What is GIS?

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School of Environment & Development (Geography)

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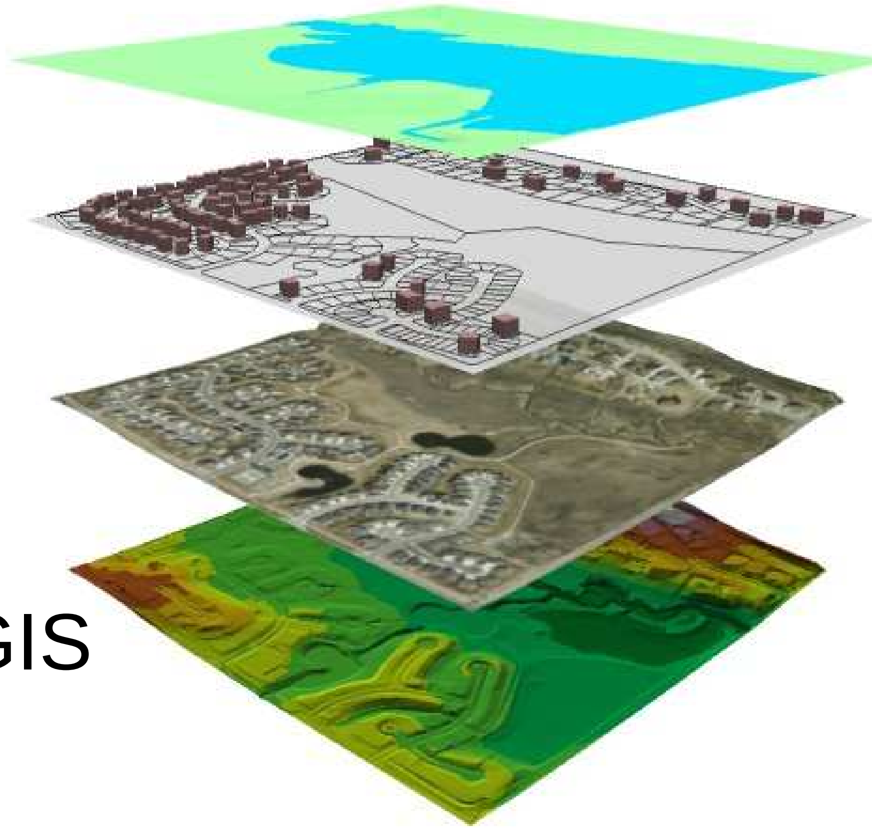
Overview

- Introduction: GIS & GISc
- Basic principles
- Key operations
- Analysis examples
- Conclusions: Reflective GIS
- Further information

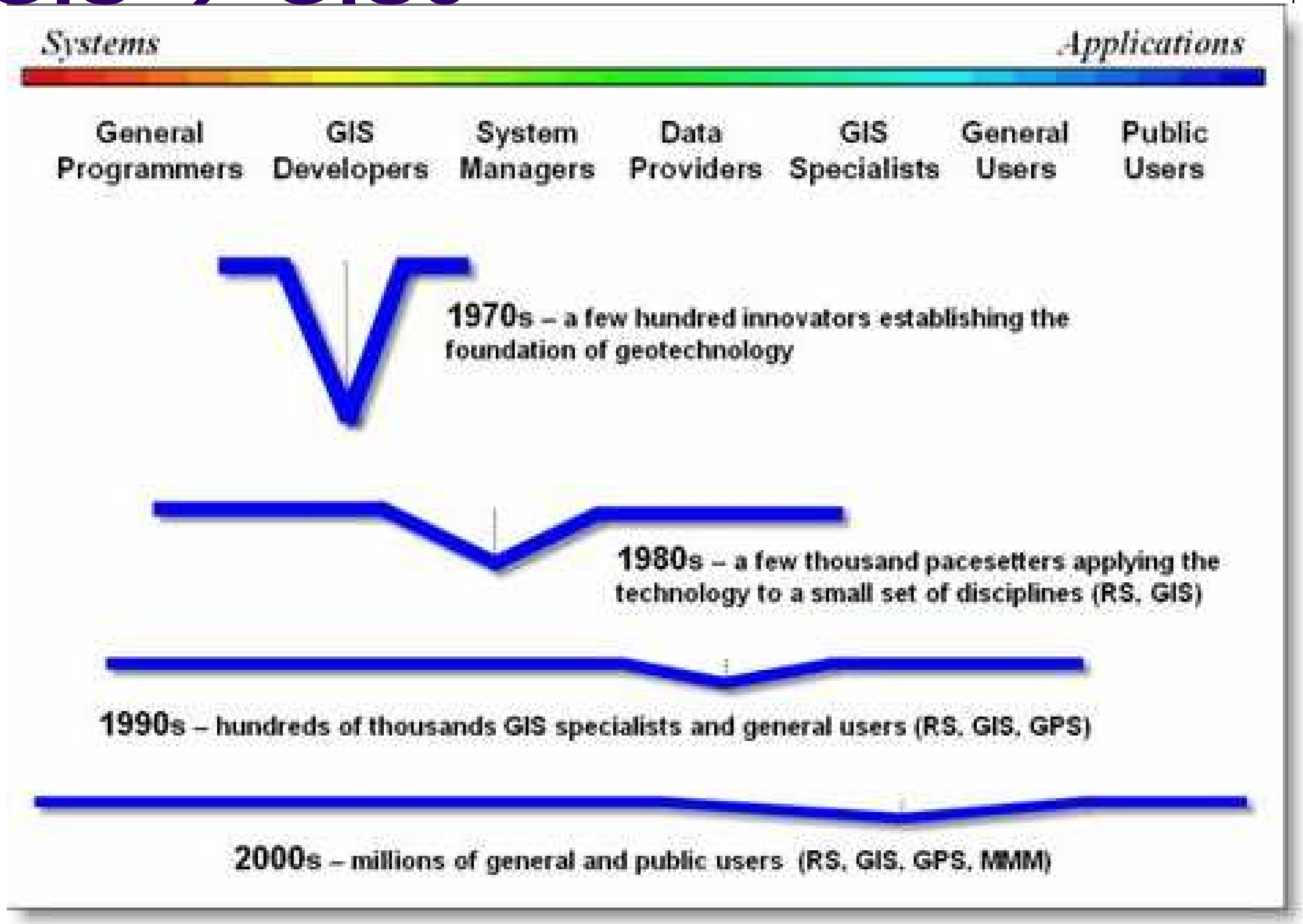


http://www.water-and-earth.com/gis.htm

Defining GIS

- GIS has been usefully defined as
  - 'a system for capturing, storing, checking, integrating, manipulating, analysing and displaying data which are *spatially referenced* to the Earth' (DoE, 1987)
    - Dept of the Environment (1987) Committee of Enquiry into the Handling of Geographic Information. London : HMSO (Chorley Report)
  - GIS has strong connections and shared principles with other spatial data handling techniques & technologies – now recognised as a distinct geography sub-discipline GI**Sc**

GIS → GISc



A Multifaceted GIS Community (GeoWorld January, 2007)

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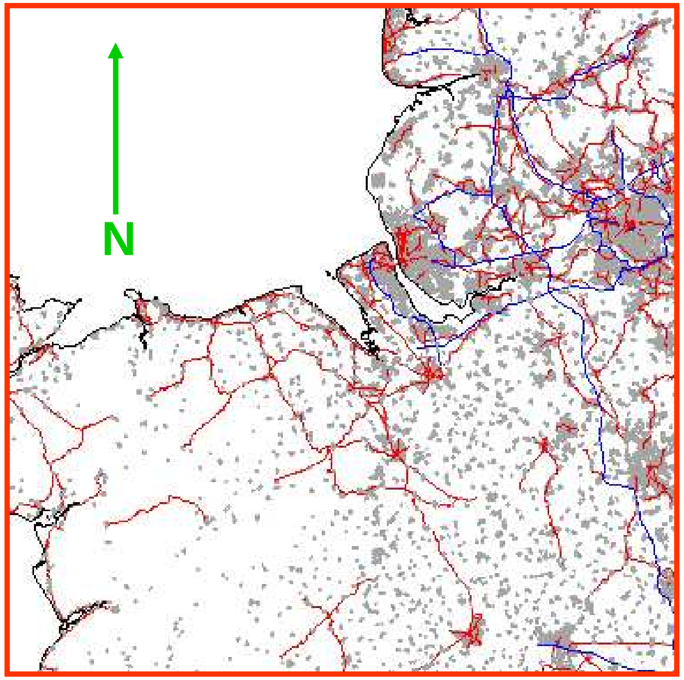
Principles:
Conceptualising geographical space

- How we represent spatial and attribute data in GIS is affected by how we view the world

- Field vs. Entity-Oriented View

Discrete valleys & hills or elevation continually varying in space?

Representing space



VECTOR

Simple **point, line** & **area** entity layers which can be visualised together giving the appearance of an OS map. They can also form the basis of more complex entities or represent a continuous surface

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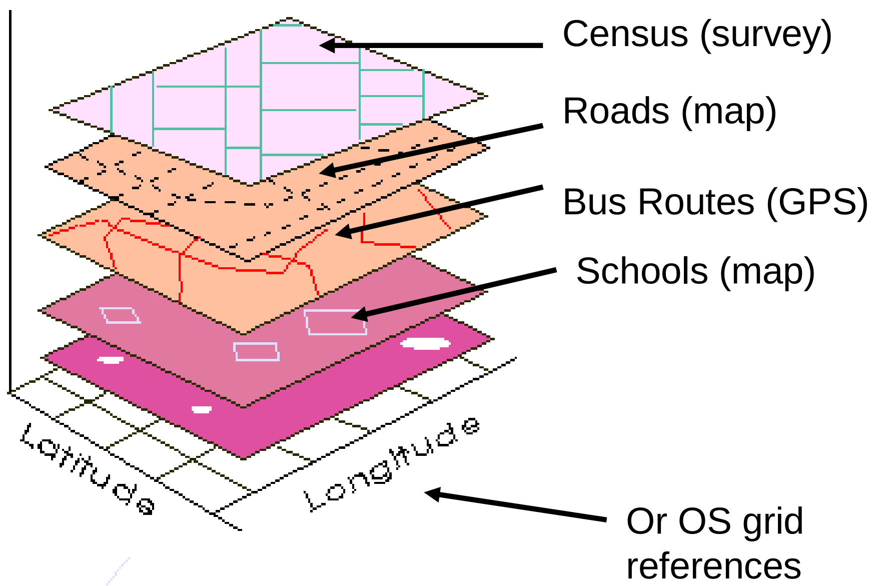
Cells or pixels, like on a satellite image, which each contain a data value which can be interpreted as simple entities or used to represent a continuous surface

Representing the ‘real world’

- Information about the real world is held in the form of **layers of data**
- Each layer has been carefully overlaid on the others & **every location is precisely matched to its corresponding location on all the other maps**.

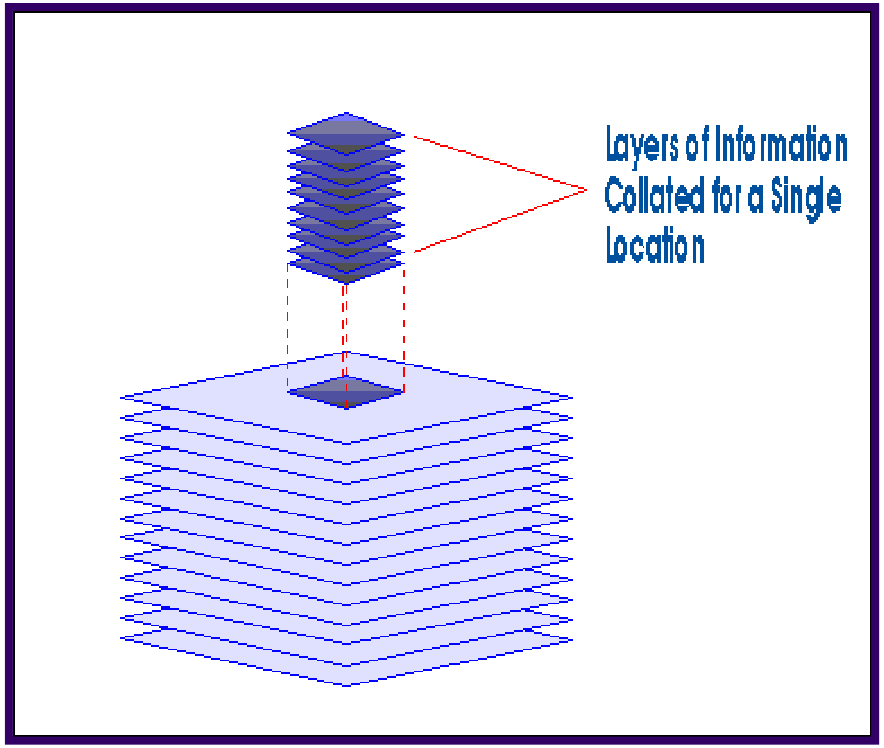


GIS: An Integrating Technology

Internet lecture - Foote and Lynch

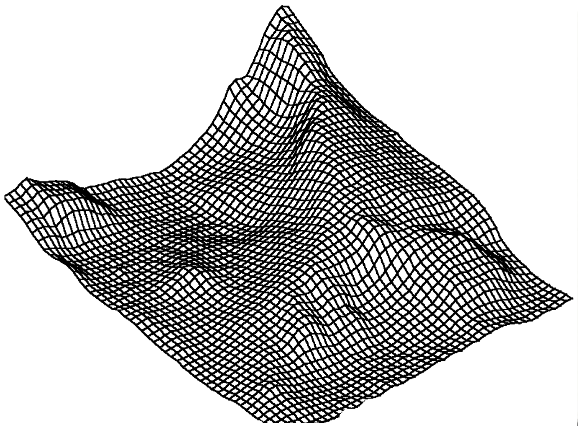
Analysing the 'real world'

- Layers can be compared and *analysed* → **new information**
- GIS offers a means of:
  - searching for spatial patterns and processes.
  - answering research questions



Where are particular features found?
What geographical patterns exist?
Where have changes occurred over a given time period?
Where do certain conditions apply?
What will the spatial implications be if an organisation takes certain actions?

2D → 2.5D



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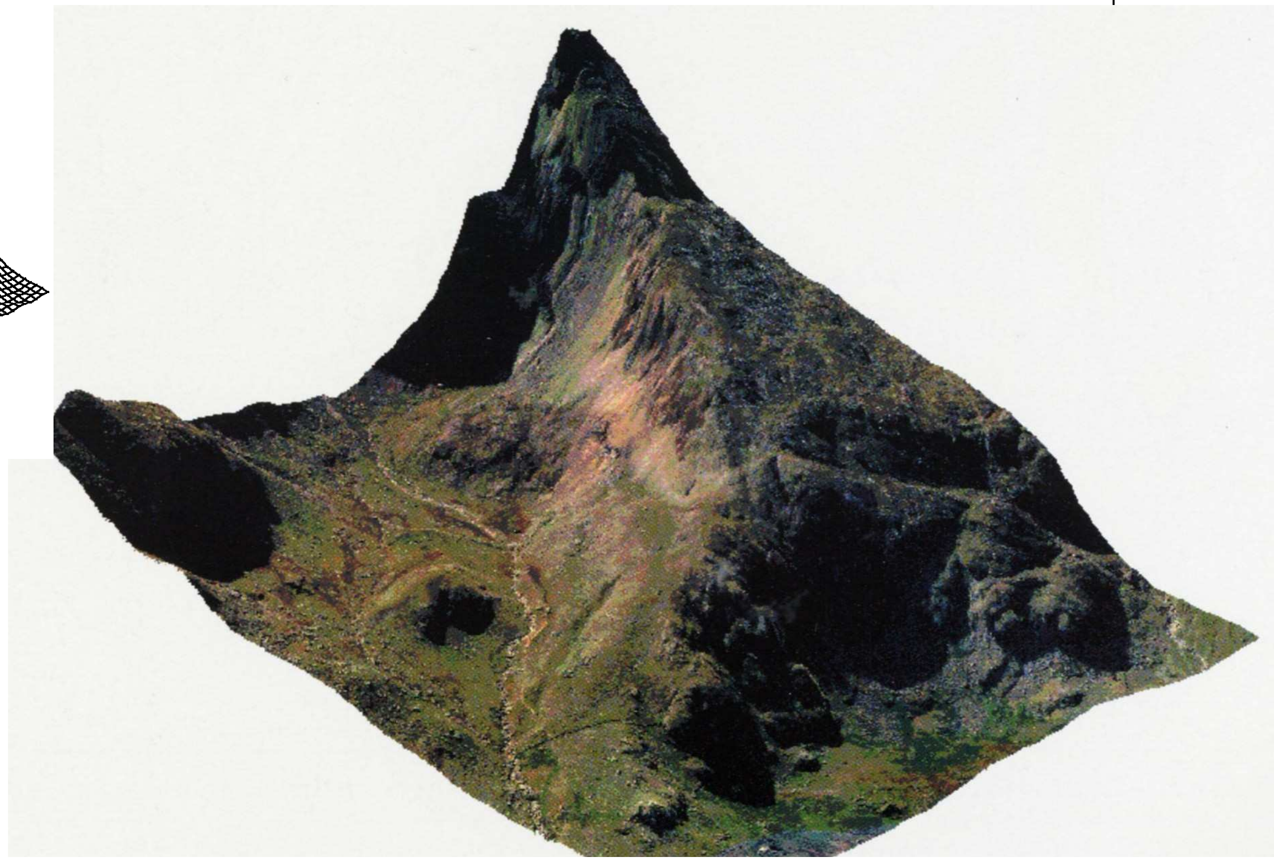
Digital elevation model (image of elevation) displayed as wire-frame ‘2.5-D’ block diagram



Orthorectified aerial photo draped over DEM, Snowdonia National Park (Heywood et al)

A digital elevation model (DEM) contains x, y ,z data (z = height)
DEMs can be created from a range of data sources too (e.g. maps, GPS, RS)

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Table 1. The 20 universal GIS operations

Search:	*Interpolation*	*Thematic Search*	*Spatial Search*	*(Re-)classification*
Location Analysis:	*Buffer*	*Corridor*	*Overlay*	*Thiessen/Voronoi*
Terrain Analysis:	*Slope/Aspect*	*Catchment/Basins*	*Drainage/Network*	*Viewshed Analysis*
Distribution/ Neighborhood:	*Cost/Diffusion/Spread*	*Proximity*	*Nearest Neighbor*	
Spatial Analysis:	*Multivariate Analysis*	*Pattern/Dispersion*	*Centrality/Connectedness*	*Shape*
Measurements:	*Measurements*			

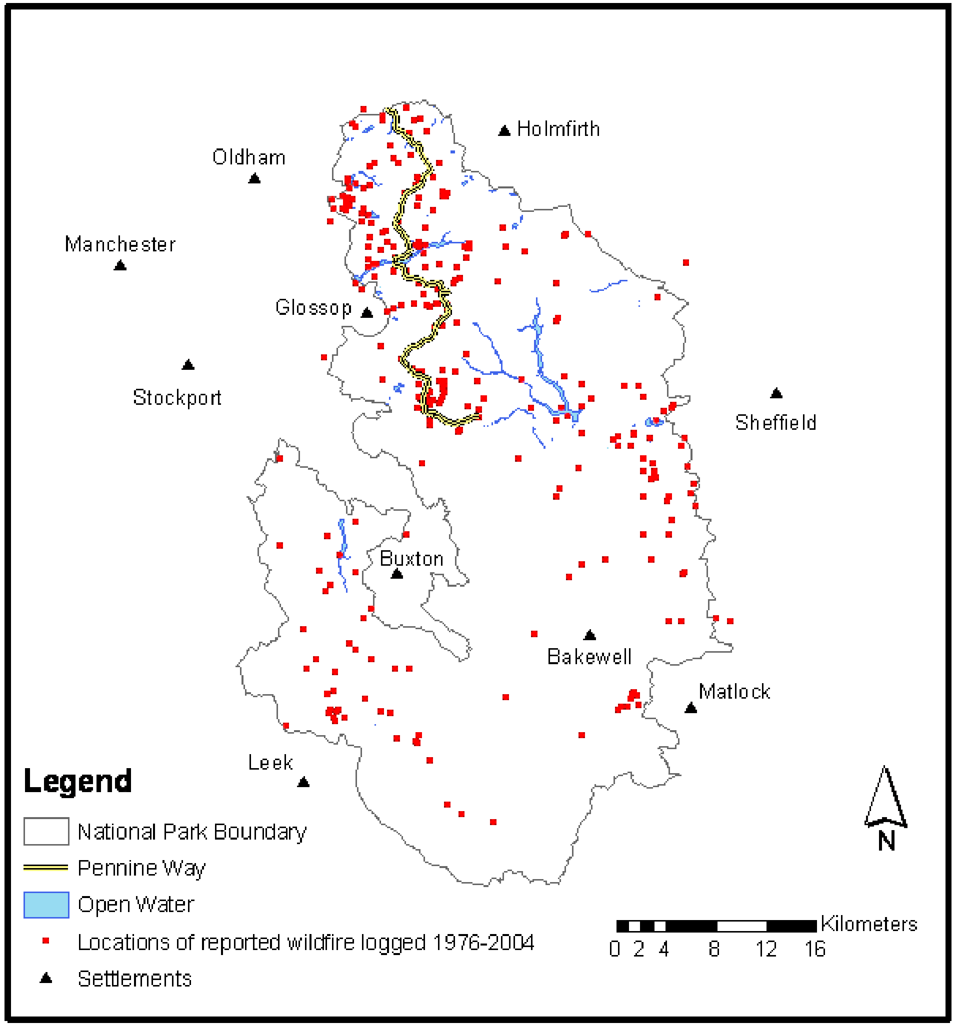
"*The true potential value of GIS lies in their ability to analyse spatial data….Spatial analysis provides the value-added products from existing datasets*" (Goodchild, 1988)

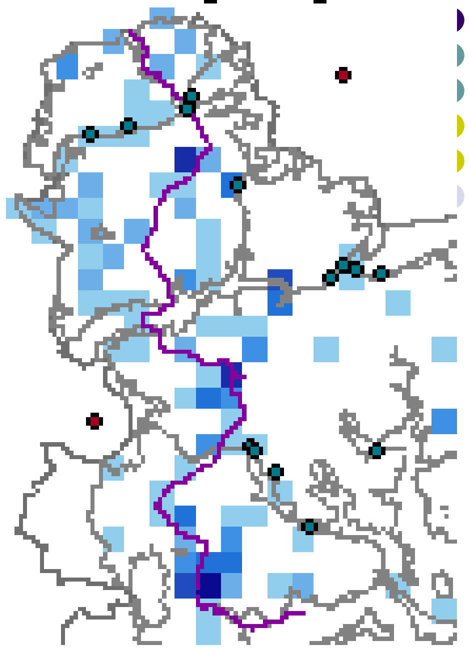
Albrecht (2005) http://www.ncgia.ucsb.edu/conf/SANTA_FE_CD-ROM/sf_papers/jochen_albrecht/jochen.santafe.html

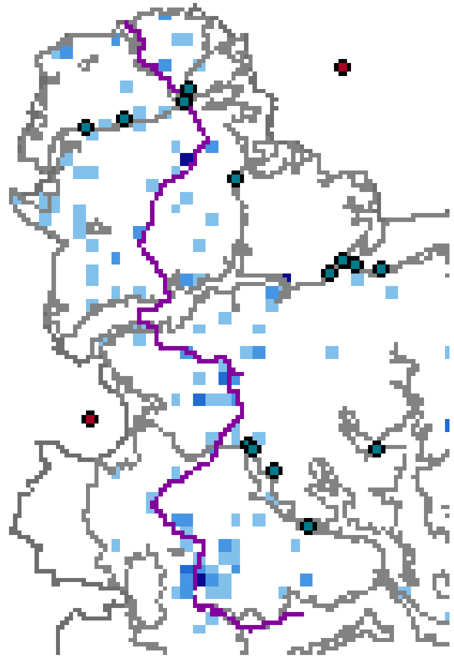
Example techniques & their application

- Data manipulation
  - Density estimation (MFF fire risk estimation, work with Julia McMorrow, Geography)
    - number of discrete objects per unit area
    - A means of going from object-based → 'continuous' measure
    - Examples of point and line density measures
- Analysis techniques
  - Network analysis (Anna Mölter, PhD student)
    - Estimating shortest paths
- Overlay analysis
  - MCE/MCA (MFF fire risk)
- Case study
  - Historical GIS for material flow analysis (Hiroki Tanikawa, visiting research fellow in Geography, 2005)

Density estimation (point)







Point density estimation via kernels

Figure 4-41 Point data

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
						X	X	X			X		X						
0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20

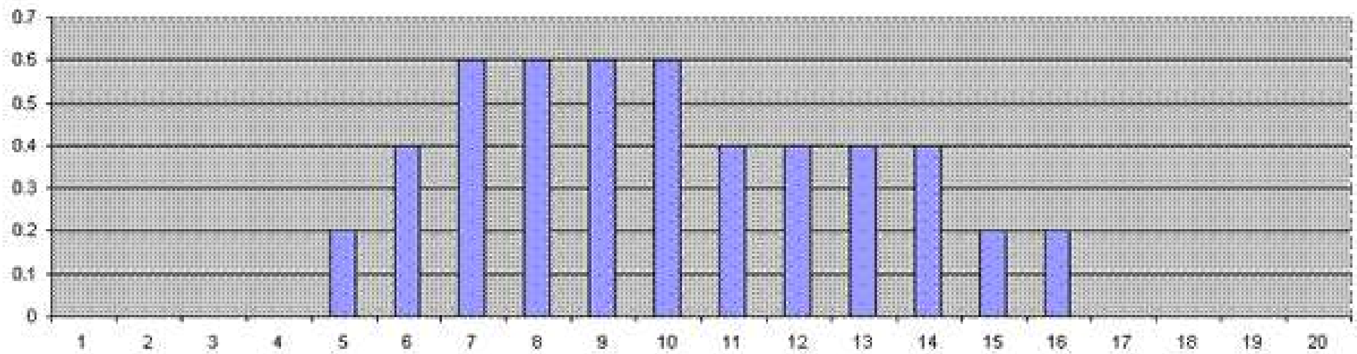
5/20=0.25 pts per unit length

3/10=0.3pts/unit or 2/10=0.2 p/u

Figure 4-42 Simple linear (box or uniform) kernel smoothing

						X	X	X			X		X						
				0.20	0.20	0.20	0.20	0.20											
					0.20	0.20	0.20	0.20	0.20										
						0.20	0.20	0.20	0.20	0.20									
									0.20	0.20	0.20	0.20	0.20						
											0.20	0.20	0.20	0.20	0.20				
				0.20	0.40	0.60	0.60	0.60	0.60	0.40	0.40	0.40	0.40	0.20	0.20				
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

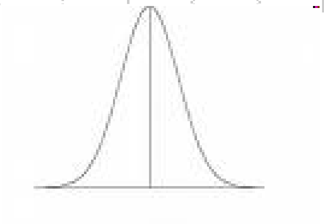
Spreading the influence of each point allows a relative density to be calculated



http://www.spatialanalysisonline.com/output/html/Pointdensity.html

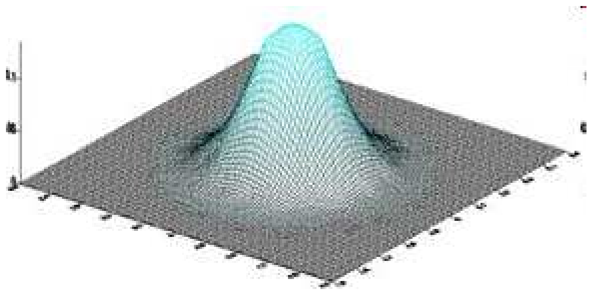
Figure 4-42 Simple linear (box or uniform) kernel smoothing

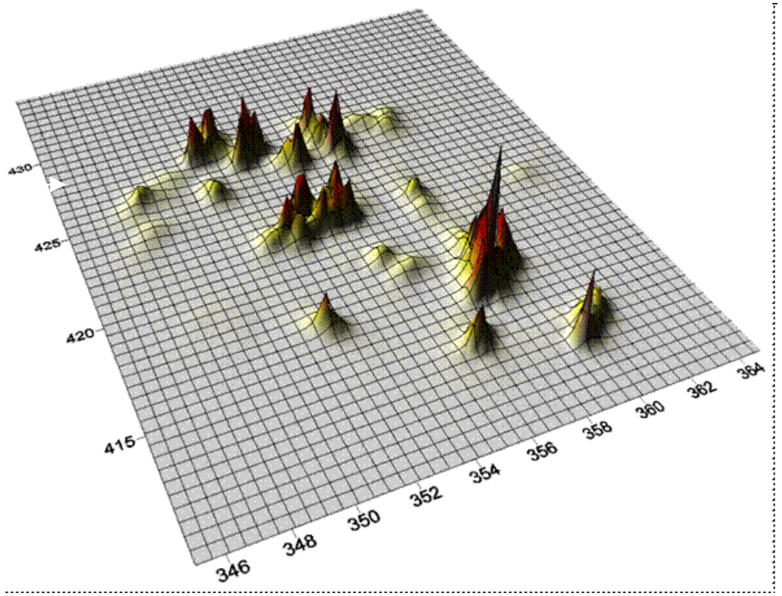
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
						X	X	X			X		X						
				0.20	0.20	0.20	0.20	0.20											
					0.20	0.20	0.20	0.20	0.20										
						0.20	0.20	0.20	0.20	0.20									
									0.20	0.20	0.20	0.20	0.20						
											0.20	0.20	0.20	0.20	0.20				
				0.20	0.40	0.60	0.60	0.60	0.60	0.40	0.40	0.40	0.40	0.20	0.20				



Spreading can be carried out via a normal distribution based kernel (highest weighting given to the centre of each point with reduced influence with increasing distance)

Moving to 2D, a more sophisticated representation of density can be calculated





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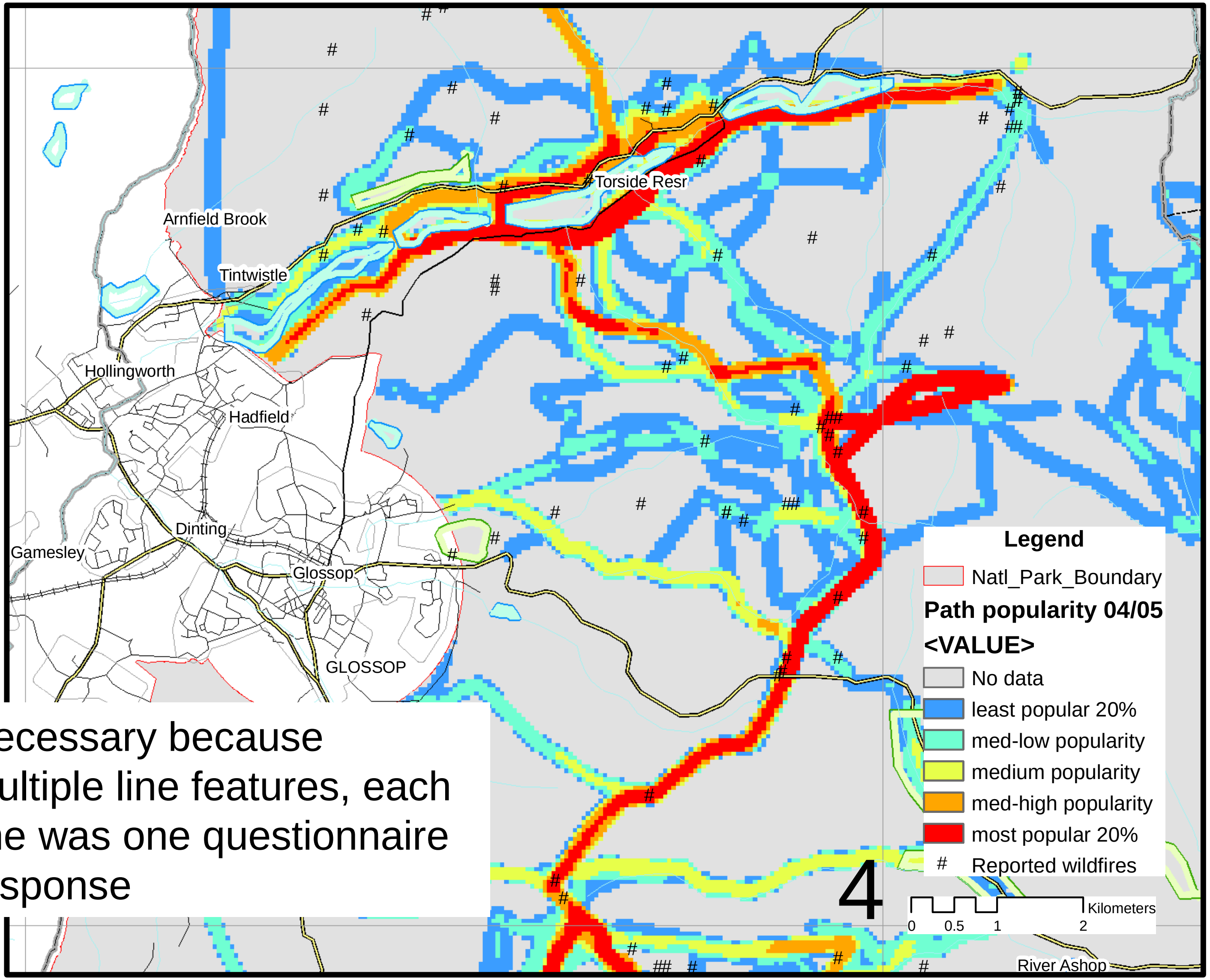
Relative path popularity Aug04 & Jan05 Bleaklow



Necessary because multiple line features, each line was one questionnaire response

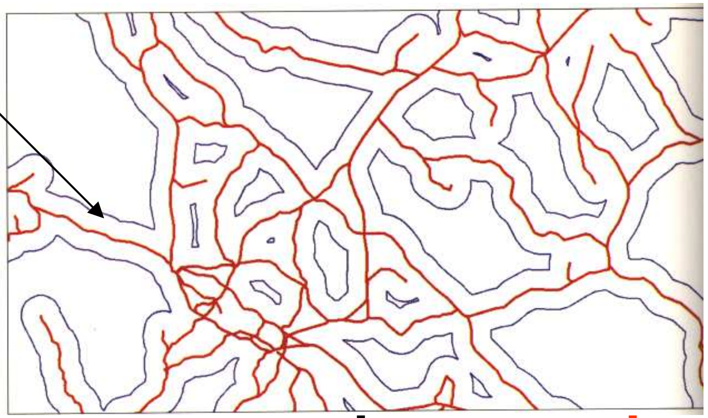
- Individual paths digitised from *'Mark your route on the map'* question in MFF Visitor attitude surveys
- A line density estimation procedure then used to look for relative density of paths → path popularity

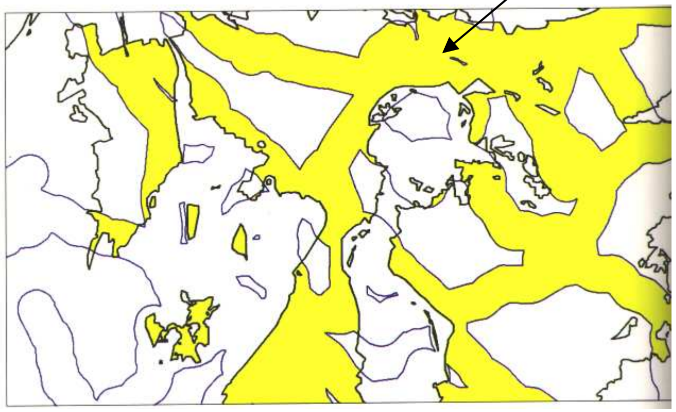
Overlay analysis for site selection

Waste disposal site selection

Within a certain distance of roads (distance buffers)

Within areas of clay soil/geology





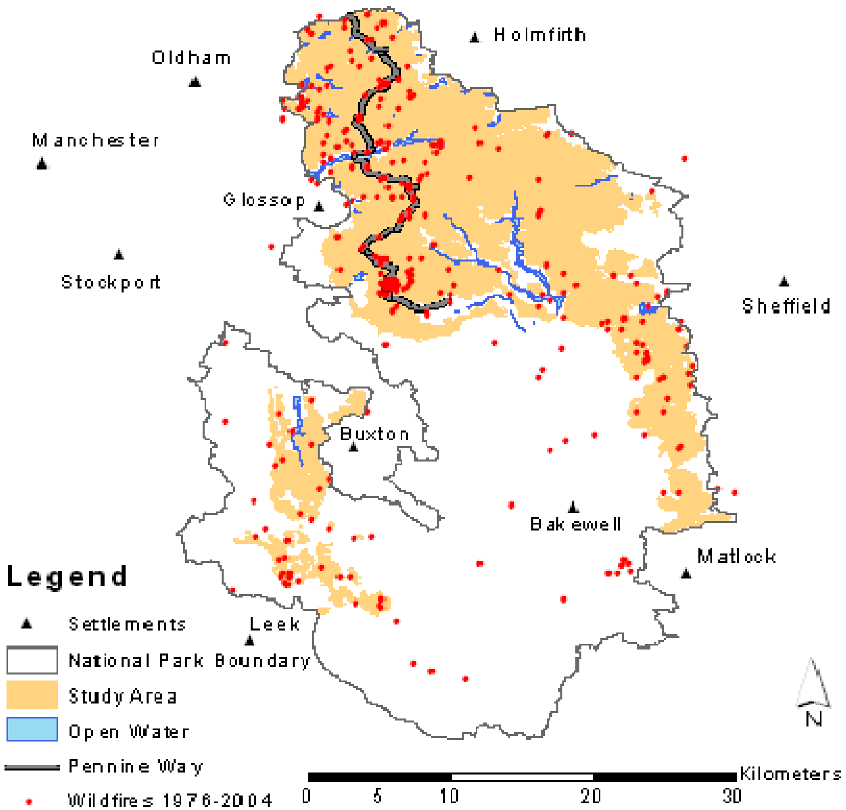
- Multi Criteria Evaluation → Criteria or *factors* as maps which can be *combined* to produce a solution

(a) Alternative 1

(b) Alternative 2

- Flexible methods
- ‘What if’ scenarios

Risk mapping : Which areas of PDNP are most at risk of ignition?



Based on:

- Where fires have been most common in the past; reported fires in Rangers' fire log, 1976-2004
  - Expert opinion: FOG and other stakeholders

Peak District National Park

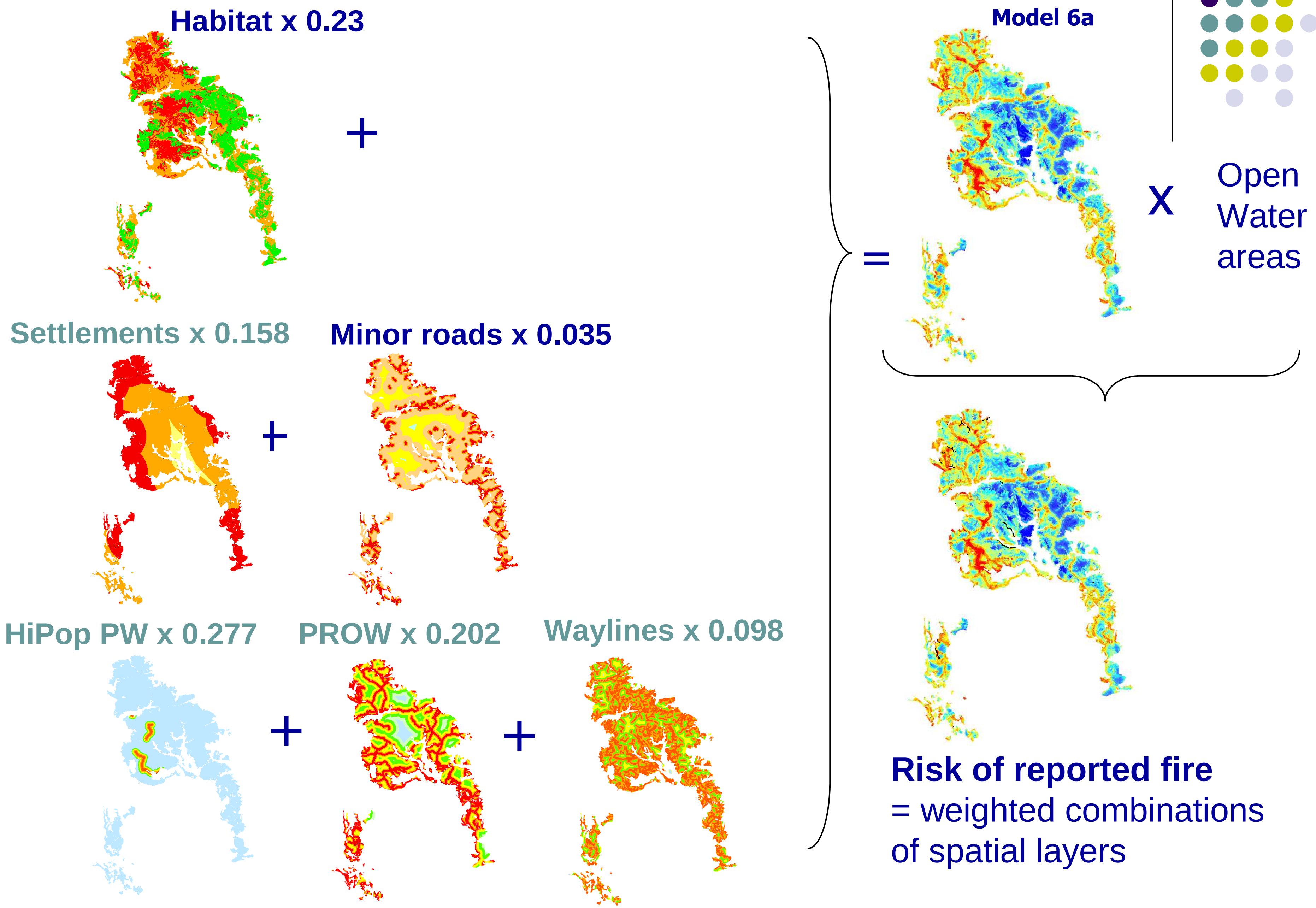
Severn Trent Water | Chatsworth | The National Trust | National Park Ranger Service | United Utilities

Cheshire Fire Service | Derbyshire Fire Service | Greater Manchester Fire Service | South Yorkshire Fire Service | Staffordshire Fire Service | West Yorkshire Fire Service

Fire Operations Group

Aim: To develop a stakeholder-informed map of the risk of wildfire ignition for Section 3 moorlands of Peak District National Park

Scoring & weighting factors



Risk of reported fire
= weighted combinations of spatial layers

Network analysis example

- Network routing
  - Find optimal path from A to B
    - Traveline journey planner → public transport
- Network allocation
  - Area covered by supply centres
    - Emergency Services
    - Delivery depots
- Research application
  - Effect of air pollution on children's health
  - Estimate children's exposure at home, school, journey using geocoded home and school addresses
- Aim:

  Determine shortest route between home and school

Slides courtesy of Anna Mölter, PhD student, Centre for Occupational and Environmental Health

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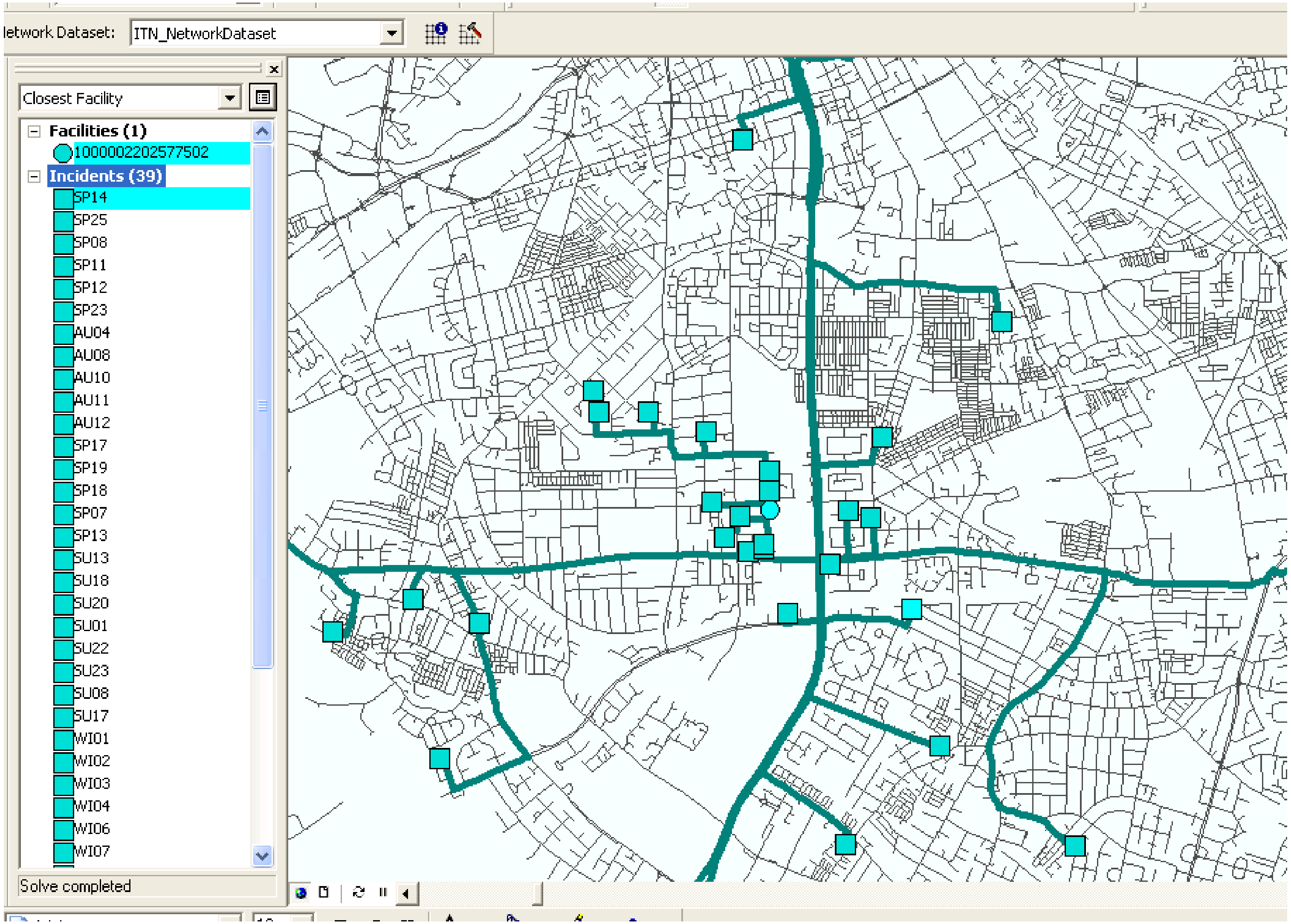
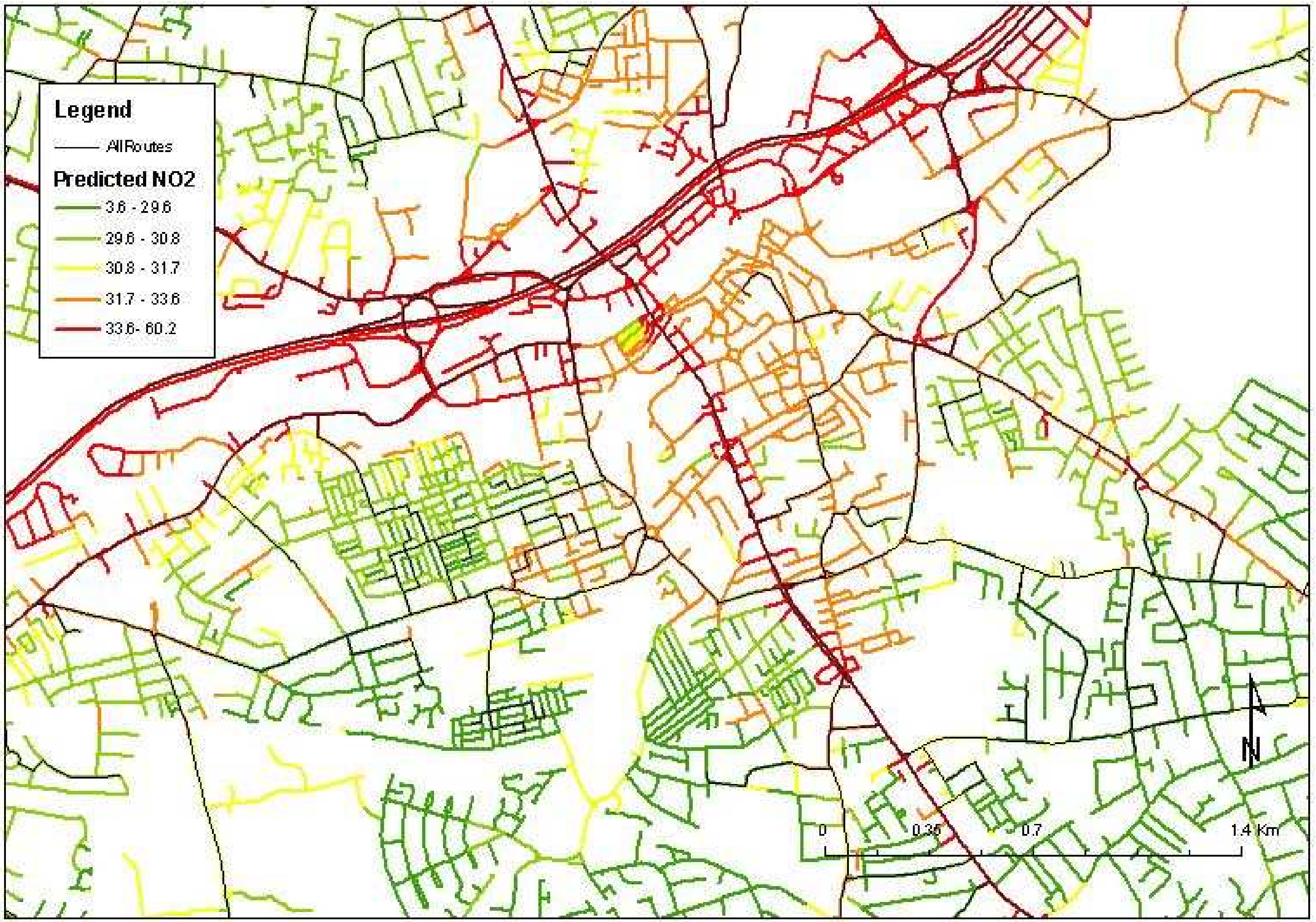
Example: Multiple homes → 1 school



Slides courtesy of Anna Mölter, PhD student, Centre for Occupational and Environmental Health

Estimated NO_2 concentrations related to the road network



Slides courtesy of Anna Mölter, PhD student, Centre for Occupational and Environmental Health

Spatial Estimation and Visualization of Regional MFA with GIS mapping

Hiroki Tanikawa

Associate Professor,
Wakayama University, Japan
Visiting Research Fellow,
The University of Manchester, U.K.

Nigel Lawson

School of Environment and Development, The University of Manchester, U.K.

Seiji Hashimoto

National Institute for Environmental Studies, Japan

Yuichi Moriguchi

National Institute for Environmental Studies, Japan

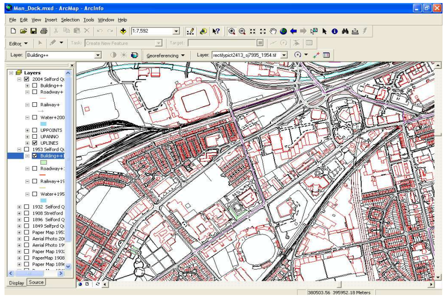
Contents:

- Linkage of Local MFA and Spatial Information
- How do we know Spatial Metabolism?
- **Case study of Construction Sector, U.K**. and Japan

For establishing Historical GIS…

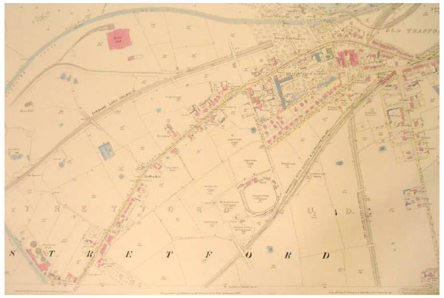
Current GIS

1/2500
2004



Paper Maps

1/2500
1849 - current

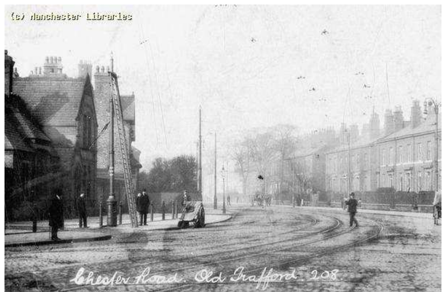


Aerial Photos

1920 – current

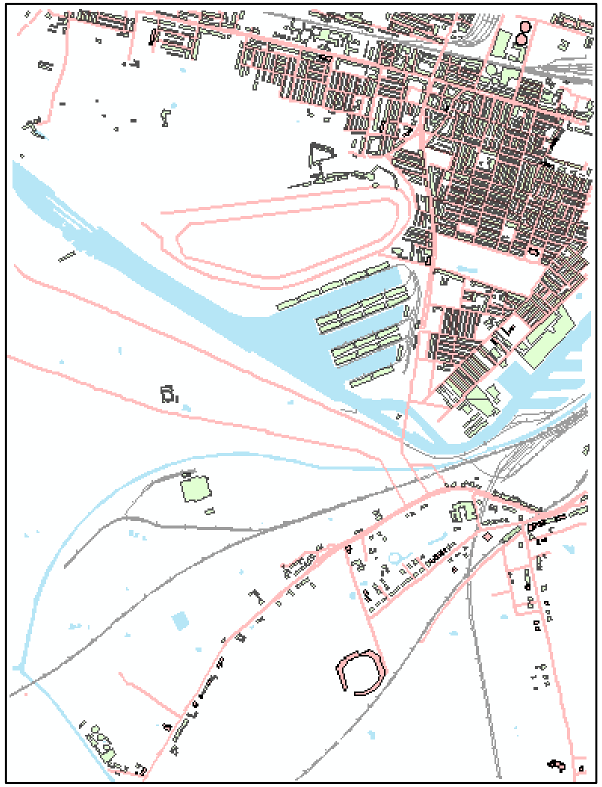
Other Photos and Picture

1850 - current



2.4 km

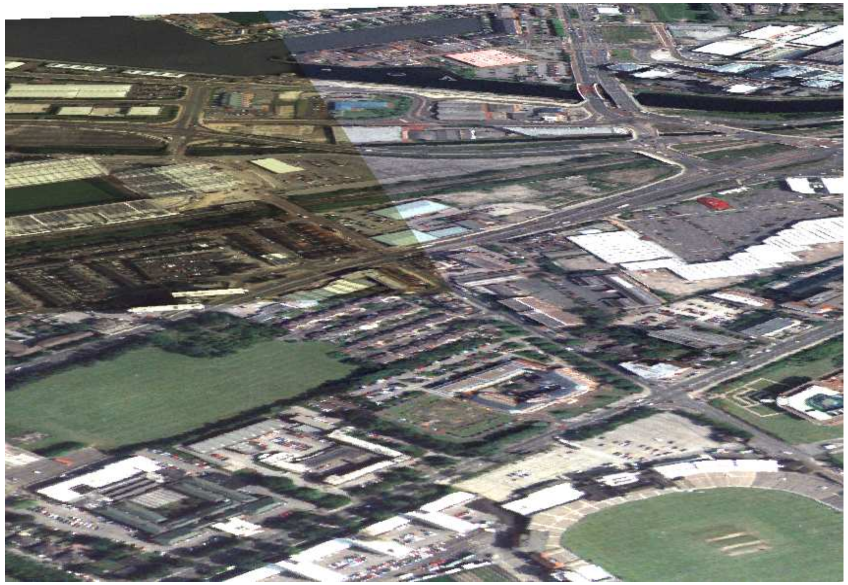
7.7 km^2



3.2 km

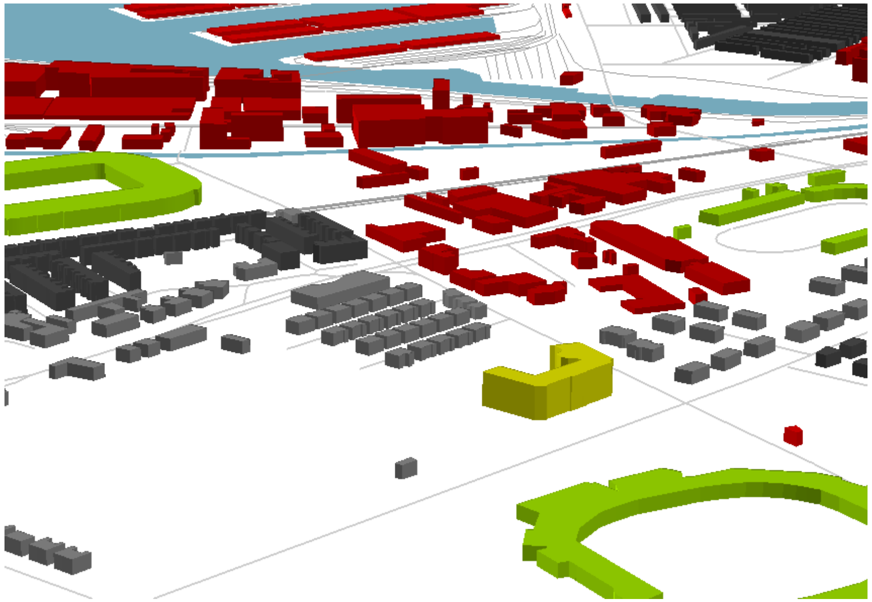
Drawing each shape and adding some attributes of “Urban Morphology Types”, “Floors of each Building”, “Width of Roadways”.

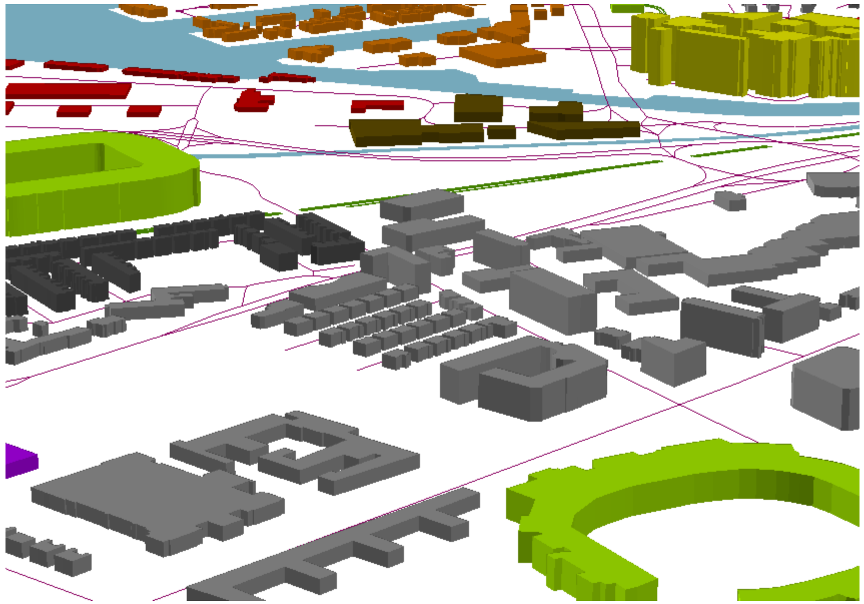
Old Trafford, Stretford Town Hall by GIS database



1932

2004





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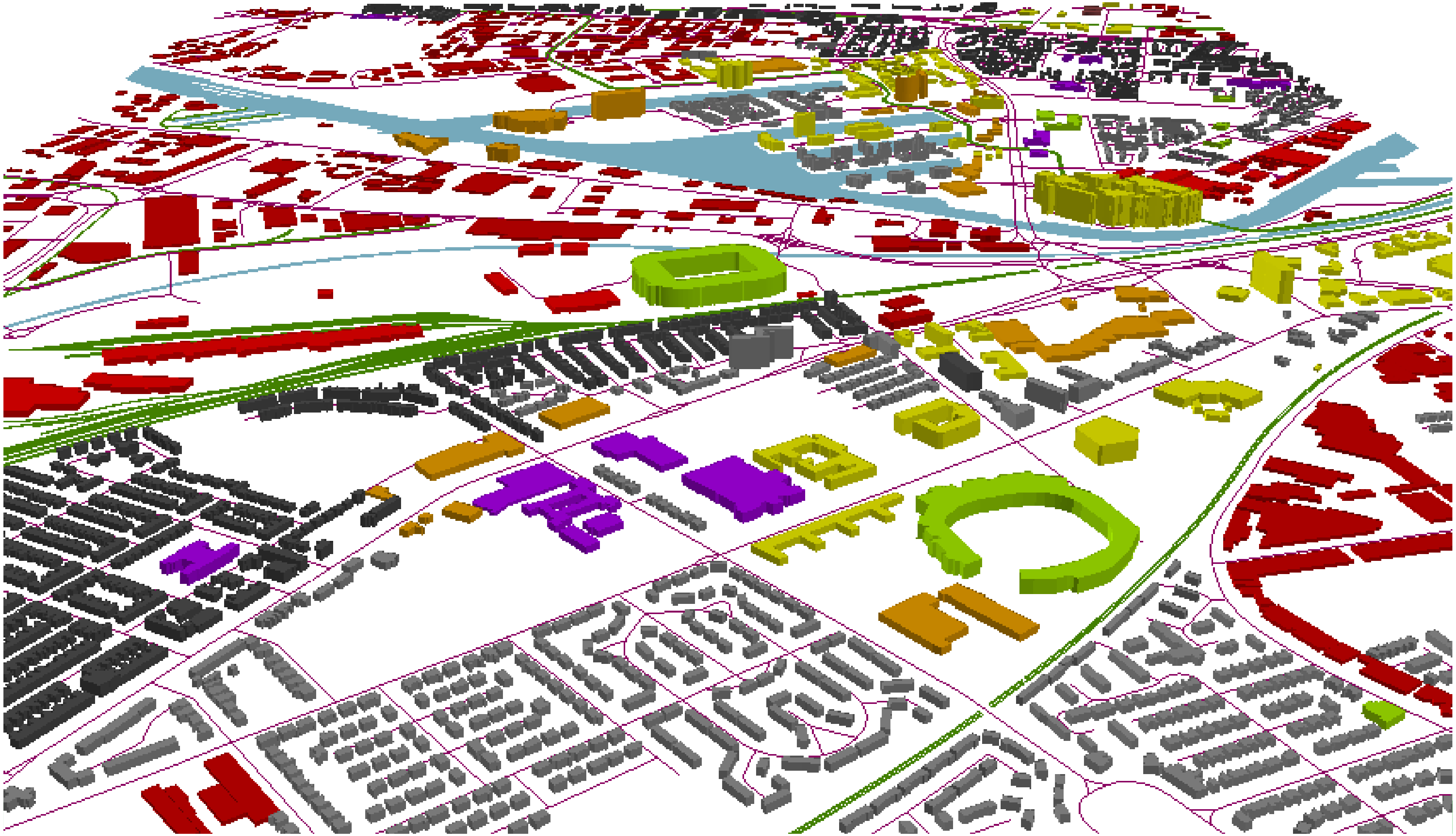
Historical 3D GIS database
Salford Quay and Old Trafford 2004



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Historical 3D GIS database
Salford Quay and Old Trafford 1990

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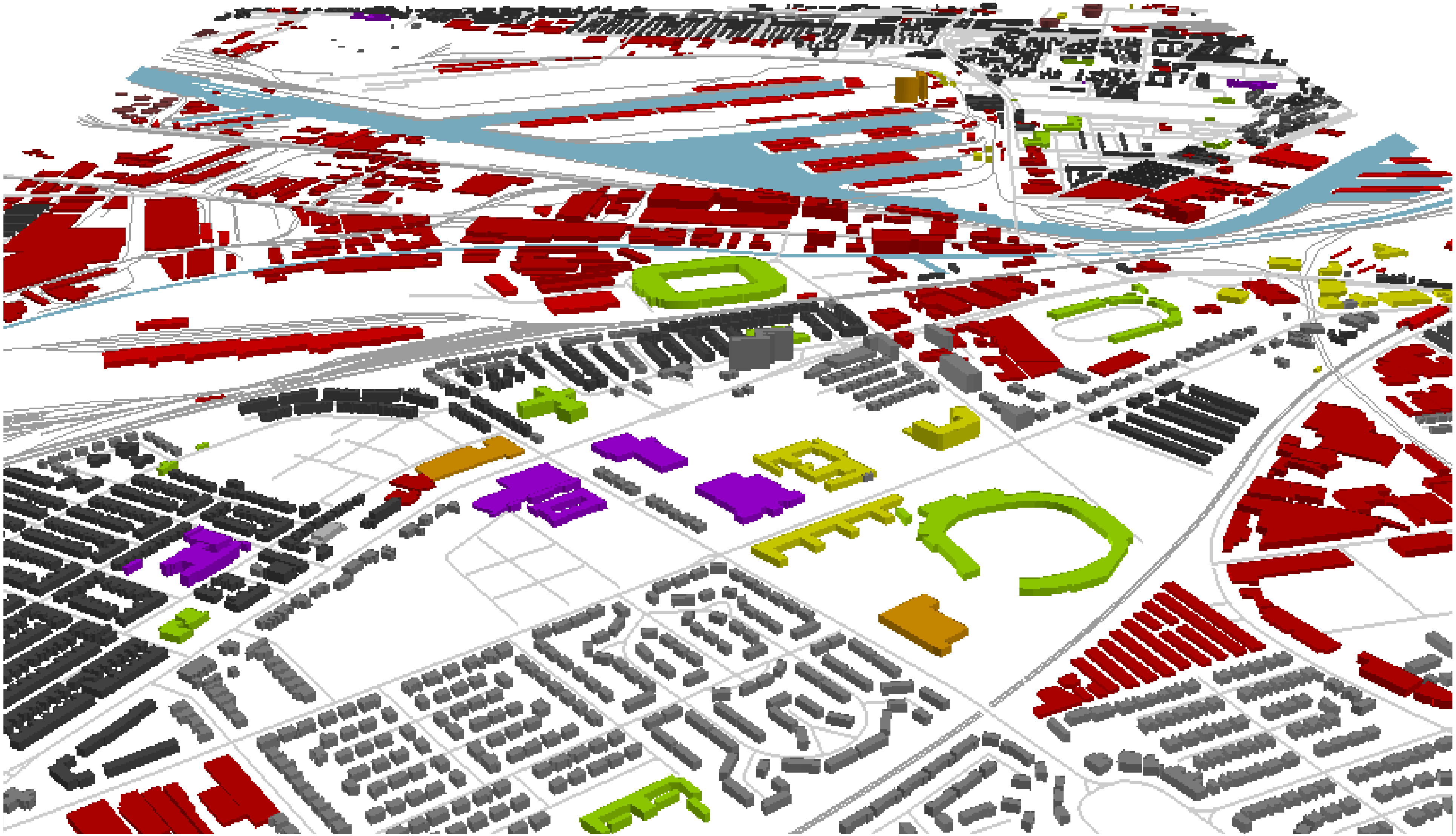
Historical 3D GIS database
Salford Quay and Old Trafford 1980



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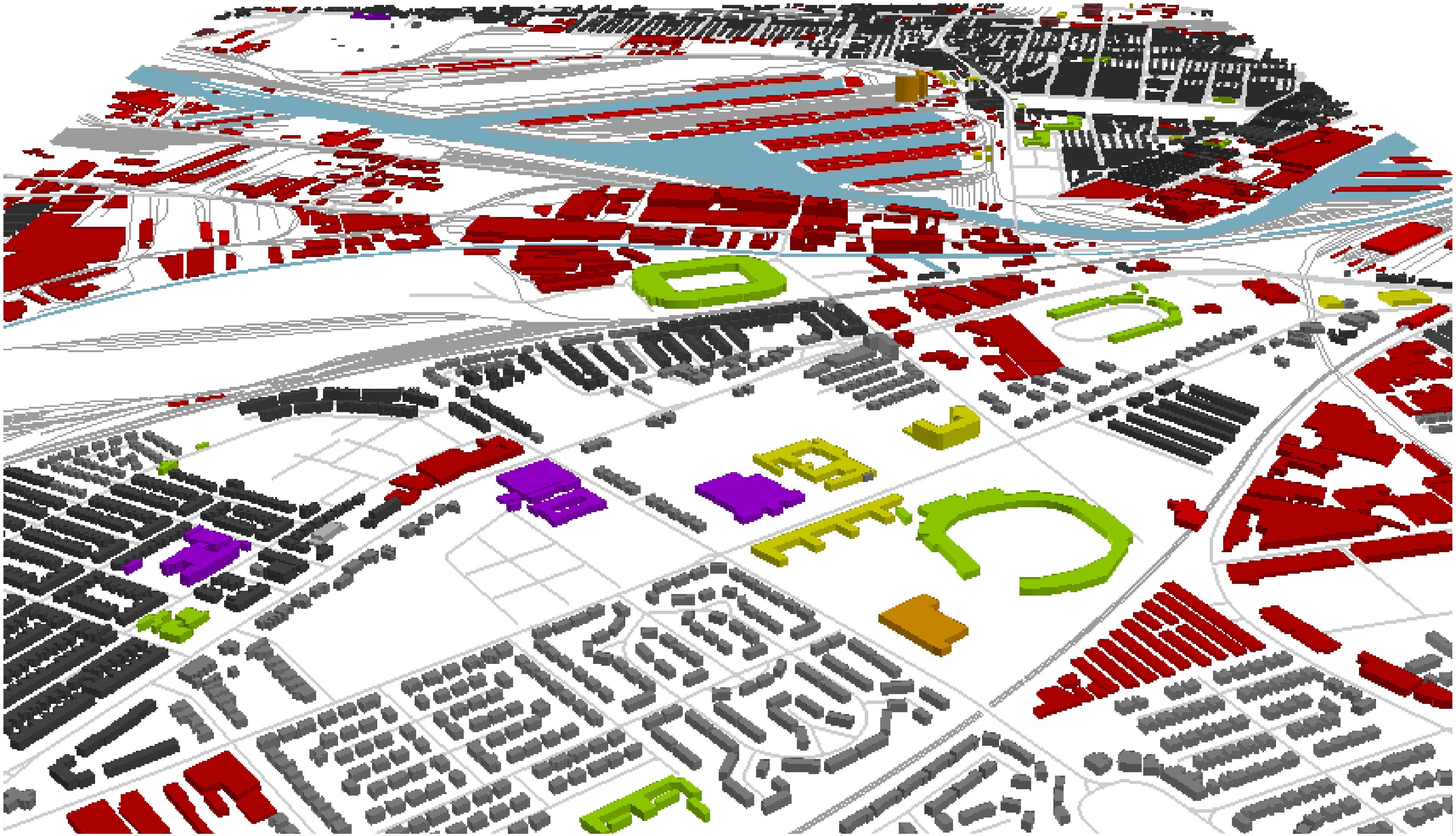
Salford Quay and Old Trafford 1972



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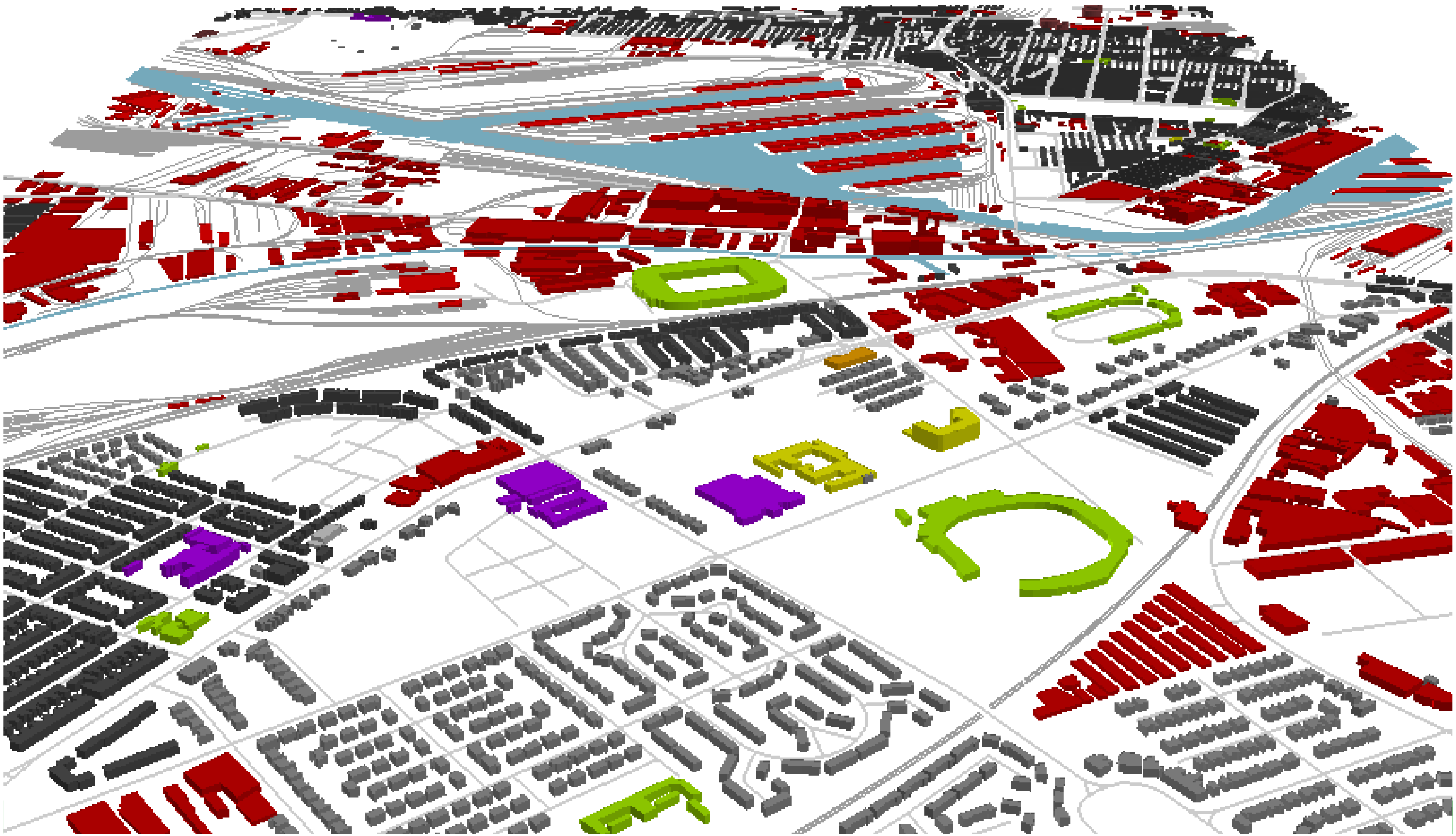
Historical 3D GIS database
Salford Quay and Old Trafford 1953



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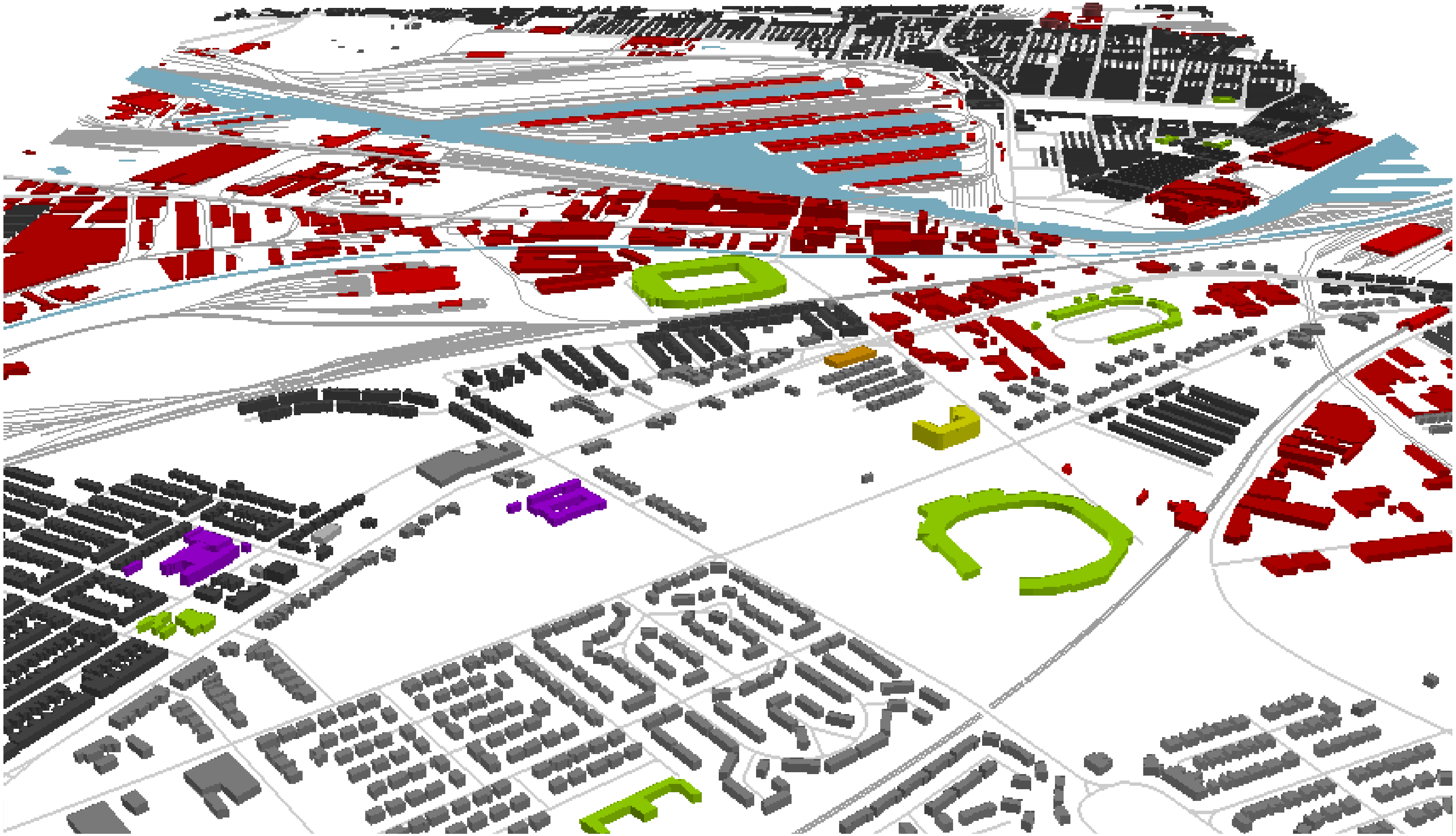
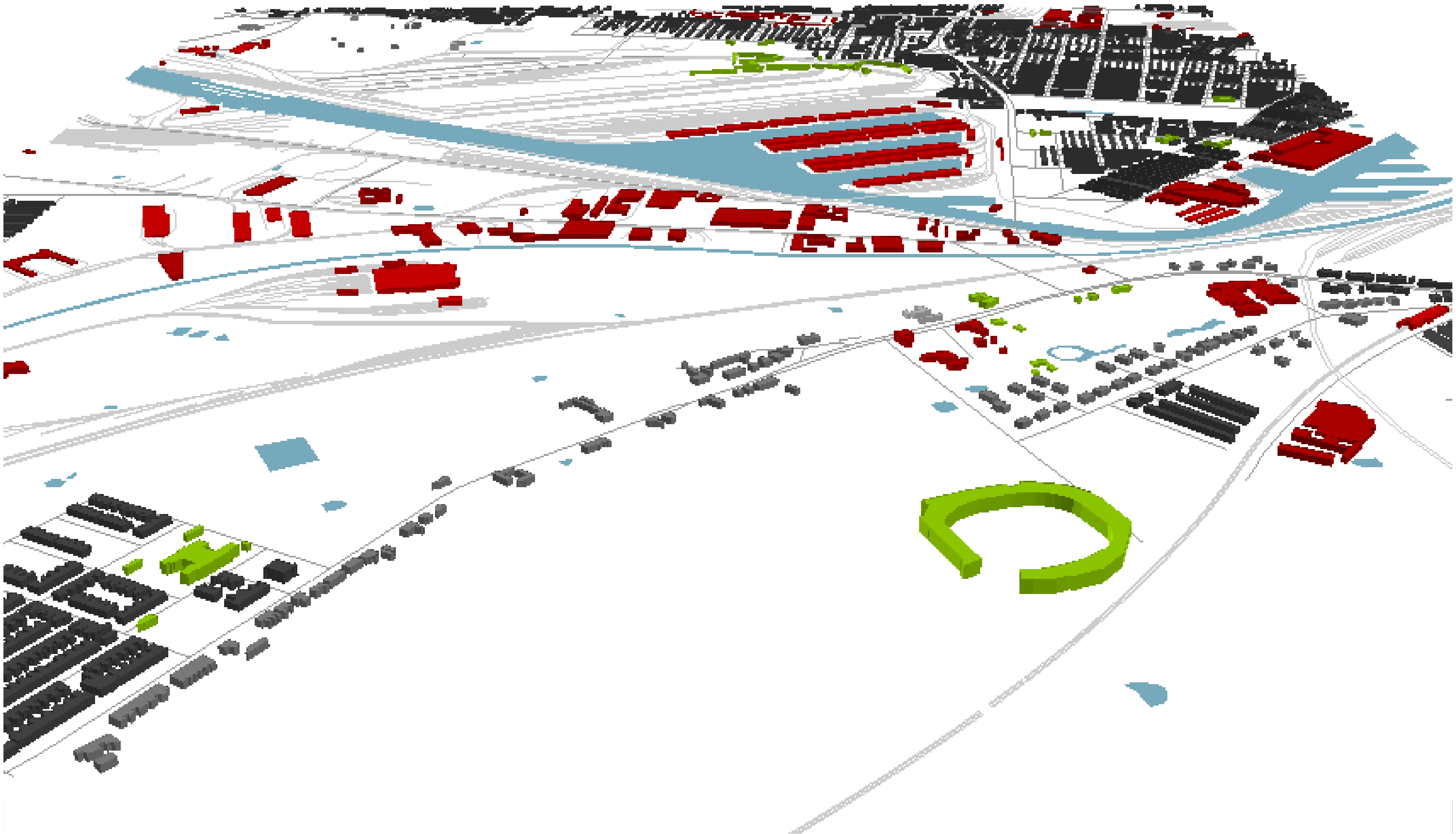
Historical 3D GIS database
Salford Quay and Old Trafford 1932



Historical 3D GIS database
Salford Quay and Old Trafford 1908



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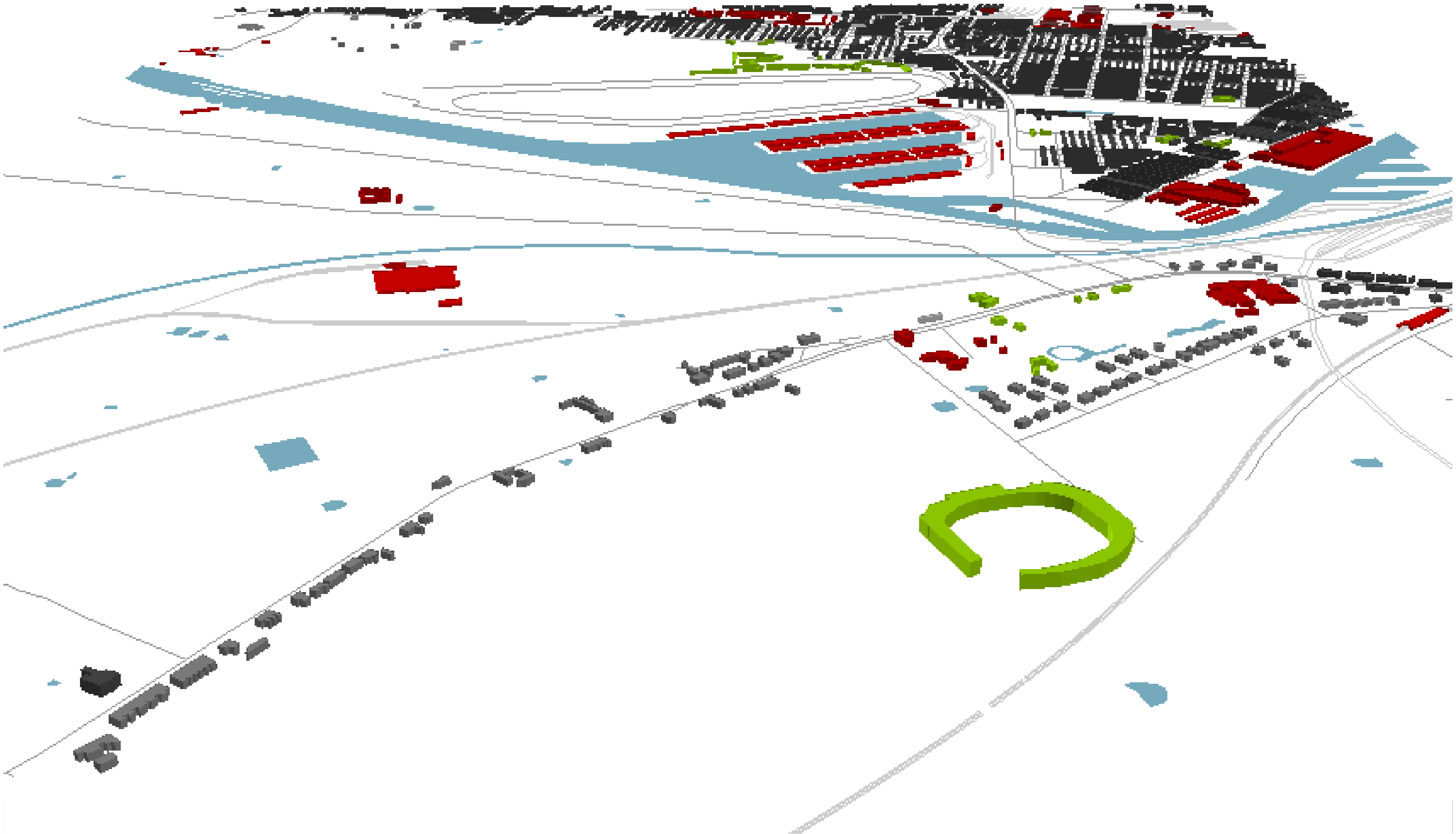
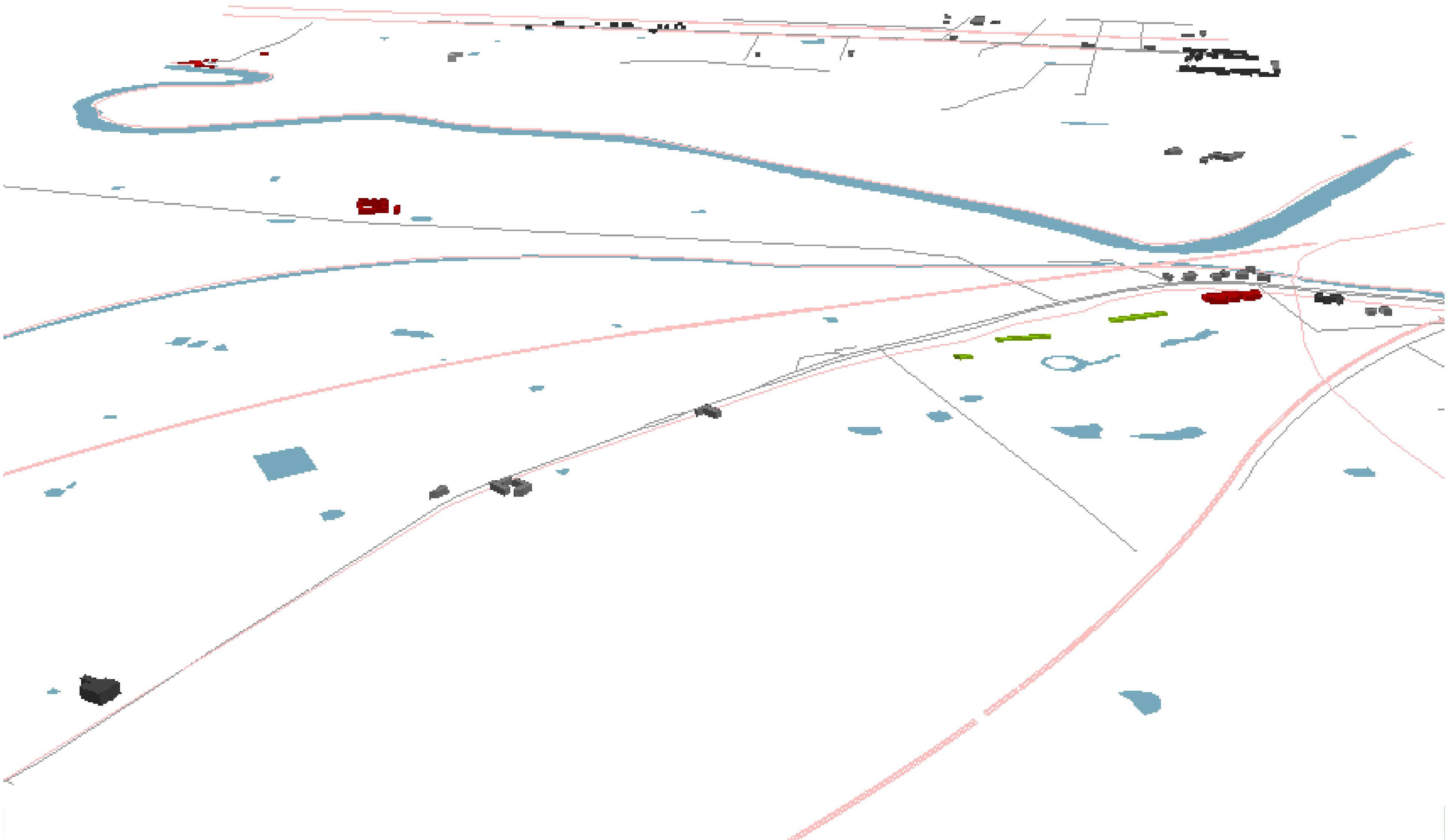
Historical 3D GIS database
Salford Quay and Old Trafford 1896



Historical 3D GIS database
Salford Quay and Old Trafford 1849



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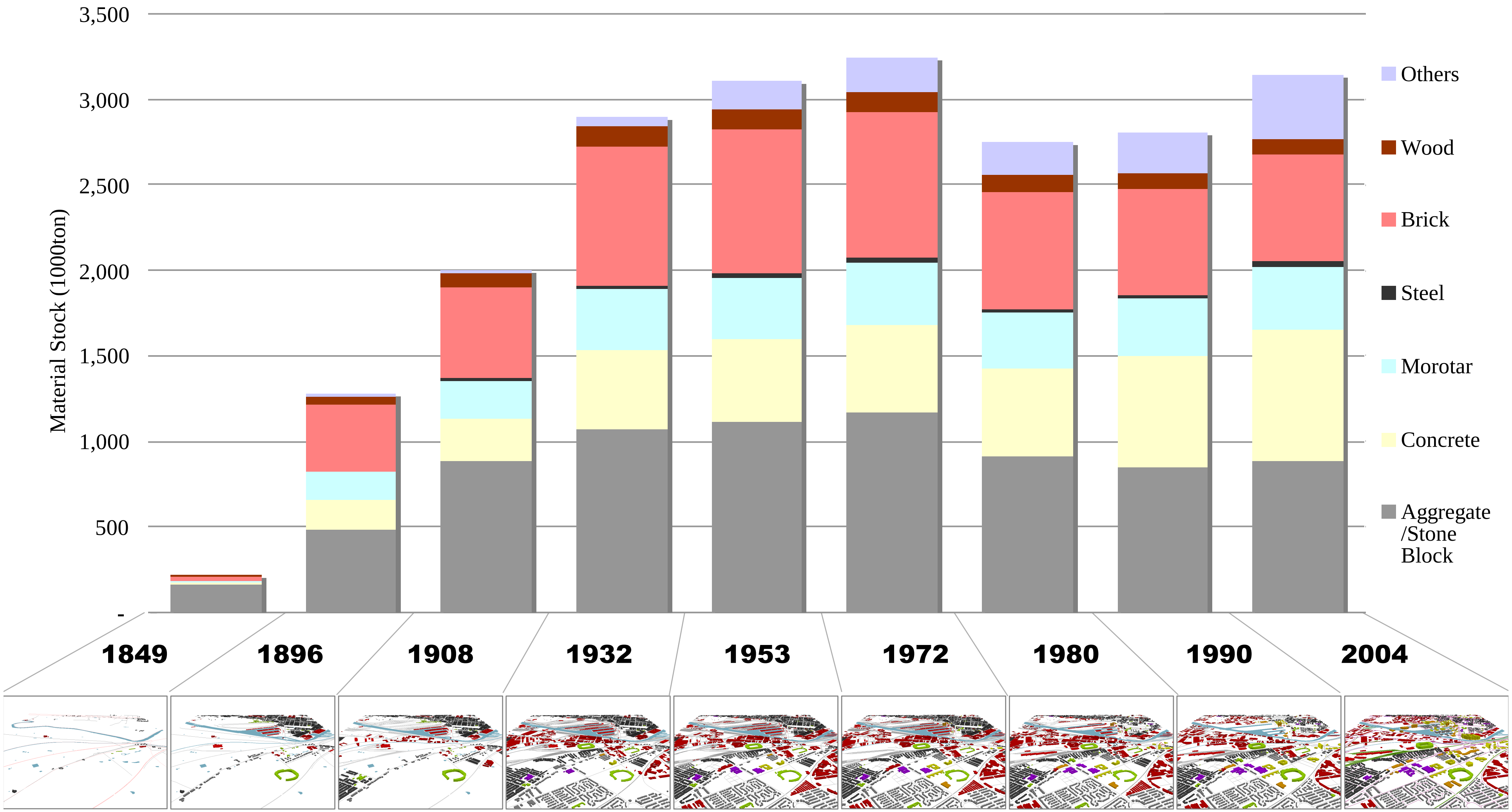
Historical Change of Material Stock #2 by construction material

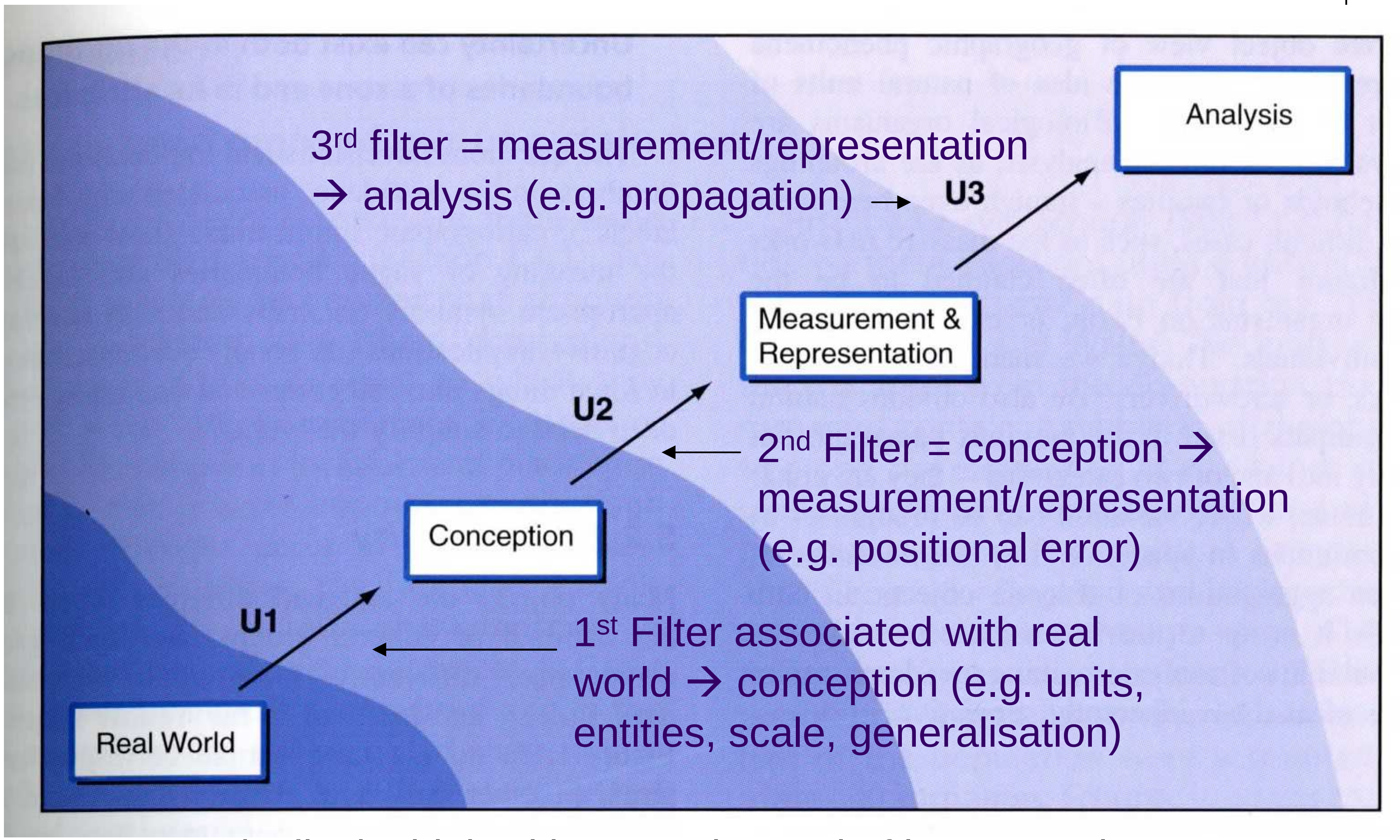


In 2004, Aggregate and Stone Block is 28%, 24% of Concrete, 20% of Bricks.

Conclusion

- GIS/GISc is associated with many methods and many exciting opportunities for interrogating and analysing spatial data
- However, methods must (of course!) be used with care
  - Whose view?
  - Individuals vs. groups?
  - Ethics?
  - Too technology led?
  - Too positivist?
- Indeed, “Many geographers remain suspicious of the use of GIS in geography” Longley et al (2001:25)
- *Reflective* use is key!

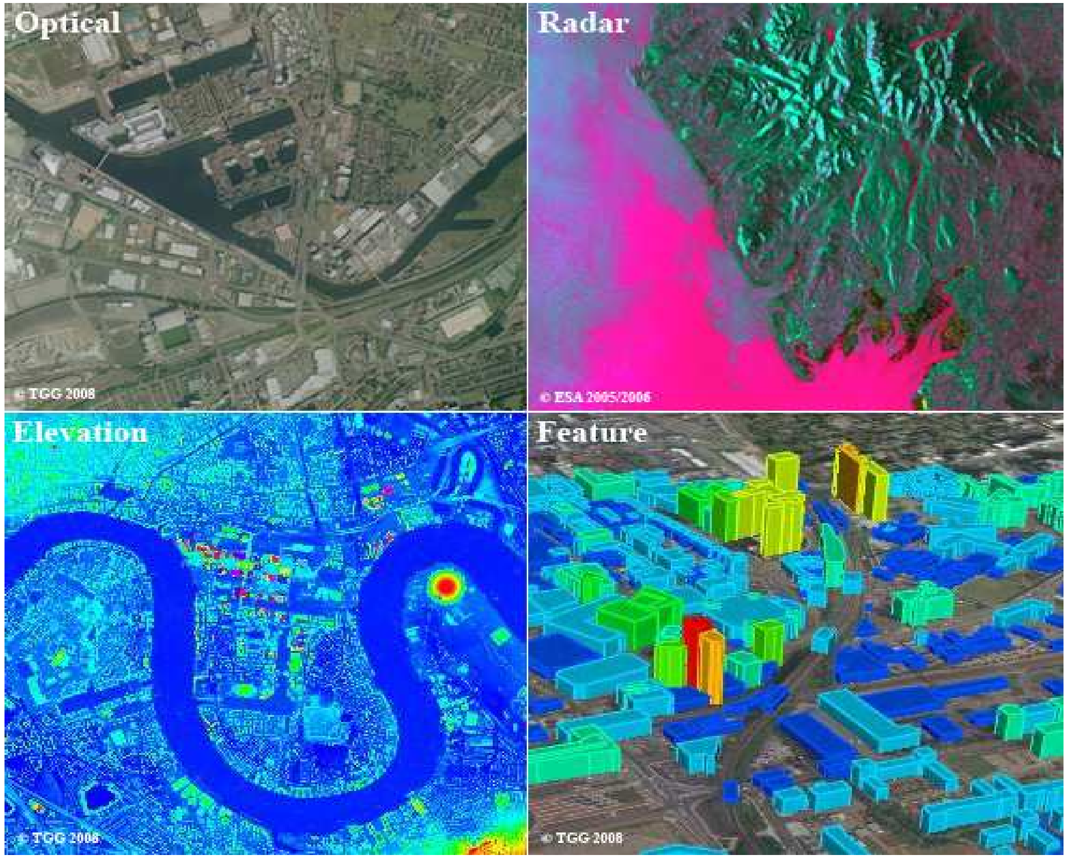
Conceptual view of uncertainty



- Berry (online) "think with maps" instead of just "mapping."

More information

- Some starter references are given at the end
- Courses
  - MSc Geographical Information Science
  - ESRI (ArcGIS) online training
- Academic data services
  - EDINA
  - Landmap
- Support
  - School of Environment and Development Spatial Data Officer



http://landmap.mimas.ac.uk/

Landmap is a free UK academic data service, based in the University of Manchester…please use it!

GIS support services

- Short consultancy - e.g. on project start-up and data sourcing. Contact Karl Hennermann.
- Software. Our main software is ESRI ArcGIS Desktop. For download from IT Services website.
- ArcGIS software support. Contact IT Service Desk.
- ArcGIS training (online). Provided by ESRI. See IT Services software website.
- Geospatial data, e.g. administrative boundaries. Provided by EDINA Digimap. See EDINA Digimap website
- Equipment loan (GPS, etc) . Contact Karl Hennermann.

Paid for services, provided by SED:

- Consultancy
- Data processing and map production
- System analysis, design and implementation
- Instructor led training
- GIS project management

Contact Karl Hennermann about these services.

Further information:

Karl Hennermann, 0161 275 3655, karl.hennermann@manchester.ac.uk

Further reading

- Heywood, I, Cornelius, S & Carver, S. (2006) An Introduction to Geographical Information Systems' Third edition, Prentice Hall : Harlow. [Basic introductory text]
- Longley, P. Goodchild, M and Rhind, D. (2005) Geographic Information Systems and Science John Wiley and Sons : Chichester
- Schuurman, N (2000) Trouble in the heartland: GIS and its critics in the 1990s *Prog in Human Geog* 24,4 pp. 569–590
- http://www.innovativegis.com/basis/
- http://www.spatialanalysisonline.com/