CBA
Rotterdam Climate Adaptation Strategy
Case: Bergpolder Zuid

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City of Rotterdam/
Office for Sustainability and Climate Change

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Executive Summary

Preparing the City for climate change on the basis of a strategic approach and well analyzed measures – that is the goal of the Rotterdam Climate Adaptation Strategy. One step in the development of this climate adaptation strategy is the economic underpinning. For this matter, an evaluation tool based on the social cost-benefit analysis (CBA) was developed by the City of Rotterdam in cooperation with Rebel, Royal Haskoning DHV (RHDHV) and Deltares. With the help of this tool, the costs of various climate adaptation measures are weighed against the benefits.

Initially, we filled the tool with data for 43 adaptation measures looking at *Rotterdam in general*. In this report we describe the application of the tool in a *specific area*, namely 'Bergpolder South' (Bergpolder Zuid).

Image **Bergpolder South is an urban area inside the dykes.**

In the long term it is expected there will be damage caused by heat, storm water flooding and drought in Bergpolder South. There are plans to redevelop parts of the area and thus this CBA considers various measures to reduce the potential damage in the future. These measures are:

1. Adjust behavior through better health advice and increase knowledge of GPs /health centers
2. Green in the street (trees, small vegetation)
3. Insulation of buildings (homes and businesses)
4. Adjusting albedo of roofs
5. Water square
6. Increase curb height and lowering of roads
7. Green roofs
8. Infiltrating pavement
9. Permeable gardens and curbs

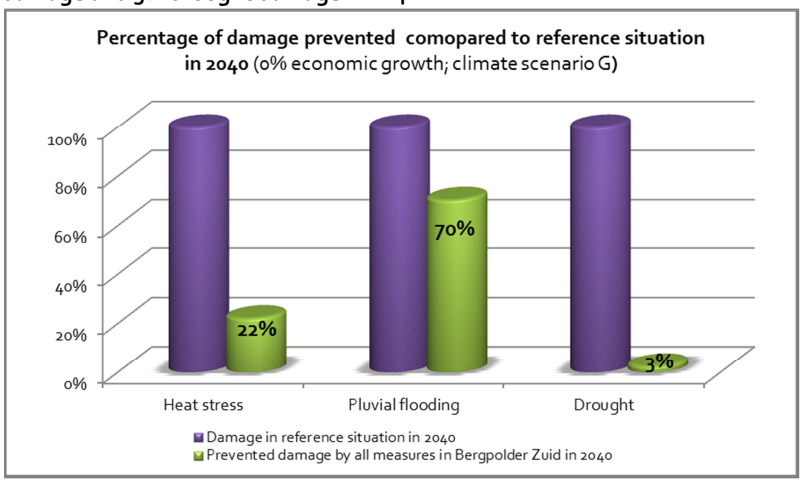
The table below shows the result for each measure for the baseline scenario. This scenario considers the Dutch climate scenario "G", an economic growth scenario of 2% and a smart use of "piggy-backing" with current maintenance programs so that costs are optimized.

Table **In the baseline scenario with 2% economic growth, five of the nine project alternatives show a positive result in climate scenario G**

2% growth; Climate scenario G (NPV in € 1,000)	Health advice	Green in streets	Insulation building	Albedo roofs	Water-square	Higher curbs	Green roofs	Infiltr. pavement	Permeable gardens and curbs
Costs									
Investment (-residual value)	1	11	1.946	83	103	62	862	59	7
Maintenance	4	9	441	96	89	10	155	98	1
Benefits									
Heat stress	266	8	152	70	2	-	48	-	-
Pluvial flooding	-	-	-	-	22	11	34	61	21
Drought	-	-	-	-	10	-	-	148	437
Energy	-	-	1.192	-	-	-	-	-	-
CO^2	-	-	495	-	-	-	-	-	-
Air quality	-	-	-	-	-	-	211	-	-
Property value	-	131	-	-	946	-	-	-	-
Total									
Total costs	5	21	2.387	179	192	72	1.016	157	8
Total benefits	266	140	1.839	70	981	11	293	209	459
Result	260	119	-548	-108	789	-62	-724	52	451

In the baseline scenario five out of nine measures show a positive result, namely *health advice*, *green in the street*, *water square*, *infiltrating pavement* and *permeable gardens and curbs* . For *green in the street* and *water square* the positive result is mainly influenced by the secondary effects. In both cases the high secondary effects are caused by a one-time increase in property values by 2.5% due to higher spatial quality. The measure *permeable gardens and curbs* has a remarkably low level of investment and maintenance. Furthermore, there are large benefits in preventing damage caused by drought, both on building foundation (approx. 98% of benefits) and on vegetation (about 2% of benefits).

Graph **All measures together solve ca. 22% heat stress damage, ca. 70% of pluvial flooding damage and 3% drought damage in 2040**



The graph above shows the share of damage that is prevented by the implementation of all measures in climate scenarios G, considered in the year 2040. In 2040 the majority of measures is implemented completely and effects of climate change are visible. All measures taken together prevent 22% of the damage by heat stress compared to the reference situation, 70% of the damage caused by pluvial flooding and 3% of the damage caused by drought. In particular, the benefits of preventing negative effects of drought seem very small compared to the damage by drought in the reference situation. This can be explained by the fact that over 80% of homes in this area might suffer from foundation problems in periods of drought. The measures against drought damage only work if applied in close proximity of the foundation. In our study, the package of measures against drought damage is limited compared to the problems in this area, and so the effect is small compared to the damage in the reference situation.

The analysis of the outcomes has shown that five of the nine measures have a positive result: *health advice*, *green in the street*, *water square*, *infiltrating pavement* and *permeable gardens and curbs*. This outcome is consistent for the whole project cycle for climate scenario G as well as W+. In addition, we tested the assumptions for economic growth, cost estimates and property value in a sensitivity analysis. The results of the positive measures stay positive and are thus robust.

The CBA approach applies a societal perspective and ignores institutions and stakeholders. Of course, in reality, there are different stakeholders with different interests. The following table gives an overview of the costs and benefits by stakeholder group.

Table **The stakeholder group that usually bears the costs of a measure is not always the group that benefits from the measures.**

	City of Rotterdam	Owners/ real estate developers	Residents/ companies	Insurance companies	General
Health advice	Construction and maintenance costs		Benefits heat stress	Benefits heat stress	
Green in streets	Construction and maintenance costs	Property value	Benefits heat stress (exterior)	Benefits heat stress	
Insulation		Construction and maintenance costs	Benefits heat stress (interior); energy saving	Benefits heat stress	CO_2 reduction
Albedo roofs		Construction and maintenance costs	Benefits heat stress	Benefits heat stress	
Water square	Construction and maintenance costs	Property value Benefits pluvial flooding	Benefits heat stress and pluvial flooding	Benefits heat stress	
Higher curb	Construction and maintenance costs	Benefits pluvial flooding	Benefits pluvial flooding		
Green roofs		Construction and maintenance costs Benefits floods	Benefits heat stress and pluvial flooding	Benefits heat stress	Air quality
Infiltrating pavement	Construction and maintenance costs Benefits green	Benefits drought	Benefits pluvial flooding and green		
Permeable gardens		Construction and maintenance costs Benefits foundations	Benefits green		

Out of the five measures that have a positive net present value, there are four that are typically constructed and maintained by the municipality. Only for making gardens more permeable the costs are carried by the real estate owners. At the same time, (most) benefits accrue to real estate owners. This measure is therefore economically attractive and easy to implement from a stakeholders' perspective (1 stakeholder for costs and benefits). Therefore, we consider this a "no regret" measure.

For those measures that have a positive result but for which the benefits and costs are spread among different stakeholders, it might be valuable to openly discuss costs and benefits with stakeholders in order to come up with solutions to reallocate costs. For example, for measures that prevent heat stress the beneficiaries are typically residents, local businesses and (health) insurance companies, while the investments are made by the municipality and real estate owners. In case new houses are developed, it might be (partially) possible to price in the insulation measures and costs for an enhanced albedo of the roof in the sales price or rent.