Common Usability Issues within Web GIS for Public Information Provision

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KEYWORDS: Web GIS, Usability, Human-Computer Interaction (HCI)

1. Introduction

Since the genesis of Web 2.0, usability has risen to the forefront of online product development. Companies are becoming increasingly aware that poor usability can negatively impact brand perception, as Apple found with the launch of its mapping service (Cook, 2012). Web GIS 2.0 (Haklay *et al.*, 2008) expanded the use of GIS to include various forms of interaction with geographic information giving rise to the 'accidental geographer' (Unwin, 2005). Due to the complexity of these systems, interactions with Web GIS which are open to the public invoke significant usability concerns. This paper discusses a range of common usability issues identified across a number of Web GIS applications which support public decision-making in public health and environmental domains (Table 1).

Table 1. A brief description of the public Web GIS evaluated within this paper, with URLs located within the references list

Application	**Provider**	**Description/ Purpose**
What's In Your Back Yard	Environment Agency	Provides a range of environmental information to the public
Eye on Earth	European Environment Agency	Provides a range of environmental information from across Europe
Health Map	Boston Children's Hospital	Provides information relating to global disease outbreaks
NHS Choices	National Health Service	Allows for the public to search for their local NHS amenities
WideNoise	EveryAware (European Union)	Allows the public to view crowd sourced noise pollution readings

2. Usability Evaluation Methods

Usability is defined by the ISO 9241 standard to be "the effectiveness, efficiency, and satisfaction with which specific users achieve specific goals in particular environments" (ISO, 1998; Nivala *et al.*, 2008). In order to achieve usability, evaluation methods have been developed in order to "make systems more usable[, producing] noticeable benefits for users by guaranteeing easy-to-use systems, which are less stressful for the user and therefore more acceptable" (Nivala *et al.*, 2008: 129). Here three popular usability evaluation methods have been used to inspect and evaluate the chosen Web GIS.

2.1 Heuristic Evaluation (HE)

HE requires at least one individual who will "judge [a system's] compliance with recognised usability principals ('heuristics')" (Nielsen and Molich, 1990; Nielson, 1992: 373; Nielsen, 1995). These heuristics mostly refer to a broad range of online environments. Due to the distinct characteristics of Web GIS applications, Nivala *et al*.'s (2008) guidelines have been used here in order to ensure that the Web GIS was thoroughly examined. Only one individual evaluated each Web GIS application, which according to Nielsen (1995) results in the identification of approximately 35% of a system's issues. Moreover, severity ratings were used to prioritise the identified usability problems and to 'quantify' the proposed redesign recommendations.

2.2 Cognitive Walkthrough (CW)

CW is used to evaluate the ease with which users can perform a set of tasks with little or no formal instruction, focusing on system learnability (Polson *et al*., 1992; Wharton *et al*., 1994; Tonkin, 2005). A fictitious persona is used to describe the needs of a typical user, with this taken on by the evaluator. Again, one individual evaluator evaluated each Web GIS by completing a set of CW tasks in order to identify problems that influence how effectively, efficiently and satisfactorily a potential user uses the system and the problems that influence interaction.

2.3 Usability Testing (UT)

UT involves an evaluator observing a 'test subject' or subjects (individually) interacting with the application without instruction. User subjects aim to achieve a specified end goal and fulfil a set of tasks revealing the system's intuitiveness. Users were also encouraged to think aloud in order for the evaluator to realise the reasons behind their actions (Skarlatidou and Haklay, 2006). For each Web GIS two 'test subjects', which were not GIS experts, were recruited and were observed in their 'natural environment' bringing good ecological validity to UT findings (Haklay, 2010).

2.4 Identified Problems and Method Performance

Figure 1 briefly illustrates **t**he number and severity of issues identified by the three different evaluation techniques employed, with Table 2 providing a description of the severity rating as defined by Nivala *et al*. (2008). It should be noted perhaps that the severity of an issue is very dependent on the role and context of the Web GIS in question, as well as the motivation and purpose the user has for using it.

Table 2. Severity ratings as defined by Nivala *et al*. (2008)

Rating	**Description**
Catastrophic	May even prevent the use of the application.
Major	Makes the use of the application significantly difficult.
Minor	Makes the use of the application somewhat difficult.
Cosmetic	Prevents the feeling of a finished design.

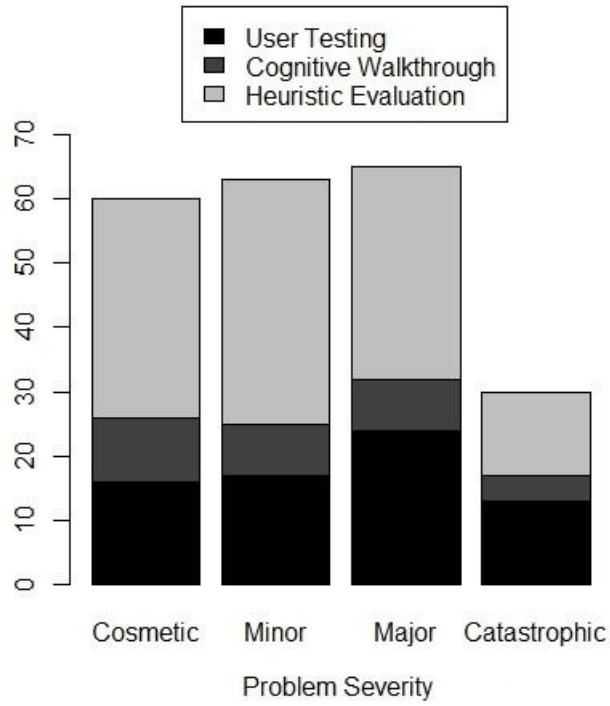

Figure 1. The distribution of problem severity across the three different evaluation techniques employed.

3. Common Usability Issues

Overall, three main areas of concern have been identified across the chosen Web GIS. A disregard for basic cartographic principals, webpage/website restrictions, and issues relating to human-computer interaction (HCI).

3.1 Cartographic Problems

In all of the evaluated Web GIS, website aesthetics appear to have been granted a higher priority than basic cartographic principles. Errors such as omitting the scale bar, reference system or a basic legend have been noted. Missing scale bars and ways in which the user can judge scale, size, distances and measurements may cause confusion and distrust (Nivala *et al.*, 2008) (Figure 2).

Web GIS applications showed a tendency towards removing these items which can lead to mistakes or judgement errors when a user is trying to interpret the information provided on maps. Small unintuitive icons and buttons are sometimes present which can lead to users taking unwanted actions as it is not understood what functions they provide. Legends with appropriate symbology and graduated data scales were also sometimes omitted as can be seen in Figure 2. This is due to the cartography being assumed to be intuitive and self-explanatory which in the case of the WideNoise Web GIS (Figure 2) is untrue, with users finding icons to be understated and lacking relevant information.

The misinterpretation of data as demonstrated by Monmonier (2005), may be deliberate in the case of WideNoise as the use of such dominant and obstructive symbology masks and avoids the issue of the data's resolution. This issue is further concealed by users having to manually search the map for information using their mice, ultimately slowing data retrieval and altering the user's perception of what is being illustrated. Similar data presentation issues are also present in Figure 3 which when additional map layers and overlays are added cause vital information such as place names to become obscured or even completely hidden.

The main finding of UT was a desire for a standardised and familiar cartography over current custom cartographies or those offered by the likes of Bing Maps. More often than not Google Maps was the top request. Lastly, measurement tools and the ability to add point markers are fundamental features of any GIS; all such features, however, are absent from all the evaluated Web GIS.

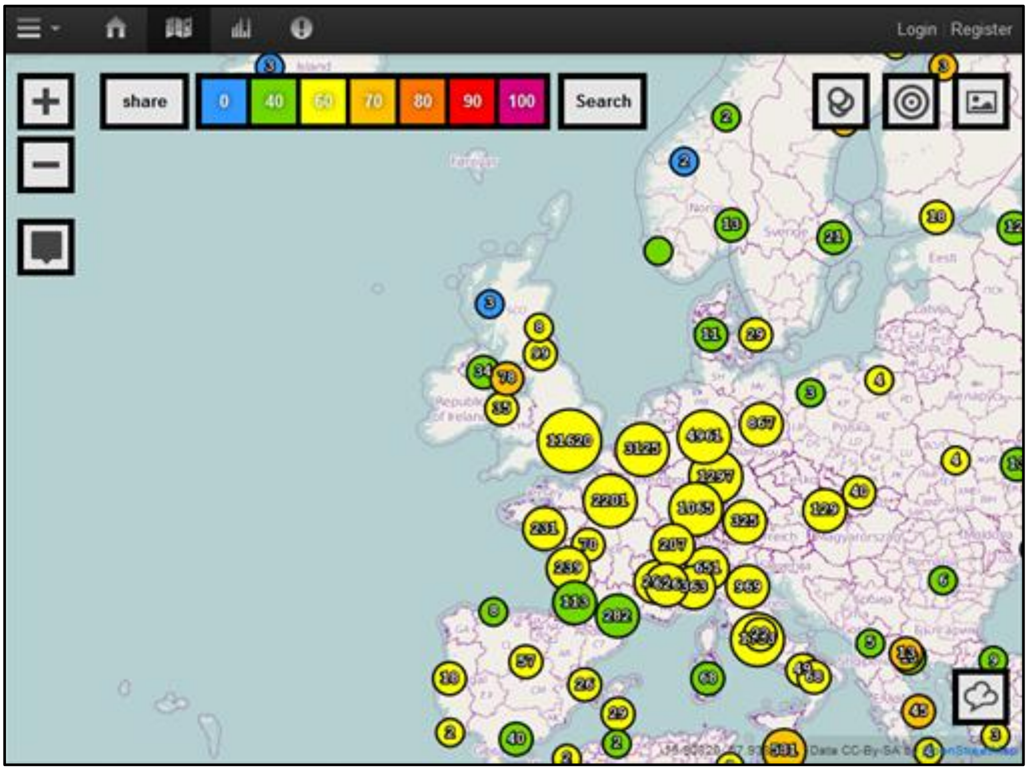

Figure 2. Missing scale, units, description and unintuitive icons in the WideNoise Web GIS.

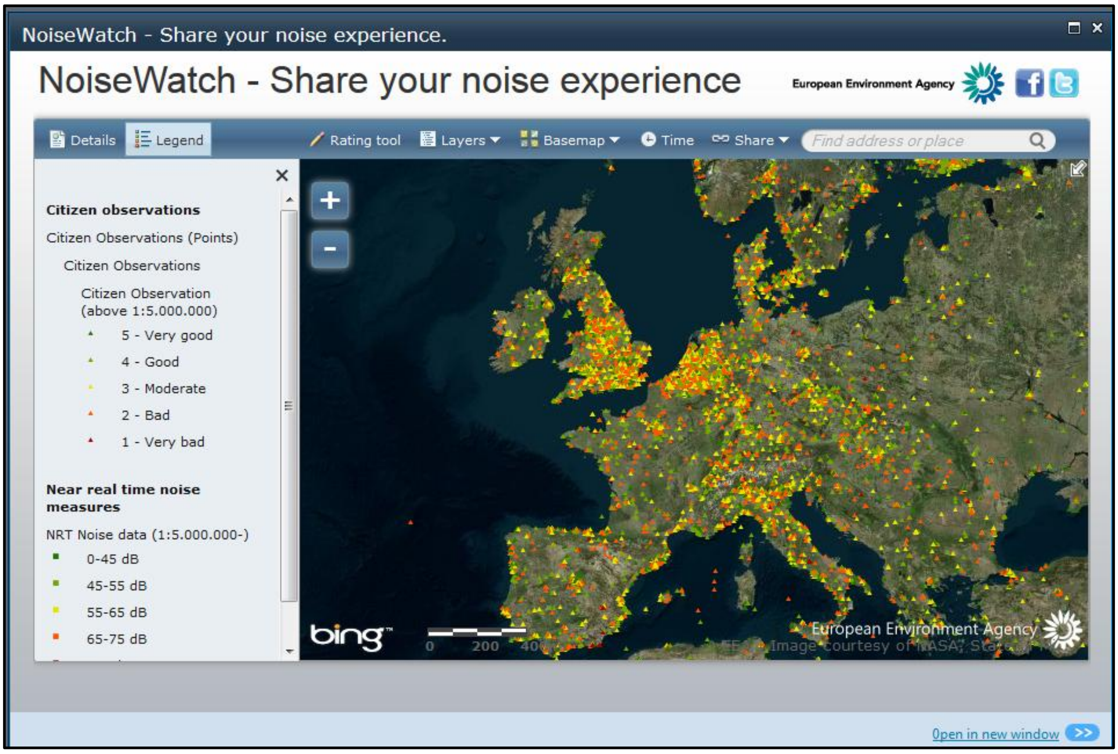

Figure 3. Eye on Earth's Web GIS which offered no place names and an array of unintuitive function names.

3.2 Accessibility Problems

Modern Website design faces a new problem where by users expect to be able to access any Website on a variety of platforms and devices. This creates issues as screen sizes and resolutions vary wildly between devices and can cause Web GIS to poorly utilise the onscreen real estate. Page orientation plays a large role in this for mobile devices as highlighted in Figure 4, where a map on a tablet in landscape view is poorly displayed. Inconsistencies and incompatibilities in layouts and presentations were discovered between platforms (different Web browsers) on the same devices.

Navigation between a list of results and the Web GIS can also cause frustration with users unexpectedly triggering events by selecting hyperlinks which can cause them to clear a list of search results and even navigate away to a new page or Website. This is highlighted by the NHS Choices Web GIS where it appears to be suggested that travel directions can be displayed on the current map although when the feature is selected users are directed to a different website (see Figure 5).

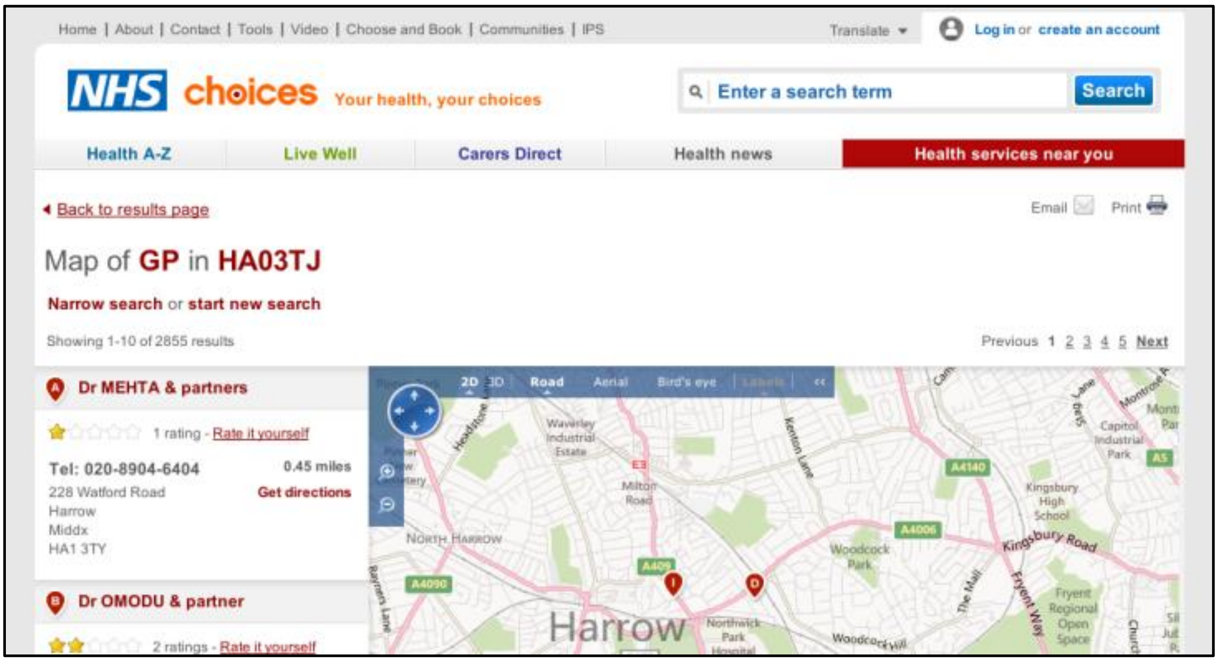

Figure 4. The NHS Choices Web GIS as viewed on a tablet in landscape view showing only one search result and a fraction of the map.

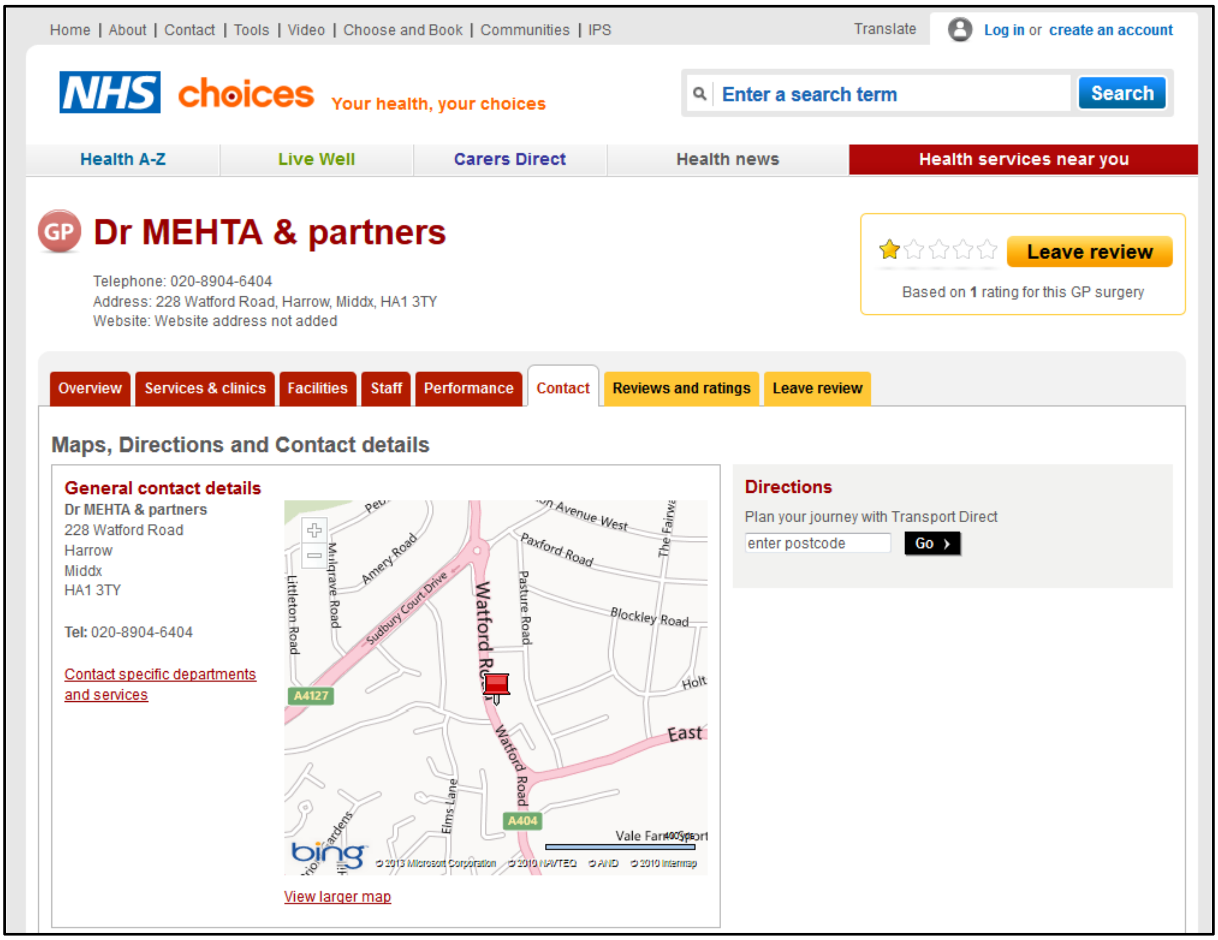

Figure 5. The NHS Choices Web GIS redirects users to an external website to provide travel directions.

3.3 Input and Search problems

The action of receiving human text based inputs and converting them into usable search queries are a common problem for GIS. Web GIS however are often aimed at a wider public audience whom typically have no prior knowledge of GIS or its functions. Figure 6 shows how the international WideNoise Web GIS misinterprets UK postcode queries and fails to produce an error message causing the user's misdirection.

Within the Eye on Earth Web GIS colloquial place names unfortunately produced error messages and null results pages which left users feeling confused. In a similar vein, Figure 7 shows how a data entry (spelling) error does not produce a possibly helpful list of similar alternative / popular results as many popular search engines users may be familiar with do.

Finally, search operations and modifications of the map can suffer from latency issue due to the complexity of the system and the lag associated with downloading and displaying any Web content. Instantaneous results are expected by the user and time spent waiting for the map to load can lead to anger and confusion. A way to cancel a prior commitment should always be available (Figure 8).

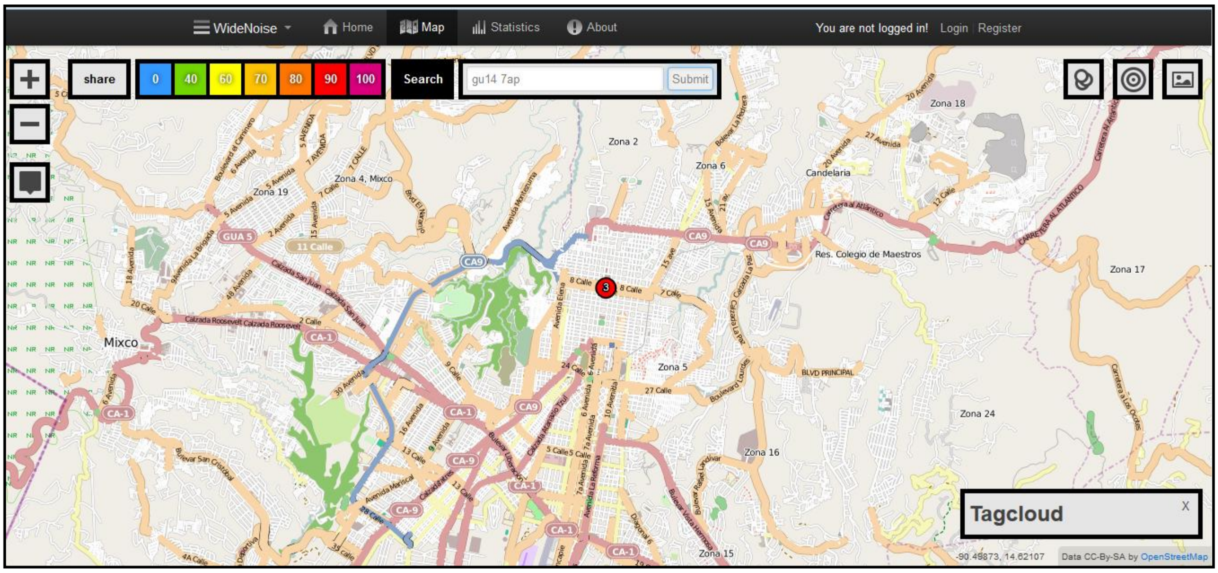

Figure 6. The WideNoise Web GIS fails to recognise UK Postcode inputs misdirecting the user.

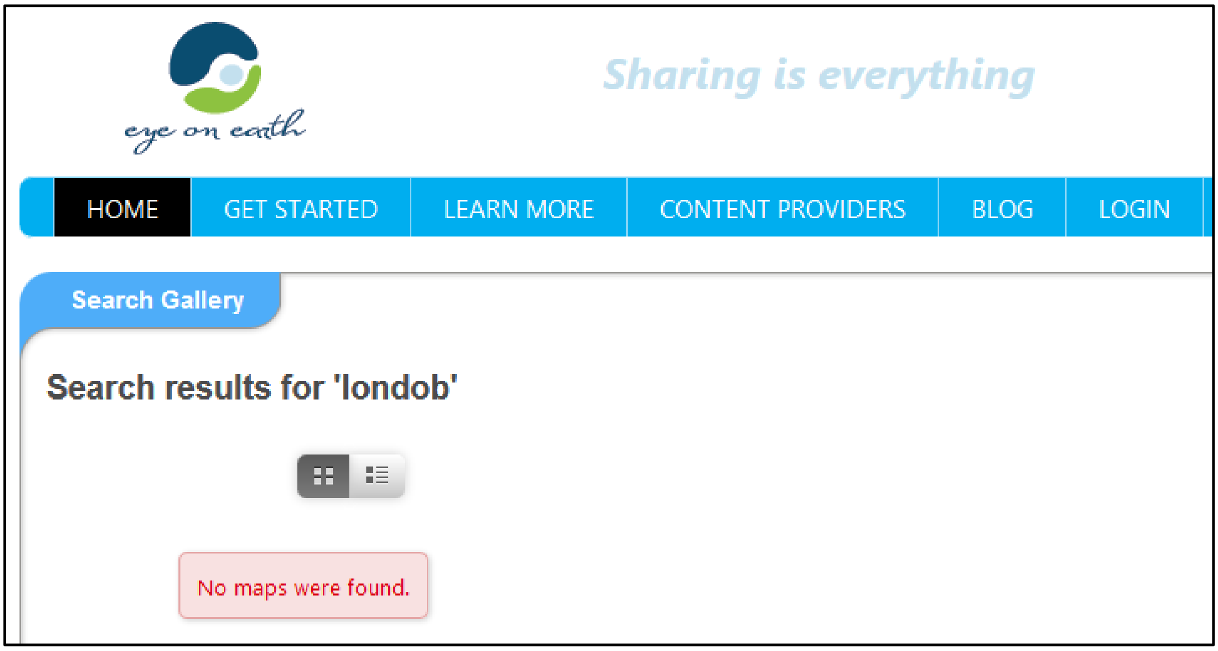

Figure 7. An example of poor human error recognition and an uninformative error log produced by the Eye on Earth Web GIS.

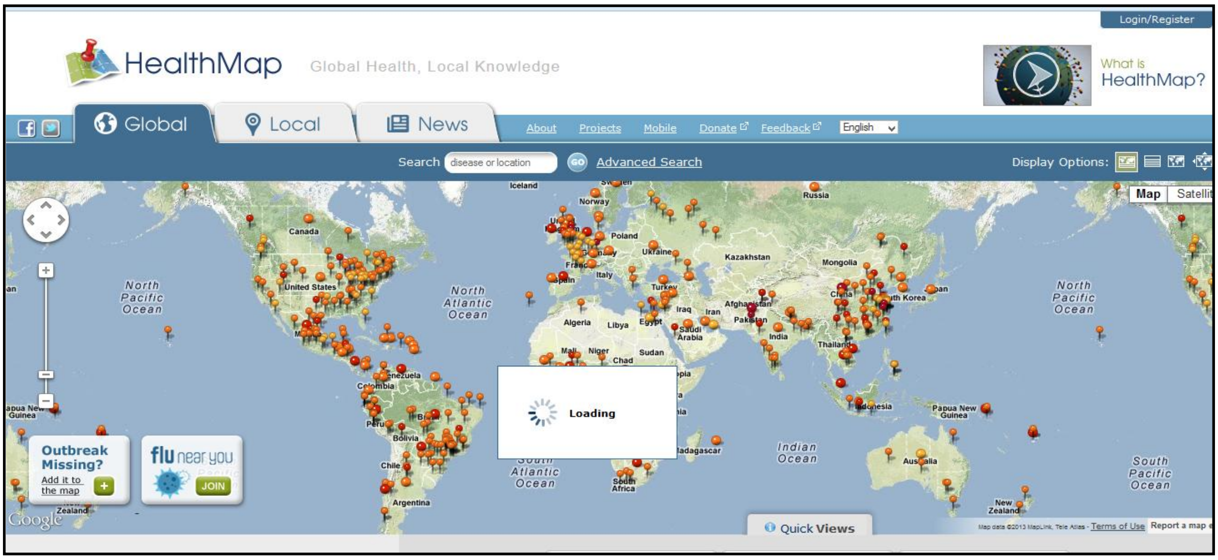

Figure 8. A loading screen for a function that cannot be cancelled within the HealthMap Web GIS.

4. Conclusion

By using various evaluation methods several usability issues common to five very disparate Web GIS have been identified. These issues range from the cartographic, to cases of poor compatibility, and those brought about during HCI. Having identified such usability issues it is hoped that future Web GIS may avoid them, improving effectiveness, efficiency, and satisfaction. It is suggested that future research revisit the evaluated applications in order to study the progress made with regard to usability.

5. Acknowledgements

With thanks to Georgios Apostolopoulos, Richard Phillips, and Pippa Wood, and a special thanks to Artemis Skarlatidou for all of her help and guidance.

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6.1 The Evaluated Web GIS

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7. Biography

D. J. Egginton - A UCL postgraduate student currently studying spatial databases and spatio-temporal data mining. Current research interests centre on the analysis of datasets from social media (e.g. twitter) and the associated data mining and geovisualisation. Other interests range from human-computer interaction, to geodemographic, and databases.

O. M. J. Turner - A UCL graduate with an MSc in Geographical Information Science. Previous work with Centrica in the development of a GIS at British Gas with the aim to incorporate Open Data with internal data for customer profiling in the UK. Current research interests revolve around the GUI's of GIS applications.

T. Wicks - A GIS graduate working at a major UK engineering company. While studying his Master's degree his research interests included analysing the geographies of social media data, specifically in relation to disaster events. He also enjoys geodemographic research and working with web mapping interfaces.