



The language of induced seismicity: understanding the associated perceptions of seismic terminology

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Key questions

What do people associate with the words 'seismic' and 'earthquake'?

Do members of the public have defined implicit assumptions about the events being described by specific seismic terminology?

Introduction

Just outside Redruth in Cornwall a new Enhanced Geothermal System (EGS) power project is being developed, called the United Downs Deep Geothermal Power (UDDGP) project. As with other EGS projects in the past, a major concern of the production company, GEL, is the likelihood of induced seismic events occurring that are large enough to be felt at the surface and may disrupt the development of the power plant.

Whilst the company is monitoring the seismicity and is using a pre-existing fault zone to transport the fluid through the system, another important factor in managing public reaction is the language that is used to communicate both the potential for and any occurring seismicity.

Anecdotal there is a perception that using the word 'earthquake' in discussion with non-experts stimulates associations with the high magnitude events that are reported in the media (Carroll, 2019), but does this association actually exist?

Using a combination of social science approaches, this research aims to examine this assumption.

Are earthquake and seismic the same?

To set the parameters of the study it was first important to determine if the words 'earthquake' and 'seismic' which are often used interchangeably, actually have the same associations, using a word association assessment method called Semantic Feature Overlap (Maki *et al*, 2006). The study found a moderate degree of overlap, with 'earthquake' having a closer alignment with 'seismic' than vice versa (Fig 1).

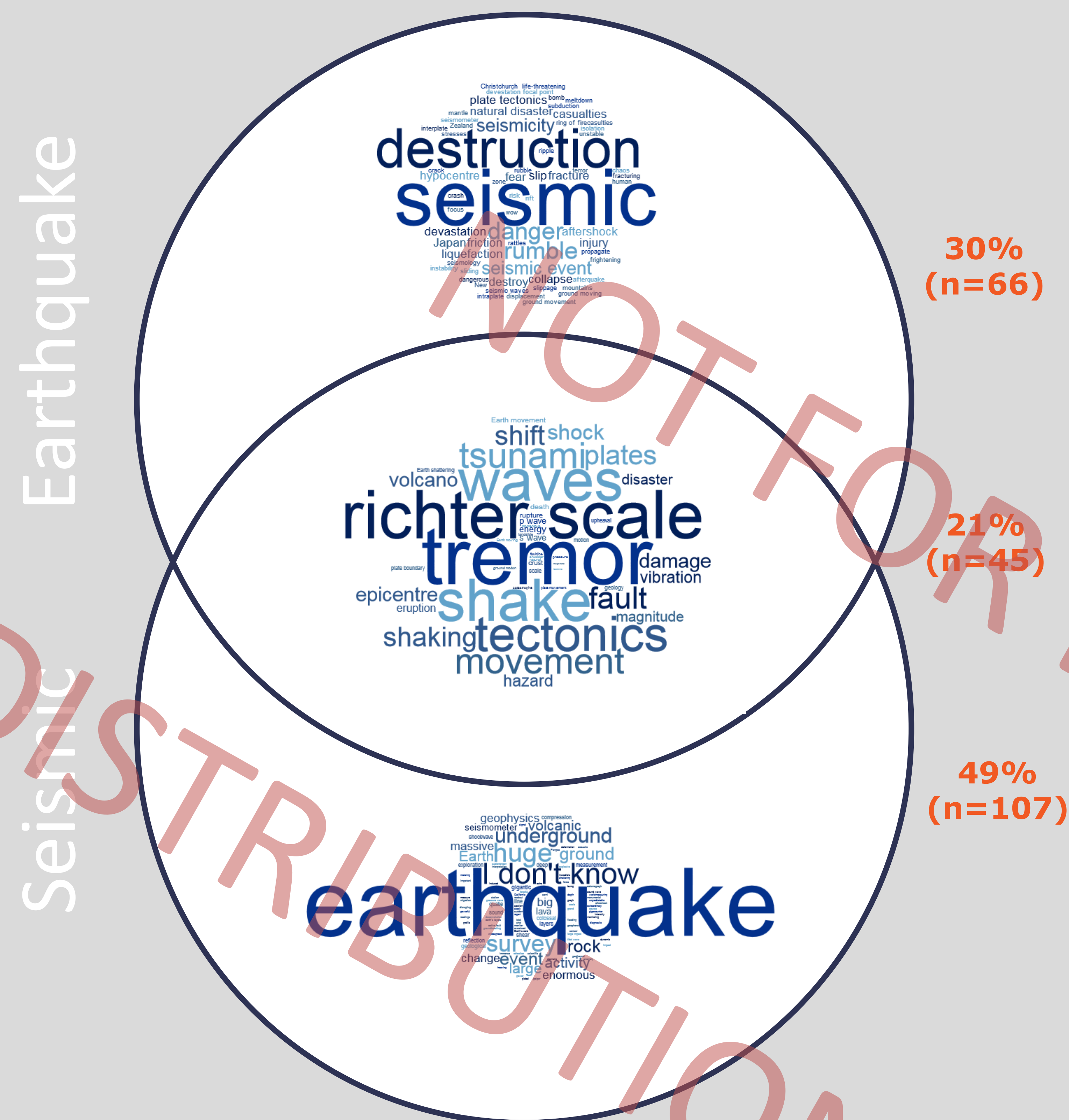


Figure 1: The Semantic Feature Overlap of the two stimulus words 'earthquake' and 'seismic'. The numbers on the right of the diagrams represent the percentage of unique words being used in association with these terms. There is a reasonable good degree of overlap, though seismic is less consistent in it's association that earthquake due to the greater variation of unique words being used. When examining the frequency of word use, the overlap remains moderate: earthquake 13% (n=111); overlap 52% (n=430); seismic 34% (n=283).

How big is an earthquake?

Given the degree of overlap between the terms (which increases when the stimulus words are included to 64%, n=526) it was decided to use these words as stimulus to examine the perceived impact. 'Tremor' was added due to it's prevalence in the overlap. The method uses Loftus and Palmer's (1974) eyewitness testimony approach which demonstrated the link between stimulus, language and scale of impact. The study is ongoing, so all results presented are preliminary.

Earthquake vs seismic vs tremor

Using Plymouth in the UK as the hypothetical epicentre, participants were asked to choose the radius that they thought the event would be able to be felt, with no quantifying data.

Thus far the mean impact radius for both 'earthquake' (black) and 'seismic event' (white) was practically the same, with 'tremor' (yellow) being much smaller (Fig 2).

However there was a much greater range of responses for the 'earthquake' stimulus (127.7km $\pm$ 185.6) compared to the 'seismic event' (128.8km $\pm$ 101).



Figure 2: Perceived impact radius for the stimulus words: 'earthquake' shown in black (127.7km $\pm$ 185.6), 'seismic event' shown in white (128.8km $\pm$ 101) and 'tremor' shown in yellow (28.04km $\pm$ 34.2) around a hypothetical epicentre of Plymouth in the UK.

'Micro' as a modifier



Figure 3: Perceived impact radius within one standard deviation for all modifiers of the stimulus words. 'Earthquake' consistently has the largest variation, 'tremor' has the smallest associated range and the most consistent values.

Adding 'micro' and 'induced' modifiers consolidates the data (Fig 3). Providing 'micro' as a qualifier to all terms reduces the perceived scale of impact and decreases the range of response for all terms, though 'earthquake' is still the least consistent (Fig 3).

Adding 'induced' as a modifier increases the scale of impact from 'micro', though this may be in part due to anchoring bias (Tversky and Kahneman, 1974).

Additionally induced was the modifier most likely to stimulate a query across all trigger words, though all 'seismic' variations had a higher proportion of clarification requests.

Conclusion

The way that people use language around seismicity has long been inferred to impact on their associations with the scale of reported events, particularly for non-experts. This study takes an experimental approach to the question of associations between language and perceived scale.

From preliminary results of this ongoing study it does appear that there is a some semantic association between the term 'earthquake' and large scale destructive events, but that the term 'seismic' is not that different. One of the key difference between the two terms is that non-expert participants were far more likely to request qualifying data when presented with the word seismic than the word earthquake. This has implications for the language choices professionals make when communicating induced seismicity.