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Specialist Knowledge.
Practical Solutions.

Long Term Continuous Simulation: Lessons Learned from Real-Life Applications

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Date – August 2019

Overview

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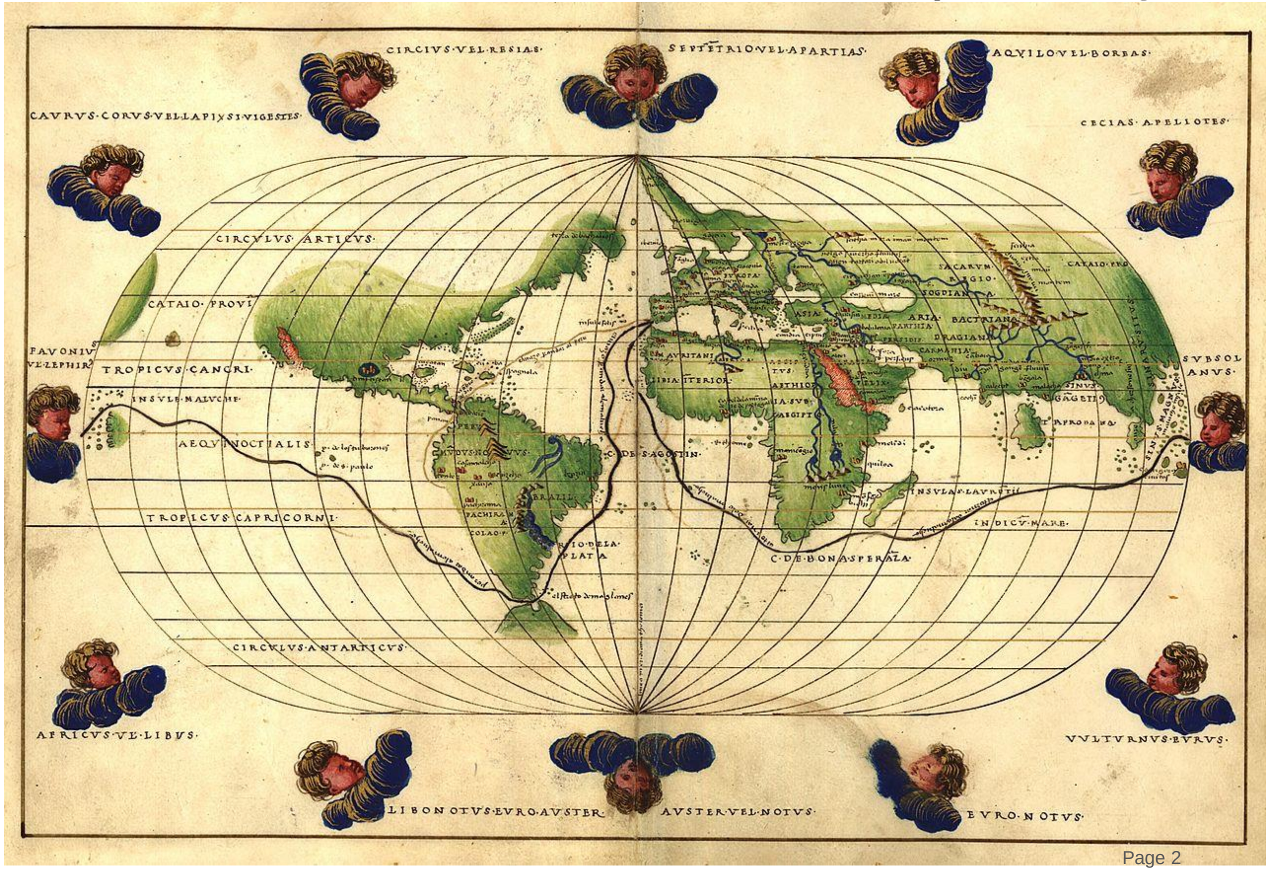
- Discussion on learnings from several projects
- Not an in-depth discussion of each project
- Not spruiking a technique or product (although I am a fan)
- My attempt to fill in the map



Why do we model stuff?

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- Because we want to understand
  - Behaviour - how complex systems respond to change
  - Quantities - how much they change by
    - Physical parameters
      - Flows
      - Flood levels
      - Water quality parameters (EC, pH, nutrients)
    - Statistics
      - How frequently - Probability or risk (AEP, ARI)
      - How long (duration)

Model concepts (specialist language)

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- **Behavioural profiles**: statistical distributions that describe behavioural characteristics, e.g. flood frequency curves, duration curves. There is a difference between building behavioural profiles and recreating history.

- **The proleptic assertion**: Proleptic data are projected to the time before they first existed. The proleptic assertion simplifies the analysis by applying a “would have been” approach.

- **Irreducible uncertainty**: your model might be right, but there is no way to prove it. We cannot eliminate uncertainty, so how do we deal with it?

- **Scalability**: Good models can be scaled up or down in space (catchment area) and time (short events v multi-year durations). Poor models simply replicate the results.

- **Rainfall disaggregation**: Going from daily to sub-daily (e.g. 5 minute) timesteps (different topic worthy of further discussion)

What is long term continuous simulation?

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- Create a model, run it for a long duration (many years), derive behavioural profiles from the results

- Gridded rainfall (e.g. SILO) provides daily rainfall from 1889 to yesterday, about 131 years
  - 131 years gives you
    - An almost 100% probability of seeing a 1, 2, 5, 10 or 20 year ARI event
    - A 93% probability of seeing a 50 year ARI event
    - A 73% probability of seeing a 100 year ARI event, etc.

- Rainfall disaggregation gives you 131 years at 5 minute intervals

Example 1: Lockyer Valley

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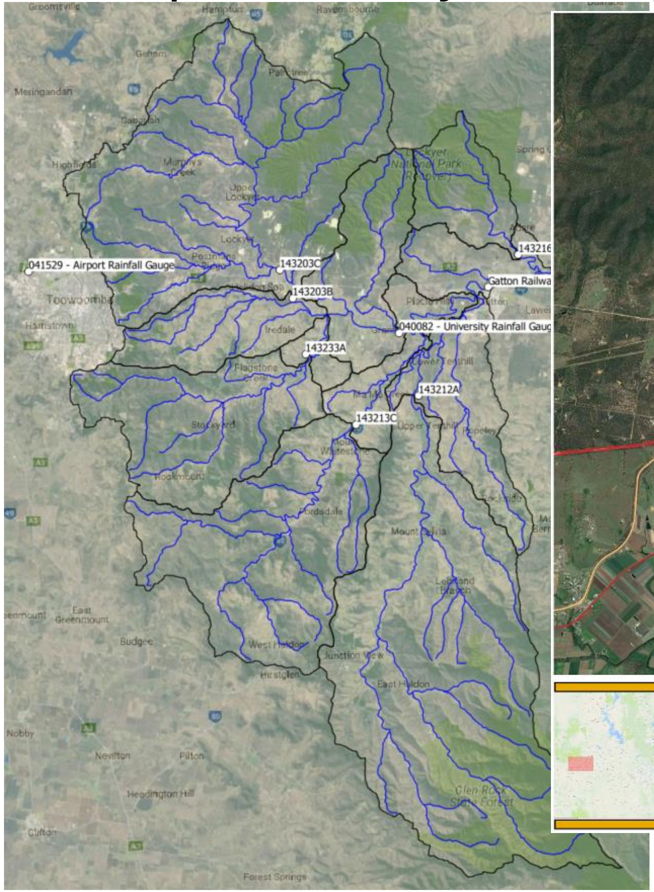
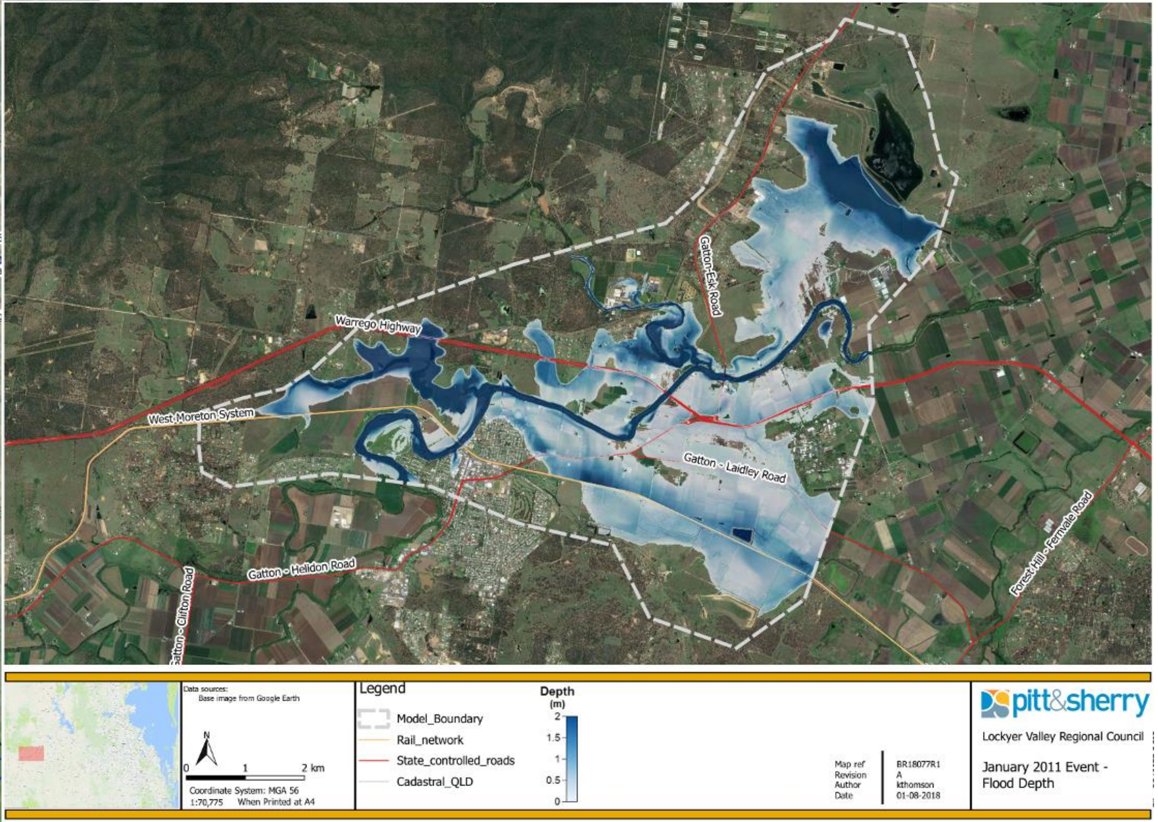
- Flood study of a complex creek system in which flooding is affected by combined probabilities of flooding from different tributaries

Example 1: Lockyer Valley





Example 1: Lockyer Valley

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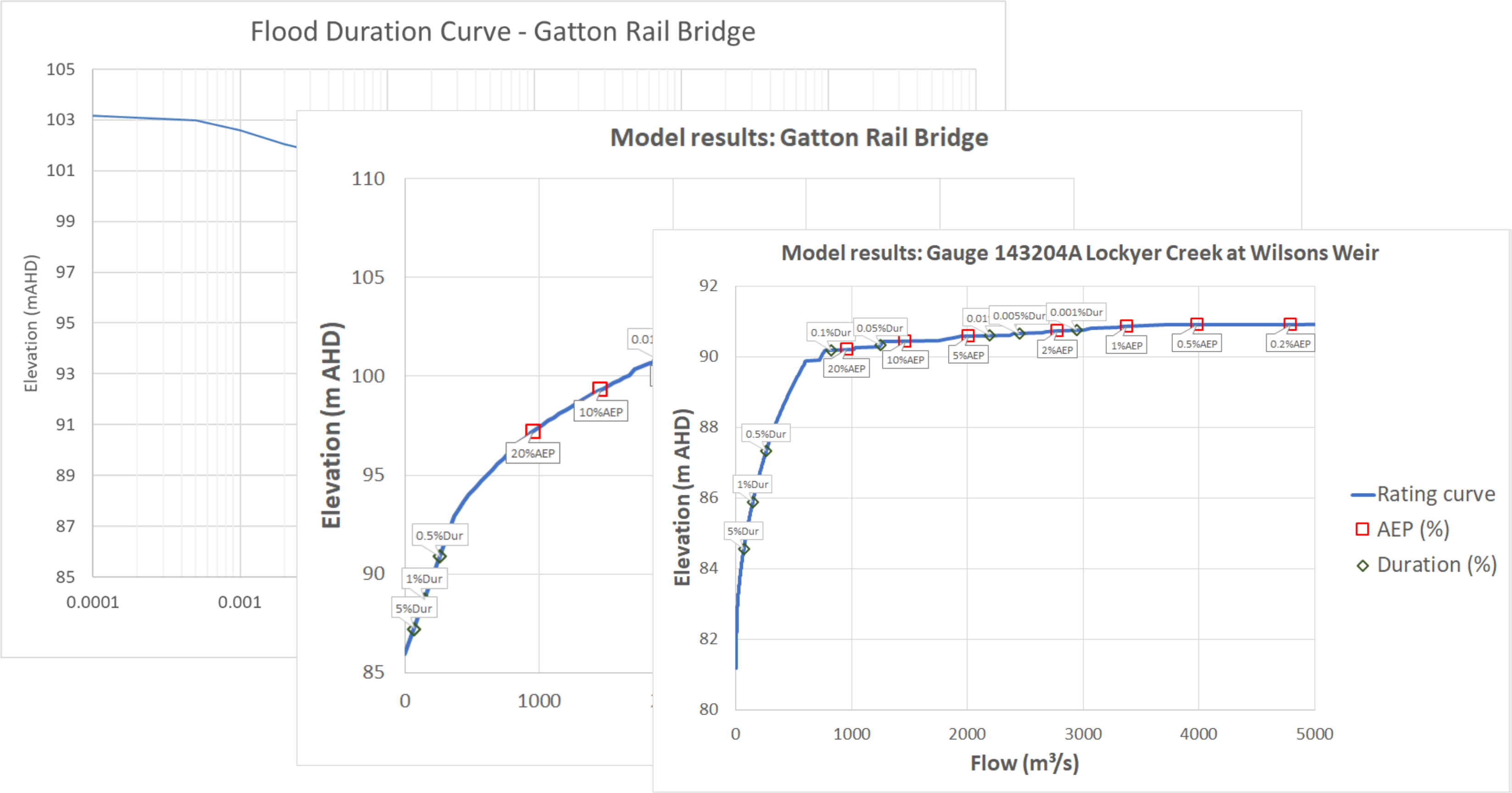

Example 2: Cane Drains

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- How does upstream development affect the drainage of cane fields downstream, and what can be done to mitigate impacts?

Example 2: Cane Drains

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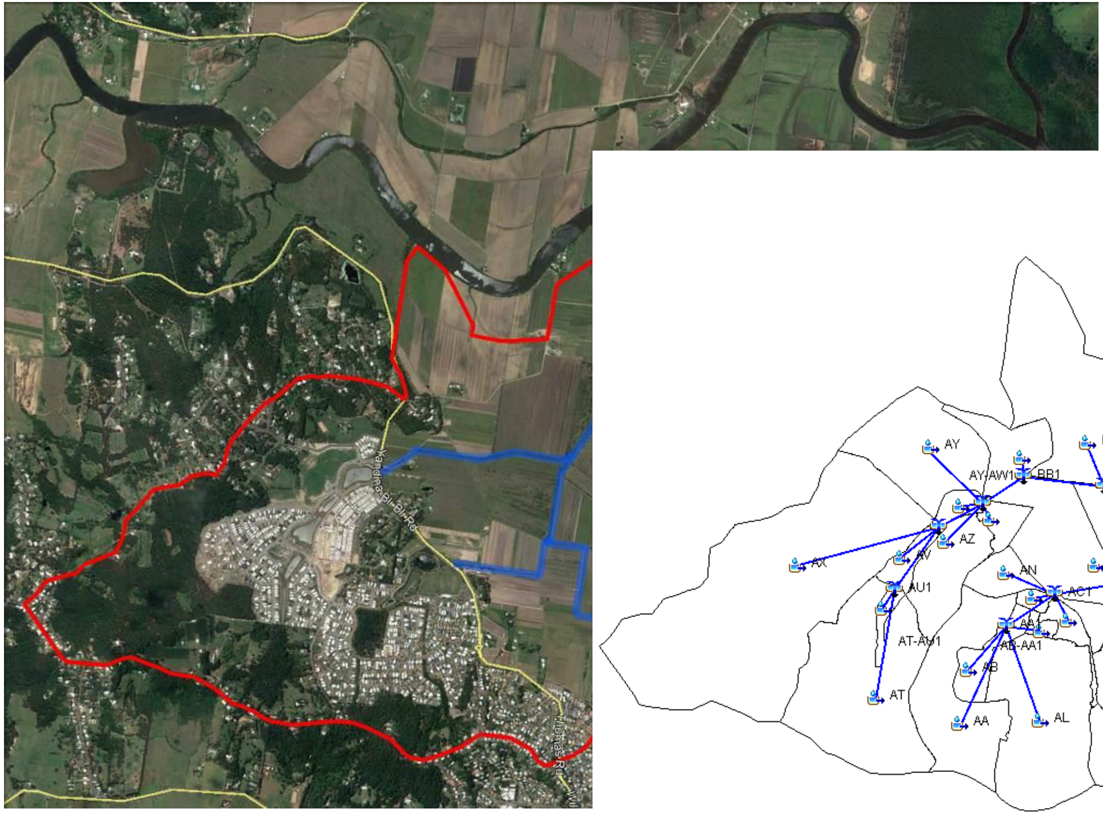

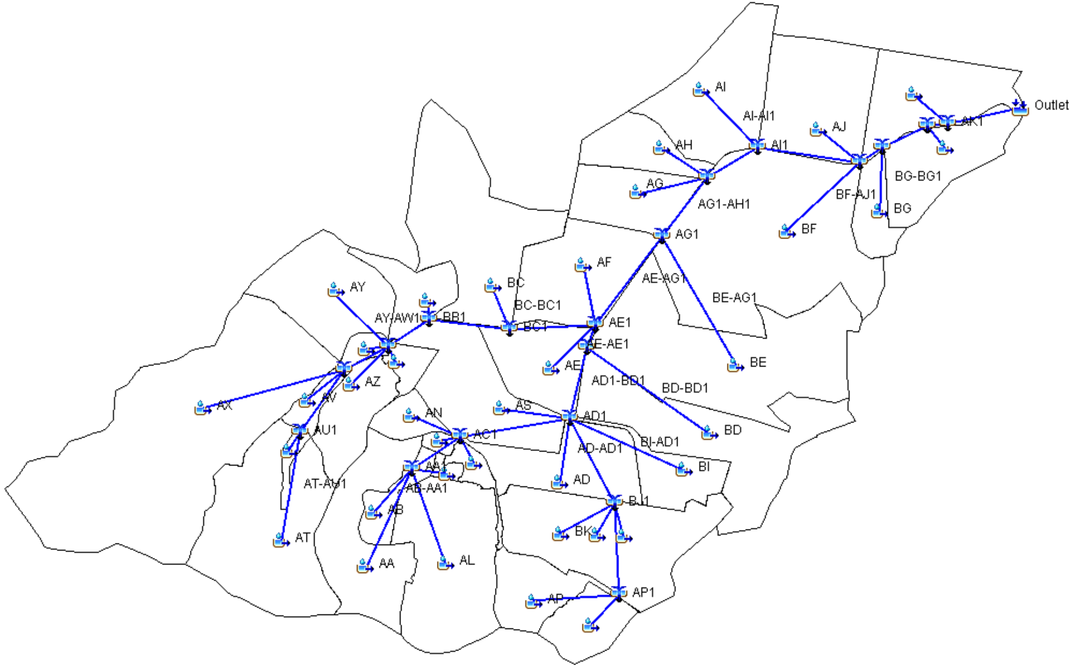

Example 2: Cane Drains

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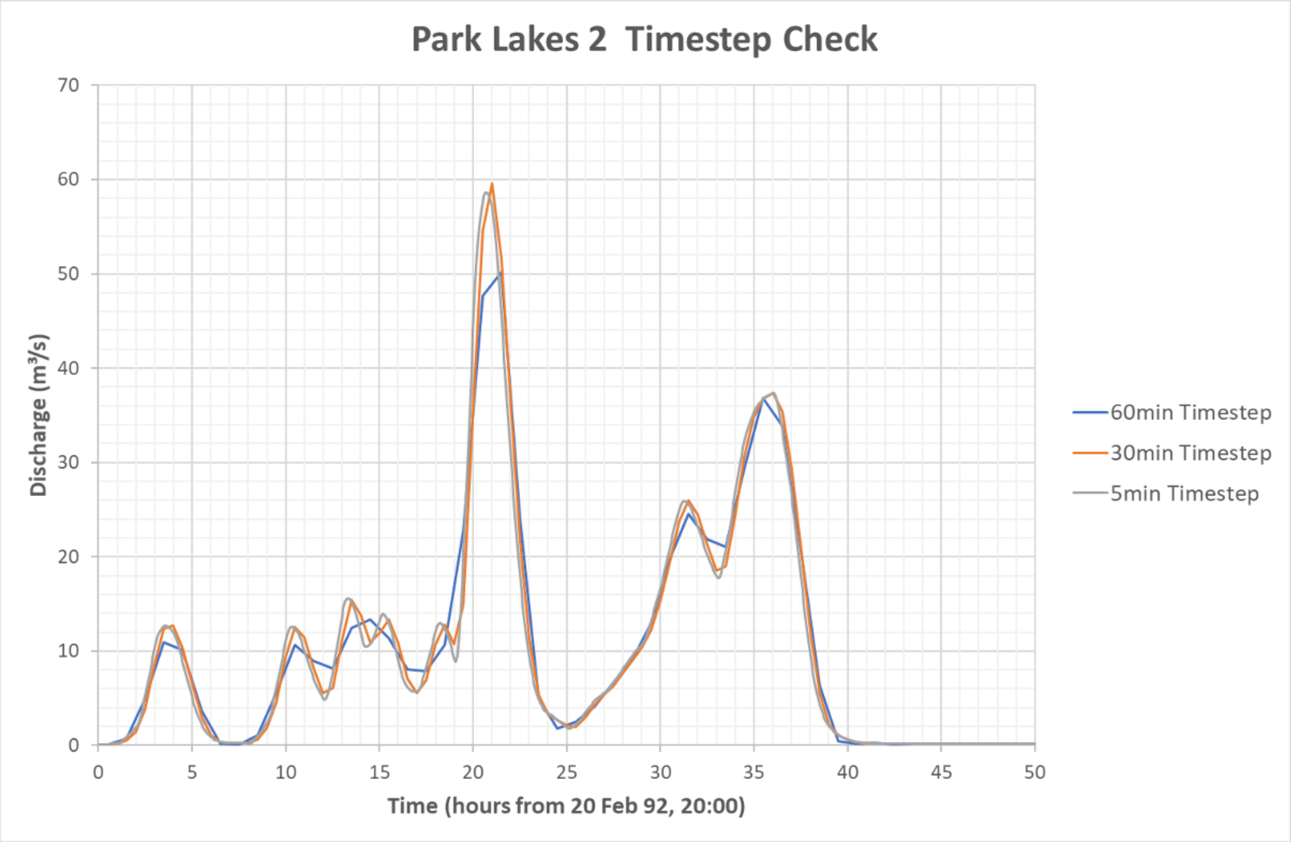

Example 2: Cane Drains

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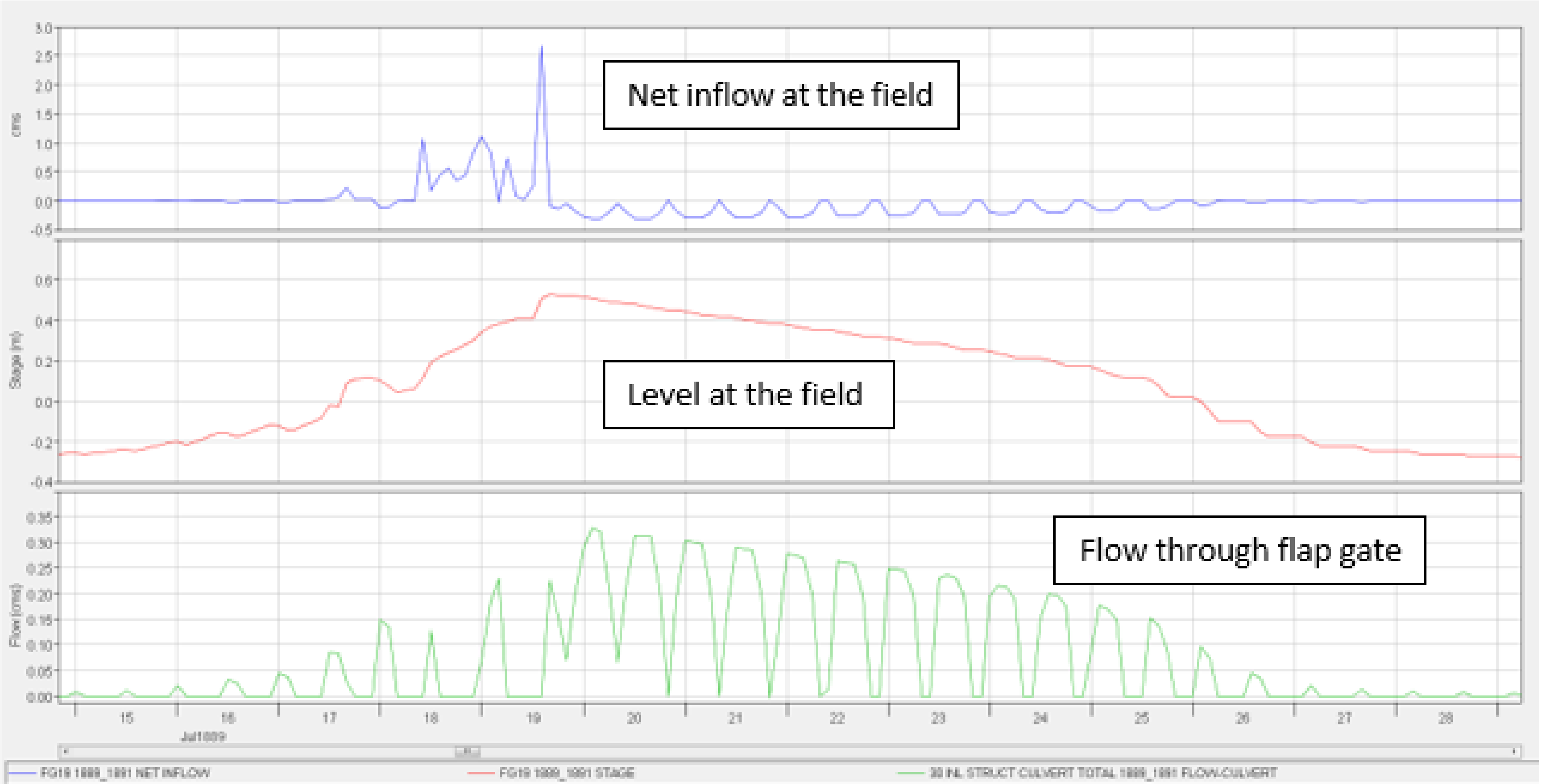
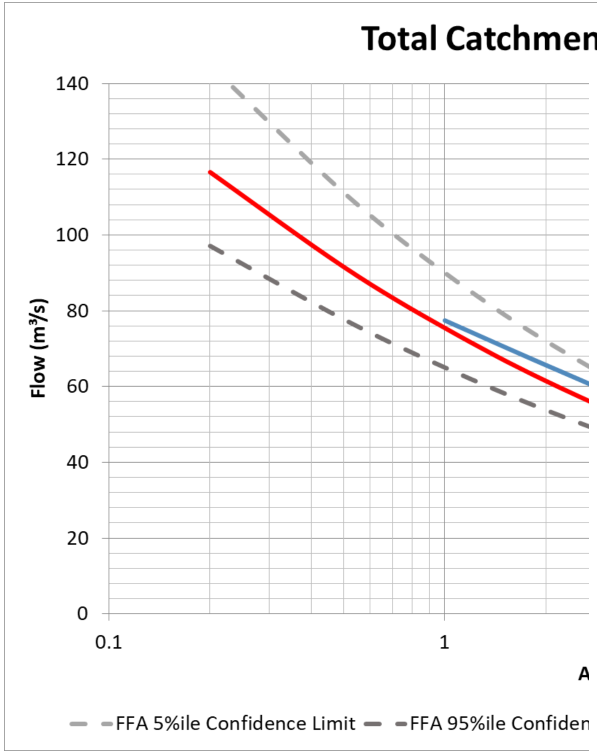
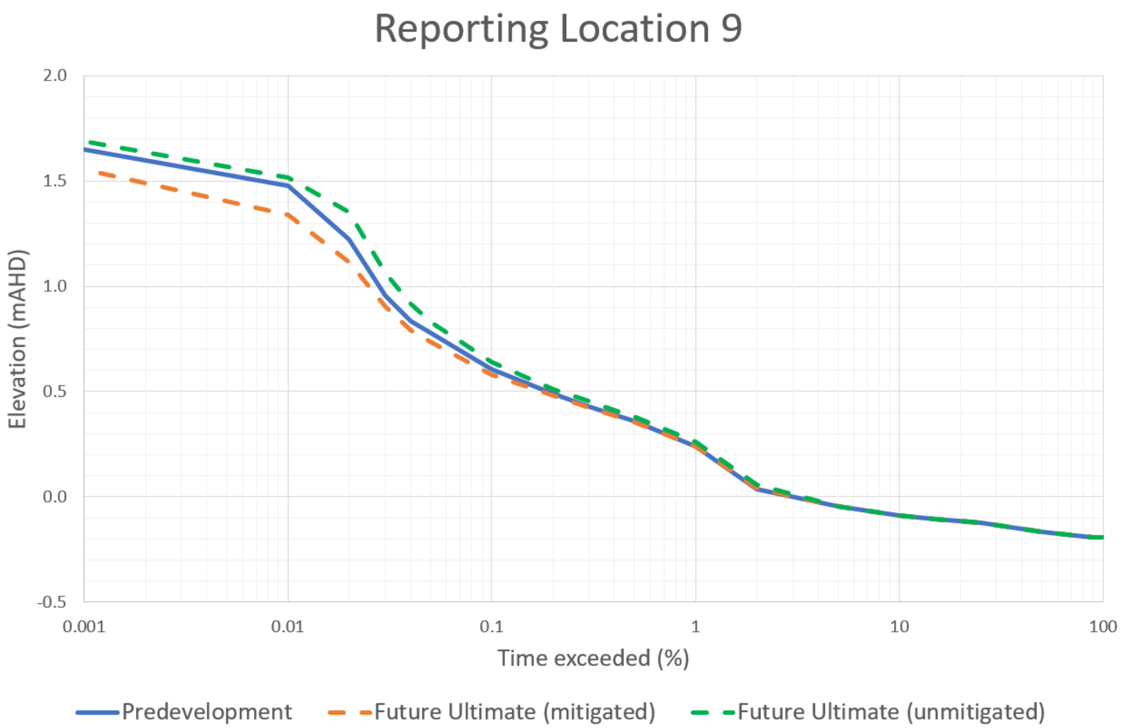


Real life applications – Cane Drains





Example 3: PNG Flood Study

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- Construct a hydrological model of a large river system so that we can estimate flows for the design of several bridges.
- Limited rain and flow gauge data in the vicinity
- River and catchment characteristics
  - Distinctive upland and lowland regions with no transitional areas in between
    - Upland regions have vee-shaped valleys, with strong downward erosion of river beds.
    - Lowland regions have extensive swampland and flood plan with strong lateral erosion of river banks, subject to avulsions.

Example 3: PNG Flood Study

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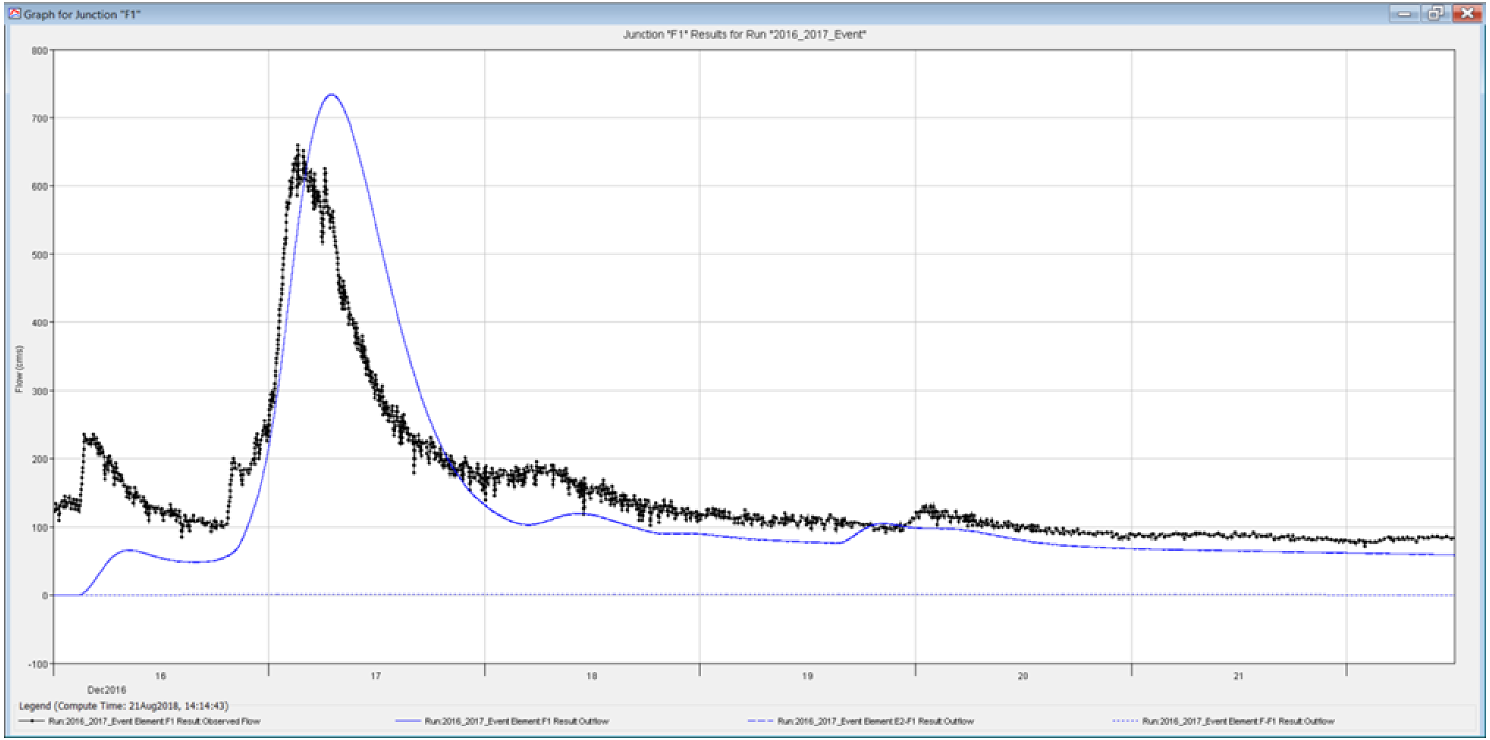
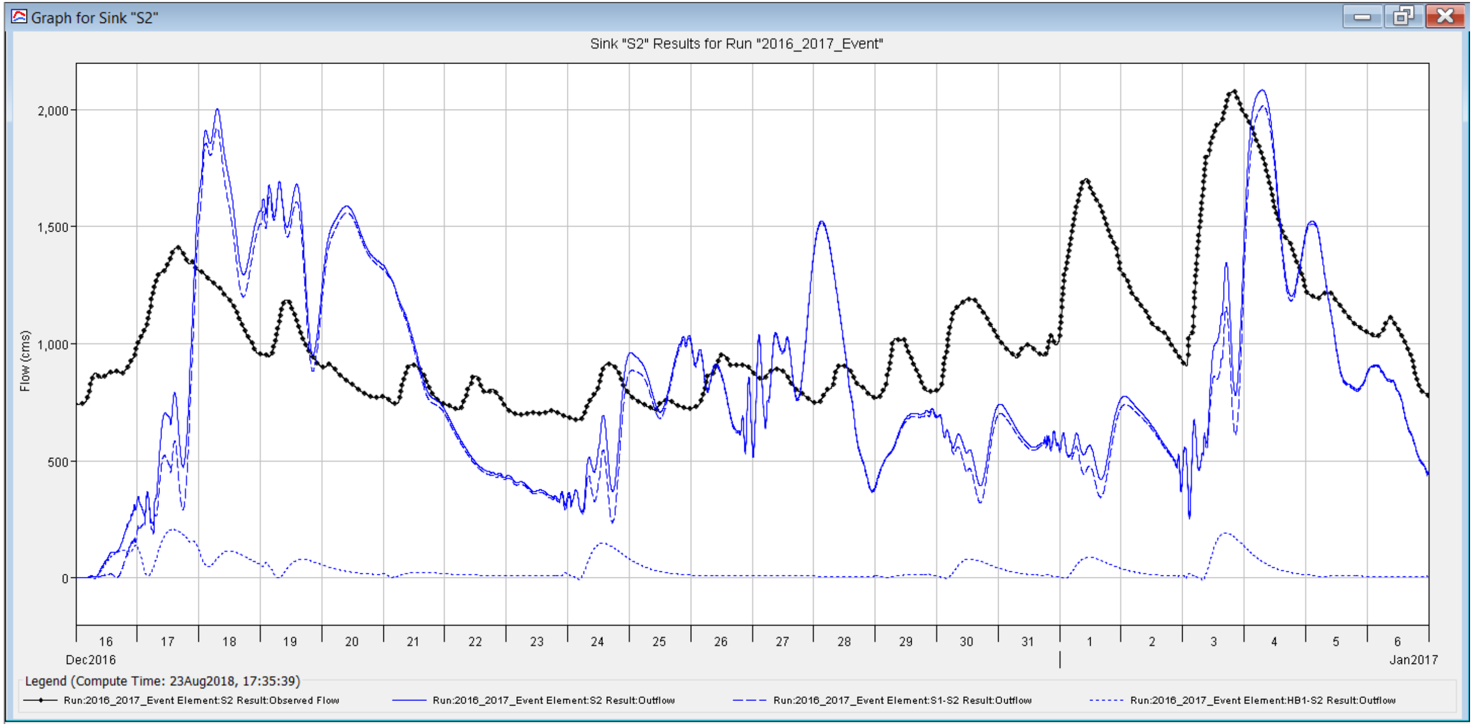


- Calibration at upland river

Example 3: PNG Flood Study



- Calibration at lowland river

Example 4: Mine water release system

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- Construct a hydrological model with tracking of salt (EC) and pH to provide information for the release of mine water from several mine sites into a receiving creek system, that conforms to environmental objectives for flow, EC and pH.

Example 4: Mine water release system

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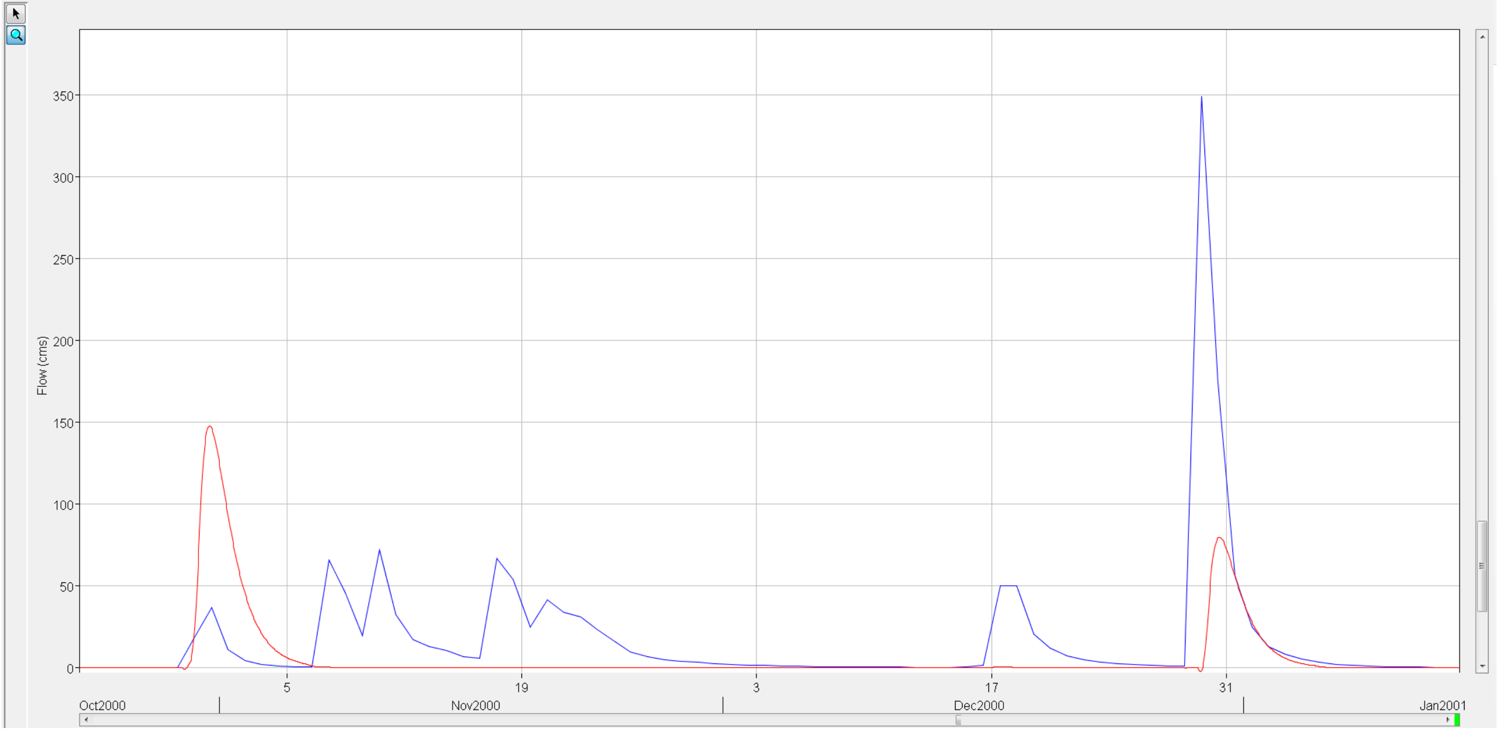

– Model calibration at gauge (blue observed, red modelled)

Example 4: Mine water release system

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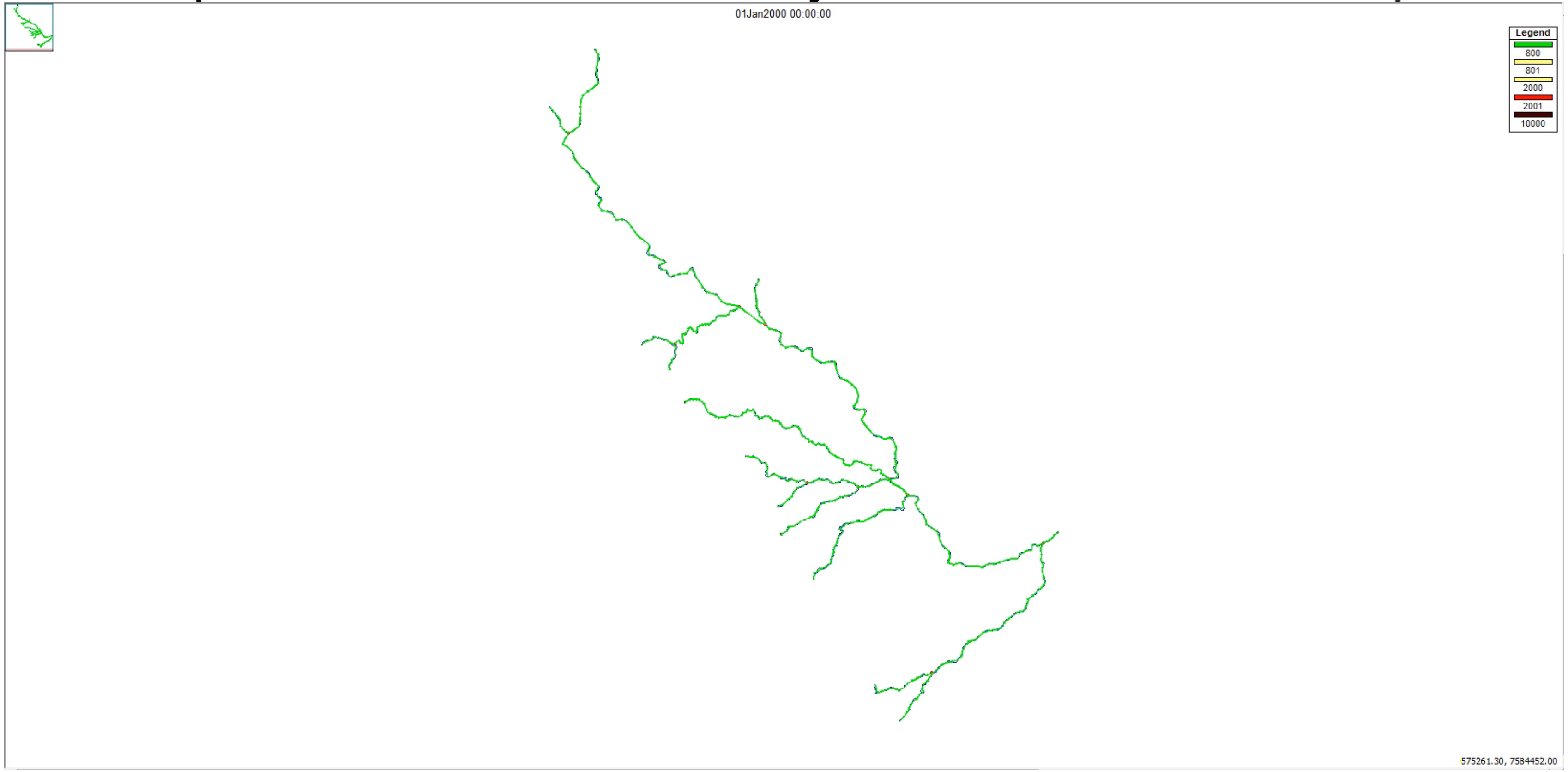

Lessons learned

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- LTCS is possible, and practical, for simulating periods of up to 131 years
- LTCS *naturally* combines factors that contribute to flooding and resolves the conundrum of joint probability
- LTCS is better at producing behavioural profiles rather than recreating history
- (although the recreation of history demonstrates the credibility of the model)
- LTCS models naturally fit into forecasting and operating systems that use continuous modelling

Conclusions

- *Ultimately, the most important model is not the assembly of numbers and equations held in the computer's circuitry, but the modeller's own mental understanding of how these data relate to one another in a unifying concept of how the real river or drainage system behaves. Only then can the modeller apply this understanding to whatever purpose the model is intended to serve, be it the design of flood mitigation works, planning schemes, road and rail bridges, or forecasting and operating systems.*

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