KWR
Watercycle Research Institute

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Impact of climate change on drinking water distribution networks

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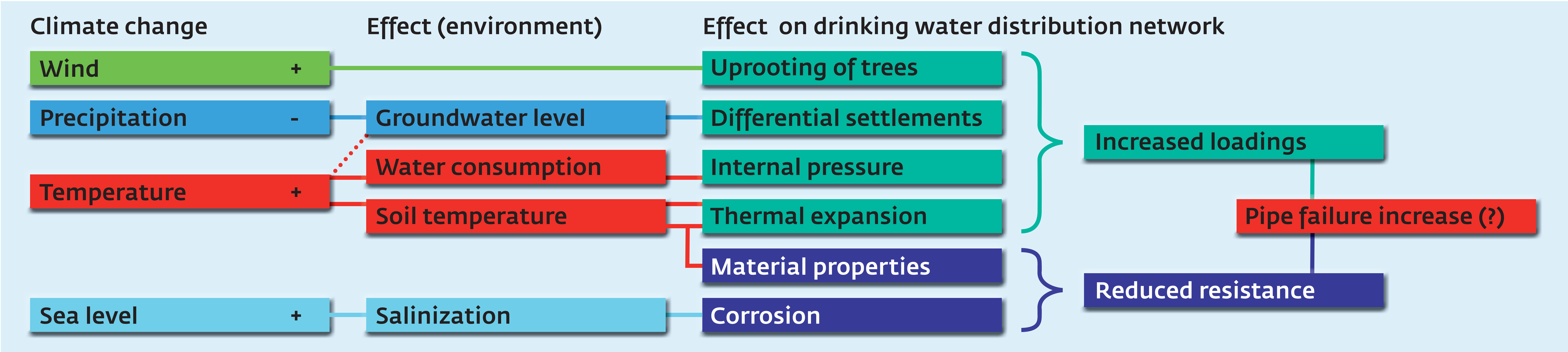
Introduction

The integrity of drinking water distribution networks may be threatened by climate change via several pathways:



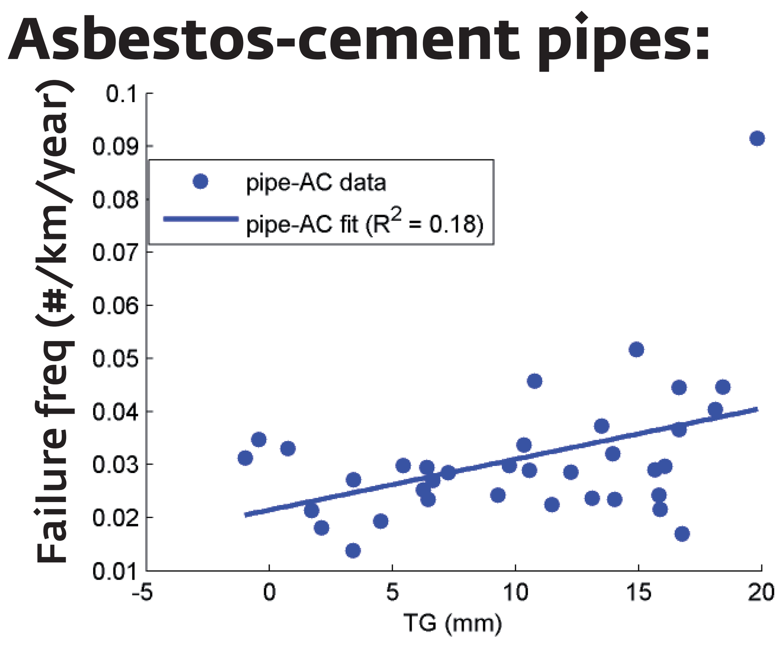
Models are being developed to assess the impact of climate change on pipe failure:

- Statistical models
- Physical models to assess the impact of **differential settlements**

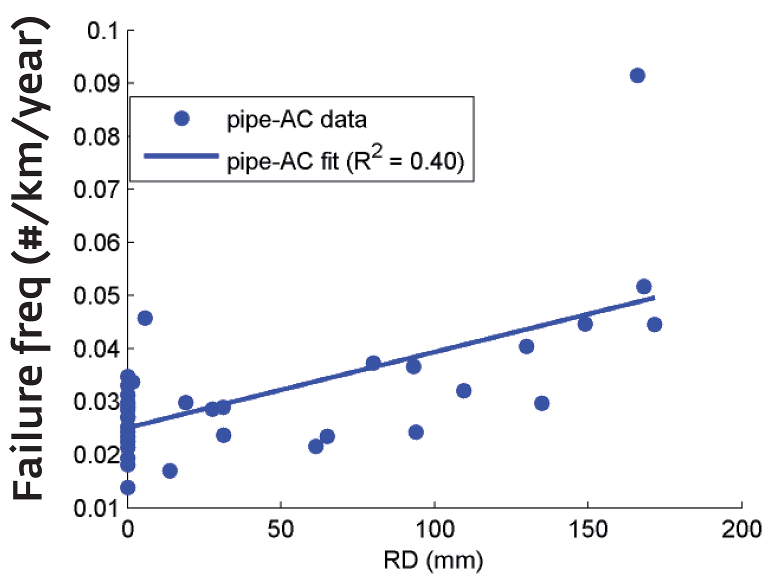
Statistical model

Meteorological data (KNMI) is compared to pipe failure data of drinking water distribution networks in the Netherlands (USTORE). Monthly averages over a period of 3 years were used. The diagrams show positive correlations for the failure frequency as a function of both mean temperature and rain deficit for both cohorts. This correlation is also seen for grey cast iron pipes, but not for PVC pipes.

Asbestos-cement pipes:

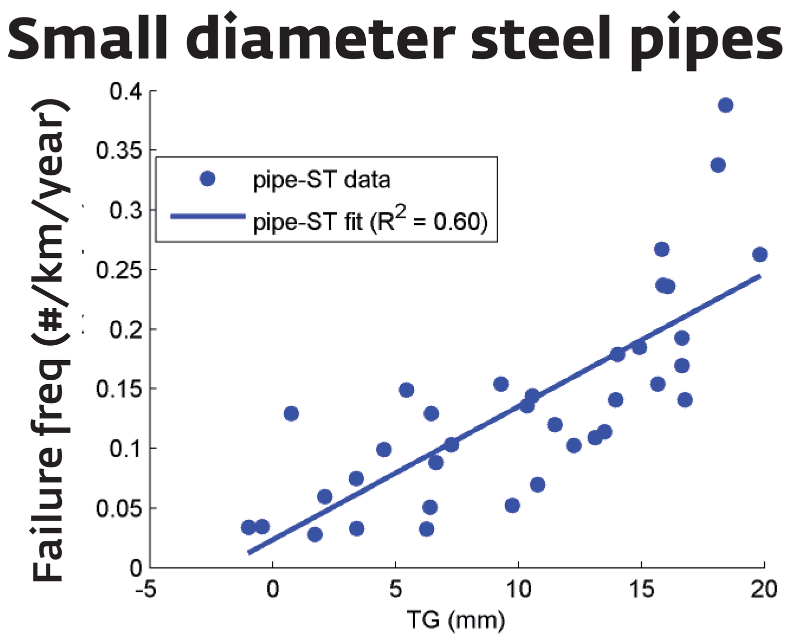


Mean temperature (°C)

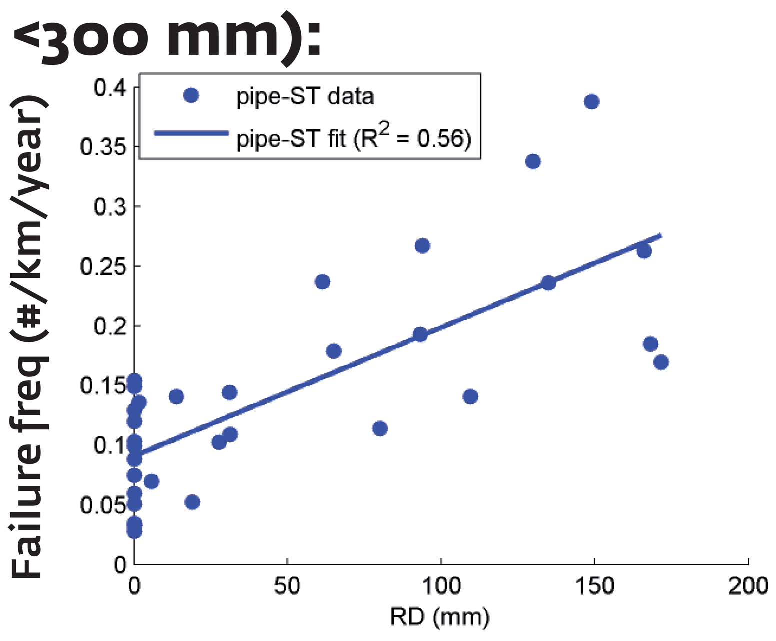


Rain deficit (mm)

Small diameter steel pipes (<300 mm):



Mean temperature (°C)



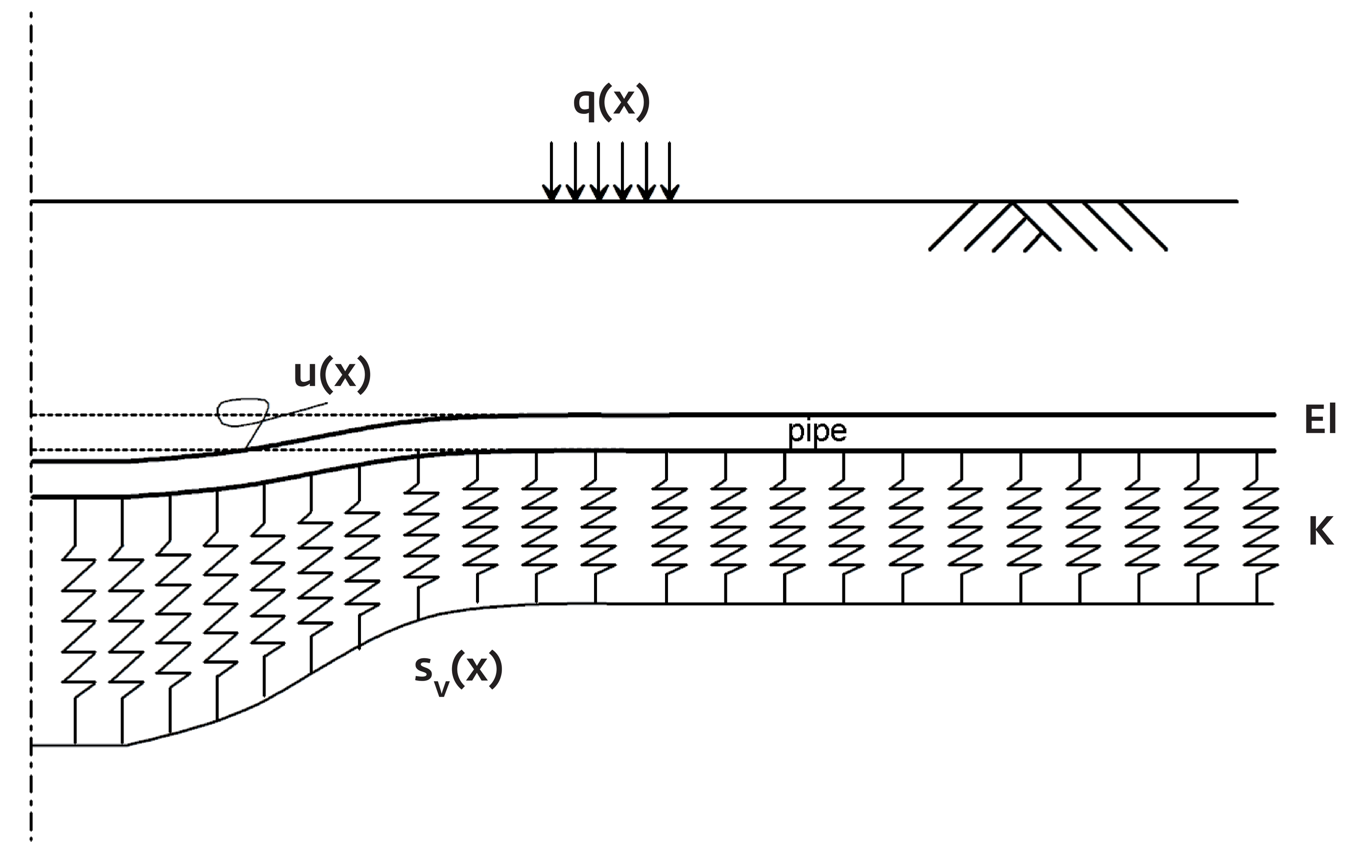
Rain deficit (mm)

Conclusions

- **Pipe failure is clearly correlated to two important climate parameters: mean temperature and precipitation.**
- **Increased differential settlements related to climate change may be one of the causes for higher failure rates.**
- **Increase in pipe stresses by differential settlements can be calculated by a physical model.**

Physical model

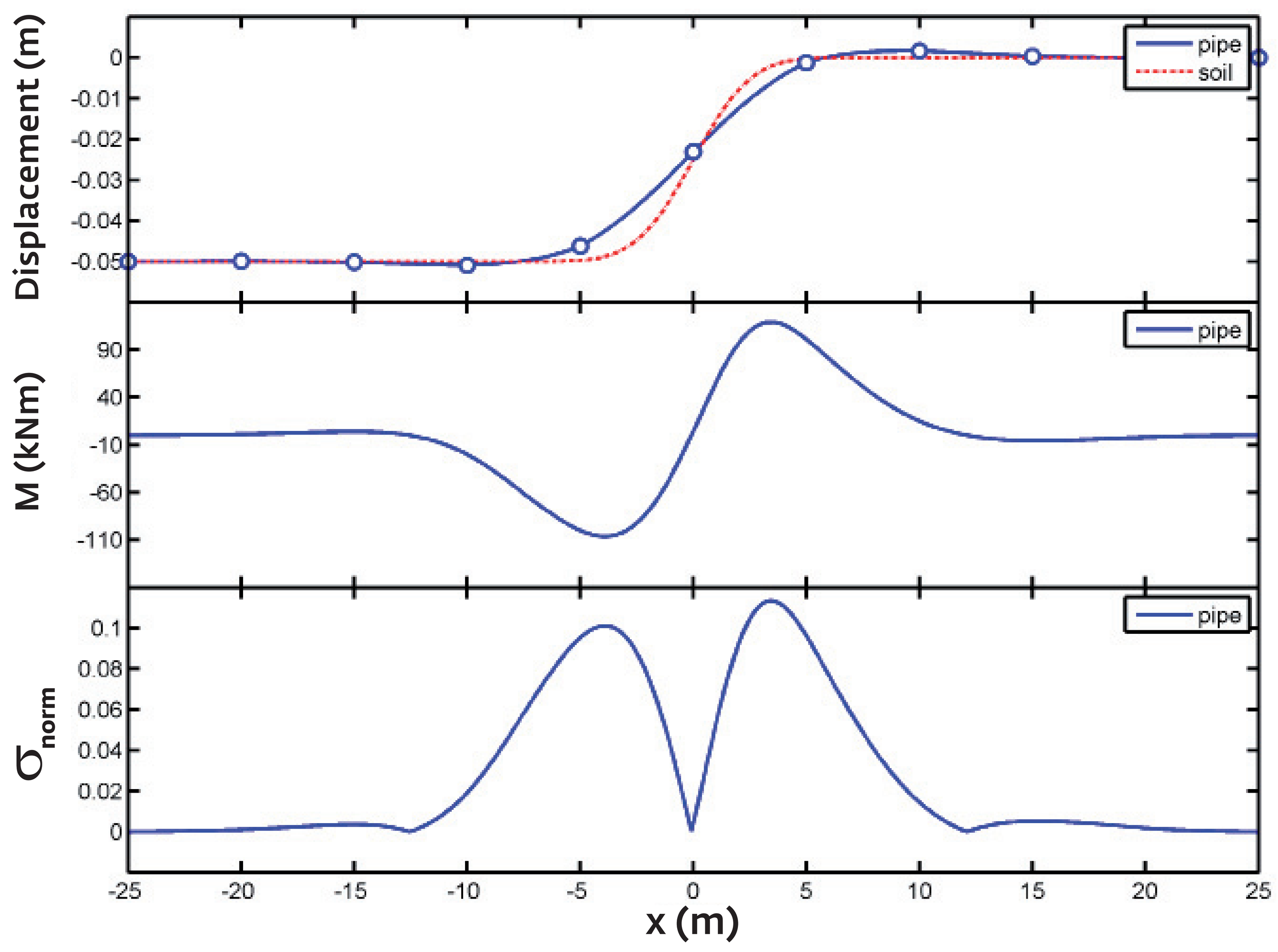
Pipes are displaced by differential settlements of the soil. Pipe-soil behaviour is schematized as a beam on a spring foundation.

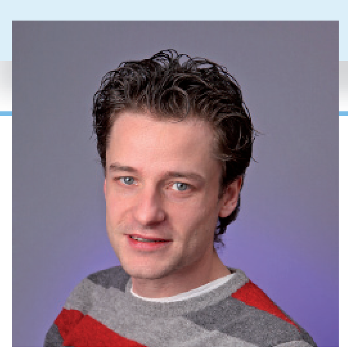


A soil settlement **S_v(x)** induced by climate change, causes pipe deformation **u(x)**, which depends on the pipe stiffness **EI** and pipe-soil behaviour (modelled as springs with constant **K**):

$$\frac{d^2}{dx^2}\left(EI\frac{d^2u(x)}{dx^2}\right)+K\cdot(u(x)-S_v)=q(x)$$

The displacements, bending moments **(M)** and increases in stresses σ_{norm} (compared to yield stress) are calculated by the model:





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