REPORT ON PILOT AREAS AND ACQUIRED DATA

Output 2.1 of Interreg Baltic Sea Region project NOAH

Protecting Baltic Sea from untreated wastewater spillages during flood events in urban areas

Contents

Introduction

NOAH project's Work package 2: Better planning and risk mitigation focuses on decreasing discharges of nutrients and hazardous substances from urban stormwater runoff to the Baltic Sea by enhancing capacity of public and private actors dealing with land use and spatial planning. For that, passive (non-structural) methods to improve urban planning will be implemented. Runoff volume is directly related to the quantity of pollutants rainwater is rinsing from the ground surface during rainfall event and flushing to the receiving waters, including combined sewer system. Therefore, this WP demonstrates how holistic spatial planning can reduce the runoff and thus reduce the discharges of substances to the BS.

For that, impact of different climate scenarios with surrounding water bodies will be modelled in conjunction with different land use patterns to minimize the urban runoff from the ground surface. Data collection from the WP2 pilot areas in 6 towns (A2.1) is the underlying task for modelling.

Pilot areas in WP2 (Rakvere, Haapsalu, Ogre, Liepaja, Pori, Söderhamn) were carefully chosen to fulfil the following conditions:

1) Situated next to the natural water body (channel, river, sea) connected directly to BS and therefore extra flowrates captured into to UDS will pose direct risk of wastewater spillages during extreme weather events;

2) Having existing urban drainage system built;

3) Having potential for further planning activities, for example - new house blocks, parking lots.

The following activities with above mentioned partners are grouped under A2.1:

1) Specification and adjustment of preliminary chosen pilot areas in 6 partner towns. This has been achieved through site visits and analysis with local municipalities and water utilities (where relevant). All target municipalities were involved and detailed plan of actions was agreed on the first workshop in city of Pori, held 20.03 - 21.03.2019.

2) Data collection from pilot areas with the involvement of 6 municipalities and relevant water companies to provide the following data:

a) land use data from existing general development plans;
b) all other planned developments in pilot areas (new house blocks, parking lots etc.);
c) ground elevation data and information about water level seasonal changes in surrounding water bodies.
d) planning policy and regulations for land use planning and urban run-off management
e) existing development plans

3) Identification of data deficiencies and missing data. Academies have performed data analysis. Minor measurements, including geodetic land survey and water level measurements, were conducted where necessary for filling important data gaps. Measurements were mostly obtained through external expertise.

4) Aggregating all necessary data for the next activity (A2.2). Academies are aggregating all the data and municipalities are performing last check to determine all necessary information about the pilot areas is present.

Herein is the output of activity 2.1: Report on pilot areas and acquired data (O2.1) that compiles information on undertaken actions, faced deficiencies and solutions.

1 Haapsalu

1.1 Description of the Haapsalu pilot area

Haapsalu is a town on West Estonia's Baltic coast, with of 13,000 inhabitants. The town is located on a southeastern-northwestern oasis, typical of the north-west coast of Estonia. The town's coastline length is 18 km and the area is 10.6 km^2. 67% of the town area is covered greenery (parks, recreational areas etc.). Due to the coastline length and ground elevation, the city is open to seawater flooding. Old drainage systems, bottlenecks in pipelines and overall incomplete information on the town's drainage system are contributing to rainwater flooding.

Figure 1-1 City map of Haapsalu with the (seawater) floodable area indicated (on the left) and the two pilot areas of Haapsalu (on the right)

Haapsalu's drinking and wastewater system, that includes 21 wells and a WWTP using mechanical, chemical and biological treatment technology, is managed by Haapsalu Waterworks (*Haapsalu Veevärk AS*).

Haapsalu City Government manages the rainwater system. Sewage and stormwater systems are separate.

The pilot area is divided into two areas located on the south part of Haapsalu (see in Fig.1-1), corresponding to actual stormwater system catchment areas.

Area 1. Activities include mapping rainwater systems and taking water samples from stormwater outflows. Rainwater outflow is a wetland that is a buffer before reaching the sea. The wetland is surrounded by a dam designed to protect seawater inflows into stormwater systems. The dam has 2 locks that are in very poor condition and release seawater to the wetland, which places a burden on stormwater systems.

Area 2. Activities include mapping the stormwater system.

1.1.1 Description of the changes and adjustments made in the pilot area

The pilot area was divided into two sub-areas corresponding to actual stormwater system catchments.

1.2 Data collection procedure

Existing information on the stormwater system was collected from the data of Haapsalu City Government and Haapsalu Water Company. A master plan and sewer pipeline information of the

pilot area were compiled. It was found that information about the stormwater system was inadequate and thus a procurement for geodetic survey was prepared.
The initial deadline of the geodetic survey (31.05.2019) was extended due to bigger than expected workload needed for mapping the system.
Additionally the Haapsalu City Government carried out a procurement for water quality analysis.

1.2.1 Acquired data

Haapsalu Waterworks shared its data on the separate sewerage system.
Ground elevation data was requested from the Estonian Land Board, which has LiDAR aerial scanning data. Precision of the height data is ±7 cm and the density of data points is 2.1 points per m^2 on average.
National Land Board also provided orthophotos obtained via aerial photography and information on permeable and impermeable areas and land use in general.
The Haapsalu City Government archive of the old pipelines of stormwater system were worked through. Data gaps were found and these were filled with geodetic survey.

1.2.2 Identification of missing data

The biggest data gaps were in the stormwater system. The layout of all the stormwater pipeline system with manholes and stormwater gullies was not known. Many stormwater manholes have been rebuilt in the past without documentation and the height of the manhole hatches has changed due to road construction or soil filling. Additionally, the available data is outdated, mainly due to changes in the elevation system (switch from Baltic Height System to European Vertical Reference System in 2018).

1.2.3 Action taken to fill data gaps

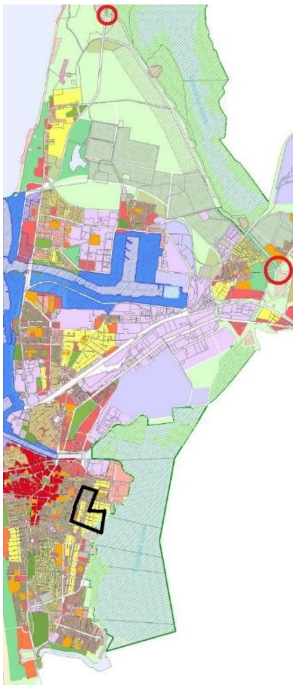
1. Conducting a geodetic survey. The aim of the procurement was to find and measure all the rainwater related objects in both pilot areas in Haapsalu. Data included manholes, routes, culverts, ditches, locks, outflows, etc. The invitation to tender was launched on 05.03.2019 and the contract was signed on 01.04.2019. Some of the works have been handed over and the survey work is ongoing.
2. Conducting water quality analyses. Water quality analyses have never been taken from the rainwater systems in the city of Haapsalu. TalTech prepared the technical specification for the procurement and Haapsalu City Government started the procurement procedure.
3. Conducting geodetic survey of the sluice in area 1 in preparation for the pilot investment

1.2.4 Data preparation and validation for the next activity

Next activities include:
1. Storm water samples to be taken and compared.
2. Procurement procedure for the samples to be finished in October, November 2019.
3. Validate the data from the geodetic survey and add the data into the model.
4. Development of the catchment area surface model.
5. Import of rainfall data into the model (individual seasonal scenarios).
6. Analysing the model for the next action plan.

2 Liepaja

2.1 Description of the Liepaja pilot area



City of Liepāja is in Western part of Latvia, between Baltic Sea and Lake of Liepāja. LMA “Komunala parvalde" defined to run NOAH project activities in several locations. Tebras Street catchment basin with separate storm sewer was chosen for detailed inventory. This pilot area is in the Eastern part of Liepāja (Figure 2-1).

The stormwater sewer (concrete pipe with diameter 500 mm) outlet of Tebras street catchment basin discharging water into Lake of Liepāja in the Natura 2000 protection area[1]. In the NOAH project, hydraulic model of Tebras street catchment basin will be developed to clarify: (a) how the sewer functions under different circumstances, i.a. the sewer operating like a tidal outfall (the outlet is submerged due to water level changes in Lake Liepāja and therefore for some period is not functioning); (b) Is it possible to add more new connections to this catchment basin in the future; (c) Understand the quality of water drained from the catchment basin. (d) Theoretically examine the possibility to use project partner experience from Haapsalu (Estonia) in application of smart weir wall system or usage of tidal check valve, which would allow stormwater flow only in one direction.

Figure 2-1 Functional zoning of Liepaja city 2
(In red – sensor locations on channel, in black – Tebras street catchment)

The area of catchment basin is approximately 19 ha. Low-rise residential buildings (in yellow color in Figure 2-2) mostly occupy the area.

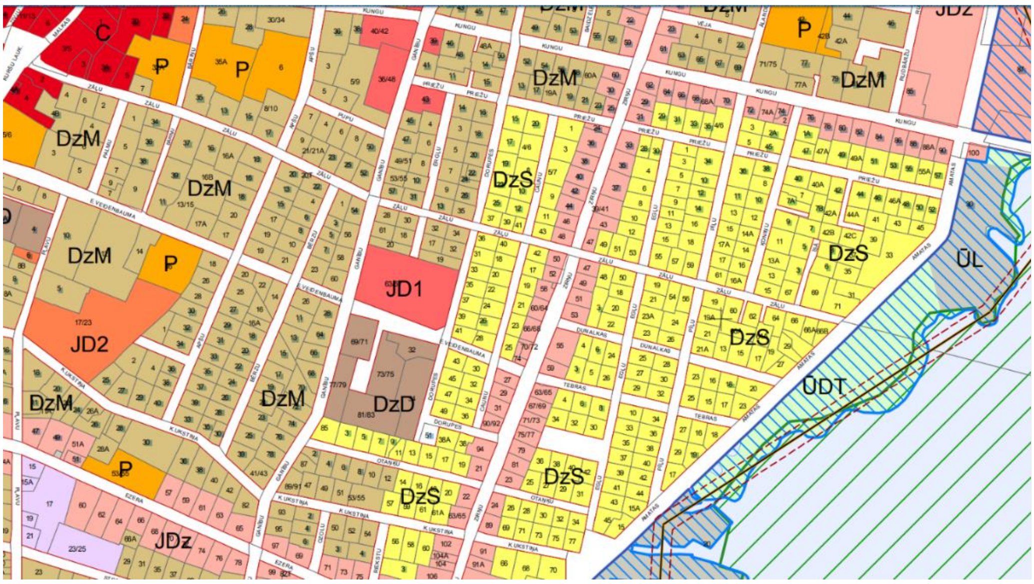


Figure 2-2 Functional zoning of Tebras street catchment basin.

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[1] https://ec.europa.eu/environment/nature/natura2000/index_en.htm
[2] https://faili.liepaja.lv/teritorijas_planota_atlauta_izmantosana.pdf

Impervious surfaces are split as follows – roofs are 42% of total area and paved roads are 8% of total area.
It is being discussed in the city that in the future (without fixed term) there can be changes in area application regarding only the lakefront, which can be developed more usable for social activities. LMA “Komunala parvalde" is interested to perform stormwater sewer inventory for other territories important from city’s development perspective (Figure 2-3).

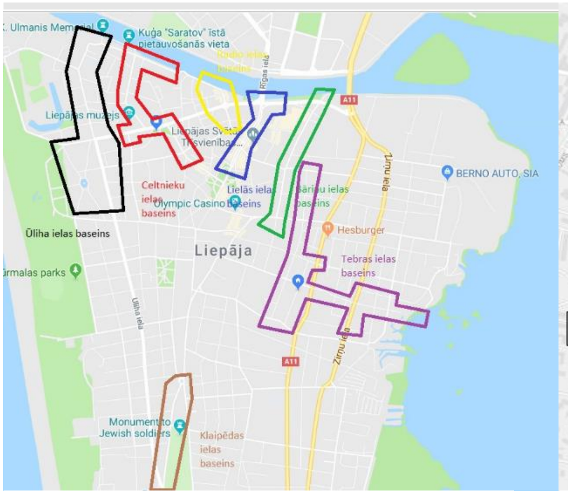

Figure 2-3 Other interested areas to be investigated.

Figure 2-4 Ground elevations in Tebras street catchment area and stormwater pipe layout

The other pilot activities planned by LMA “Komunala parvalde" will be performed in northern part of Liepaja city nearby Tosmare lake. This part of the city is enclosed by Cietokšņa channel/creek. There is a plan to install two water level sensors in Cietokšņa channel near Grīzupe street culvert and near Lībiešu street culvert (red dots in Figure 2-1). These territories around Cietokšņa channel are potential flood areas and sensors will indicated the water level rising in channel. Thus, they will be used to prevent flooding in areas Jaunā Liepāja, Aroniju, Slimnīcas street and others.
The main problem is that if the Cietokšņa canal outlet into the Baltic Sea is clogged, the adjacent areas are flooded.

2.1.1 Ground elevation data and information about water level seasonal changes in surrounding water bodies.

Ground elevation data for Tebras street catchment pilot territory was not clearly defined (Figure 2-4).
The water level in Lake Liepāja is almost the same as in the Baltic Sea in general. There are available data from LEGMC level hydrological monitoring stations (Figure 5 and 6).

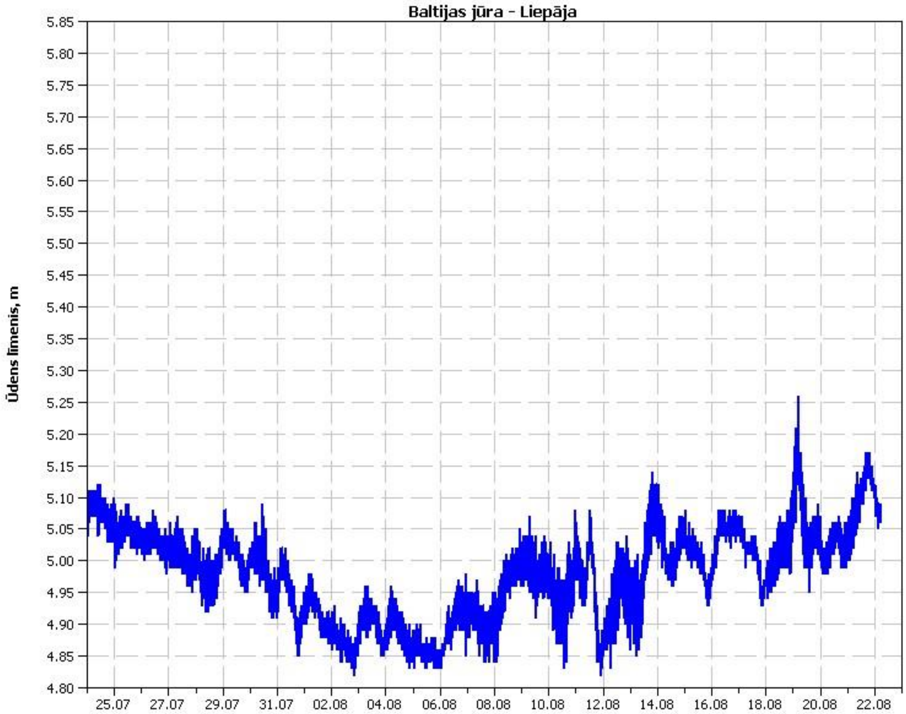

Figure 2-5 The water level in the Baltic Sea near Liepāja city

Figure 2-6 The water level in Lake Liepāja

2.1.2 Planning policy and regulations for land use planning and urban run-off management

There are no changes planned for this territory in near future. Tebras street basin pilot area territory survey is needed for the whole city development to better understand existing rainwater drainage and find out what else can connect to this existing basin.

2.1.3 Existing development plans

Existing development plan for Liepāja city can be found here - https://faili.liepaja.lv/teritorijas_planota_atlauta_izmantosana.pdf

2.2 Data collection procedure

Figure 2-7 Available GIS data before storm drain sewage system catchment area inventory

All data was collected according to the task by setting survey boundaries for pilot area. Main sources for data were existing Liepaja City Construction Board GIS information and surveys and inspections in nature by contracted survey company.

When data acquisition started the only source available was a primitive picture based navigation tool which showed limited data about the storm drain sewage system (Figure 2-7).

2.2.1 Acquired data

- Data about land use and soil types
- Ground elevation data, seasonal changes of water level in surrounding water bodies
- Existing development plans in the pilot area
- Outflows (coordinates, type e.g. free, submerged)
- Weirs (coordinates, type, height, measures)

2.2.2 Identification of missing data

RTU identified that data about manholes, gullies and conduits was insufficient for model build-up. Liepāja City Construction Board provided data available in the form of a CAD, which was dated and did not match the situation in the field in most places. Some information was found to be missing and some unidentifiable, because topographical data was compiled a long time ago. Specific data for creating the planned GIS was missing.

There was difficulty interpreting CAD drawings of existing stormwater drainage system. In some places, new data had been drawn over old data, while old networks that are no longer functional were still present. The contracted survey company inspected these places further after the Tebras street catchment basin storm drainage system was inventoried to make sure all data is correct.

2.2.3 *Action taken to fill data gaps*

RTU prepared a template for inventory of missing data in Tebras street catchment basin pilot area so it was possible to export the data directly in to GIS format.

A land and territory surveying company (SIA "Metrum") was hired to collect all missing data in accordance with Liepaja City Construction Board and responsible municipal authorities.

After inventory of the area, RTU received GIS data of the whole system as an Esri Shapefile (Figure 2-8).

Attributes	Geometry
Level	0
Layer	
RefName	
veids	lietus kanalizācijas sūknis
Inv_nr	
Nr	106
apaksa	-2.64
augsa	1.64
relj_atz	1.63
ieks_diam	
materials	plastmasa
caurules	5,206
pieserej	
foto	
aps_datums	
izb_gads	
izmant_nol	
piezimes	
Baseins	Tebras iela

Figure 2-8 Example of filled attribute table of manhole data after inventory

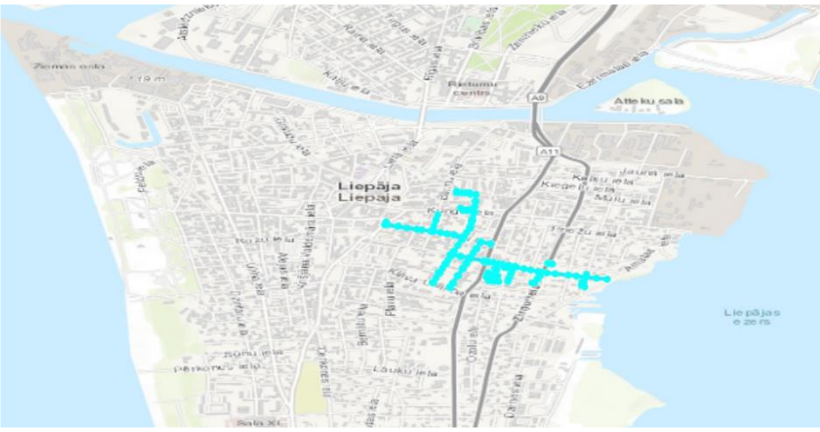

Figure 2-9 Stormwater pipe layout in Tebras street catchment area after inventory

2.2.4 *Data preparation and validation for the next activity*

All data was collected according to project guidelines.

All final results available in this link prepared by RTU and provided to LMA "Komunala parvalde": http://lscm.lv/LIEPAJA_TEBRA.html

GIS data will be acquired for all other catchment basins defined in Figure 2-3 by the end of autumn 2019.

RTU will provide further activities, including hydraulic model for pilot area – Tebras street basin.

Regarding water level measurement in Cietokšņa channel LMA "Komunala parvalde has prepared procurement procedure for level sensor purchase in autumn 2019.

3 Ogre

3.1 Description of the Ogre pilot area

Ogre town is located 36 km from Riga on the right bank of the Daugava River near Ogre mouth of the Daugava. The total area of the town is 13.6 km² with a total population of 25,380.

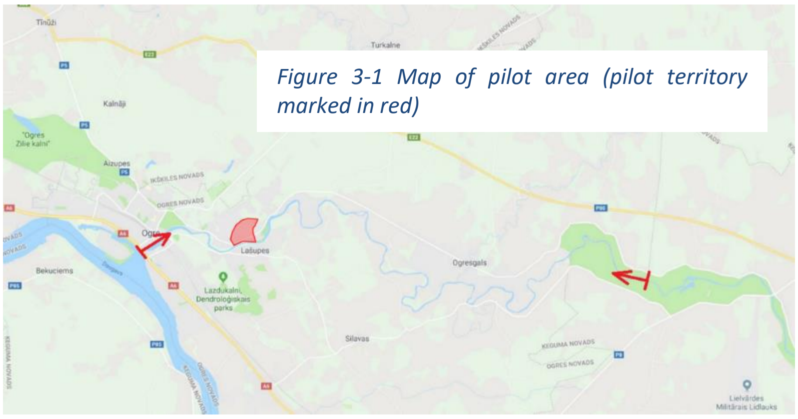

Figure 3-1 Map of pilot area (pilot territory marked in red)

The pilot area (Figure 3-1) is alongside Ogre river in Ogre town and Ogresgals parish. This area has been selected as it has a major flood problem and it is strongly affected by a climate change. Accordingly, the municipality needs to understand the flood risks better and to adapt to climate change.

Project activities:

* Measurements of the Ogre riverbed upwards from Daugava river water reservoir (including measurement data processing and cartographic material preparation);
* Identification and evaluation of sensory locations, the technical design of automatic hydrological stations;
* Installation/construction of at least 2 automatic hydrological stations (AHS) in Ogre municipality.

The following types of land use are defined in the territory of Ogre municipality (Land use data taken from existing general development plans):

1. Residential housing building area:
   1.1. High-density private housing building area;
   1.2. A limited-territory private housing building area;
   1.3. Garden housing building area;
   1.4. Apartment housing building area;
2. Public building area;
3. Town centre building area;
4. Manufacturing building area;
5. The traffic infrastructure area;
6. Technical or public utilities building area;
7. Green area:
   7.1. Parks;
   7.2. Forests;
8. Agricultural area;
9. Water area.

All other planned developments in pilot area: *recreational areas.*

3.1.1 Ground elevation data and information about water level seasonal changes in surrounding water bodies:

According to the legislation of the Republic of Latvia, engineering topographic survey is carried out before the start of the construction project. The municipality does not carry out regular measurements of the surface of the land.
According to LEGMC, there are two existing water level measuring stations: one in Ogre and other in Lielpeci. From 2016, there have been measurements in Ogre HPP reservoir at Ogre municipality territory, but since August 2018 water level measuring station is working in Palienes Street 4,

Ogresgals. States energy company “Latvenergo” has acquired water level data for Daugava water reservoir. Therefore, water level can be monitored and controlled, especially during flood period, when it needs to be lowered.

3.1.2 Planning policy and regulations for land use planning and urban run-off management:

Land use planning and urban run-off management are in accordance with the spatial plan and all the laws in the Republic of Latvia, which determine the spatial planning documents. The Ogre municipality issues technical regulations for construction intentions that support sustainable urbane drainage solutions, encouraging for the implementation of sustainable water management practices. Ogre municipality staff review and evaluate project solutions in collaboration with the town’s communications holders.

3.1.3 Existing development plans

Ogre municipality has two major development plans:
- Sustainable Development Strategy of Ogre municipality 2013 – 2037 (long-term development plan) is a long-term territorial development-planning document, which defines the long-term development vision, goals, priorities and spatial development perspective of Ogre municipality. This strategy is the highest hierarchical planning document for municipal development.
- Ogre municipality Development Program 2014-2020. Program is a medium-term planning document, which is a set for implementation of the long-term priorities of the municipality from 2014 to 2020. This document ensures a balanced long-term development of the Ogre area and serves as a basis for attraction of investments in the private and public sectors.

3.1.4 About pilot project area in Loka street neighbourhood:

The Loka Street neighbourhood has developed from a low swampy meadow. The surface water runoff has been organized with a network of open ditches along the streets, draining into the Ogre River. Due to intensive detached housing construction, the traffic volume has increased, and part of the ditches have been arbitrarily filled or the culvert elevation marks after construction have not been aligned with each other. That has led to a loss of functionality of the existing drainage network.

In order to control the surface runoff, the municipality must provide rainwater drainage from the street and adjacent areas by creating a single network. Therefore, municipality has already started the gradual construction of a rain drainage piping system. A main rainwater collecting manifold is intended to be built with a possibility for house owners to connect their own local rainwater collection pipeline system without the need to rebuild the newly created road covers.

3.2 Data collection procedure

Main data collected:
- Pre-project documentation on the cleaning of the Ogre estuary in the Riga HPP Reservoir (State Ltd. “Meliorprojekts”, 2012);
- Conclusions on Ogre River Dam and Deposits at the River Ogre estuary in the Daugava (State Ltd. “Meliorprojekts”, 2014);

- Hydrological and hydraulic calculations, hydrological mathematical model development for the reconstruction of the old dam (Brīvības Street 60 - 80, Ogre) and construction of a new dam at the mouth of the Ogre River in the Daugava (Ltd. "Nāra", 2016);
- Water levels (Figures 3-2 and 3-3) – according to LEGMC two existing measuring stations in Ogre and Lielpeci;
- Measurements in Ogre HPP reservoir (from 2016) and Palienes Street 4, Ogresgals (from 2018).

Figure 3-2 A view from the web-camera (Yellow dot in Figure 2).(http://www.ogresnovads.lv/lat/vide/udens_limenis_ogres_hes/) →

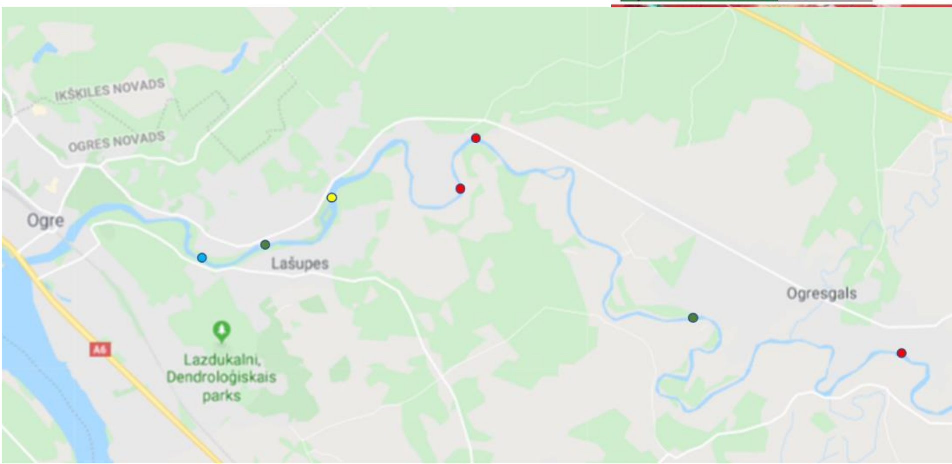

Figure 3-3 Water level monitoring. Green – existing LEGMC level monitoring stations (the one at right calculates flow); Blue – level monitoring at pumping station; Yellow – level monitoring from web-camera (Figure 3); Red – other level monitoring stations. The one most to the right is still to be constructed within NOAH project. ←

3.2.1 Satellite data

Satellite data over Ogre pilot territory was used from Sentinel-1 and Sentinel-2 polar-orbiting missions which are part of European Union's Earth observation Copernicus program. Data were collected from Copernicus Scientific data HUB.

Sentinel-1 SAR Interferometric Wide swath (IW) ground range detected high-resolution data were collected over the Ogre pilot area, with a spatial resolution of 10 m, available from five different relative orbits. Satellite overpass from these orbits is 2 to 5 days.

Sentinel-2 high-resolution optical data with the same spatial resolution of 10 m were collected from 3 different relative orbits. However, due to frequent cloud cover during autumn, winter and spring months, data are used mainly for reference purposes. Satellite overpass from these orbits is 2 to 3 days.

3.2.2 Acquired data

- Data about land use and soil types;
- New planned developments in the pilot area;
- Ground elevation data, seasonal changes of water level in surrounding water bodies;
- Existing development plans in the pilot area;
- The layout of the CSO-s and WWTPBP-s;
- Existing water quality data from CSO-s and WWTPBP-s;
- Policy and regulation for urban run-off management and UDS operation (including regulation for CSO activation);
- Description of the existing SCADA system;
- Outflows (coordinates, type e.g. free, submerged);
- Weirs (coordinates, type, height, measures);
- Flow division in the system.

3.2.3 Identification of missing data

The main issues Ogre municipality identified:

- Fragmented databases;
- No information on drainage network and rainwater collection network in Ogre town (much rebuilt, no information passed to construction board);
- Currently large human resources are being involved in river water level monitoring during flood event;

A lot of human resource is needed to conduct the announcement and initiation of evacuation.

3.2.4 Action taken to fill data gaps

- There have been ice, water and surface inspections using FLIR on airborne platforms for all Ogre river area in Ogre city and Ogresgals parish. The extraction of digital data from the Ogre river and coastal areas is necessary to prepare a 3D model from aerial surveys.
- Ogre river bed profiling in low water period completed by the 15th of September 2019. In order to be able to evaluate the Ogre River bed, its peculiarities, as well as ice movement in the Ogre River, it is necessary to carry out the Ogre River Bed Survey during the low water period, thus achieving accurate riverbed cross-sectional data.

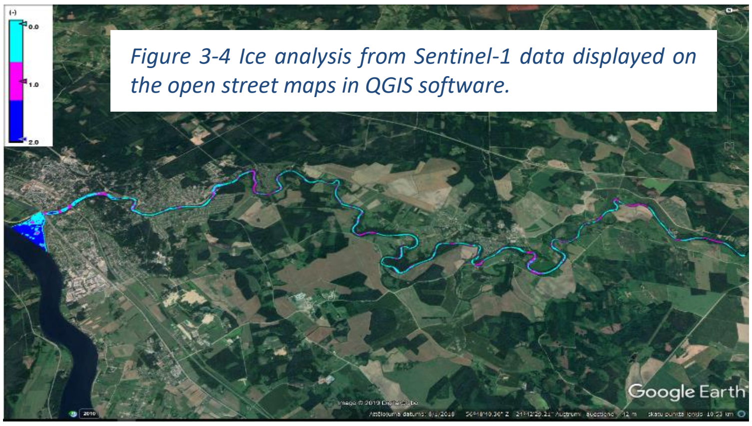

Figure 3-4 Ice analysis from Sentinel-1 data displayed on the open street maps in QGIS software.

During winter and spring seasons, information about ice condition is relatively hard to acquire manually, especially during freeze-up and breakup periods, which are characterized by ice jamming and extensive flooding. To fill this information gap, such satellite data can be used that provide data over a large area and long river stretch with relatively frequent revisit time of a few days. Radar satellites acquire

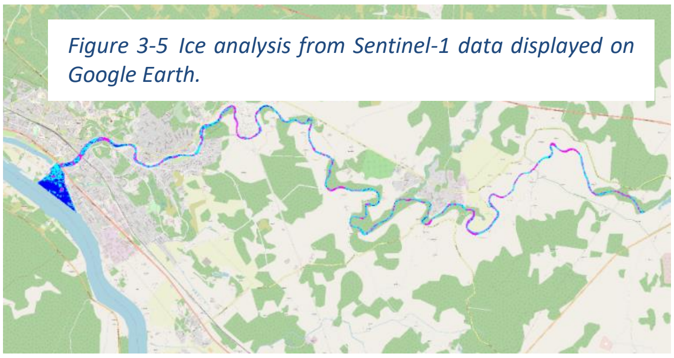

Figure 3-5 Ice analysis from Sentinel-1 data displayed on Google Earth.

data in all weather and day and night conditions, which also minimizes data gaps, which are profound during winter-spring seasons in northern latitudes.

Figures 3-4 and 3-5 present ice condition analysis using Sentinel-1 IW data on February 23, 2019, in Ogre river, inside the pilot territory. Due to relatively small river size and satellite image resolution, the river stretch was divided into three classes: ice-free areas and areas with low and high ice concentration.

The results of analysis can be shared in formats suitable for GIS software to use in different thematical maps (Figure 3-4) or Google Earth *.kmz format (Figure 3-5) for even easier data sharing, as the file size is very small.

Sentinel-2 optical data can be used as reference information or to fill the gaps between Sentinel-1 acquisitions, as the clear images in visible spectrum provide a good overview of ice conditions in the Ogre river (Figure 3-6). The Sentinel-2 data contain 13 different spectral bands that can be used in different combinations to acquire different information on the ice conditions (Figure 3-7).

Figure 3-6 Visible ice cover on Ogre river in the pilot territory (Sentinel-2 image, Feb 21, 2019).

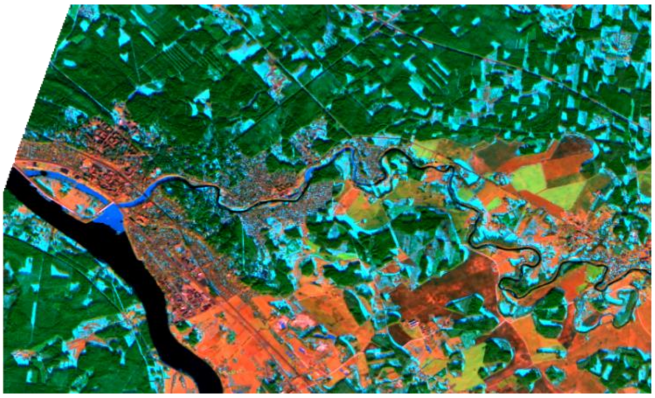

Figure 3-7 Ice cover on Ogre river in the pilot territory (Sentinel-2 image – natural colours with atmospheric removal, Feb 21, 2019).

3.2.5 Data preparation and validation for the next activity

After ice, water and surface inspection using FLIR on airborne platforms for all Ogre river area in Ogre city and Ogresgals parish, there has been development of a 3D model for Ogre river and coastal area. Further, based on gained information, the municipality will be able to asses a sufficiency of current Automatic Hydrological Stations and if needed move existing level sensors to different locations or install additional ones.

Satellite data preparation and analysis was done using the respective toolboxes from the European Space Agency's Sentinel Application Platform (SNAP).

Sentinel-2 data preparation involves atmospheric corrections and subsetting image over the region of interest. Depending on the weather conditions, histogram adjustment can be done, but in order to use information across the all available spectral bands, image resampling is necessary.

Sentinel-1 SAR data have many specific properties; therefore, data preparation requires several steps that also requires subsetting image over the region of interest for faster data processing. Regarding the data properties, data calibration, noise filtering and correction of distortions are required. After data preparation, ice analysis is carried out based on the backscattering values.

4 Pori

4.1 Description of the Pori pilot area

Pori is a town on the south-west coast of Finland. The city is located about 10 kilometers from the Gulf of Bothnia on the estuary of the Kokemäenjoki river. Pilot area is Suntinoja ditch catchment area; ditch water exits into the Kokemäenjoki river, which is the 4th largest waterbody catchment area in Finland. The catchment area is mostly rural: fields and forests. The northernmost area is urban residential area.

The ground surface is flat, which increases drainage problems and stormwater and snowmelt flood threat. Besides risk to property, flooding increases contaminant and nutrient migration into the Baltic sea.

In general, the city of Pori is responsible for stormwater management, but Pori water owns and maintains the main line for stormwater drains. The city of Pori, on the other hand, manages other structures related to stormwater management in the town planning area (main ditches, drainage of streets and parks, etc.).

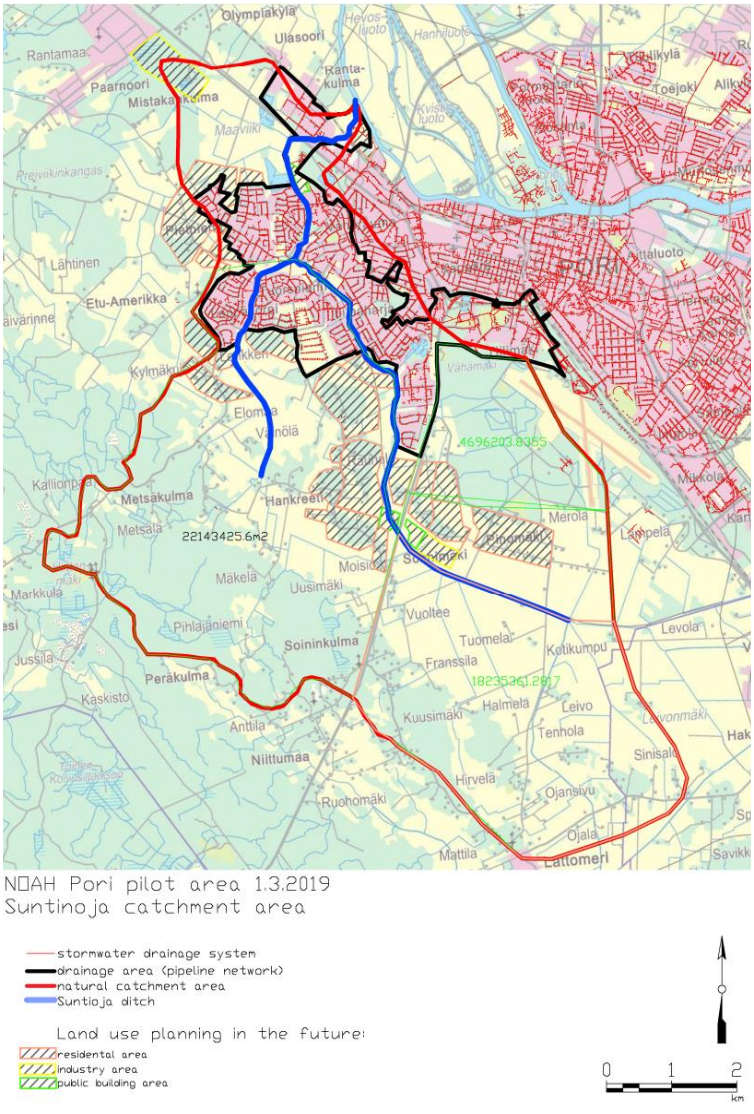

Figure 4-1 Suntinoja ditch pilot area

Suntinoja ditch is managed by the Lattomeren ditch drainage company, of which the City of Pori is a shareholder. The city of Pori is not responsible for the ditch because it is not completely in the town planning area. There are also beneficiaries other than residents of the town planning area.

The ditch was originally designed for drainage of agricultural areas, so its capacity may not be enough in heavy rainfall situations, and the ditch may begin to flood residential areas through stormwater drains into the inland or properties near the ditch. That's why this area is selected to be a pilot area.

The modelling carried out in the project determines the effects of different heavy rain events.

The scenarios to be used are 1/10, 1/100- and 1/500-years probability rain events. In addition, climate change effect is taken into consideration.

New residential areas are also planned for the pilot area, so the extreme weather layer can be used to look at the

impact of residential construction on Suntinoja's capacity.
Water sampling is conducted to analyse the quality of the stormwater and for modelling it in different flood situations.

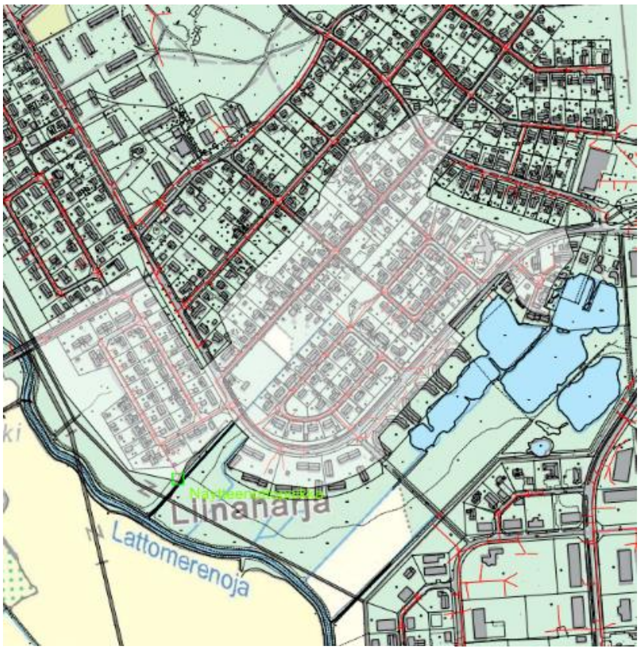

Figure 4-2 Sampling site 1, which is discharging to Suntinoja ditch.

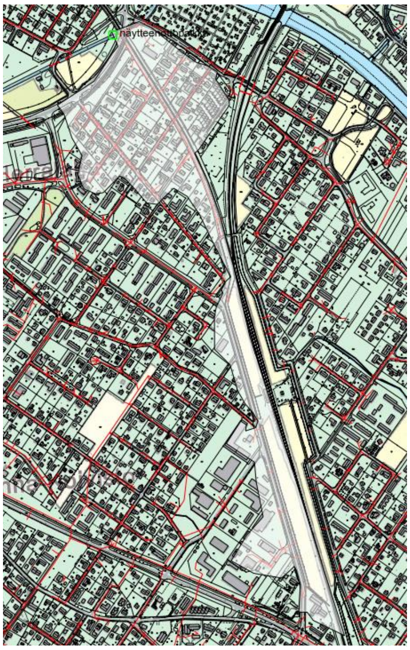

Figure 4-3 Sampling site 2, which is close to the Pori central area

4.1.1 Description of the changes and adjustments made in the pilot area

Pilot area borders were clarified. Some sectors of the initial pilot area were left out from the modelling due to insufficient data and irrelevance to the necessary model output.

4.2 Data collection procedure

Most of the data was gathered from official databases. Main ditches were mapped by the city of Pori. Calibration measurements were carried out by the city of Pori.
The data collection procedure consisted of two successive steps

4.2.1 Pipeline modelling

1. Determination of pilot area
2. Topographic overview - Determination of drainage areas; drainage area and natural drainage area.
3. Delivering existing digital data to Taltech University for modelling
4. Water table calibration and cross-section measurements from the Suntinoja ditch by the city of Pori.
5. Choosing the rain events to the modelling
5. Identification of missing data and identification of key data
6. Selecting which data is going to be collected from the field
7. Collecting all the missing data from the field

4.2.2 Stormwater quality measurements

1. Determination of water sampling places and drainage areas
2. The City of Pori has taken water samples from sampling sites and water quality analysis have been made.
3. More sampling will be taken from the sampling site
4. LUKE and SAMK are doing the analysis of the results

4.2.3 Acquired data

- Ground surface from National land survey of Finland laser scanning data.
- Land use and catchment area from SYKE (Finnish environment institute).
- Master plan, city plan, buildings, roads and other land use data from the city database.
- Pipeline network from Porin Vesi (Pori Water) database and measurements by the city of Pori. Detailed information about pipeline is needed (coordinates, diameters, elevation, type of pipe and length of pipelines).
- Main ditches by GPS mapping.
- Meteorological data from FMI and SYKE database.
- Waterbody data from SYKE database.
- Calibration i.e. water table and discharge measurements by the city of Pori.

4.2.4 Identification of missing data

Some of the pipeline data is missing. Typically, pipe id, inlet and outlet node id, pipe diameter and material are missing. It is not possible to construct the model without this data.

4.2.5 Action taken to fill data gaps

Two sectors were left out of the pilot area because there was too much data missing and these section are not that relevant to the model. Additionally, some pipes with diameter less than 200mm were left out from the model, because there was too much missing data in those smaller pipes.

Problems associated with missing data for modelling were solved by performing GPS-measurements on-site.

4.2.6 Data preparation and validation for the next activity

All the data that has been gathered and sent to TalTech for evaluation and model building.

Data from measurements still ongoing is stored in the Porin Vesi (Pori Water) database. From there, the data is shared with Taltech.

More stormwater samples will be taken and results sent to Samk and LUKE.

5 Rakvere

5.1 Description of the Rakvere pilot area

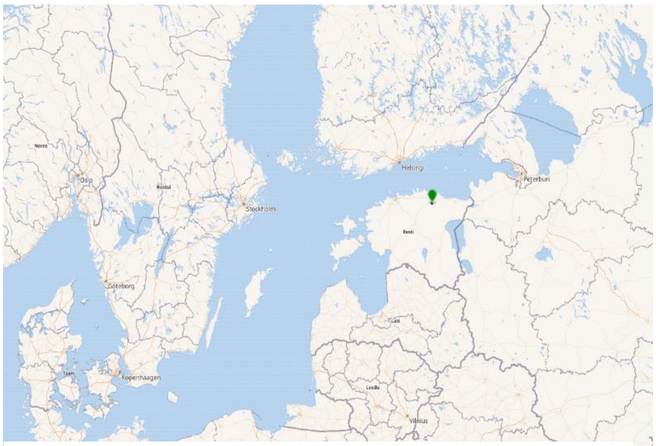

Figure 5-1 Location of Rakvere

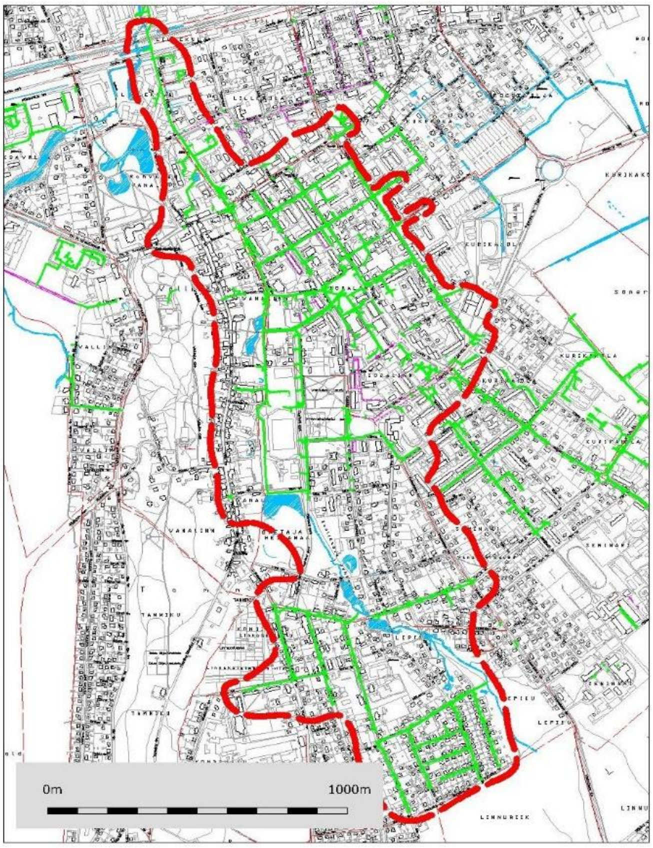

Figure 5-2 Rakvere pilot area

Rakvere (area 10,73 km²) is a town in northern Estonia and the capital of Lääne-Viru County, 20 km south of the Gulf of Finland of the Baltic Sea. There are approximately 15,100 inhabitants in Rakvere.

There are two waterbodies in Rakvere, which are included in Estonian Nature Information System – Soolikaoja creek and Tobia main-ditch. The Tobia main-ditch flows down to the Soolikaoja creek, The Soolikaoja flows down to the river named Selja and the Selja river flows to the Baltic sea. The Tobia main-ditch catchment area is 31,8 km² and the Soolikaoja catchment area is 122,1 km².

The selected pilot area of about 1 km² is located in the middle of the town. This area is the most over flooded area in Rakvere.

Rakvere Vesi AS manages water supply communications (total length 156 km), waste water sewerage system (132 km) and maintains stormwater system, consisting of more than 45 km of closed pipelines and 115 km of ditches.

In the lower part of the selected area, there is a pond, instrumental to avoiding stormwater flooding in the center of the town. The pond will be used as a reservoir to temporarily hold surplus rainwater until the central town pipeline is free to take the rainwater from the southern part of the town.

5.1.1 Description of the changes and adjustments made in the pilot area

Borders of the pilot area were clarified. It was decided to use a bigger pilot area.

5.2 Data collection procedure

1. Mapping the pilot area on the Rakvere map.
2. Procurement of topographical overview – surveying of stormawater systems and data processing
3. Aggregation of data, surveying and forming a single database, that is suitable for developing a calculation model of stormwater systems.
4. Collecting archive data of topographical plans on pilot area, and surveying the manholes without data.
5. Surveying the cross profile of the Soolikaoja in five places.
6. AS Rakvere Vesi will make the procurement for taking and analyzing the samples from stormwater that comes from the pilot area.
7. TalTech is developing a storm water model.

5.2.1 Acquired data

All the data from surveying the manholes is collected - 108 manholes in total. 25 manholes remained unexplored. In summary, data for 83 manholes (coordinates, diameters, elevation marks ((inlet, outlet heights can be calculated)), type of pipeline, pipe length) was obtained.

5.2.2 Identification of missing data

Data gaps on manholes remained due to many reasons. Some of them were under road surface and some of them were full of soil.
It may be possible to get an approximate data of pipeline from old construction plans.

5.2.3 Action taken to fill data gaps

For now, AS Rakvere Vesi cleaned some manholes to get the data. As the process is ongoing, there may be a need to get data on some manholes under the road surface.
Missing data on the amount of stormwater and its quality will be obtained after taking samples from stormwater in the framework of the procurement, that AS Rakvere Vesi is organizing.

5.2.4 Data preparation and validation for the next activity

Next activities include:

1. More storm water samples will be taken and further compared.
2. Procurement procedure for taking samples from stormwater will take place in October 2019.
3. Equipment will be installed and first data set will be gathered and analyzed in October 2019, second data set in October 2020.
4. Development of the catchment area surface model.
5. Clarification of existing cross-sections of the Soolikaoja.
6. Survey of objects in nature and supplementing model data.

6 Söderhamn

6.1 Description of the Söderhamn pilot area

The town of Söderhamn is a coastal town located far into the bay of Söderhamn and at the outlet of Söderalaån. The city is surrounded by forested mountains. In addition to the Söderala River, Lötån also flows into bay of Söderhamn. The pilot area was chosen because the effects of heavy rainfall are most severe in the central parts of Söderhamn. In addition, some densification is planned with new buildings and other changes regarding park areas, as well as streets in this area.

Figure 6-1 Söderhamn pilot area

6.1.1 Description of the changes and adjustments made in the pilot area

Pilot area borders were clarified.

6.2 Data collection procedure

Söderhamn NÄRA delivered all data required for the project such as maps and information on wastewater and stormwater systems.

For data collection the following procedure was used:

• Determination of extent
• Development of map data
• Saturation in manhole (two needed)
• Weighing the respective descent well
• Calculation
• Registration
• Compilation
• Accounting

For measuring water inlets, Söderhamn municipality has used a map tool to find which manholes have a lid level and which lines do not have a water inlet. A map with marked manholes to be measured is exported from tool accompanied by a fillable form for missing data (see Figure 6-2).

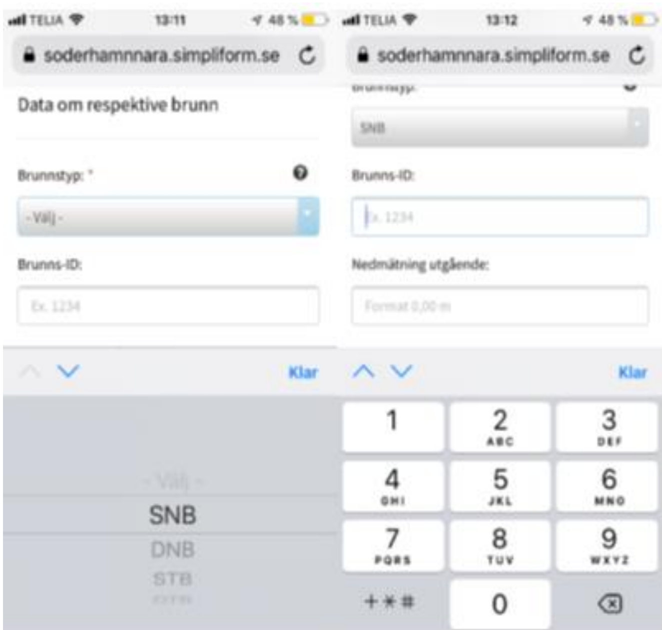

Figure 6-2 Fillable form for missing manhole data

While one team has measured the lid height on remaining unknown manholes with manual instrument, the other team has done measurements in the manhole bottom (see Figure 6-3). All measurements are done in such a simultaneous way to ensure consistent workflow.
In order for the teams to be able to work independently of each other, and still get information registered, the form (Fig 6-2) has been created to be able to send in surveys in retrospect, and at the same time be able to inspect the wells.

Figure 6-3 Measurement taking at manholes

The measured values are entered manually into the map system and based on them the calculations are made.

6.2.1 Acquired data

- Data about land use and soil types is forwarded for model building in form of primary map
- New planned developments in the pilot area from planning program Söderhamnsporten in map form.
- Ground elevation data as a special map file; seasonal changes of water level in surrounding water bodies is obtained from Rivers LVVF (Ljusnan Voxnans water conservation association) (for rivers) and SMHI(State Metrological and Hydrological Institute) (for sea).
- Existing development plans in the pilot area stemming from Center program in map material

6.2.2 Identification of missing data

Missing data was identified in cooperation with TalTech and Söderhamn NÄRA. There were data gaps in stormwater and sewerage pipelines, manhole heights, and outlet heights and ID-names.

6.2.3 Action taken to fill data gaps

NÄRA delivered:

- Available data about stormwater and sewerage pipelines, manholes, and outlet height and ID-name.
- Known Stormwater-manholes that are connected to the sewerage-system.
- Updated data about stormwater and sewerage pipelines, manholes, and outlet height and ID-name.

Additionally, approximately 300 manholes were measured by NÄRA.

6.2.4 Data preparation and validation for the next activity

In summary, coordinates, piping network for stormwater and wastewater including manholes, dimension, material, year of construction, levels of gravity, ground levels, pipe length, pumping data were gathered. This data will be used as input for the hydraulic model.