Secondary Geography

Using GIS

in geographical enquiry

FSC
Bringing Environmental Understanding To All

www.geography-fieldwork.org/gis
for technical help in using GIS and data sets to explore

Introduction and planning

Planning a geographical enquiry, but not sure where to begin? Geographical Information Systems are a great source of secondary data to help find topics and places to investigate. No matter what your starting point, GIS can help you to choose a location, ask enquiry questions, and carry out *contextualising research.*

What is GIS? Geographical Information Systems (GIS) are designed to capture, store, manipulate, analyse, manage and display spatial data.

▶ An example of a GIS: the Datashine website www.datashine.org.uk. The map shows 2011 census data for a rural settlement.

- What features do you notice?
- What geographical questions could you ask?
- How could you investigate this further?

"I know where I'm going, but don't know what to investigate"

- Your teacher has given you a fieldwork destination, or you are doing fieldwork locally
- You know the area you are visiting (e.g. Guildford), but haven't chosen the area(s) your question will focus on (e.g. North Street)
- You need to identify a topic for your enquiry

GIS gives access to maps and aerial photos at several scales and for many different topics. Start looking at maps of the area:

- What features do you notice?
- What do these features suggest?
- Can you see any links to geographical topics you have studied?

"I want to investigate this topic, but don't know the best place to do it"

- Your teacher has given you a free choice of fieldwork destination
- You have an idea of a topic that your question will focus on (e.g. inequalities between places)
- You need to choose a fieldwork destination, and smaller area(s) to focus your question on

GIS gives access to data for many different topics. Start looking at secondary data sets related to your chosen topic:

- What patterns do you notice?
- Do any places show interesting characteristics?
- Are there any contrasting areas close to each other?

"I know we are going here, and I want to investigate this topic"

- Your teacher has given you a fieldwork destination, or you are doing fieldwork locally
- You know the general area you are visiting but haven't chosen the area(s) to focus on
- You have an idea of a topic that your question will focus on

You might have reached this point from one of the two other starting points.

Use GIS to carry out contextualising research relating to your chosen topic and location.

Research should help you understand the location in enough detail to generate sensible questions or hypotheses, based on geographical theory AND some relevant understanding of what the location is like.

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Methods and data collection

Good fieldwork data collection is well planned. The special feature of GIS is that each piece of data is tied to a particular location. So GIS can help you plan both where you will collect data and how you will collect data. To get the most of out GIS, there are a few technical terms that it is useful to know.

Data Observations and recordings.

Location type In GIS each piece of data is tied to a particular location. There are three possible types of location: *Point* or *Line* or *Area*. Your data collection might use a combination of these.

Location format Details of the *Location type*.

Attribute type How GIS software describes data formats: *Integer*, *Float*, *String* or *Date*.

Location type	Example
POINT A single location	Locations of individual trees
LINE Several linked points in a known order	Route taken through a town for a dérive
AREA Several linked points in a known order to form a closed shape	Area of uniform land use or Census Area

Using GIS to plan where you will collect data

Example of fieldwork	Location type	What location format?	Considerations
Sampling locations for pebble measurements chosen on map in the classroom (navigate to sampling point to collect data)	Point	Latitude and Longitude (Lat/Long) or Ordnance Survey Grid Reference	• Use GPS app or appropriate map to identify and navigate to locations • Need to convert OS Grid References to Lat/ Long for most GIS
Record the location and orientation of striations identified in the field		Full Postcode e.g. SY4 1HW	• Less error-prone than asking for name of place • Some GIS can use or you can convert to Lat/ Long online
Recording and mapping visitor response to '*Where have you come from?*' question			
Mapping severity of footpath damage within a sensitive area	Line	Latitude and Longitude or Ordnance Survey Grid Reference	• Record as a series of individual points, make sure you know the order • For areas ensure points form a closed loop
Mapping land use	Area	Census Output Area (or Super Output Area): MSOA (2000-6000 Households) LSOA (400-1200 Households) OA (40-125 Households)	• Identify Census areas to be studied in advance (using secondary data) • Ensure you have a map showing area boundaries
Assessing environmental quality as part of a study of deprivation	Area		

Using GIS to plan how you will collect data

What information you will collect	What data you will actually record	Attribute type
A count of the number of houses (or houses of a particular type) within an area	A whole number	Integer (or Short or Long)
Score based on an index, such as an environmental quality survey score		
The length of a pebble on a beach (or the mean length of a number of pebbles at a given point on a beach)	A number with a decimal point	Float (or Double or Decimal or Real)
Answers to a question within a questionnaire: 'Where have you come from?'	A set of characters of any type in any order (i.e. Text or text and numbers)	String (or Text)
A description of your mood		
1st May 1982 or 30th January 2017, 15:55:54	A date and/or time	Date

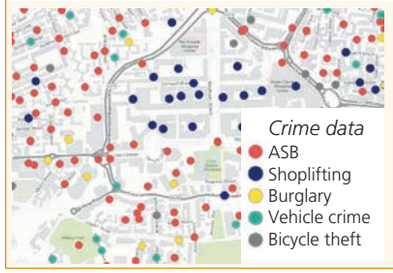
It is important to choose the right attribute type as it will impact on how you can present data in GIS.

Data presentation

Maps are a powerful medium for representing spatial relationships, but they can take a long time to draw by hand. GIS software can quickly draw a range of maps from your data, making it easy to pick the most appropriate map for your enquiry question and for the data type and location.

Categorical data: variables that are not numerical (e.g. land use, gender, ethnicity)

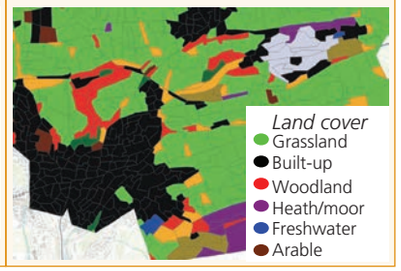
POINTS Map by colour or shape



LINES Map by colour or shape

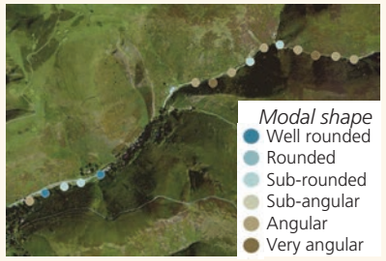
Visitor journeys to Shrewsbury

AREAS Map by colour

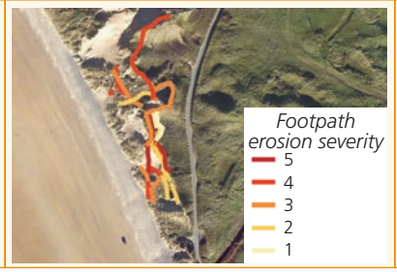


Ordinal data: variables where order matters but difference between values is not important (e.g. ranks like 1st, 2nd, 3rd)

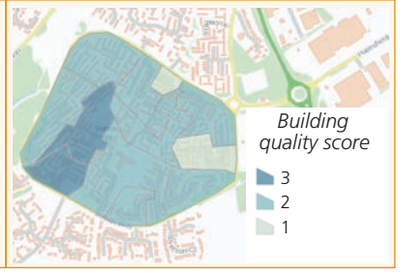
POINTS Map by shade or size using discrete categories



LINES Map by shade or size using discrete categories



AREAS Map by shade using discrete categories

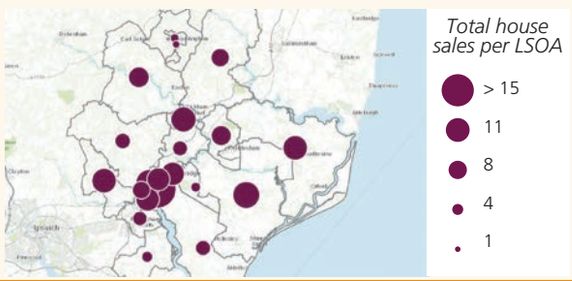


Numerical data: variables where the difference between values is important (e.g. distance in metres, time in seconds)

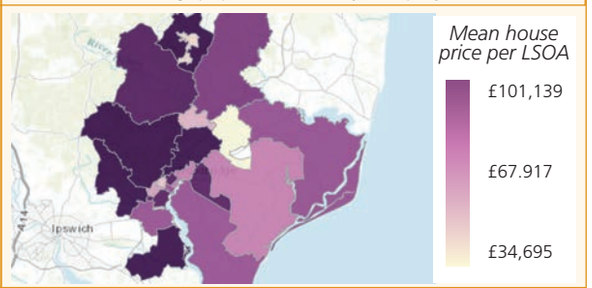
POINTS Map by shape or size. Can show direction

LINES Map by shape or width

AREAS Raw data (such as counts and totals): map by size (proportional symbols)



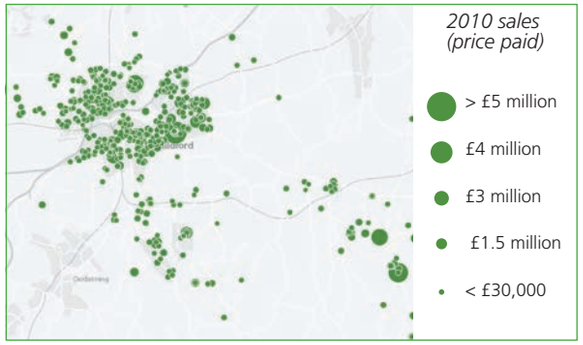
AREAS Processed data (such as mean or % or ratios, e.g. population density): map by shade



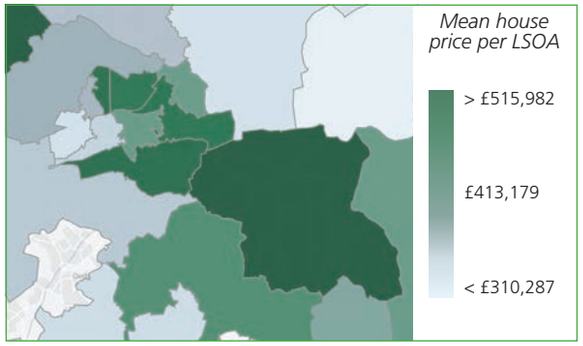
Data analysis

Trends and patterns can be difficult to spot, especially when a large number of data points are presented on a map. To help make sense of the information that you have collected, GIS software offers a range of tools to summarise raw data, carry out calculations and find spheres of influence.

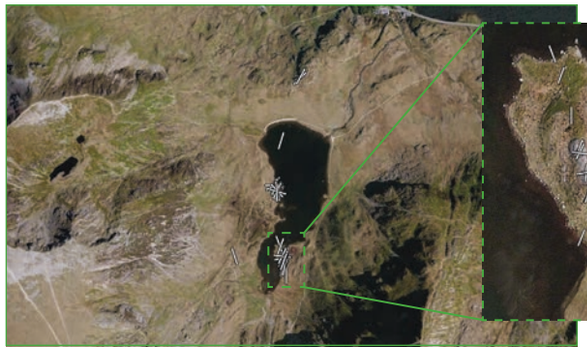
Summarise tools reduce the number of data points into areas or fewer points. These tools include *Summarise Within* and *Summarise Nearby*. The examples below show how these can make patterns clearer.



▲ *Before using Summarise Within*: Individual house prices



▲ *After using Summarise Within*: Mean house price by LSOA



▲ *Before using Summarise Nearby tool*: Orientation of striations mapped by a student – the trend is not obvious (see inset)

▲ *After using Summarise Nearby tool*: Mean striation orientation – the summarised results are easier to interpret

Proximity tools (like *Travel Time Area* or *Buffer*) create new areas based on distances or travel times.

Connect origin to destination tools join multiple points to a single destination. They can also calculate distance or travel times on flow maps, and help find the sphere of influence.

▲ *Travel Time Area results*: 2, 3, 4 and 5 hour drive time to Betws-y-coed

▲ *Connect origin to destination results*: Visitor home locations by postcode

▲ *Overlays*: Field results (visitors to Betws-y-coed) overlaid on secondary data

Conclusions

When drawing conclusions, you will need to look for links between different sets of results. This means looking at primary and secondary evidence together. GIS makes this much easier, allowing you to overlay data sets onto the same base map and explore relationships within and between the different layers.

Analysis tools can help you explore links between data sets and identify anomalous results.

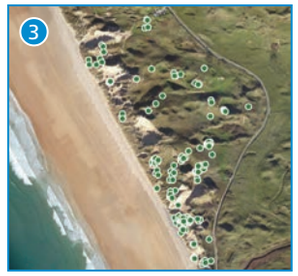
Filter tools help you to explore patterns you may have noticed by only showing certain values e.g.

- show all locations where infiltration rate was more than 150 mm per hour
- show only trees containing more than one tonne of carbon

Or you can show multiple attributes e.g.

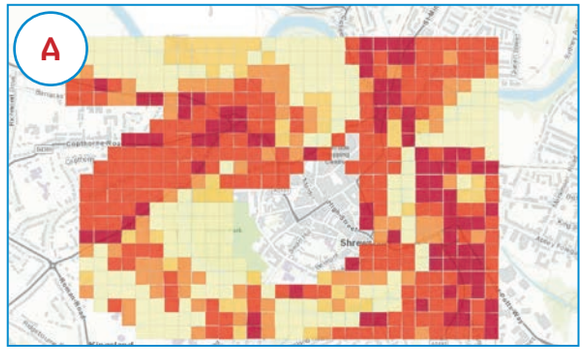
- show all areas where the environmental impact is greater than the economic impact
- show all locations where the soil texture was clay AND infiltration rate was more than 50 mm per hour

Find, Derive or Overlay tools use logic arguments (AND, OR and NOT) across two layers.

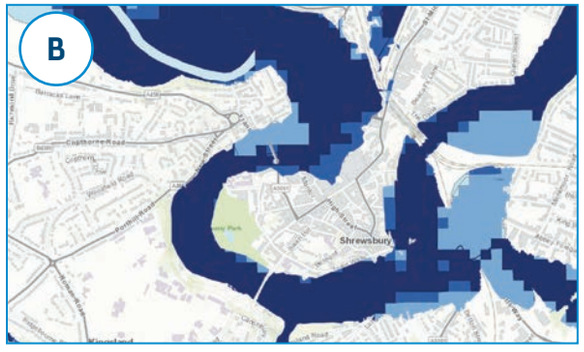


▲ *Filter tools in action*:

1. Unfiltered data: show all quadrats
2. Filtered data: only show quadrats where marram grass is present
3. Filtered data: only show quadrats where marram grass is dominant

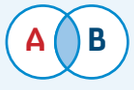


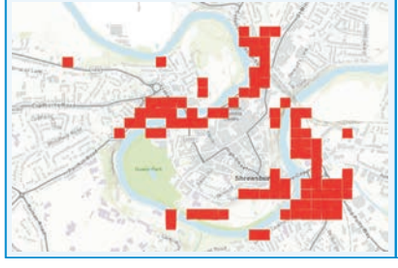
▲ *Fieldwork results*: flood severity impact scores (Layer A)



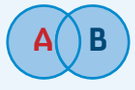
▲ *Secondary data*: Environment Agency flood likelihood (Layer B)

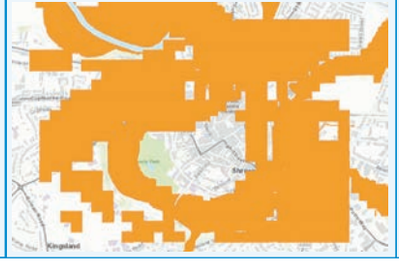
AND
Which areas would have the highest severity impacts if flooded AND are highly likely to flood?



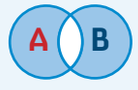


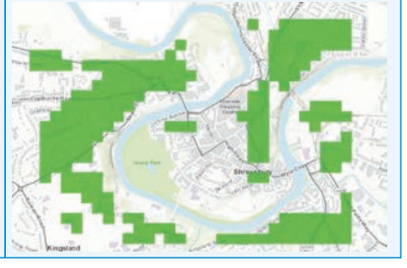
OR
Which areas would have the highest severity impacts if flooded OR are highly likely to flood?





NOT
Which areas with the highest severity impacts if flooded are NOT highly likely to flood?



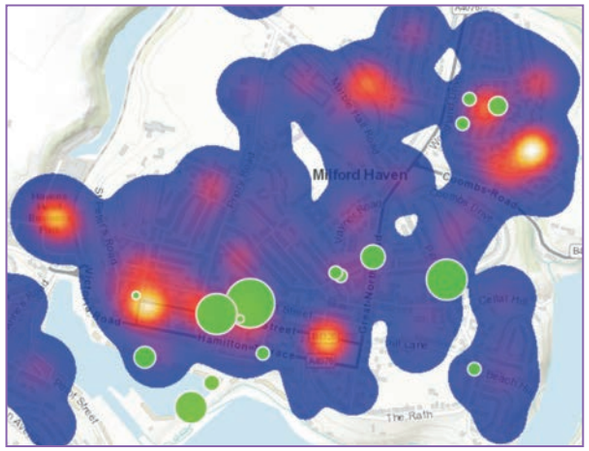


Evaluation

Critically evaluating the accuracy, validity and reliability of your methods and conclusions is a demanding geographical skill. But GIS can help! By overlaying different data sources onto the same base map, such as primary data you have collected with published secondary data, you can easily compare the two sources.

- How do data you have collected compare with existing data sets for that area?
  - To what extent do the two match?
  - To what extent are the two different?
- Why might there be differences? Could the time of day, day of week, or time of year have led to systematic errors in your data?
- How do your anomalies compare against a bigger (longer term or wider area) data set? If you look at them in the bigger picture are they still anomalous?

Even if your primary data does not match the secondary data, it does not automatically mean that your primary data is 'wrong'. Do the two data sources actually measure the same thing? How old is the secondary data? Could the situation have changed since it was collected?



▲ *Evaluating two sets of data.* Green circles show primary data: a count of how many anti-crime features were observed. Other colours show secondary data for crime rate (purple is low, red is intermediate, white is high). How do the two data sets match? How do they differ? Is it valid to compare the two sources, or are they measuring two different things?

Using GIS to make meaningful maps

Maps should be as easy to interpret as possible:

- Shape or symbol

- Colour

- Shade

- Size or width

- Orientation

- The colours you use in mapping have a big impact on how easily your map can be interpreted
  - **Categorical data:** use colours that make sense, e.g. grey for urban land use, light green for grass, dark green for woodland
  - **Ordinal or numerical data:** for simple scales use a High to Low scale, where the darkest shades represent the highest values
  - Use an Above and Below scale to highlight positive and negative scores, to focus on the highest and lowest values within a range (e.g. top 10% and bottom 10%) or values above and below the mean
- Choose your base map carefully. The colour of the underlying map can make it hard to interpret the overlay. Avoid located proportional symbols on top of a very detailed map, as this can make the map hard to read.

Further information

For students – further opportunities with FSC

FSC provides lots of ways for you to learn more, get skills and experience which can help with future career and university decisions. There are a series of courses and summer camps which will give you the chance to learn more with people of your own age in some pretty stunning locations. If you are 16 or 17 and interested in understanding more about an area – what lives there and its place in the world – then you may even want to apply for an FSC Young Darwin Scholarship. You can find out more about these opportunities by visiting **www.field-studies-council.org/young-people**

For teachers – new directions in fieldwork

FSC recognises the potential benefits that GIS can have to the study of Geography and has worked with the Geographical Association and ESRI UK, an international supplier of GIS software, to develop ways to incorporate GIS into FSC's courses.

Technology should enhance geographical learning and not detract from the excitement of immersing yourself in stunning locations. FSC's Education Technology Officer evaluates the use of technology and develops ways in which they can be incorporated into FSC's teaching in the most positive way possible.

Geographical Association

Geographical Association is the leading subject association for all teachers of geography. Our charitable mission is to further geographical knowledge and understanding through education. The GA represents the views of geography teachers and plays a leading role in public debate relating to geography and education.

www.geography.org.uk

esri UK

Esri is an international supplier of geographic information system software, including ArcGIS Online; a cloud-based mapping platform that makes teaching with GIS easy. UK schools can now access ArcGIS Online free of charge.

schools.esriuk.com

This guide was developed by David Morgan (Field Studies Council).

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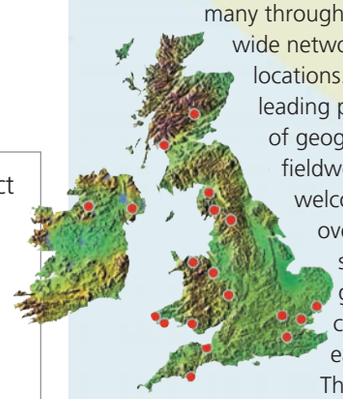

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