Economic analyses of urban subsidence in Gouda and Amsterdam, the Netherlands

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Abstract

This paper presents the updated research on an approach and outcomes of two exploratory economic analyses of subsidence: 1) in the inner city of Gouda, the Netherlands; 2) in five areas in the city of Amsterdam, the Netherlands. Results from the Gouda case study indicate that especially the mitigation strategy focusing on reducing damage, rather than a strategy aiming to halt subsidence altogether, might have a positive economic rationale. Results from the Amsterdam case study show that there is no single approach that works for all areas and other neighborhoods in the municipality of Amsterdam. The methodological framework for economic analysis in a subsidence context does however help to quantify and compare the main expected damages for each research area.

Introduction

In the Netherlands, subsidence of clay and peat soils is mainly caused by artificial lowering of phreatic groundwater levels, and soft-soil loading by buildings and infrastructure. Expected damages are significant: estimated at EUR ~ 22 billion until 2050 (van den Born et al., 2016). As in the Netherlands land subsidence is mostly human-induced, much of this damage may be prevented: the rate of subsidence can be reduced, and/or structural or non-structural measures can be taken to minimize the negative effects of land subsidence. As subsidence mechanisms and asset exposure characteristics differ across rural and urban areas, but also within urban areas (e.g. new urban developments versus historic city centers), the optimal approach needs to be targeted to local circumstances.

Kok & Hommes-Slag (2020) demonstrate how the economic rationale for interventions in a subsidence context was determined in the case of Gouda, the Netherlands. Although economic estimates in the analysis are specific to the context of a subsiding historic urban zone with a mix of shallow and piled foundations, the methodological framework used is applicable to other subsidence contexts as well. In this update, an extra economic rationale (quick scan) is added for five research areas in the city of Amsterdam, the Netherlands.

Methods

The quick scan carried out for the city of Amsterdam consists of two parts: 1) an analysis when ‘tipping points' can be expected to be reached affecting the quality of life in an area; 2) Indication of economic effects of subsidence. This paper focuses on the second part of the quick scan. This part uses the same methodological framework that was used in the case of Gouda (Kok & Hommes-Slag, 2020).

Results

The results from the quick scan for the city of Amsterdam show a differentiated picture between the five research areas. The various causes and aspects of the subsidence problem of the five areas are reflected in the economic damage. In areas where buildings are founded on piles and where the ground level drops significantly, a lot of damage is expected to cable & pipe connections and reduced

accessibility of buildings. In the research area, where buildings are built on shallow foundations, the decreasing drainage depth with consequent frequent groundwater flooding of buildings is the dominant problem. However, the slight subsidence in this area only has a small effect on the aggravation of this problem. In one of the research areas a variety of problems plays a role. The main process is damage to foundations due to the low groundwater level due to the proximity of a low-lying park. Decline of cultural heritage (monumental buildings and trees) calls for urgent action in this area.

On a methodological level, we can conclude that the framework that is used for the cost-benefit analysis in Gouda and Amsterdam is helpful in pointing out the main expected economic effects.

Conclusion

Unfortunately, there is no single approach that works for all areas and other neighborhoods in the municipality of Amsterdam that provides a ready-made answer to subsidence. Therefore, further research is needed to adapt the approach to local circumstances.

The quick scan does show that all areas will have to deal with subsidence. The extent to which differs per research area. It is recommended to further investigate the level of subsidence in the area, the groundwater levels and subsidence of the buildings. It is also recommended to build a detailed and validated groundwater and subsidence model of the entire city. Together with a detailed description of the (geotechnical) properties and structure of the subsoil, more well-founded statements can be made about changes in the future (e.g. due to climate change) and the effect on the expected damage.

In any case, this quick scan shows that subsidence can be a serious problem in parts of the built environment of Amsterdam, next to the parks and rural peat meadow areas, which are already on the agenda for dealing with subsidence. What this exactly means for the whole of the municipality of Amsterdam requires a further analysis of both the problem and the possible solutions and the responsibilities of the different parties.

References

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