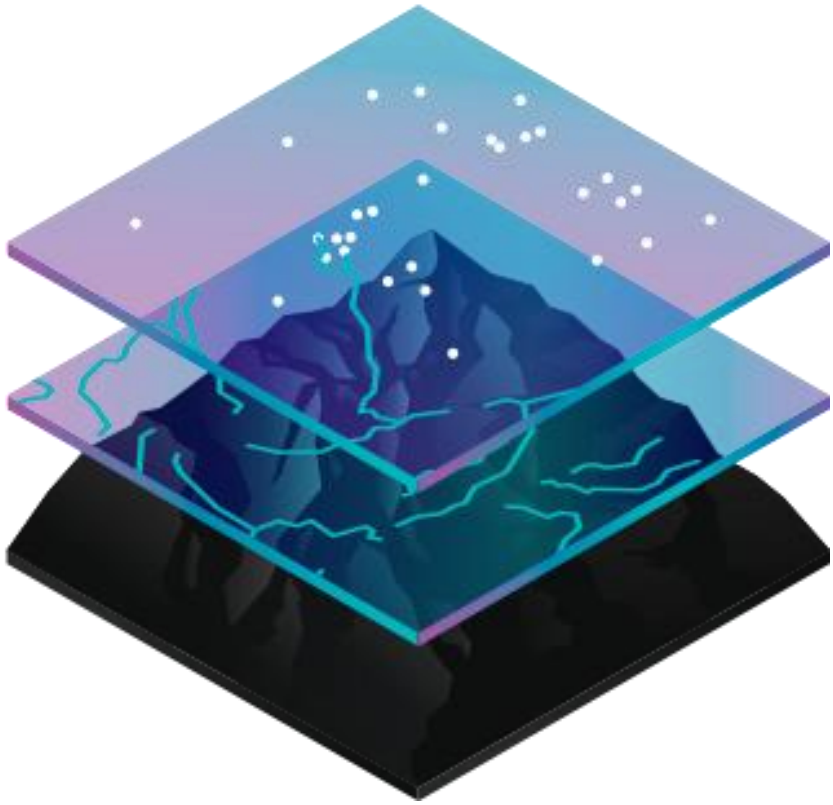

GIS and Data Analysis

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1. Introduction

"P. ramorum is the most serious tree disease to have affected forests in Wales."
-Welsh Government, 2019

Phytophthora ramorum (p.ramorum) is a microscopic fungal- like organism closely related to algae, referred to as a water mould. The name 'phytophthora ramorum' literally means 'the plant destroyer' and the disease has been responsible for some of the worst plant disease epidemics in history, including the Irish potato famine of the 1800s. The disease famously effects larch trees and they have been proven to be highly susceptible to the disease, however it can also have devastating effects on rhododendron, viburnum, pieris, camellia, douglas fir, beech and sessile oak too. (Woodland Trust, Unknown.) Symptoms of ramorum include withered and blackened leaves/needles leading to the dieback of the outer branches as well as areas of black 'bleeding' on the trunk among other things. Progression of the disease in larch is very rapid and the diseased tree will be dead within in short period of being infected.
Though it is not exactly known how ramorum entered the UK, the most likely culprit is through global trade and the importation of plants, wood and other potentially infected material. Increases in global trade have led to governments seeing an increase in new pests and diseases in recent years and current climate conditions are due to see that increase again as warmer, wetter conditions are suitable for these pests, but also extreme conditions such as drought leave native plants and trees more vulnerable to attack. The disease can move very easily within plant networks as it cannot be easily detected to stop the spread, and as a result it is now a worldwide issue. (NRW, Unknown.)

1.2 Spread of pathogen

The first instance of ramorum in the UK was reported in 2002, infecting nursery shrubs in Sussex, but was discovered sporulating on large larch trees in 2009. In 2010 the first report of welsh larch trees being infected was made in Afan Valley and it has become increasingly prevalent from then, particularly in south-west Wales.
The ramorum pathogen is known to spread via spores. There are two types of spores, the zoospores, which are relatively short-lived spores that travel in water droplets or films, and chlamydospores, which are resting spores that allow the disease to survive even through unfavourable conditions. The majority of spread is through zoospores (produced on the needles of larch trees) which operate to the highest efficiency in warm and moist air conditions, meaning the most important time in terms of production for the disease in order to spread is in late summer and early autumn time. The zoospores are transported in wind-driven rain, making areas with an abundance of such conditions (South-West Scotland, Wales, Northern Ireland and Cornwall) high susceptible to major outbreaks. When the spores land on a leaf they grow into the tree by breaking down the cell walls in the leaf, which leads to the initial blackening symptom of the disease. From there it grows within the tree and blocks its water transport system leading to dieback and eventual death. While this process is happening, the pathogen will also spread onto other nearby trees and shrubs.

Larch trees are widely grown in the UK for the timber market so there could be a widespread economic devastation if the disease eradicates a key industry. Another concern is the fact that several other woodland and heathland species are susceptible to ramorum and its distant relative, phytophthora kernovii. The species known as bilberries or blaeberries have been found to be infected in the wild, which is a concern due to bilberries close relation to the blueberry. If the pathogen were to infect blueberries there would be serious consequences for the blueberry industry and further economic disruptions. (Forestresearch, Unknown.)

1.3 Controlling the spread of ramorum

Natural Resources Wales has issued guidance to the members of the public to try and minimise the spread of the disease by raising awareness about removing mud, leaves and other debris from shoes, pets and tires after leaving a woodland area. However, since there is no cure for the infection, the most effective method of control and eradication of the disease is through felling and killing the trees with chemical treatments.
In order to effectively track the spread of the disease and recognise trends in the movement of the pathogen, including how it is commonly spread based on region or season, a geographical information system (GIS) can be created to visualise the data and highlight areas in need of felling or stricter control regulations.

2. Geographical Information Systems (GIS)

A geographical information system combines the power of the map with the power of database and allows people to gather, manage and analyse information about the location by virtualising the dataset. The function of GIS is to produce a visualisation of the data in the form of a map in order to communicate an idea that may not be obvious from the raw data alone and reveals a deeper insight into the data in terms of patterns and relationships, helping the user to create a better plan from the data. (Ordnancesurvey, 2018.)

2.1 Organisations use of GIS

Many different organisations across virtually every field have begun using GIS to create maps in order to communicate, analyse and share information that can solve problems across the world. From healthcare, insurance, telecommunications and even manufacturing, the use of GIS has strengthened the presentation and the sharing of information outside of specialists and has led to increased efficiencies in data communications. GIS has six predominant functions including identifying problems, monitoring change, managing and responding to events, performing forecasting, setting priorities and understanding trends. GIS has been used in environmental decision making (GIS for Environmental Decision Making, Lovett et al.) and for land use management (Spatial Information for Land Use Management, Hill et al.)

2.2 History of GIS

The last 50 years has seen GIS develop from a concept to a science, evolving from a rudimentary tool to a massively powerful modern platform for planning and

understanding. GIS got its start in the 1960s led by Michael Goodchild for the National Centre for Geographic Information and Analysis which formalised research on key geographic information topics alike visualisation and spatial analysis, laying the groundwork for GIS. It wasn't until 1981 that GIS went commercial. GIS plays an important role in the future of mapping and data communication solutions and will continue to expand and grow in relevance as world and climate problems intensify. (ESRI, Unknown.)

3. Methodology

In order to create a GIS, the data must first be collected or sourced externally. In the case of ramorum, data was retrieved from the Forestry Commission in Wales (now known as Natural Resources Wales) and additional data showing water and road systems had to be retrieved from other locations. The most commonly used sites to retrieve this data are Digimaps and the UK Data Service which both provide a diverse range of spatial data ranging from hydrological and geological all the way to populous data.
The decision to separate and group the data in this way was due to the belief that the data would hold a greater benefit if it was presented as such. The separations suggested allow for relevant and concise data to be viewed at once.
Once the relevant data had been downloaded from their respective sites, they were then uploaded to Mapinfo and accompanied by a base map provided by Bing. The points were drawn from the infected sites data spreadsheet by using the 'create points' function and adding them to the map as the top layer, above the relative data layer and the base map.

4. Data and Analysis

A map of the data provided by the NRW could be beneficial to their team if presented in an informative way. By separating the data and highlighting only the relevant parts, it not only reduces the amount of data visualised, making it easier to dissect, but it also creates a more intricate and detailed map as opposed to a generalised data set.

4.1 All infected sites

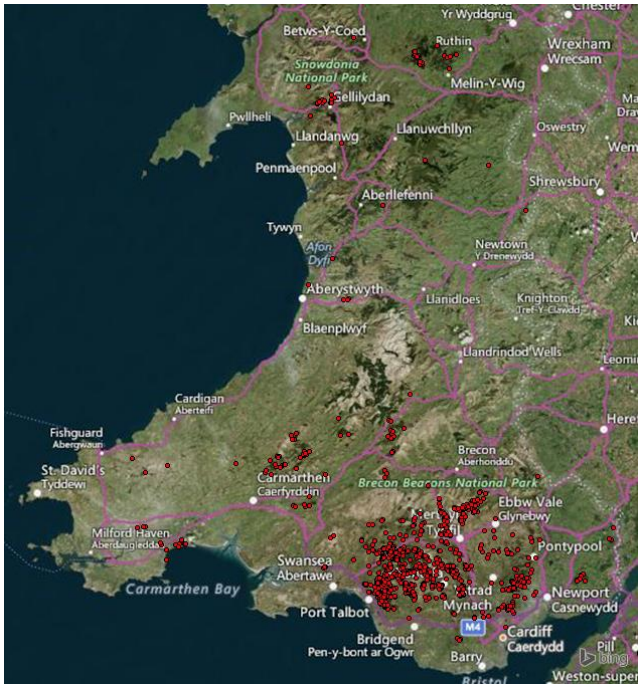

Figure 1 – All infected sites

This initial map shows all the infected sites as reported by the NRW, most of the points can be found within national park boundaries (Snowdon and Brecon). This is likely due to the fact that the trees within national park boundaries are regularly monitored and symptoms are picked up on by individuals who are not only more likely to recognise the symptoms early on but also report them either as part of their job or just as a naturalist.

4.2 Yearly progression of the spread of ramorum across Wales

Figure 2 - 2010/2011

Figure 3 – 2011/2012

Figure 4 – 2012/2013

Figure 5 – 2013/2014

The yearly progression of the pathogen shows a clear explosion in the spread across South West Wales. Though there are infected sites in North Wales the spread of the disease over the same number of years is not nearly as drastic as that in the South. The rapid spread in this area is likely linked to tourism and weather conditions being better suited for the pathogen.

4.3 Infected sites against road maps layer

Figure 6 – Infected sites with road network map containing, motorways and a + b roads

This layer showing the road maps can help to determine if there is a lot of transportation of the pathogen on vehicles, other than a few spots that follow the road lines there is not a massive correlation between the roads and the infected areas, suggesting that vehicles are not a main cause of spread of disease.

4.4 Flood Plains / River routes

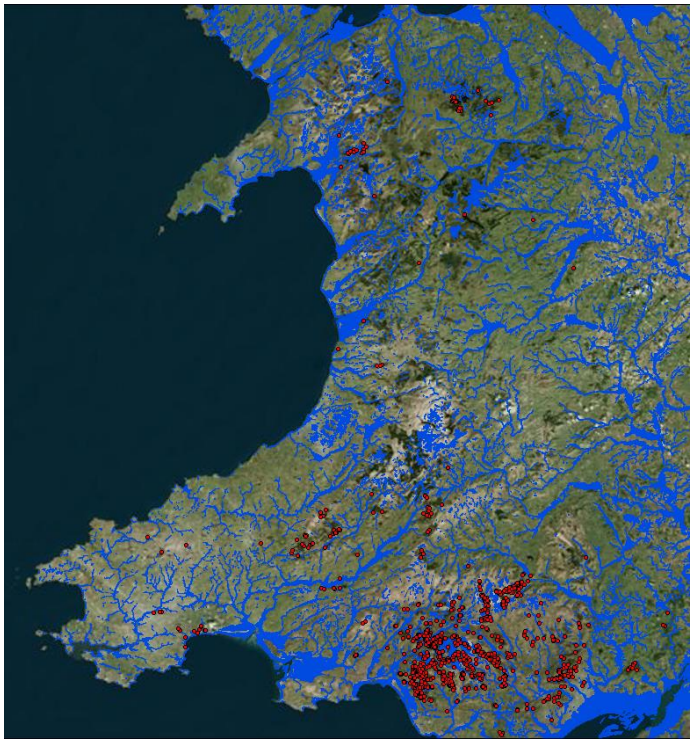

Figure 7 – Flood plains and river routes

A large majority of points fall around these river routes or flood areas showing that river systems are probably the leading cause of spread in the UK. Weather and seasonality will have an effect of spread through river systems and flood zones as obviously, in the wetter seasons the number of spores produced and transported is greatly increased.

4.5 Private and Public sectors

Figure 8 – FCW points

Figure 9 – Private points

There is a significant different between the number of FCW trees infected and the number of private trees infected, though again, this is likely due to the fact that FCW are more often monitored by people who are aware of the symptoms of disease and more likely to report it.

5 Findings

The two main clusters of points are probably originating from the three docks (Swansea, Cardiff and Mostyn) where imports of infected plants or timber may have occurred. The further spread of the disease then can be due to the advanced road and river networks as it is known that the disease spreads these ways and many infected trees can be seen along the river and road lines. Infected sites within close proximity to other infected areas, but secluded from water or road networks are likely due to extreme weather conditions in South Wales, aided by warmer temperatures due to geological location and urbanisation, the rapid spread of the pathogen in South Wales in particular could be explained.

6 GIS Software

The system used to create the maps, Mapinfo Pro, requires a reasonably advanced knowledge of GIS in order to achieve the desired function, making the programme more difficult to use than is strictly necessary. In order to create the maps, data had to be pulled from external sources and uploaded individually by the user, leaving room for error on the creator's part. Additionally, these external sources are often protected by paywalls or subscription services or can be difficult to navigate making access limited for some. Though there is an in-programme option for background maps provided by Bing, those also require a license key in order to access.

Other issues with the programme include the inability to edit or reduce file clutter without risking corrupting the entire workspace. Each workspace consists of numerous duplicates of the same file in various locations but any attempt to remove apparent duplicates will leave the whole file unusable. This unforgiving layout can lead to increased frustrations and lead to a confusing number of files per data set due to a fear of removing any in case of a completely in-operable workspace as a result. It also means progress is being repeatedly saved in a number of different locations due to this same reason.

Other programmes that have more user-friendly interfaces and require less effort to get the same results will soon render MapInfo redundant in both private and government segments. Already many businesses have transitioned to other programmes like Arc Info and QGIS, Swansea City Council uses a mix of the two.

In order to create a visually effective map in Mapinfo it is vital that the design is limited to simplicity, using a blank background map or a simple outline is most effective to avoid clutter. Filtering segments such as doing points by year and sticking to relevant data also aid in creating an effective map.

7 Conclusion

The use of GIS in order to analyse geo-spatial data is evidently a highly valuable tool, despite its complications with Mapinfo, GIS as a concept has the capabilities to process a vast amount of data and condense it into a visual and aesthetically pleasing presented form. It allows trends and other valuable findings to more easily be identified and explained to non-professionals in the public or specialists in other areas of work and is easily applicable to any location-based set of data.

The problems faced with using Mapinfo, can easily be overcome with a frequent utilisation of the programme and a build in experience. However, other programmes such as QGIS may offer better support for beginners in the industry.

8 References

NRW (n.d.). *Natural Resources Wales / Tree health in Wales*. [online] Naturalresources.wales. Available at: https://naturalresources.wales/guidance-and-

advice/business-sectors/forestry/tree-health-and-biosecurity/tree-health-in-wales/?lang=en [Accessed 24 Jan. 2020].

ForestResearch.gov (n.d.). *Ramorum disease (Phytophthora ramorum) - Forest Research*. [online] Forest Research. Available at: https://www.forestresearch.gov.uk/tools-and-resources/pest-and-disease-resources/ramorum-disease-phytophthora-ramorum/ [Accessed 24 Jan. 2020].

ForestResearch.gov (n.d.). *Phytophthora manual 1 - Introduction and contents - Forest Research*. [online] Forest Research. Available at: https://www.forestresearch.gov.uk/tools-and-resources/pest-and-disease-resources/ramorum-disease-phytophthora-ramorum/phytophthora-manual-1-introduction-and-contents/ [Accessed 24 Jan. 2020].

Gov.Wales (2019). *Revised strategy launched for management of tree disease affecting the larch | GOV.WALES*. [online] GOV.WALES. Available at: https://gov.wales/revised-strategy-launched-management-tree-disease-affecting-larch [Accessed 24 Jan. 2020].

Gov.Wales (2019). *Phytophthora ramorum Strategy for Wales*. [online] Gov.wales. Available at: https://gov.wales/sites/default/files/publications/2019-05/phytophthora-ramorum-management-strategy.pdf [Accessed 24 Jan. 2020].

NAFW (2015). *Phytophthora ramorum*. [online] Assembly.wales. Available at: https://www.assembly.wales/Research%20Documents/RN15-014%20-%20Phytophthora%20ramorum/RN15-014.pdf [Accessed 24 Jan. 2020].

WoodlandTrust (n.d.). *Phytophthora ramorum*. [online] Woodland Trust. Available at: https://www.woodlandtrust.org.uk/trees-woods-and-wildlife/tree-pests-and-diseases/key-tree-pests-and-diseases/phytophthora-ramorum/ [Accessed 24 Jan. 2020].

Ordnancesurvey (n.d.). *What is GIS mapping?*. [online] Ordnancesurvey.co.uk. Available at: https://www.ordnancesurvey.co.uk/business-government/tools-support/gis/what-is-gis [Accessed 24 Jan. 2020].

Mango (n.d.). *The Beginner's Guide to GIS - GIS Mapping | Mango*. [online] Mango. Available at: https://mangomap.com/gis-mapping [Accessed 24 Jan. 2020].

marineenergywales (n.d.). *Ports | Marine Energy Wales*. [online] Marineenergywales.co.uk. Available at: https://www.marineenergywales.co.uk/supply-chain/ports/ [Accessed 24 Jan. 2020].

Esri (n.d.). *What is GIS? | Geographic Information System Mapping Technology*. [online] Esri.com. Available at: https://www.esri.com/en-us/what-is-gis/overview [Accessed 24 Jan. 2020].

Lovett, A. and Appleton, K. (2007). *GIS for Environmental Decision-Making*. [online] Syndetics.com. Available at:

http://syndetics.com/index.aspx?isbn=9780849374234/SUMMARY.HTML&client=walestsd&type=rn12 [Accessed 24 Jan. 2020].

Hill, M. and Aspinall, R. (2000). *Spatial Information for Land Use Management*. [online] Syndetics.com. Available at: http://syndetics.com/index.aspx?isbn=9056993151/SUMMARY.HTML&client=walestsd&type=rn12 [Accessed 24 Jan. 2020].