wetsus
european centre of excellence for sustainable water technology

Smart Detection and Real-time Learning in Water Distribution: an Integrated Data-Model Approach

Caspar Geelen
caspar.geelen@wetsus.nl

Motivation

Although Dutch drinking water is of high quality and only 5% of clean drinking water is lost per year [1], the actual behavior of flows within the distribution network and **current state** of the pipes remain largely unknown. Due to the unknown state and continuous degradation of pipes, water companies yearly spend millions in investigating the state of water mains, without a detailed strategy to target most likely degraded pipes.

Although increased water sensor placement in water mains yields **big & fast data streams**, analysis of this data is currently limited to a **reactive** approach of real-time leak detection [2].

However, in order to guarantee robust performance and avoid leakages, a more **proactive** approach is required. Since sensor placement and pipe inspection are costly, the abundance of currently collected sensor data can be further analyzed to facilitate cost-effective monitoring and management of the water supply grid.

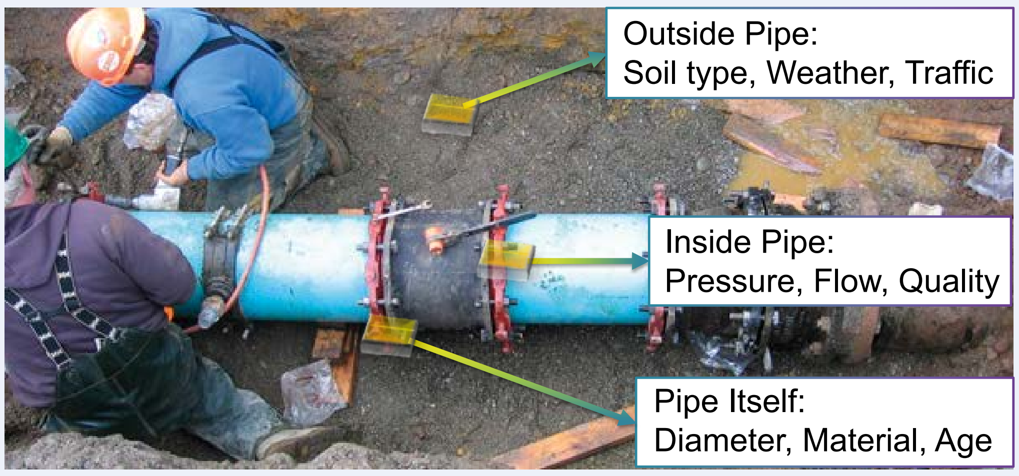

Fig 1. Available data sources influencing pipe condition

Technological challenges

1. **Integration** of multiple data streams with the aim to discover more information than currently possible with separated sensor data processing.
2. **Reconciliation** of flow dynamics from prior (physical) knowledge of the drinking water distribution process and data streams.
3. **Development** of innovative decision support that allow the integration of (noisy/perturbed) data and (incomplete) prior systems knowledge for real-time learning and early warning systems (EWS).

Research goals

- Obtain real-time insight in the state of the assets in the drinking water distribution grid.
- Realize decision support for cost-effective monitoring and management of the water distribution network.

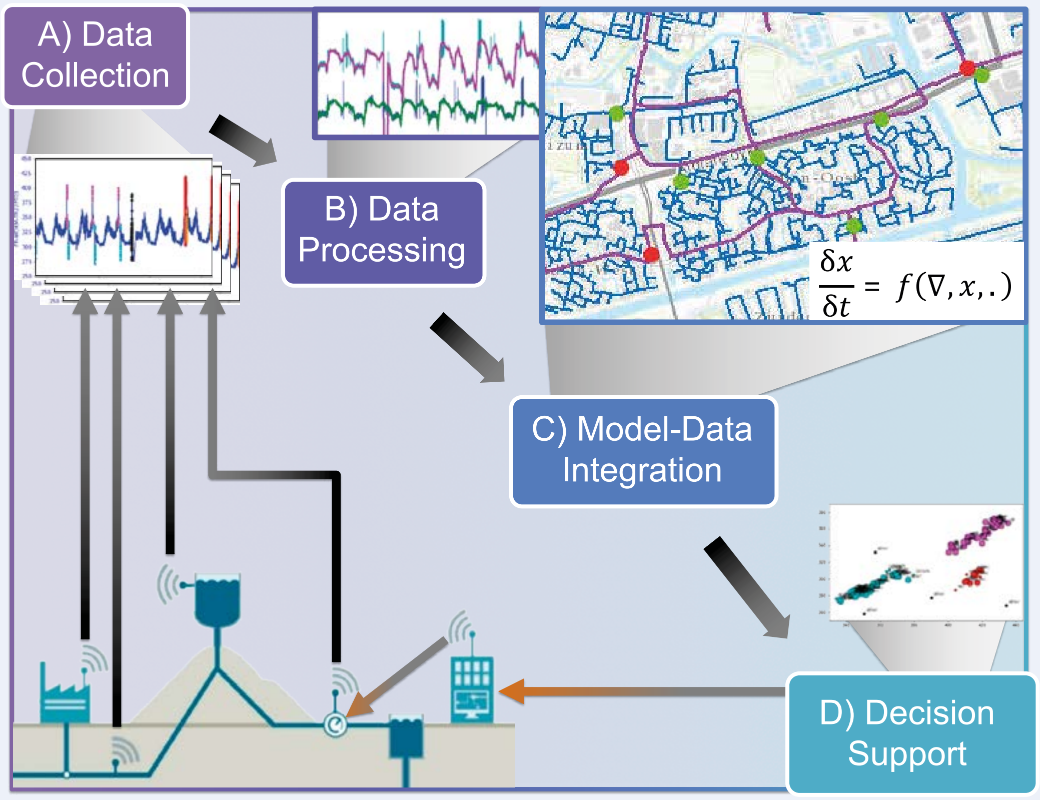

Fig 2. Research approach

Approach

With the help of Dutch drinking water companies, current available data streams (Fig. 1) are collected & investigated (Fig. 2A) and integrated using data science (Fig. 2B). The resulting developed software sensors will allow discovery of new unexpected physical relationships within the water grid. These software programs are combined with GIS maps and mathematical MATLAB models of the water distribution grids in order to reconcile flow dynamics with discovered data relationships (Fig 2C). These insight in the state of the network assets are used to develop real-time decision support (Fig 2D).

Expected Outcome

1. **Early stage** faults and failures detection with corresponding probabilities
2. **Software sensors** for accurate information of network segment conditions in and around the pipes
3. Optimal (mobile) **sensor locations**
4. **Fault detection & isolation** (FDI) for accurate information of the conditions inside the distribution grid

1 [1] "Drinking Water Fact Sheet 2016." VEWIN (2016).
2 [2] Gelazanskas, Linas, and Kelum AA Gamage. "Demand side management in smart grid: A review and proposals for future direction." *Sustainable Cities and Society* 11 (2014): 22-30.

ir. C.V.C. Geelen, dr.Ir. D. Yntema,
prof.dr.ir. K.J. Keesman, prof.dr.ir. J. Molenaar

WAGENINGEN UNIVERSITY & RESEARCH