations.

3 METHODS AND MATERIALS

The methods and materials used for this background report can be divided into:

- Planning documents
- Site inspection
- Workshops in Denmark
- Stormwater flowmaps
- Hydraulic drainage system model – MIKE URBAN

3.1 Planning documents

To gain insight of the current and future sewer and stormwater plans, the 'Vinh Phuc New Urban Area Drainage and Sewage Planning 2030' has been central. This document and its sewer plans also make the basis of the setting up a dynamic hydrological model in MIKE URBAN.

3.2 Site inspection

An initial site inspection (figure 2) was made by Anja Wejs, NIRAS, Nguyen Viet Dung, Phan Dung, IRURE (VIUP), Mr. Pham Ngoc Long, Mr. Le Manh Cuong, Mr. Nguyen Ngoc Thu, Vĩnh Yên city's People committee on June 29th 2016, followed by a two day technical site inspection by Jens S. Kofod, NIRAS, Nguyen Viet Dung and Phan Dung, IRURE (VIUP) on July 10th – 11th 2016.

Figure 2. Site inspection in Vĩnh Yên.

3.3 Stormwater flowmap

By the use of topographic data from QGIS and SCALGO Live two flowmaps was developed to show the main run off paths in stormwater situations. Appendix 1.1 contains a flowmap from QGIS and outlines the catchment in question. The catchment area is approximately 402 Ha. The map is based on free data available in QGIS. Appendix 1.2 contains a flowmap from SCALGO Live. This flowmap is based on the World SRTM (Shuttle Radar Topography Mission) digital elevation model (DEM).

Digital elevation model for drainage model

To simulate terrain floods in MIKE FLOOD a DEM is interpolated. Terrain levels from contour lines and manhole ground levels are used as input data. Both dataset are received as CAD-files named “Contour” and “Current drainage Vinh Yen_Updated_29_6_Urban management Division” respectively. This DEM is more detailed within the catchment than the ones used for the flowmaps. Appendix 1.3 shows a section of the DEM. The accuracy of this DEM is limited by the input and only an approximation of the true elevation. The DEM does not include topographic differences in the terrain due to buildings, walls, large infrastructure, road-site edges etc. A wall around the Military Academy is included, as it could potentially be an important water barrier.

3.4 Hydraulic drainage system model

The hydraulic model is set up to make a preliminary analysis of pluvial terrain flooding with the current drainage system. Furthermore a climate change adaptation scenario is inserted in the model to access the effect on overflow from the drainage system. MIKE URBAN version 2016 by DHI is used for modelling the drainage system. Terrain floods are simulated with the 2D overland flow tool

MIKE FLOOD and compared with a 1D pipe simulations. The water level in the lakes are kept constant. Flooding due to rising lake water levels are not included.

Drainage system

The hydraulic model describes a simplified version of the drainage system in the northern part of Vĩnh Yên. Only pipes with a diameter equal to or above 600 mm are included. System data is taken from CAD-file "Current drainage Vĩnh Yên_Updated_29_6_Urban management Division". The drawing does not contain ground and invert levels for all parts of the drainage system. Levels are interpolated on pipe stretches, where sufficient data are not available.

Catchment description

The catchment severed by the drainage system is defined based on the typography (see Appendix 1.1). To obtain a flooding pattern mirroring experienced floods, the degree of imperviousness and the hydraulic reduction factor is adjusted. The imperviousness describes the degree of paving within the catchment and the hydraulic reduction factor describes the extent to which the paved areas are connected to the sewer system.

Rain input

Rain input is based on methodological data from Vĩnh Yên in document "Meteorology Data of Vinh Yen City" and IDF-curves found in "Asian Pacific FRIEND - Rainfall Intensity Duration Frequency (IDF) Analysis for the Asia Pacific Region, November 2008" by United Nations Educational, Scientific and Cultural Organisation; International Hydrological Programme VI. The average maximum intensity over 1 hour for a rain with a 10 year return period was estimated to 110 mm/hr. This intensity was translated into the CDS-rain (CDS = "Chicago Design Storm") found on Figure 3.

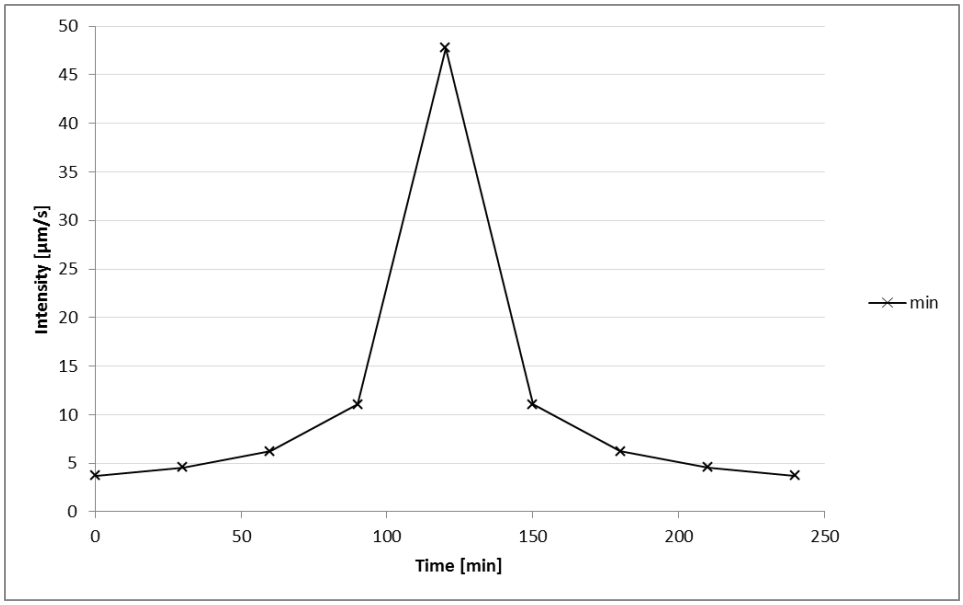


Figure 3. Rain input: CDS-rain with maximum intensity corresponding to a 10 year rain with an 1 hour duration.

This rain is applied in the terrain flood analysis. The total length of the CDS-rain is 4 hours and the time step is set to 30 min.

Climate Change predictions for Vietnam

According to Table 1, is it predicted that the average annual rainfall may increase 6.3% by year 2100, and the summer rains may increase 11.8% by 2100.

Table 1. Estimated Rainfall Change (%) of Vinh Phuc Province from 2020-2100 compared with period 1980-1999 based on Medium Emission scenario (B2).

Time	Timeline of the 21st century								
	2020	2030	2040	2050	2060	2070	2080	2090	2100
Yearly Average	1.2	1.8	2.5	3.3 (3.0-4.0)	4.0	4.6	5.2	5.8	6.3 (5.0-7.0)
Winter (XII-II)	0.5	0.7	1.1	1.3	1.6	1.8	2.0	2.3	2.4
Spring (III-V)	-0.5	-0.8	-1.1	-1.4	-1.8	-2.1	-2.3	-2.6	-2.8
Summer (VI-VIII)	2.3	3.4	4.8	6.2	7.5	8.8	9.9	10.9	11.8
Autumn (IX-XI)	0.5	0.7	1.0	1.3	1.6	1.9	2.1	2.3	2.5

We may adjust our predictions for Vĩnh Yên City with a factor 1.063 for annual rains or 1.118 for summer rains (Table 1), but this will not change the flood risk results in the present model. What really matters are the predictions for extreme events, which may cause more frequent severe floods in Vĩnh Yên City.

The present modelling is not yet adjusted with a specific climate factor, mainly because:

- Climate factors for high intensity rains with low frequency are not yet available.

- The present simulations are mainly to get an idea of, where floods may occur. Models are not yet suitable to adapt the drainage system to a certain rain event or service level for the sewage system.

Scenarios

2 scenarios are simulated. Scenario #1 is a 2D status simulation of terrain flooding. The sewer system is described as it is today according to received CAD-file. Scenario #2 is a flood simulation as scenario #1. It includes two pipes proposed by the Vĩnh Yên municipality with separate outlets into the lakes. Connections between existing and proposed pipes are made at intersections. The new pipes are described on received CAD-file "Planning map of Orientation Drainage system to 2030 in Vinh Yen City".

3.5 Workshop in Denmark

During a study tour to Denmark, NIRAS hosted a workshop with a focus on hydraulic flood models, SUDS and the selection of possible sites in Vĩnh Yên. Programme presented in Appendix 1.11.

3.6 Experienced flood spots in Vĩnh Yên City, August 2016

On 15th of September 2016 a list of Temporary Flood Spots in Vinh Yen City, August 2016" was received (see Appendix 1.10). Time constraints did not allow a comparison between these experienced floods and the flow maps.

4 FLOOD RISK ANALYSIS RESULTS

Flood risk analysis results are presented in two categories; stormwater flowmaps and hydraulic drainage system model

4.1 Stormwater flowmap

The flowmaps (Appendix 1.1 and Appendix 1.2) and DEM (Appendix 1.3) generated for the flood simulation gives an initial idea about the overall surface flow in this area of Vĩnh Yên. The catchment is characterised by a small valley going from north to south. This valley results in the main flow path being also from north to south. The lowest area is found along the Mê Linh road in the southern part of the catchment. Consequently, surface water is expected to gather around Mê Linh. A map received as a CAD-file "Fig. H-3.7. Current Inundation points in Vinh Yen City" with experienced floods mirrors this expectation. The two flowmaps depict two different outflows from the catchment. Appendix 1.1 depicts the south-western corner as the lowest location and outflow point, whereas Appendix 1.2 depicts the south-eastern corner of the catchment.

The generated DEM is a rough estimate based on the available data and may look different if not based on interpolation. A DEM may easily be produced for the catchment by use of a small drone and a digital scanner.

4.2 Drainage system model

Scenario #1 – Current drainage system

Maps in Appendix 1.4 shows simulated terrain floods. As expected, water gathers in the lowest areas. More floods are found the northern part of the catchment than expected. This error likely due to a mismatch in levels in data use to interpolate the DEM. The wall around the Military Academy forms a significant water barrier as water gathers north of the wall. Appendix 1.5 shows the effect of excluding the wall from the DEM. Consequently, floods increase further downstream.

The result of a 1D pipe simulation can be presented as the flooding level of each manhole. Appendix 1.6 shows such a result still with the current drainage system. At most locations an overlap is found between terrain flood and flooding of manholes. However, at the intersection between the roads Mê Linh and Bà Triệu manholes are flooded, but the terrain is not. From experience this area is prone to flooding. This mismatch is assumed to be due to a DEM error.

The present simulation is a rough estimate based on available data, and may show different results, if the model is integrated with a better DEM and calibrated with data over experienced floods.

Scenario #2 – Proposed drainage system

The new pipes at Chu Văn An will primarily reduce the flooding events close to Mê Linh (compare Appendix 1.4 and Appendix 1.7). Minor flood reduction is also observed around Nguyễn Tất Thành. The proposed pipes contribute to a faster water transport downstream to pipes around Mê Linh and the outlet. These pipes are already facing a hydraulic overload. Transporting water faster downstream might hamper the flood reduction achieved by making a new outlet.

Sum up on drainage model – recommendation for flood prevention

The hydraulic simulations shows a drainage system heavily overloaded during a 10 year rain event. This overload will increase as more paved areas is connected to the existing drainage system. Urbanization is mainly expected north of the city in the high-lying upstream areas. Today water from the catchment upstream causes floods downstream (see Appendix 1.8). The steep slope transports water fast downstream to a part of the drainage system with lower pipe slope and less hydraulic capacity.

To mitigate the risk of increased floods and minimize the current ones it is recommended to analyse the hydraulic effect of storing/retaining water upstream in the catchment and create more outlets to the lakes downstream. Floods are expected to be reduced both by decreasing the load on the drainage system and allowing easier outflow to the lakes downstream where floods occur. Such solutions are expected to have a positive effect on the performance of the drainage system and minimize floods. In addition it should be considered only to allow

future urban developers and landowners to connect a limited part of their lots to the drainage system. The remaining part should ideally be retained on each lot.

4.3 Possible sites in Vĩnh Yên City

During on-site visits in June and July and the subsequent workshop in Denmark, representatives from Vĩnh Yên City presented ideas for possible sites for SUDS and urban gardening in the city Subsequently, urban planners and experts from IRURE and NIRAS have identified further potential sites, according to the urban plans presented in appendix App. 1.13 (Detailed plan from 2010 for Ha Tien New urban area) and appendix 1.14 (Urban plan). All ideas for possible sites are presented in Appendix 1.9.

Possible sites were selected based on the following primary criteria:

a. Potential positive effect on urban green planning
b. Potential positive effect on drainage system
c. Potential positive effect on stormwater management
d. Potential positive effect on sustainable re-use of rainwater
e. Potential positive effect on stakeholders urban gardening and household income.

Five possible areas and sites were identified by Vĩnh Yên City representatives in collaboration with experts from IRURE, MOC and NIRAS:

1) Water square in green park at Yết Kiêu
2) Green roofs/urban gardening on Vĩnh Yên Market/Chợ Vĩnh Yên
3) Stormwater management in main roads Bà Triệu and Chu Văn An.
4) Rainwater collection and urban gardening for private households in areas around Yết Kiêu, Tôn Thất Tùng, Nguyễn Văn Linh and Bà Triệu (around the park at Yết Kiêu).
5) Rainwater collection and urban gardening are households in other areas in Vinh Yen city.

An additional 3 possible sites were identified in the Ha Tien New urban area (appendix 1.13):

6. The green park areas around Chùa Hà Tiên new urban area along Nguyễn Tuân road.
7. The green areas identified for parking lots north and south of Nguyễn Tuân road.
8. The square at Phạm Văn Trác

All sites (1-8) will have a potential positive effect on urban green planning (a) and a potential positive effect on the urban drainage system (b), by adding green areas to the city and reducing the amount of water being led to the sub-surface pipe system. The effect will depend on where activities are located and how big volumes of water will be detached from the system. The further upstream – the higher effect.

The main roads Bà Triệu and Chu Văn An may have a positive effect on storm water management (c), if they are allowed to transport stormwater in a controlled manner on the surface and connections to the downstream pipes, lakes and basins are sufficiently secured.

A water square/basin in the green park at Yết Kiêu may collect and store water during heavy rains from the adjacent buildings to be re-used for urban gardening. To optimize the positive effects on the drainage system houses adjacent to the park must be disconnected from the existing drainage system and led to the park. The outlet from the water square/basin must be control in such a way that water is only discharged from the park, when the exiting drainage system has free capacity or the storage capacity in the park is reached.

A green roof on Vĩnh Yên Market may also collect and store water for urban gardening, thus reduce the immediate run-off in the neighbourhood and have potential positive effects on sustainable re-use of rainwater (d) and on stake-holders urban gardening and household income (e). Rainwater collection and urban gardening for private households in selected neighbourhoods will also have potential positive effects on sustainable re-use of rainwater (d) and on stakeholders urban gardening and household income (e).

The green parks and parking areas in the Ha Tien New urban area (sites 6-8) all have the potential for collecting, storing and infiltrating rain water, thereby reducing the load on the existing drainage system downstream. As the areas are all upstream from the city centre, where major flood events have occurred recently (appendix 1.10), the expected potential effect on criteria a-c is greater than on sites 1-5. This however needs to be further analysed by a calibrated dynamic model based on a revised Digital Elevation Model (DEM).

5 RECOMMENDATIONS FOR FUTURE PLANNING

The Flood Risk Analysis shows more comprehensive solutions than included in the NCF project. NIRAS have the following recommendations to Vĩnh Yên City in regard to future stormwater and drainage management and urban planning.

5.1 Stormwater and drainage management

It is recommended:

a) To gather systematic information about historic and future rain and flood events in Vĩnh Yên City focusing on rain intensity, rain duration, flood duration, depth of water, areal spread of water, flood origin (surface, manhole, drain), flood depart etc.

b) To set-up a comprehensive dynamic hydraulic model for drainage and stormwater modelling for relevant water catchment areas in Vĩnh Yên City. This will enable a prediction of the consequence of floods and the effect of SUDS implementation and a calibration of simulated floods with observed events (a).

c) To measure and calculate the volumes of water, potential retention, infiltration rates, evaporation rates, of potential sites for SUDS Vĩnh Yên City.

d) To use the dynamic model to predict the effect of different SUDS applied in the selected catchment area under a normal everyday rain event and a stormwater event Vĩnh Yên City.

e) To use the dynamic model to predict the possible effects of storing/retaining water upstream in the catchment and opening more outlets to the lakes downstream.

f) To set-up a calibrated Digital Elevation Model (DEM) for selected project sites, possibly using a small drone with a portable digital scanner.

5.2 Urban Planning and Urban gardening

It is recommended:

g) To further analyse Vĩnh Yên City urban plans and upcoming urban development projects, identifying possible project sites where SUDS with synergies between Green Infrastructure development, water storage, infiltration and urban gardening, may be developed, taking into account the flood risk analysis.

h) To calculate to economic and social costs- and benefits of different SUDS solutions in Vĩnh Yên City to make a more informed decision making and prioritised selection of suitable sites and areas for setting up SUDS and urban Gardening projects

6 NEXT STAGES

This report is the last output related to Milestone 1. The next stage starts with Milestone 2 by 1st of October 2016. The Flood Risk Analysis creates a basis for understanding the water flow, in which selected SUDS will be a part.

Milestone 2 has already been initiated with a study trip for MOC, IRURE and Vĩnh Yên City representatives to Copenhagen on 5-10 September as inspiration for designing the SUDS to be implemented in Vĩnh Yên.

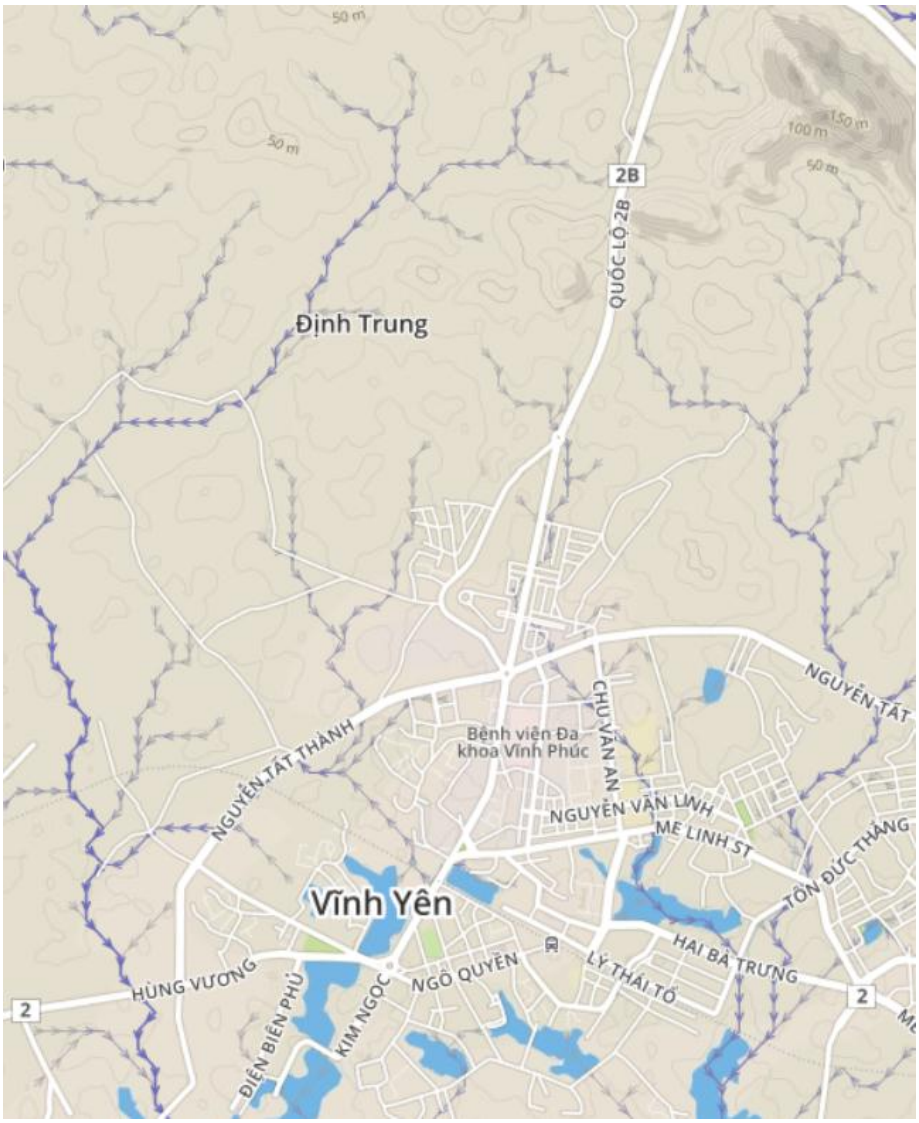
The programme of the study trip is presented in Appendix 1.12.

The further design of the SUDS will be based on the Flood Risk Analysis, inspiration from the Copenhagen study trip, international experiences and the local conditions (Vietnam as well as in Vĩnh Yên).

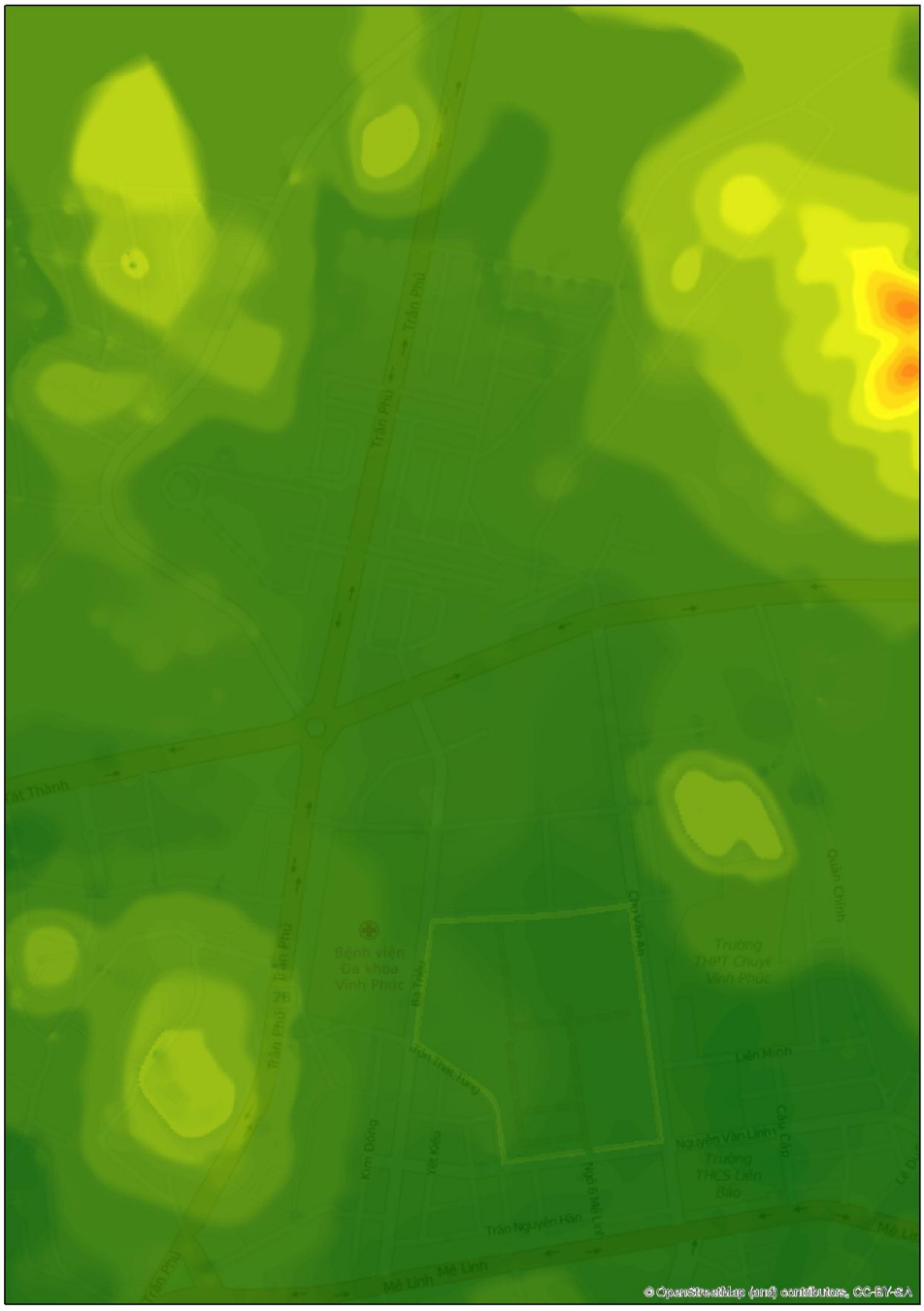
1 APPENDICES

Appendix 1.1 Flowmap from QGIS with catchment outline

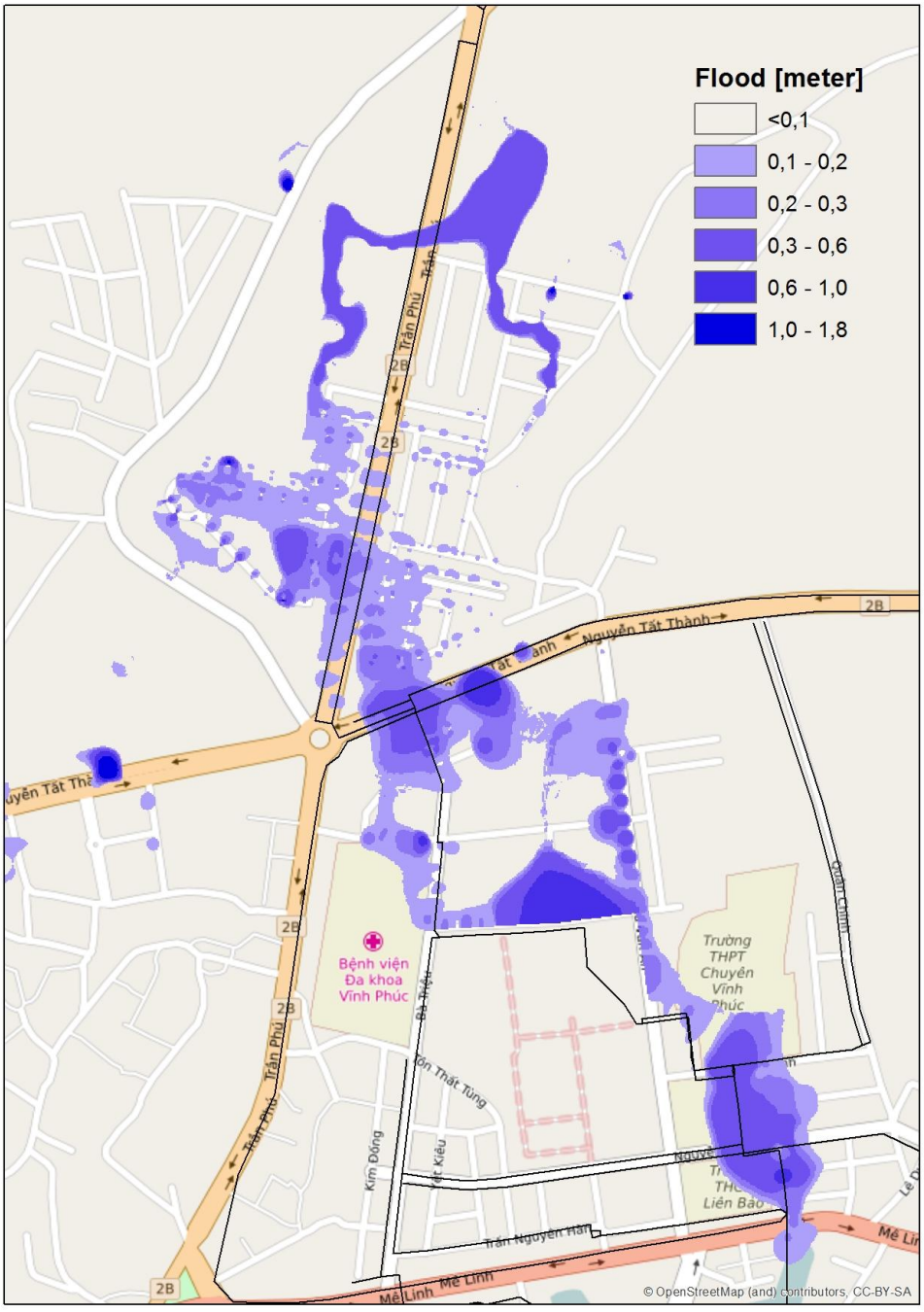
Appendix 1.2 Flowmap from SCALGO Live

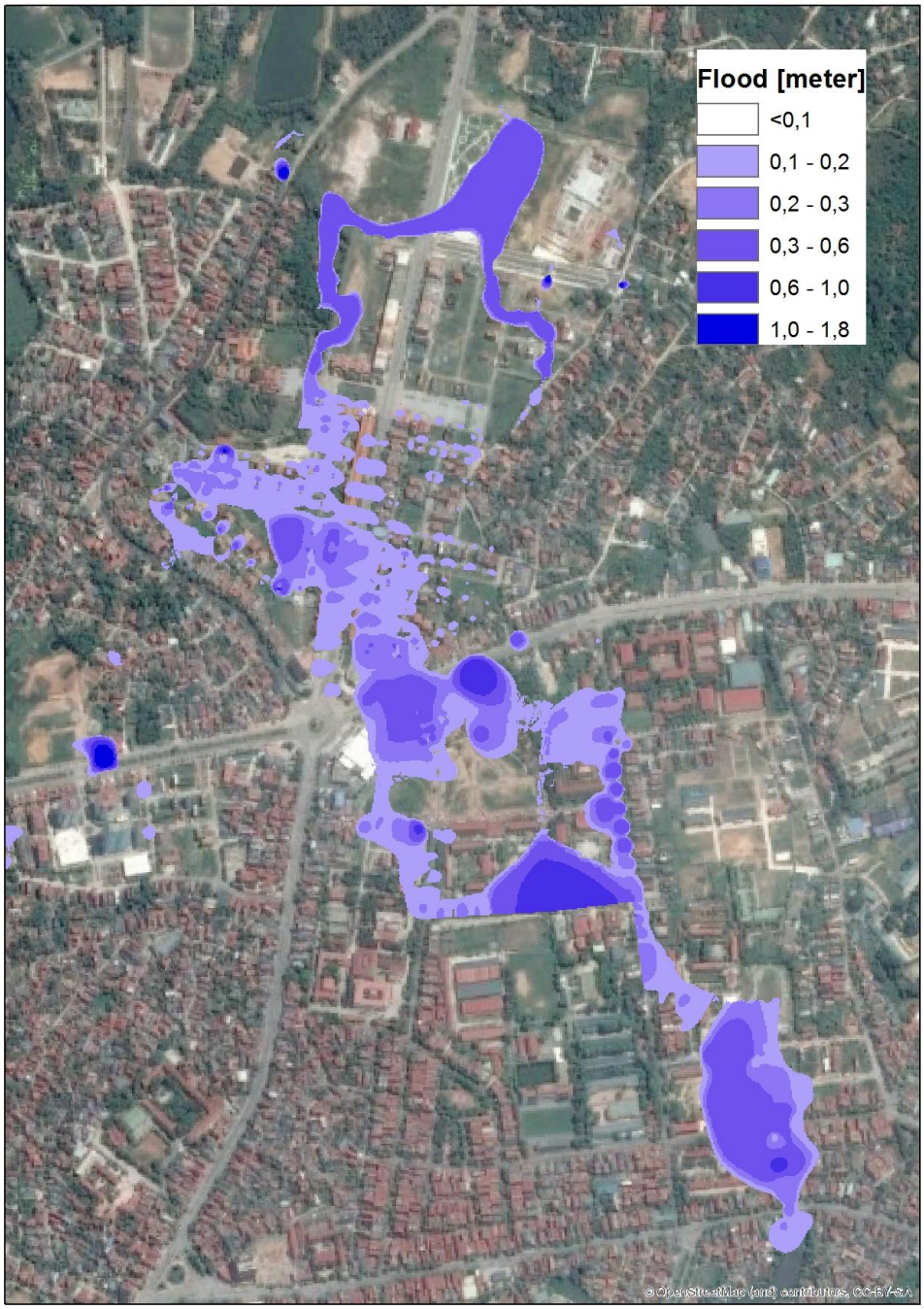


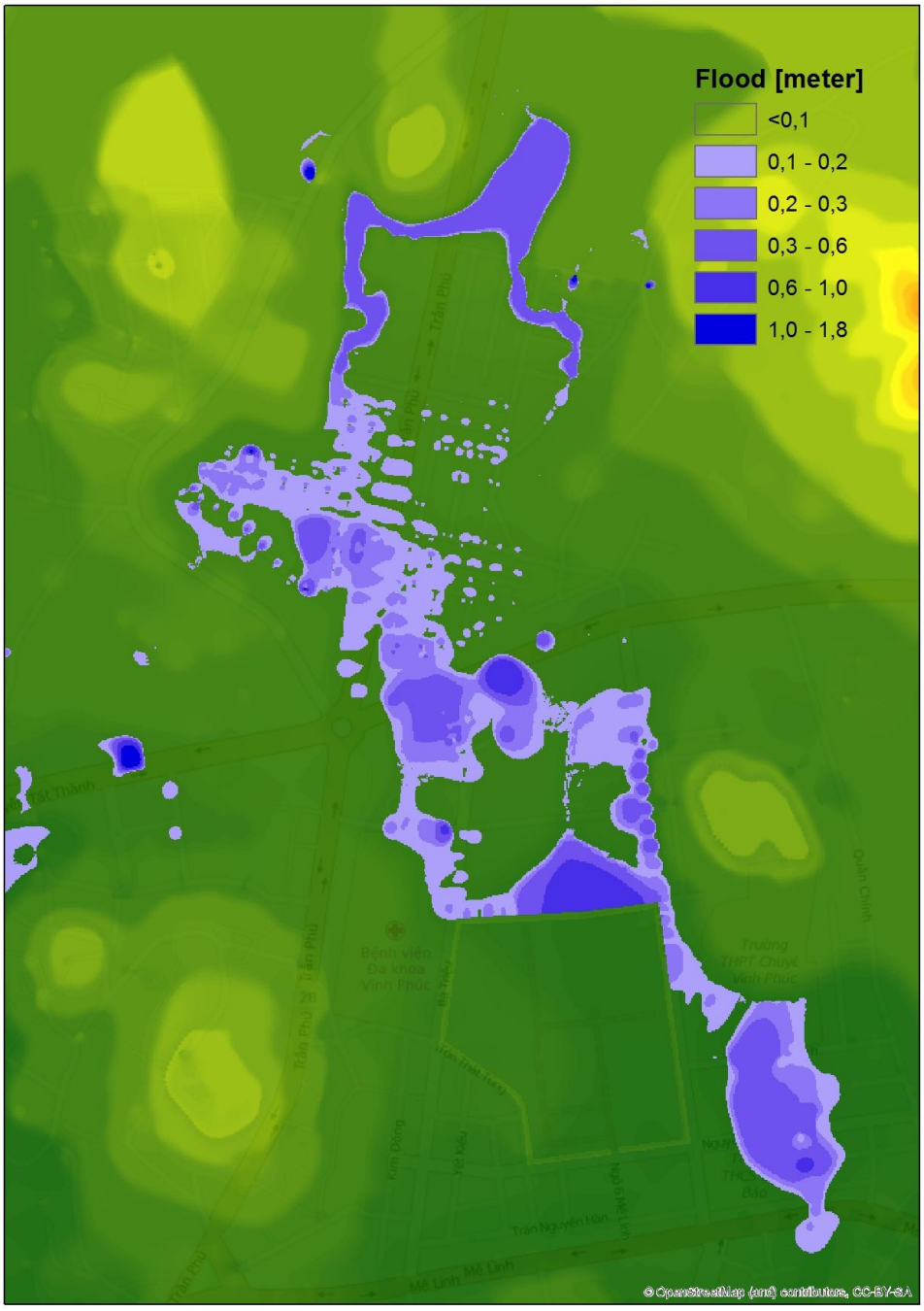
Appendix 1.3 Preliminary Digital Elevation Model (DEM) based on contour lines and manhole ground levels



Appendix 1.4 Terrain flooding with current drainage system




Flood [meter]
<0,1
0,1 - 0,2
0,2 - 0,3
0,3 - 0,6
0,6 - 1,0
1,0 - 1,8
© OpenStreetMap (and) contributors, CC-BY-SA


Flood [meter]
<0,1
0,1 - 0,2
0,2 - 0,3
0,3 - 0,6
0,6 - 1,0
1,0 - 1,8
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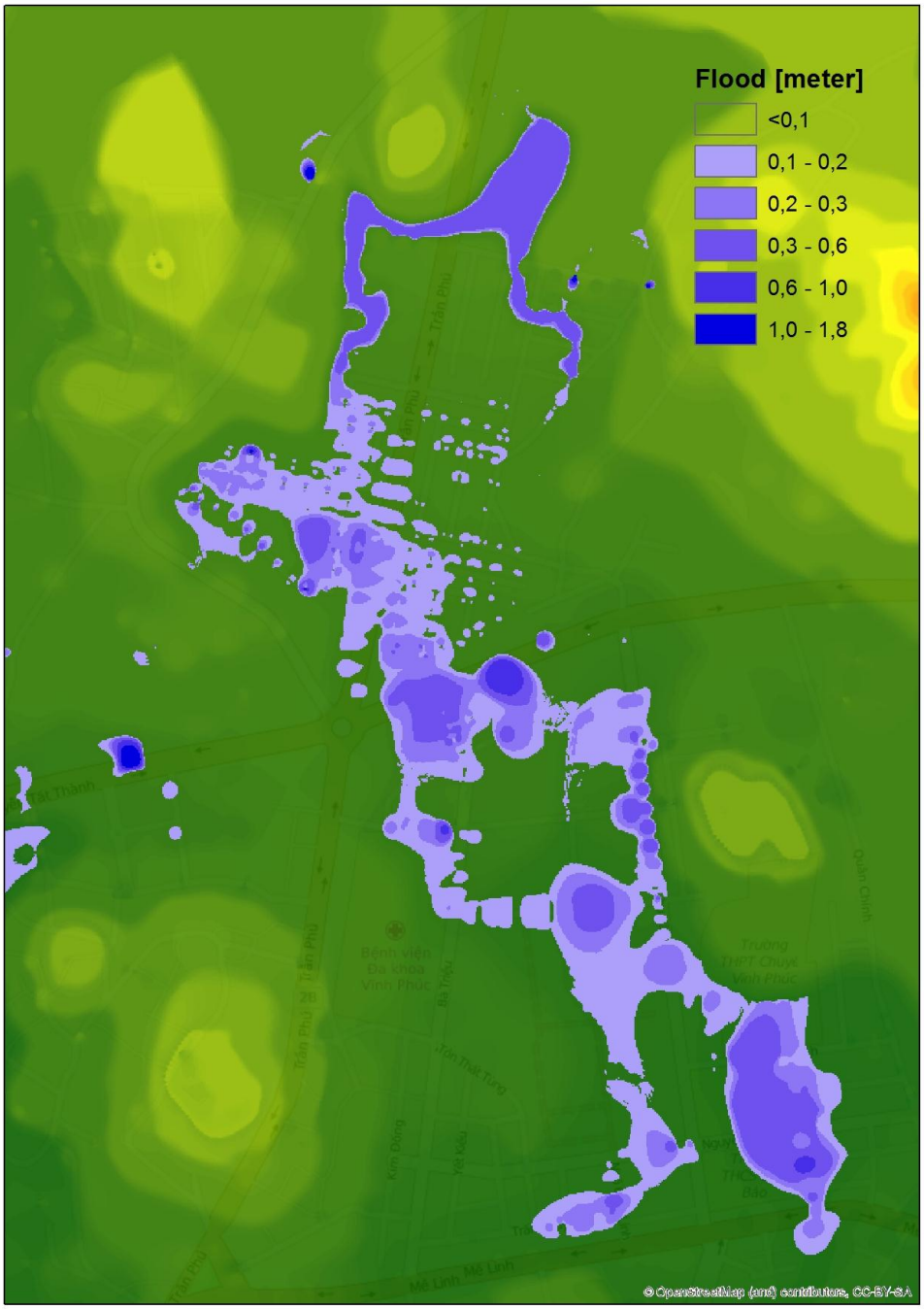
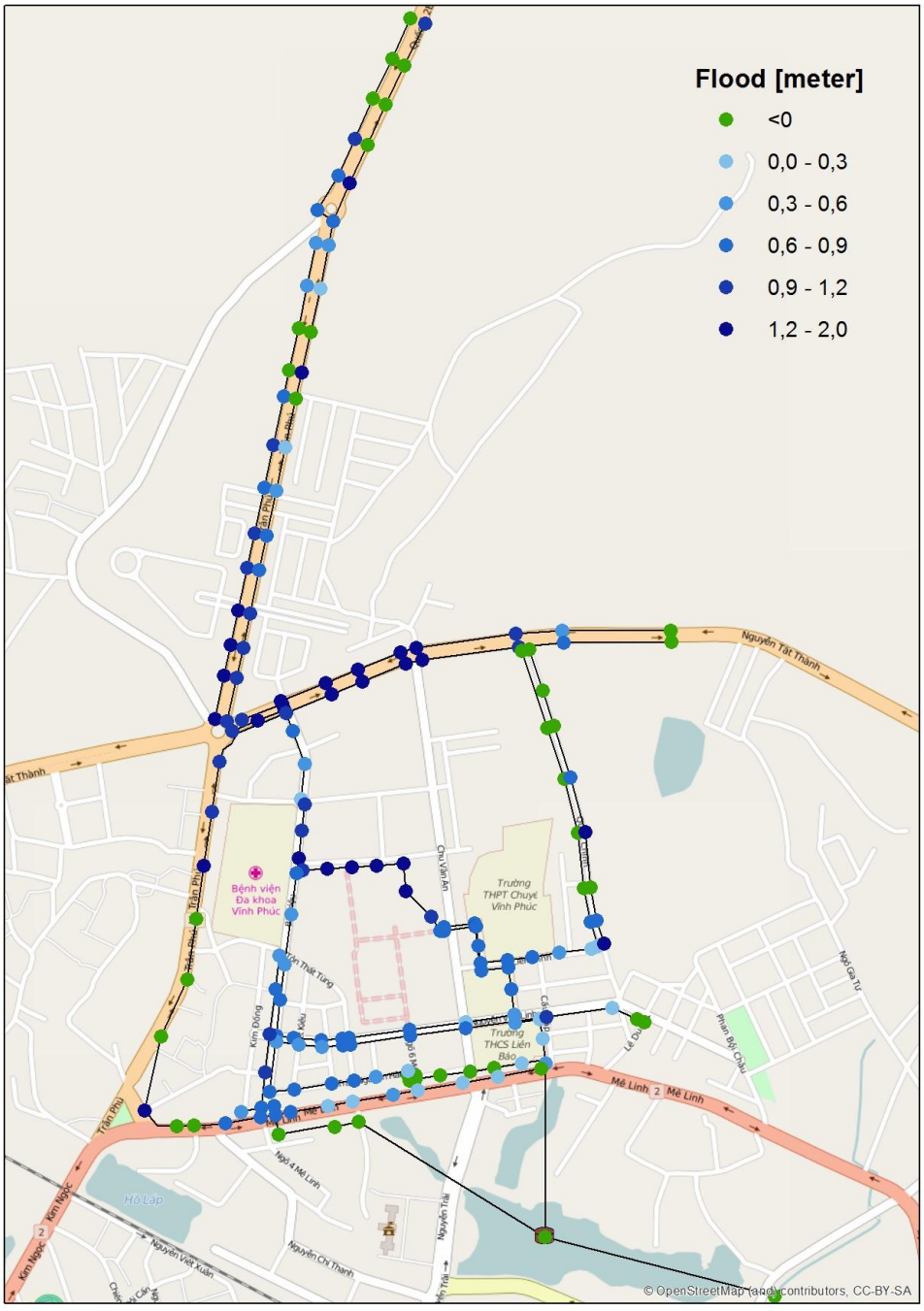
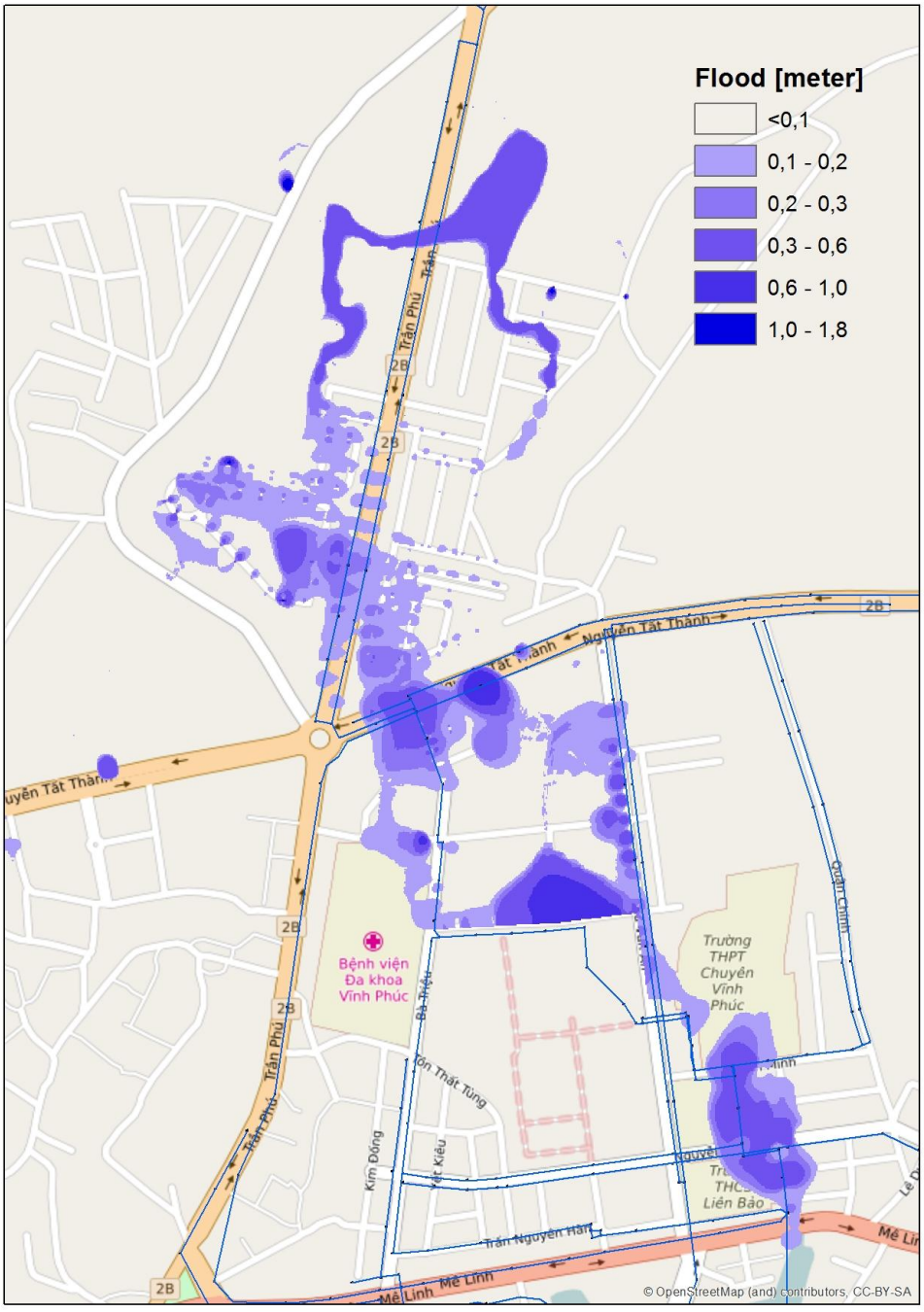
Appendix 1.5 Terrain flooding with current drainage system and without a wall around the Military Academy



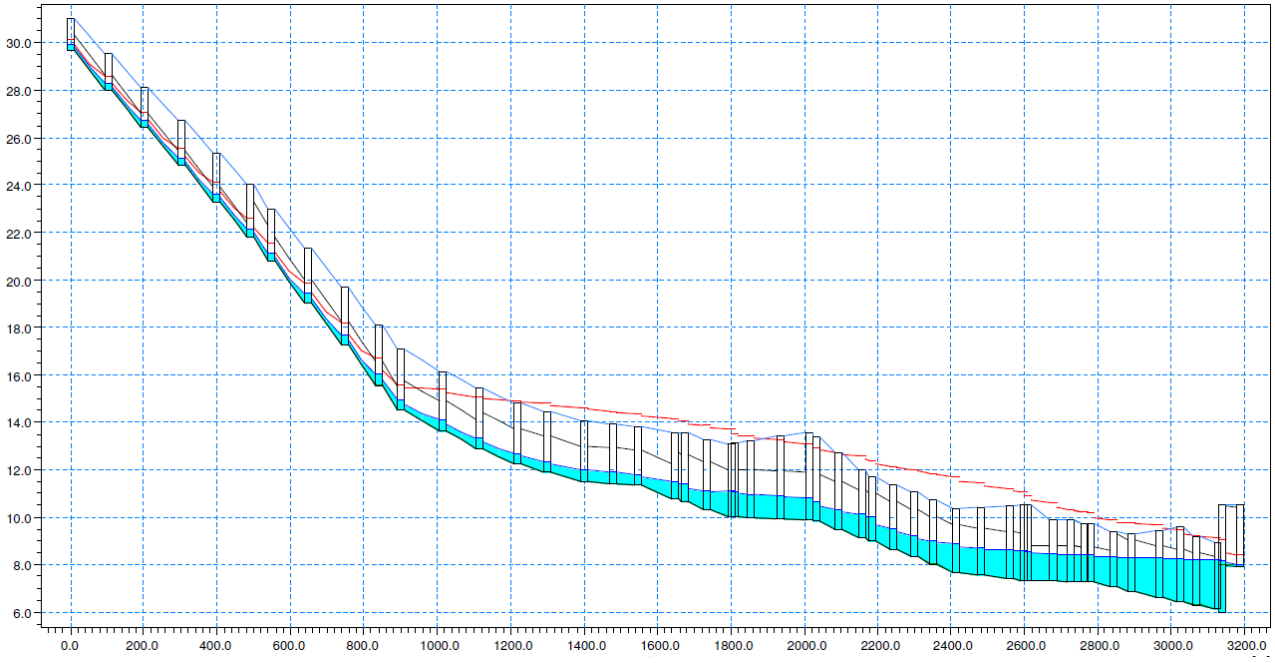
Appendix 1.6 Manhole flood with current drainage system



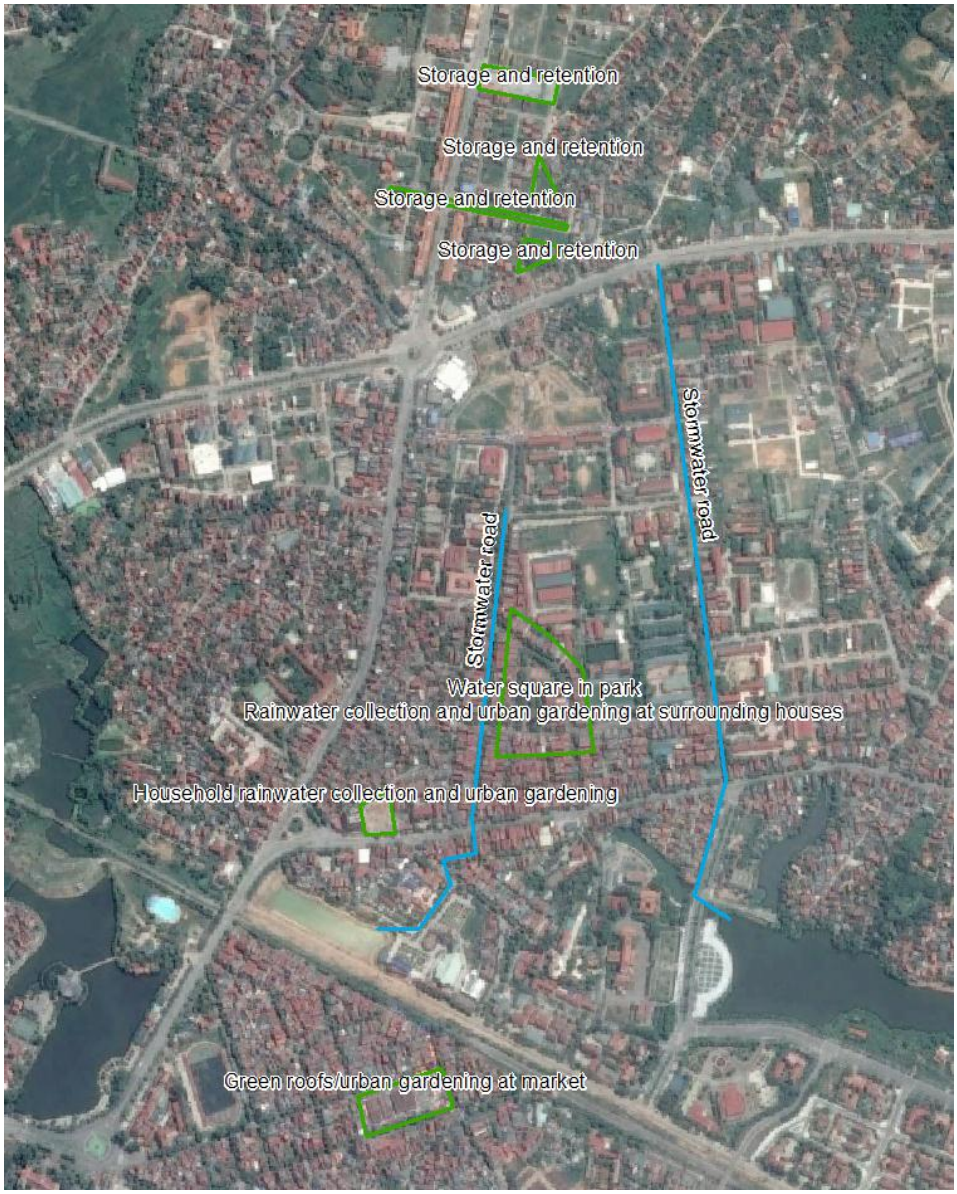
Appendix 1.7 Terrain flooding with proposed drainage system



Appendix 1.8 Water level in pipe stretch from most upstream point to outlet



Appendix 1.9 Ideas for possible sites for SUDS and urban gardening in Vĩnh Yên City



Appendix 1.10 List of Temporary Flood Spots In Vinh Yen City

List of Temporary Flood Spots in Vinh Yen City (heavy rains in the end of August 2016)

I. The temporary flood spots after the rain on August 10th 2016 (Rains lasted for 70mins)

1. Me Linh Road, in front of Vehicle Registration Center, deep average 0,4 meter
2. The intersection between Nguyen Van Linh road and Chu Van An road, deep average 0,25 meter
3. Kindergarten Oct 28th (Phung Ba Ky road), deep average 0,3 meter
4. The intersection between Chu Van An road, Tue Tinh road, deep average 0,4-0,5meter
5. The intersection between Ba Trieu road and Me Linh road, deep average 0,4-0,5meter
6. The intersection between Nguyen Tat Thanh road and Me Linh road, deep average 0,4meter
7. Nguyen Tat Thanh road (between Ba Trieu to Chu Van An road), deep average 0,5meter
8. Department of Education and Training, deep average 0,2meter
9. Ngo Gia Tu road (near Bridge number 2), deep average 0,5meter
10. Nguyen Thi Minh Khai road (Provincial road TL305 near Cong hop Bridge), deep average 0,3-0,4meter

II. The temporary flood spots after the rain on August 14th 2016

11. Me Linh Road (in front of Vehicle Registration Center), deep average 0,6 meter
12. The intersection between Nguyen Van Linh road and Chu Van An road, deep average 0,25 meter
13. Kindergarten Oct 28th (Phung Ba Ky road), deep average 0,4 meter
14. The intersection between Chu Van An road, Tue Tinh road, deep average 0,4-0,6meter
15. The intersection between Ba Trieu road and Me Linh road, deep average 0,4-0,6meter
16. The intersection between Nguyen Tat Thanh road and Me Linh road, deep average 0,4meter
17. Department of Education and Training, deep average 0,2meter
18. Zone near Cau Cap Bridge includes: Me Linh road 0,5m; Le Thanh 1,0m; Nguyen Thieu Tri 0,8m; ACB Bank 1,0-1,2m.
19. Residence zone near Vinh Phuc High School, deep average 0,2 meter

20. Ngo Gia Tu road (near Bridge number 2), deep average 0,5meter
21. Nguyen Thi Minh Khai road (Provincial road TL305 near Cong hop Bridge), deep average 0,3-0,4meter

Rainfall from 7 a.m 27th August 2016 to 7 a.m 29th August 2016 are as follows:

No.	Station	Rainfall from 7 a.m. 27th August 2016 to 7 a.m. 28th August 2016	Rainfall from 7 a.m. 28th August 2016 to 7 a.m. 29th August 2016	Total rainfall (mm)
1	Vinh Yen	8	157	**165**

Note: Heavy rain occurred almost 3 hours in the morning of 28th August (http://baovinhphuc.com.vn/goc-anh/33015/vinh-yen-ngap-nang-sau-con-mua.html)

Rainfall from 7 a.m 18th August 2016 to 7 a.m 22th August 2016 of measuring stations are as follows:

No.	Station	Rainfall from 7 a.m. 18th August 2016 to 7 a.m. 19th August 2016	Rainfall from 7 a.m. 19th August 2016 to 7 a.m. 20th August 2016	Rainfall from 7 a.m. 20th August 2016 to 7 a.m. 21st August 2016	Total rainfall (mm)
1	Vinh Yen	43	48	78	**169**

Appendix 1.11 Programme for workshop on SUDS, Flood models and possible solutions in Vĩnh Yên , held at NIRAS HQ, Allerod, 6. September 2016.

13.15 Short intro to workshop

13.25 Urban drainage systems and climate change solutions in CPH and Singapore, JCR

13.50 Short break

14.00 Vĩnh Yên project, objectives and activities JCR

14.10 Vĩnh Yên catchment properties and possible SUDS solutions, JSK

14.30 Vĩnh Yên flood simulation, preliminary results BN

14.50 Discussion on ways forward

15.15 The programme for the week

Participants:

Mr. Nguyen Viet Dung, Vice Director of IRURE

Assoc. Prof. Dr. Luu Duc Cuong, Deputy Director General, VIUP

Ms. Luu Linh Huong, Expert, Technology and Environment Department, MOC

Mr. Le Duc Dung, Vice Chairman of Vĩnh Yên city's People committee

Mr. Nguyen Ngoc Thu, Vice Head of Finance and planning Division, Vĩnh Yên

Ms. Vu Viet Ha, Vice-Head of Administration Division of IRURE

Ms. Dao Thi Thu Thuy, Chief accountant, IRURE

Mr. Jens Christian Riise, Market Director, Climate Change, NIRAS

Mr. Jens Saxtorph Kofod, Chief engineer, Water and Utilities, NIRAS

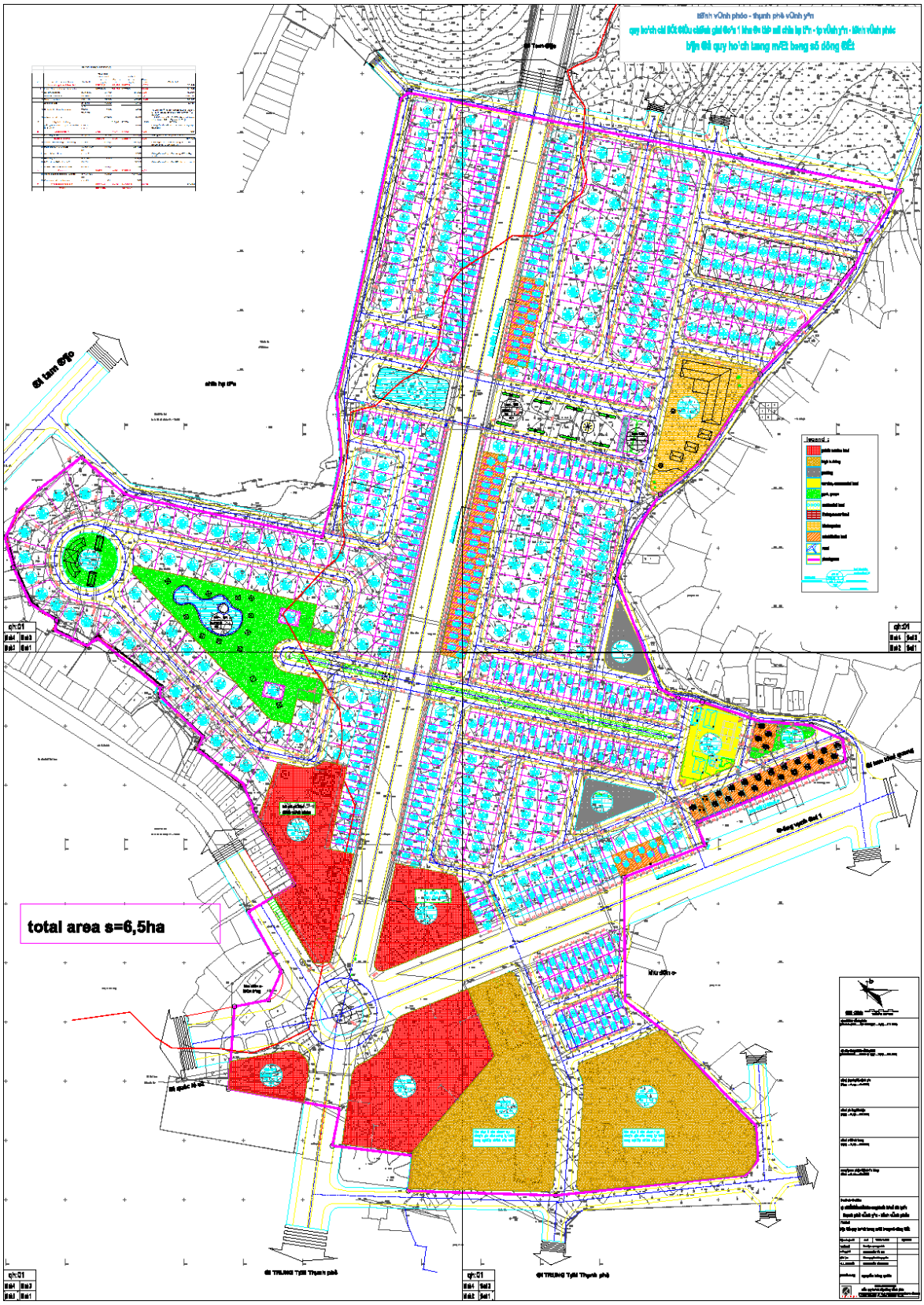
Mr. Bo Matthiesen, Civil Engineer, Water and Utilities, NIRAS

Appendix 1.12 Study trip on SUDS and Urban Gardening

DAY	#	TIME	ACTIVITY	Actions/responsible
Monday 05.09	1	12:00 15:00 -	Arrival Pick up at CPH airport – look for the sign with your names. Relax at hotel on your own	Pick up at airport JCR Transport to hotel by mini bus JCR Hotel Hillerød, Milnersvej 41, DK-3400 Hillerød (see map) Tel: +45 48 24 08 00 – Fax: +45 48 24 08 74 www.hotelhillerod.dk – hotel@hotelhillerod.dk
Tuesday 06.09	2	09:00 – 12:00	"Tagtomat"– Urban farming projects in CPH Visits to private urban garden projects in North-Western part of Copenhagen	Pick-up at hotel 8 am *Mr. Mads Boserup Lauritsen, Founder of Tagtomat,* Husumgade 2, st. tv
	3		Lunch at NIRAS HQ, Sortemosevej 19, 3450 Allerød, www.niras.dk	CHN
	4	13.30-16:00	Workshop on SUDS at NIRAS HQ	*Jens Christian Riise, NIRAS* Mr. Bo Matthiesen, hydraulic expert
	5		Evening free – relax at hotel	
Wednesday 07.09	2	10:00-11:30	Lindevangsparken, Frederiksberg, Urban park – SUDS and Cloudburst management. Morten Pedersen and Mrs. *Emeli Møller, NDF will join us.*	Pick-up at hotel, JSK, 9 am *Director of Water, Mr. Henrik Bay, Frederiksberg utility* Meeting point: Sløjfen, Peter Bangsvej
		11:30-12:00	*Lunch at local spot – Sløjfen*	*CHN*
	3	12:00-13:15	The open channels of Albertslund – Climate change and urban water for recreation and gardening	*Jens S. Kofod, NIRAS*
		13:15-14:00	*Transport*	

	4	14:00-16:00	The Rainwater trip – following different SUDS in a peri-urban context, Brøndby municipality	*Jens Christian Riise, NIRAS*
		18-21	*NCF5 Dinner with Emeli Møller, NDF*	Dinner hosted by NIRAS Transport to hotel, JSK
Thurs-day 08.09	5	09:00-10:00	ØsterGro Urban Farming Project	Mr. Kristian Skaarup, co-founder of Østergro urban farming project
	6	10:30-11:30	Israels Plads – visit to Urban water square – Central Copenhagen	*Jens S. Kofod, NIRAS*
		12:00-13:00	*Lunch at NIRAS HQ in Allerød*	
	7	13:00-14.00	Rain water separation facility, Kokkedal.	*Mr. Claus B. Sørensen, Project manager Fredens-borg Utility and Jens S. Kofod, NIRAS*
		14:00-16:00	Tourist tour *We will visit the castles of Fredensborg and Kronborg (the place of Shakespeare), drive through the valley with old fishermen towns, Strandvejen.*	*Jens S. Kofod, NIRAS*
		17:30-20:30	*Dinner at home of Jens S. Kofod, NIRAS*	Transport to hotel, JCR
Friday 09.09	8	09:00-10:00	Tåsingeplads- Visit to urban water square – combing climate change adaptation and recre-ational facilities	*Jens S. Kofod, NIRAS*
	9	10:30-12:00	Workshop at Copenhagen Municipality Climate change solutions and cloudburst plan in CPH municipality	*Mr. Jan Rasmussen, Head of Section, Climate Adaptation Copenhagen Municipality, Njalsgade 13*
		12:00-14:00	*Islands Brygge - lunch and final reflexion*	*JCR, JSK* *Transport to hotel or on your own*

App. 1.13 Detailed plan from 2010 for Ha Tien New urban area



App. 1.14 Land use