GEOFILE 767

GIS – Why is it important for geographers?

By Lucy Scovell

Synopsis

This **Geofile** looks at how geographical information systems (GIS) help people to make decisions. It introduces some of the key concepts and shows how GIS can be used to analyse and describe spatial data. The use of GIS has grown because of developments in technology. It is now commonly used by different organisations to analyse the data that they collect. These organisations can apply GIS to real world issues to identify patterns in a certain area and to suggest solutions. Examples will be used to show how GIS can address issues linked to the environment, transport, humanitarian needs and military, as well as students' own enquiries.

Key terms

Geographical information system, spatial data, spatial analysis, web-based mapping, 'big data'

Learning objectives

By the end of this **Geofile** you will have learned about:

- What a GIS is
- Why GIS is becoming more mainstream
- How GIS is used to measure the real world
- How GIS can be used to analyse problems
- How GIS is applied by different organisations
- The types of spatial issues GIS can help with

Links

Exam board	Link to specification
AQA	3.4 Geographical skills checklist, see pages 40–41 Click here
Edexcel	Appendix 1: Geographical skills, see page 91; Appendix 2: Fieldwork skills, see page 93; Guidance for integrating geographical skills, see pages 13, 18, 23, 34, 50 Click here
OCR	Geographical skills, Geo-located data, see page 48 Click here
Eduqas	Using geographical skills, see page 39; Appendix A: Geographical skill, see page 49 Click here
WJEC	Using geographical skills, see pages 43–44; Appendix A: Geographical skill, see page 57–58 Click here

GIS – Why is it important for geographers?

What are geographical information systems?

Geographical information systems (GIS) help people who make decisions to solve the problems that they face. A GIS uses technology to take information that is collected in the real world and put it into a digital map. GIS is the general term given to connected software which can store, handle, analyse and display information which has a location attached to it. It involves five major different parts (Figure 1), all of which are needed to create digital maps showing the information collected. Spatial data is information which has an exact location. Spatial analysis allows us to use that data to see different patterns of that data within a certain area.

What is the difference between a traditional map and GIS?

A map can provide geographical information about an area at one point in time. Once it has been made, it is difficult to change. However, a GIS can be updated to include to change or add many types of data.

Reasons for the increased use of GIS

GIS has been used in geographical decision making for many years. However, recently GIS has been used by more people and organisations. This is because of three main factors:

- online mapping
- a growth in the devices capable of running GIS
- an increase in user interest in GIS.

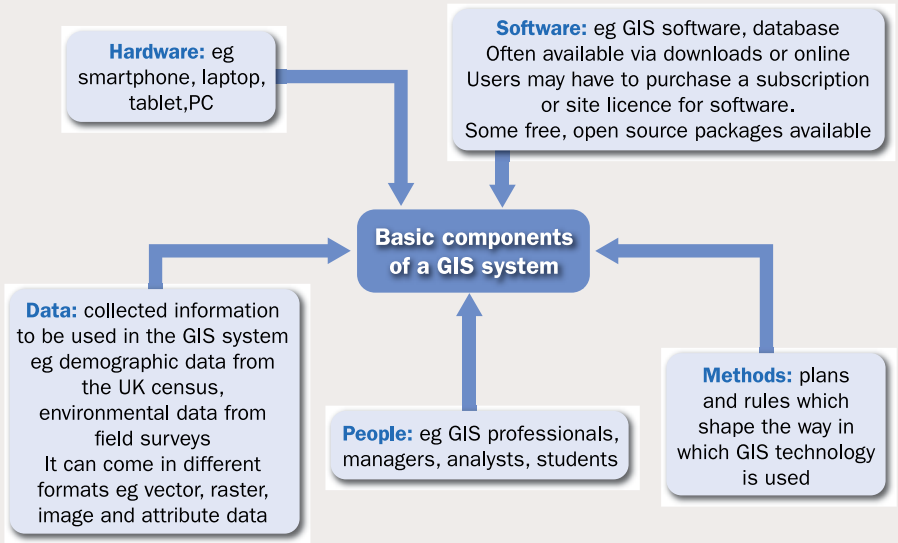

Figure 1 Components of a GIS

First, improved technology has made mapping software more accessible. Web-based mapping lets people create, manipulate and share maps online. Commercial companies have produced online software, eg ESRI's ArcGIS Online, which can be used by different organisations to develop maps using both their own data and those available from other organisations, eg Ordnance Survey. Free and Open Source Software (FOSS) has also grown in use, eg QGIS is used to map areas susceptible to wildfire risk in Portugal. More powerful computers can handle very large qualities of data, or 'big data'. For example, local authorities in the UK can use the data that they have to provide better services eg road gritting and social care.

Secondly, since the mid-2000s, more devices which can handle GIS applications are available to both the general public and people who already use GIS at work. Smartphones, tablets and laptops make it easier to collect, analyse and share large amounts of geographical data. These devices are 'geo-enabled', ie are able to transmit their location. Any data collected by the device is linked to a particular place at a certain moment in time. Apps are also available on smartphones which allow people to collect data and transfer it to a GIS.

Thirdly, more people are using data in GIS for themselves, through apps on their smartphone or on websites. Digital maps are now a part of everyday life for many people eg planning their journeys. At work, more organisations are using GIS software so that different departments can share, analyse and visualise their data.

Using GIS to measure the real world

GIS uses spatial data that has been collected in many different ways. This data helps us to present different features in the real world and make decisions.

Satellite imagery and aerial photography can be used to map the landscape and its land uses. Height data can be presented as a 3D digital elevation model. Census data can be used to show patterns of demographic information. Social media can also provide us with spatial data as Twitter users can show their precise location when they tweet.

The data that has been collected is represented in a GIS in either vector or raster data models. Vector models represent the world on digital maps using points, lines and polygons (eg using a point to show where a school is). Vector models are very useful for showing discrete data that has a specific value. Raster models show the world as a surface divided into a collection of squares, like pixels in a computerised image. They store data from aerial photographs and satellite images. Raster models are very useful for showing continuous data that has no defined boundary, eg how temperature varies across a particular area. GIS users have to make sure that the data they use is as accurate as possible.

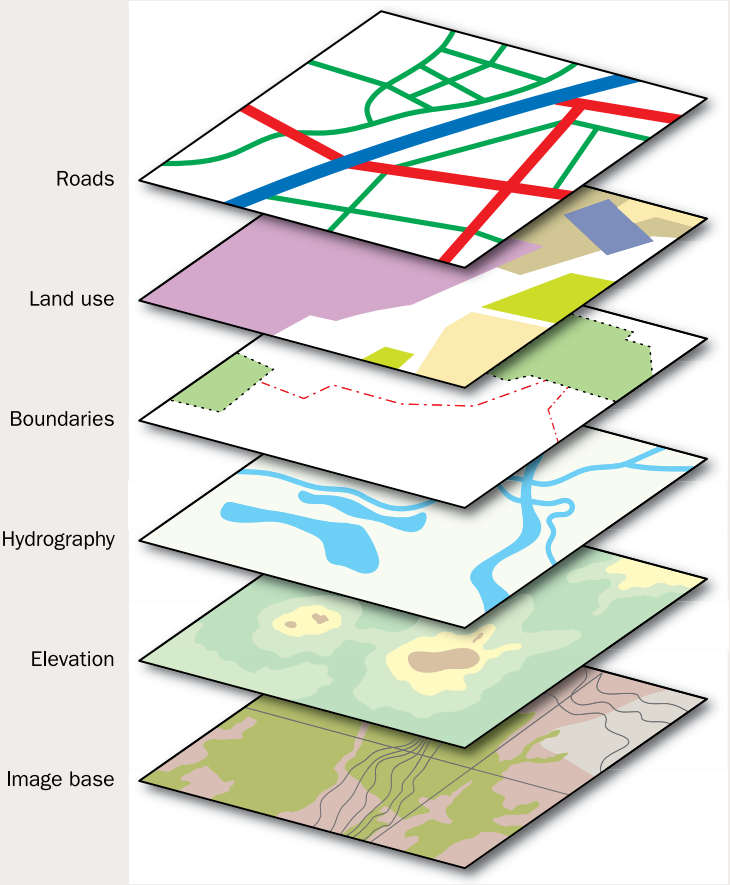

Figure 2 Examples of different layers used in a GIS

Using GIS to analyse problems

A GIS brings together digital information from different sources in the form of layers (Figure 2). The data for each layer is stored in a database. For example, the London Fire Brigade is one of the busiest fire and rescue services in the UK. It produces data which includes details of the incidents that it responds to. This dataset includes many 'attributes' which give more detail about the incident, eg date and time of the fire brigade call-out, type of incident, fire stations involved. This information is included in a table and can be selected by the user to show different spatial patterns. For example, the attribute table can be filtered so that the GIS only shows the location of outdoor fires, eg in gardens, wasteland or woodland (Figure 3(a)). Where many incidents occur, a 'heat map' can be produced to show more clearly which areas are affected most by the problem (Figure 3(b)).

In a GIS, each layer can be analysed on its own or with other layers. Geo-processing

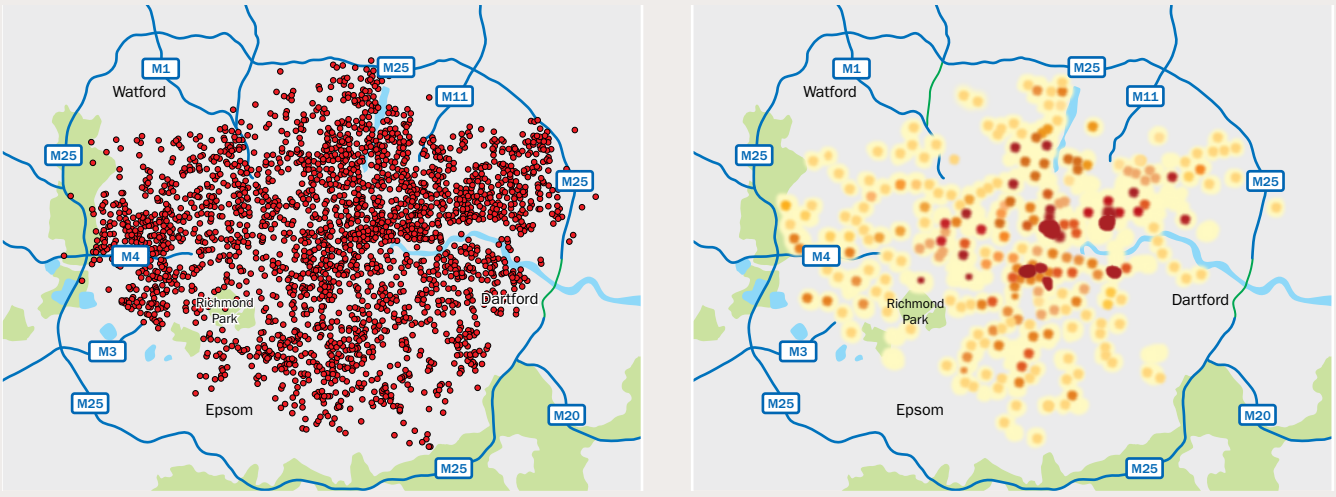

Figure 3 (a) London outdoor fire incidents, July–Dec 2016; (b) London outdoor fire incidents as a heatmap

performs a particular type of spatial analysis on the data. Proximity analysis shows how close one feature is to another one. Network analysis can show the best routes that can be taken. These might be the shortest, fastest or most fuel efficient.

GIS case studies

1. Environmental management

GIS plays an important role in the management of our surroundings. The Environment Agency (EA) maintains the environment in England, including land, water and atmospheric management. The EA uses GIS to visualise its large database of information, eg data from monitoring stations. When used with Ordnance Survey mapping, areas at different levels of risk from coastal or river flooding can be identified. When combined with other data sources such as property and demographic data, decision-makers can identify those areas which are vulnerable to the greatest financial loss from flooding. This information can be used by insurance companies to assess the likely cost of flood damage and enable them to adjust their premiums. It can also help local governments to locate which areas should be prioritised for flood protection investment.

2. Transport

GIS is an essential tool for the maintenance and management of transportation networks. Transport for London (TfL) is the local government organisation which has responsibility for the majority of London's transport system. GIS continues to play an important part in the planning and management of TfL's transport networks including the London Underground and the road system. It enables TfL to centralise the data it collects for its traffic management schemes. It can improve the efficiency of its projects and reduce disruption to the public. Their Traffic Information Management System (TIMS) is a regularly updated database which holds information on live traffic and planned disruptions to traffic such as roadworks. This information is used by the London Streets Traffic Control Centre (LSTCC) to manage daily traffic in London. People can also plan their routes in real time using the TfL website, so they can move more efficiently around the city.

3. Humanitarian action

GIS is invaluable when used in humanitarian activities. MapAction is a non-governmental organisation (NGO) which provides up-to-date maps of areas affected by disasters such as earthquakes and hurricanes. The physical and human landscape can change dramatically after a tectonic or climatic event. Villages can be destroyed and roads can be washed away. Existing maps showing landscape features and road networks are not accurate. MapAction sends an emergency response team to the region and gathers essential data such as the location of the worst affected areas, any remaining communication networks and

Spatial Questions	Example
What is at place X?	Identification of physical and human features in a specific place eg location of active volcanoes
What is the pattern shown by my data?	Different data sets can be used to show the distribution of different characteristics eg the relationship between the location of wildfire sites and the location of tourist facilities in a heathland area
How have features in a place changed over time?	Plotting data sets from different time periods to investigate change eg how vegetation coverage at different times of the year affects visibility for road users
What is the best way to get from A to B?	Analysis of networks to show different ways of moving between places during different scenarios eg most time-efficient route for transport to collect patients scheduled for hospital visits on a particular day

Figure 4 Different types of spatial questions

places that are in need of medical help. The response team then makes updated maps of the area and shares them with the groups of decision makers who will use the information to manage the situation eg disaster relief charities and government officials. Recent events where MapAction has been involved include Hurricane Matthew's effect on Haiti in 2016 and the Nepal Earthquake in 2015.

The Missing Maps project encourages users to help map places which up until now have not had detailed coverage. The maps are made using OpenStreetMap, an open sourced editable map, and are focused on vulnerable areas in the developing world. International and local NGOs can use the maps created, not only to respond to a disaster event but also to improve the efficiency of their ongoing projects. For example, Missing Maps have created maps which help Médecins Sans Frontières (MSF) to identify the location of patients and to prioritise areas for medical care in South Sudan.

4. Military uses

Geographical data is also very important for military activities both in war and in peace time. The army gathers spatial data from field surveys, aerial photographs and satellite data to produce maps and 3D models of the terrain. This information can be used to plan operations. Demographic and cultural data can also be compiled and displayed on maps to help decision-making, particularly in urban and rural areas in foreign countries.

5. Student enquiry

Students can put the primary and/or secondary data they have collected as part of a geographical investigation into a GIS, analyse it and then display the results. Selected examples of this are shown in Figure 4.

Conclusion

This **Geofile** acts as an introduction to the many uses of GIS and gives ideas for your own use of its data sets. Use of GIS would certainly broaden a geographical enquiry.

Useful websites

ArcGIS: Click here wide range of examples of how GIS can be used in real world situations, from ESRI, one of the world's largest GIS companies.

Ordnance Survey: Click here information about GIS.

Environment Agency: Click here interactive maps showing a range of environmental data.

MapAction: Click here information more about the activities of the humanitarian charity.

Missing Maps: Click here open collaborative project to improve mapping in more disadvantaged areas of the world.

Greater London Authority: Click here open data on a range of topics.

Focus questions

1 Explain in detail to someone who is not familiar with GIS exactly what it involves.

2 Explain the problems that might be encountered when using GIS.

3 A student is investigating the environmental quality of their local area. What type of data could they collect? How could they use GIS to analyse their data and show their results?

Learning checkpoint

After working through this unit, consider the following questions:

- Describe the five different parts of a GIS.
- Explain why more organisations and people are using GIS.
- Explain how GIS is a useful tool for emergency services like the London Fire Brigade.
- Explain how GIS is used by different organisations to make decisions, for example:
  - ➢ The Environment Agency trying to reduce the impacts of river flooding.
  - ➢ London Transport (or a similar body) in transport planning.
  - ➢ Helping NGOs in disaster-hit areas.