Guidelines for Good Practice in Flood Risk Mapping: The Catchment Change Network

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Pitt Review following 2007 floods
- 94 recommendations including taking more account of uncertainties in the flood risk management process

• Suddenly a host of new Environment Agency projects on ensemble forecasting, probabilistic flood forecasting, probabilistic flood risk mapping, probabilistic incident management (and possibly more to come)
Science into Practice...

• But...... what are appropriate assumptions and what do results mean to users - what should “Good Practice” mean in informing decisions?

• Need for a *translatory discourse* between scientist and practitioners about nature and meaning of uncertainties (Faulkner et al., *Ambio*, 2007)
Good Practice…and Climate Change

• Good practice implies using model predictors that a fit for purpose – *best available* model does not always imply *fit for purpose*.

• *Fit for purpose* – are your climate/hydrologic/hydraulic/ecological models within *limits of acceptability* in simulating current conditions.

• Testing for change is testing a hypothesis – you would not normally do so without reference to the relevant uncertainties.

• Probabilities for ensemble RCM predictions are *incomplete* in representing odds of how future climate might be.
Science into Practice...

from NERC: Policy into Practice
NERC KT project “…..to enable the exchange of knowledge between the NERC research base and science user community to understand and manage uncertainty and risk related to water scarcity, flood risk and diffuse pollution management”
Structure of CCN

Three focus areas
- Change and Flood Risk Management
- Change and Water Scarcity
- Change and Diffuse Pollution

Mechanisms
- Expert facilitator
  www.catchmentchange.net (with blogs)
- Workshops / Training / Annual Conference

Evolving Guidelines for Good Practice as a way of operationalising uncertainty in the science
The Catchment Change Network

Raises many questions...

• What are the critical sources of uncertainty that can be quantified (and those that cannot)?
• When are predictions informative and when not (but uncertain flood risk map should be more meaningful than a risk map without uncertainty)?
• What methods should be used in estimating uncertainty (especially when some past observations are available to constrain future uncertainty)?
• How to agree (and communicate) assumptions with stakeholders?
Evolving the Guidelines

Science/Practitioner Translationary Discourse

→ Defining and framing the type of application
→ Communication of sources of uncertainty considered
→ Communication of assumptions used in assessing sources of uncertainty
→ Communication of how uncertainties combined
→ Communication of meaning of probabilistic or possibilistic information
Risk Mapping: Defining and framing the type of application

- Planning decisions
- Emergency planning
- Flood damage assessments and defence design
- Insurance
- Generating household resilience
- ......
Evolving the Guidelines

Guidelines as a set of decisions

→ Assumptions to be agreed between analyst and stakeholder(s)......though many would prefer a “recipe”

→ Explicit agreement and record means that later review can be carried out

→ Default options, or decision tree of potential options
Flood Risk Mapping: Sources of Uncertainty (1)

1. Uncertainty in Design Flood Magnitude

D1.1 Are gauge data available?

D1.2 If yes: what is an appropriate frequency distribution to fit (Default: use of WinFAP to fit GL or GP distributions)?

D1.3 If no: what method of extrapolating to ungauged site to be used?

D1.4 Do multiple inputs to flood risk site need to be considered?

D1.5 If yes: generate correlated samples for design event AEP (using methods of Keef et al., 2009)
2. Uncertainty in Conveyance Estimates

D2.1 Are observations available to allow the calibration of channel and/or flood plain roughness values (if yes: go to section 7)?

D 2.2. If not: decide on a range of roughness values for channel and flood plain units (if possible obtain a credible range from the CES).

D2.2 Decide on a (probabilistic) interpretation of the estimated range.
Flood Risk Mapping: Sources of Uncertainty (3)

3. Uncertainty in rating curve extrapolation
4. Uncertainty in flood plain topography
5. Uncertainty in model structure
6. Uncertainty in flood plain infrastructure
7. Uncertainty in observations used in model conditioning
8. Uncertainty in assessing effects of future catchment change

9. Uncertainty in assessing effects of future climate change

10. Uncertainty in fragility of defences

11. Uncertainty in consequences/vulnerability

13. Defining an uncertainty propagation process

14. Defining an model calibration/conditioning processing

15. Defining a presentation method

16. Managing and reducing uncertainty
Sources of Uncertainty in Flood Risk Mapping

- Conditioning observations
- Flood plain geometry
- Flood plain infrastructure
- Rating curve extrapolation
- Choice of model structure
- Conveyance Estimates: channel geometry and effective roughness
- Design flood magnitude: upstream and lateral inflows
- Fragility of defences
Interactions between Sources of Uncertainty
1. Run Monte Carlo simulations varying upstream discharge estimate and roughness coefficients
2. Evaluate each model run in predicting maximum inundation for 2007 event to determine behavioural simulations and weights
3. Apply behavioural models to predict AEP 0.01 event
4. Map CDF for inundation depths
Mexborough: Summer 2007

Mapped maximum inundation and model predicted flow depths for Summer 2007 floods at Mexborough, Yorkshire using 2D JFLOW model.
WinFAP estimate of 0.01 AEP (T100) flood peak at Adwick

Mean: 86.6 (m$^3$s$^{-1}$)
Var: 6.25 (m$^3$s$^{-1}$)
Google maps API

100 year flood Mexborough

Definition:
Probability selector: 100

95% chance that the 100 year flood will be larger than the extent shown. Therefore it would be very lucky but still possible for the 100 year flood to be as small as this.

Definition:
This webpage shows that flood extent forecasting can never be exact. This is because flood forecasting is based on computer estimates of what might happen during a real flood. One way to communicate the range of possibilities for what might happen is to specify the chance that a flood will be bigger than the one shown on the map. For example a probability of exceedance of 20% means that the computer simulation estimates that the 100 year...
Google maps API

100 year flood Mexborough

Definition:
The return period is the average amount of time in years that you would expect a flood of a particular size to occur once. For example, a flood with a return period of 100 years would be expected to occur 10 times in a century. It is very important to realise that this does not mean that if a flood with a return period has just happened that there will definitely not be another one for 100 years. Also the accuracy with which the return period can
Definition:
Probabilities can be expressed as percentage values. Here an expression such as "80% chance that the 100 year flood will be larger than that shown..." means the study that estimated the size of the 100 year flood found that 80% (or 8 out of 10) of the acceptable computer simulation results showed a flood larger than the flood shown on the map.
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River Eden: January 2005 event

Upstream at Appleby

Emergency Centre at Carlisle

Public response at Carlisle
Overlays of probabilistic flood risk
Links to database (here only centroids of building vectors)
Concluding Comments

- Uncertainty estimation as a means of maintaining integrity (and avoiding being wrong)
- But needs a translationary discourse between science and stakeholders
- One framework for doing so is to evolve Guidelines for Good Practice within which assumptions and means of communication/visualisation must be agreed (and recorded for later evaluation)
- Guidelines as a decision framework (perhaps with default options)
• Draft guideline document for flood risk mapping currently under review by Environment Agency

• Intended initially to be a dynamic (wiki-type) document in which decisions, defaults and case studies evolve over time.

• More on uncertainty estimation methods at www.uncertain-future.org.uk