Uncertainty

Science-Practice roadshow, 2 November 2022, NIWA Christchurch
Assessing flood risk...

Data:
- Rain
- River flow
- Tides
- Topography
- Bathymetry
- Friction
- etc.

“Geofabrics”:
- i.e. boundary conditions, parameters

Flood model

Prediction:
- Depth, flows, extent

Hazard assessment:
- RiskScape

Scenarios
... through a cascade of uncertainty...

Errors in input data

"Geofabrics": i.e. boundary conditions, parameters

Sampling and parameterisation issues

Errors in scenarios

Hydraulic approximations, physical representation, numerical errors

= uncertainty in predicted depths and extents

Uncertainty cascades (and magnifies) through the hazard assessment

Errors in input data

Data:
Rain
River flow
Tides
Topography
Bathymetry
Friction etc.

Flood model

Prediction:
Depth, flows, extent

Hazard assessment:
RiskScape

+++ errors with hazard assessment
... uncertainty which continues through the hazard assessment process:

Infrastructural data, e.g.:
- Building footprint,
- Type, construction,
- Floor height

Errors in input data...

Variability in depth, flows at building level

Uncertainty in depth/flow-damage relationships

\[
\sum d_B = f(h) \text{ when type } B \\
\sum d_A = f(h) \text{ when type } A
\]

\[ d = f_B(h) \] when type B
\[ d = f_A(h) \] when type A

= uncertainty in impact assessment

Decision making, e.g., mitigation
Technical uncertainty in flood risk assessment

... leading to decision making and social implications...

Social, economic and political contexts
(Uncertainty in everyday decisions)

What does this mean for me?
For the outcomes I want?

Will it flood again soon?
Will the next flood be bigger?
Should I move?

Will I get insurance?
What happens if I can’t?

How will my decision be received by others?

What will happen if I make this choice?

Will this action make a difference?
How do we communicate risk with uncertainty?

We need to move from deterministic to probabilistic mapping:

Deterministic

\[ P(w) = \begin{cases} 1 & \text{if } w_i = 0 \\ 1 - P(w) & \text{otherwise} \end{cases} \]

\[ P_{st} = [1, 0] \]

Probabilistic

\[ P = [P(w)_i, 1 - P(w)_i] \]


What are the priorities for mapping flood risk with uncertainty?
How do we communicate risk with uncertainty?

Beven et al. 2015: [doi:10.1080/15715124.2014.917318]


What are the priorities for mapping flood risk with uncertainty?
How are we approaching this?

• Four PhD projects:
  • Current
    • Andrea Pozo Estivariz: Advancing methods of rapid flood risk scenario assessment using hybrid approaches of hydraulic modelling and machine learning
    • Martin Nguyen: Advancing methods of uncertainty estimation in flood inundation modelling using machine learning approaches
  • Recruiting now
    • Implications of uncertainty in flood hazard assessments for planning under climate change
    • Building future urban development scenarios into assessments of future flood risk

• Plus two masters projects, to be established later this year
Motivation

Current computer power limits flood risk assessment:

- Number of scenarios
- Level of detail and complexity of the model
- Catchment size

Fast, efficient and accurate tool for flood risk assessment

Research outline

1. Inundation drivers
   - Extreme rainfall
     - Cross validation WRF model – rain gauge data

2. Characterization of rainfall extreme events

3. Flooding
   - Hybrid model
     - Sample of flooding scenarios

4. Inundation maps
   - Hydrodynamic model + Machine learning model

Andrea
UNCERTAINTY IN PREDICTIONS OF FLOOD INUNDATION CAUSED BY MODEL GRID SAMPLING

Problem idea

*North-south grid* is usually employed without considering sampling issues.

*Transformed grid* orientation can lead to variability in topographic representation.

Methodology

- LiDAR
- Transformation
- DEMs
- Flood model (LISFLOOD-FP)
- Outputs
- Reverse transformation
- Statistical Analysis
- Monte Carlo simulations

Results when rotating and translating the grid

- Mean
- Standard deviation
- Proportion
What does uncertainty mean to you?
What does uncertainty mean to you?

Quick poll: In the context of flood risk, how does uncertainty affect your work and how is it accounted for?

Join at slido.com, #1141 111

Poll direct link: https://app.sli.do/event/uHgJUTXFLLkoewoqPCDmWc

Results link: https://wall.sli.do/event/uHgJUTXFLLkoewoqPCDmWc?section=73b7c31d-1171-4eba-810d-dffb1ebcb52d
Questions for (quick) discussion

Q1. How does your organisation deal with the uncertainty when communicating flood risk or activities related to flood hazard?

Q2. How could our programme outputs help to improve your organisations communications regarding risk and uncertainty?
   • How can uncertainty be represented on flood maps/communications most effectively? What statistics should be selected?