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Enriching Great Britain's National Landslide Database by searching newspaper archives

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ABSTRACT

Our understanding of where landslide hazard and impact will be greatest is largely based on our knowledge of past events. Here, we present a method to supplement existing records of landslides in Great Britain by searching an electronic archive of regional newspapers. In Great Britain, the British Geological Survey (BGS) is responsible for updating and maintaining records of landslide events and their impacts in the National Landslide Database (NLD). The NLD contains records of more than 16,500 landslide events in Great Britain. Data sources for the NLD include field surveys, academic articles, grey literature, news, public reports and, since 2012, social media. We aim to supplement the richness of the NLD by (i) identifying additional landslide events, (ii) acting as an additional source of confirmation of events existing in the NLD and (iii) adding more detail to existing database entries. This is done by systematically searching the Nexis UK digital archive of 568 regional newspapers published in the UK. In this paper, we construct a robust Boolean search criterion by experimenting with landslide terminology for four training periods. We then apply this search to all articles published in 2006 and 2012. This resulted in the addition of 111 records of landslide events to the NLD over the 2 years investigated (2006 and 2012). We also find that we were able to obtain information about landslide impact for 60–90% of landslide events identified from newspaper articles. Spatial and temporal patterns of additional landslides identified from newspaper articles are broadly in line with those existing in the NLD, confirming that the NLD is a representative sample of landsliding in Great Britain. This method could now be applied to more time periods and/or other hazards to add richness to databases and thus improve our ability to forecast future events based on records of past events.

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1. Introduction

Risk management decisions can only ever be as good as the risk assessments upon which they rest. The United Nations Hyogo Framework for Action on Disaster Risk Reduction (UN, 2005) identifies the development and improvement of relevant databases as a key capacity-building priority. In the particular case of landslide risk, the limitations of existing landslide inventories have been repeatedly highlighted as the greatest source of error in the landslide susceptibility and risk maps used to inform land-use planning and other mitigation measures (van Westen et al., 2006; Fell et al., 2008). Better data are also important for estimating landslide damage functions and thus for assessing risk in the classic sense of the combined probability and consequences of suffering landslide losses (Fuchs et al., 2007; Quan Luna et al., 2011).

In Great Britain, landslides commonly occur due to physical factors such as coastal erosion and maritime climate, particularly during very wet seasons (Jones and Lee, 1994; Bromhead and Ibsen, 2006). Coupled with vulnerability factors such as high population densities and high-value infrastructure, impacts from landslide events range from economic losses and infrastructure damage, disruption, injuries and (less commonly) fatalities (Pennington et al., 2009). For example, in 2012 Great Britain experienced the highest monthly rainfalls for the last hundred years in many regions (Parry et al., 2013). This resulted in approximately five times as many landslides as usually recorded (Pennington and Harrison, 2013), impacts such as major transport disruptions, evacuations and four fatalities (Pennington et al., 2015-in this issue). These losses have peaked policy interest in better understanding landslide impact and in developing a country-wide landslide hazard impact model to forecast and thereby help prevent them in future (Met Office, 2013).

The principal source of data regarding landslide occurrence in Great Britain, what causes them and the history of their impacts is the National Landslide Database of Great Britain (NLD) (described in detail in Section 2.2). The NLD is an archive of the location, date, characteristics and impact of landsliding in the past, with records dating from the last glaciation to present (Foster et al., 2008). First created in the early 1980s by Geomorphological Services Ltd, the NLD is now maintained and constantly updated by the British Geological Survey (BGS) (Foster et al., 2008). Since its creation, the strategies of data collection have been variable, due to shifts in the underlying resources available, change

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in available technologies and variation in the intended applications of the database (Pennington et al., 2015-in this issue). The variation in the methods and intensity of past data collection make it reasonable to assume that there are additional landslide events to be found, and more information to be added about existing landslides in the NLD.

In this paper, we present a method to increase the richness of the NLD by searching a digital archive of 568 regional newspapers for articles referring to landslide events. Our aim is not to 'complete' the NLD, but rather to complement existing sources by providing more and richer information about landslide phenomena in Great Britain. In particular, we demonstrate the capacity of this method to enrich the NLD in two ways: (i) adding records of additional landslide events not previously documented in the NLD and (ii) supplementing currently recorded NLD landslide event information, particularly about impacts. As this method draws consistently upon an independent dataset, comparing the results to the contents of the NLD can also provide a way to assess potential bias in the NLD and enhance overall confidence in its data. The method we present here could also be applied to enhance understanding of other natural hazards, such as surface water flooding, whose incidence and impacts are not systematically recorded in existing datasets, particularly when examining records pre-remote sensing (Moores and Rees, 2011; Hurford et al., 2012).

This paper is organised as follows: In Section 2, we discuss the broader difficulties of producing landslide inventories and how these relate to the NLD. We then consider the potential of newspaper articles as a supplementary source of landslide inventory data and review existing studies using this approach before introducing the particular newspaper archive used in our research. In Section 3, we describe the methodology we developed for searching and filtering digital archives of regional newspapers to collect news stories about landslide events and extract factual information from them to enrich the NLD. Then in Section 4, we present results of our newspaper searches for two search periods. In Section 5 we discuss the implications and uncertainties of our methodology and how this methodology might be applied in other contexts. In Section 6 we summarise results and draw conclusions.

2. Background

2.1. Landslide inventories and databases

Detailed information about the nature of past events is important for understanding, predicting and managing landslide risk (Guzzetti et al., 2005, 2012). Van Westen et al. (2006) identify four basic types of information about past landsliding needed to support risk assessment and management:

(i) Inventories of landslides
(ii) The environment surrounding the landslide
(iii) What triggered the landslide
(iv) What elements are/were at risk.

Of the four categories given above, van Westen et al. (2008) and Van Den Eeckhaut and Hervás (2012) demonstrate that the first category, landslide inventories, is the most important when considering potential risk for the future.

Compiling such inventories is complicated by a number of factors, including the following: (i) There are first order conceptual questions about the definition of a landslide 'event' to be recorded as distinct from a landslide triggering event (e.g., an earthquake or heavy rainfall) (Kirschbaum et al., 2010). (ii) Compared to other hazards (e.g., earthquakes or extremes of temperatures), where we often have direct instrumental measurements of the phenomena over a wide region (e.g., ground motion, air temperature), landslide deposits (and associated erosional surfaces) observed on the ground are the *outcome* of a set of interacting processes (Guzzetti et al., 1999) that are rarely feasible to measure systematically instrumentally. Consequently, to produce a landslide inventory, one must actively search for them across a landscape, through methods such as remote sensing and photogrammetry (Soeters and van Westen, 1996), field investigations (Brunsden, 1985), public reporting/interviews and archival research (Salvati et al., 2009) or a combination thereof (Guzzetti et al., 2012). (iii) It can also be difficult to identify and extract landslide events from public databases. For example, in the UK the Highways Agency Road Impact Database, landslides do not have a specific event code. Landslides and engineered slope failures are sometimes noted in a free text field but are more commonly recorded in their database of traffic disruption as "other" (Met Office, personal communication, March 2014).

For the above three reasons, it is rare to have databases of all landslides that have occurred over a region within a given time period, and there may be biases towards locations where humans are affected (Carrara et al., 2003) or larger landslides that are more discernible in imagery/field studies (Wills and McCrink, 2002). The 'completeness' of an inventory will also be affected by the time lag between the landslides occurring and when they are inventoried, as smaller landslides may be eroded/erased from the landscape within a few months of occurring (Malamud et al., 2004; Bell et al., 2012). In a survey of 22 European countries that have or are developing national landslide databases, Van Den Eeckhaut and Hervás (2012) found that 68% of respondents estimated the completeness of their country's database to be less than 50%.

The above difficulties with the completeness of landslide inventories limit the quality and predictive power of landslide susceptibility assessment (Galli et al., 2008). Consequently, landslide risk may be under or overestimated depending on the completeness and homogeneity of coverage of the landslide inventory.

2.2. The National Landslide Database (NLD) of Great Britain

The NLD is the most extensive source of information about British landslide occurrence. A metadata description with examples of its content can be found online at BGS (2014a). The NLD currently contains over 16,500 records of individual landslides occurring between the last glaciation and present day. For each landslide, more than 35 possible attributes can be recorded (Foster et al., 2008; Pennington et al., 2015-in this issue). These can broadly be categorised into:

(i) *Landslide location* (Latitude/Longitude and estimation of locational precision)
(ii) *Landslide timing* (date of occurrence or age)
(iii) *Type of landslide* (fixed categories)
(iv) *Cause of landslide* (fixed categories)
(v) *Size of landslide* (free text)
(vi) *Impact of landslide* (number of fatalities, number injured, cost and other free text)
(vii) *Geological setting of landslide* (fixed categories).

Perhaps due to the somewhat episodic nature of landslide activity in Great Britain, policy concern for landsliding has waxed and waned (Gibson et al., 2013), as have resources for NLD data collection and database maintenance, resulting in temporal and spatial variations in database richness. The first national landslide database was initially established in the early 1980s to raise awareness of the nature and distribution of landslides for planning purposes at a local authority level (Foster et al., 2012). As the method employed was a desk-based review of secondary sources such as technical reports, theses, maps and diaries (Jones and Lee, 1994), the spatial extent of records in the original NLD were biased towards locations of human interest, such as high impact landslides or 'classic' field study locations. During the 1990s, sources of revenue from the database were not large enough to fund the maintenance and regular updating of the database and the project was mothballed. In the early 2000s, the Department of the Environment made the database available to the BGS, who over the next few years devoted considerable effort to restructuring, quality controlling, and supplementing this database into a more user-friendly and commercially relevant resource (Foster et al., 2012). As of 2006, the NLD

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