TECHNISCHE UNIVERSITÄT KAISERSLAUTERN

The Sanitation Challange

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Implementation of new sanitation concepts in a city scale

- finding long-term strategies by mathematical optimisation

       

University of Kaiserslautern

Urban Water Management

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Content Overview

- **Background and Motivation**
  - Question: What’s the optimal way to the favoured future system?
- **Methods**
  - Development of a mathematical optimisation model
  - Application case study
- **Implementation**
  - Scenarios and specifications
  - Results and discussion
- **Conclusions and Outlook**

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Background and Objectives

What's the present state?

centralised supply and disposal concepts

- apparently not sustainable
- numerous disadvantages

How to get there?

What do we aim for?

changes in exposure to wastewater

- stormwater: turning away from piped drainage systems
- sewage: discussion of alternatives for disposal

How can new sanitation concepts be realised in existing systems?

high demand of rehabilitation

intensive reconstruction work /extensive efforts

→ every step of reconstruction should ecologically and economically benefit the future

→ new strategies for "hot plug-in" are required

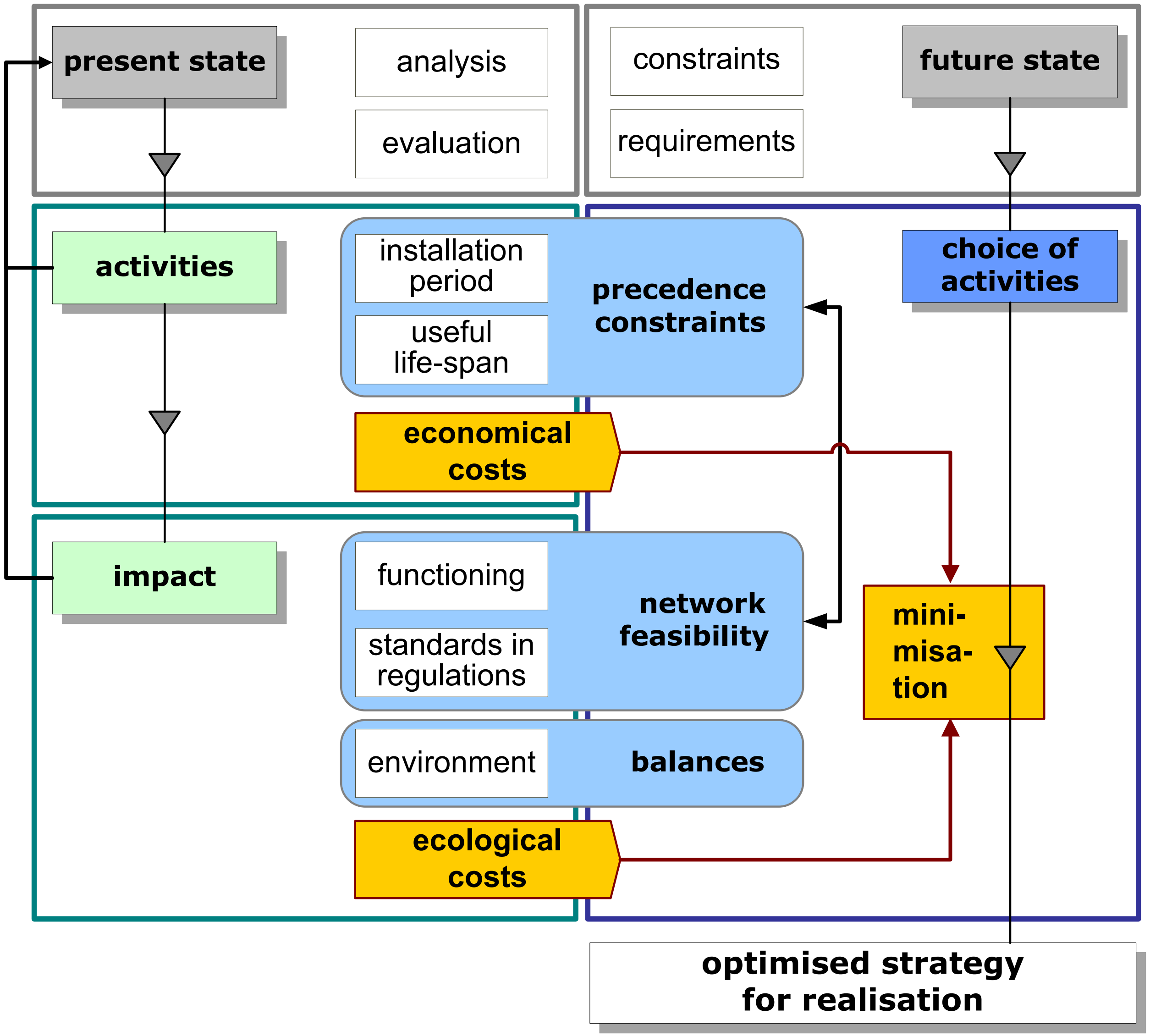
Development of a mathematical approach

Mathematical Model

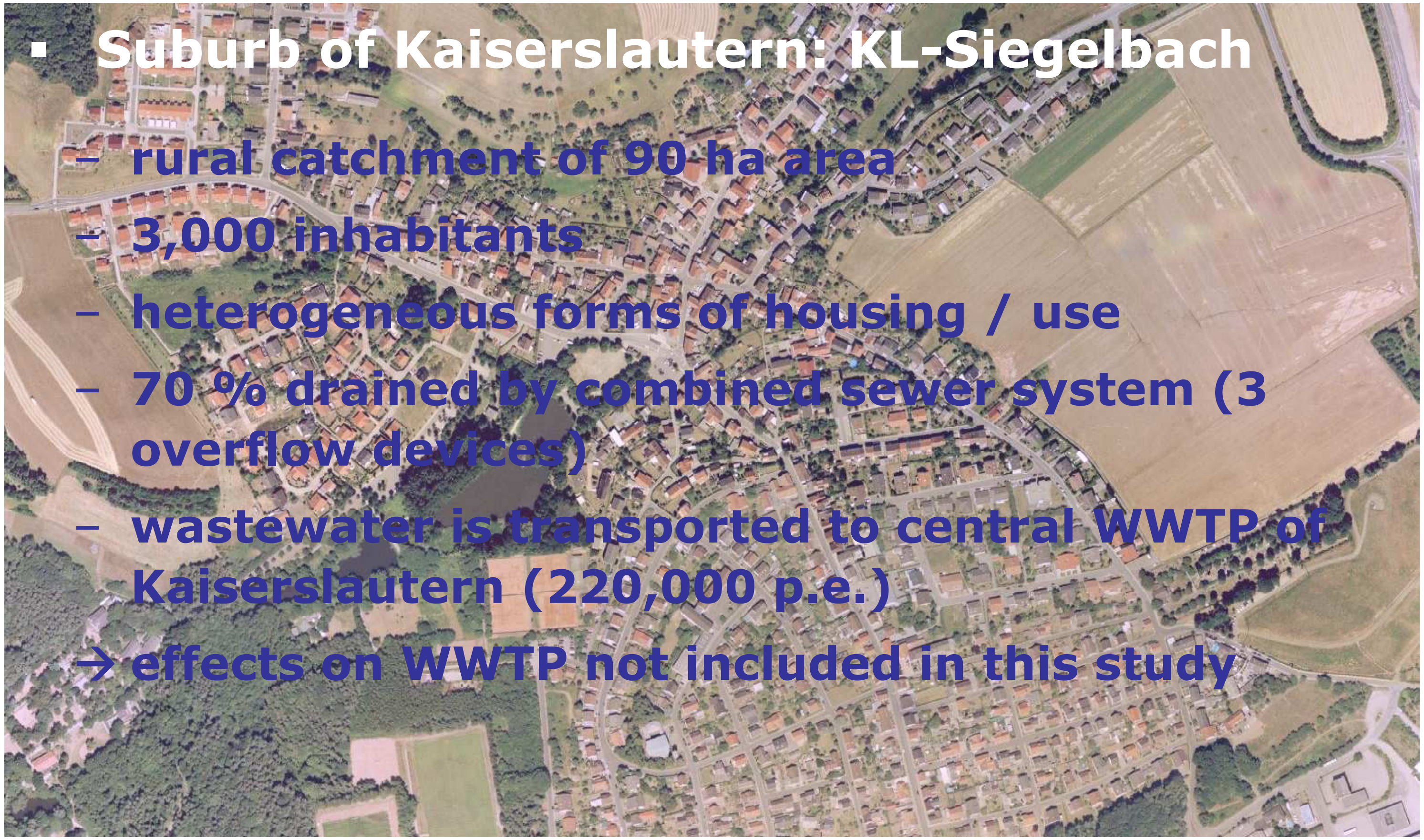
initial situation

mathema-tical model

aim



Application



- **Suburb of Kaiserslautern: KL-Siegelbach**
  - rural catchment of 90 ha area
  - 3,000 inhabitants
  - heterogeneous forms of housing / use
  - 70 % drained by combined sewer system (3 overflow devices)
  - wastewater is transported to central WWTP of Kaiserslautern (220,000 p.e.)

  → effects on WWTP not included in this study

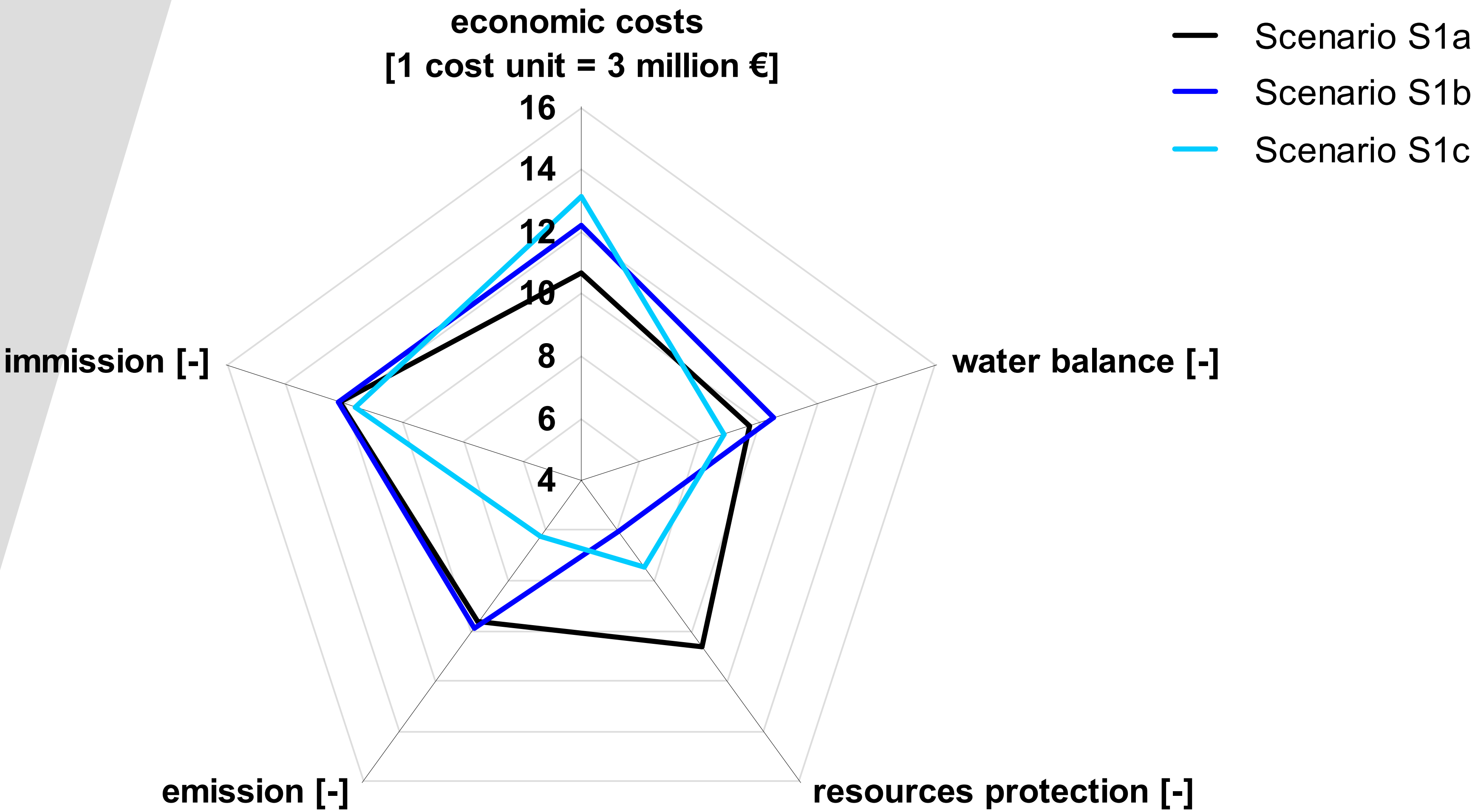
Implementation - future state

- **future state and conditions**
  - **example** of future state for implementation
    - + **Scenario 1:** seperated treatment of **blackwater, greywater** should be treated centrally in WWTP
    - + **stormwater** runoff and wastewater should not be mixed any more, achieve natural stormwater management

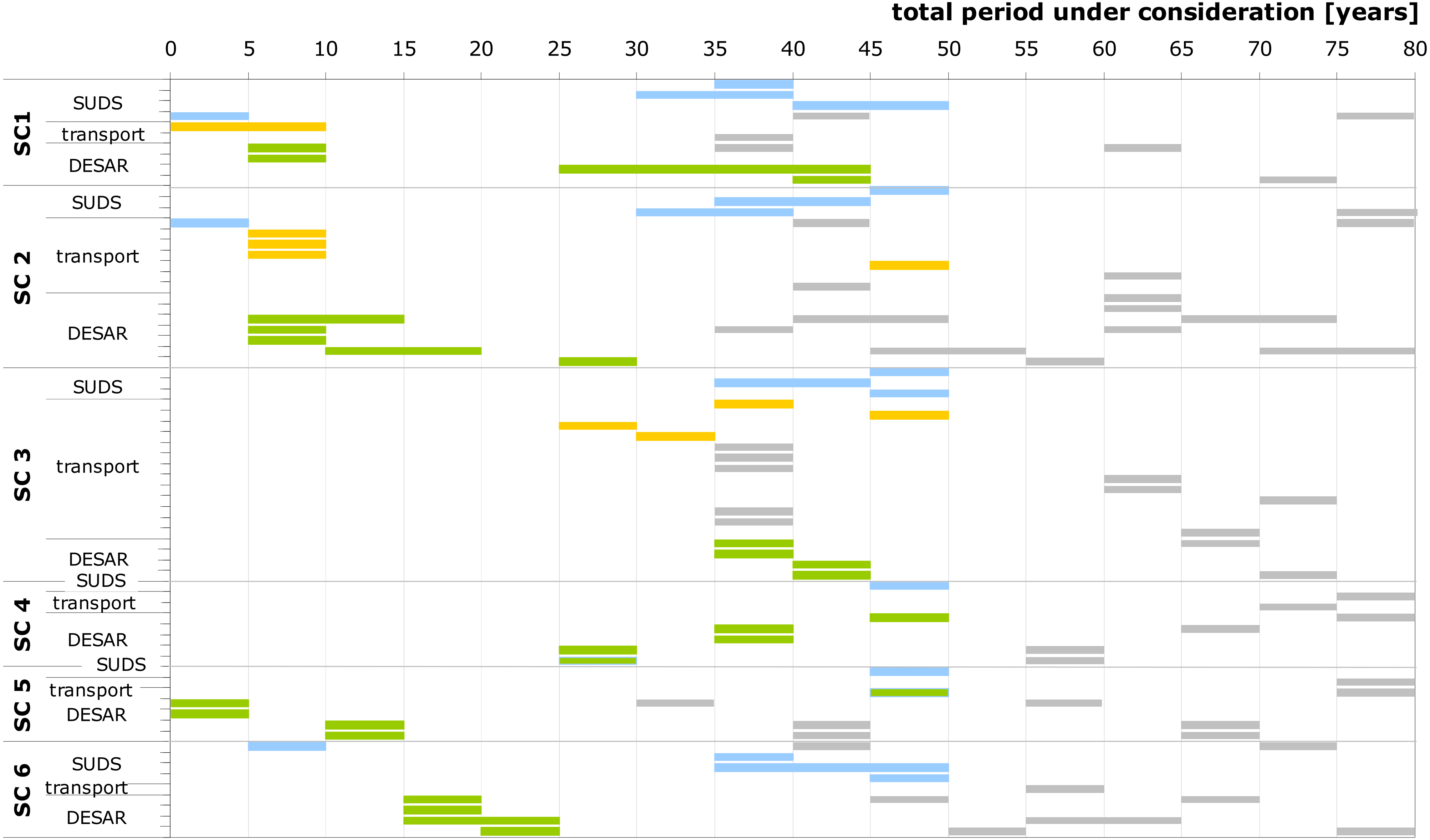
Implementation - future state

- **period of consideration**
  - 50 years of conversion + 30 years of ‘maintenance’
- **objective functions: economic costs**
  - total project costs with 3 % interest rate
  - budget 2.5 million € / time step (5 years)
- **objective functions: ecologic costs**
  - many different criteria count to these costs
  - **3 different modifications**
    - **a)** no ecological criteria (minimise only econ. costs)
    - **b)** only ‘resources protection’ should be minimised
    - **c)** 3 criteria (resources protection, natural water cycle, emissions)
  - weight economic costs : ecologic costs = 1:1

Results – Scenario 1 (blackwater)



Results – activities S1c



Conclusions and Outlook

- **To reach a future state different optimal solutions are possible!**
  - choice of criteria is essential
  - not only apparent criteria should be chosen for minimisation!
- **only the discussion of local deciders with engineers can lead to definite choice of solution**
  - difficult!

  → potential of the approach in making possible to show all impacts in detail when calculating different scenarios

  → **big potential for complex systems!**

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