The provision of an online neural network system for flood estimation in ungauged catchments

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The provision of an online neural network system for flood estimation in ungauged catchments

- Introduction
- Artificial Neural Networks
- Flood Estimation Handbook
- Model development
- Web site implementation
- Conclusions

Artificial Neural Networks

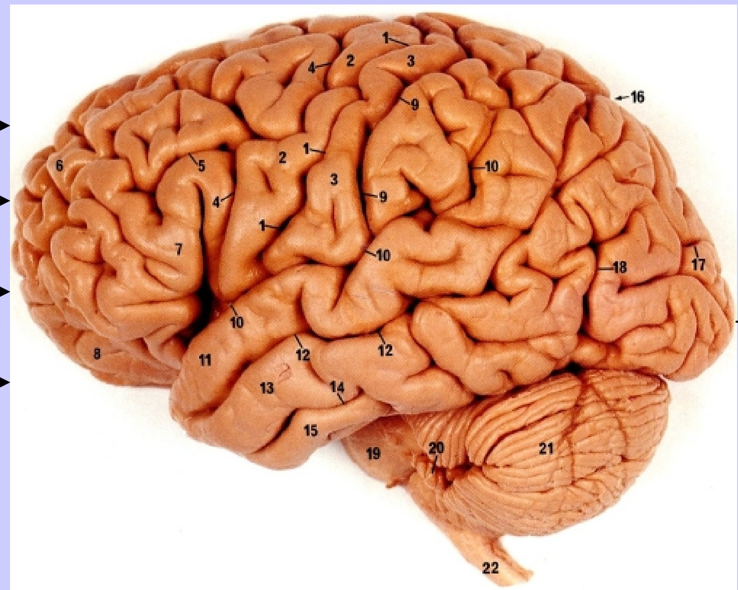
Touch

Sight

Taste

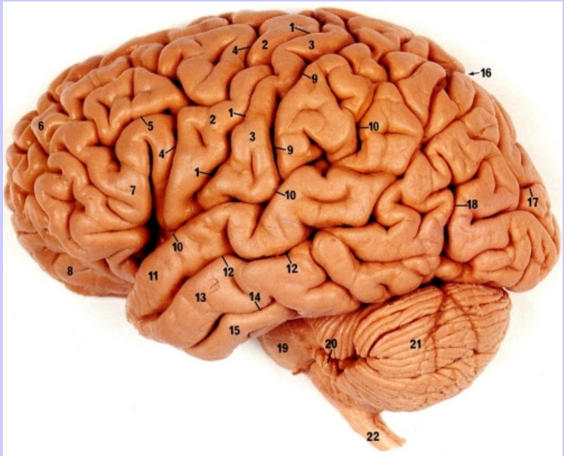
Smell

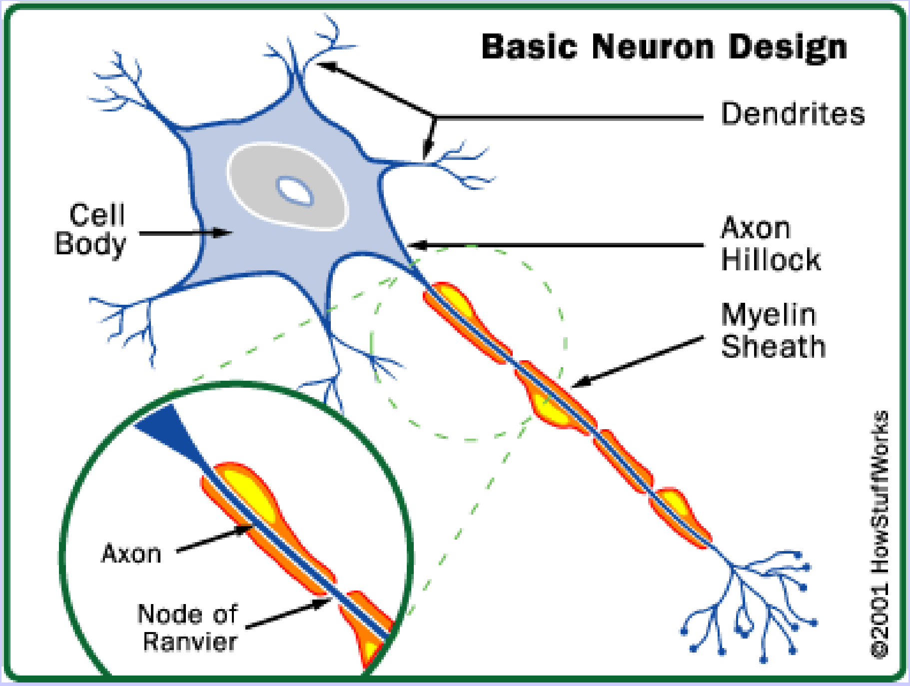
Hearing



Muscle movement

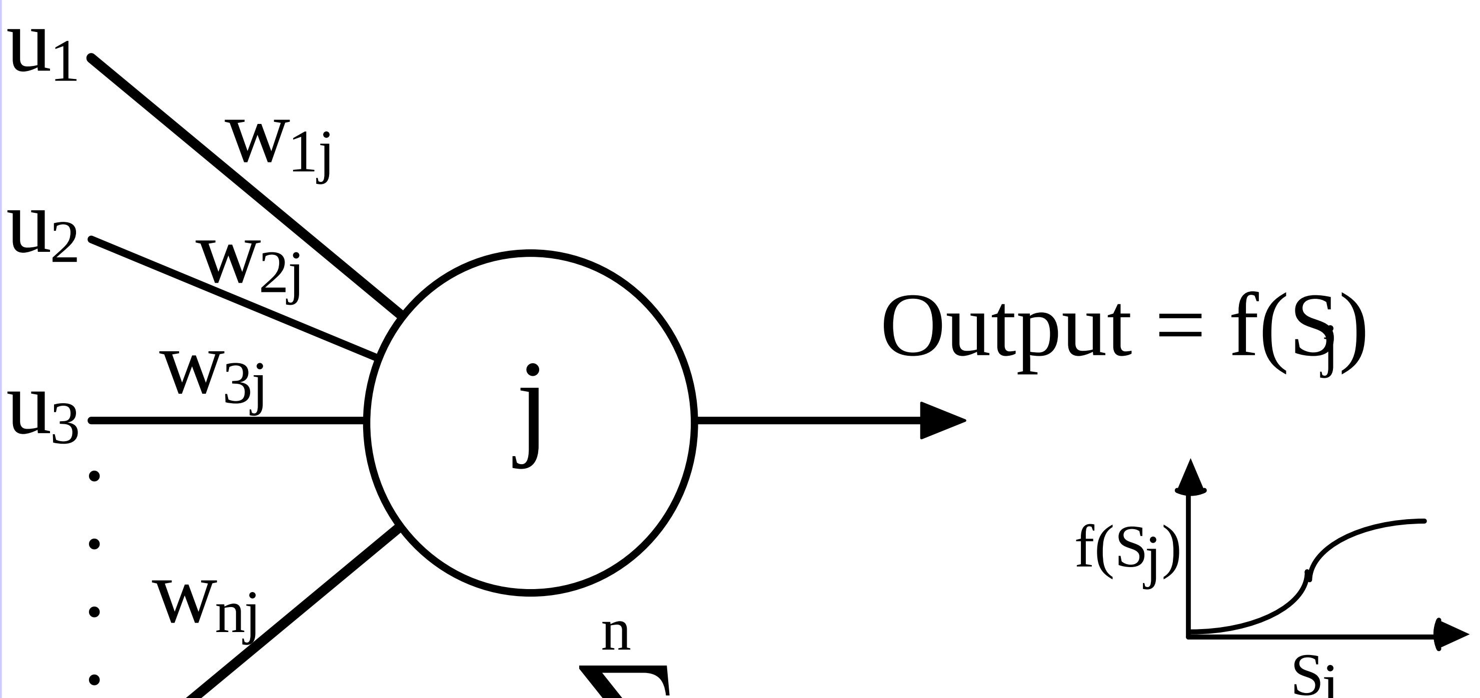
Artificial Neural Networks





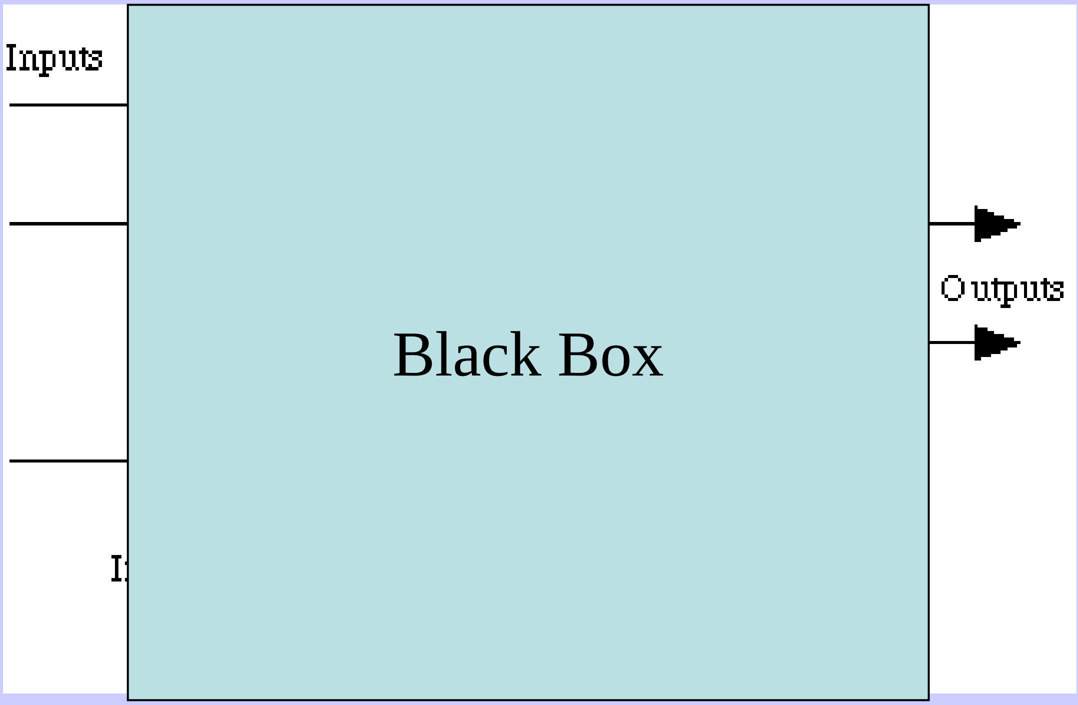
100 Billion neurons
1,000 Billion+ connections

Artificial Neuron



$$S_j = \sum_{i=0}^{n} w_{ij}\, u_i$$

Artificial Neural Networks



Advantages of ANNs

- **New problems** - ANNs are well suited to new problems that are difficult to define. They act as 'black boxes'
- **Robustness** - ANNs can handle missing and fuzzy data. Because data and processing is distributed throughout an ANN they can tolerate faults and can tolerate damage to themselves.
- **Fast processing** - can solve complex problems quickly once trained by operating on problems using a massively interconnected number of processing units.
- **Flexibility** - can adapt to changing environments. Easy to maintain and can learn new things.

Summary of criticisms of ANNs

- No physical reasoning/ explanation (i.e., black boxes)
- Inability to generalise to extreme events outside training data
- Data dependent
- No single “true” solution (i.e., equifinality)
- Difficult to assign confidence limits
- Over–parameterised
- Fails to build on conventional hydrological “wisdom”

Flood Estimation Handbook

- FEH – produced by CEH
- FEH CD ROM - Data on 1,000 UK catchments ($0.5km^2$+)
- 3 Files:
  - Annual maximum series (100+ years to 5 or 6)
  - POT series (may not be same period as AMS)
  - Catchment descriptors

Model Development

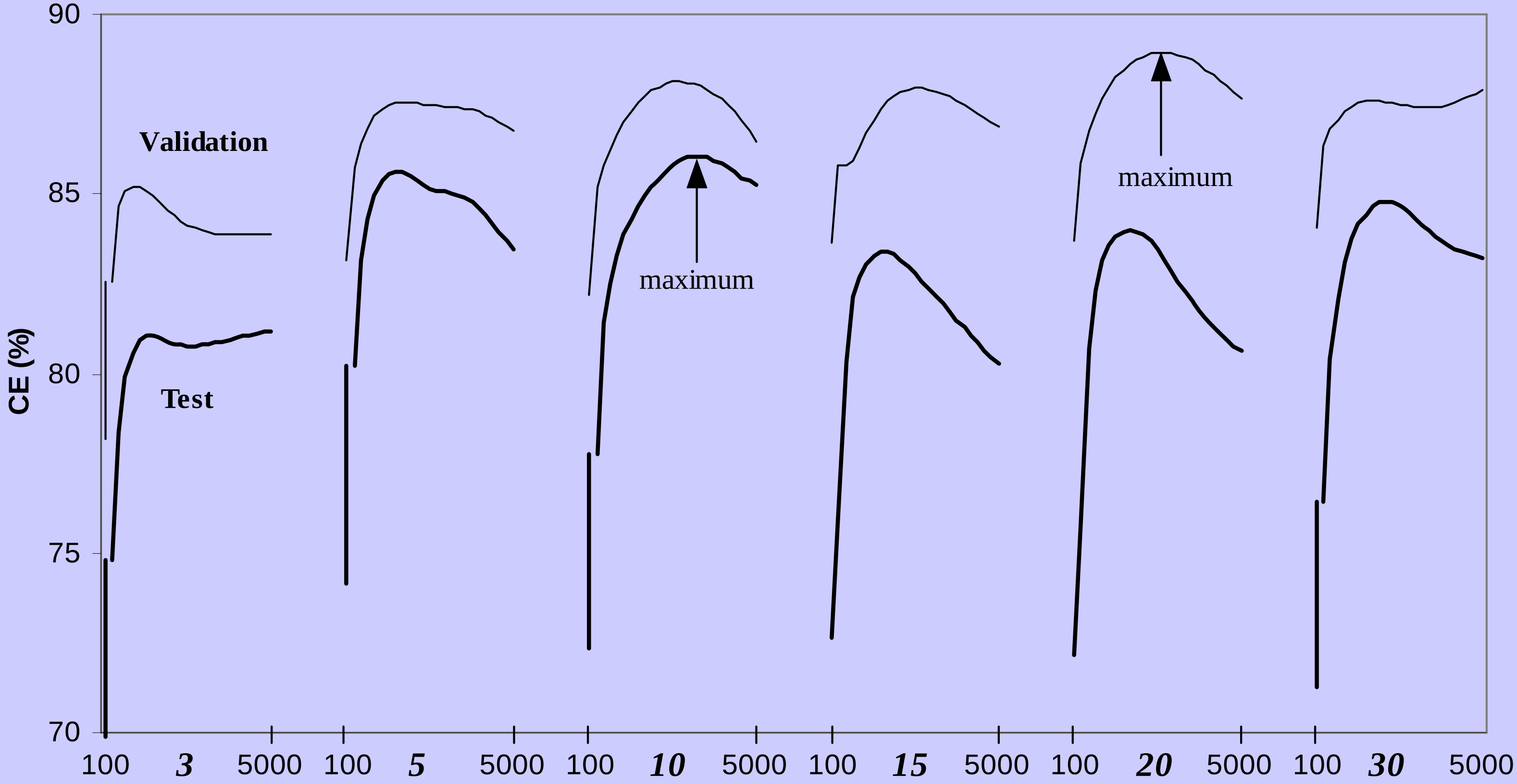
- 1,000 catchments;
- Processing $\longrightarrow$ 850 catchments (10+ years)
- AMS extracted
- T-year flood events calculated based on Gumbel Type 1 distribution:
- $Q_T = \overline{Q} + K(T)S_Q$
- K(T): frequency factor, $\overline{Q}$ mean AMS, S_Q SD of AMS

Model Development

- 20-year flood event derived
- 16 catchment descriptors

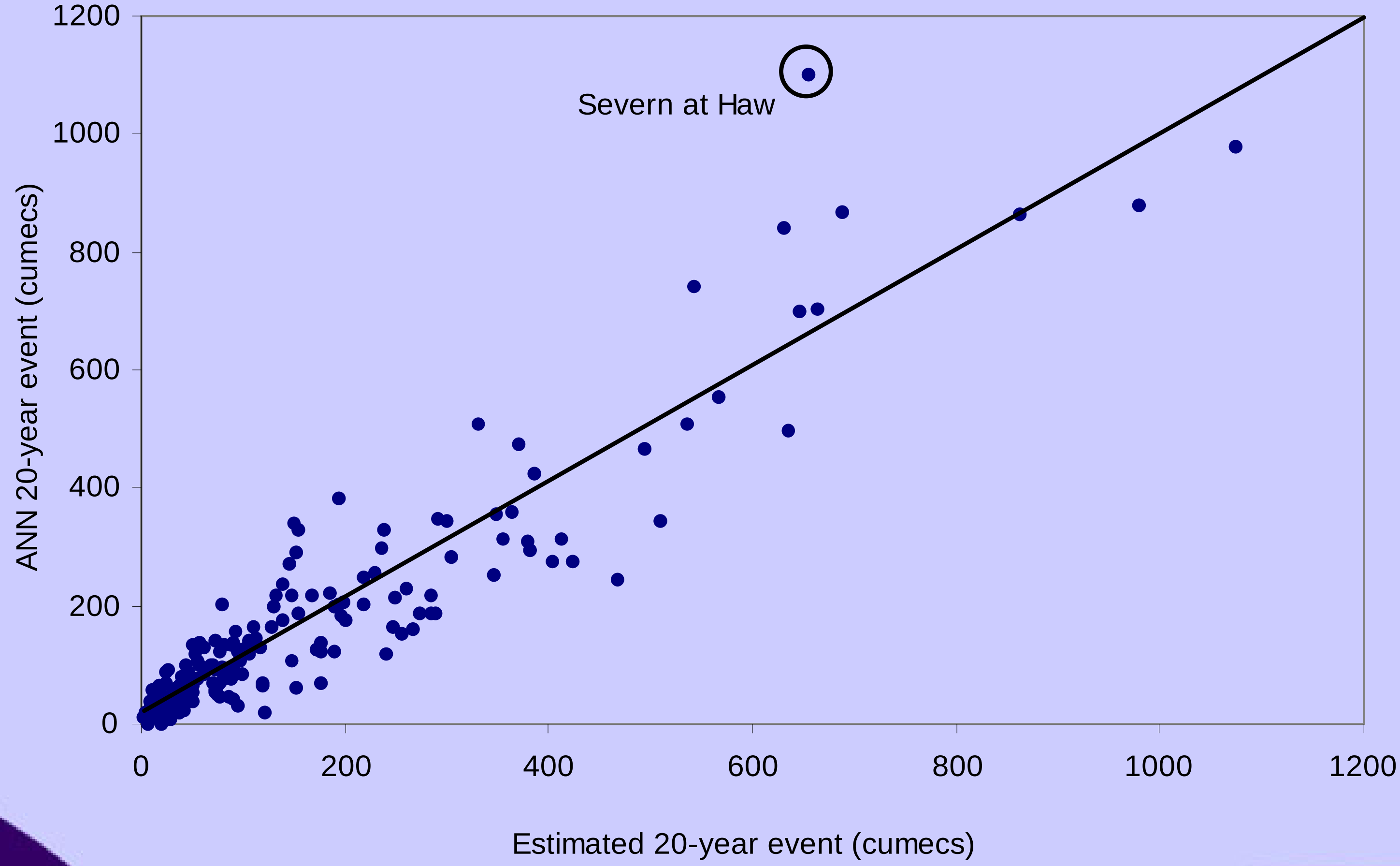
DTM AREA	Catchment drainage area (km^2)
BFIHOST	Base flow index
SPRHOST	Standard percentage runoff
FARL	Index of flood attenuation attributable to reservoirs and lakes
SAAR	Standard period (1961-1990) average annual rainfall (mm)
RMED-1D	Median annual maximum one-day rainfall (mm)
RMED-2D	Median annual maximum two-day rainfall (mm)
RMED-1H	Median annual maximum one-hour rainfall (mm)
SMDBAR	Mean Soil Moisture Deficit for 1941 – 1970 (mm)
PROPWET	Proportion of time when Soil Moisture Deficit<6mm during 1961 - 1990
LDP	Longest drainage path (km)
DPLBAR	Mean distance between each node (on a regular 50m grid) and catchment outlet (km)
ALTBAR	Mean altitude of catchment above sea level (m)
DPSBAR	Mean of all inter-nodal slopes in catchment (m/km)
ASPVAR	Invariability of slope directions
URBEXT1990	Extent of urban and suburban land cover in 1990 (%)

Avoiding Over Fitting



Number of hidden nodes and epochs; 100 - 5000 for each configuration

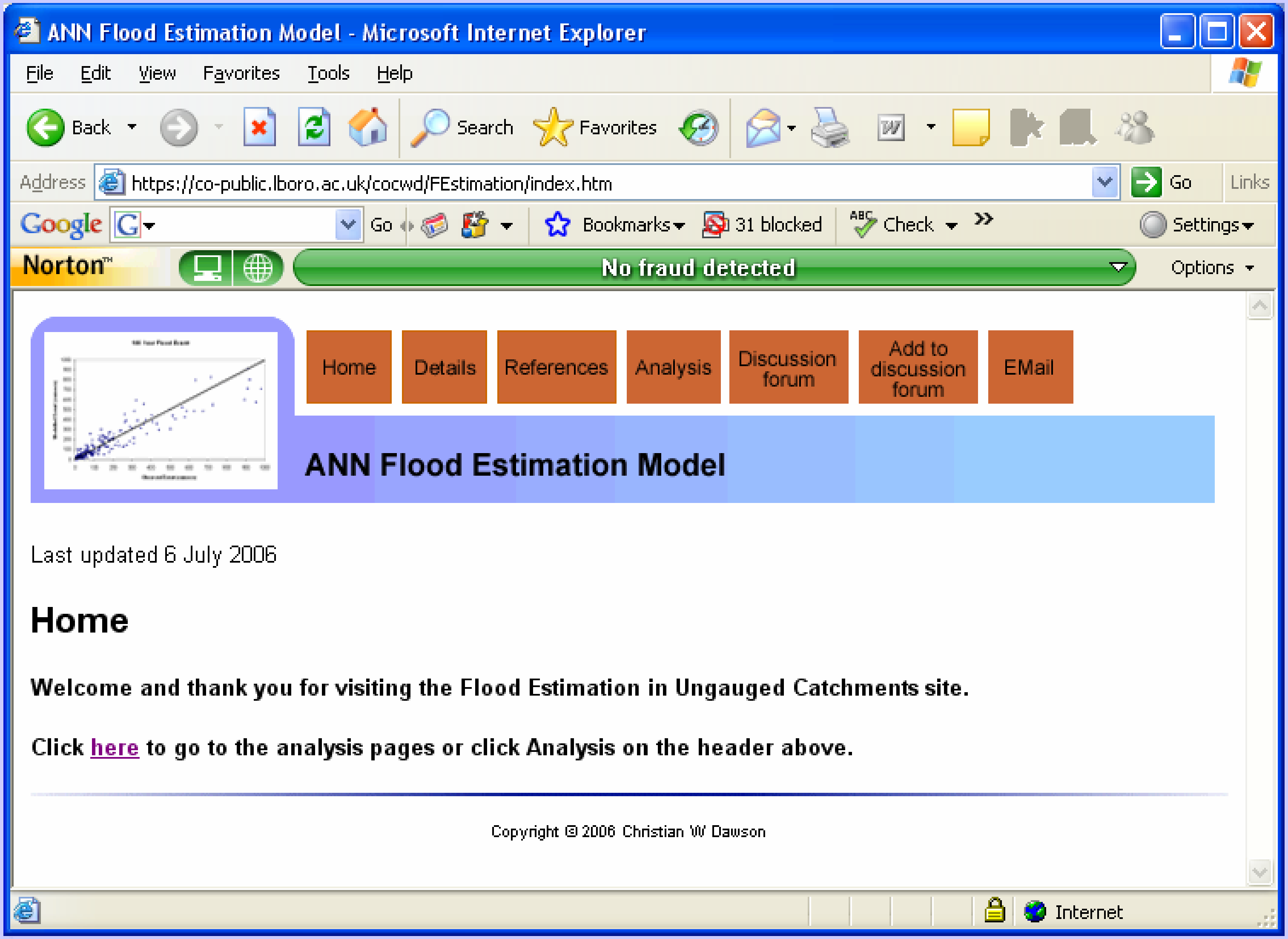
Accuracy of Model



Web site implementation

- https://co-public.lboro.ac.uk/cocwd/FEstimation/index.htm

- Developed using PHP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ANN Flood Estimation Model

Complete the appropriate fields below and click 'Calculate' to perform the analyses.

Variable	Value	Minimum	Maximum	Description
DTM AREA	410.77	1.07	9951	Catchment drainage area (km2)
BFIHOST	0.5	0.17	0.97	Base flow index
SPRHOST	36.86	4.80	59.90	Standard % runoff
FARL	0.97	0.64	1.00	Index of flood attenuation
SAAR	1084.76	547	3473	Average annual rainfall (mm)
RMED1D	39.11	25.20	84.20	Median annual max rainfall 1-day (mm)
RMED2D	51.85	32.20	122.00	Median annual max rainfall 2-day (mm)
RMED1H	10.73	8.10	14.90	Median annual max rainfall 1-hour (mm)
SMDBAR	25.21	3.29	53.78	Mean soil moisture defecit (mm)
PROPWET	0.46	0.21	0.83	Proportion of time SMD<6mm
LDP	39.95	2.41	280.96	Longest drainage path (km)
DPLBAR	21.48	1.14	140.81	Mean distance between nodes (km)
ALTBAR	207.47	25.00	683.00	Mean altitude (m)
DPSBAR	97.71	11.61	415.21	Mean inter-nodal slopes (m/km)
ASPVAR	0.18	0.01	0.57	Invariability of slope directions
URBEXT	0.03	0.00	0.43	Urban and suburban land cover (%)

Calculate Reset

20 year event = 140.75 cumecs (max: 1521.62; min: 1.15)

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ANN Flood Estimation Model

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ASPVAR	0.18	0.01	0.57	Invariability of slope directions
URBEXT	0.03	0.00	0.43	Urban and suburban land cover (%)

Calculate Reset

20 year event = 158.44 cumecs (max: 1521.62; min: 1.15)

The University of Nottingham

Loughborough University

Conclusions

- Web-based flood estimation model – quick and easy model to use
- Forum for discussion
- Other models still to develop (index flood, 10-, 30-, 50-, 100-year events)
- Urban / rural models
- UK only so far

Questions?

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