Water Pipe Failure Predictions under Different Climate Scenarios

Water For a Healthy Country Flagship

F. Boulaire, S. Gould, D. Beale, J. Kodikara, S. Burn and D. Marlow
Presented by Scott Gould
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Presentation outline

• Background
  • Pipe failure modelling
    • Purpose of modelling
    • Factors which influence failure

• Enhanced model for predicting pipe failures
  • Does the enhanced model improve predictions?
  • Validation of model at cohort level, comparing
    • Predictions using the original model
    • Predictions with enhanced model (inclusion of climate factors)

• Quantifying the impact of climate change
  • Predictions on number of failures under three different scenarios
Background
Failure modelling

• Water asset managers use simulation tools to help make maintenance decisions

• Tools are based on failure predictions models
  • Physical
  • Statistical
  • Physical-probabilistic

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Causes of failures

• Failures are caused by a range of inter-related factors

Water Pipe Failure Predictions under Different Climate Scenarios

Broader Environment
  - Weather
    - Rainfall, Evaporation...
  - Season
    - Extreme events
      - Drought, Flood

Surrounding Environment
  - Soil
  - Traffic
    - Coverage

Pipe Attributes
  - Material
  - Diameter
  - Installation Year
  - Pressure
Failure number variation

- Original model allows for Pipe Attributes and Surrounding Environment to be included

- Enhanced model also includes Broader environment (climate).
Model Validation
Can the model detect most at risk pipes?

- ROC (receiver operating characteristic) curves
  - x-axis: relative length of pipe ranked by decreasing predicted number of failures
  - y-axis: cumulative percentage of observed failures
  - Perfect prediction corresponds to an inverted L curve
  - Random guess corresponds to the diagonal line

- Area Under Curve
  - Measure of quality of predictions
  - Provides a way of comparing models

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Original model (Area = 0.708)
Enhanced model (Area = 0.716)
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Are the yearly variations better captured?

Observed vs. Predicted Number of Failures

- Enhanced model captures some yearly variations
- Overall predictions
  - Enhanced model under predicted by 7%
  - Original model under predicted by 19%
Long term predictions
2001 - 2100
Predictions under various climate scenarios

- Without the inclusion of climate factors
  - Original model

- Using current climate conditions
  - Enhanced model assuming current average conditions continue without change

- Using projections from the A2 climate change scenario
  - Enhanced model using data from the CSIRO 3.5mk model
Predictions on number of failures 2001-2100

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At risk cohorts

- Asset managers look at the most at risk cohorts when budgeting
Cost estimations

• Different types of costs associated with failures
  • Repair costs depending on
    • Type of repair or replacement
    • Location of pipe
    • Diameter
  • Social costs (depending on location of pipe and time of day)
  • Penalty costs (depending on outage length)

• A2 scenario costs are
  • overall 5% higher than when compared to a scenario of no climate change
  • with peaks up to 20% in some years

• Other climate change scenarios are expected to show more dramatic differences
Conclusion

• **Enhanced failure prediction model**
  • Assess long term performance of the networks
  • Determine the direct economic cost of various climate change scenarios on network maintenance

• **Identify at risk pipe cohorts**
  • Optimising maintenance
  • Supporting management strategies.

• **Failure number variation**
  • Identify potential peaks in failure numbers
  • Supporting advanced planning to reduce stress on resources (budgets and labour)
Thank you

Contact Us

Phone: 1300 363 400 or +61 3 9545 2176
Email: Enquiries@csiro.au  Web: www.csiro.au