Cost-benefit analysis of green- and blue infrastructure in Grefsen-Kjelsås

assessing the costs and benefits of stormwater management

September 20th 2021, Gert-Jan Wilbers

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Content

- Background or the problem
- Main research questions
- Methodology
- Scenarios
- Define costs- and benefits
- Results
- Sensitivity analysis (uncertainties)
- Suitability for decision makers

Background

- Extreme rainfall events causing CSO’s and urban floods in Grefsen-Kjelsås
    - Climate change effects enlarges the problem
- Need for stormwater management investments: range of options available

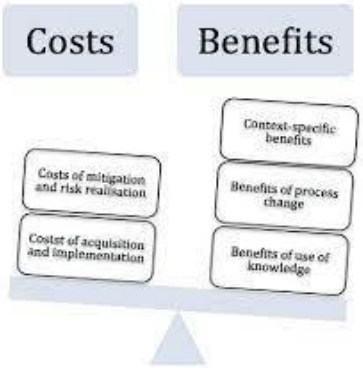
Grey

Blue

Green

Main research questions

- What are possible (green- blue) measures?
- What are the costs and benefits of those?
- How does climate change affect costs and benefit?
- And what is the effect of different stormwater protection levels on costs and benefits?



Socio Cost-Benefit Analysis

Methodology of the Socio CBA

- We compare effects (costs and benefits) of scenarios with the Business-as-Usual situation
- For costs we considered different implementation durations and lifetime
- Benefits: multiple monetarization techniques
- Discount rate of 4%
- Calculation period 2021 – 2051
- Outcomes of the socio CBA in net benefits and Benefit/Cost ratio for each scenario
- Sensitivity analysis to account for uncertainties

Scenarios

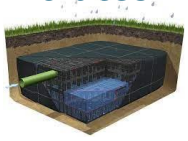
- 36 scenarios
  - 6 measures
  - 3 extreme rainfall events (M5, M20, M100)
  - Considering current and future predicted rainfall events due to climate change (RCP 8.5)

1. Wadi’s

2. Green roofs

3. Combination of raingarden, rain barrels and wadi’s

4. Infiltration crates



5. Water square

6. Separate sewer system

Scenario	Current rainfall events (2020)			Future rainfall events (RCP 8.5)		
	M5	**M20**	**M100**	**M5**	**M20**	**M100**
Wadi's	479 m^2 Wadi	1,092 m^2 Wadi	1,692m^2 Wadi	791 m^2 Wadi	1,486 m^2 Wadi	2,835 m^2 Wadi
Green roofs	9,685 m^2 Green roofs	22,063 m^2 Green roofs	34,185 m^2 Green roofs	15,970 m^2 Green roofs	22,063 m^2 Green roofs	57,275 m^2 Green roofs
Green / blue	459 Raingarden	681 Raingard. 601 Rain barrels	681 Raingard. 681 Rain barrels 343 m^2 Wadi	681 Raingard. 125 Rain barrels	681 Raingard. 681 Rain barrels 343 m^2 Wadi	681 Raingard. 681 Rain barrels 1,692 m^2 Wadi
Infiltration crates	151 Infiltration crates of 1m^3	344 Infiltration crates of 1m^3	533 Infiltration crates of 1m^3	249 Infiltration crates of 1m^3	468 Infiltration crates of 1m^3	893 Infiltration crates of 1m^3
Water square	1 Water square	1 Water square	1 Water square	1 Water square	1 Water square	1 Water square
Separate sewer system	Separate sewer system (151m^3)	Separate sewer system (344m^3)	Separate sewer system (533m^3)	Separate sewer system (249m^3)	Separate sewer system (468m^3)	Separate sewer system (893m^3)

Definition of costs and benefits

- Costs
    - Investments (CAPEX)
    - Operational and maintenance (OPEX)
- Benefits
    - Prevented CSO --> water quality and biodiversity
    - Prevented flood damage
    - Increased aesthetical value
    - Increased house prices (green roofs)
    - Prevented sewage water treatment
    - Fresh water savings (rain barrels)

Main benefits

Co-benefits

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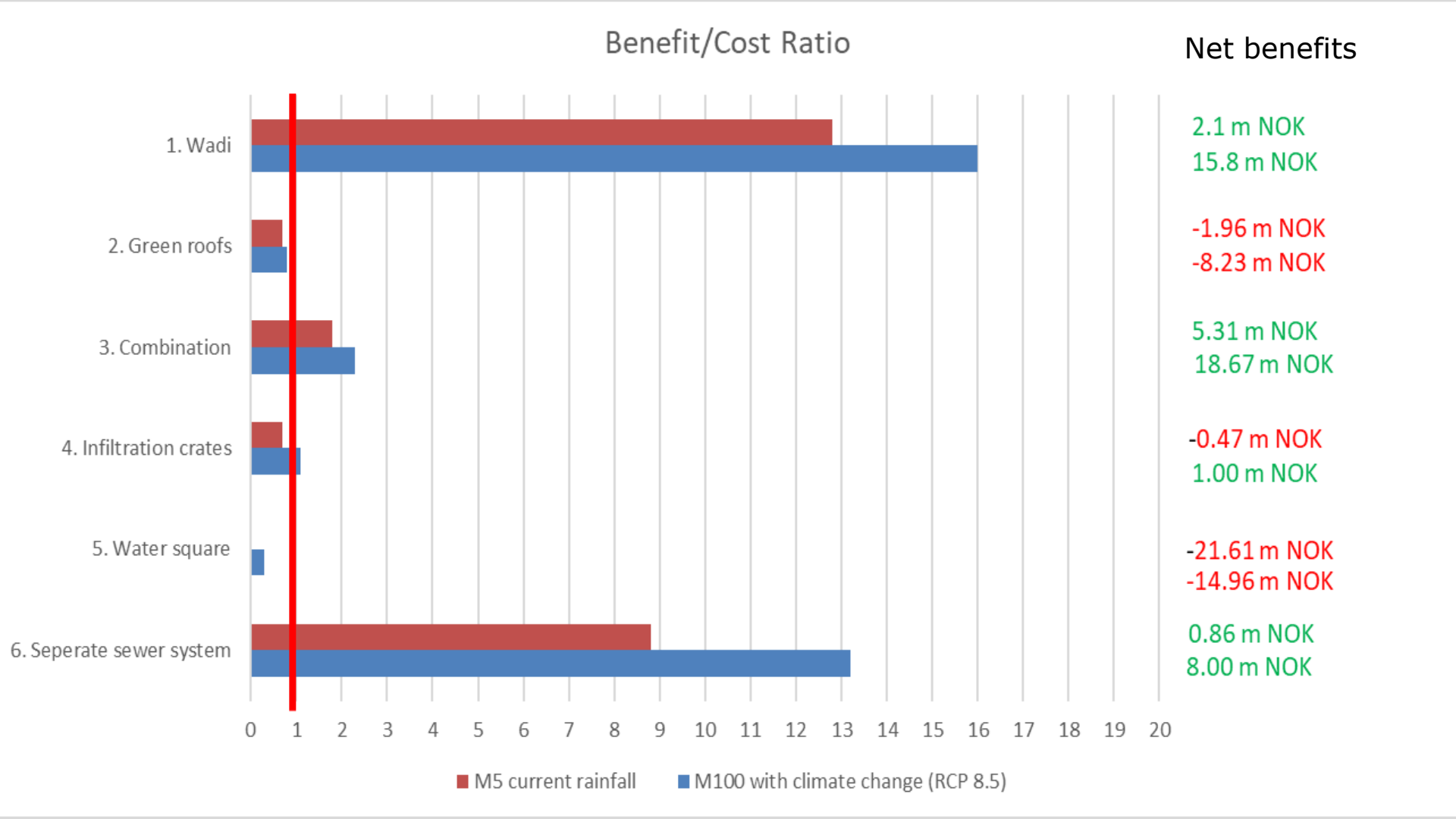
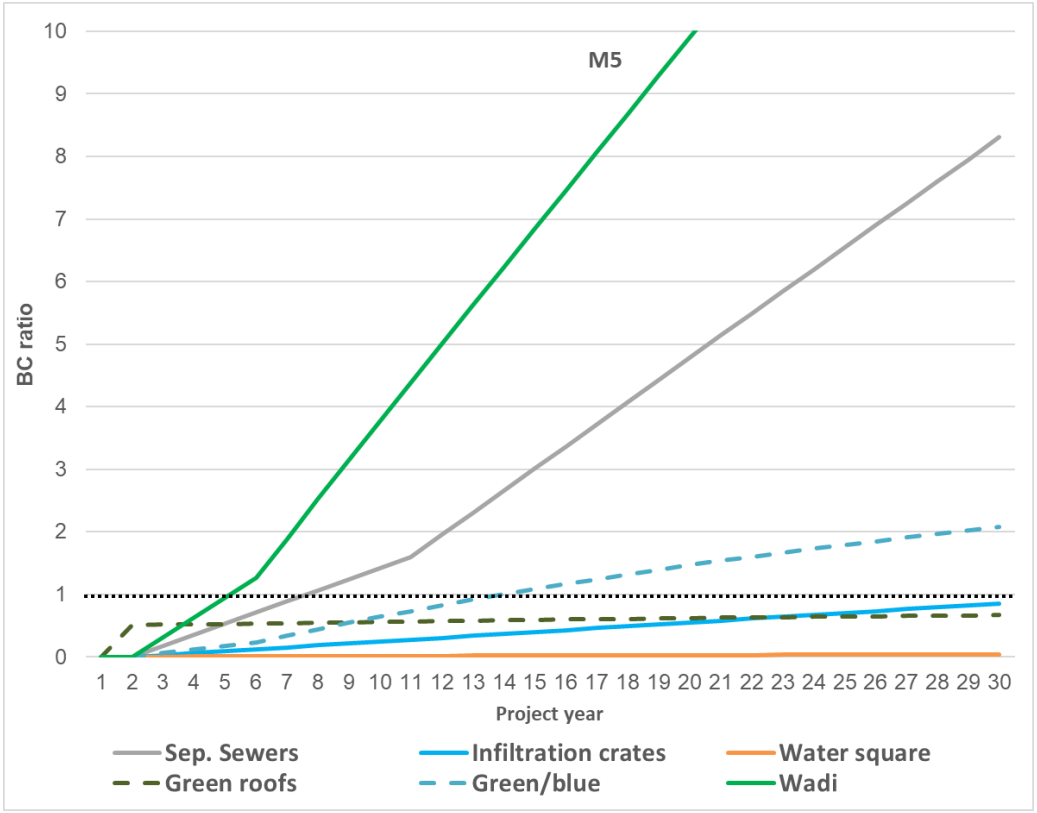

Benefit/Cost Ratio
Net benefits
1. Wadi
2. Green roofs
3. Combination
4. Infiltration crates
5. Water square
6. Seperate sewer system
2.1 m NOK
15.8 m NOK
-1.96 m NOK
-8.23 m NOK
5.31 m NOK
18.67 m NOK
-0.47 m NOK
1.00 m NOK
-21.61 m NOK
-14.96 m NOK
0.86 m NOK
8.00 m NOK
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
M5 current rainfall
M100 with climate change (RCP 8.5)

Return on Investment



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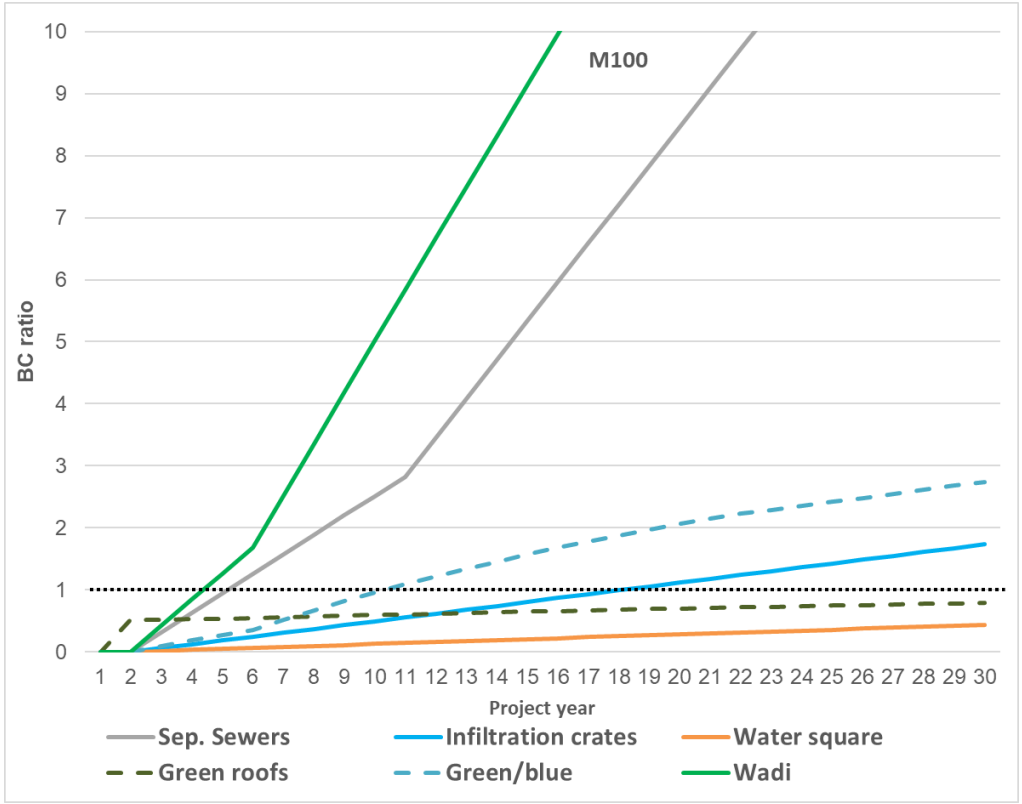
Return on Investment



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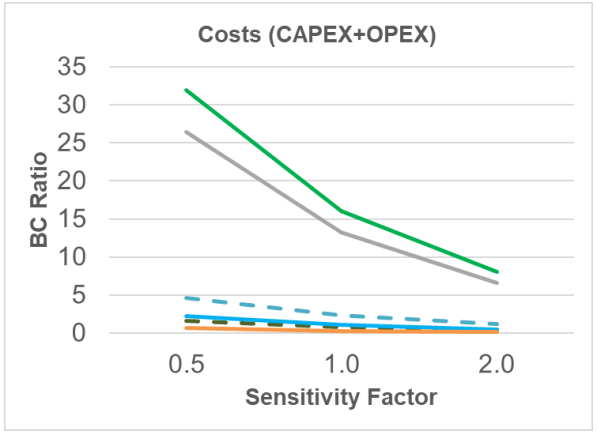
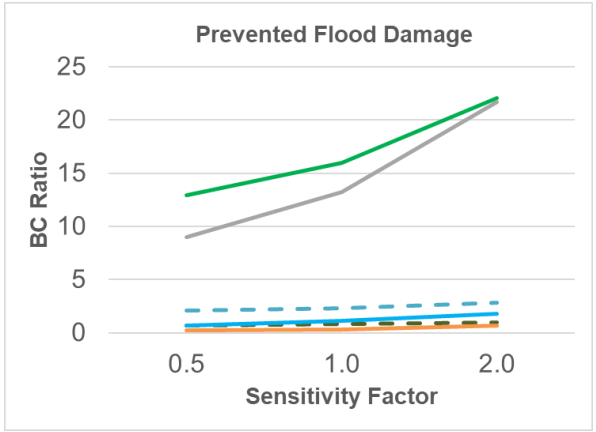
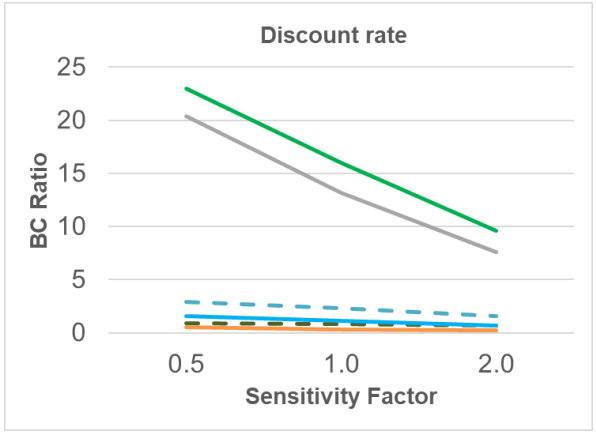
Sensitivity analysis

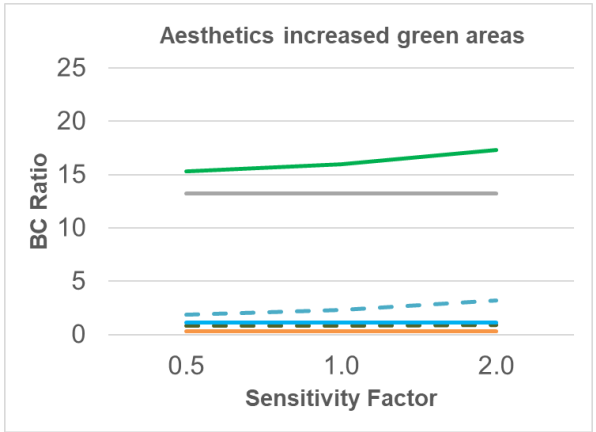
- To assess impact of assumptions on CBA outcomes
  - CAPEX and OPEX
  - Discount rate
  - Prevented flood damage
  - Aesthetics of green area
  - Prevented sewage water treatment
  - Increased house prices
- Two sensitivity tests (reduction factor 2; increase factor 2)

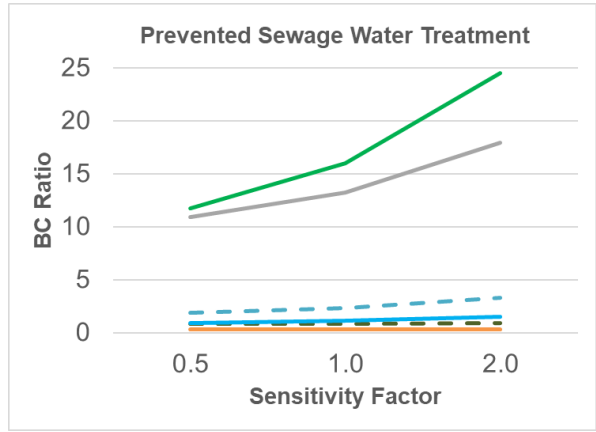
Sensitivity analysis outcomes

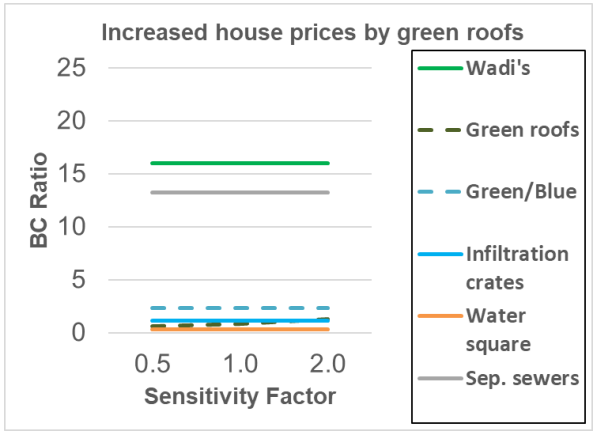




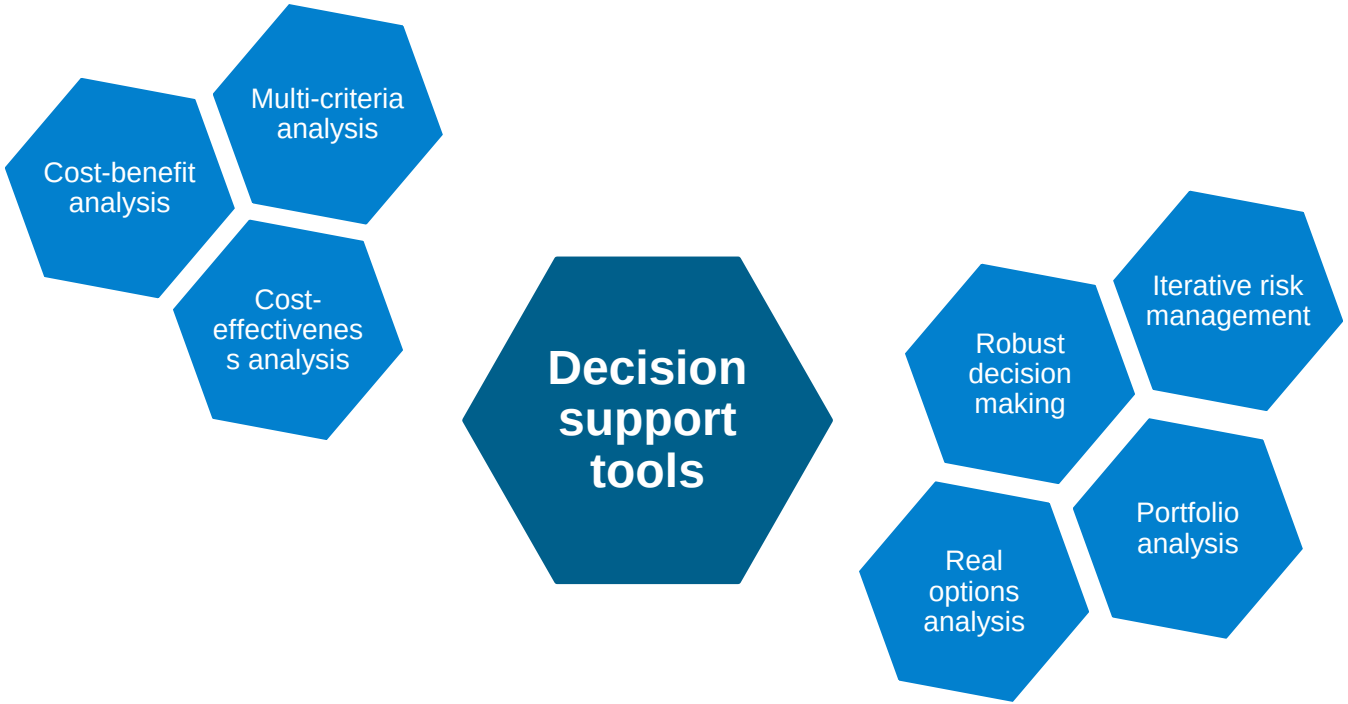








Suitability for decision makers



Policy advice

- When Benefit / Cost ratio is most important → wadi's or seperate sewer system
- When total benefits are most import → combination of raingardens, rain barrels and wadi's
- When return on investment time is most important → wadi's or seperate sewer system
- Investments focussed on M100 rainfall event are on the long-term more efficient than those for M5
- Recommended to dimension interventions considering climate change effects → more efficient

Questions and/or comments?