Modelling stormwater and evaluating potential solutions

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Introduction

- Stormwater management is a complex topic
- Typically, **different options** are thinkable
  - Conventional measures (pipes with end-of-pipe-treatment)
  - SUDS (Sustainable urban drainage with green roofs, infiltration, on-site retention, rainwater harvesting,…)
  - Combinations of the two strategies
- Many **different criteria** have to be considered
  - Technical (hydraulics, flooding, …)
  - Environmental (pollution, hydraulic stress, …)

Typical multi-criteria problem!

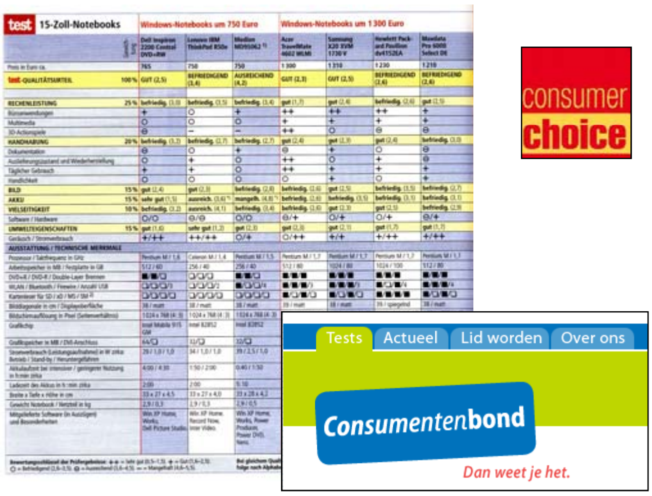
Decision Matrix

Options

	Convent. Drainage	SUDs	…
Life-Cycle Cost	100.000	108.000	…
Flexibility	-	Facts +	…
...	...	...	...

Indicators

Product Reviews in Consumer Magazines



Decision Matrix

- Steps necessary to set up a Decision Matrix

1. Development of Scenarios
2. Definition of Indicators
3. Computation of Facts
4. Decision making

	Convent. Drainage	SUDs	...
Lifecycle -Cost	100.000	108.000	...
Flexibility	-	+	...
...	...		...

Supporting Tools

	Convent. Drainage	SUDs	...
Lifecycle -Cost	100.000	108.000	...
Flexibility	-	+	...
...	...	...	...

- Stormwater Management Options
  - Task 2.1.1. Review of current options
  - Task 2.1.2. Innovative technological options
- Indicators
  - Set of indicators (sustainability indicators)
  - Input from Task 2.2.1 to WP 1.1

Supporting Tools

	Convent. Drainage	SUDs	...
Lifecycle -Cost	100.000	108.000	...
Flexibility	-	+	...
...	...	...	...

- Life-Cycle-Cost-Tool Eco.SWM
  - Task 2.2.2, finished in 2007
  - Presented in Tel Aviv
- Quantification of diffuse pollution
  - Task 2.1.3: A hydrological and water quality model in conjunction with GIS will be used to quantify pollutant and hydraulic loadings on a catchment scale
  - STORM-Model has been selected

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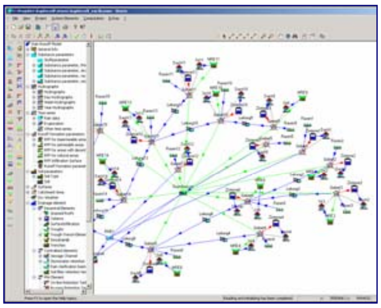
STORM

- Developed by IPS since 1998
  - Commercial product
  - Some modules (SEWSYS) have been developed in the Daywater project (EU-FP5)
  - Free of use within SWITCH
- Modern PC-Software
  - Graphical user interface GIS-based (Mapobjects)
  - Object-Oriented programming
  - Microsoft® Visual C++



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STORM

- Hydrological rainfall-runoff-model
  - Urban & rural areas (module for unsaturated zone is included)
  - Plot scale & catchment scale (up to 400 km^2)
  - Design storms & Long-term-simulations
  - Runoff- and water balance modelling
  - A large variety of SUDs are implemented
- Pollution load model
  - Standard concentration approach
  - Source and Flux module SEWSYS (Chalmers Univ.)

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Supporting Tools

	Convent. Drainage	SUDs	…
Lifecycle -Cost	100.000	108.000	…
Flexibility	-	+	…
…	…	…	…

- Filling a Decision Matrix with STORM
  - Peak flows
  - Impact on water balance & base flow
  - Hydraulic stress
  - Pollution loadings (COD load, CSO overflow frequencies)
  - (Impact on water quality)
  - …

Supporting Tools

	Convent. Drainage	SUDs	...
Lifecycle -Cost	100.000	108.000	...
Flexibility	-	+	...
...	...	...	...

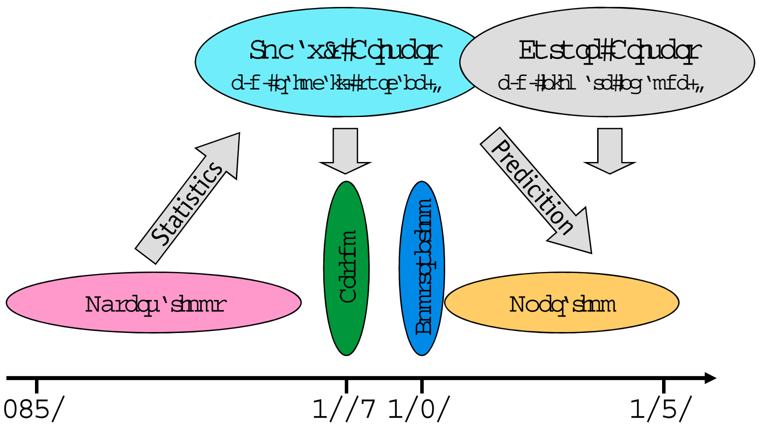
- Measuring Flexibility
  - Flexibility becomes an important decision criteria
  - COFAS is a method to compare different options regarding their flexibility to be adapted to future changes
  - Partly an output of Task 2.1.1 "review of the adaptability and sensitivity of current stormwater control technologies to extreme environmental and socio-economic conditions"
  - Master thesis (Björn Helm) in cooperation with TU Dresden (P. Krebs)

Background

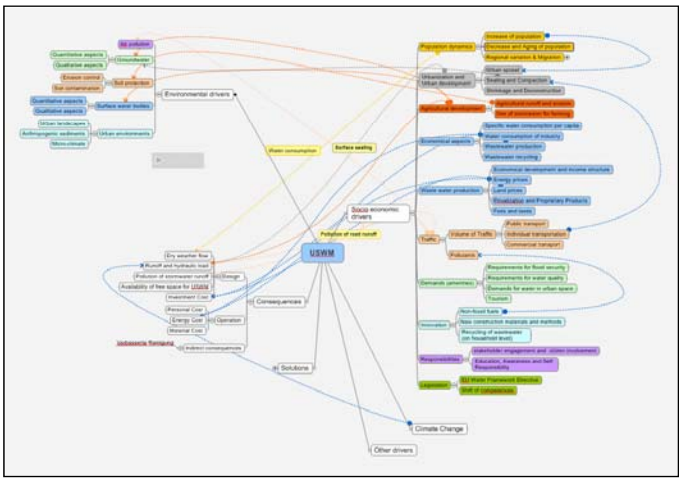
- Urban Stormwater Management (USWM) systems are often long-lasting investments

Type of installation	Average life in years
Sewers (new construction)	50 - 80 (100)
Pressure pipes and culverts	30 - 50
Tanks (CSO-tanks, clarifiers, construction part)	(40) 50 - 70
Pumping stations (construction part)	25 - 40
Gully (inlet)	40 - 80
Infiltration systems	20 - 40

Problem of Uncertainty



Drivers for USWM



One way out of the Dilemma

1. Work with Scenarios
   - Future scenarios
   - Multiple scenarios: worst case, best case, most likely, etc.
2. Define indicators to measure the performance of different measures for each scenario
   - Indicators should reflect the drivers
   - Use models to predict the performance
   - Setup decision matrices
3. Take flexibility into account when assessing measures
   - COFAS "Comparing the Flexibility of Alternative Solutions"
   - Base: Utility Value Analysis

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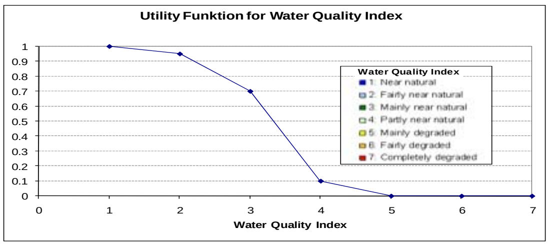
Utility Value Analysis (UVA)

- Classical method in Multi-Criteria Assessment (MCA)
- Transformation of indicators => standardized values
- Definition of utility value functions
- Example



- Utility values are weighted and added

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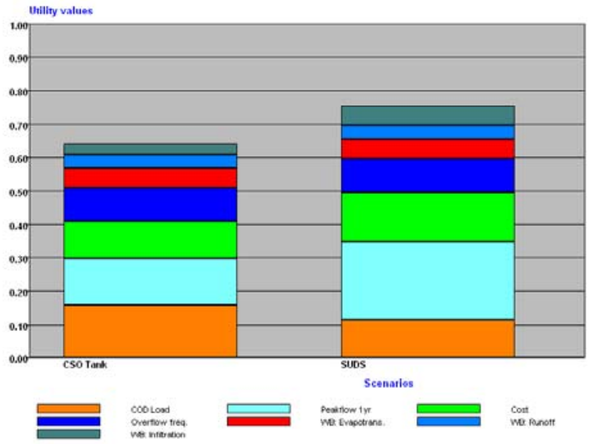
Utility Value Analysis (UVA)



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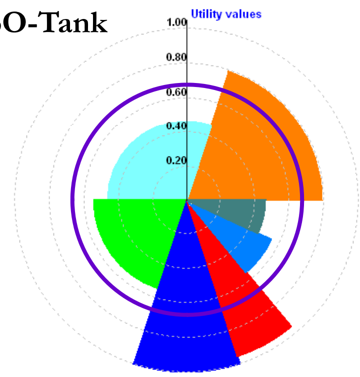
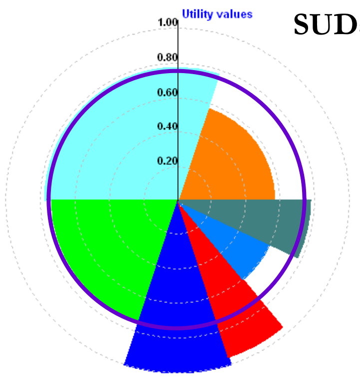
Robustness

CSO-Tank



SUDs



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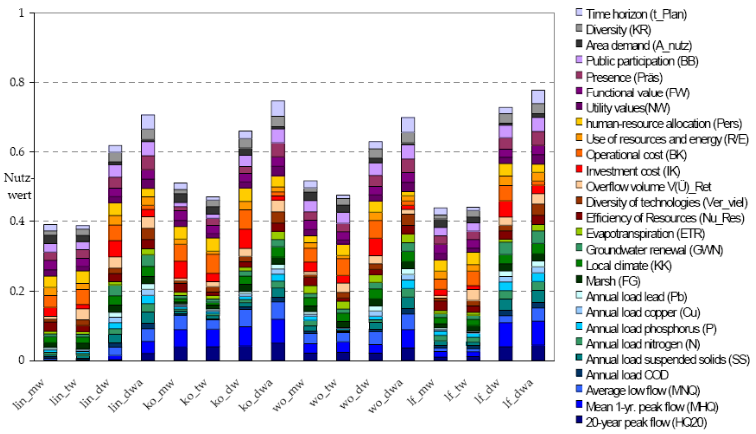
Flexibility

- **Flexibility** (or Adaptability/Adaptiveness): Ability of a system to be adapted to future changes
- Example: Stormwater master plan for Kupferzell, a small City in southern Germany
- Futures scenarios have been developed

Combined sewer system (mw)	New areas will be drained with a combined sewer system	
Separate sewer system (tw)	New areas will be drained with a separated sewer system	ion. ible
Decentralised system (dw)	Stormwater runoff from new areas will be managed with a decentralised infiltration system	. ıted
Extended decentralised system (dwa)	Stormwater runoff from new areas will be managed with a decentralised infiltration system. In addition 20% of the existing impervious area will be disconnected, for another 20% green roofs will be implemented and 20% of the water supply will be covered by rainwater utilisation.	ıcial

Results of COFAS



Results of COFAS

all numbers in [%]	Combined sewer system	Separate sewer system	Decentralised system	Ext. decentr. system
Utility values				
Conservational scenario	51.4	47.4	66.4	74.1
Growth-oriented scenario	51.9	47.7	63.2	69.4
Linear scenario	39.3	38.8	61.9	70.1
Loading case scenario	44.1	44.1	72.9	77.5
Mean value	46.7	44.5	66.1	72.8
Internal homogeneity				
Conservational scenario	42.1	45.4	59.6	66.7
Growth-oriented scenario	61.6	40.0	65.6	64.2
Linear scenario	33.7	33.7	61.1	68.6
Loading case scenario	50.4	50.7	69.9	74.1
Mean value	46.9	42.4	64.1	68.4
External homogeneity				
	83.8	88.0	92.3	95.0
multi-dimensional, multi-variant Degree of Target Achievement (dvDTA				
	56.4	55.0	73.3	78.0

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Conclusion

- WP 2 provides several tools for supporting decision making processes
  - Eco.SWM – a Lifecycle-Cost-Assessment-Tool
  - STORM - a hydrological and pollution load model
  - COFAS - a method to compare the flexibility of alternative solutions
- Tools are ready to use (in the LAs)!
- For support, please contact us: h.sieker@sieker.de

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Thank you for you attention!