KOMPETENZZENTRUM Wasser Berlin

SEMA BERLIN

financed by

Berliner Wasserbetriebe

AI-based Approaches for Short- and Long-term Sewer Asset Management in Berlin (Germany)

Mathias Riechel [1], Hauke Sonnenberg [1], Alexander Ringe [2],
Nic Lengemann [2], Elke Eckert [2], Nicolas Caradot [1], Pascale Rouault [1]

[1] Kompetenzzentrum Wasser Berlin; [2] Berliner Wasserbetriebe

From defects to deterioration models

CCTV Inspection

Defect coding

Pipe assessment

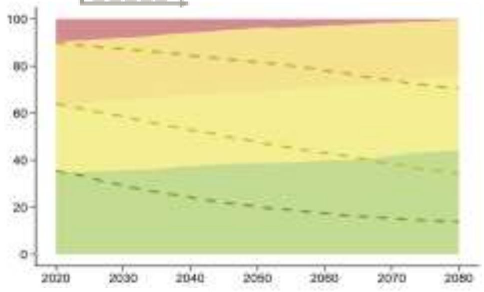
Condition	Need for action
Good	None / Long term
Fair	Mid term
Bad	Short term
Very Bad	Immediate

Deterioration factors

Age · Material · Drainage type · Shape
Width · Length · Slope · Soil type and coverage
Groundwater coverage · Trees · District

Model predictions

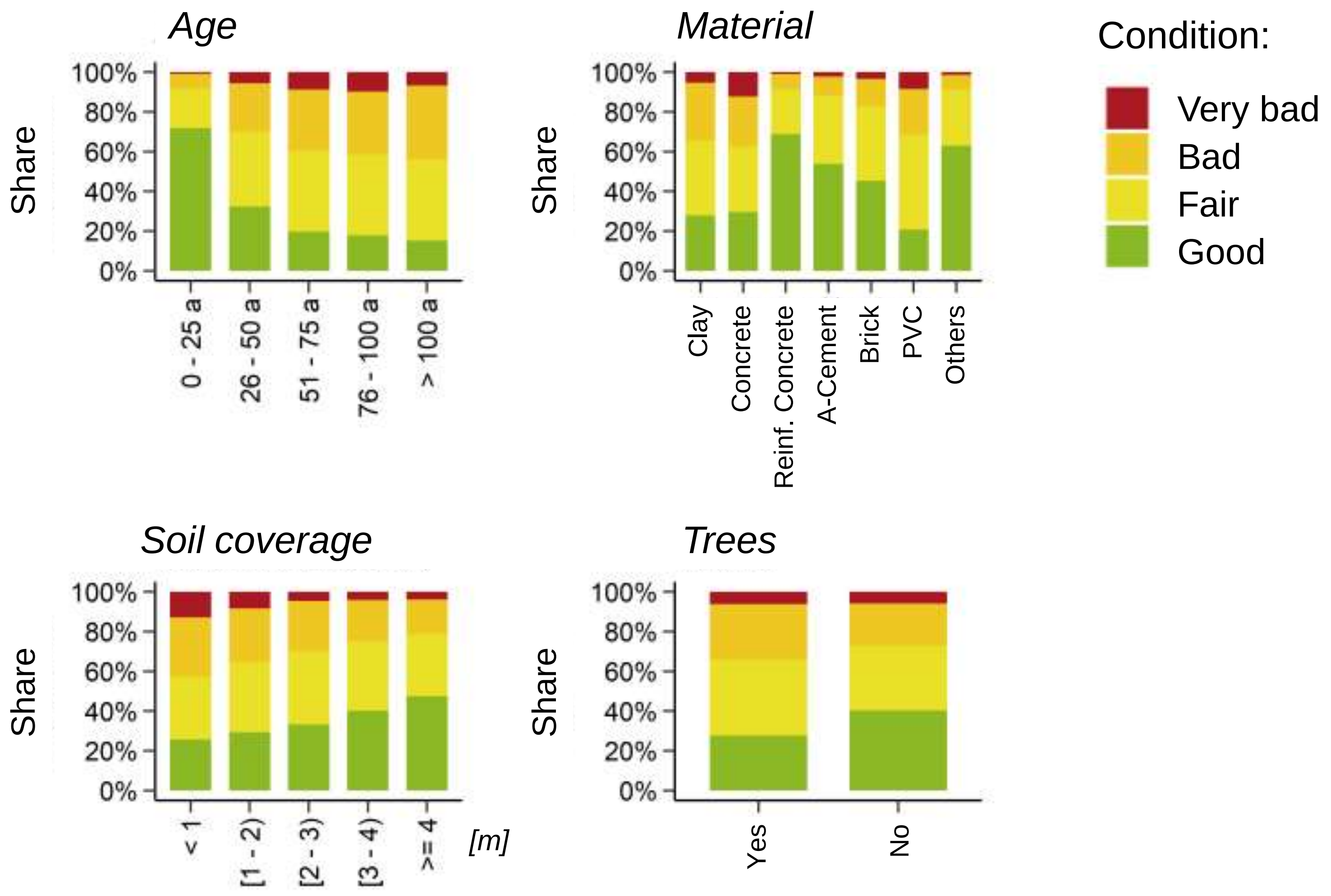
Network level



Pipe level

Status quo

Deterioration factors

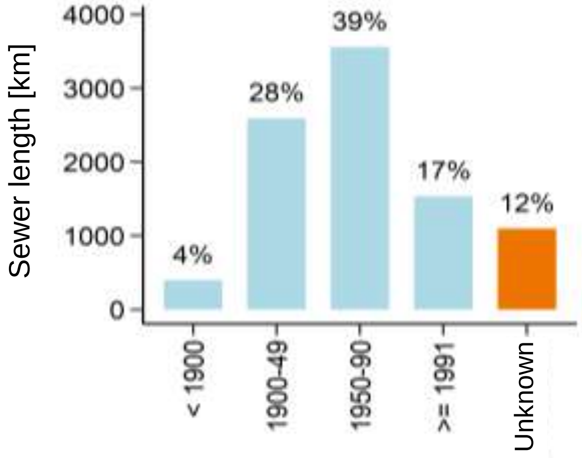


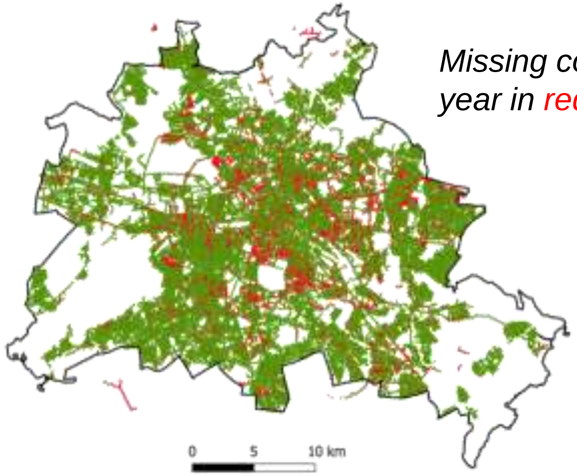
Other variables:

- Sewerage type
- Width
- Shape
- Length
- Slope
- Soil type
- Groundwater coverage
- District

Filling gaps in sewer asset data

Construction year / pipe age



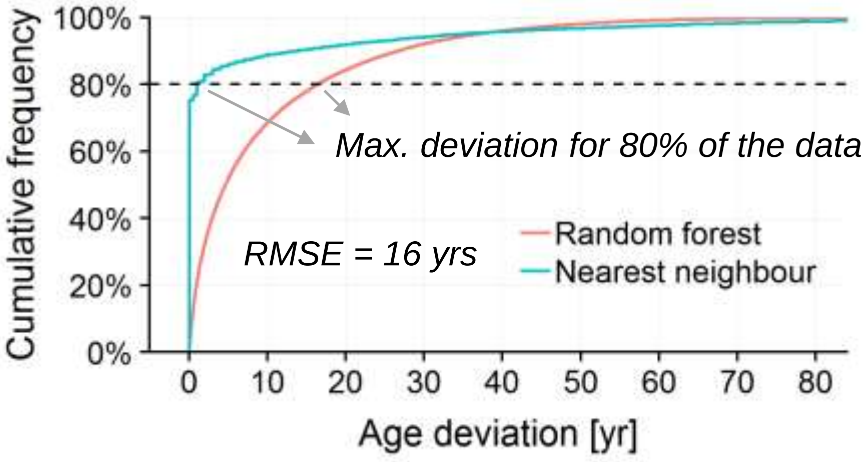


Missing construction year in red

- Very similar problem in data of most cities

Method: Nearest neighbour model + Random Forest machine learning approach under consideration of sewer pipe characteristics and environmental factors

Results: i) Accurate prediction of age for majority of pipes; ii) Symmetric error distribution; iii) All gaps can be closed by combining both approaches

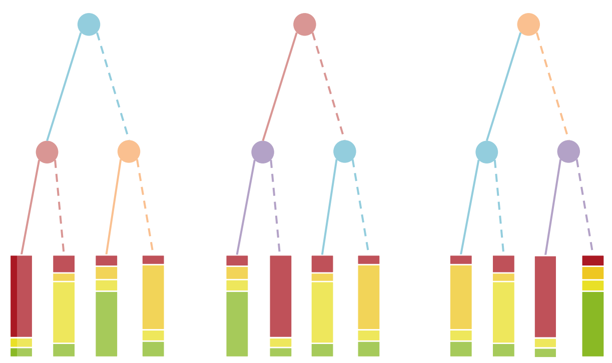


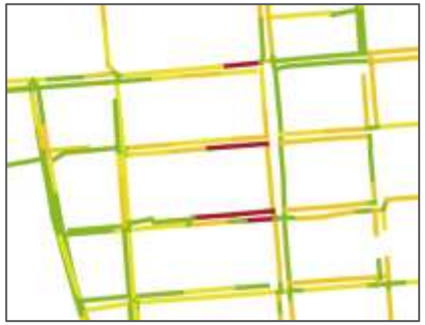
KOMPETENZZENTRUM Wasser Berlin

I. Pipe simulator

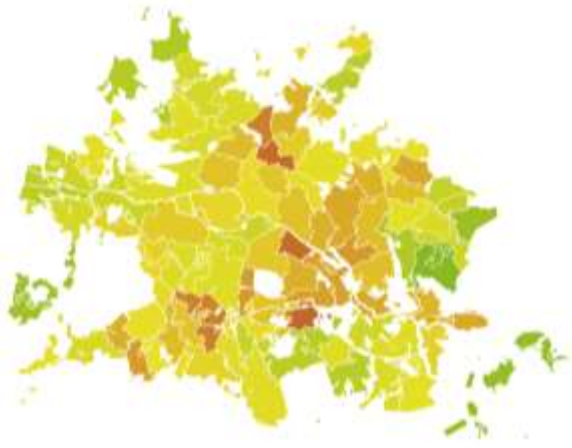
Goal: Prioritisation of pipes with high probability of defects to support short-term inspection planning

Random Forest





Hotspots at pipe level



Area prioritisation

Variables:

Pipe characteristics

Environmental factors

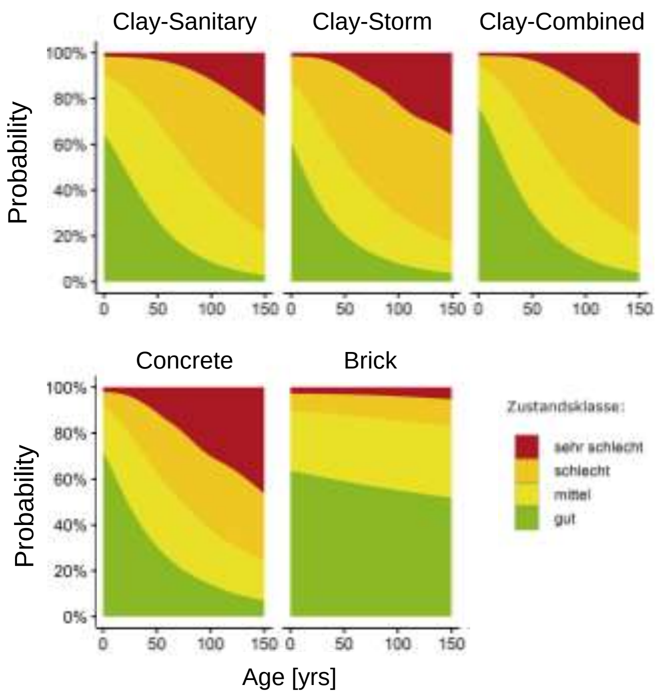
- ➢ Model finds about 4 times more defect pipes than current strategic inspections
- ➢ Valuable information for efficient inspection programs

KOMPETENZZENTRUM Wasser Berlin

II. Strategy simulator

Goal: Long-term predictions for sewer network condition and strategic rehab planning

Deterioration model

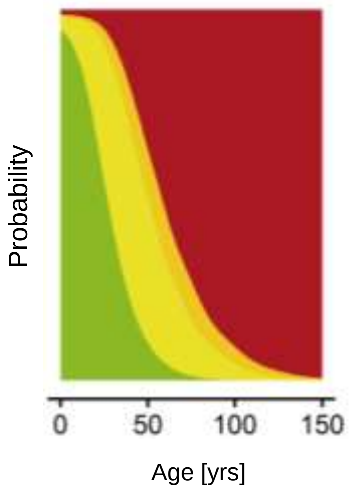


Statistical regression model based on survival curves for different pipe cohorts

+

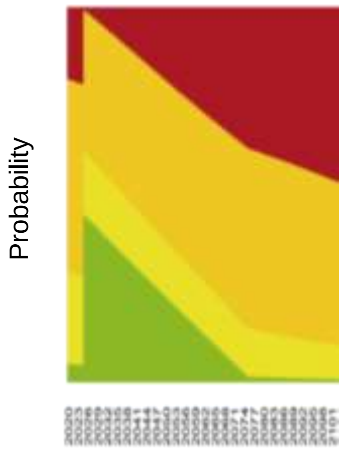
Rehabilitation components

Renovation



Estimated survival curves

Repair



Offset model

Strategy configurator

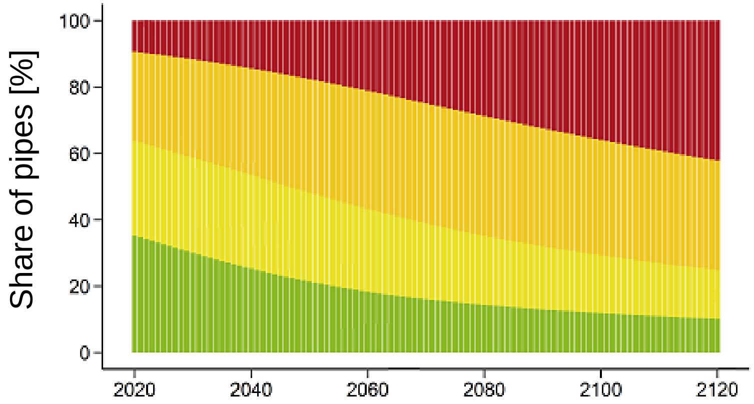
Variables:

KOMPETENZZENTRUM Wasser Berlin

II. Strategy simulator

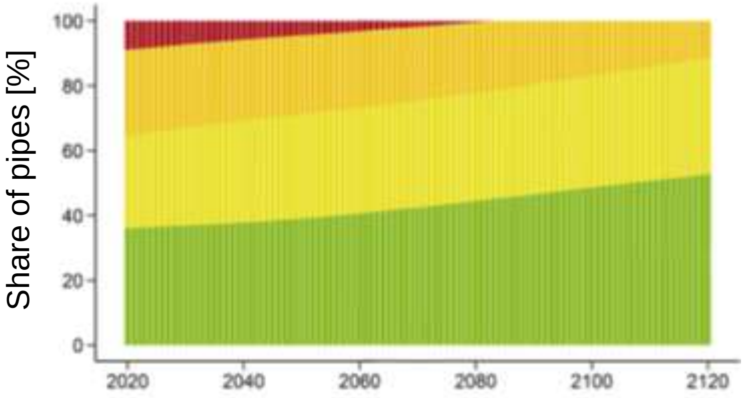
Condition distribution for different rehab strategies

A. "Do nothing"



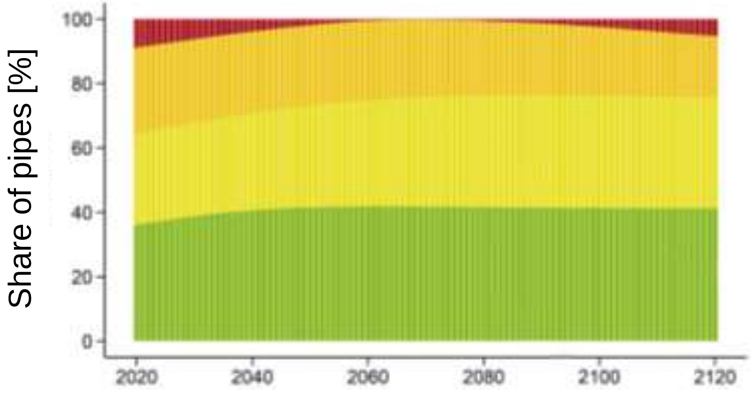
- ➢ constant increase in the share of pipes with severe defects (0.3% per year)

B. Renewal strategy (1%/a)



- ➢ Continuous improvement of condition, but limited by high costs and other constraints

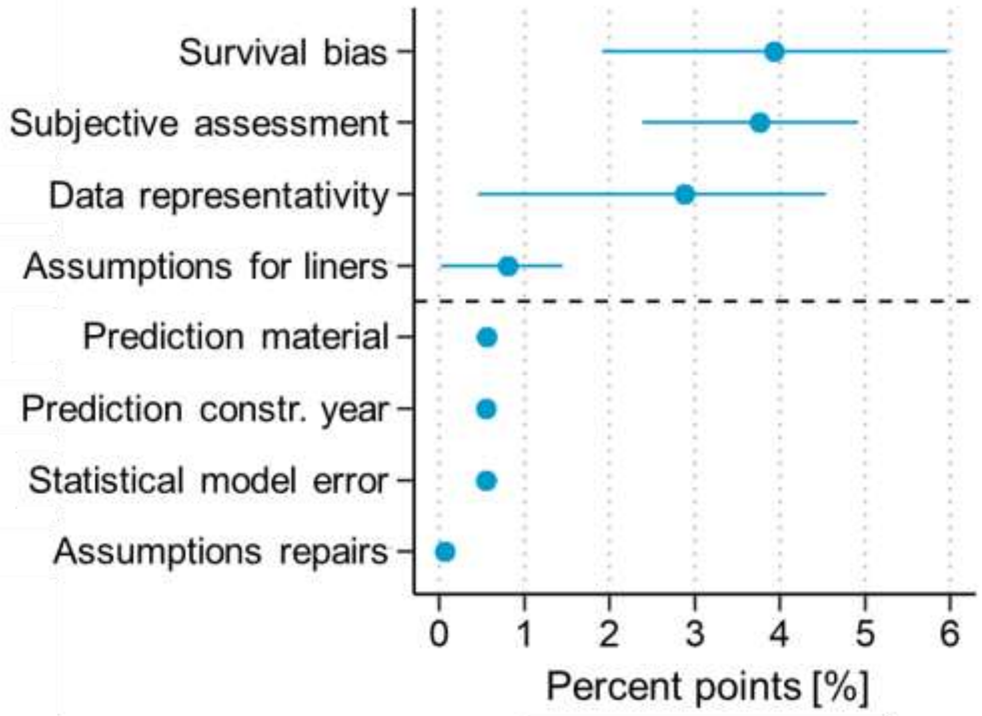
C. Mixed rehab strategy (1,1%/a, renewal + renovation + repairs)



- ➢ Short-term condition improvement followed by deterioration → effect of liners

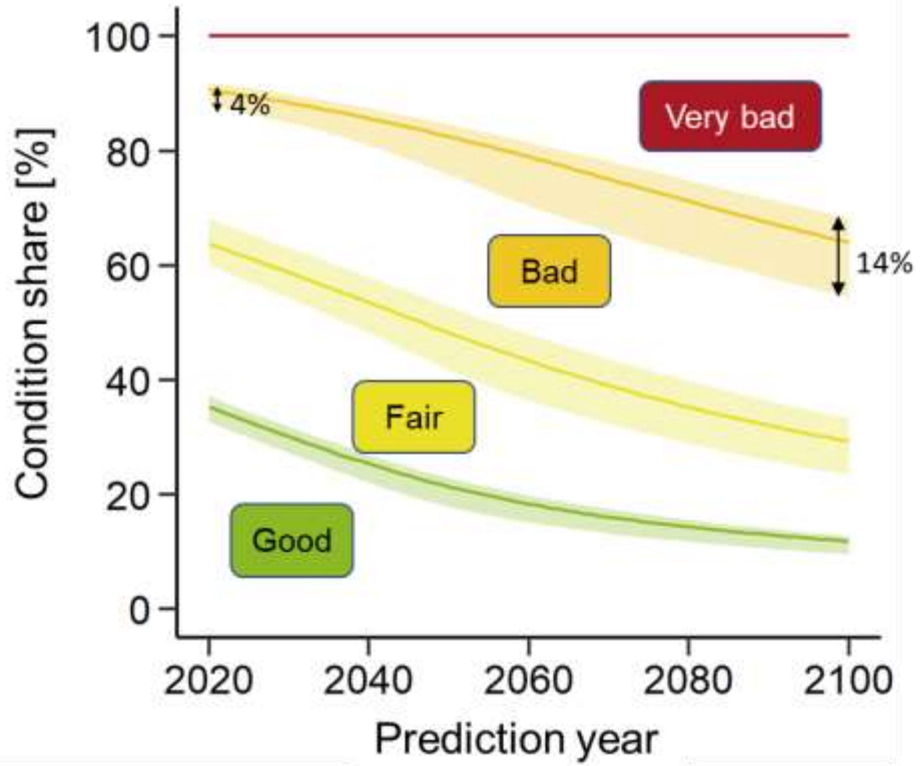
Model uncertainties

Ranking of uncertainty sources:



(= Relevance over time)

Total uncertainties for a do-nothing simulation:



- Assumptions on liners can become major source of uncertainty for a given rehab strategy

KOMPETENZZENTRUM Wasser Berlin

Summary and conclusions

- The **strategy simulator** can support utilities in long-term planning of efficient rehabilitation and investment strategies
- The **pipe simulator** prioritises pipes according to their defect probability, allowing for more efficient inspection programs
- Data gaps can be filled with reliable ML-based prediction models
- Important uncertainty sources and countermeasures identified
- Both simulation tools are planned to be tested in other cities ➡ SEMA plus

Contact:

mathias.riechel@kompetenz-wasser.de