E07

Study on the Spatial Distribution Characteristics of Natech Events in United States

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Introduction

Natural hazard triggered hazardous material (hazmat) release accidents are considered as Natech events. According to the previous studies, Natech events can not only cause huge economic losses [12] but also cause long-term effects on human health and the environment (e.g. Fukushima nuclear accident[3]).

Due to climate change, the risk of natural hazards and extreme events have increased[4–6]. As a result, it is a critical to analyze how past Natech accidents are spatially distributed over time to check if climate change is effecting Natech incidence. Most past studies are focused on Natech events that happened during a single natural hazard at the local scale, and what lessons learned from past events. However, only a few studies have investigated the incidence of Natechs in a wider area in the US and in Europe. Sengul et al. studied the frequency of Natechs per state, and Santella *et al*[7] determined conditional probabilities of Natechs per natural hazard affected area in the US. However, none of the previous studies have looked at the spatial distribution of Natech accidents based on geographical location at the national scale. Understanding the spatial distribution of Natech events is important for assessing Natech risk on a regional scale and meaningful for policy formulation on Natech risk prevention and management.

Study area and data collection

In this study, we choose the United States (US) as the study area. As a big industrial county, the US has suffered many Natech events in the last century and the beginning of this century. According to Sengul *et al.* (2012) [7], there were 16,600 Natech events (3% of all hazmat release accidents) reported to the National Response Center (NRC) database during 1990 to 2008. Furthermore, Natechs continue to be reported every year to the NRC. The availability of data from the US Coast Guard's NRC database which contains records of all reports of hazmat release accidents in US (including Natechs) from 1990 until the present; and the fact that there are many open source data for the US (e.g., USGS, NASA, EPA) makes it ideal for this case study.

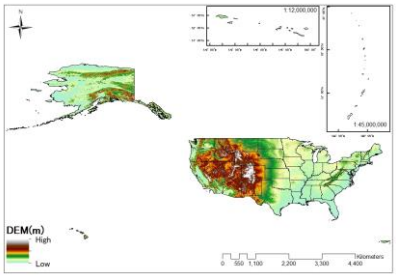

Figure 1 Study Area

All NRC data files from 1990 to 2017 were downloaded from NRC (http://www.nrc.uscg.mil/). By combining natural language processing methods such as the long short-term memory and key word retrieval methods, the field of "incident description" in the NRC database was analyzed. A total of 32,913 accidents were labeled as Natech events.

Table 1. Number of hazmats and Natechs (1990-2017)

Number of hazmat releases	Number of Natech events	Natech in fixed facilities	Natech events per year
826099	32913(3.98%)	18976	1219

In this study, google map API was employed to update the location information of Natech events. Spatial statistics was used to analyze the spatial clustering of Natech accidents over time. Kernel density analysis

was employed to understand how the distribution center (hot spot) of Natechs changed over time.

Result and discussion

We divided Natech events into two groups, one is the Natech events from fixed facilities and the other one is pipeline Natech events. Using spatial statistics in an ArcGIS 10.5® environment, we find Natech affected grids, and estimate the total affected area per year. Due to limited space, we show the results for a few y, we got the area changing resuears in Table 2. By comparing the kernel density analysis result (shown in Figure 2), we see that the area for pipeline Natech events is getting larger. The area of Natech events at fixed facilities increases first and then decreases.

Table 2. Natech effected area in different type and years(km^2)

	Fixed Facilities	Pipeline
1990	1,416,422.00	833,833.68
1997	1,791,131.05	1,028,457.27
2004	2,295,165.42	1,288,624.62
2010	2,168,016.40	1,614,768.95
2017	2,088,854.12	1,776,250.28

Figure 2 shows the distribution of fixed facilities, Natech events at fixed facilities and pipeline related Natech events. The distribution of Natechs at fixed facilities is related to the distribution of the fixed facilities, but the spatial centers are different. The spatial centers of facilities did not change so much, however, the spatial centers of Natechs at fixed facilities changed particularly in the eastern part (near New York), eastern-middle part (near Indiana), western part (middle of California) and the southern part (around Texas) of the US. However, for the pipeline Natech events, the spatial centers did not change so much and they were always around Texas and Florida.

Conclusions

The study showed that the distribution of Natech coincides with the distribution of fixed facilities. But the spatial centers of Natech events are not related to the spatial centers of facilities, in fact they seem to be related to the areas affected by natural hazards.

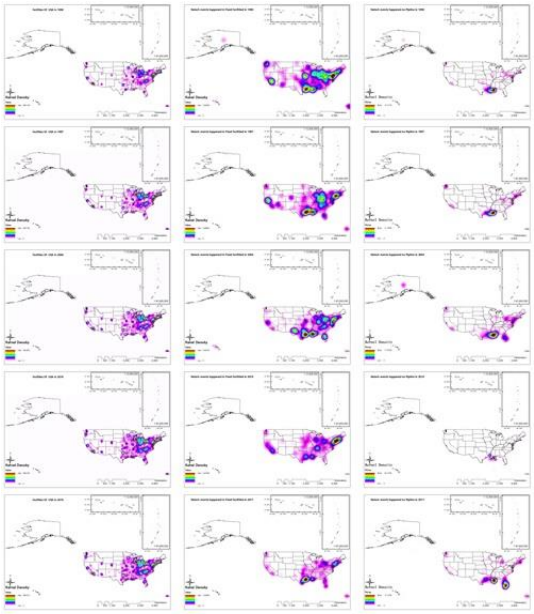

Figure 2. Kernel density result (a) facilities (b) Natechs at fixed facilities, and (c) pipeline Natech events.

Reference

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