Changing best practise methods in climate adaptation project design and implementation in urban areas

Modifier les bonnes pratiques de conception et mise en œuvre des projets d'adaptation aux changements climatiques en zones urbaines

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RÉSUMÉ

La mise en œuvre de mesures de contrôle de l'écoulement des eaux pluviales pour réduire les risques d'inondations en zones urbaines est confrontée à des défis importants en raison des restrictions spatiales et de l'existence d'infrastructures souterraines complexes.
Cette étude propose un ensemble de méthodes de bonnes pratiques fondées sur l'expérience de deux cas concrets à Copenhague et sur l'étude de projets semblables situés principalement au Danemark.
Pour ces deux cas, l'ampleur et le niveau de détails avaient été réduits durant la phase d'études de conception préliminaire, afin de permettre la mise en œuvre des projets le plus rapidement possible. Mais ils ont connu des retards significatifs et des hausses de budgets en raison de conflits et de difficultés liées aux infrastructures souterraines existantes.
A travers ce retour d'expérience, et celui d'autres projets similaires, il est constaté que le renforcement du contenu des phases de conception préliminaire, avec une collecte plus complète de données et l'évaluation des risques portant sur les aspects critiques, conduira à des projets plus robustes et permettra de réduire les risques économiques et techniques.

ABSTRACT

Implementation of storm water control measures to reduce the risk of flooding in urban areas face significant challenges due to spatial restrictions and existing complex underground infrastructure. This study proposes a set of best practise methods based on experiences from two concrete cases in Copenhagen as well as studies of similar projects mainly located in Denmark. The two specific cases both had reduced scope and detail level in the preliminary design phases, in order to start the implementing the projects as early as possible.
Both cases experienced severe delays and increased budgets due to conflicts and challenges with existing underground infrastructure. Based on this and experience with similar projects, it is found that expanding early design phases, with a much more comprehensive data collection and risk assessment of critical points, will lead to more robust projects and reduced risk for economic and technical shortcomings.

KEYWORDS

Best practise, Climate adaptation, risk assessment, urban areas

1 INTRODUCTION

With the increasing intensity and frequency of cloudbursts, city centres and fully developed urban areas face an increasing risk of sustaining flood damages. Risks are being amplified by the high share of hard surfaces and limited open space. To accommodate and reduce the risk of floods, Danish cities are increasingly changing their sewer systems from combined sewers to separated storm water systems, which are adapted to increased rain quantities and intensities. The overall goal is to diverge flooding to areas where the potential damages are acceptable or eliminated. This could be green areas without critical infrastructure or water bodies, such as lakes, streams or the sea. However, in a dense urban area green spaces tend to be scarce, and discharge to the sea complicated and expensive.

Typically the available areas underneath roads and parking lots in urban areas are filled with century's worth of utility piping, such as water supply pipes, waste water pipes, cooling and high voltage cables and their exact location and size can be rather uncertain. Thus, these existing utilities pose a huge potential risk for the successful implementation of storm water solutions, be it surface or pipe based. Especially because their actual impact on the proposed project are unknown until the excavation starts. Proposed storm water and climate adaptation projects might ultimately end up shutting down due to increased construction costs or substantial project changes, not approved by the project owner.

The purpose of this study is to identify a set of best practise methods and investigations to be conducted when implementing climate adaptation solutions in fully developed urban areas, and highlight the potential consequences of deviating from these. The study identifies risks based on general data from relevant projects in the greater Copenhagen area, where existing conditions had a large impact on the final design.

2 METHOD

To identify a set of best practise methods, experiences from two cases where similar conditions and complications are present, have been collected and compared. Both projects ended up with significant changes in the original outlines, due to complications with existing conditions, primarily underground infrastructure pipes.

The experiences from the two cases are compared to general findings and lessons learned from similar projects. The latter is included by comparing standard evaluation reports submitted following the completion of projects conducted by Ramboll.

3 CASES AND RESULTS

3.1 Cases

In the following, the two cases will be presented, and the lessons learned from these as well as other similar projects are presented with suggestions on regarding altered best practise methods used when designing cloud burst projects in urban areas.

3.1.1 First case - climate adaptation on Sankt Annæ Square

In the case of climate adaptation on Sankt Annæ Square in the historic centre of Copenhagen, a landscaping solution with an urban river on the square was initially planned. This should transport cloudburst water on the terrain straight to the harbour. However, during the detailed design phase it became clear, that the proposed project could not be carried through due to an existing 120 year old wastewater pipe of significant historical value.

Altering the project design from a longitudinal river to a local storage of cloudburst water in four separated basins only temporarily solved the problems the project was facing. Three months before the end of the detailed design phase, it was discovered that various existing utilities, including cooling pipes, old sewers and high voltage cables, blocked the collected water from reaching the sea, by literally forming a wall down to 6 meters below terrain, and thereby preventing a conventional piping solution. The solution became a more creative and innovative design shown in Figure 1, where the cloudburst pipes weave in between existing utilities.

Figure 1. Cloudburst pipes barely able to pass between existing utilities.

The first changes to the project design were made late in the detailed design stages and caused significant delays in the final project.

Several new solutions were designed during the construction phase, such as splitting a large pipe in smaller pipes, to pass in between existing utility pipes. This increased the complexity and level of uncertainty of the project and the risk of implementing an insufficient or ineffective solution. The construction costs for the cloudburst pipes and constructions increased with about 55%, compared with the prices collected in the original tender.

3.1.2 Second case - recreational park combined with a rainwater retention basin

The second case is a recreational park combined with a rainwater retention basin located on an old parking lot, designed to protect the new main building of the pharmaceutical company Lundbeck, that was completely flooded during a cloudburst in 2011.

The project was rushed through the initial design phases. During implementation various unknown infrastructure pipes emerged, these included high voltage cables, fiber optics cables and cooling pipes, and their appearance caused a complete redesign during the excavation period.

Figure 2 shows the originally planned project of one large rainwater basin handling rainwater from the area and the final design which consists of three connected basins separated by the existing utilities in the ground.

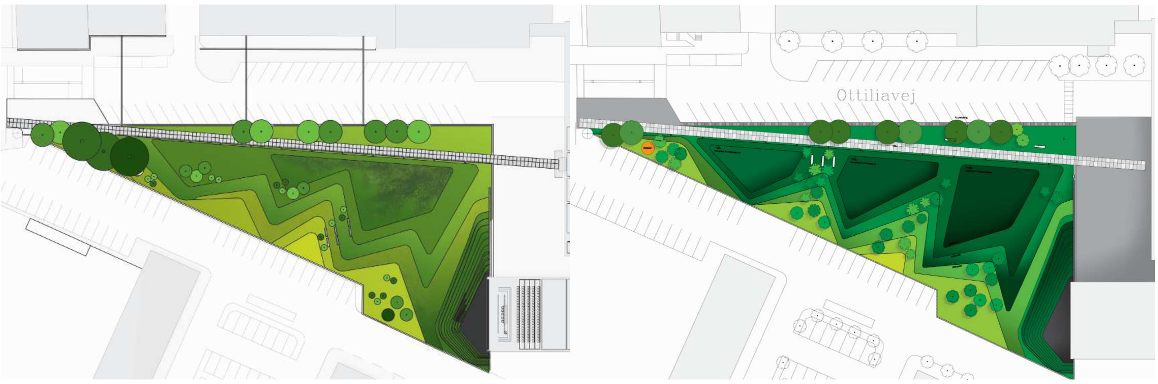

Figure 2. Lundbeck - Originally proposed project, with only one large basin for rainwater retention (left) and final design, with 3 connected rainwater retention basins (right)

A complete redesign of the approved landscaping design, while contractors were waiting, increased economic expense of around 60% of the initial contract budget as well as causing a general delay.

3.2 Results and suggestions for best practise methods

The study shows that, even though most utility companies have their pipes and cables digitally mapped, that data can at best be used a guideline. Quite frequently even large pipes can be misplaced with several meters both spatially and vertically, and this is expected not to be just a Danish phenomenon, but more a generally occurring problem for all urban areas. The study also shows that data collection and risk identification of potential complications are a necessity and that project owners and decision makers have an exaggerated focus on completion date, leaving the projects vulnerable to unforeseen obstacles and challenges, by reducing or skipping the initial design phases, as was the experience in both described cases.

The study concludes that it is crucial that project proposals are extended to map potential uncertainty sources, and alternative solutions. Once the primary project uncertainties and risks have been mapped, these should be minimized, primarily by trial excavations if they are utility based, and if not by a risk assessment analysis. If it shows impossible to minimize an identified project risk, useful alternatives could be prepared in advance, in case they become necessary.

Early design phases should include more thorough data collection, including trial excavations and should include an actual risk assessment for the project area in question, with enhanced focus on potential risks from existing utilities. Once thorough data has been collected, 3D design of the proposed systems will also aid in locating potential collisions between utilities. Best practises for this type of projects can thus be summed to:

- Data on existing utilities are only guidelines
- Conduct thorough investigations of the area in question
- Identify potential risk areas and prioritize them according to complexity and potential construction costs
- Minimize the identified risks using trial excavations and other measures like pipeline video inspections and surveyors.
- For unsolved identified risks design potential alternative solutions
- Design the project in 3D models, in order to identify pipe collisions

4 CONCLUSION

To achieve best practice, a general change in attitude is necessary within project owners and decision makers. Implementing risk assessments and more detailed data collection will increase the cost of the initial project phases, but also increase quality of project design thus making the projects more robust in regards to uncertainties, ultimately the projects will most likely be both cheaper and faster to implement. However experience show, that this is rarely the case. As it is today, there appear to be a general consensus, that the sooner a project starts the construction phase, the sooner it is done. This means, that in many projects preliminary the data collection and preliminary phases are cut short.

Common for the greater Copenhagen area and larger European cities is the limitation in space for surface based rainwater retention and the high presence of underground utilities. The study show, that storm water management projects carried out in urban areas have a high risk of economic or physical failure or shortcomings. The risks are mainly associated with the potential increase in construction costs and the development of less suitable solutions, due to uncertainties regarding existing conditions. Thus the best practices suggested in this study can be applied where similar conditions and complications are present, regardless of geography.