# DEVELOPMET OF AN ASSET LIFETIME MODEL FOR DISTRIBUTION NETWORK MANAGEMENT

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**Canal de Isabel II gestión**

It is a public company responsible for managing the whole water cycle in the region of **Madrid** in Spain

**6,238,000**
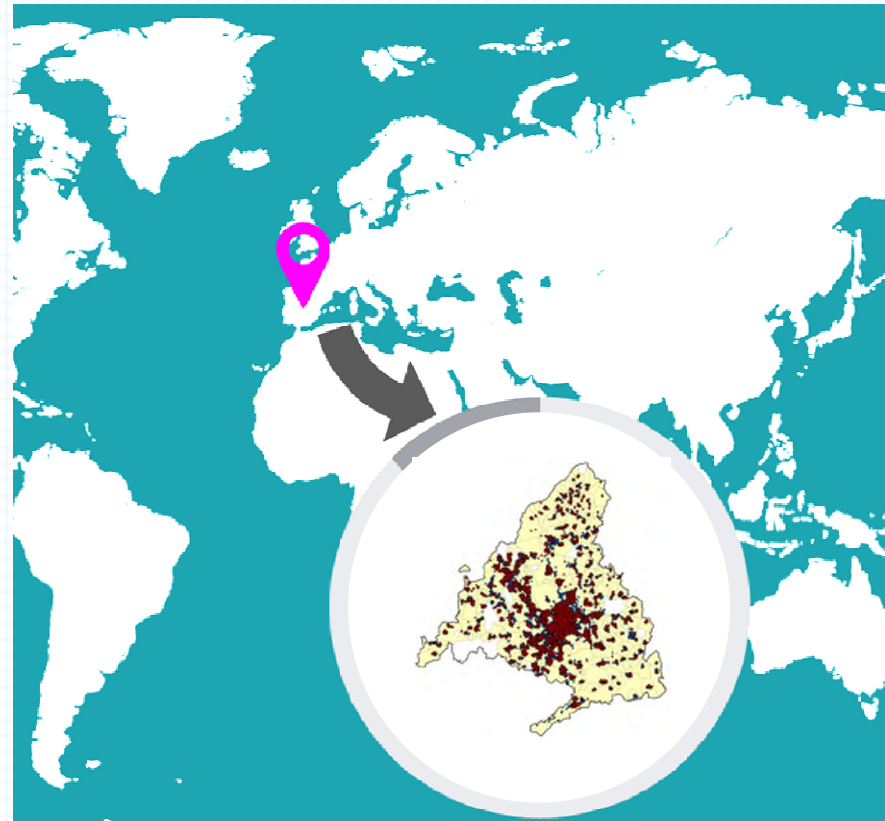Inhabitants supplied

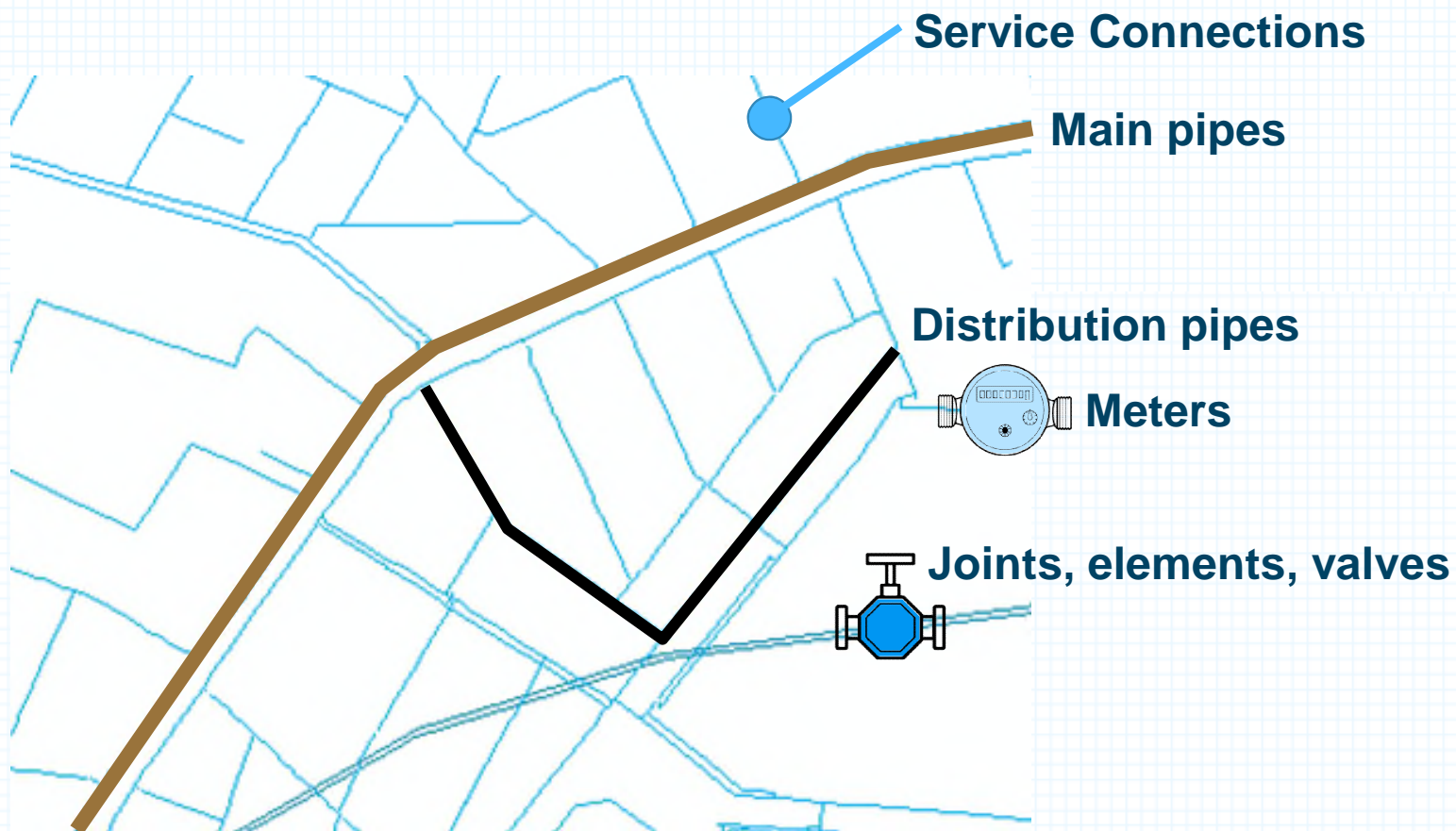**17,500**km
Distribution Network

**177**
Municipalities

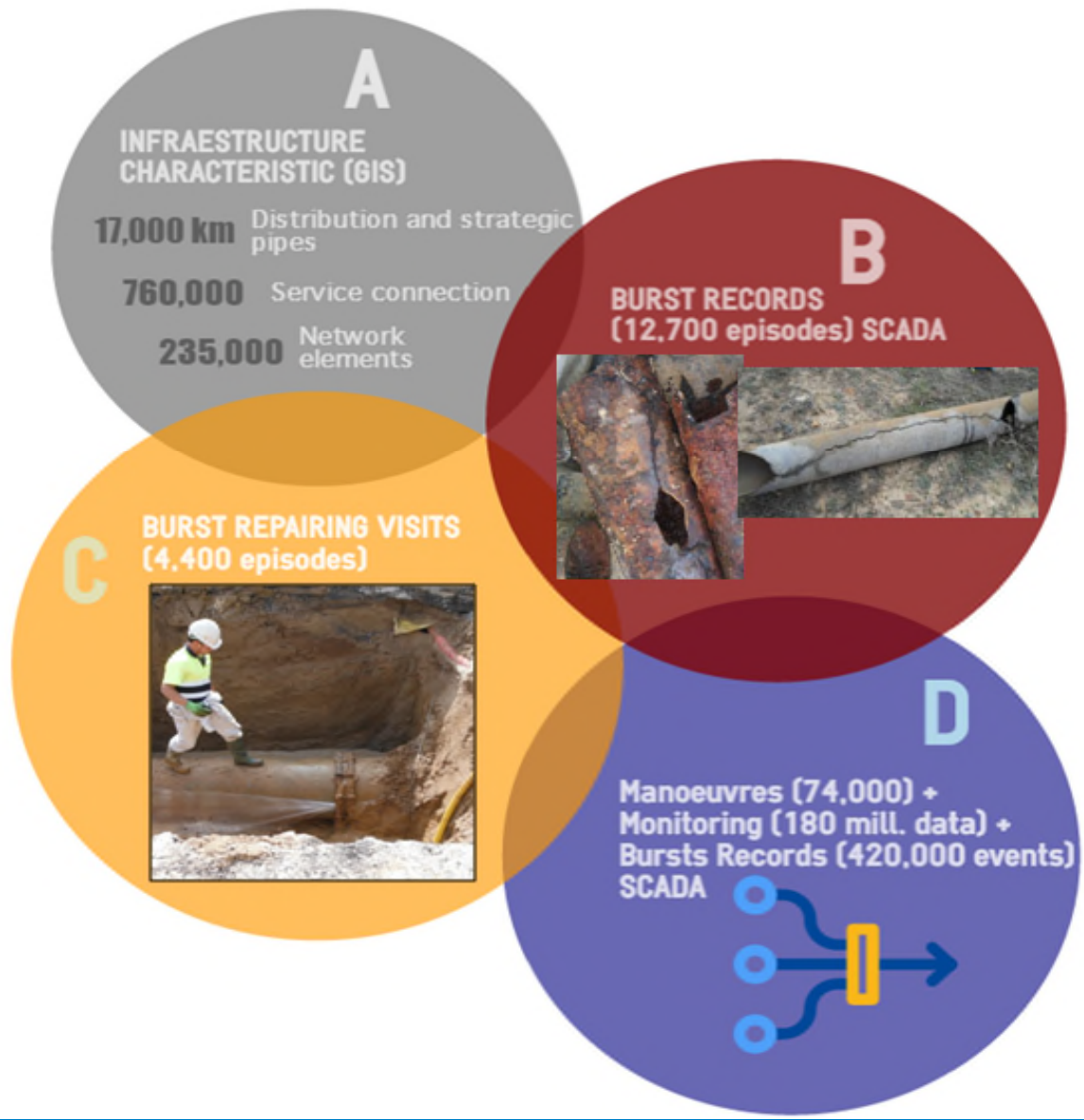# Criteria & methods for asset management

★ **Improve efficiency**

★ **Minimize possible service disturbance events**

# An asset lifetime model

## with a specific function for each type of element

# Failure prediction model



**A** INFRAESTRUCTURE CHARACTERISTIC (GIS)

17,000 km — Distribution and strategic pipes

760,000 — Service connection

235,000 — Network elements

**B** BURST RECORDS (12,700 episodes) SCADA

**C** BURST REPAIRING VISITS (4,400 episodes)

**D** Manoeuvres (74,000) + Monitoring (180 mill. data) + Bursts Records (420,000 events) SCADA

# *In-situ* visits

# Variables

| Group | Source | Variable | Service connections | Distribution pipes | Transport Mains | Elements |
|---|---|---|---|---|---|---|
| **A** | Geographic Information System (GIS) | Diameter | green | green | green | green |
| | | Age | green | green | green | green |
| | | Material | pink | green | green | pink |
| | | Depth | green | pink | pink | green |
| | | Location (burried, chambers…) | green | pink | pink | green |
| | Geological, urban and regional Planning Maps | Type of soil | green | pink | pink | pink |
| | | Soil cover | pink | pink | pink | pink |
| | | Traffic loads | pink | pink | pink | pink |
| **B** | Bursts and leakages records | Failures' date and location | pink | pink | pink | grey |
| | | Spatial failures distribution | pink | pink | pink | grey |
| | | Temporal failures distribution | pink | pink | pink | grey |
| **C** | Field visits to bursts and laboratory tests | Soil temperature | pink | pink | pink | |
| | | Soil agresiviness | pink | pink | pink | |
| | | Isolated conductive zones | pink | pink | pink | pink |
| | | Pipe bedding condittion | pink | orange | orange | pink |
| | | Compaction of embedment soil | pink | orange | orange | pink |
| | | Deficiencies on elements materials | pink | orange | orange | pink |
| | | Field pressure registered | pink | orange | orange | pink |
| | | External loads from traffic or walls | pink | pink | pink | pink |
| | | Presence of roots | pink | pink | pink | pink |
| | | Corrosion (internal and external) | pink | pink | pink | pink |
| | | Section thickness reduction | pink | pink | pink | |
| **D** | Calibrated hydraulic models of system perform | Max. Pressure | pink | green | pink | |
| | | Av. Pressure | pink | pink | pink | |
| | | Min. Pressure | pink | green | pink | |
| | | Max. Velocity | | pink | pink | |
| | | Av. Velocity | | pink | pink | |
| | | Min. Velocity | | pink | pink | |
| | Monitoring records (SCADA) | Max. Pressure at sectors' entrance | | pink | pink | |
| | | Min. pressure at sectors' entrance | | pink | pink | |
| | | Pressure oscilation at sectors' entrance | | pink | pink | |
| | Operation and works records | Operational manoeuvres | | green | pink | |

# Evidences
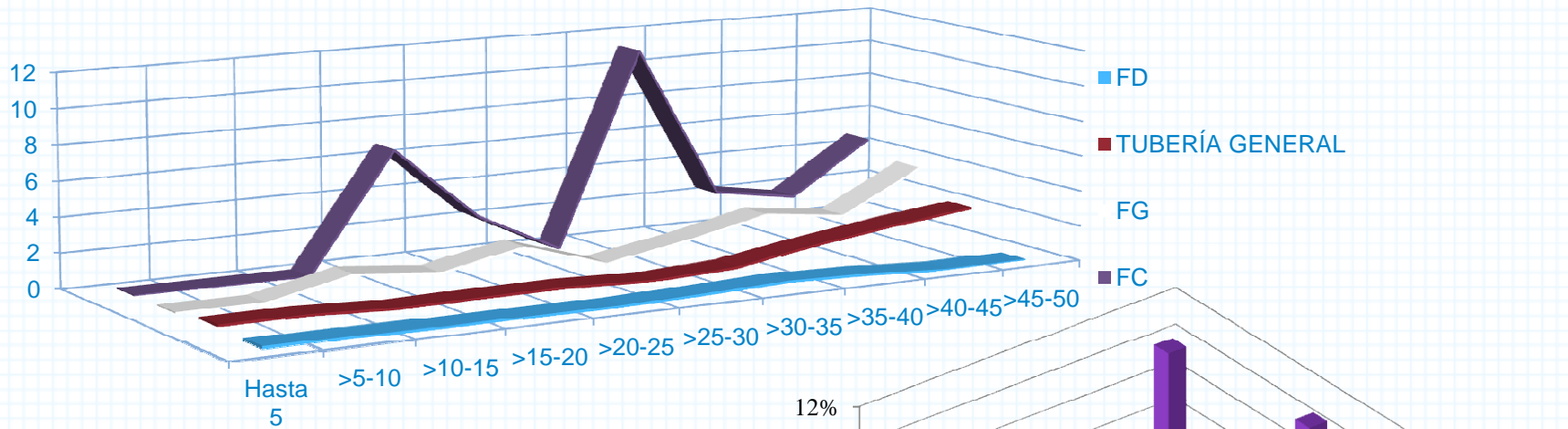




- **Bursts**

- **Element failures**

- **Equipment failures**

- Leakage

- Corrosion. Loss of material (thickness)

- Loss of hydraulic section

- Biofilm

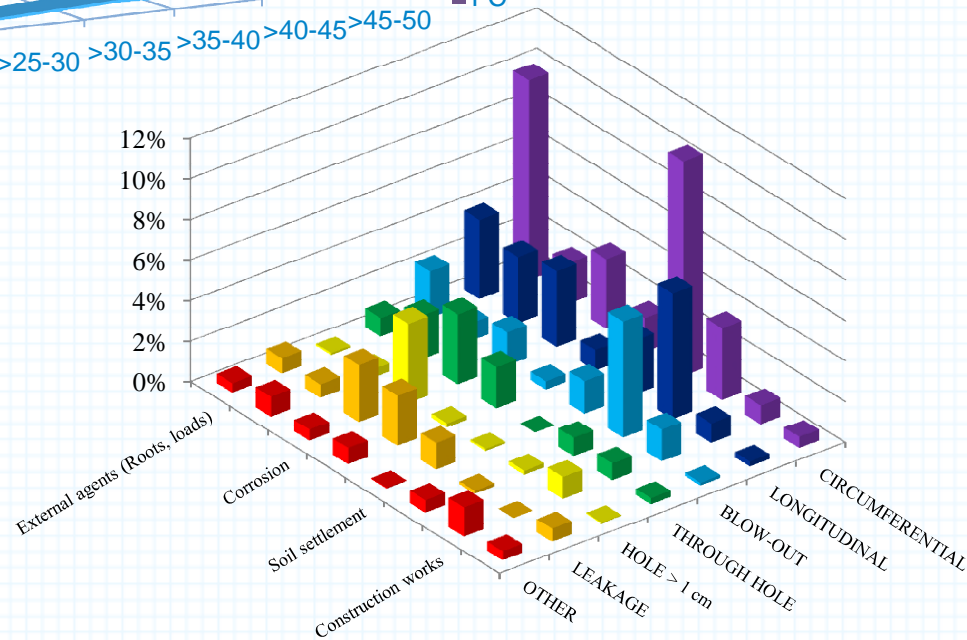- Water quality affections

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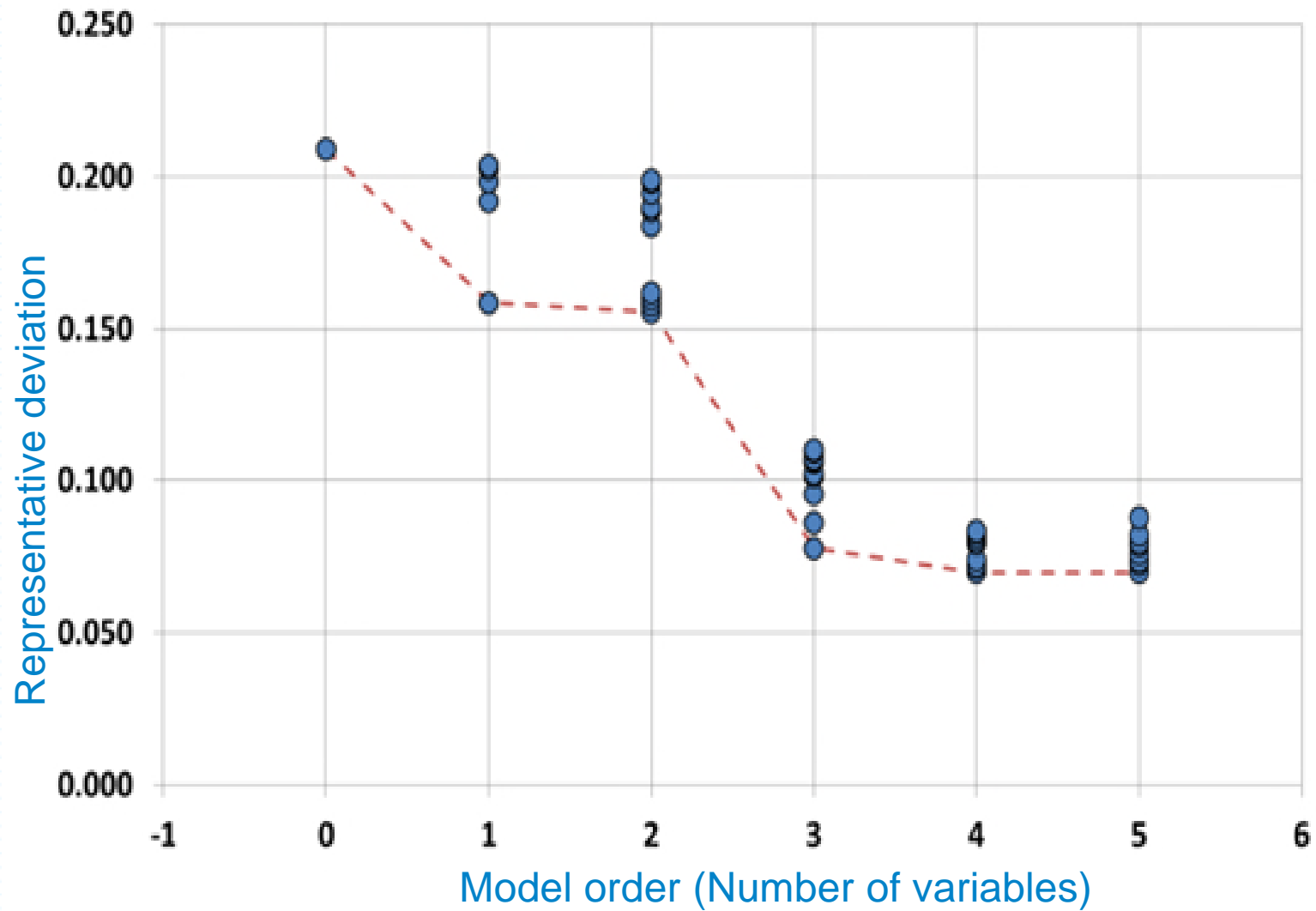# Models to select variables related to deterioration processes
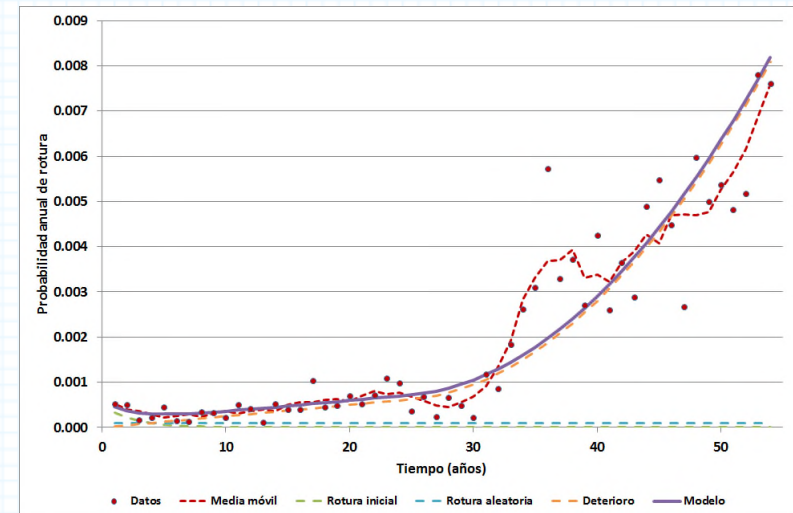


Statistical Analysis

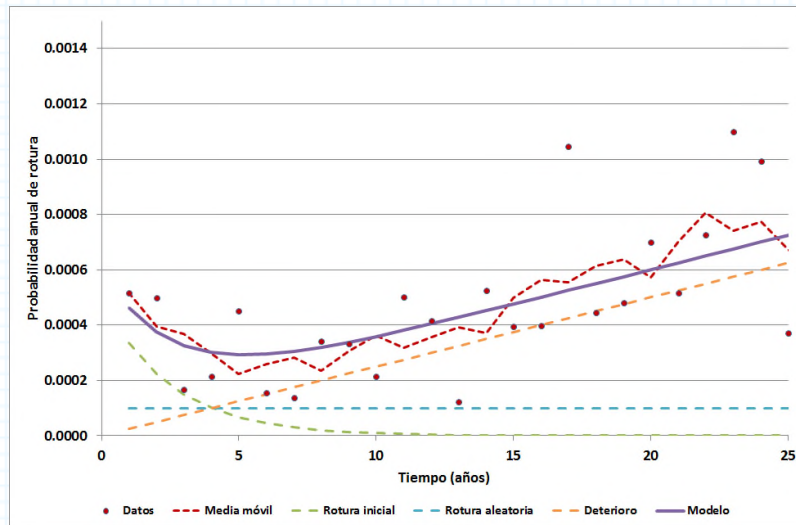Causes vs. Type of failure

# Optimal model order analysis

# Likelihood of failure for every element

$$p = p_1(t) \cdot f_2 \cdot f_3 \cdot f_4$$

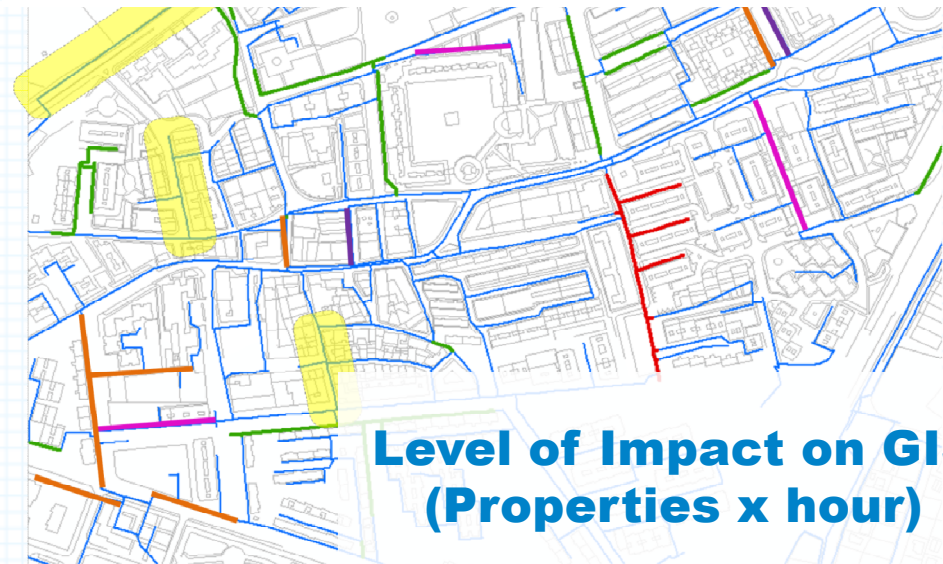| | Service connections | Distribution pipes | Strategis pipes | Network Elements |
|---|---|---|---|---|
| Diameter | ◎ | ◎ | ◎ | ◎ |
| Age | ◎ | ◎ | ◎ | ◎ |
| Material | ● | ◎ | ◎ | ● |
| Depth | ◎ | ● | ● | ◎ |
| Location (burried, chambers…) | ● | ● | ● | ◎ |
| Type of soil | ◎ | ● | ◎ | ● |
| Operational manoeuvres | | ◎ | ● | ● |

# Renewal strategy

Investments lead to previously selected elements

**Likelihood of failure**

**Impact in service provision to the end user**



Level of Impact on GIS
(Properties x hour)

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# A renewal cost effective value for every element
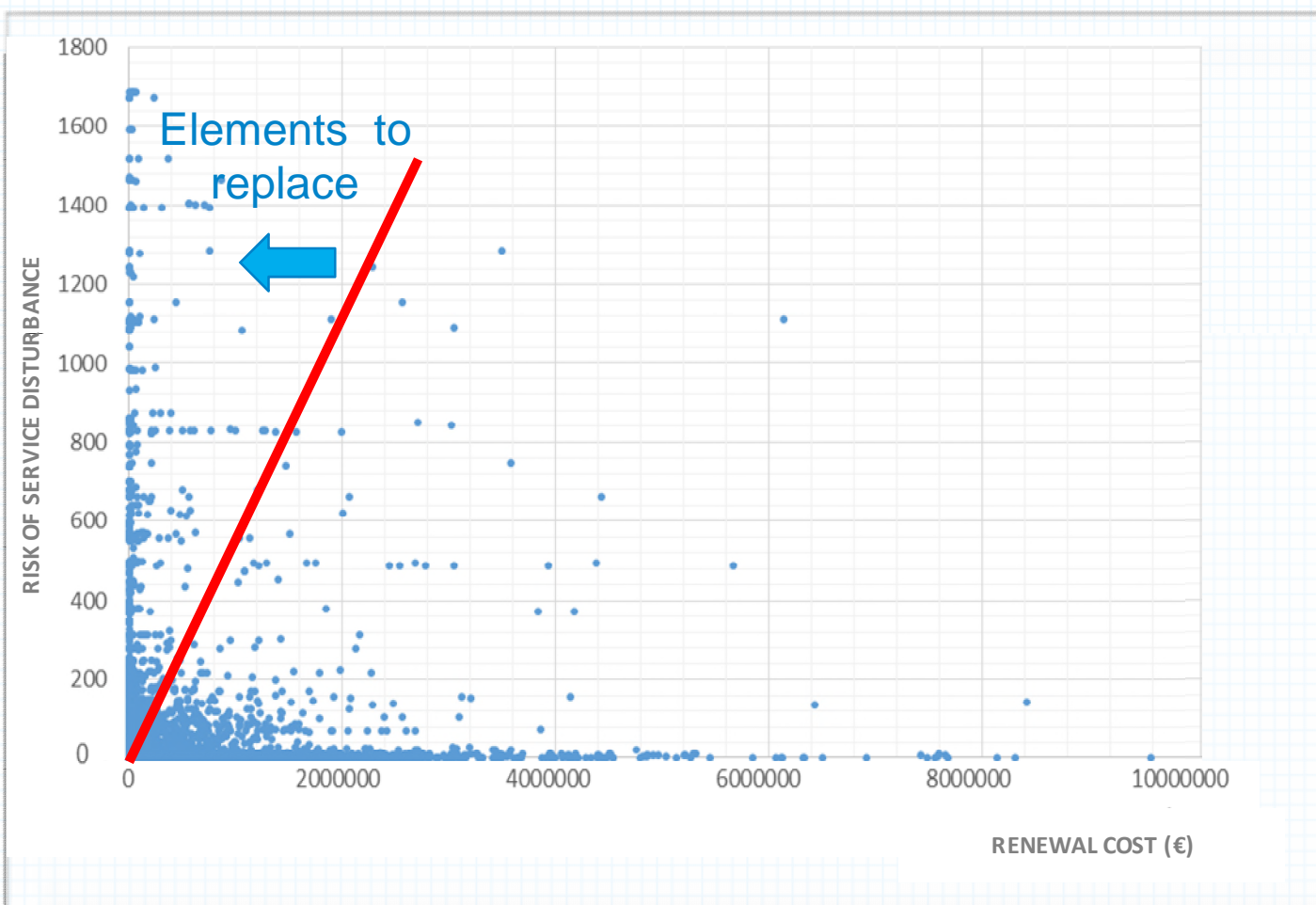
- ✓ An asset lifetime model **has been built and applied** based on Madrid's network data

- ✓ Different models are proposed for **service connections, distribution pipes, transport mains & elements**

- ✓ Every model require **diferent explanatory variables**

- ✓ Models with **more than 4 variables do not add predictability Age is not allways the most relevant factor**

- ✓ The new renewal strategy proposed will provide an improvement on:

  - ✓ **Investment efficiency** for water companies
  - ✓ **Customers' satisfaction** from reductions on service disturbance events.

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