GIS, COASTAL FLOODING AND GEOGRAPHY DEGREES

WHO AM I?

- Robin Wilson

- **Dysons:** 1999-2004
- **Hereford Sixth Form College:** 2004-2006
- **Year in Industry (British Energy):** 2006-2007
- **University of Southampton:** 2007-Present

WHAT IS GIS?

Geographical Information System

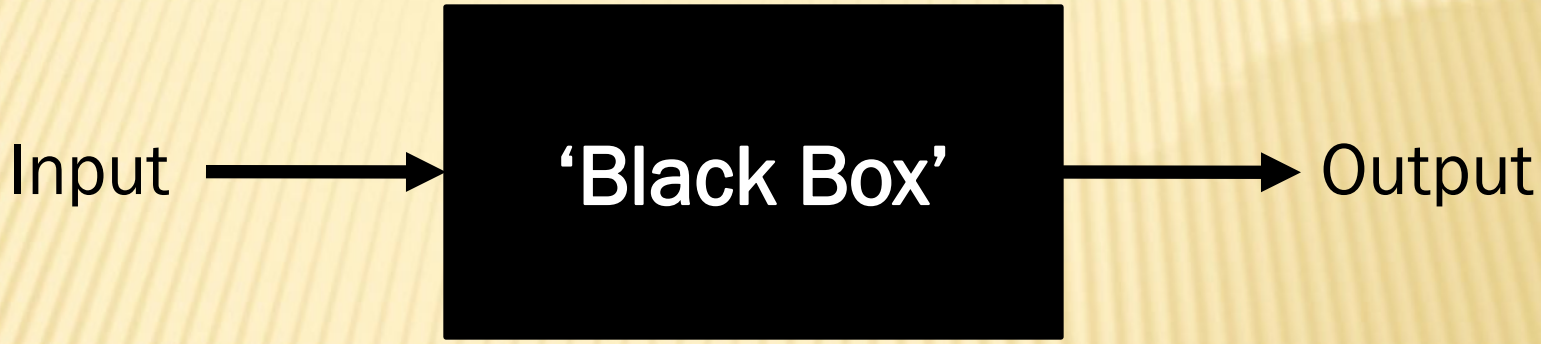
Science

Studies

One possible definition:

"A system for capturing, storing, checking, integrating, manipulating, analysing and displaying data which are spatially referenced to the Earth" (Dept of Environment, 1987)

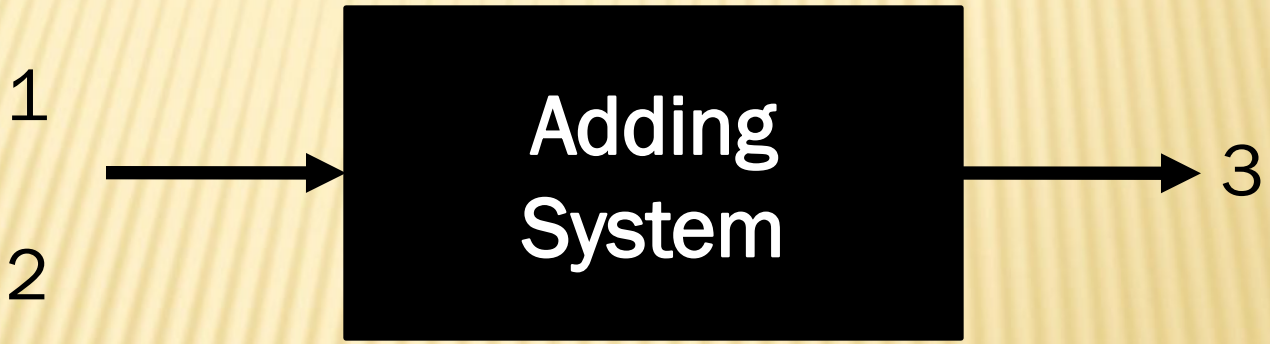
WHAT IS A SYSTEM?



- 'Systems approach' used a lot:
  - Physical Geography
  - Natural Sciences
  - Computer Science

EXAMPLE SYSTEMS

- From primary school…



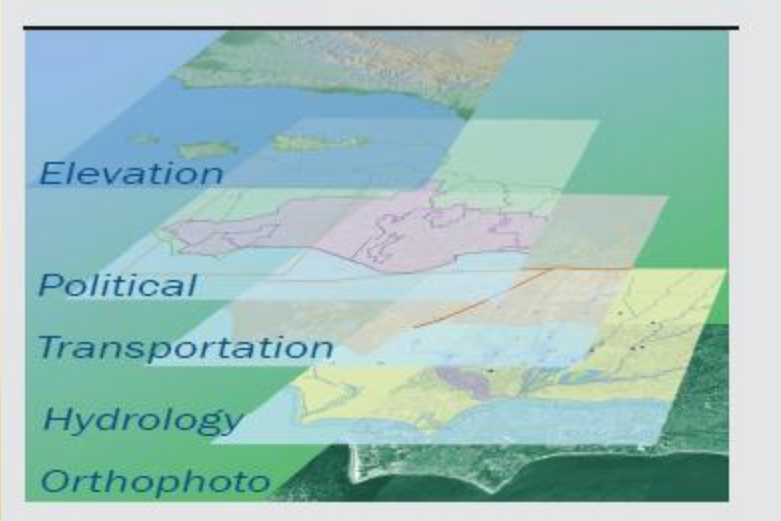
EXAMPLE SYSTEMS

- To GIS…

COASTAL FLOODING AND GIS

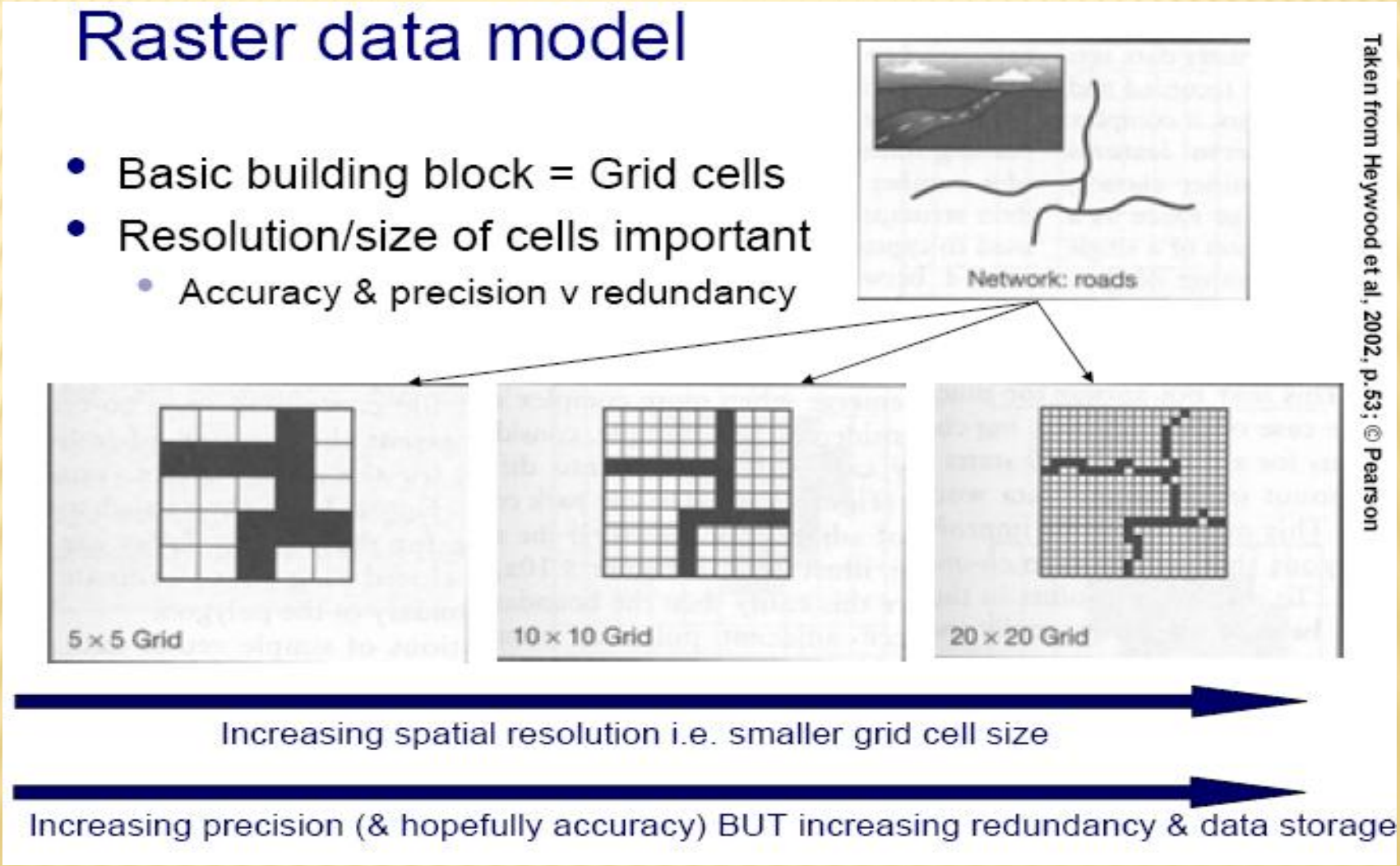
INPUT DATA

- **Physical**
  - Topography
  - Sea level predictions
    - From IPCC Climate Change Scenarios
  - Shape of coasts
- **Human**
  - Population distribution
  - Demographics
  - Sea defences



From FEMA

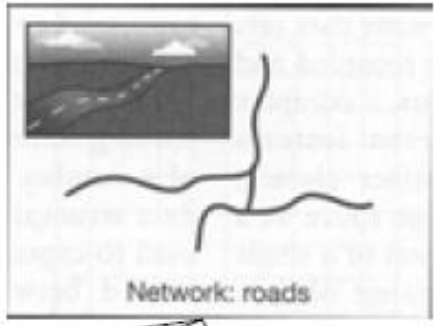
STORAGE OF DATA IN A GIS

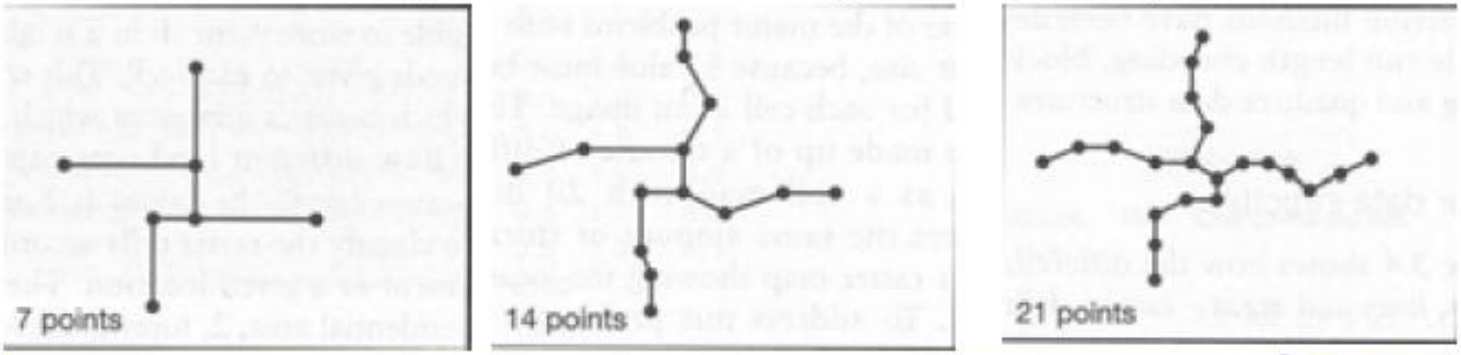


STORAGE OF DATA IN A GIS

Vector data model

- Number of points determines complexity of shape
- Accuracy/generalisation v duplication/redundancy





Increasing number of points / decreasing generalisation

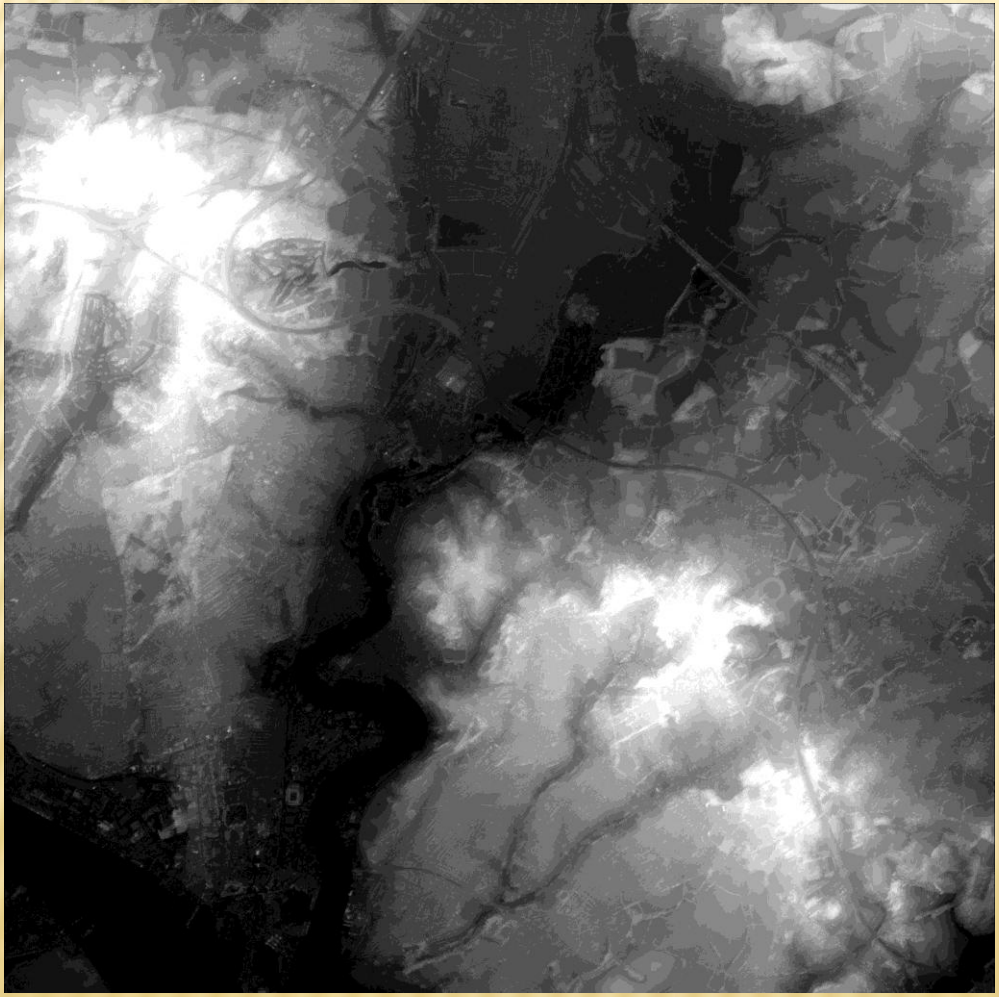
Increasing accuracy BUT increasing redundancy & data storage

STORING ELEVATION

- Raster with heights in metres
- Called a Digital Elevation Model (**DEM**)

- Many ways of creating it
  - National project called **NeXTMap** uses **InSAR**

EXAMPLE DEM



	634	635	636	637
62	136.360	135.830	135.890	136.200
63	136.310	136.160	136.400	136.180
64	136.490	136.620	136.670	136.120
65	136.450	136.430	136.410	136.210
66	136.670	136.440	136.380	136.180
67	137.080	136.800	136.530	136.210
68	137.010	136.880	136.680	136.370
69	136.760	136.760	136.630	136.130
70	136.660	136.560	136.310	135.790
71	136.690	136.340	136.000	135.530
72	136.500	135.930	135.580	135.150
73	136.440	135.790	135.420	134.990
74	136.610	135.940	135.650	135.180
75	136.570	136.060	135.870	135.460
76	136.420	136.140	135.940	135.670
77	136.390	136.210	135.950	135.590
78	136.320	136.330	136.030	135.720

DSM or DTM?

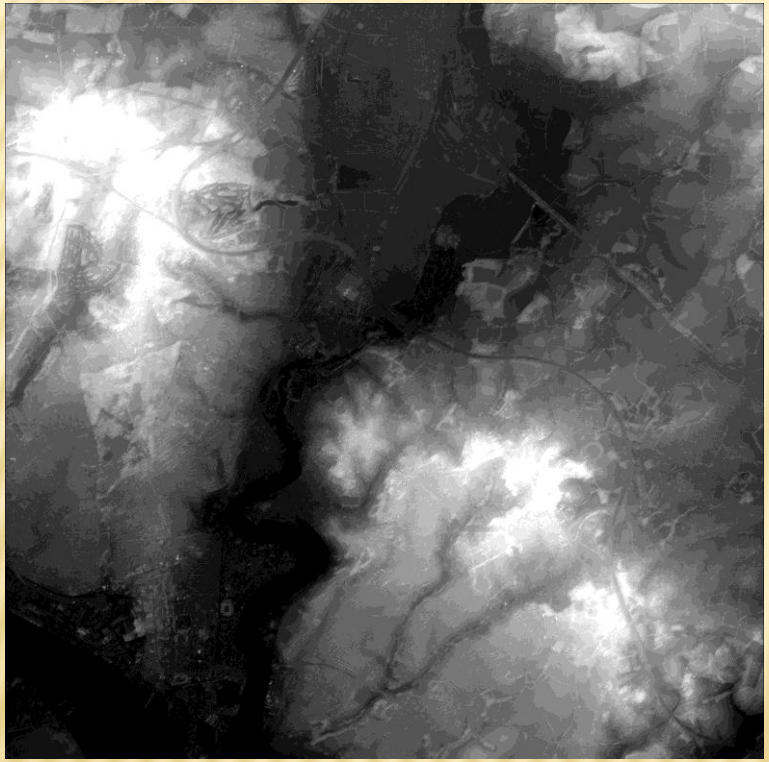
ISAR

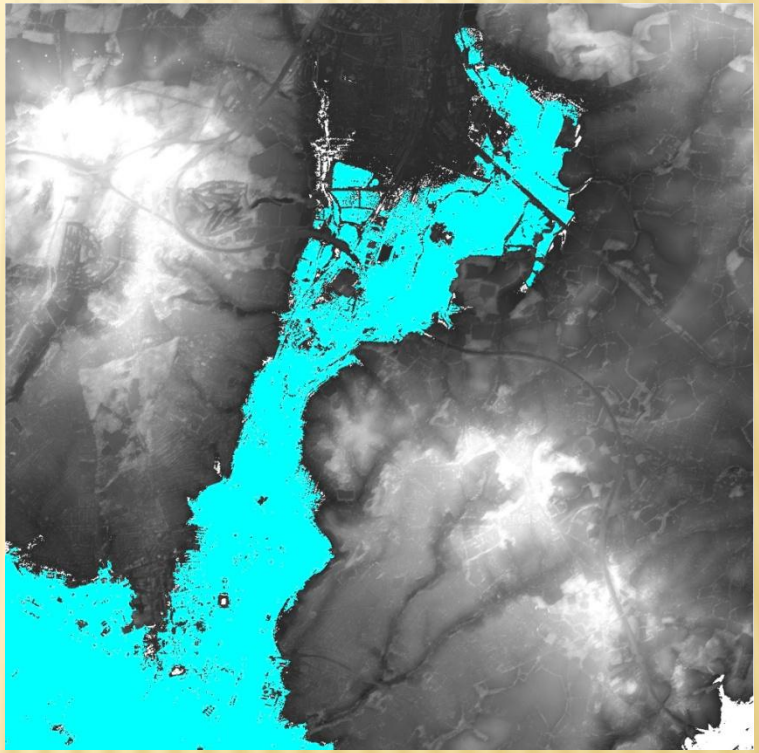
- Interferometric Synthetic Aperture RADAR
  - Sends a pulse of radio waves and times how long it takes to come back
  - Does this with very high accuracy (using the interference between waves with a phase difference)
- Two options: **Digital Terrain Model, Digital Surface Model**
- NeXTMap: 5m spatial resolution
  - Originally commissioned by Norwich Union to investigate flood risk
- Normally from aircraft but sometimes from satellites

MODELLING COASTAL FLOODING

- **Simple Model:**
  - Just dunk it in water!
  - The ‘bathtub’ model (Poulter and Halpin, 2007)
  - Simulate slowly lowering the whole DEM into water…any cell which is less than sea level will be flooded
  - Simple IF statement:
    - **IF** cell height < sea level **THEN** cell is flooded

BATHTUB EXAMPLE



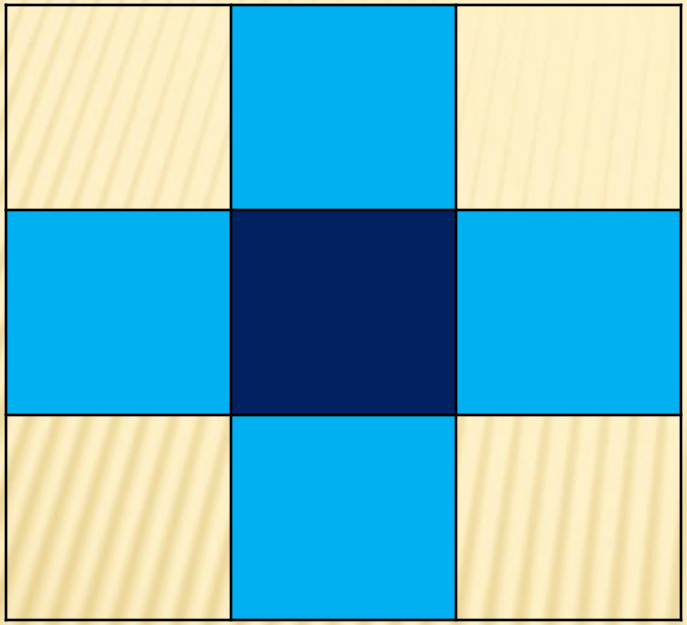


MODELLING COASTAL FLOODING

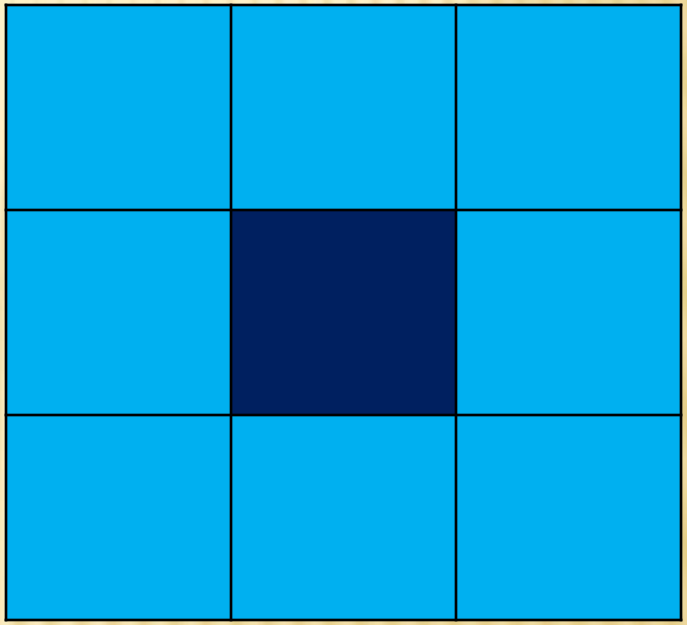
- Problems
  - What if Malvern was actually below current sea level. Would it flood?
    - **NO!** It has to be actually connected to the sea in some way…

HYDROLOGICAL CONNECTIVITY IN GIS

What do we mean by connected?



Rook's Case



Queen's Case

CASE STUDY 1 – FLOOD AREA ASSESSMENT

- (Poulter and Halpin, 2007)
- North Carolina coast, USA

- Just looked at flooded area, not flood risk:
  - **Input data:** DEM
  - **Output data:** Flood area maps

- Three different models:
  - Bathtub
  - Rook's Case
  - Queen's Case

CASE STUDY 1 – FLOOD AREA ASSESSMENT

- Found that it made quite a difference!
  - Lower flooded area for the Rook's and Queen's cases; higher for bathtub model
- More **complex** than previously thought!
- Analysed uncertainties – eg. from the LIDAR
- Found a '**threshold effect**': flooded area increases rapidly for low sea level rise (< 0.4m) and then slows down for higher sea level rise.
  - Why is it useful to know this?

CASE STUDY 2 – FLOOD RISK ASSESSMENT

- East Anglian coast
  - From Humber estuary to Thames estuary
- Climate Change scenarios from IPCC for 2050 and 2100
- Tried to calculate areas of high and low risk, and monetary values of land flooded

CASE STUDY 2 – FLOOD RISK ASSESSMENT

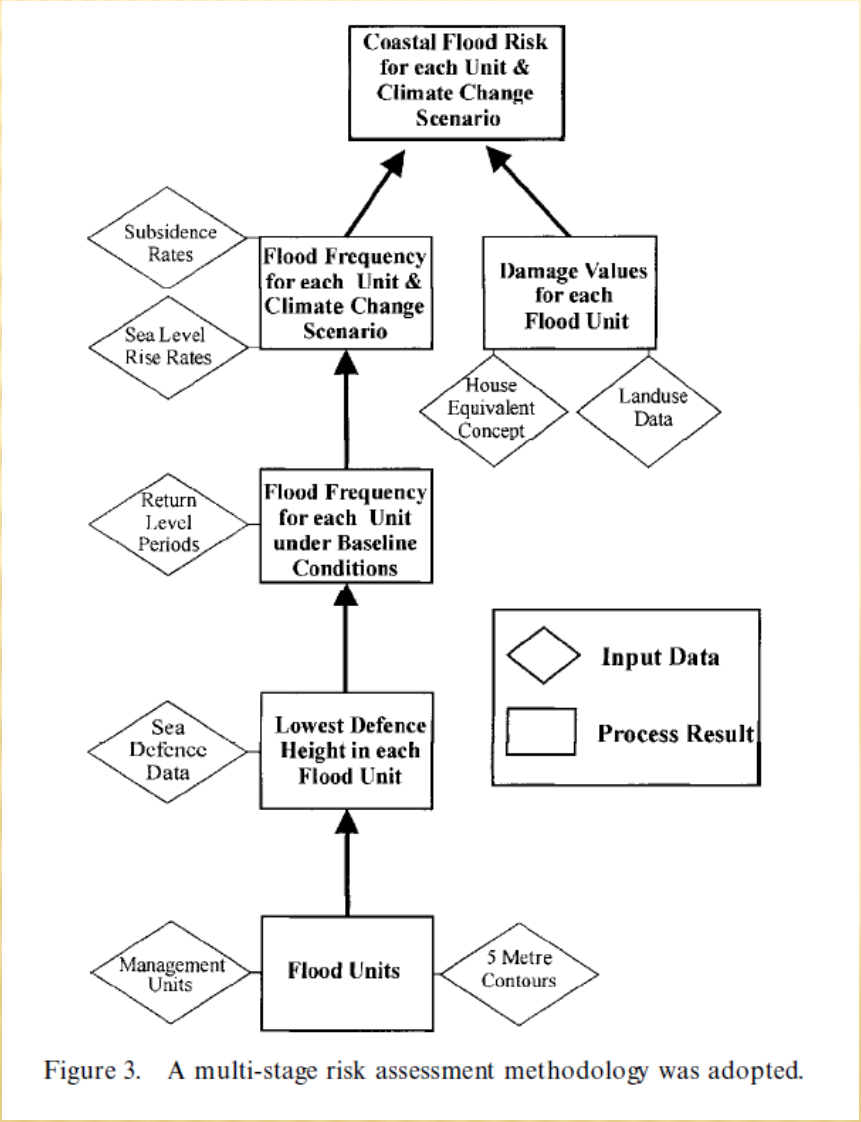
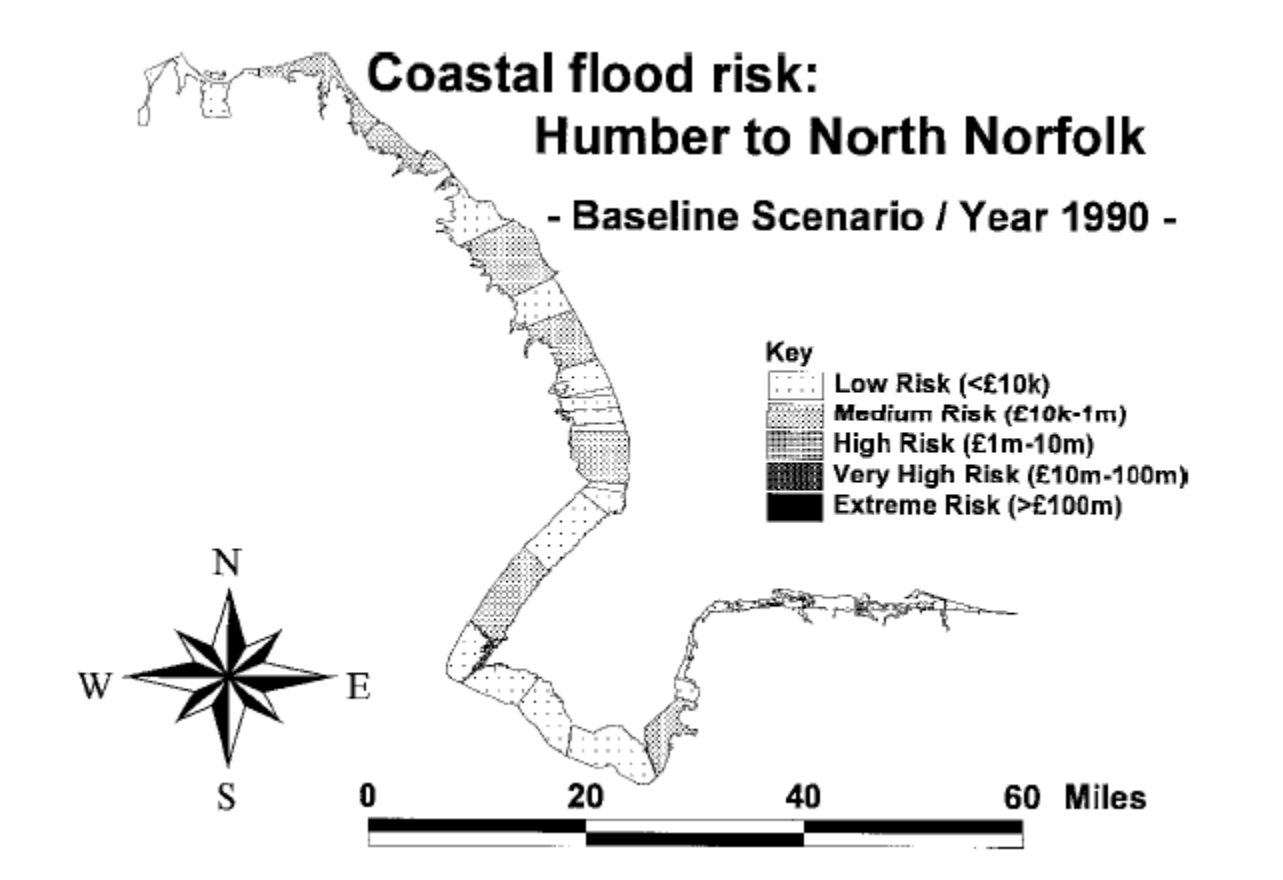


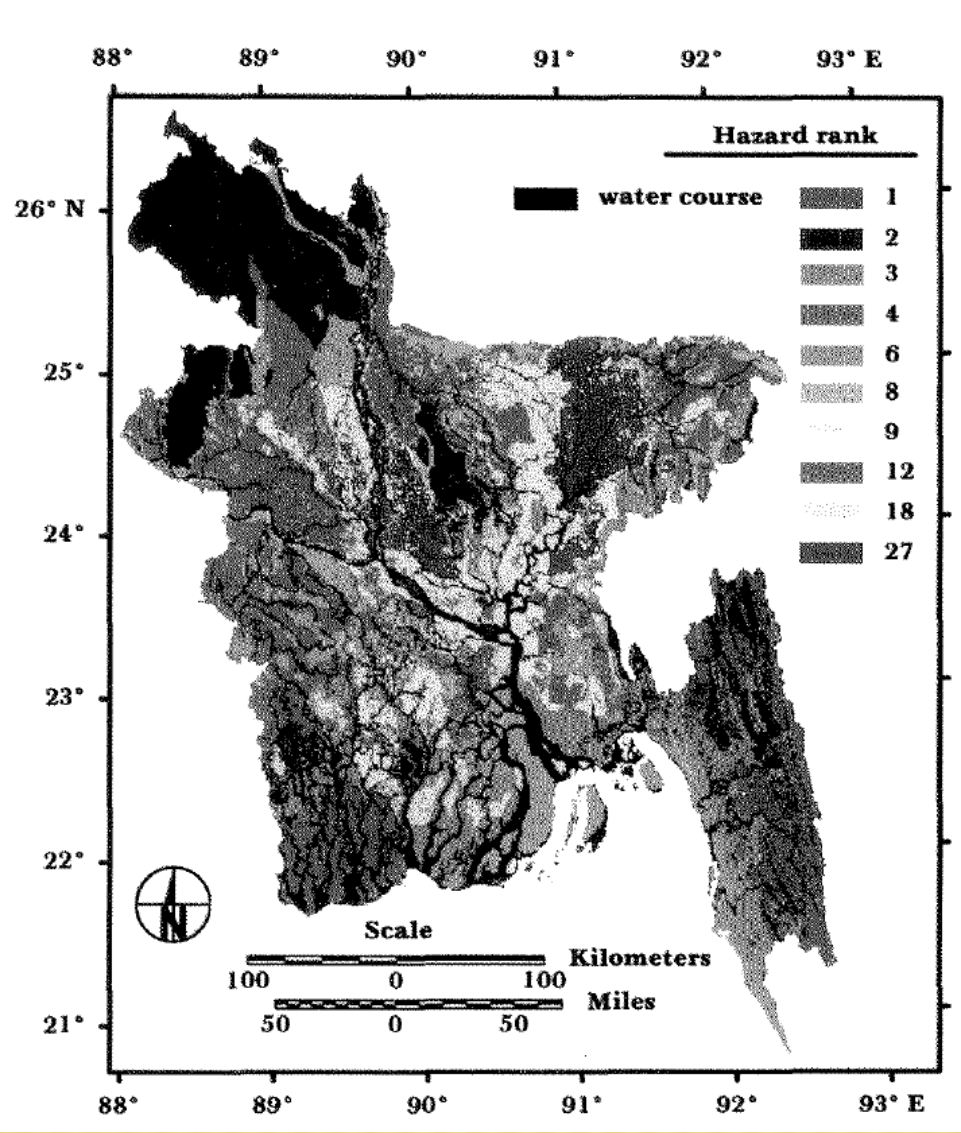
Figure 3. A multi-stage risk assessment methodology was adopted.

- Input Data
  - ‘Flood Units’
    - Including elevations
  - Sea Defence Height
  - Flood return periods
  - Sea level rise rates
  - Subsidence rates
  - Land use data
    - Land value data

CASE STUDY 2 - RESULTS



CASE STUDY 3 - BANGLADESH



- Looked at depth of floods over time
  - From satellite imagery
- Used different combinations of map layers to estimate flood risk

CASE STUDY 3 – BANGLADESH

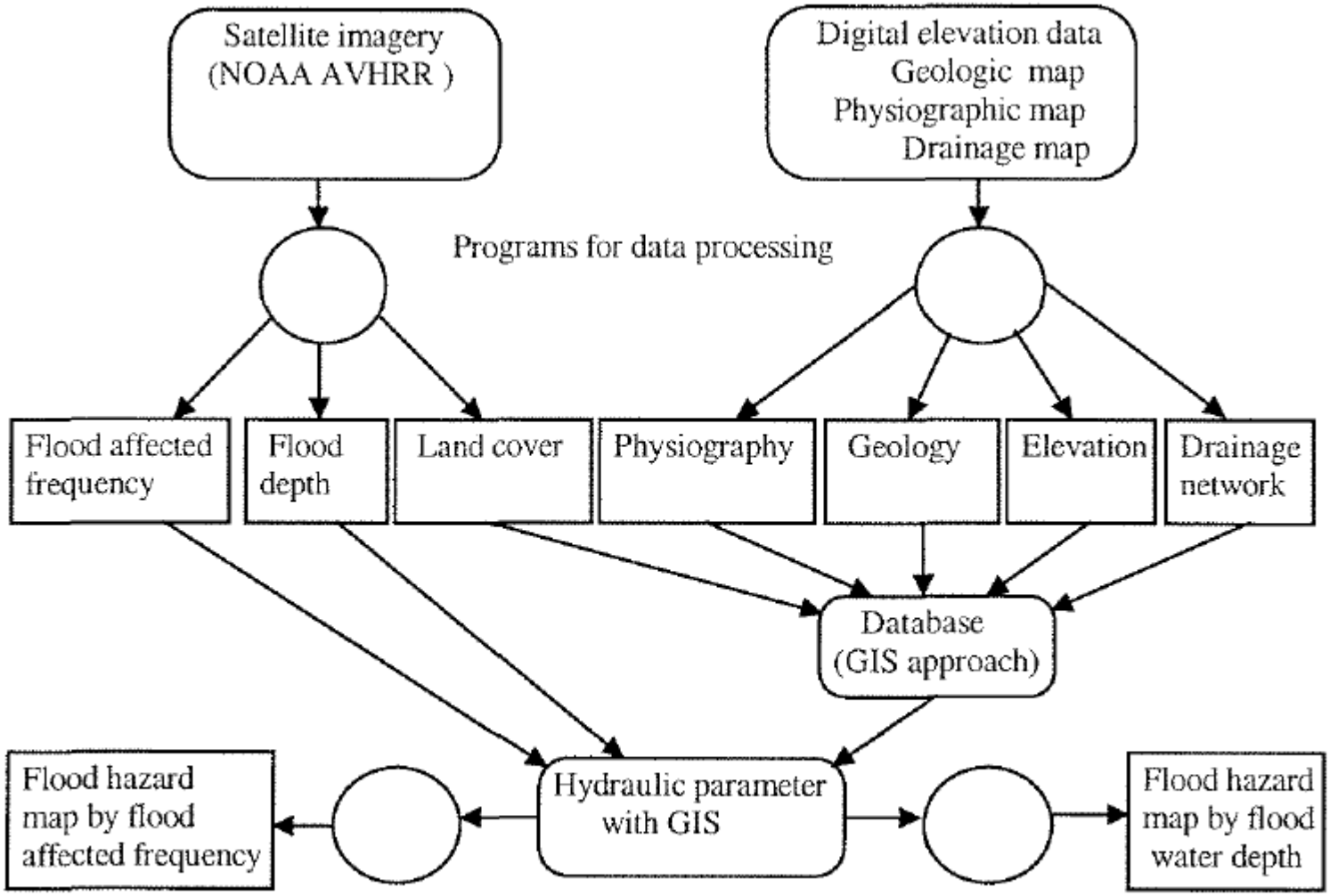
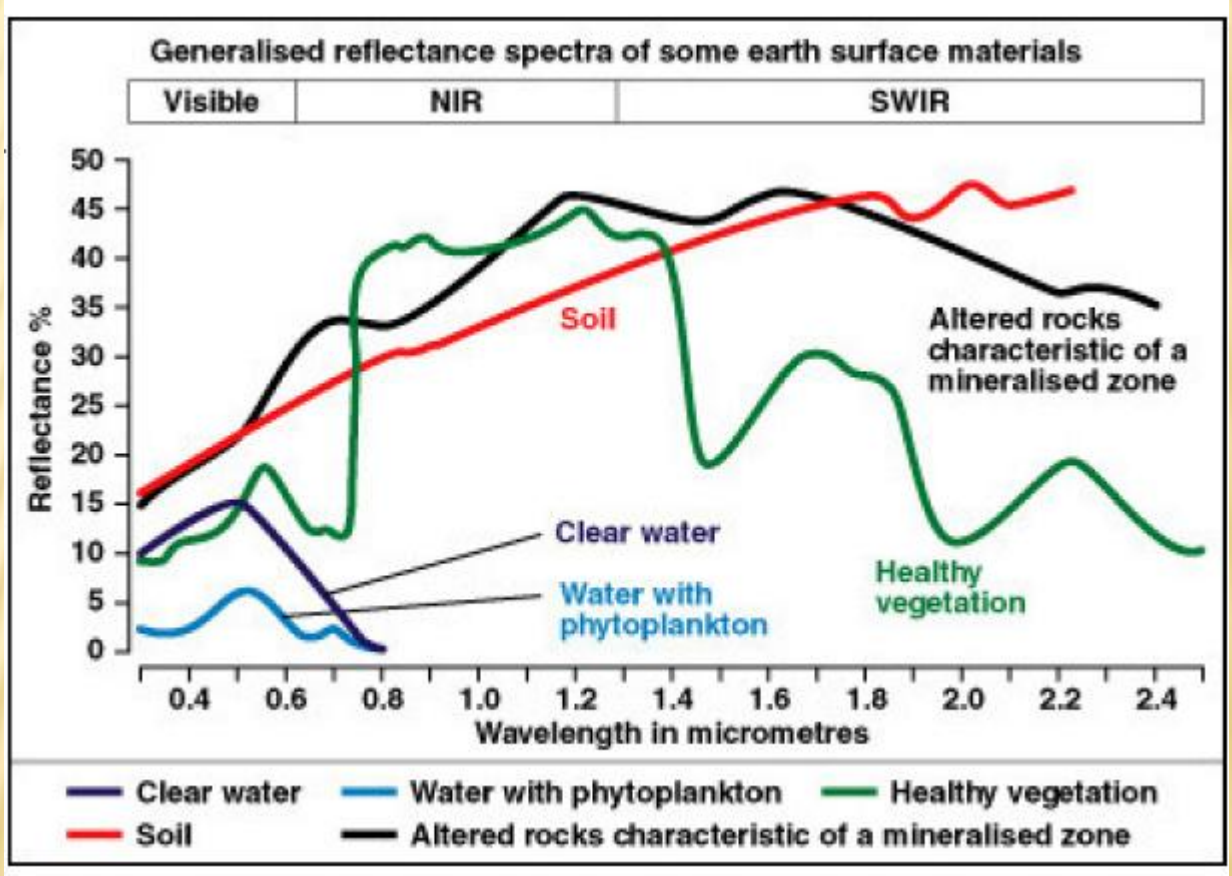


Fig. 2 Schematic concept of a model for flood hazard assessment.

SATELLITE IMAGING

- Satellites approx 750km up in the atmosphere
- Take images using a raster format – with varying resolution (pixel size)
- Use various **spectral bands**
  - Different wavelengths of light
    - Red, Green, Blue, Near Infrared (NIR)
- Can identify the types of materials based on their **spectra**

SPECTRAL SIGNATURES



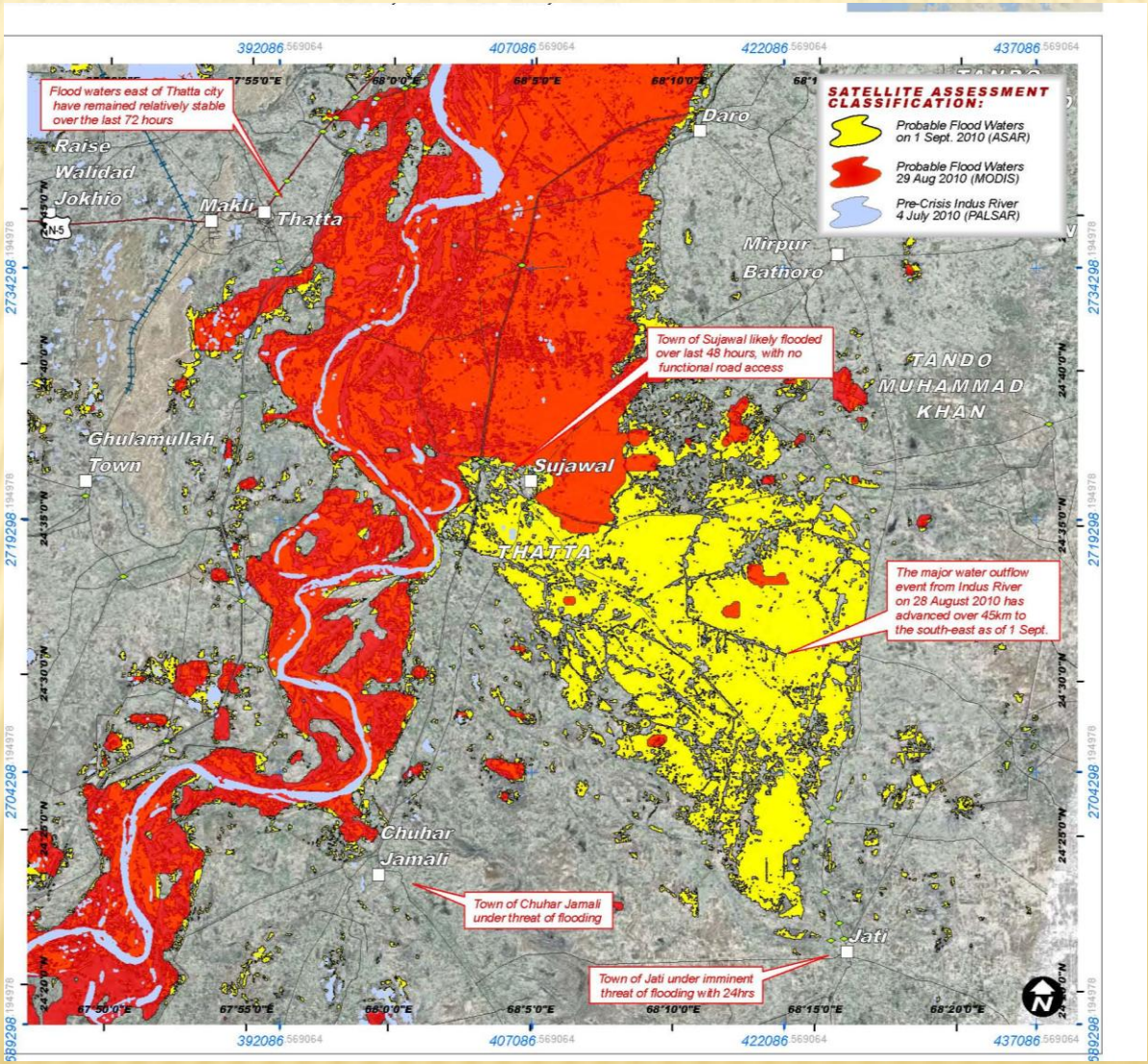
SPECTRAL SIGNATURES

- Used to classify images
- Can be used to identify flooded areas – eg. Bangladesh case study
- Also can identify collapsed buildings after an earthquake by their texture
- Can be done very quickly after flooding to help rescue teams

CASE STUDY 4: FLOODING IN PAKISTAN

- July-August 2010
- Over 2000 dead, 1 million homes destroyed
- More people homeless than 2004 tsunami, Kashmir earthquake and Haiti earthquake combined!
- Data from ENVISAT (ESA)

CASE STUDY 4: FLOODING IN PAKISTAN



INTERNATIONAL CHARTER

- International Charter on Space and Major Disasters
- Allows free use of satellite data for disaster assistance
- Disaster Monitoring Constellation

- See www.disasterscharter.org for good case studies

GEOGRAPHY AT UNIVERSITY

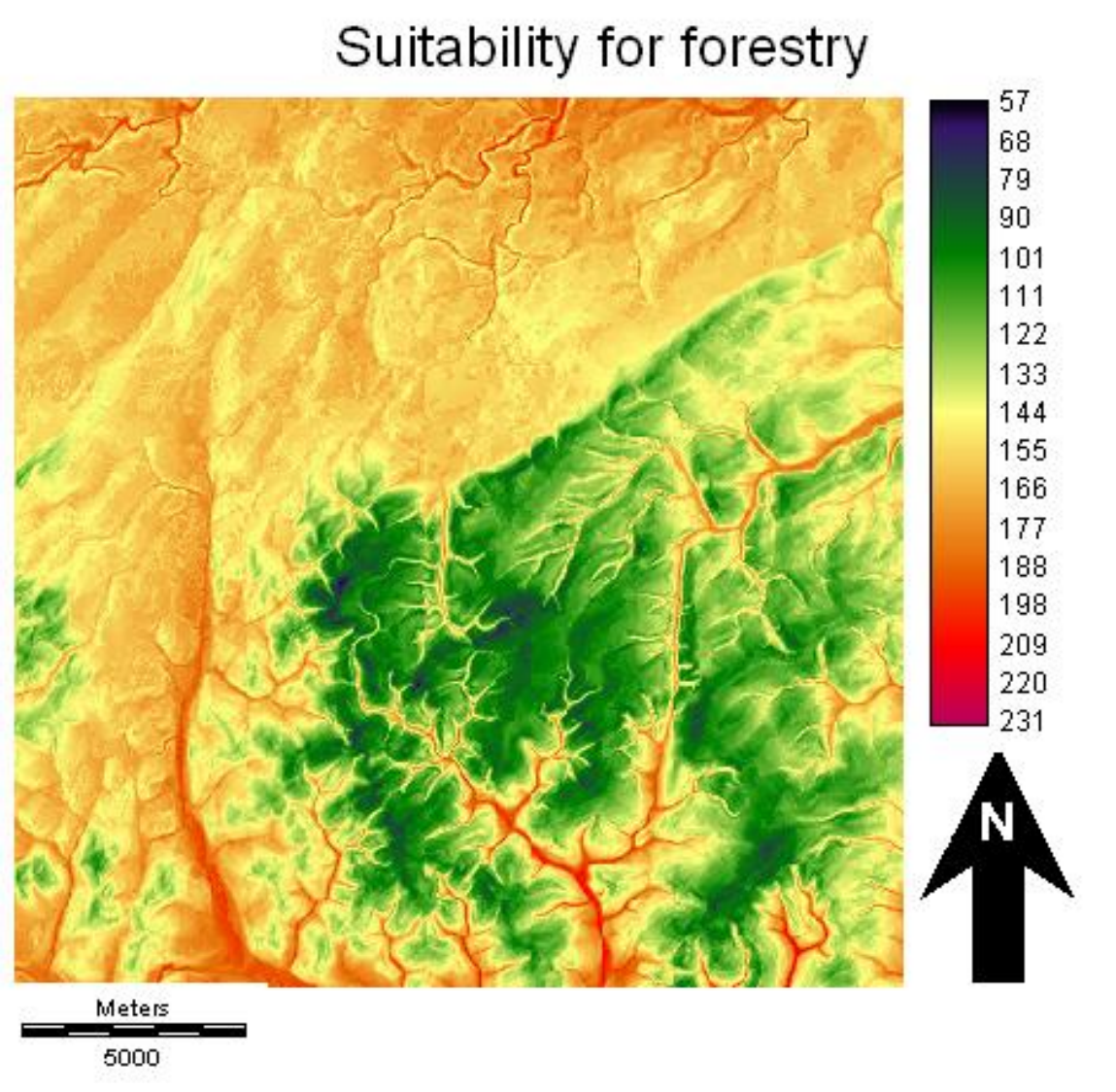
- Why Geography?
  - Interesting
  - Relevant/Topical
  - Broad
  - Flexible
- What is it like?
  - Human/Physical split (BA/BSc)
  - Modular
  - Assessment
  - Fieldwork
- Choose a course carefully (and ask for advice)

AROLLA FIELDTRIP

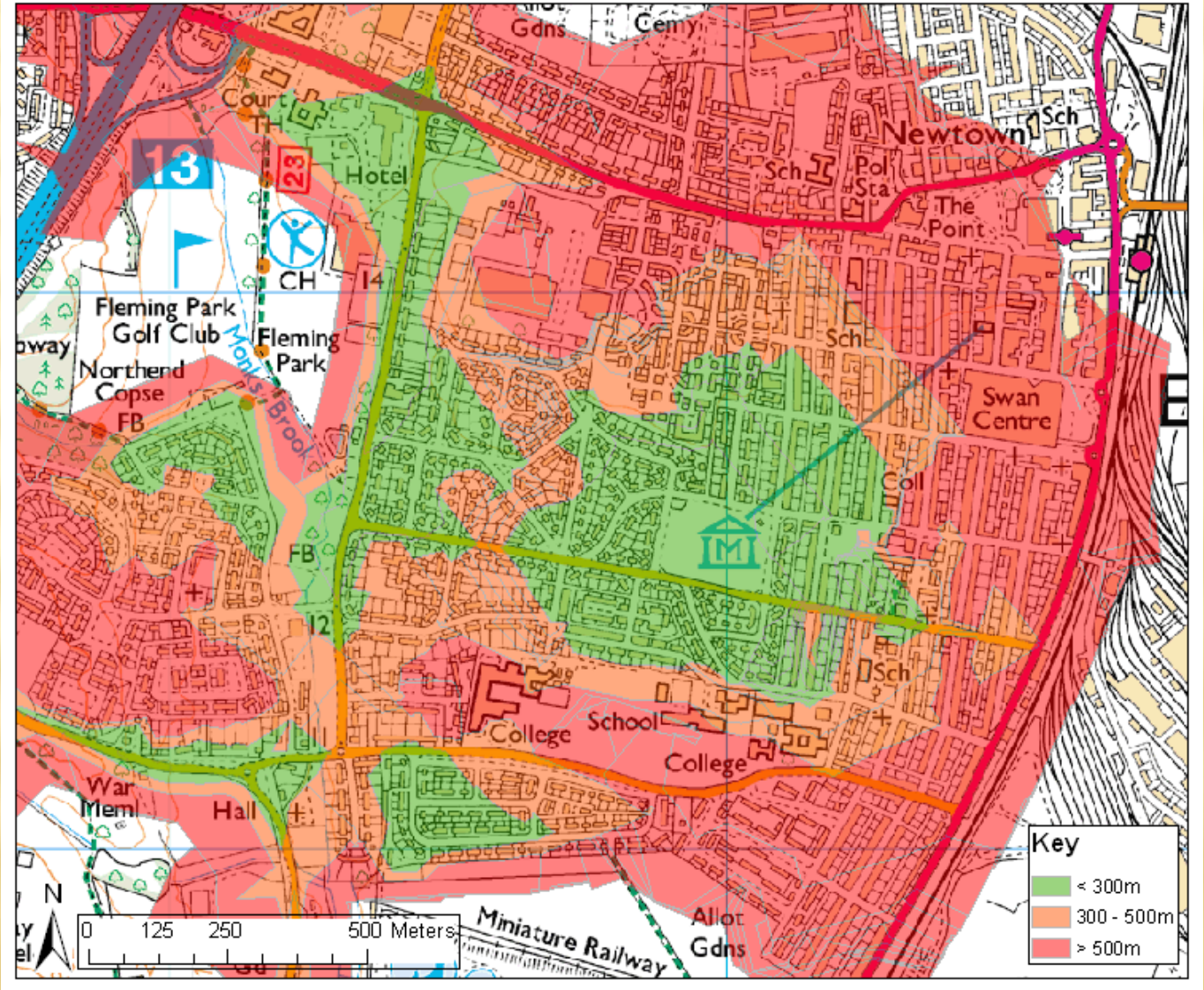
ANY QUESTIONS?

- Feel free to contact me at robin@rtwilson.com
- My website (www.rtwilson.com/academic) has examples of university-level geography work

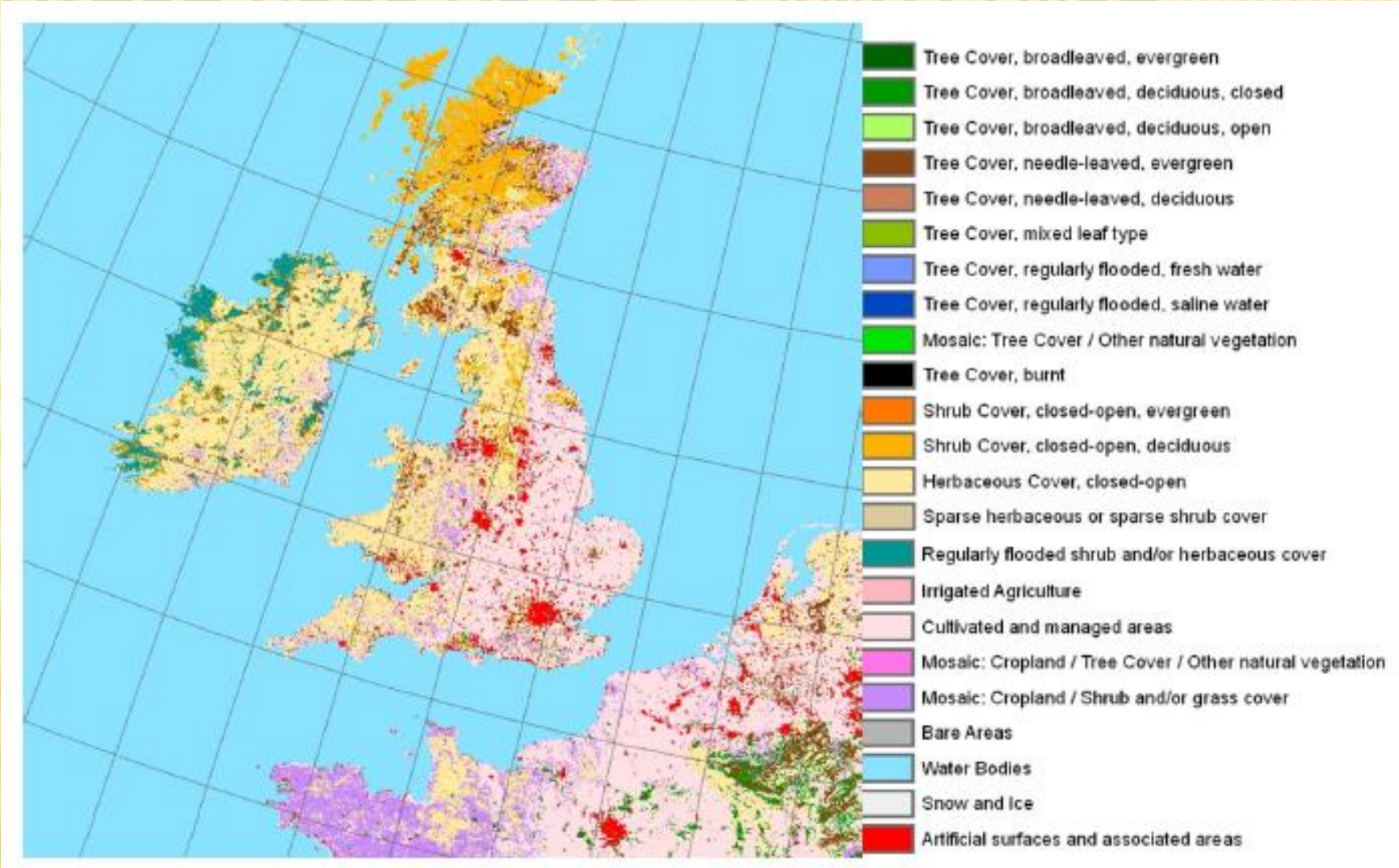
OTHER USES OF GIS - FORESTRY



OTHER USES OF GIS – ACCESS PLANNING



OTHER USES OF RS – LAND COVER



OTHER USES OF RS – PRECISION FARMING