Which types of rainfall cause urban flooding

Sörensen, Johanna

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Which types of rainfall cause urban flooding

Johanna Sörensen

Water Resources Engineering, Lund University

The SuRF Project

Pluvial flooding is the most common type of flooding in Malmö. Only a very few flood claims have been registered during high sea level caused by storms and there is only one minor watercourse in Malmö (Riseberga Brook/Sege Brook), which seems not to be severely affected by riverine flooding. All of the eleven biggest flood events during the 20-year period are caused by local or wide-spread rainfall events. These eleven events account for about 80% of the flood claims reported to the water utility VA Syd and the insurance company Länsförsäkringar Skåne. Three severe, pluvial flood events are presented in the study: 5 July 2007 with 150 and 169 flood claims to VA Syd and Länsförsäkringar Skåne respectively, 14 August 2010 with 210 and 148 flood claims, and 31 August 2014 with 2 109 and 2 649 flood claims. These flood events were all caused by heavy rainfall distributed over the entire city. The 2010 and 2014 events were intense and with a quick development, while the 2007 event was less intense, but with a long period of pre-event rainfall. The 2014 event was heavier than a 100-year event for durations between 3 and 16 h (average for all stations in Malmö).

There is a relation between large-scale topography and flooding in Malmö. Areas within 100 m from the major system are more than twice as affected by flooding, compared to areas further away. During the severe flood events in 2010 and 2014, areas close to the major system were even more affected by flooding (3.0–4.2 times), compared to areas further away. During such downpours, runoff is quickly directed towards low-lying areas, both through the pipe system and by overland flow. In Malmö, like probably in most other places, the main sewers (minor system) are located under the main overland flow paths (major system), as they follow the topography. The spatial distribution during these two, highly intensive rainfall events (2010 and 2014) were different than during other events, with more flood claims clustered around the main sewers. For the other events, including the 2007 event, the flood claims were more evenly distributed within the city (Figure 1).

The combined system is more exposed to flooding than the separate system. Even if only 31% of the urban land in Malmö is connected to the combined system, 70% of the flood claims are reported from these areas.

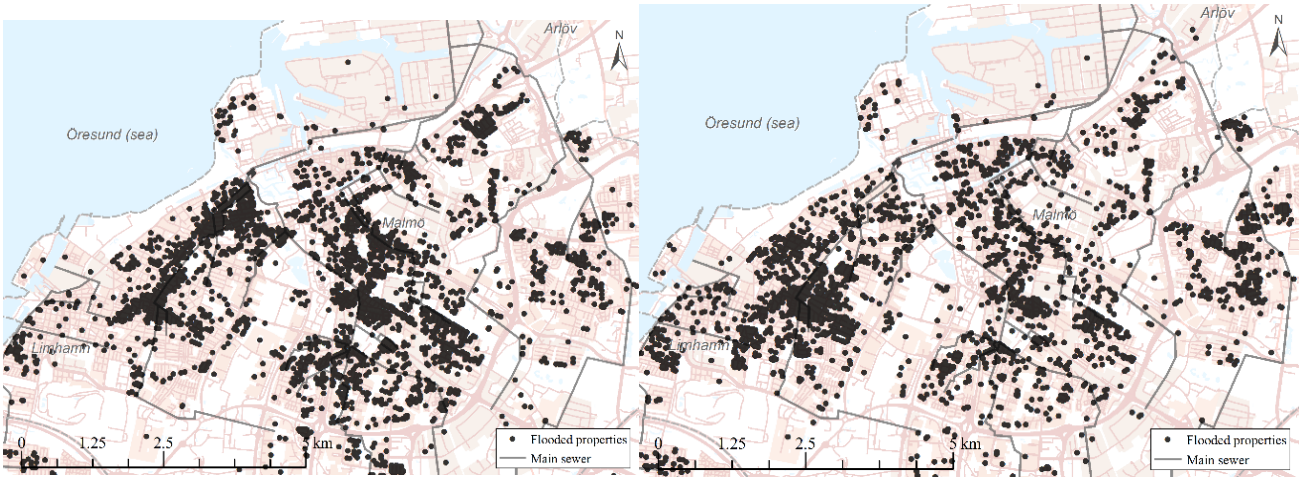

Figure 1. *Left: Flood claims reported by LF Skåne and VA Syd during two of the three severe flood events in Malmö (2010 and 2014). Right: Flood claims reported by LF Skåne and VA Syd during all other events, except for two severe flood events (2010 and 2014).*

During the 2010 and 2014 events, the combined system was 3.8–4.2 times more affected by flooding compare to the separate system. Similar figures are found if all flood events are included. The 2007 event shows a different pattern: the combined system areas were only slightly more than twice (2.3 times) as severely affected by flooding during this event, compared to the areas with separate system. One reason why the 2007 event differs from the other events might be the difference in flood causality, where continuous rainfall during the preceding weeks saturated the ground with water. Flooding during this event was therefore less related to type of drainage system. The dataset is biased as more people live in areas with combined system. However, the difference in reported flood claims still exists when adjusted for this bias.

Locally, some flooding is caused by breakdown of the system, e.g. when a sewer pump stops pumping due to system error. On the one hand, the phenomenon with local breakdowns could be seen as unique incidents that are not likely to happen during future flood events. On the other hand, and in reality, it seems inevitable that a few of these unique incidents happen during every flood event.