Aqua Flanders

VLAKWA
Flanders Knowledge Centre Water

VLAAMSE MILIEUMAATSCHAPPIJ

IMPORTANT INFORMATION FOR PARTICIPANTS – PREPARATION EVENT

Tool for innovative leak detection and leak localisation with (existing) data

VLAIO - PIO

VERHAERT | MASTERS IN INNOVATION

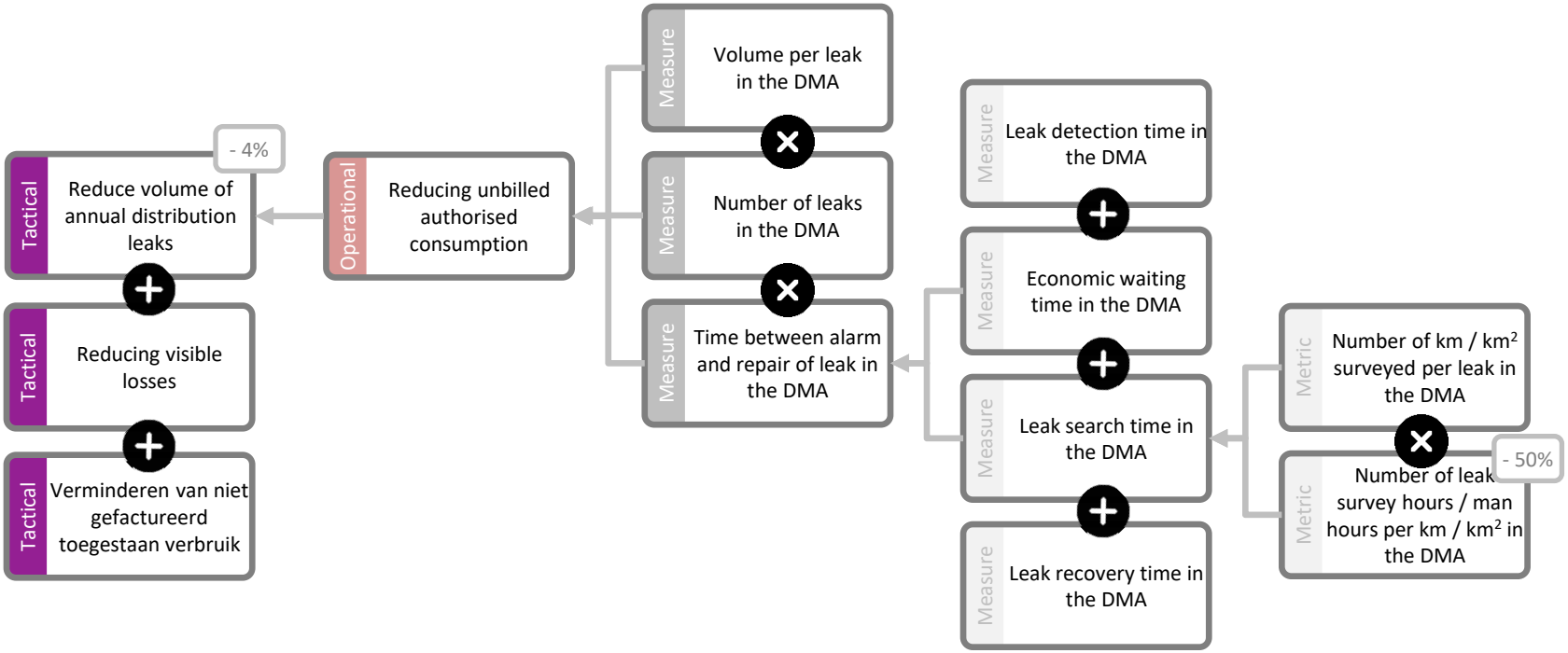
Optimizing leak detection and localization to meet the Flemish Government's Blue deal ILI target of 0.5 by 2025

- Through the Blue Deal program, the Flemish government aims to **address water scarcity and drought by achieving an Infrastructure Leakage Index (ILI) of 0.5** by 2025.

- Today, water companies follow a process for detecting and repairing water leaks in the distribution network, which consists of various DMAs (District Metered Areas). The **flow rate at the entrance of each DMA is continuously monitored** and thoroughly analyzed. **Anomalies are detected by comparing the baseline level of nighttime consumption with the actual measurements**. Potential issues are identified, and priority zones are determined using methods such as step testing (mainly for large leaks) and the use of mobile sensors. The current solution requires additional sensors within the DMA to narrow down the search area for leaks. Although a larger number of physical sensors increases accuracy, this approach also entails higher costs in terms of purchase and maintenance.

- **The water companies aim to optimize leak detection and leak localization in the water distribution network through data analysis** to reduce the share of NRW (Non-Revenue Water). The goal is to focus resources and efforts on areas with the highest likelihood of leaks, enabling quicker and more effective intervention. Both **large and small leaks (<= 5 m^3/hour) should be accurately located within an area of up to ~100 km of pipeline, preferably down to street level.**

Reducing the yearly non-revenue water



Innovative leak detection and localization using indirect, virtual, and existing hydraulic datasets

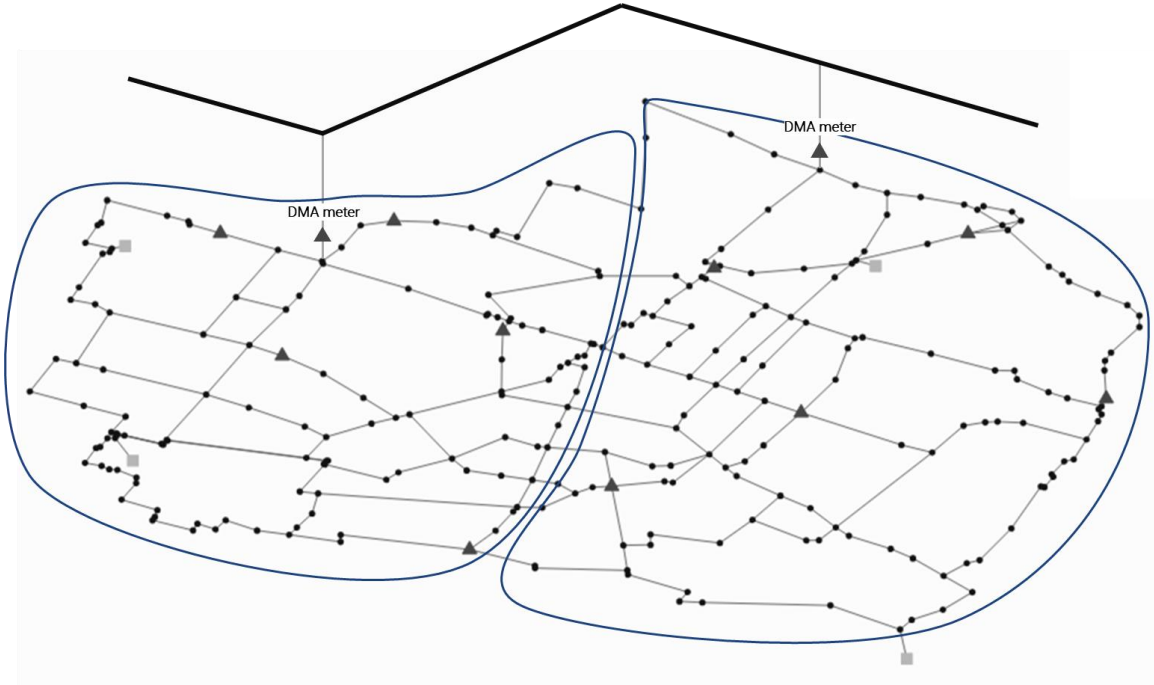
- The intended innovation focuses on deploying virtual data, such as estimates or predictions for locations without physical sensors, and indirect or proxy data that indirectly provides insights into the condition at a specific location, such as customer reports, construction work, fire brigade interventions, and anomalies, as an alternative to placing additional physical sensors in the network.

The ideal solution is an algorithm that combines direct data from existing[1] physical sensors with virtual and indirect datasets for analysis. These datasets would advise the leak locator on priority search zones where an incident like a leak is occurring, including the type, size, and location of the leak. This should lead to faster and more targeted localization, significantly reducing search time and water loss.

- The hypothesis, however, is that current market solutions are insufficient. Therefore, the drinking water sector wants to accelerate innovation by stimulating collaboration within the NRW ecosystem. Based on lessons learned from the event, AquaFlanders intends to place a public tender to develop and validate solutions.

[1] While DMAs currently have a range of physical sensors and will also incorporate digital meters in the future, the goal is to avoid the need for installing any additional sensors

Innovative leak detection and localization using indirect, virtual, and existing hydraulic datasets



Network elements

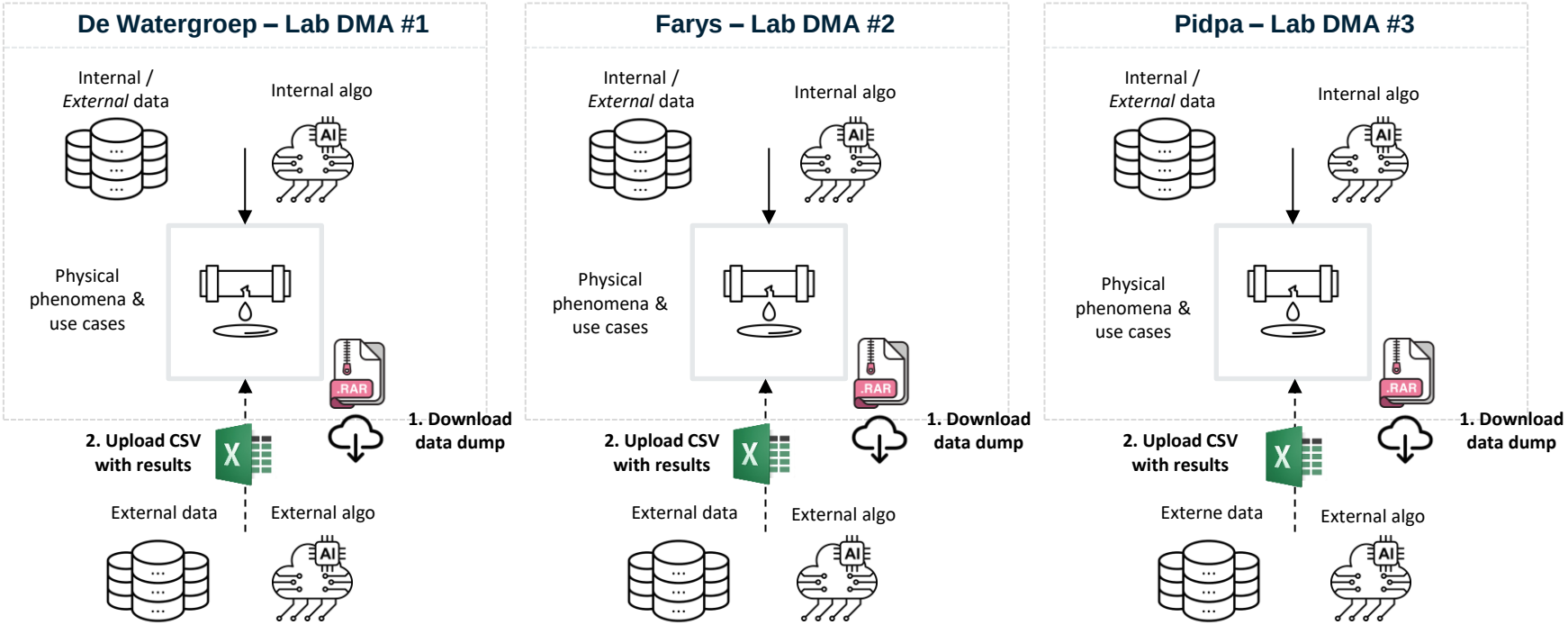
- Junctions / Shut-off valve
- Reservoirs
- Distribution pipes
- Transmission pipes

Data sources

- Direct / Measured data e.g. physical sensors that obtain data at specific locations[1]
  - Sensor data (physical / fixed*)
  - Sensor data (physical / mobile)
  - Digital meter data
- Derived data e.g. virtual sensors that estimate or forecast data for locations lacking physical sensors
  - Sensor data (virtual)
- Proxy / Indirect data e.g. data that indirectly reflects the conditions in the network
  - Sensor data (remote (sensing))
  - Human observation / reporting data
  - Human logging / registration data

[1] While DMAs currently have a range of physical sensors and will also incorporate digital meters in the future, the goal is to avoid the need for installing any additional sensors

The goal is to test promising algorithms that utilize diverse data sources across three laboratory DMAs



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At the event, you will have the chance to showcase your data-driven solution(s) to address the challenge(s)

- With this project briefing we aim to prepare you for the upcoming event where you'll have the opportunity to present your company's ideas, insights, and innovative (data-driven) solutions for addressing the challenge faced by water companies. We are looking forward to your visually compelling one-pager or one-slider that addresses the following three key questions:

1

How do you understand the challenge faced by water companies, and how do you think your company's core technology, currently on the market, can address this challenge?

2

Where do you see potential gaps between your current offerings and the challenge or demand at hand?

3

How do you plan to bridge this gap, and what specific internal and external knowledge, expertise, or technology will you need to achieve this?.

Your one-pager or one-slider will be displayed on the wall during the poster session, where you can present it to other attendees. Als you will be able to view and discuss other attendees' presentations.

For your data-driven solution, you may use one of the available datasets or select your own if required

- A variety of internal and external data sources are provided for you to use as input for your algorithms. Additionally, you're allowed to use your own data if it could improve the algorithm's performance or if it seems relevant and worth exploring within this context.

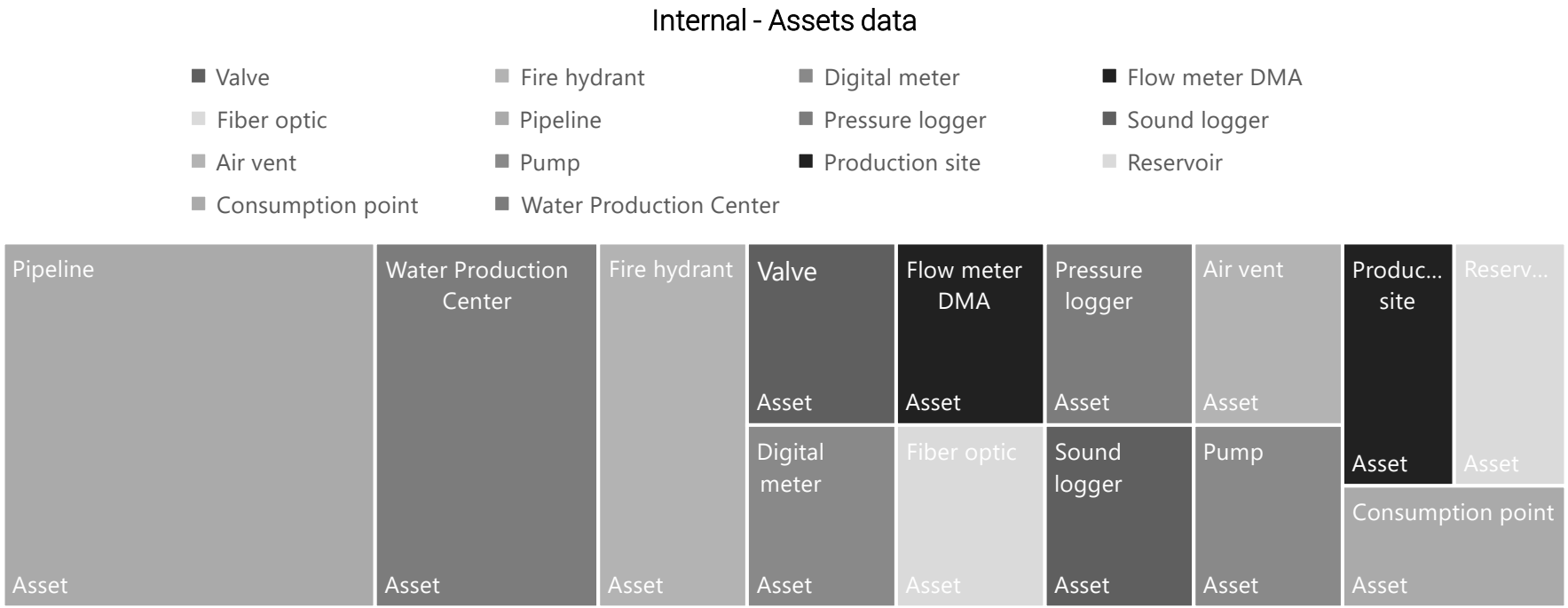
Internal data	**External data**	**?**
Data includes asset information such as valves, meters, pipelines, and operational data like anomalies, incidents, notifications, reports and maintenance records.	Data includes notifications from sewer operators, municipalities, environmental data from social media, satellites, drones, weather, and dispatching of fire department	Your own data - What other data types are needed or are worth exploring?

- In appendix, you can find the details of some of these internal and external data sources

APPENDIX

Overview of data sources available as input for the algorithm(s)

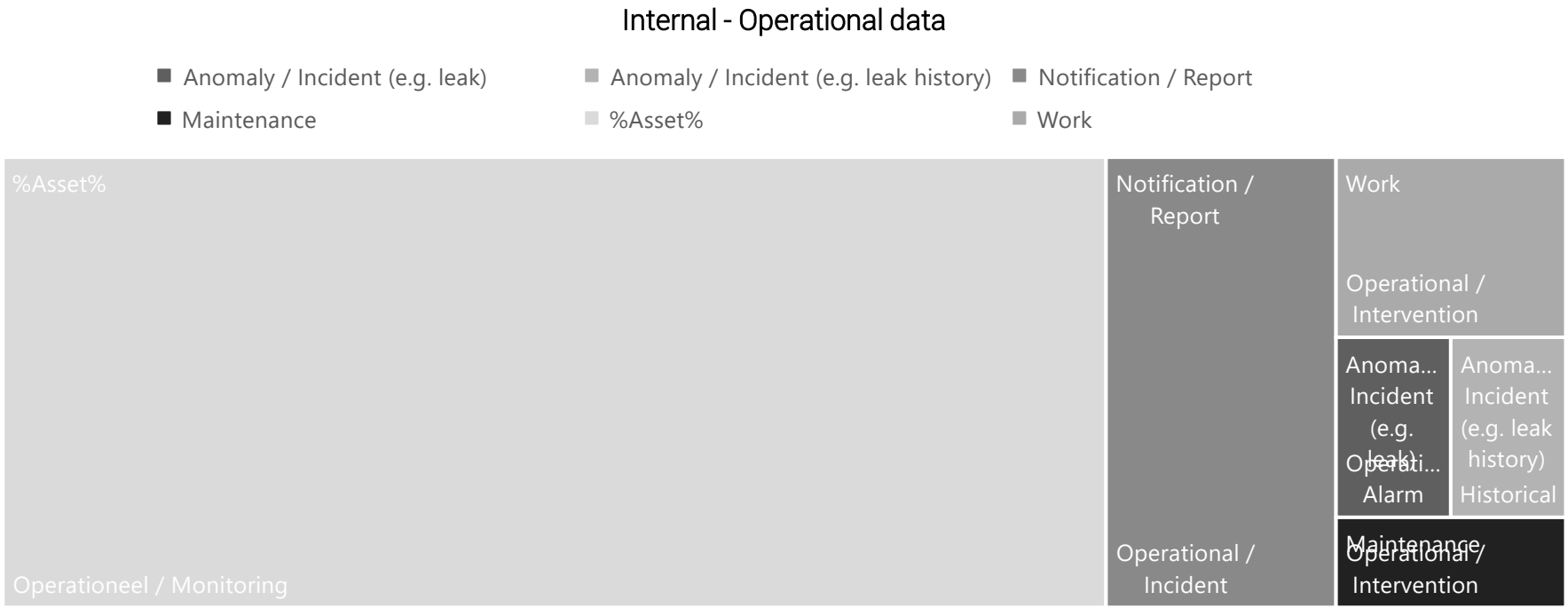
Overview of asset data sources available as input for the algorithm(s)



Overview of potential asset use cases

Category	Asset	Potential use case
Asset	Network elements	Aging pipelines, including branches, tapping saddles, and rubbers, increase the likelihood of leaks.
Asset	Flow Meters (DMA)	The incoming and outgoing flow of a DMA/registration zone is crucial for establishing the water balance, where leak loss is calculated as the difference between the incoming flow and the sum of consumption and flushing.
Asset	Digital Meters	Digital meters are essential for accurately establishing the water balance by better tracking incoming and outgoing water usage, identifying leaks and stolen water, and detecting pressure drops, which is currently difficult due to the use of extrapolated consumptions that do not account for variable night usage, especially in zones with active businesses.
Asset	Mobile Pressure Loggers / Pressure Transients	Pressure fluctuations in the network can lead to leaks. The phenomenon of water hammer, also known as hydraulic shock, occurs in pipeline systems when the water flow suddenly changes, for example, by the rapid closing of a valve or the abrupt stopping of a pump, resulting in pressure waves that can cause damage to pipes and system components, and may be exacerbated by a faulty pressure reducing valve (PRV).
Asset	Mobile Sound Loggers	Sound loggers identify locations where potential leak sounds have been detected—the improvement of historical recording falls under the project "Monitoring Acoustic Measurements" led by PL Tom Van Brabant.
Model	GIS	By updating valve data (semi-)automatically and correctly in the GIS, leak localization can occur more efficiently, as up-to-date and accurate information on the status of valves helps quickly identify problem areas and analyze pressure deviations, which is crucial for detecting leaks in the network.
Model	Hydraulic Model	A hydraulic model, based on average and peak days, may be supplemented with live data to enable accurate pressure calculations at every point, where deviations from these calculations may indicate a leak.

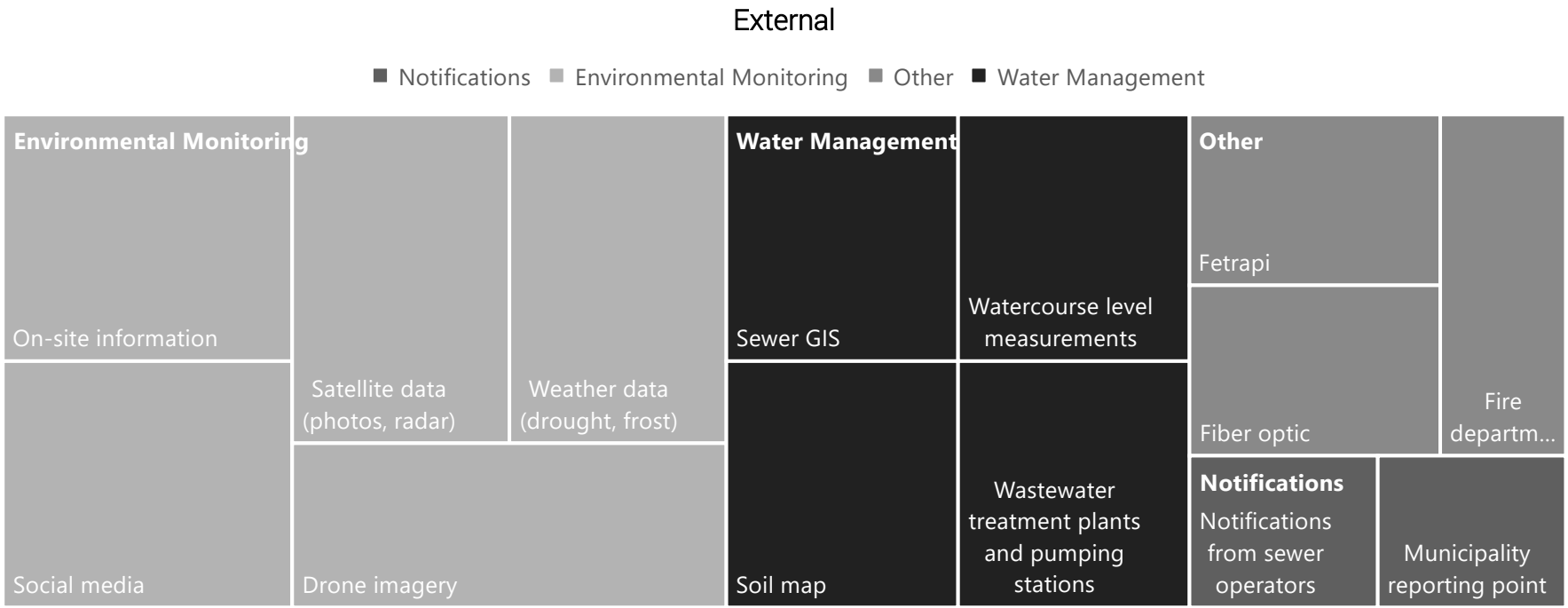
Overview of operational data sources available as input for the algorithm(s)



Overview of potential operational data use cases

Category	Operational Data	Potential use case
Operational	Customer / Employee Reports	Reports from customers or employees can indicate a leak in the drinking water pipe and the surrounding area (e.g., pressure issues, water in the basement). Ground subsidence may also signal a nearby leak.
Operational	Works and Manipulations	During pipe work, water may be lost, the distribution pattern may change due to temporary pipe closures, and the network may be reconfigured.
Operational	Pressure / Supply Distribution	Abnormal pressure can indicate a leak, and leak detection may be accompanied by increased pressure, potentially leading to new leaks.
Operational	Pressure / Water Production Center (WPC)	Abnormal pressure may suggest a leak, but if WPC pressure is lower without prior knowledge, a leak may be wrongly assumed (e.g., pressure taken over by a water tower while WPC pumps are off).
Operational	Pressure / At Flow Meter	Abnormal pressure can indicate a leak, and leak detection can be associated with increased pressure, potentially causing new leaks.
Operational	(Maintenance / Use) Fire Hydrants	Distinguishing normal from abnormal or improper use, as normal use can lead to incorrect reports without actual leaks, while improper use and maintenance can cause future leaks or issues due to pressure changes and defects.
Operational	Water Quality	Degradation of cement joints in piping systems due to water quality can lead to structural problems and leaks.
Operational	Leak History	A database with 10 years of leak repair orders can show that certain pipes or streets frequently have problems, indicating the need for replacement and a higher likelihood of future leaks.

Overview of external data sources available as input for the algorithm(s)



Overview of potential external asset use cases

Category	Asset	Potential use case
Asset	RWZI's and Pump Stations	In the context of leak detection, a wastewater treatment plant (RWZI) from Aquafin can help identify leaks in the drinking water or distribution network by detecting the unusual entry of clean water into the sewer system, which may indicate a leak allowing drinking water to flow into the sewer.
Asset	Fiber Optics	Leak detection techniques using fiber optics, including vibration detection, Distributed Temperature Sensing (DTS), Distributed Acoustic Sensing (DAS), and Optical Time Domain Reflectometry (OTDR), each use unique methods to identify leaks and other issues in pipes by measuring vibrations, temperature changes, sound waves, and light reflections.
Asset	Soil Map / DOV	The soil map from Data Ondergrond Vlaanderen indicates areas where subsidence and settlement may occur, depending on the type of geological layers in the subsurface.
Model	Sewer GIS / Geopunt	The database that records the location of sewers, including those not managed by water companies, is important because poor sewer conditions can cause ground subsidence, leading to shifts in the soil and leaks in drinking water pipes. Damage to sewers can complicate leak detection as water may disappear underground without being visible.
Model	Traffic Maps	Heavy traffic and constant load from traffic congestion can contribute to leaks in pipes by causing joint shifts and ground displacement, leading to subsidence and wear on PVC pipes, which can jeopardize the structural integrity of the pipes.

Overview of potential external operational data use cases

Category	Operational Data	Potential use case
Operational	Works / GIPOD	Locations of contractor works can indicate potential issues that may arise.
Operational	Reports / Sewer Operators	At the municipal level, municipalities or other organizations like Fluvius and Farys, in addition to Aquafin, are responsible for wastewater treatment plants (RWZI's). They can contribute to identifying leaks in the drinking water or distribution network by detecting unusual entry of clean water into the sewer system, which may indicate a leak.
Operational	Fire Brigade	Using data from fire dispatch, including the type of intervention, water usage, time, and location of the event, and often which hydrant was used; fire brigade data are also frequently reported in newspapers after the fact.
Operational	Weather / KMI	The phenomenon of drought and frost in the subsoil, such as in clay or loam, can lead to pipe movement due to subsidence, increasing pressure on pipes and potentially causing leaks, especially during thaw periods. Areas with cyclic seasons may show a higher risk of problems.
Operational	Municipal Reporting	…
Operational	Fetrapi	A legal requirement for builders, contractors, architects, or study bureaus to report work within a 15-meter zone around pipelines to pipeline operators, allowing them to provide necessary information in time to ensure the stability and integrity of the pipes.
Operational	Info Terrain	Additional information about specific contractor activities, such as excavation or hydrant use, and other activities near distribution pipes, such as infrastructure works, can help water companies detect leaks, as these activities increase the risk of pipe damage.
Operational	Social Media	Detecting leaks and narrowing the search area by gathering information and reports from residents about water issues, visible leaks, or other related problems, allowing water companies to respond more quickly and target their search.
Operational	Satellite Data	Location of tree roots entangled in pipes.
Operational	Drone Imagery	TBD
Operational	Water Level Measurement	Water level measurements of streams and areas with high groundwater levels are useful for identifying leak detection zones in water distribution networks. Abnormal increases in water levels and changes in groundwater patterns can indicate leaks, and correlating these data with known water losses can help delineate specific leak detection zones

Overview of all data sources and their specifics

Datapoint / Measured value >>	"Result of sweeping" / Color code	Bandwidth	DateTime	Flow rate	Flow rate - indirect	Diameter nominal	Pressure	Pressure force	Pressure transients	Fluctuations	Frequency/vibration	Frequency range	Sound volume	Length	Location	Material	Network	Task type	Potential	Type of pump	Status	Current (electric)	Temperature	Type	Type of leak	Type of pump	Water temperature	Water consumption	Content: ["X", "Water in the basement", "Subsidence"]	Related asset		(blank)	
Unit of Measurement >>		(Hz)	(YYYY-MM-DD HH:MM:SS)	(in m^3 of m^3/u)	(in m^3 of m^3/u)		(bar)	(bar)	(bar)	(Hz)	(Hz)	(Hz)	(dB)						(mV)			(A)	(°C)				(°C)	(L per 15 min)					
Asset	**1**	**1**	**3**	**2**	**1**	**4**	**5**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**3**	**1**	**1**			**1**	**1**	**1**					**37**
Valve						1																										1
Fire hydrant						1														1												2
Flow meter DMA			1	1																												
Digital meter			1				1																				1					3
Pressure logger									1																							1
Sound logger	1	1			1					1	1	1	1																			7
Fiber optic																																
Pipeline						1								1	1	1	1		1		1	1				1						10
Air vent						1																										1
Pump																			1	1					1							3
Production site																																
Reservoir																																
Consumption point																																
Water Production Center							1																									1
Water Production Center - Flow meter								1																								1
Water Production Center - Infeed distribution			1				1																									2
(blank)				1			1	1																								3
Other			**1**												**1**			**1**						**1**	**1**				**1**	**3**		**9**
Anomaly / Incident (e.g. leak)																		1						1								2
Anomaly / Incident (e.g. leak history)																									1							1
Notification / Report			1												1														1	1		4
Maintenance																														1		1
Work																														1		1
Totaal	1	1	4	2	1	4	5	1	1	1	1	1	1	1	2	1	1	1	1	1	3	1	1	1	1	1	1	1	1	3		46

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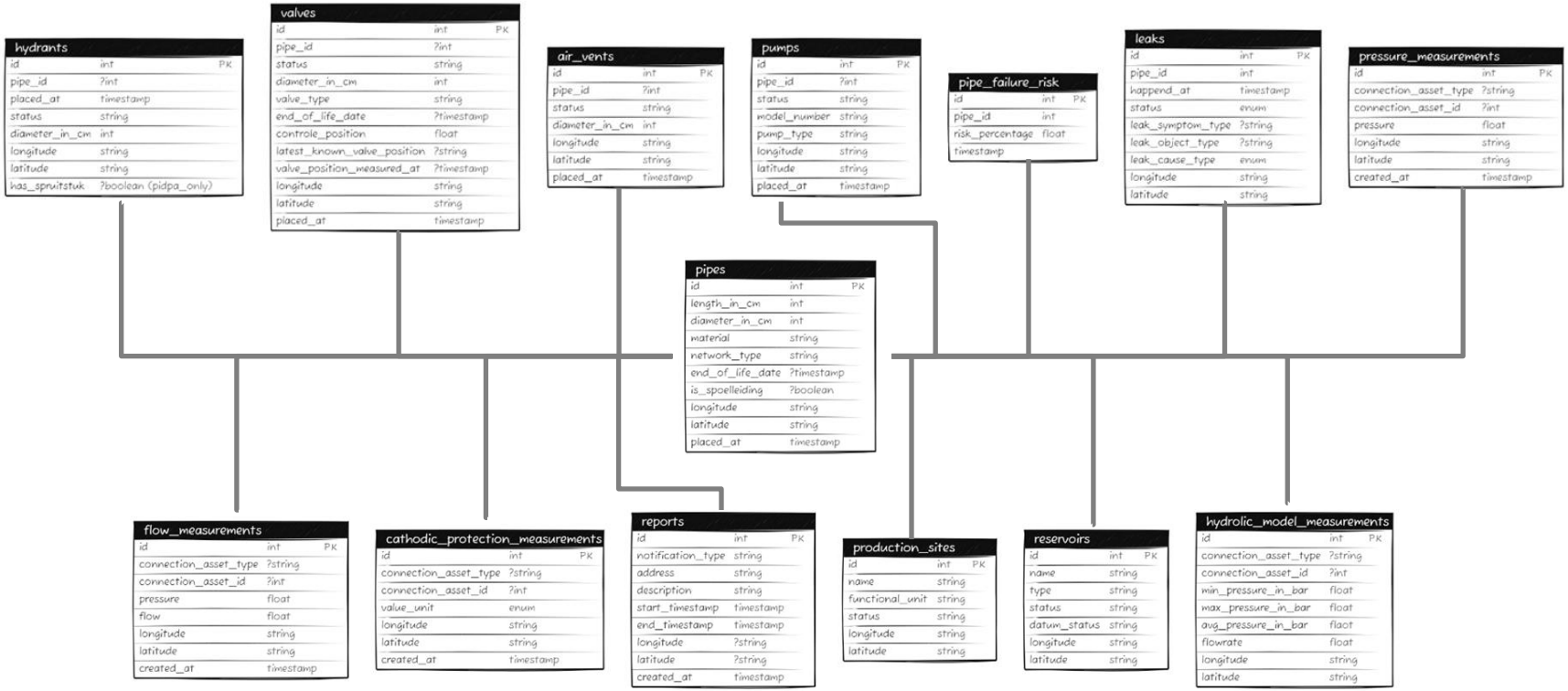
Data model with entity attributes and their relationships



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