Flood analysis Lussebäcken, Helsingborg

Hydraulic impact of urbanization and effect of implemented water management measures

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County administrative board for Scania
(Länsstyrelsen Skåne Län)

Rapport

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Hydraulic impact of urbanization and effect of implemented water management measures

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Sammanfattning

På uppdrag av Länsstyrelsen i Skåne har DHI Sverige genomfört en studie av översvämningsrisker längs Lussebäcken i Helsingborgs kommun. Studien syftar till att utvärdera effekter på översvämningsutbredning vid införande av vattenvårdande åtgärder såväl som vid en ökad urbanisering. Flertalet scenarion har simulerats med en hydrologisk och hydraulisk modell av Lussebäcken etablerade i Mike FLOOD.

Inom Lussebäckens delavrinningsområde har flertalet vattenvårdande åtgärder i form av dammar, våtmarker och två-stegsdiken genomförts för att skapa högre basflöde och lägre flödestoppar. Effekterna ska återskapa de förhållanden som förekom innan utdikningarna genomfördes i stor skala i södra Sverige. Förutom att åtgärderna har stora positiva effekter på ekologi, biologisk mångfald och minskat näringsläckage är det av intresse att utvärdera effekten vid höga flöden.

Totalt har översvämningskartering genomförts för åtta scenarion. Ett 10-årsflöde och ett klimatanpassat 100-årsflöde har tagits fram genom extremvärdesanalys av flöden generade av den hydrologiska modellen baserat på nederbörd för de senaste 25 åren. De båda flödesbelastningarna har utvärderats för scenarion med utan anläggandet av vattenvårdande åtgärder samt kombinerat med scenarion med en markanvändning som bedömts motsvara förhållandet för 1969 och för 2019 respektive.

Resultaten visar att de mest översvämningsutsatta områdena återfinns i utkanterna av Påarp, längs det nordvästra biflödet till Lussebäcken i höjd med Ljusekulla samt mellan Östra Ramlösa och Ramlösaravinen.

Den övre delen av Lussebäcken har flertalet dammar och våtmarker vilka kraftigt begränsar maximala flöden. Vid kraftig nederbörd genererar dagvattenutlopp i Ramlösaravinen stora flöden i Lussebäcken. Däremot styrs maximala flöden ut i Råån starkt av flödesfördelning under järnvägen nedströms Ramlösaravinen, där delar av flödet även avleds västerut mot Oceanhamnen.

Utifrån genomförd jämförande analys av översvämningsscenarion framgår att anlagda vattenvårdande åtgärder i Lussebäckens delavrinningsområde har en klart positiv översvämningsbegränsade effekt. Dammar och våtmarker både begränsar utbredning och högsta flöden, medan tvåstegsdiken får en översvämningsdämpande effekt om dessa samtidigt kombineras med reglerade utlopp. Utifrån analysen framgår även att förändringen i markanvändningen mellan 1969 och 2019 har en underordnad effekt när det kommer till översvämningsrisk jämfört med de anlagda vattenvårdande åtgärderna.

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1 Background and objectives

The County Administrative Board is a partner in an Interreg project, "Building with nature" (BwN), which has been ongoing since 2016. The purpose of the project is to improve adaptation and resistance to climate change for coasts, estuaries and river basins.

As part of the project The county administrative board for Scania (Länsstyrelsen Skåne), has commissioned DHI Water & Environment (DHI) to assist with hydraulic modelling services to conduct a flood mapping analysis along the Lussebäcken watercourse in Helsingborg, Sweden.

The Lussebäcken sub-catchment has been selected within BwN, as many water management measures have been carried out over a small area. Ideally the effect of the measures will produce effects that mimic the hydrological conditions that existed prior to the large scale constructions of drainage ditches in southern Sweden as a whole and in Lussebäcken catchment in particular. The aim is to create a watershed with higher base flows and reduced peak flows. It is desirable to recreate conditions with a prolonged residence time to improve the ecological system in the watershed. The discharge regulation is also a prerequisite for reducing the risks of both flooding and drying of watercourses that may be the result of a changed climate.

The purpose of the project is to model the flood reducing effect of wetlands, stormwater ponds and two-stage ditches in the Lussebäcken sub-catchment area. The report includes comparative studies of the flood situation from discharge at different return periods and from scenarios with different land use and implementation of measures.

In a separate report, DHI together with EA International have studied the hydraulic effect of a two-stage channel.

2 Methodology

The flood mapping has been carried out with a hydrological and hydraulic model. Lussebäcken basin and watercourse are described in Mike Urban CS. The model has been obtained from NSVA and was originally set up in 2008 (DHI, 2008). The model describes runoff from different types of surfaces, as well as discharge and water levels in the watercourse.

The model was updated with water management measures implemented over the last decade and land use was updated. Model changes carried out are based on obtained documentation and in consultation with the client, see section 2.1. A scenario where no measures have been constructed and another scenario with a less impermeable surfaces, corresponding to a landuse of 1969, is compared to the existing state of the Lussebäcken.

A dynamic link between the MIKE Urban model and the elevation model of the surface is made. The surface is described in MIKE 21 and a connection is made with the linking software MIKE FLOOD. By introducing a link between the 1D model of the watercourse and the surface described in a 2D model the flooding behavior of Lussebäcken is well described. When the water level in the watercourse is overtopping the riverbanks it is possible for the water to flood the surroundings and when the levels recedes it is again possible for water to flow back to the watercourse. The surface model also enable flow on the surface, for example over a structure such as a road when there is a buildup caused by limited capacity in the underlying culvert.

2.1 Updating the model

The model was updated with a hydraulic description of a various set of environmental measures to achieve improved ecosystem function with good ecological status and water quality as well as an increase in retention time. The measures aim to restore the watercourse to a more natural state and the introduced structures consist of ponds, wetlands and two-stage ditches.

For the flooding analysis two separate scenarios are studied. The existing watercourse with the water management measures implemented are compared with a scenario with none of the ponds or wetlands constructed. By comparing the two scenarios it is possible to analyse the flood reducing effect of the measures in Lussebäcken.

2.1.1 Water management measures

Based on data supplied by The County Administrative Board for Scania (Länsstyrelsen Skåne) and NSVA water management measures were included in the model, Figure 2-1. Ponds and wetlands are described based on both design drawings, personal knowledge and aerial measurements supported by elevation data. The two stage ditches are described based on field measurements carried out by Helsingborg city.

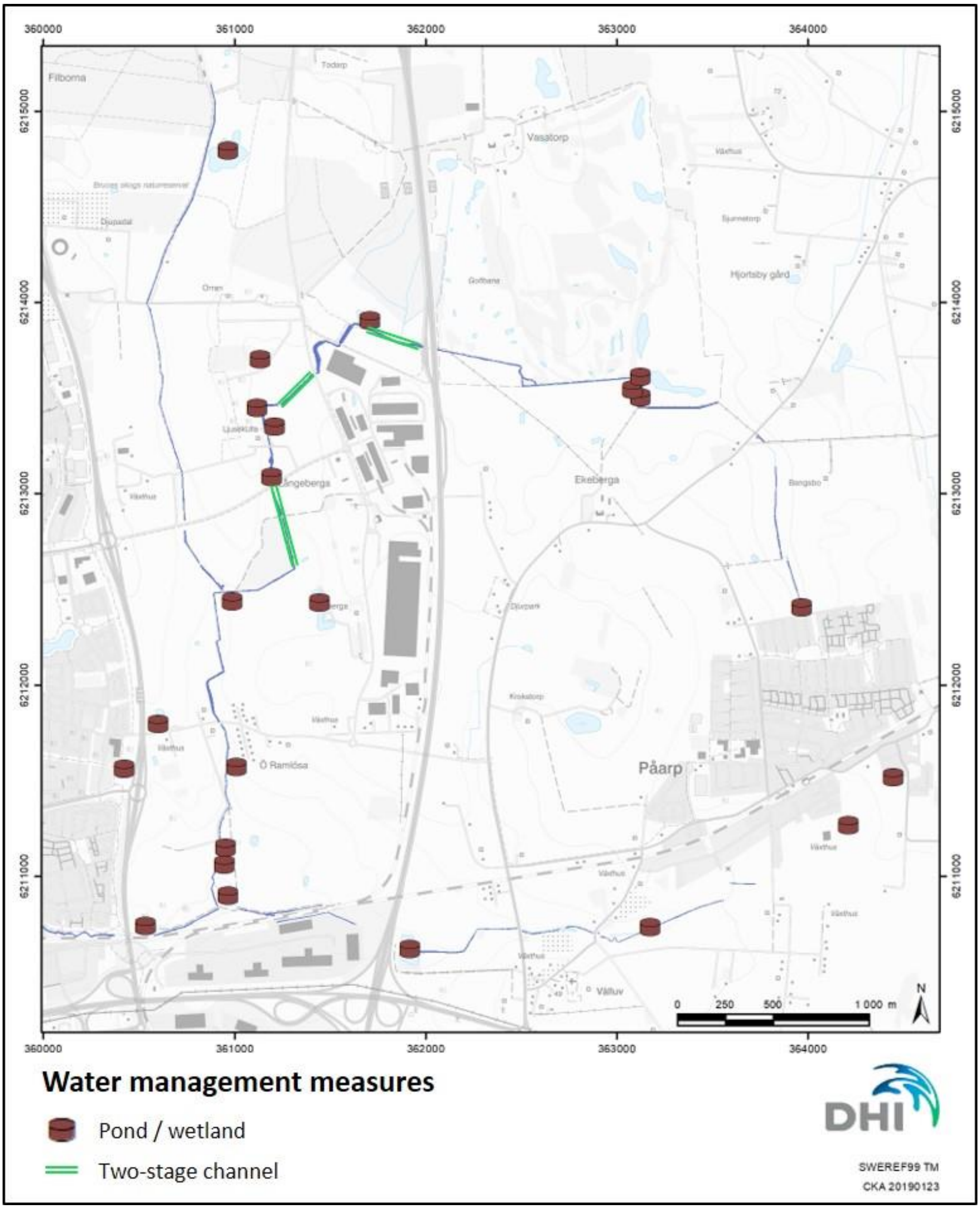

Figure 2-1 Water management measures in Lussebäcken catchment.

2.1.2 Urbanisation scenario 1969 and 2019

Over the last 50 years urbanization in the Lussebäcken catchment has caused an increase in impermeable surfaces and consequently created a faster runoff to the stream. In order to study the effect of the urbanization runoff coefficient has been differentiated based on the land use distribution of 1969 and 2019. The assigned runoff coefficients are based on national guidelines presented in P110 (Svenskt Vatten, 2016). Land use distribution is presented in Table 2-1 and in Figure 2-2 and 2-3.

Based on a runoff analysis on a 2x2 m elevation model and with consideration to the technical catchments of the stormwater network, the Lussebäcken catchment was divided into smaller sub-catchment. Based on flow routing of the sub-catchments load points were assigned to the watercourse.

Table 2-1 Land use distribution for the years 1969 and 2019, together with runoff coefficient used in the model.

Land use	1969 area [ha]	2019 area [ha]	Runoff Coefficient φ
Agrable land	1798.4	1186.8	0.1
Fruit / Seed farming	63.4	3.9	0.1
Water	3.2	20.3	0.1
Forest	250	366.2	0.1
Residential	201.6	294.6	0.3 – 0.5
Industrial	82.3	200.7	0.8
Other open land*	353.9	679.9	0.2

* e.g. grazing land, hard surface, major roads, individual plots and gardens

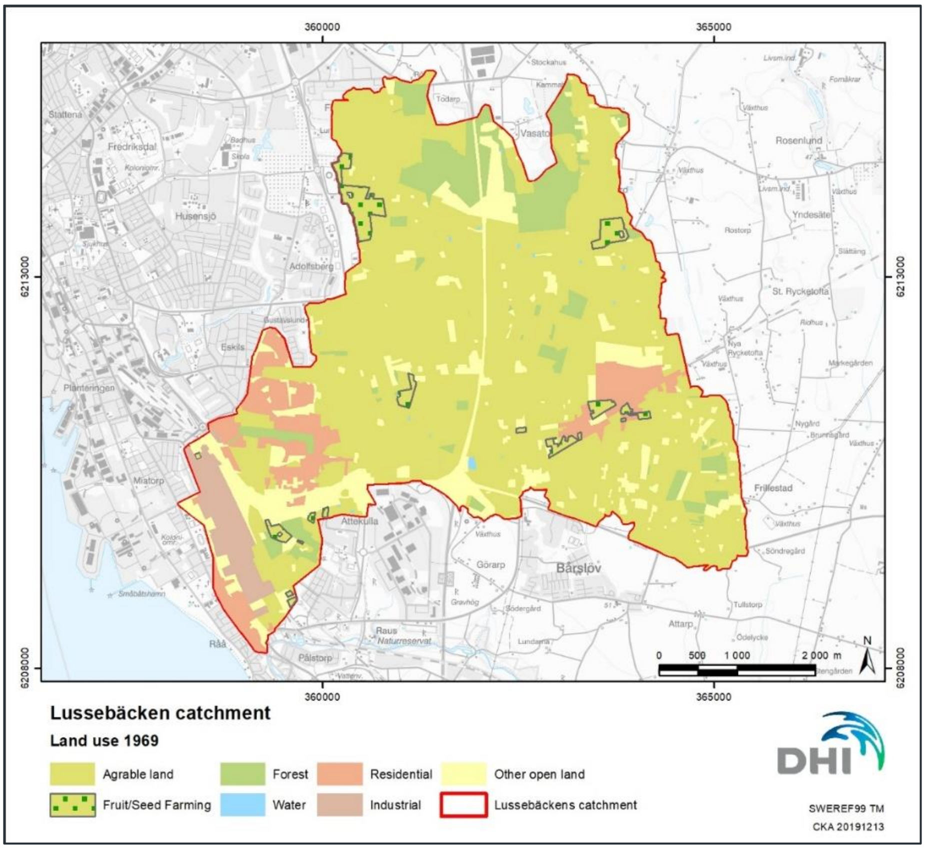

Figure 2-2 Landuse distribution of year 1969

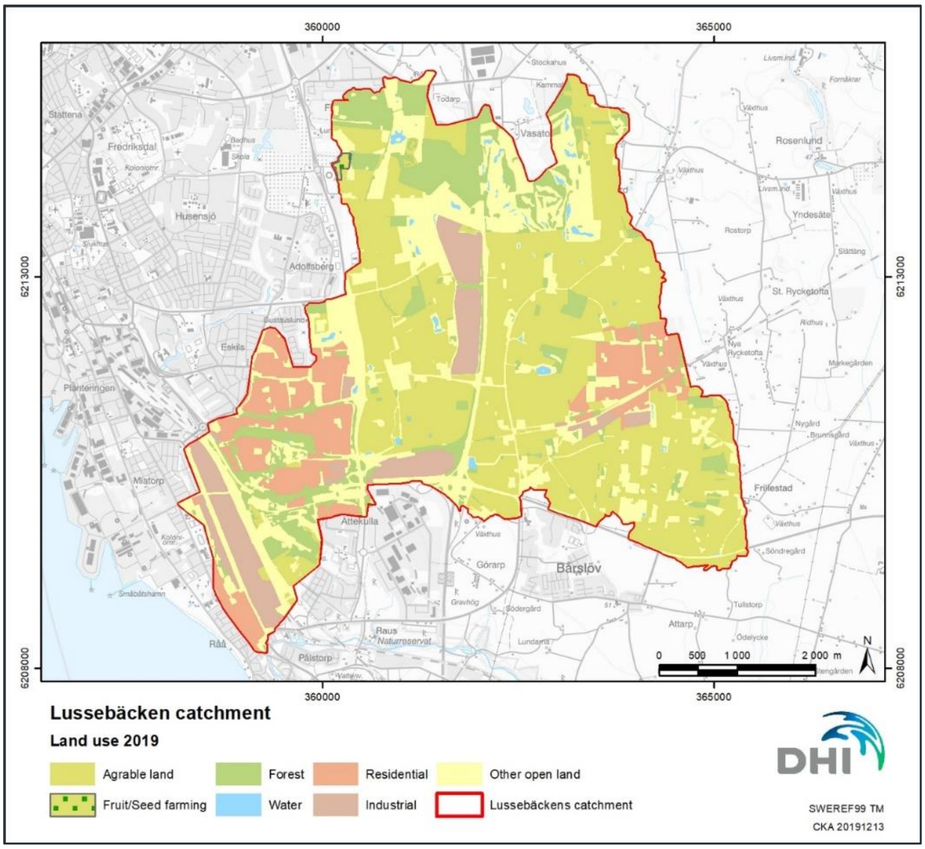

Figure 2-3 Landuse distribution of year 2019

2.2 Extreme value analysis

An extreme value analysis was carried out to calculate flow rates with 10 years and 100 years return period based on modelled flow rates. The data for analysis consist of 24 years of observed meteorological data for Helsingborg with a 15 min resolution. The observed data used as boundary conditions for the model consist of measured volume of rain, calculated evaporation and measured temperature and was obtained from the weather station Helsingborg A. Data from 1st of August 1995 until 16th of September 2019 was used.

From a frequency analysis using Gumbel distribution of total runoff in the Lussebäcken catchment, real rainevents that fit well with a 10-year respective a 100-year runoff could be isolated and corrected with a coefficient to correspond with the runoff-value from the analysis. According to SMHI's regional climate analysis (RCP8.5) scenario for Råån, total runoff for a 100-years event in the river basin is expected to increase by a factor 1.25 by the year 2100. Local meteorological data corresponding to the 100-year runoff was corrected based on the RCP8.5 scenario to describe the conditions at the end of the century.

Updated precipitation series for the two events were created and assigned as catchment load for the hydrodynamic model describing the watercourse of Lussebäcken. The rainfall events are presented in Figure 2-4 and Figure 2-5.

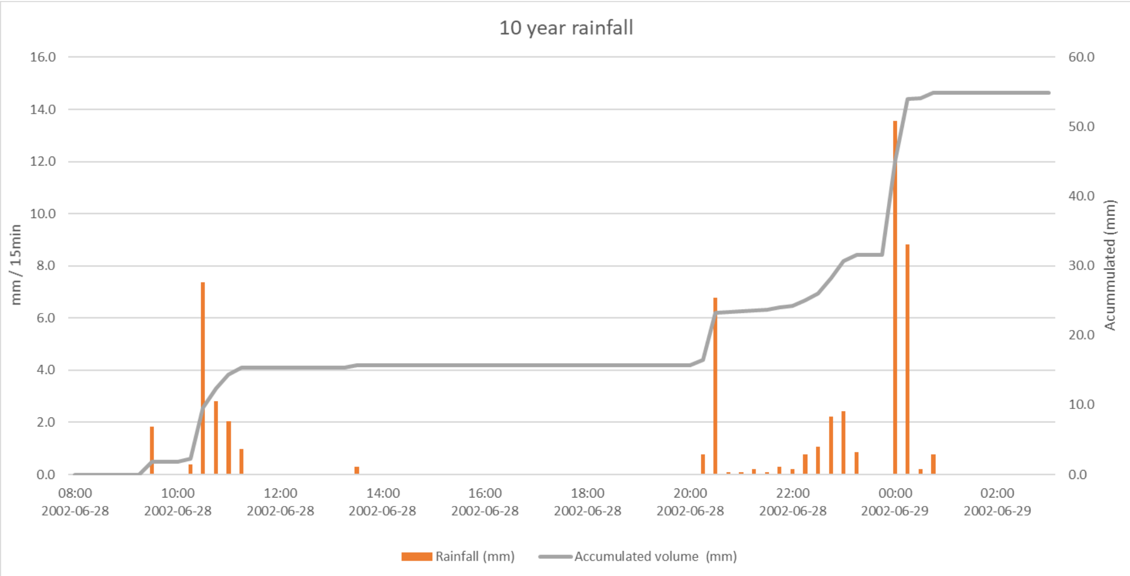

Figure 2-4 10 year rainfall, presented as load per 15 min together with accumulated rain volume.

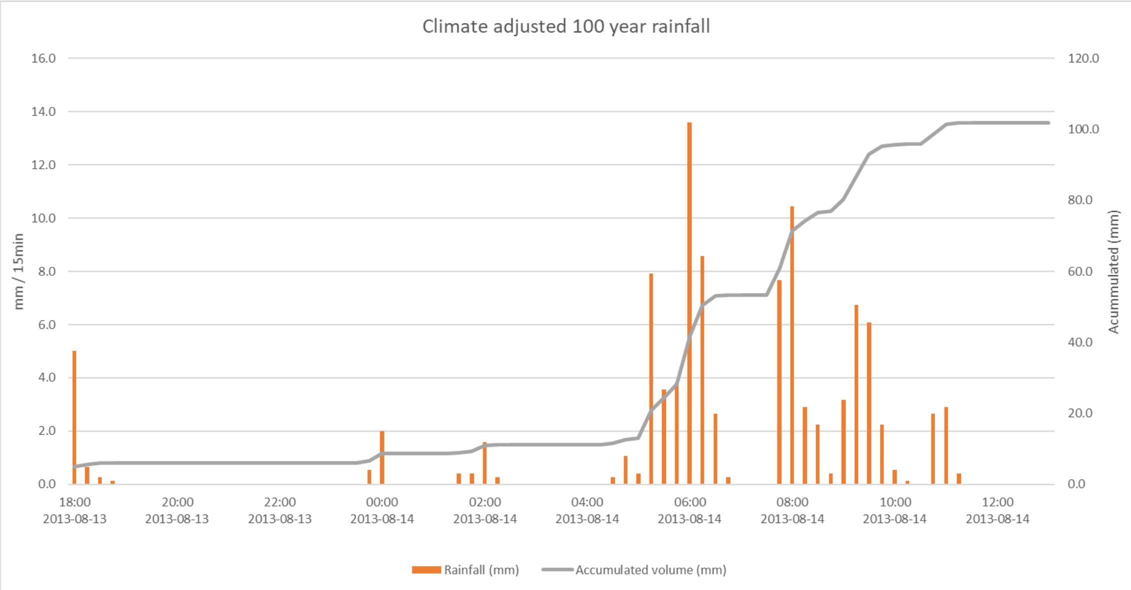

Figure 2-5 Climate adjusted 100 year rainfall, presented as load per 15 min together with accumulated rain volume.

3 Flood analysis

Flood simuations has been conducted for eight scenarios. The purpose of simulated scenarios is to analyze the effect of an increased urbanization as well as water management measures on flood risk. Computed scenarios are presented below. Focus of the analysis has been on the upper part of Lussebäcken, upstream of Ramlösaravinen.

In the figures of chapter 3 the flood results for a 100-year event is presented for scenarios with and without water management measures. The results for the remaining scenarios are presented in Appendix A.

- 100-year discharge, land use 2019 - with measures
- 10-year discharge, land use 2019 – with measures
- 100-year discharge, land use 1969 – with measures
- 10-year discharge, land use 1969 – with measures
- 100-year discharge, land use 2019 - no measures
- 10-year discharge, land use 2019 – no measures
- 100-year discharge, land use 1969 – no measures
- 10-year discharge, land use 1969 – no measures

3.1 Flood extent

In Figure 3-1 - Figure 3-2 the flood extent for a 100-year event with land use of today is presented for a scenario with and without water management measures. In Figure 3-3 - Figure 3-4 the 100-year flood extent of Lussebäcken is presented without measures and with a land use corresponding to 1969 and 2019 respectively.

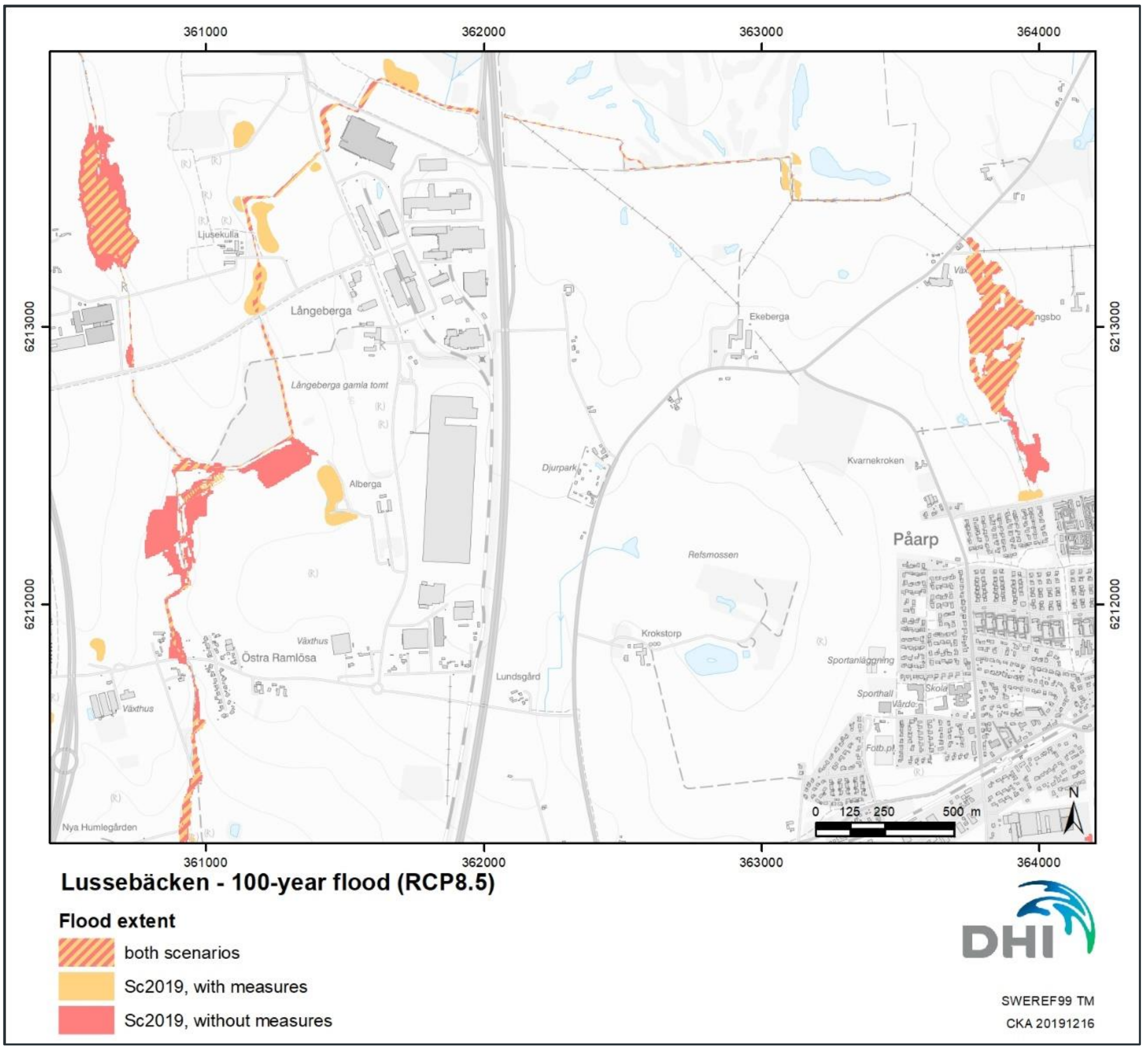

Figure 3-1 Calculated flood extent in the north part of Lussebäcken for a 100-year flood event with land use corresponding to the year 2019. Flood extent is presented for two scenarios with and without measures.

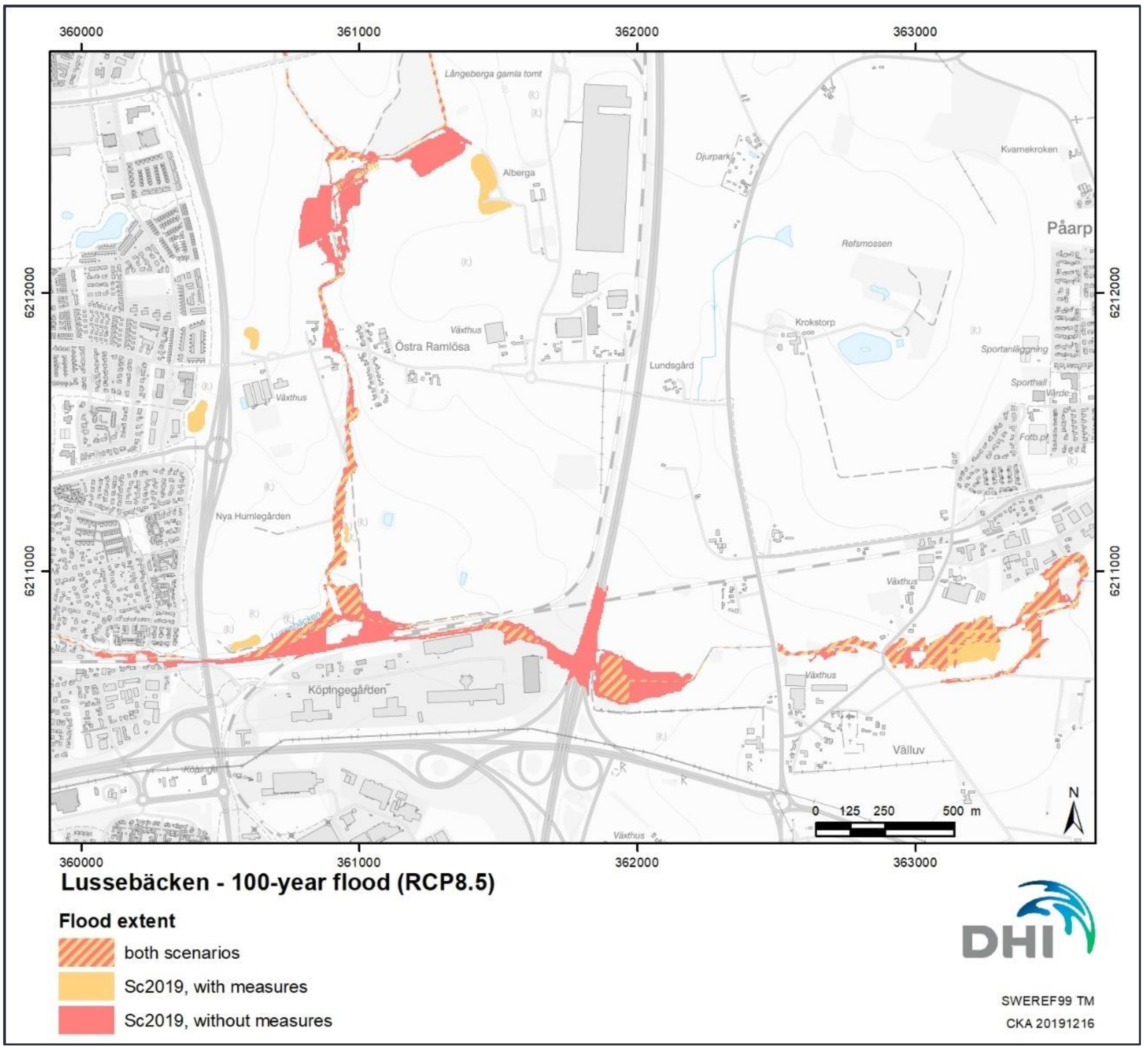

Figure 3-2 Calculated flood extent in the east part of Lussebäcken for a 100-year flood event with land use corresponding to the year 2019. Flood extent is presented for two scenarios with and without measures.

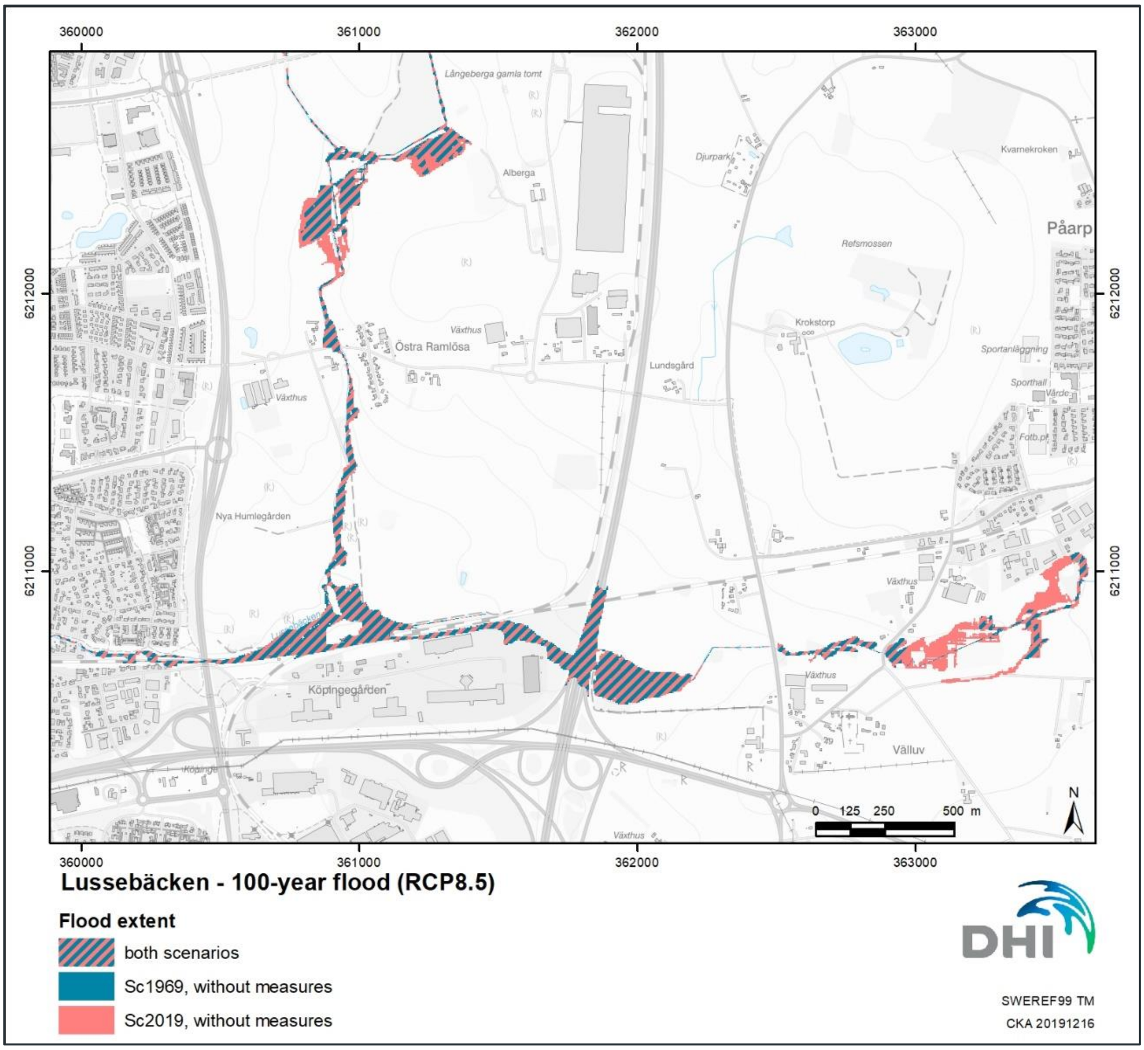

Figure 3-3 Calculated flood extent in the north part of Lussebäcken for a 100-year flood event were no water management measures have been conducted. Flood extent is presented for two scenarios of urbanization; 1969 and 2019.

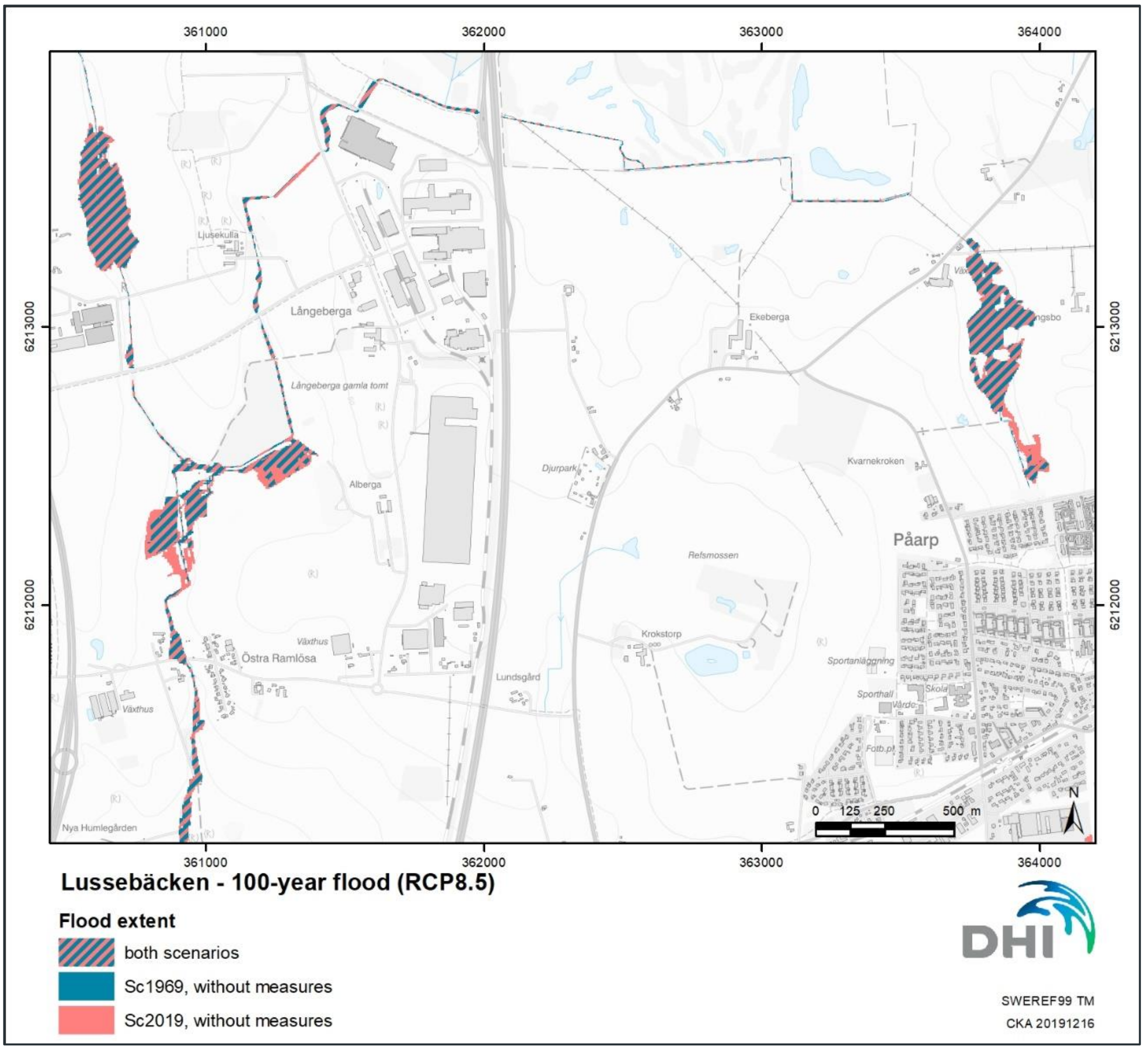

Figure 3-4 Calculated flood extent in the east part of Lussebäcken for a 100-year flood event were no water management measures have been conducted. Flood extent is presented for two scenarios of urbanization; 1969 and 2019.

3.2 Discharge distribution

In Table 3-1 the computed maximum discharge at 9 different locations, distributed along the Lussebäcken watercourse, are presented. The specific positions are seen in Figure 3-5. The computed maximum discharges are presented for all scenarios connected to the 100-year event.

Presented maximum peak flows might differ in time between the scenarios. The rainfall series for the climate adjusted 100 year rainfall consists of two periods of more intense rainfall and with an accumulated volume of about 50 mm each, Figure 2-5. The first period has the most intense rainfall and the second has a longer duration. Typically, the peak flows from the fast urban runoff are reached during the first, most intense, rainfall whereas a slower runoff is expected for more natural and rural areas where peak flows typically occur during the second rainfall period.

Table 3-1 Calculated maximum discharge at different locations along Lussebäcken. Locations in the table correspond to letters presented in Figure 3-4.

Discharge locations	Sc2019 – without measures [m3/s]	Sc2019 – with measures [m3/s]	Sc1969 – without measures [m3/s]	Sc1969 – with measures [m3/s]
A	2.8	2.5	2.6	2.5
B	4.4	3.0	4.0	2.5
C	0.9	0.9	0.9	0.9
D	5.0	2.6	4.5	3.3
E	1.5	0.7	1.3	1.1
F	3.8	1.3	3.6	0.9
G	7.0	3.6	8.3	4.1
H	10.4	7.7	11.3	6.2
I	6.8	6.3	6.2	5.9

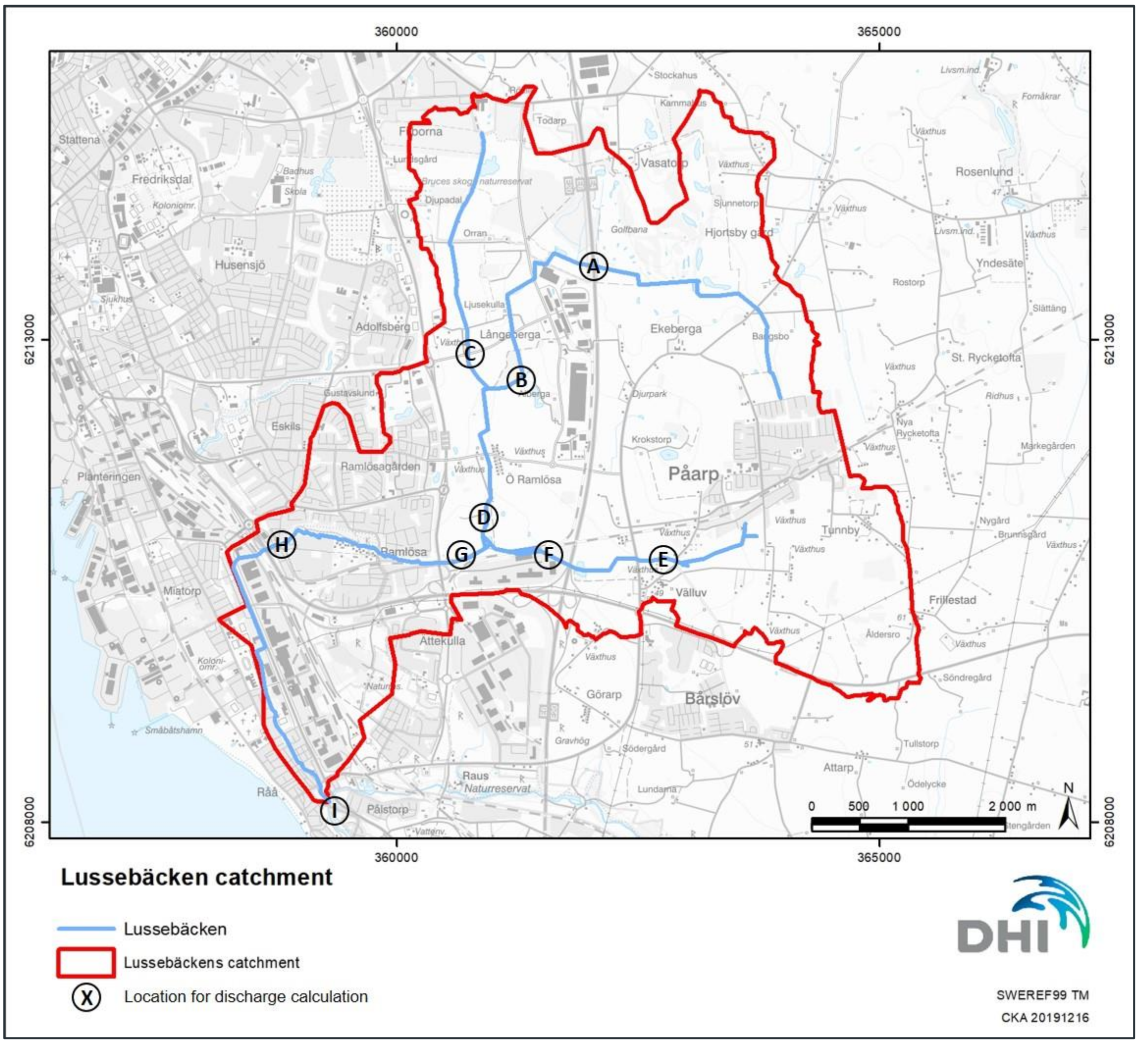

Figure 3-5 Locations along Lussebäcken where maximum discharge is calculated.

3.3 Comparing analysis

A comparing analysis between the computed scenarios has been carried out in order to evaluate the effect of the water management measures in the Lussebäcken and the effect of urbanization in the catchment.

From the result in flood extent it is seen that the measures implemented in Lussebäcken has a positive effect in limiting the flooding at a 100-year flood event. In the north of Lussebäcken, Figure 3-1, a bigger area of flooding between Långeberga and Östra Ramlösa is completely avoided and in the east of Lussebäcken, Figure 3-2, the flooding of the freeway (E6) and downstream railway is prohibited by upstream retention ponds.

When looking at the differences affected by the urbanization between 1969 and 2019 when no measures are implemented there is a visible increase in flood extent, Figure 3-3 and Figure 3-4. However, the flood areas are the same. For the scenarios where measures have been implemented in Lussebäcken the differences in flooding between the scenario of 1969 and 2019 are barely observable, flood maps are presented in the Appendix.

The discharge distribution between the different scenarios illustrate a decreasing peak flow in Lussebäcken as a result of the measures implemented, Table 3-1. The discharge in Lussebäcken is also lower for a scenario with land use of 1969 compared to the land use of 2019. An exception is however seen for the locations G and H, Figure 3-5, where maximum discharge is higher for the less urbanized scenario of 1969 compared to 2019. The reason behind the higher peak discharge is due to the timing of the peak. Since runoff from hard impervious surfaces are faster than from soft pervious ones the peak flows will have a time lag between each other. The increased amounts of impervious surfaces of 2019 will increase the fast discharge but consequently reduce the slower discharge. In Figure 3-6 the hydrograph at location H is presented for the scenarios without measures and with a land use of 1969 and 2019 respectively.

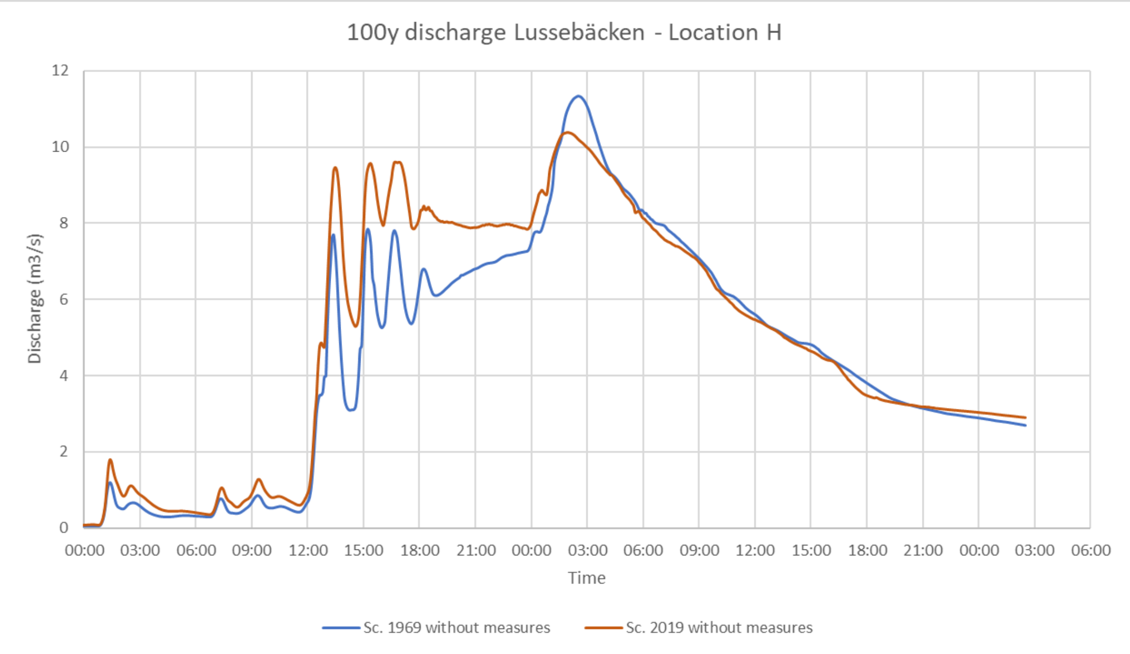

Figure 3-6 The 100 year discharge at location H. Presented are the scenarios without water management measures with land use of 1969 and 2019 respectively.

There is a considerably lower maximum peak flow at location I compared to H, see Table 3-1 and Figure 3-5. The main reason is that just downstream location H, the water flow is distributed in two separate systems. Lussebäcken continues through a culvert under the railway and thereafter by alternating culverts and open channels towards the outfall in Rååån. At high flows in Lussebäcken some part of the incoming flow will be diverted through a culvert leading towards Gåsebäcken in north east and ultimately discharge into the Ocean harbor. The flow distribution upstream the railway is depending on the water level and discharge. A baseflow of about 0.25 m^3/s are designed to follow Lussebäcken towards Rååån while higher flows are diverted through a 1600-mm culvert towards the Ocean harbor. At times when the capacity of the culvert is insufficient an overflow weir towards Lussebäcken is used.

Based on calculated maximum discharge, Table 3-1, it is seen that the accumulation in peak flow when water management measures are implemented are low for the upper part of Lussebäcken. Down to location G, about 75% of the Lussebäckens total catchment, the maximum discharge is about 4 m^3/s. On the distance between location G and H, about 12% of the total catchment area, the peak flow will almost double. This both demonstrate that the measures implemented in the upper part of Lussebäcken regulate the discharge well and that the fast runoff from the urban areas surrounding the Ramlösaravinen have major part in the total discharge of Lussebäcken.

4 Further water management measures

Even though the effects of implemented measures are positive there are still room for optimization. The available volumes in the water management measures are not completely used. By adjusting the outlet capacity from dams and wetland, either by new weir designs or smaller outlet diameters, several thousands of additional cubic meters can be retained. As a result the risk of downstream flooding will decrease along with reduced peak flows.

An evaluation of how well the available retention volumes in the Lussebäcken watercourse are utilized have been carried out. By analyzing the inflow and outflow, water level, weir positions and surrounding ground elevation of dams and wetlands it is seen that the east branch of Lussebäcken is well controlled by measures introduced over the years. The northern branch has however room for optimization. One pond in particular have been identified, the Ljusekulla detention pond.

The Ljusekulla detention pond is designed to detain water but the capacity of the outlet pipe is too high and even at high discharge the spillway is rarely used. By looking at the surrounding ground elevation it seems as if the highest water level for the 100-year scenario could be raised at least another 0.5 m (from +46.1 to +46.6) without causing flooding upstream. To evaluate the effect on the discharge and water levels, the 100 year discharge was simulated with a restriction in the pipe outlet of Ljusekulla pond to a maximum discharge of 0.4 m^3/s and simultaneously the spillway was raised to +46.6. At high discharge, the restricted outlet from Ljusekulla pond will also increase water level in upstream parts of Lussebäcken around Långeberga, meaning that an additional volume is detained in the stream. The result from the simulation indicates no flooding around or upstream Ljusekulla pond and a reduction in maximum discharge from Ljusekulla pond with 1.7 m^3/s (from 2.1 m^3/s to 0.4 m^3/s).

Studying the scenario of 2019 with measures, Figure 3-1 and Figure 3-2, the most flood prone area of Lussebäcken is located just north and southwest of Påarp, upstream the greenhouse in Ljusekulla and along the stream between Östra Ramlösa and Ramlösaravinen.

The floodings in the outskirts of Påarp are a result of limited capacity in culverts. The flooding is seen where an open channel section enters a smaller pipe. The flooding is dealt with by making sure that the capacity of the culverts corresponds to incoming flow. However, since the model doesn’t explicitly describe the urban stormwater network the flooding around Påarp have some uncertainty. Especially the flood area south of Påarp. Further studies are suggested in order to fully understand the dynamic between stormwater network and Lussebäcken.

The flooding upstream the greenhouse in Ljusekulla, along the western of Lussebäckens two north branches, are mainly due to a widespread depression in the terrain and the stream has low banks with a flat bedslope. The surrounding land compose a natural flood plain and should be preserved or taking into consideration at an eventual exploration near the stream.

The flooding between Östra Ramlösa and Ramlösaravinen are mainly caused by the limiting capacity of road culverts. About every 200 m between Östra Ramlösa and Köpingegården there is a culvert constricting the discharge and causing upstream flooding. The discharge is regulated through these culverts and the flooding occur on agricultural fields close to the stream. In order to better control the flooding and even reduce peak flows, detention ponds with a more restricted outlet design could be formed upstream all, or upstream a few of the culvert locations.

5 Discussion

The findings from the comparing analysis that was carried out indicate that water management measures implemented in the Lussebäcken has an important part in the flood management of the Lussebäcken catchment. The ponds and wetlands created in Lussebäcken catchment have a positive effect on both flooding extent and peak flows for the studied scenarios. The two-stage design compared to a traditional channel typically offer more capacity or space for water when the water rises, if combined with a restricting outlet design it will improve flood risk management. Moreover, implemented measures have a far bigger effect on the hydraulic conditions than the increased urbanization between the years 1969 and 2019.

Based on result from the flood mapping of the current state of the water course, it is concluded that Lussebäcken withstand a 100 year flood event well. Only a few major flood areas are caused. The peak flows are regulated throughs ponds, wetlands and several culverts. Flooding with a larger extent are commonly formed upstream culverts with limiting capacity and at stretches of the stream with a plane bedslope.

The upper part of Lussebäcken is the most regulated in the catchment. At the confluence of the eastern and northern branch downstream the Köpingegården pond a peak discharge is calculated to about 4 m^3/s. Upstream catchment area is 75% of the total Lussebäcken catchment. Over the next kilometer through Ramlösaravinen down to the railway the peak flow will double, even though the extra surfaces creating the load in the stream only measure up to 12% of the total catchment area. At the railway the water flow is distributed into two separate systems, either continuing in Lussebäcken with outfall in Råån or towards Gåsebäcken with outfall in the Ocean harbor. The discharge distribution is based on the magnitude of incoming discharge. A baseflow of about 0.25 m^3/s are designed to follow Lussebäcken towards Råån while higher discharges are diverted through a 1600-mm culvert towards the Ocean harbor. At times when the capacity of the culvert is insufficient an overflow weir towards Lussebäcken is used. The 100-year flood event for a scenario describing current state of the Lussebäcken has a calculated maximum peak discharge into Råån of 6.3 m^3/s. Consequently, these findings demonstrate that the measures implemented in the upper part of Lussebäcken regulate the discharge well and that the fast runoff from the urban areas surrounding the Ramlösaravin have a larger effect on the flood situation for the lower part of the Lussebäcken catchment. Another important structure that is highly affecting the flood situation in the lower part of Lussebäcken is the discharge distribution at the railway.

An evaluation of how well the available retention volumes in the Lussebäcken watercourse are utilized have been carried out. The measures introduced in the east branch of Lussebäcken have a well-designed flow reducing ability while in the northern branch there are room for optimization regarding flow reduction. The Ljusekulla detention pond has been identified as a pond with great potential of improvement in discharge reduction. By regulate the outflow of Ljusekulla pond to 0.4 m^3/s and raise the spillway to +46.6, the maximum discharge from Ljusekulla pond would decrease with 1.7 m^3/s. The proposed modification of the outlet design for Ljusekulla detention pond would create an extra storing volume with relatively simple measure and cost making it a promising alternative to building a new pond with the sole purpose of flood control.

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APPENDIX

APPENDIX A

Flood mapping

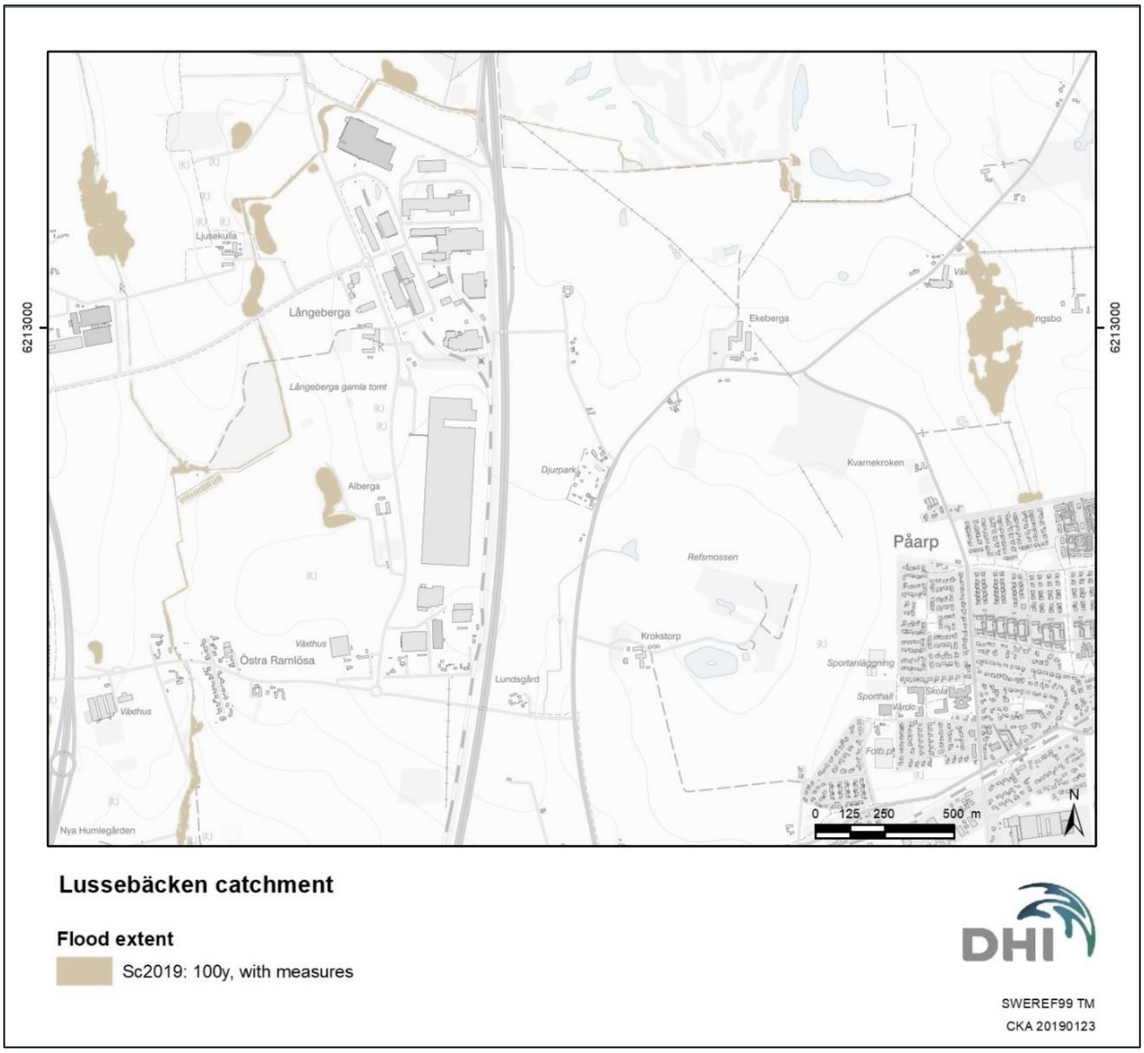
A AppHeading1

Flood simuations has been conducted for eight scenarios. Computed scenarios are presented below. Focus of the analysis has been on the upper part of Lussebäcken, upstream Ramlösaravinen.

In the presented figures the flood results for listed scenarios are presented:

- 100-year discharge, land use 2019 - with measures
- 10-year discharge, land use 2019 – with measures
- 100-year discharge, land use 1969 – with measures
- 10-year discharge, land use 1969 – with measures
- 100-year discharge, land use 2019 - no measures
- 10-year discharge, land use 2019 – no measures
- 100-year discharge, land use 1969 – no measures
- 10-year discharge, land use 1969 – no measures

A.1.1 100-year discharge, land use 2019 - with measures



Lussebäcken catchment

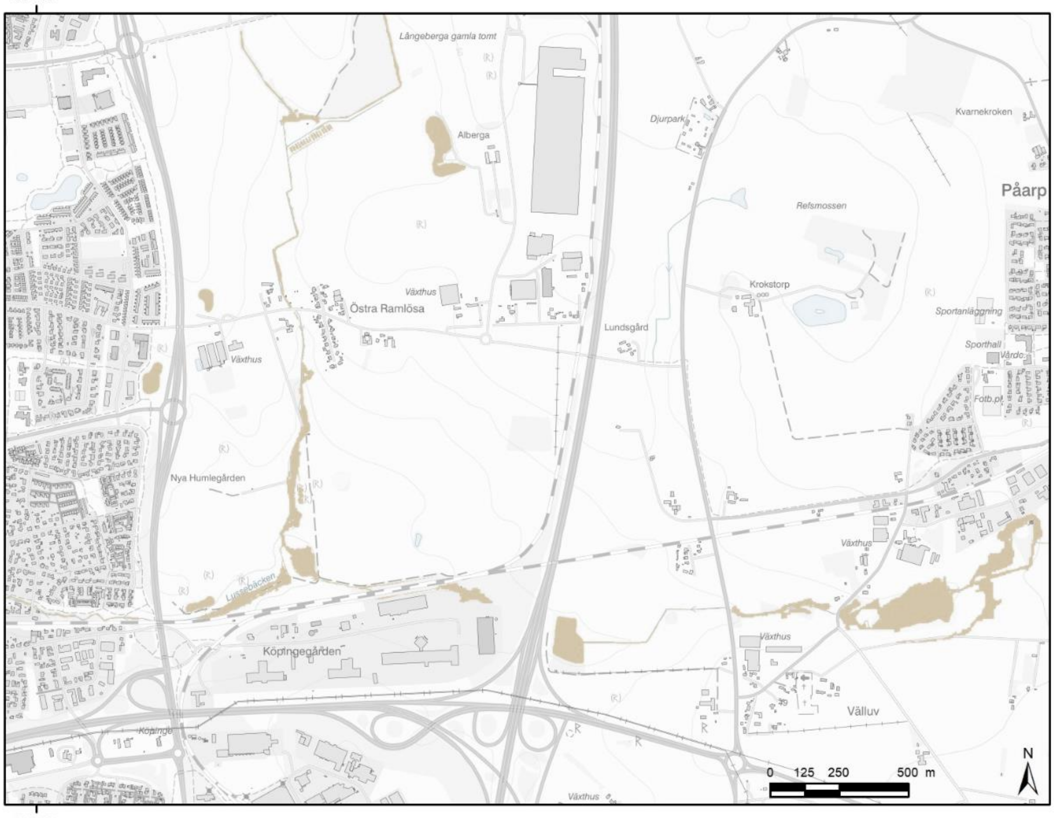
Flood extent

Sc2019: 100y, with measures

SWEREF99 TM

CKA 20190123

360000



360000

Lussebäcken catchment

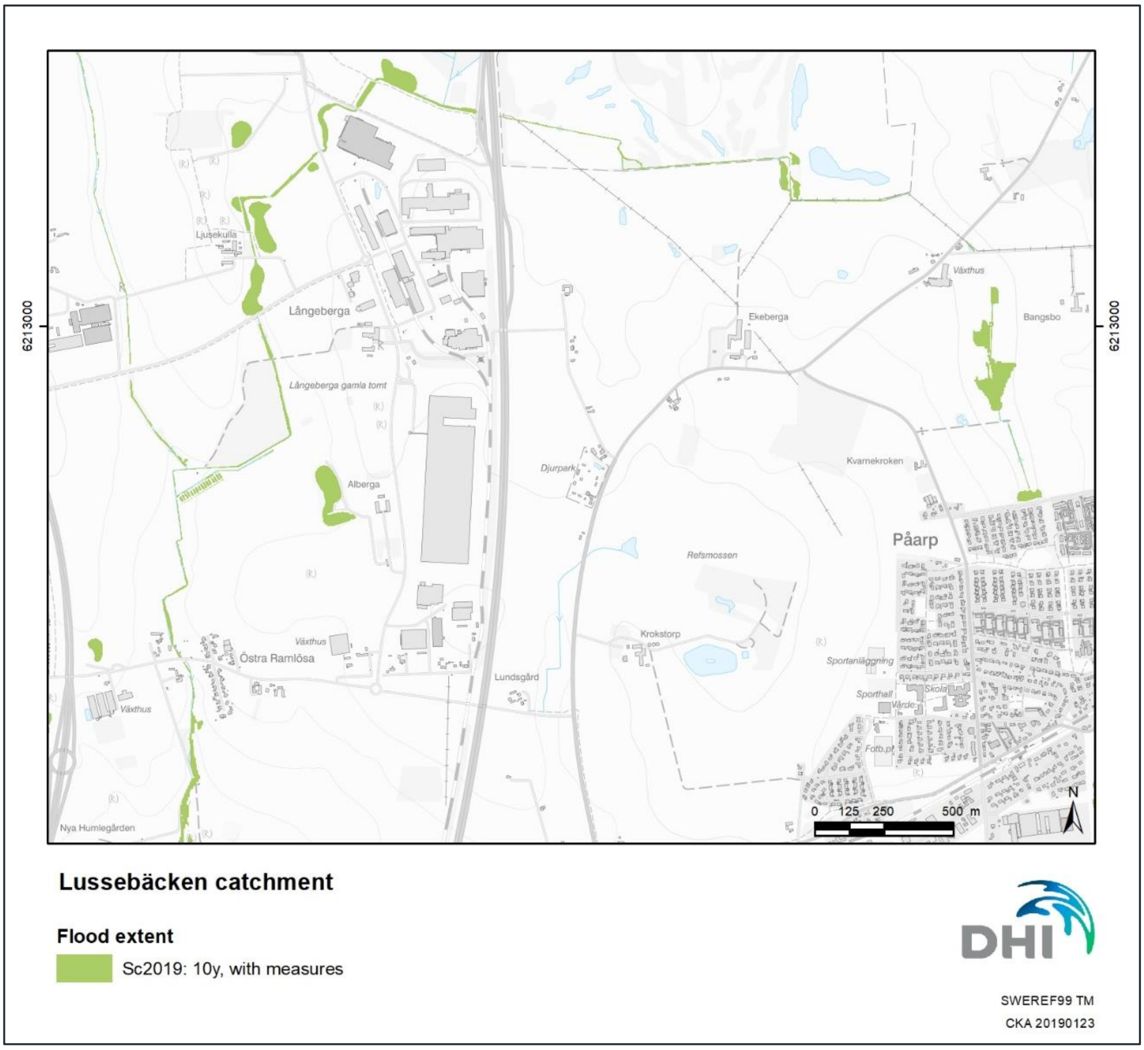
Flood extent

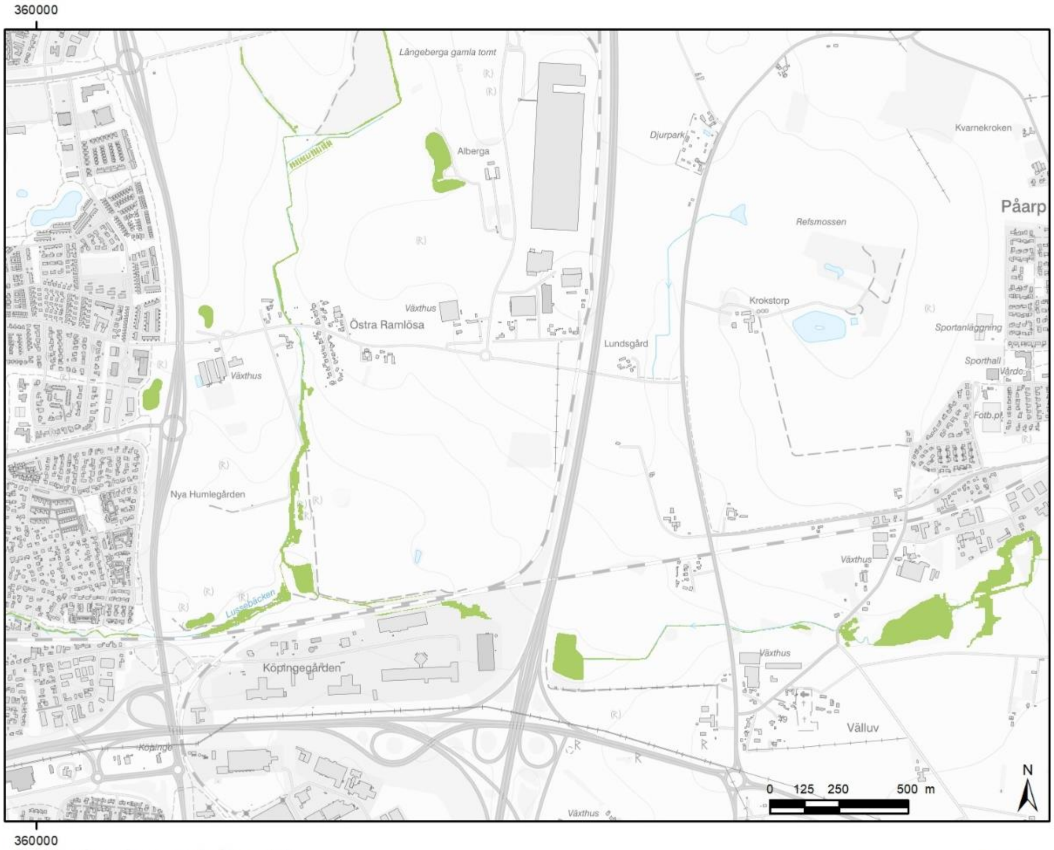
Sc2019: 100y, with measures

SWEREF99 TM

CKA 20190123

A.1.2 10-year discharge, land use 2019 - with measures





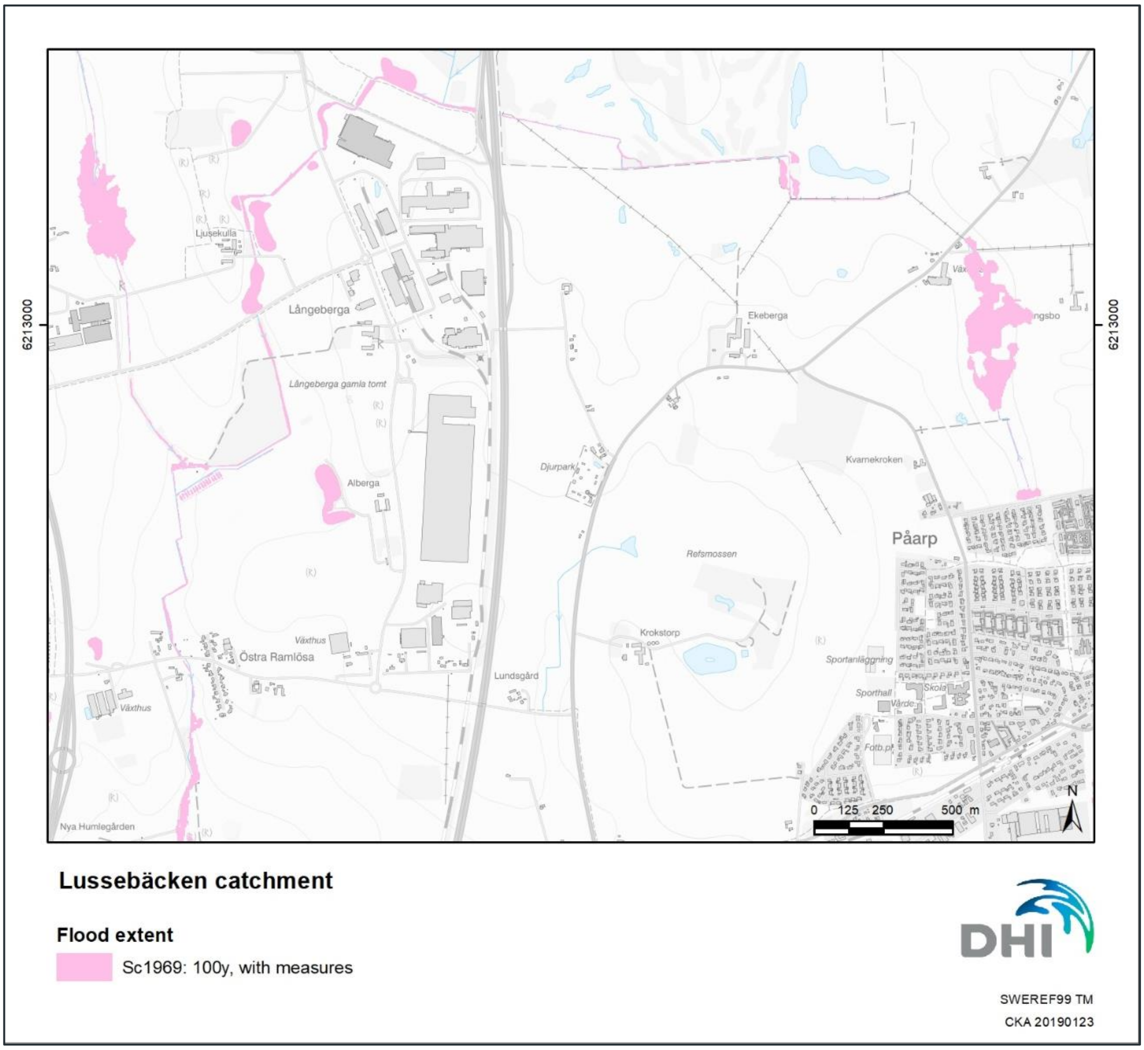
Lussebäcken catchment

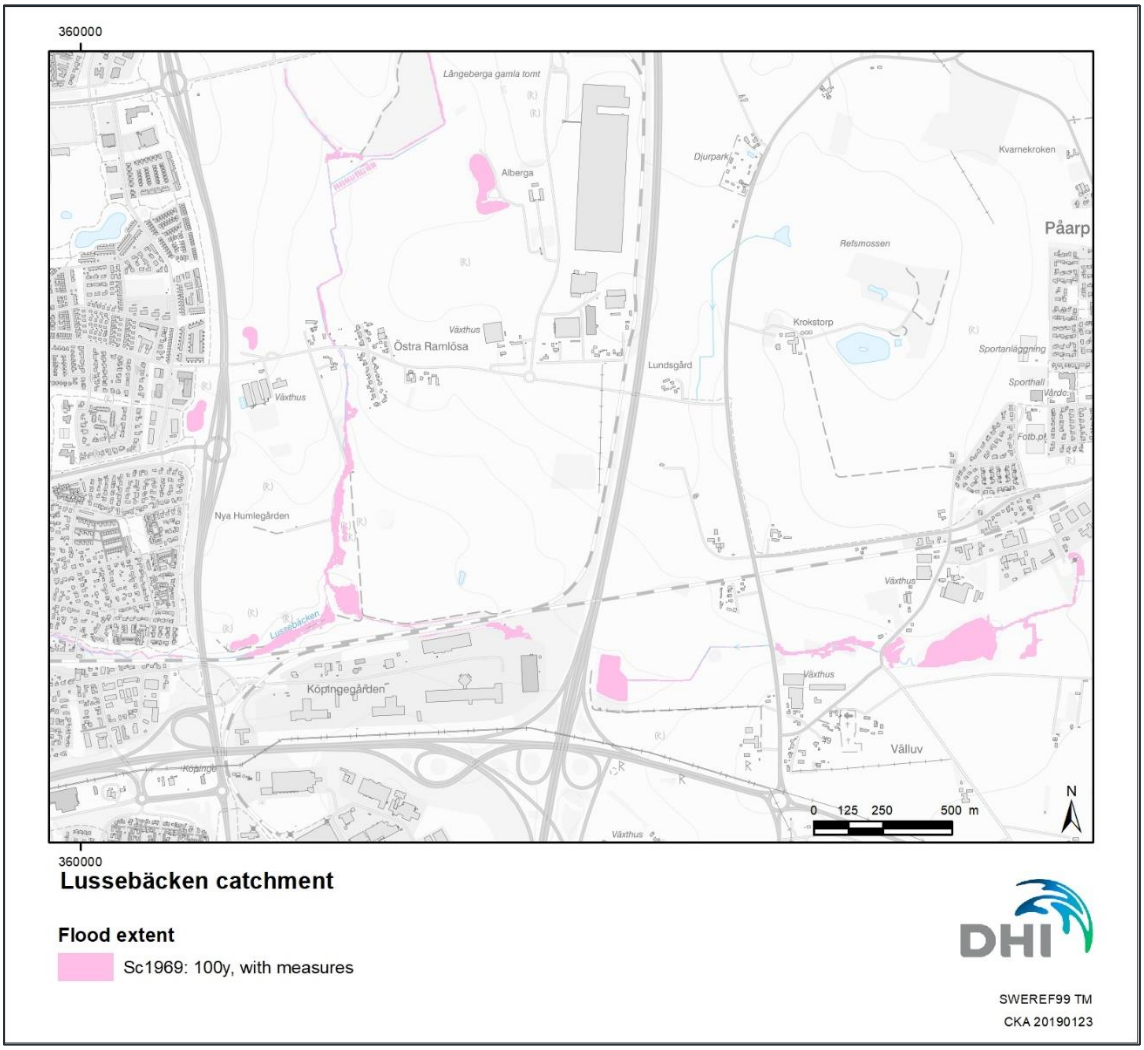
Flood extent

Sc2019: 10y, with measures

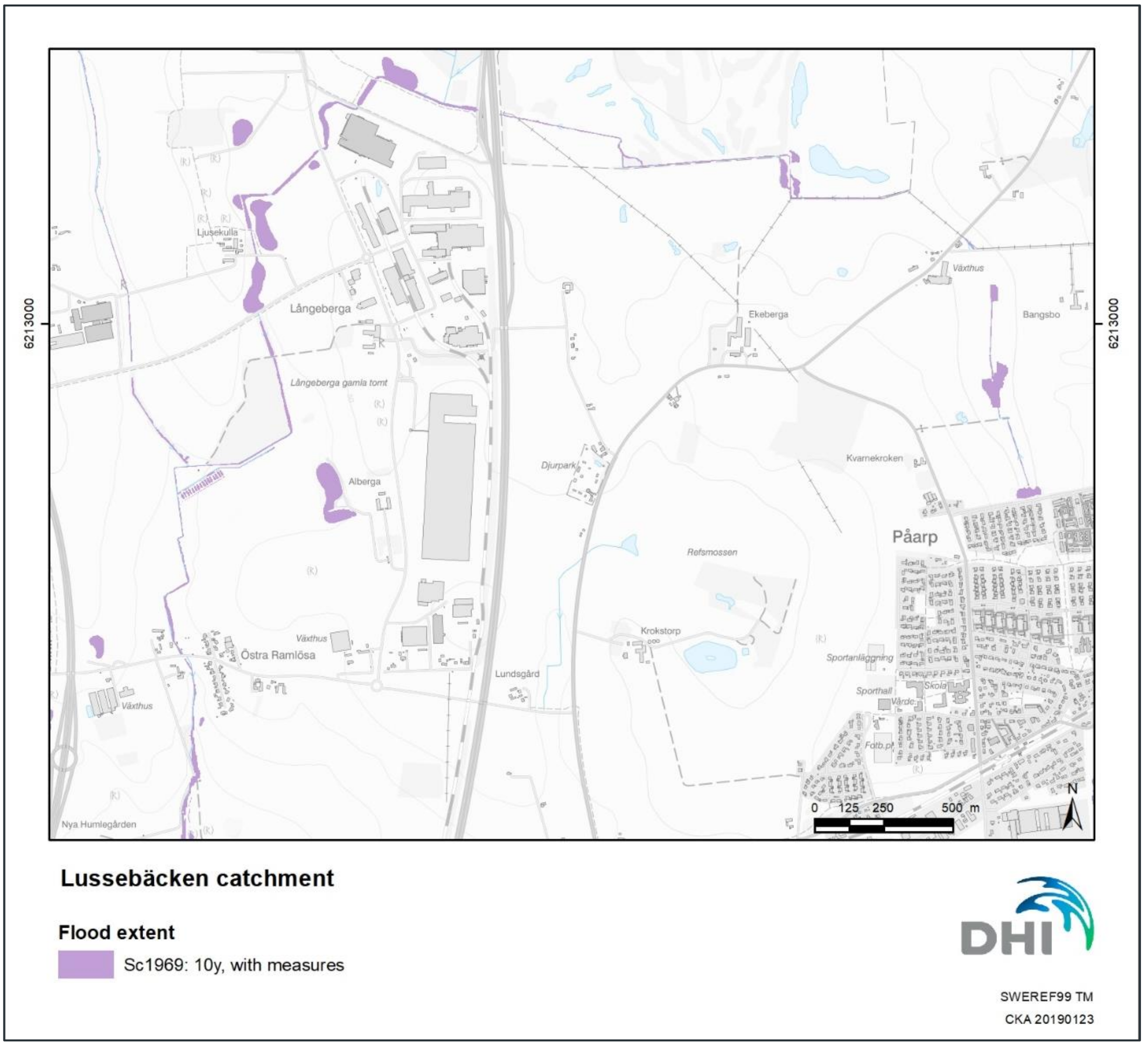
SWEREF99 TM
CKA 20190123

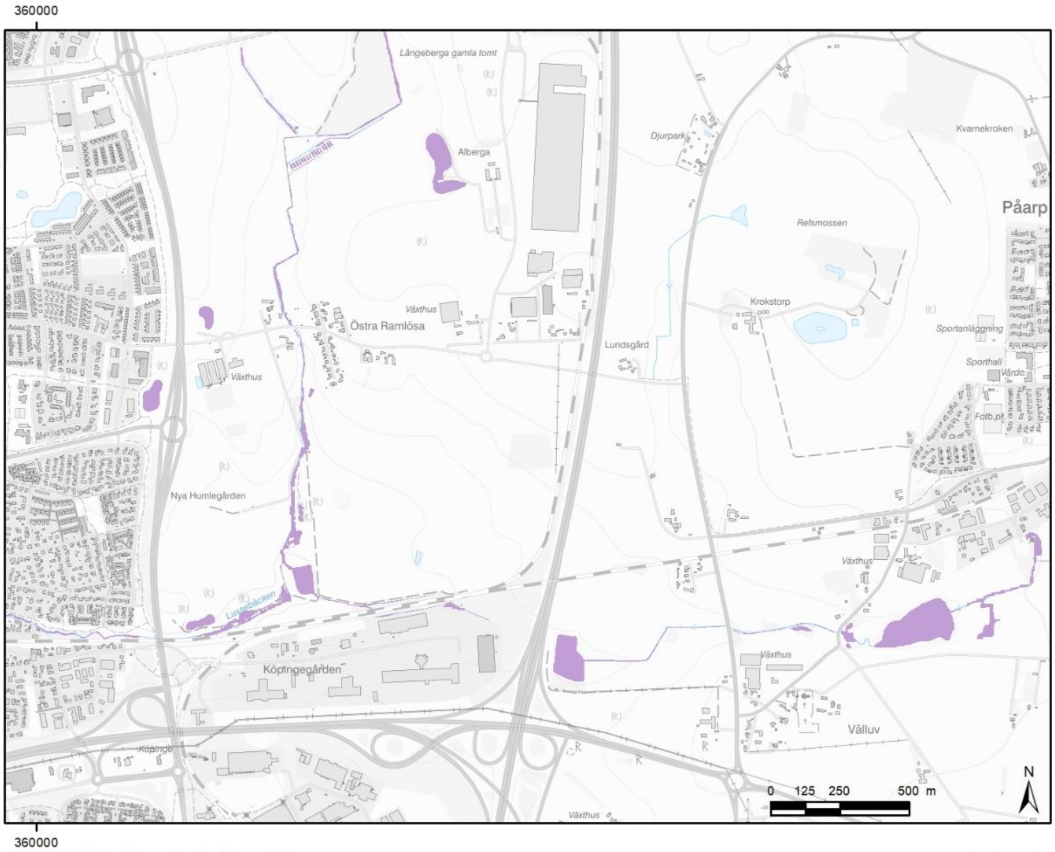
A.1.3 100-year discharge, land use 1969 - with measures




360000
Långeberga gamla tomt
Alberga
Djurpark
Kvarnekroken
Påarp
Refsmossen
Krokstorp
Sportanläggning
Sporthall
Vårdc.
Fotb.pl
Växthus
Östra Ramlösa
Lundsgård
Nya Humlegården
Lussebäcken
Köpingegården
Vålluv
0 125 250 500 m
N
360000
Lussebäcken catchment
Flood extent
Sc1969: 100y, with measures
SWEREF99 TM
CKA 20190123

A.1.4 10-year discharge, land use 1969 - with measures





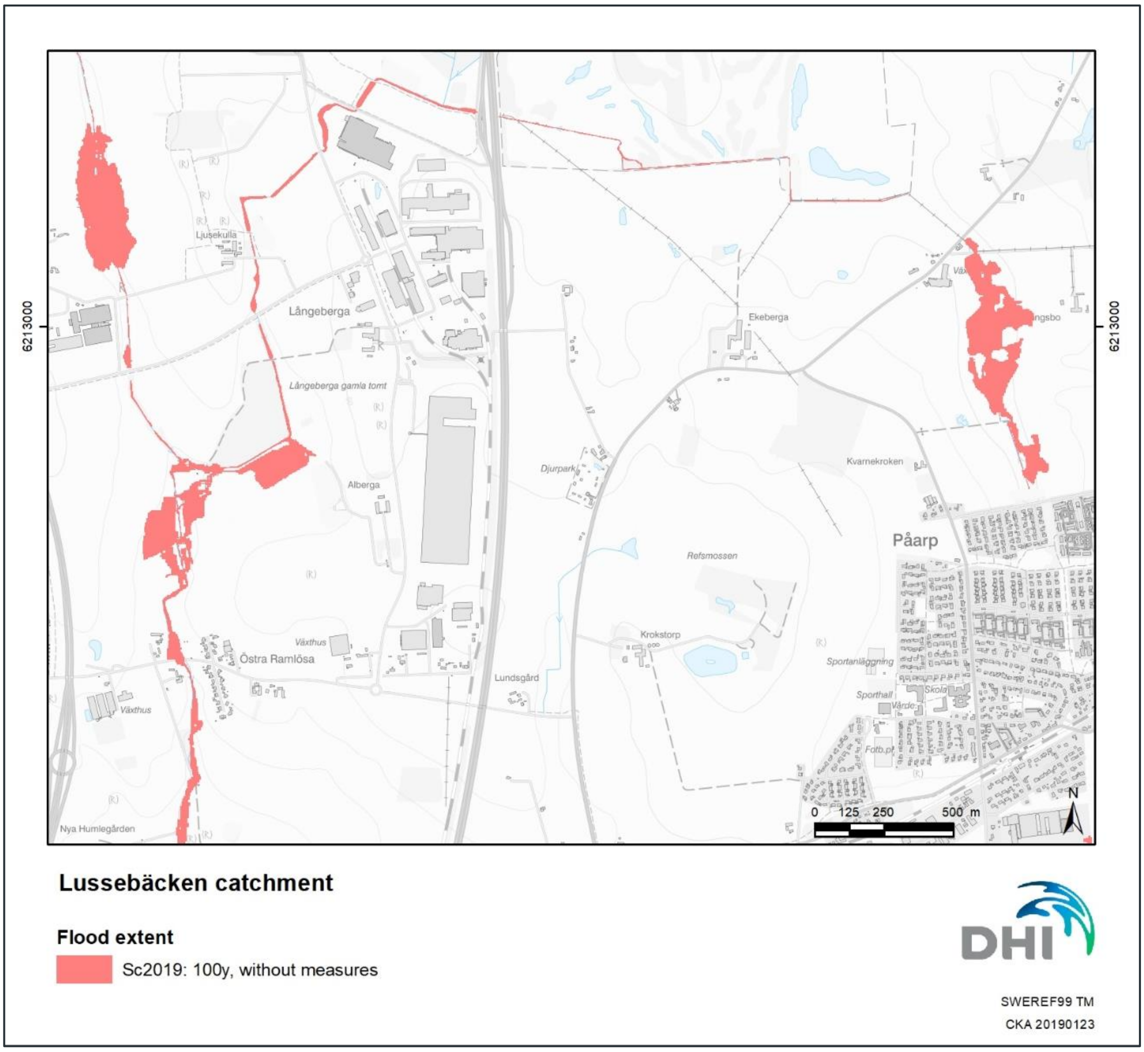
Lussebäcken catchment

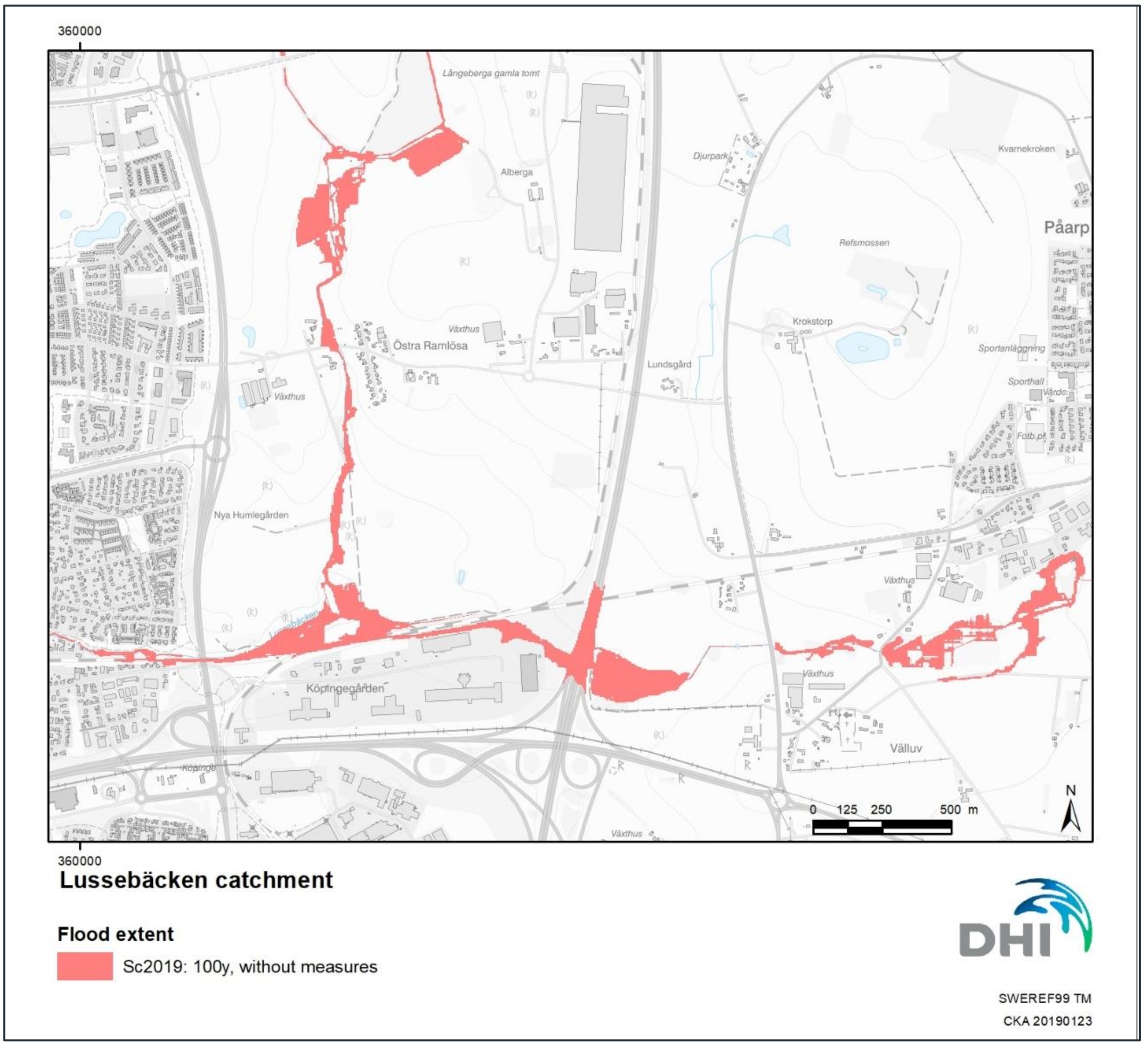
Flood extent

Sc1969: 10y, with measures

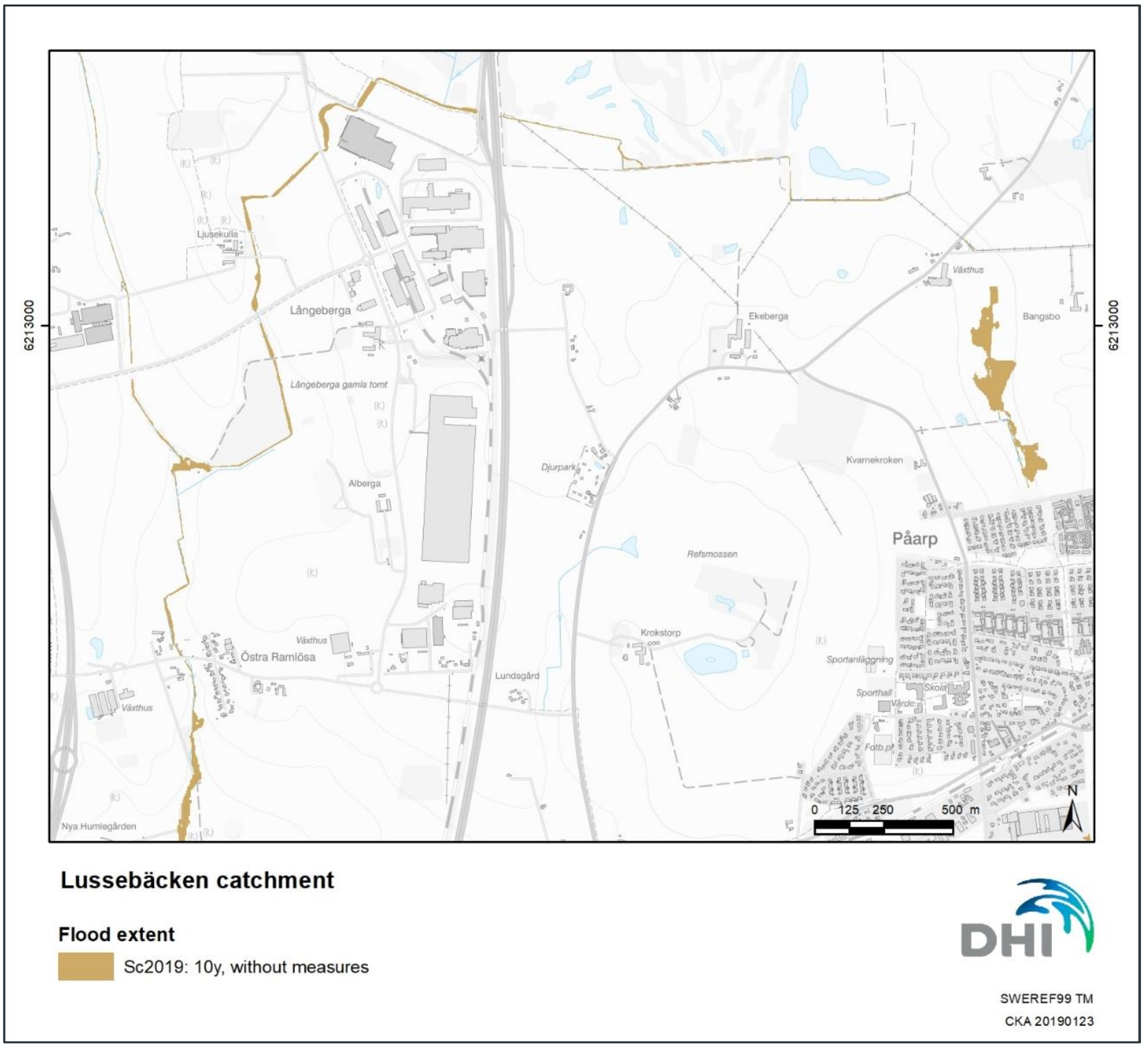
SWEREF99 TM
CKA 20190123

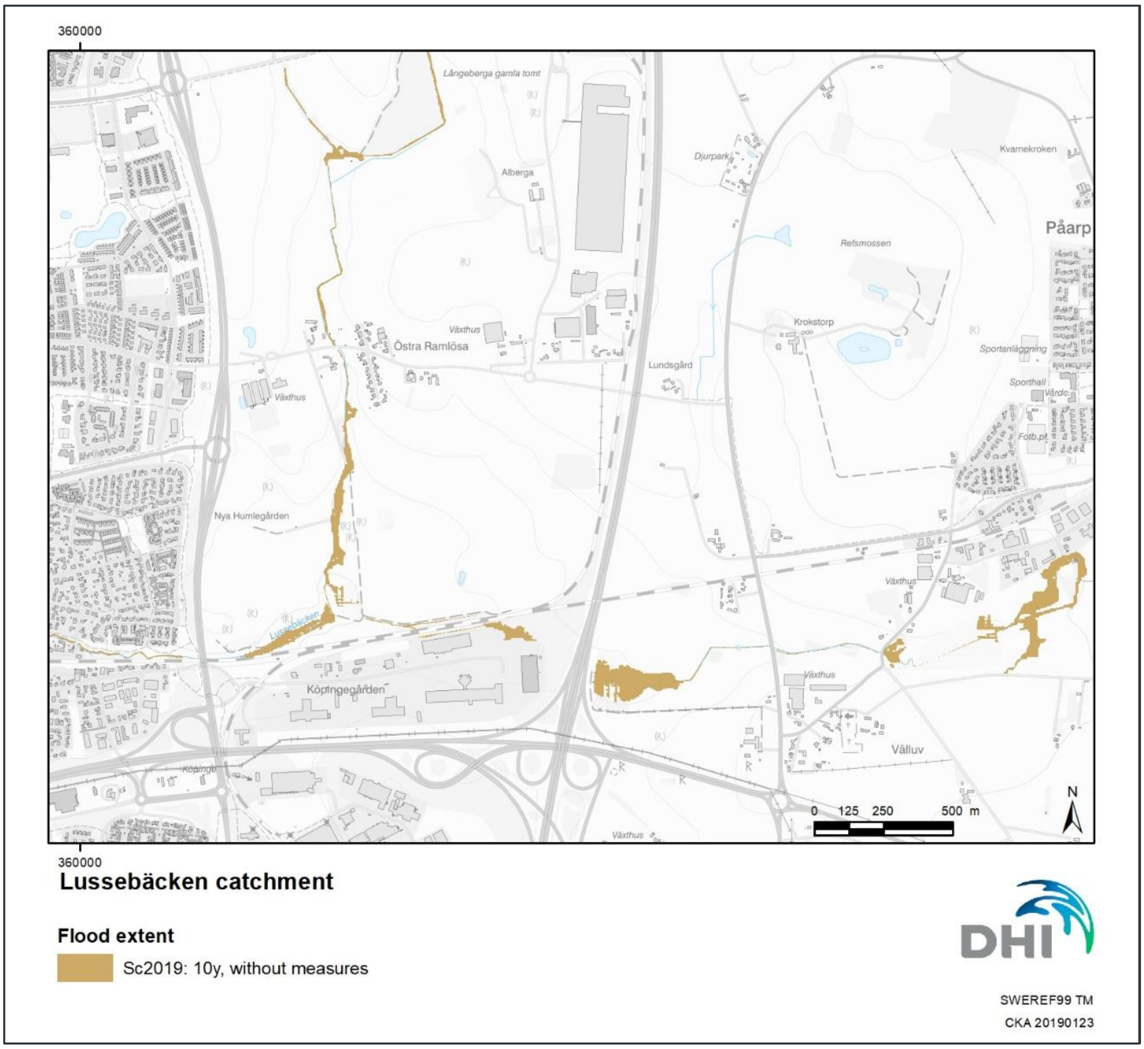
A.1.5 100-year discharge, land use 2019 - no measures



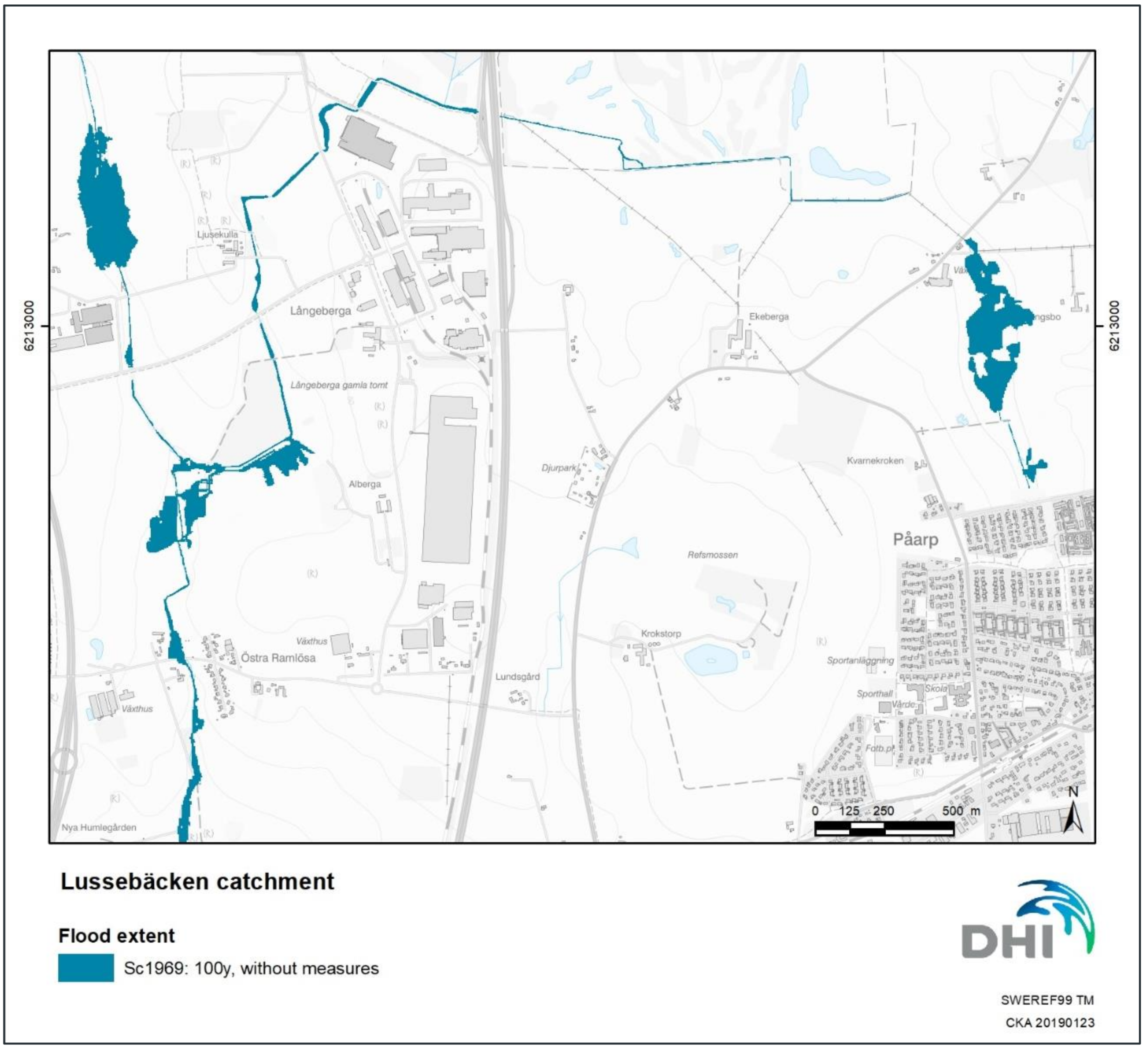

360000
Långeberga gamla tomt
Alberga
Djurpark
Kvarnekroken
Påarp
Refsmossen
Krokstorp
Växthus
Östra Ramlösa
Lundsgård
Sportanläggning
Sporthall
Växthus
Nya Humlegården
Köpingegården
Växthus
Välluv
0 125 250 500 m
N
360000
Lussebäcken catchment
Flood extent
Sc2019: 100y, without measures
SWEREF99 TM
CKA 20190123

A.1.6 10-year discharge, land use 2019 – no measures




360000
Långeberga gamla tomt
Alberga
Djurpark
Kvarnekroken
Påarp
Refsmossen
Krokstorp
Östra Ramlösa
Växthus
Lundsgård
Sportanläggning
Sporthall
Nya Humlegården
Lussebäcken
Köpingegården
Välluv
0 125 250 500 m
N
360000
Lussebäcken catchment
Flood extent
Sc2019: 10y, without measures
DHI
SWEREF99 TM
CKA 20190123

A.1.7 100-year discharge, land use 1969 – no measures



Lussebäcken catchment

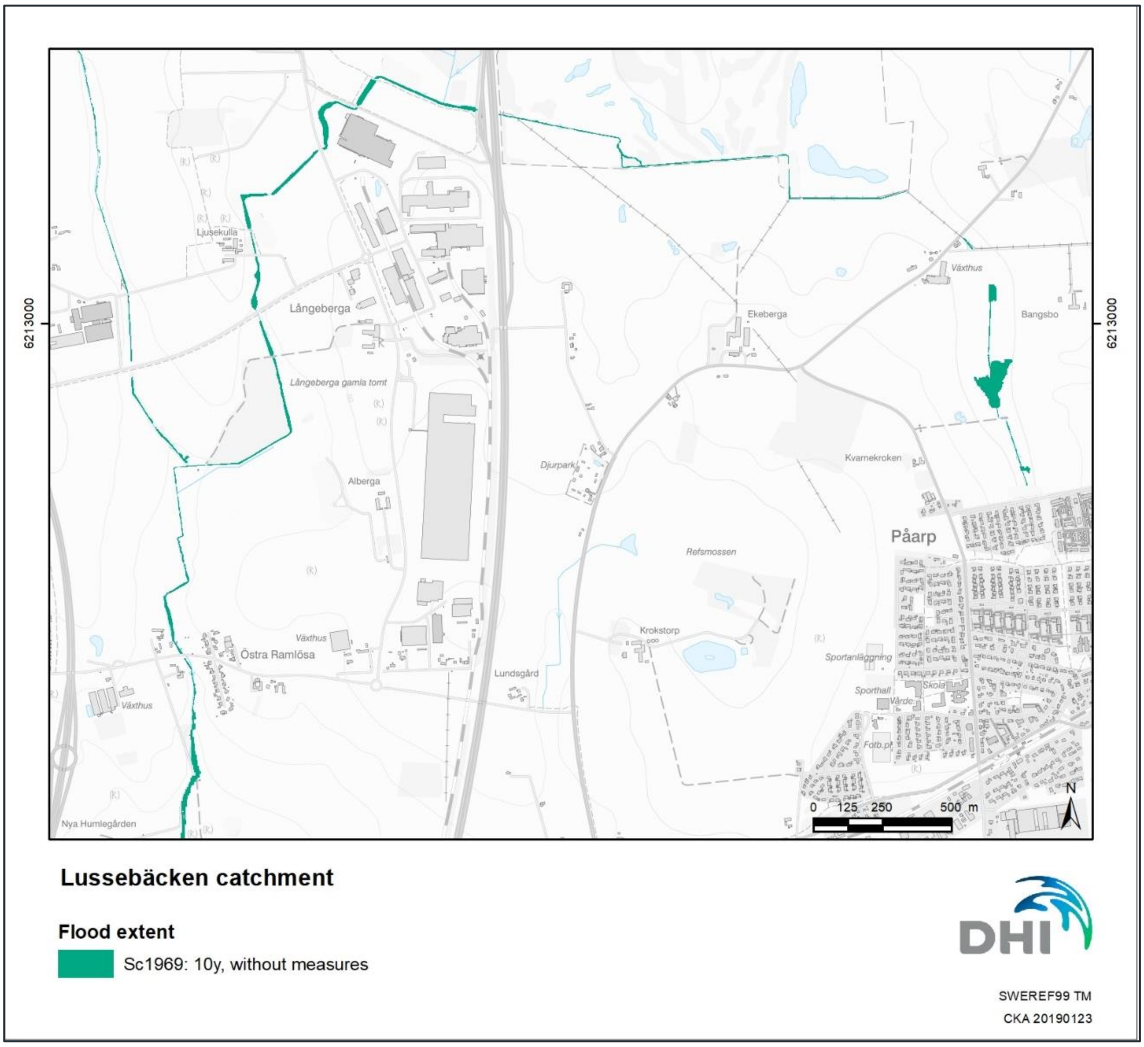
Flood extent

Sc1969: 100y, without measures

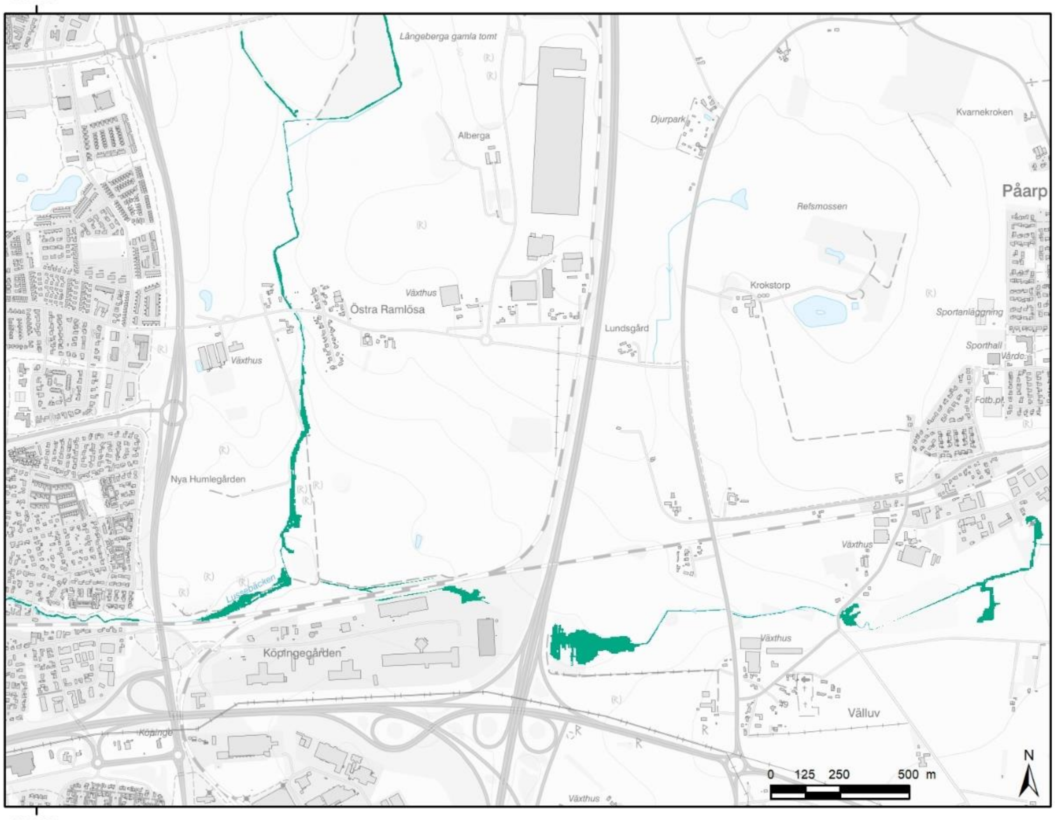
SWEREF99 TM

CKA 20190123

A.1.8 10-year discharge, land use 1969 – no measures



360000



360000

Lussebäcken catchment

Flood extent

Sc1969: 10y, without measures

SWEREF99 TM
CKA 20190123