ICUD-0454 Retrofitting of urban areas: Climate proof for the same cost

J. Kluck[1], L. Kleerekoper[2], F. Boogaard[3], J. Tipping[3]

1 Amsterdam University of Applied Sciences, Techical Faculty, Amsterdam, Netherlands
2 Amsterdam University of Applied Sciences, Technical Faculty, Amsterdam, Netherlands
3 Hanze University of Applied Sciences, Groningen, Netherlands

Summary

Due to climate change the frequency of extreme precipitation is set to increase. To reduce the risk of damage, Dutch municipalities will need to retrofit the urban areas in a climate resilient (CR) way. To justify this investment, they need evidence for the possibilities of CR urban street designs and insight into the costs. For characteristic Dutch typologies of urban residential areas we have investigated how to retrofit the urban area. For 10 cases we designed alternatives of street lay-outs and determined the life cycle costs and benefits. This showed that most flat Dutch urban typologies can easily be retrofitted in a CR way without additional costs (compared to the standard designs).

Keywords

climate adaptation, water, urban typologies, retrofitting

Introduction

Due to climate change the frequency of extreme precipitation is set to increase further. To reduce the risk of damage from these cloudbursts, Dutch municipalities will have to retrofit the urban areas in a CR way (DPRA, 2014). Several municipalities expressed that they required evidence of typical case examples showing climate proofing designs are feasible and not too technically complex. It was therefore necessary to show the possibilities of CR urban street designs and provide insight in the costs.

Methods and Materials

For characteristic Dutch typologies of urban residential areas we have investigated how to include climate proofing options when carrying out the infrastructure retrofitting of a street that is required on an intermittent basis . For ten cases we designed alternatives of street lay-outs and determined the life cycle costs and benefits using a design tool that we developed for this purpose. This tool calculates the net present value of costs for retrofitting (e.g. sewers, pavement, grass, trees) as well as maintenance costs. It also calculates flood damage to properties based on the expected likelihood of extreme cloudbursts. The tool allows to carry out sensitivity analyses of various parameters in the design. Along with the cost of retrofitting streets, the tool gives an estimation of the additional benefits of vegetation (trees, grass, hedges) in the street, based on the TEEB-method (KPMG, 2012).

We used urban typologies as a framework to investigate the possibilities of climate proofing in different streets. The typologies differ in building period, density of building, typology of houses and are easily recognized by urban planners and designers (Kleerekoper, 2012).

The basis for the street designs is the three points approach (Fratini 2012), which states that a design should not only be based on standard design levels, but also on extreme events and the functioning within the daily situation. For ten case studies of streets (belonging to one of the nine urban typologies) we made and compared four designs. The first design is the traditional standard arrangement whereby the street is designed in such a way that all the rainfall for an extreme event of once per two years water will fit into the sewer system (this is the standard Dutch design criterion). A higher intensity storm would then cause temporary flooding of the streets. The event of properties flooding would be for the extreme storm with an estimated return period of more than 10-20 years.

The other three designs are more climate robust, because they provide more space for water within the streets. They are designed in such a way that properties will only be flooded once every 100 years. Similar to the traditional design described above, the water of an extreme event of once per two years will fit into the designed storm water system which includes not only sewers but also SUDS (e.g. impervious pavement, infiltration facilities and swails). Furthermore one of the climate proof designs was made especially to show the effects of more green in the design.

Results and Discussion

The designs and calculations for the ten cases showed that streets in most flat Dutch typologies of urban living areas can easily be transferred in a climate proof way without additional costs (when compared to the standard designs).

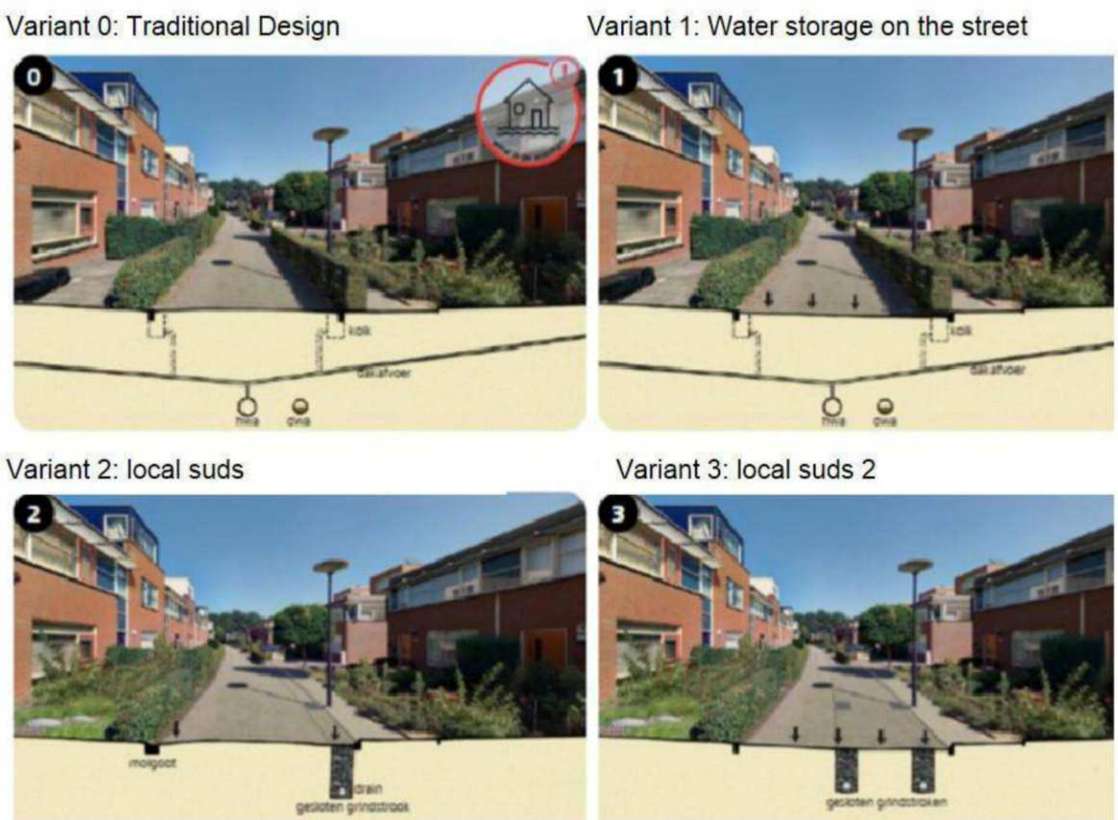

Fig. 1. *an example of the 4 designs for the recent suburban development typology.*

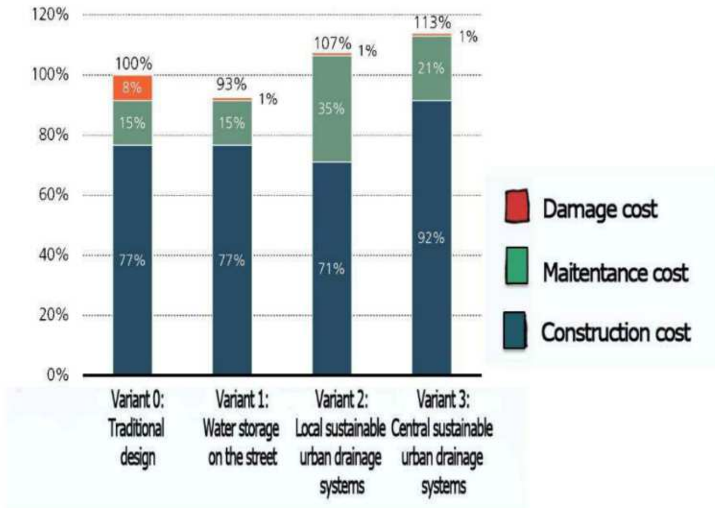

__Fig. 2.__ shows for this case that the total yearly costs of the alternative designs are either lower or just a little higher than the traditional design. The costs are a summation of building costs, maintenance cost and flood damage costs. The traditional design has been set as the reference.

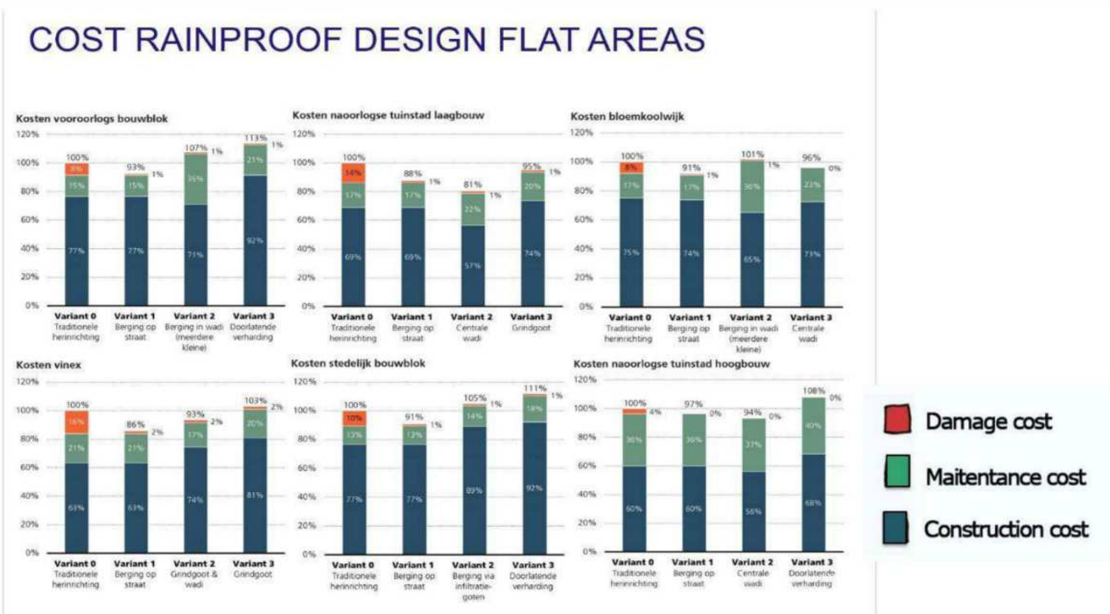

Fig. 3. *the costs for six cases in flat areas.*

The partners involved in the project had quite some discussion on the definition of a 'climate proof' street design. This proved to be complex because the climate is changing rapidly and old rainfall characteristics are no longer trusted. New extreme value estimates for rainfall of one hour are not yet available. Furthermore there are no Dutch guidelines that state how often flooding of a house is allowed. In this project we made a practical choice which was then approved by the municipalities involved. We decided that we would call a street climate proof if no houses flooded at 60 mm in one hour. This is an estimate of an extreme event with a return period of 100 years for the climate of 2050 (Kluck, 2013).

Conclusions

The urban typologies in flat areas can be retrofitted in a CR way without additional costs. Climate proofing areas which are not flat can be even simpler if the excess storm water can be diverted downstream into waterways and parks without any damage. Otherwise the cost for providing storage in hilly areas are likely to be much higher.

The results have been presented in a book (Kluck, 2017), showing for each typology the standard design as well as the alternative (CR) designs. It is envisaged that this will encourage municipalities to make CR choices. There are ideas to further develop a standard for climate robust design guidelines at street level.

Acknowledgement

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