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TVW infrastructure investment planning process: use of forecasting and uncertainty modelling tools

E. Algaard, P. Campbell, P. Chadwick, S. Pochet, K. Winfield

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Use of forecasting and uncertainty modelling tools

- Context
  - In England & Wales
  - For Three Valleys Water
- Objectives
- Methods
  - TVW Tools and Methodologies
  - Uncertainty modelling and Optimisation
- Results
- Conclusion

Infrastructure Investment Planning in the England and Wales Context

- Acceptance of forward-looking, risk-base approach (The Common Framework).
- Decision making based on improved asset management processes.
- Investment requirements using risk based, performance focused, whole life costs, data based analysis.

Infrastructure Investment Planning in the Three Valleys Water Context

- High bursts predominantly in dense urban areas with high unit costs for renewal
- Tough leakage targets
- Need to deliver value while improving Quality, Service and Reliability :
  - Need to minimise cost and maximise benefit from renewal programme
  - Need to understand and include risk trade off in decision making process

Objectives of pilot study

- Collaboration with Mott MacDonald

- To incorporate uncertainty and optimisation into existing planning tools
- To assess the impact of data or model uncertainty on performance targets and cost optimisation at strategic level
- To achieve a bottom up optimisation of pipe renewals allowing for uncertainty in key parameters

Method

- Build upon Three Valleys Approach for its investment planning
  - Burst Model
  - Risk Analysis
  - Whole Life Investment Model
- Integrate Uncertainty modelling & Optimisation Process
  - Uncertainty modelling associated with Burst Model through Monte Carlo Simulation
  - Uncertainty modelling and option optimisation associated with the Investment Model
- Analysis and modelling of uncertainty in Crystall Ball 2000®
- Optimisation in OptQuest®, a global optimisation software

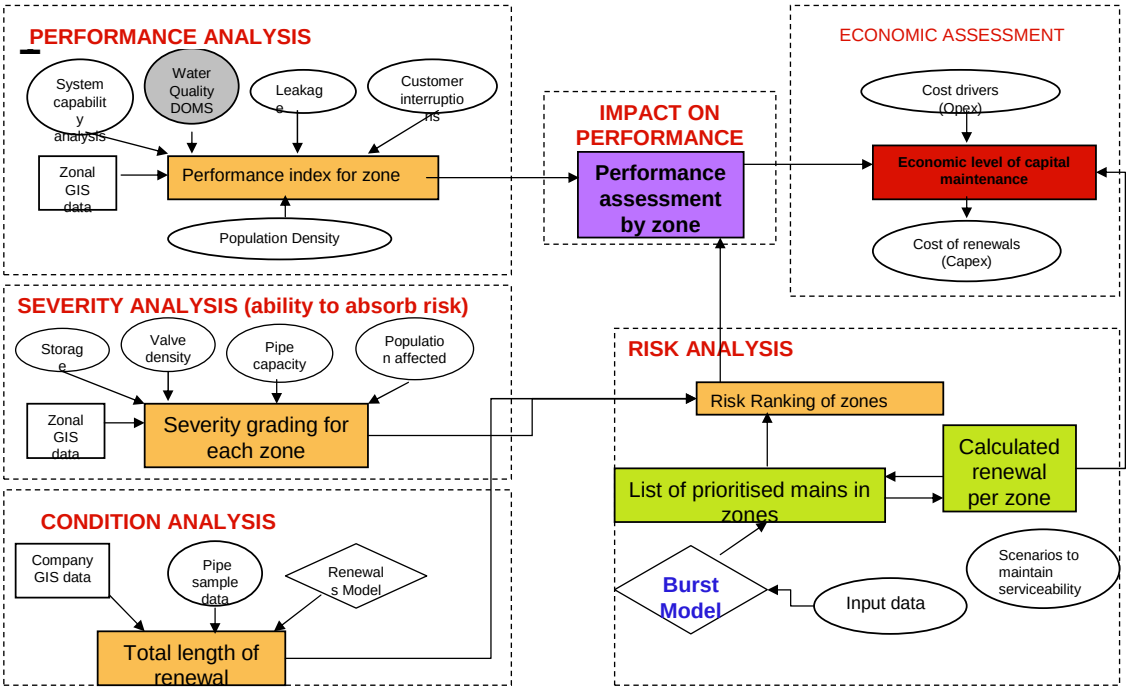
TVW Burst Model

- Based on survival analysis principles: Cox semi-parametric Proportional Hazard Model
- Variables
  - Strata variable: past failure data,
  - Covariates: length, diameter, age , ground movement, speed of corrosion
- Baseline Hazard function: Weibull or exponential
- Forecast probability of bursts at pipe level
- Results transferable in GIS

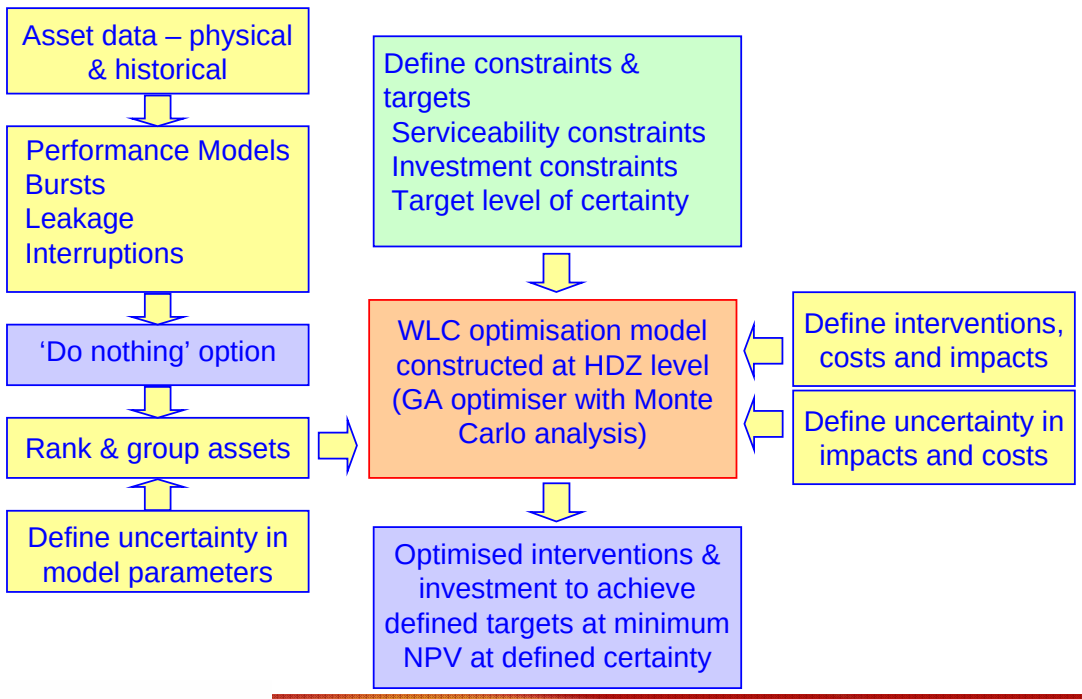
Whole-life Investment Model

- Estimation of whole life costs for each renewal scenario
  - Renewal costs
  - Impact of burst levels
- Leakage and leakage control costs are linked to incidence of burst
- Include all associated operational costs:
  - reactive maintenance, leak detection costs, call centre costs, compensation payment, PR costs
- Include long run marginal cost of developing new water resources schemes if leakage exceeds a set threshold

Risk, Performance & Economic Assessments



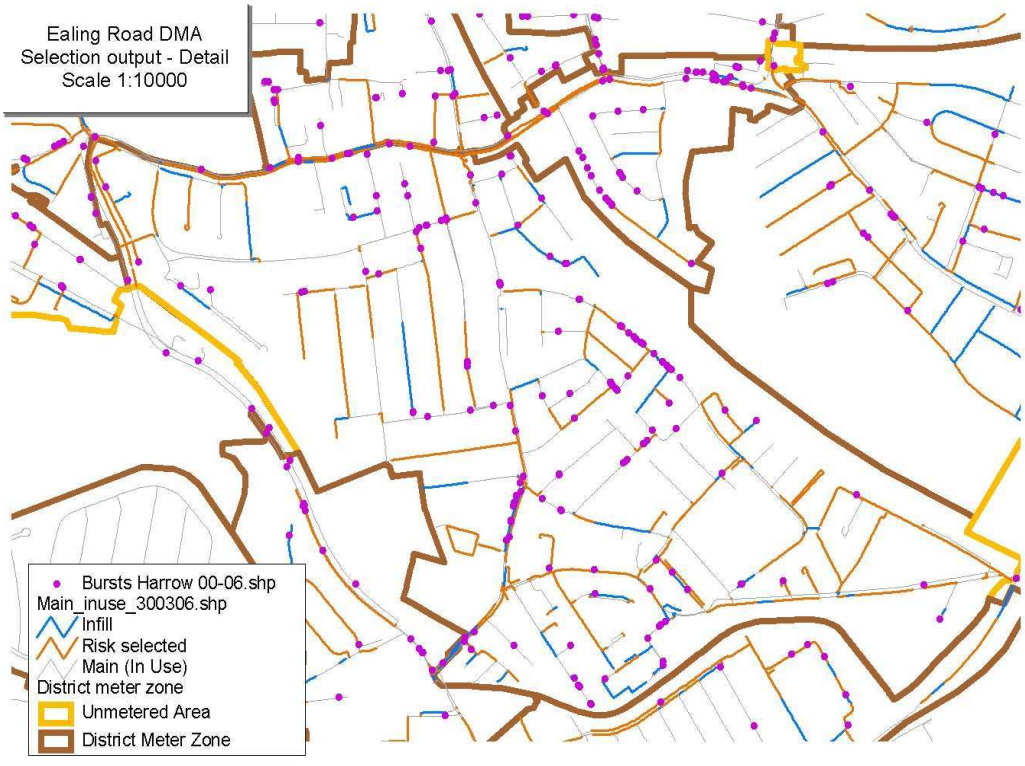
Uncertainty Modelling & Optimisation Process



Areas of uncertainty

- Asset data: info extracted from GIs or WMIS
- Performance Data such as leakage data
- Costs : detection and repair costs, renewal costs, compensation costs, insurance costs, marginal cost of water, call centre costs...
- Statistical model such as Cox semi-parametric model in the "Burst Model"

- Define or model best fit probability distribution of input variables in Crystall Ball 2000®



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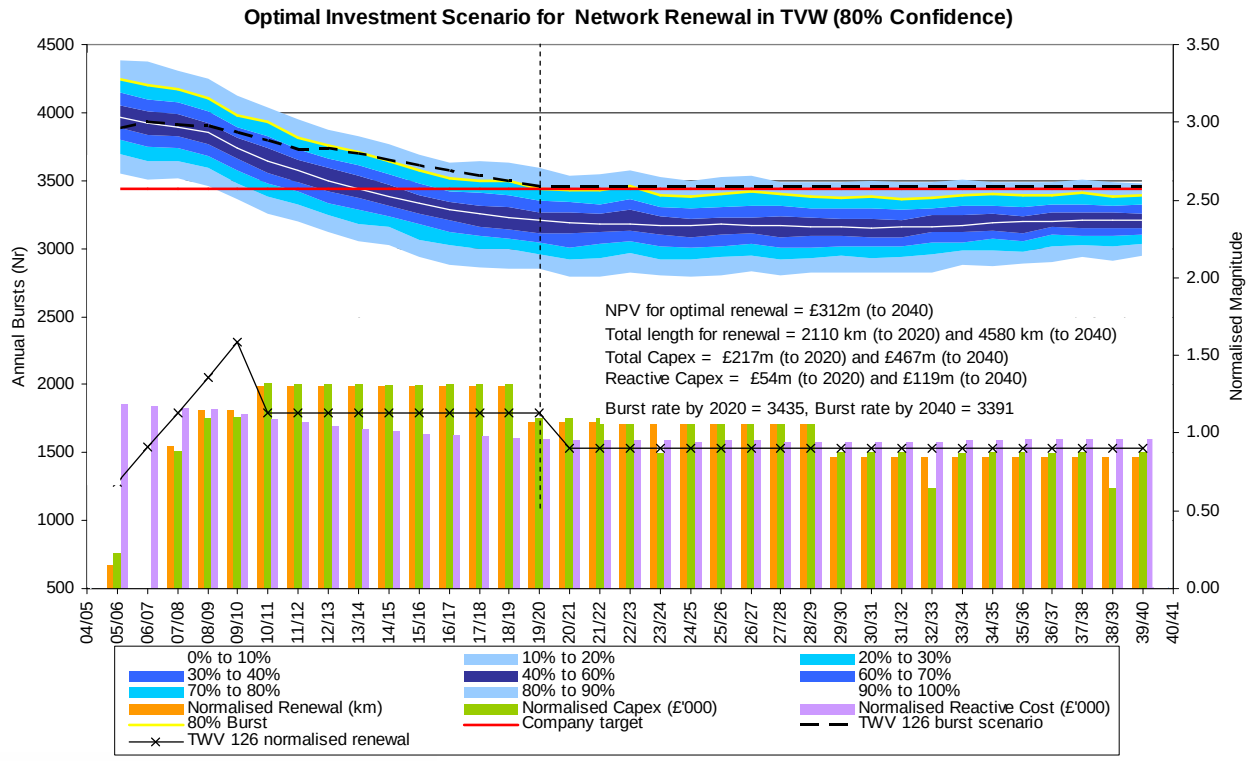

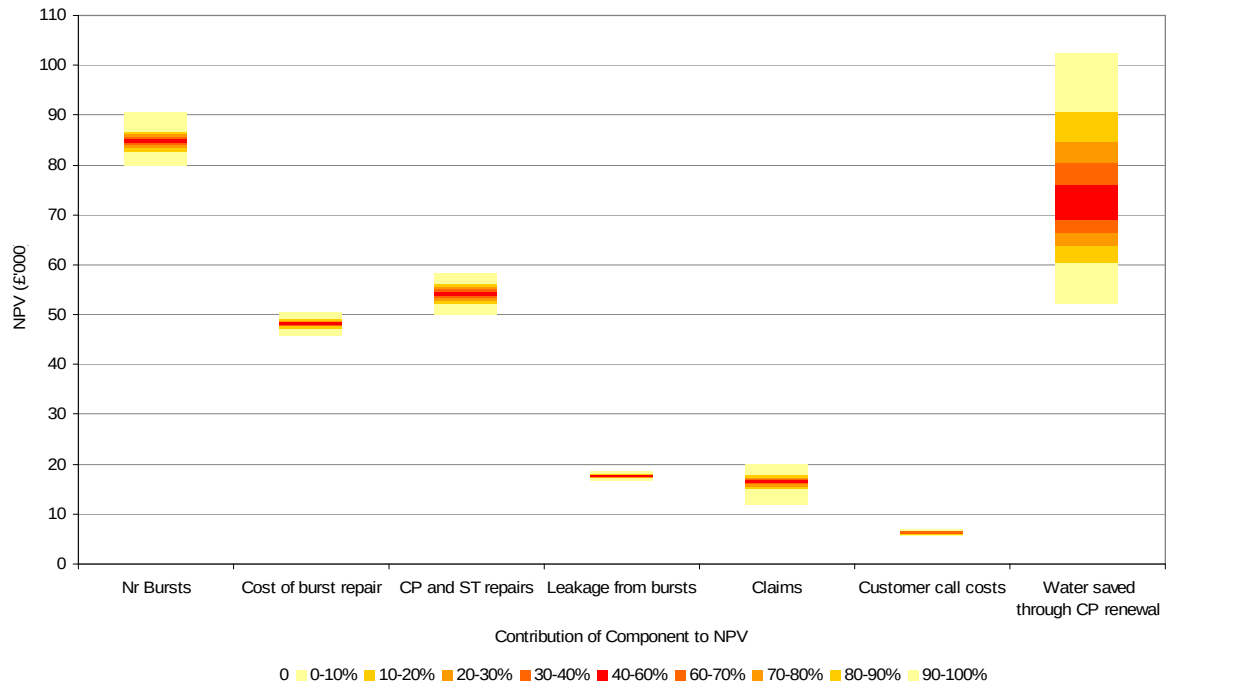

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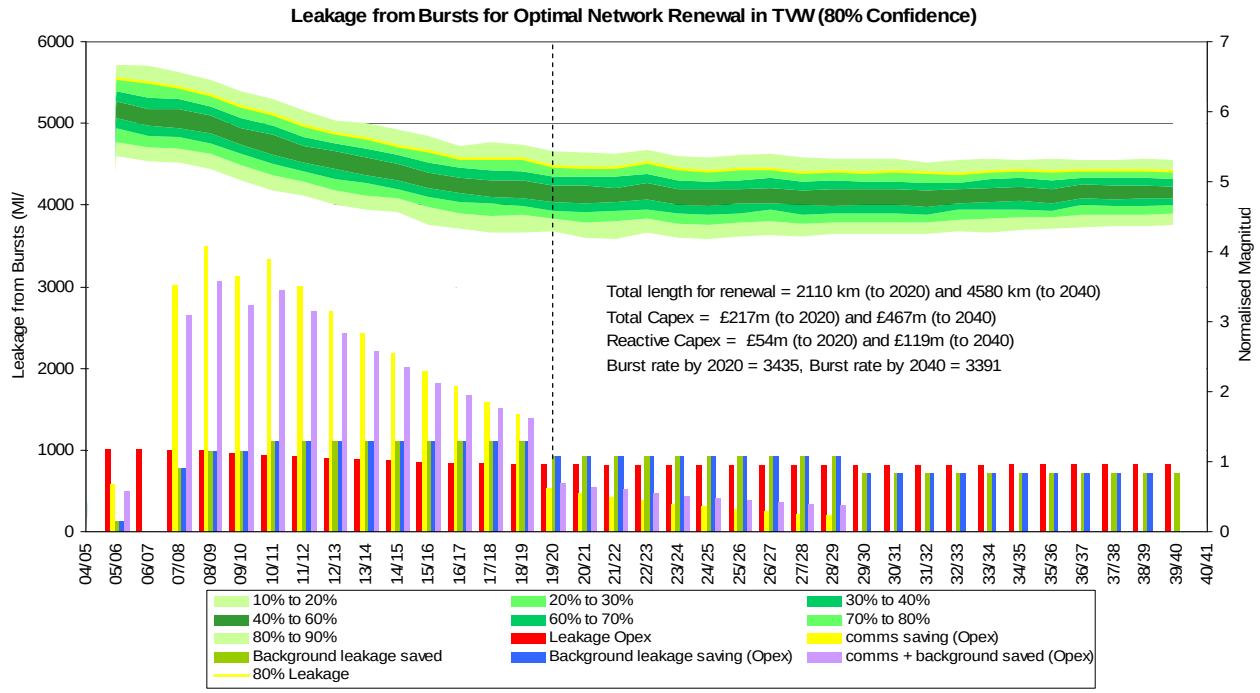

Conclusion

- Tools are available to predict and model uncertainty for "business as usual" investment decision making and realisation of benefits
- Clearer view of risk and levels of confidence in data
- Can be used for a number of business objectives (eg risk of meeting leakage target)
- Importance of influencing factors such as cost variability will prioritise data capture and provide clarity to your data collection strategy

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