

# Incidence of chemical accidents caused by natural hazard events in Japan

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# 1. Introduction

- The Great East Japan Earthquake in 2011 caused widespread damage to buildings, people and society.
- Many high pressure facilities were also damaged. For example, at Cosmo oil refinery in Chiba.
- The analysis of chemical accidents caused by natural hazard events is important to understand accident mechanisms, failure modes, consequences, etc., which provide lessons learned for improved chemicals management.

## 2. Background

- Chemical accidents due to natural hazard events have been studied in other countries (for example Sengul et al. 2012).
- They found Natechs account for about 3-7% annually of all chemical accidents reported to databases in the United States and in Europe.
- But, in Japan there are few analysis of these accidents.
- The High Pressure Gas Safety Institute studied accidents involving high pressure gases.
- Their focus is accidents that occurred between 2008 and 2012(Kobayashi (2014)).
- They found accidents related to the High Pressure Gas Safety Act have been caused by human factors, inadequate facility design and fabrication defects, inadequate facility maintenance and management, and natural hazard events.

### 3. Objectives

- To identify and extract natural hazard triggered chemical accidents (known as Natechs) from the database of accidents related to the High Pressure Gas Safety Act in the period 1965-2014.
- To analyze the frequency of Natechs in Japan by location, types of hazard trigger, types of activity, and types of accidents.
- To make recommendations on countermeasures.

## 4. Methodology

- The Database used in this study was provided by the High Pressure Gas Safety Institute in Japan.
- The database is an excel file containing accident records from 1965 to 2014.
- Accident are reported by industry to local prefecture and then to national government.
- Natech accidents were identified and extracted using causes such as “natural phenomena” and also by using keyword search (ex., Earthquake and Flood).

# 5. Results and Analysis

Figure 1-a. Number of accidents involving high pressure gases in Japan (1965 to 2014)

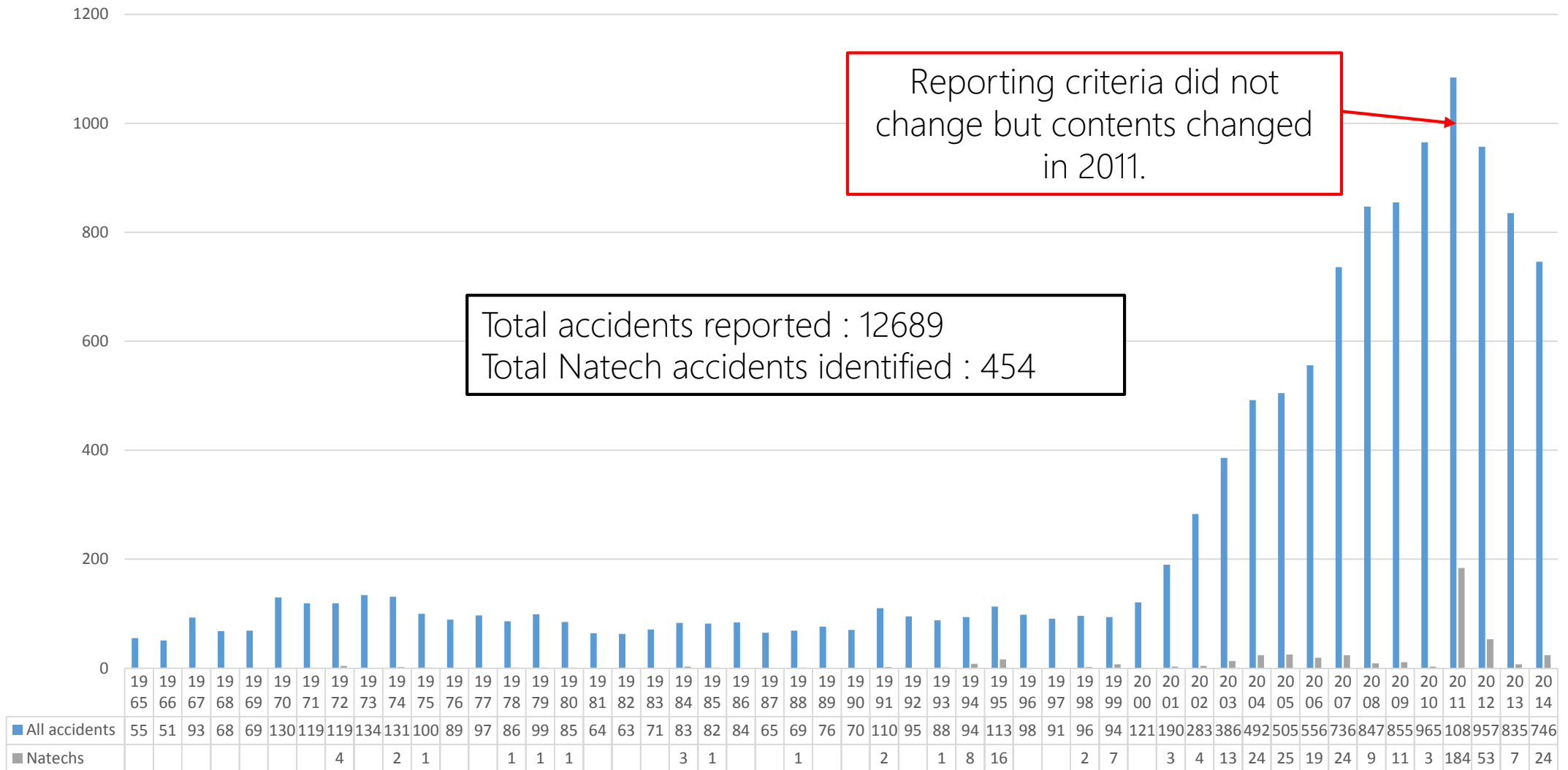




Figure 2. Number of accidents caused by each natural phenomena (1965 to 2014)

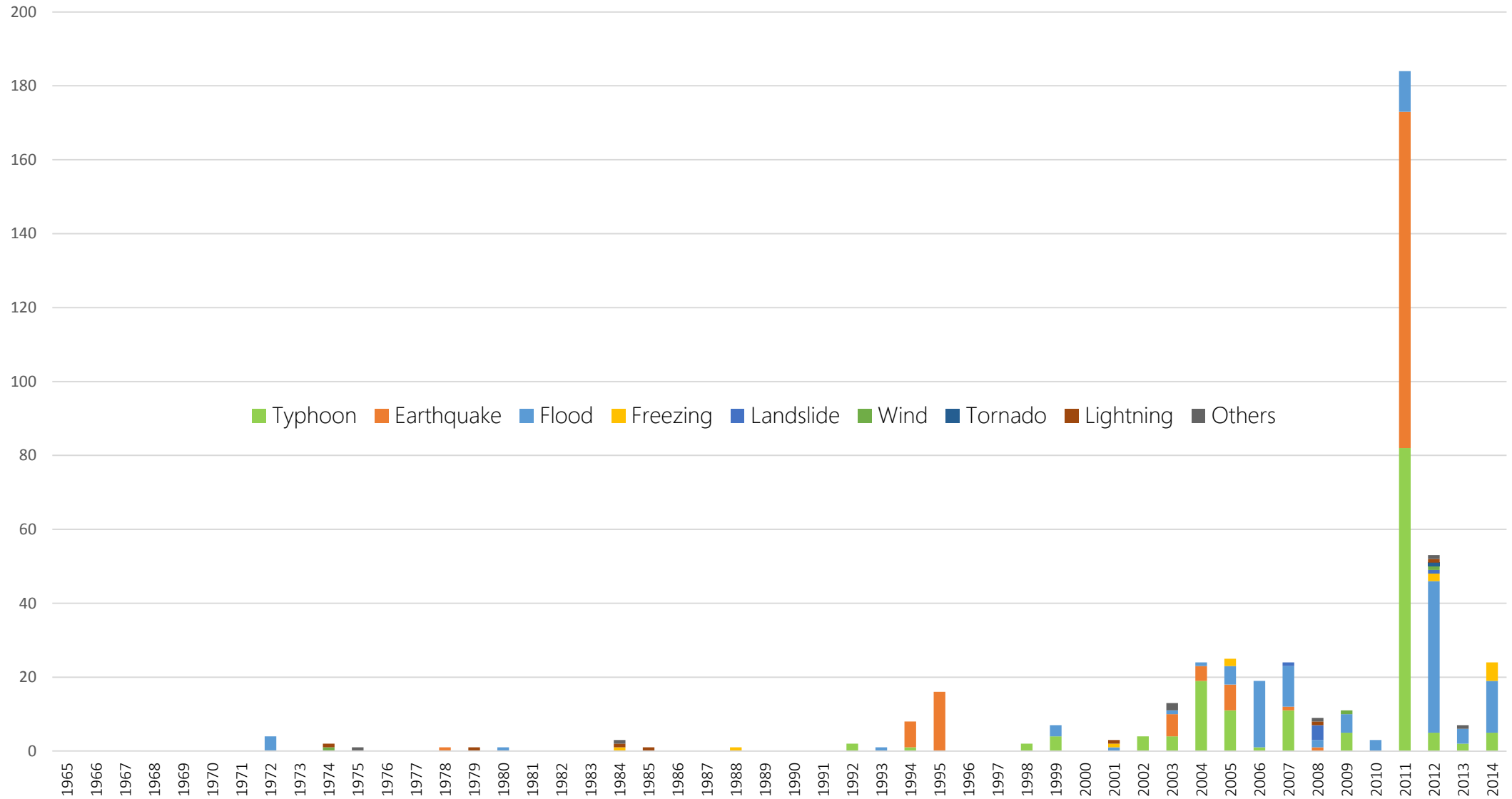




Figure 3. Number of accidents caused by each natural phenomena (1965 to 2014)

- Typhoon : 158
- Earthquake : 134
- Flood : 126
- Freezing : 12
- Lightning : 7
- Landslide : 6
- Wind : 3
- Tornado : 1
- Others : 7

92%

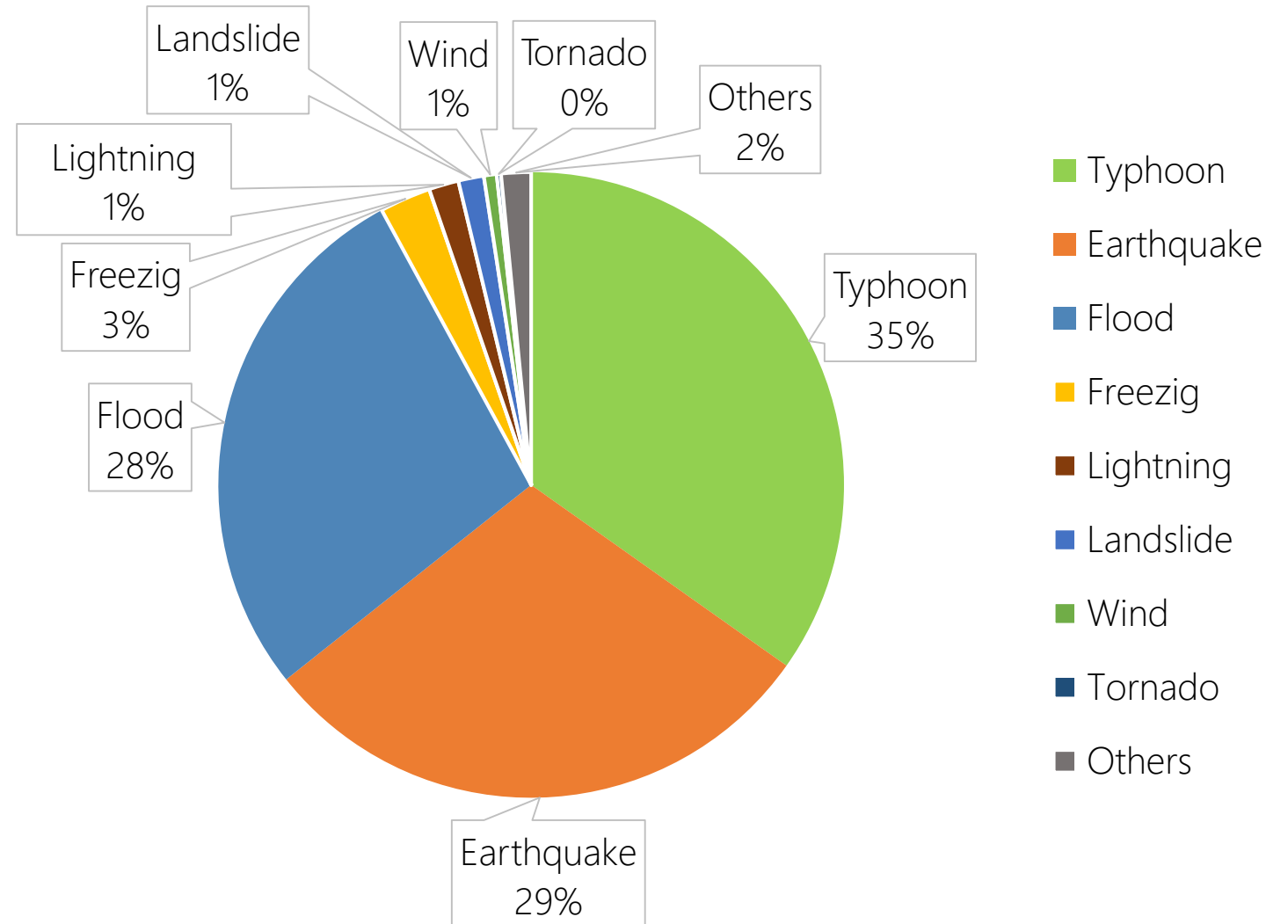




Figure 5. Number of natural disasters in Japan (1965 to 2015)

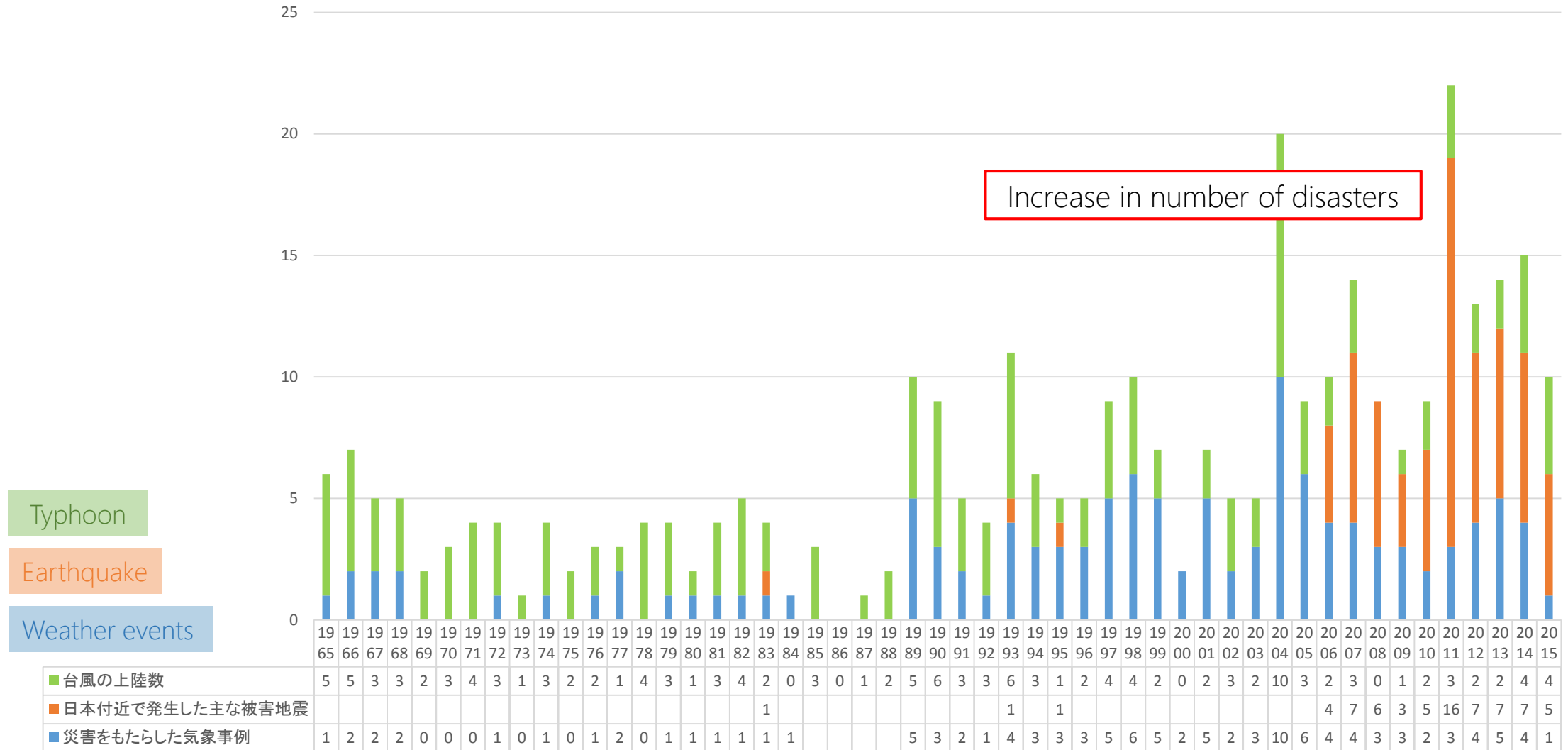


Figure 6. Geographical distribution of Natechs (1965 to 2014)

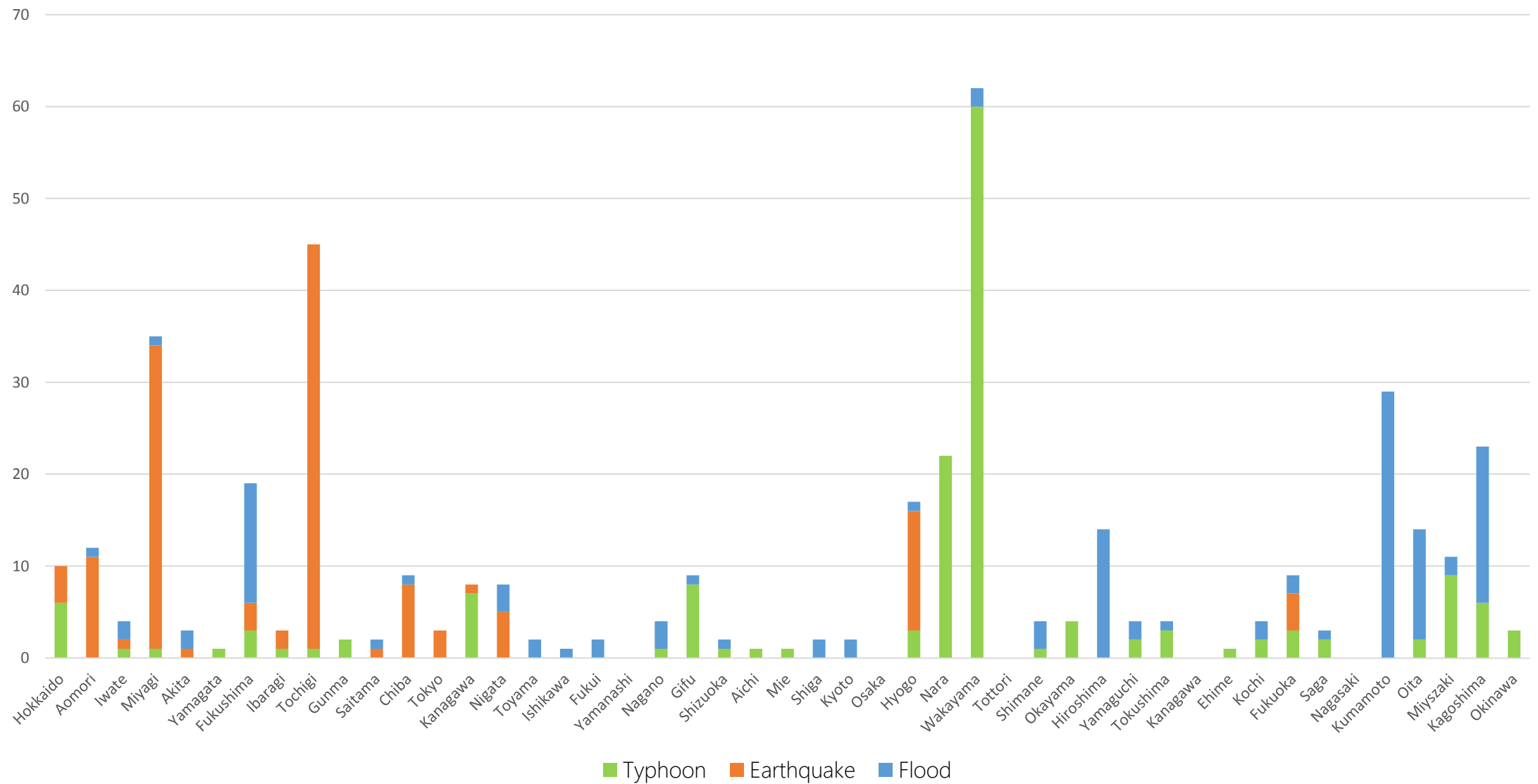


Figure 7. Distribution of Natechs by types of activity

- Industry

(for different tiers :

Normal, Refrigeration, Conbinato, LPG)

- Transfer

- Consumption

- Other

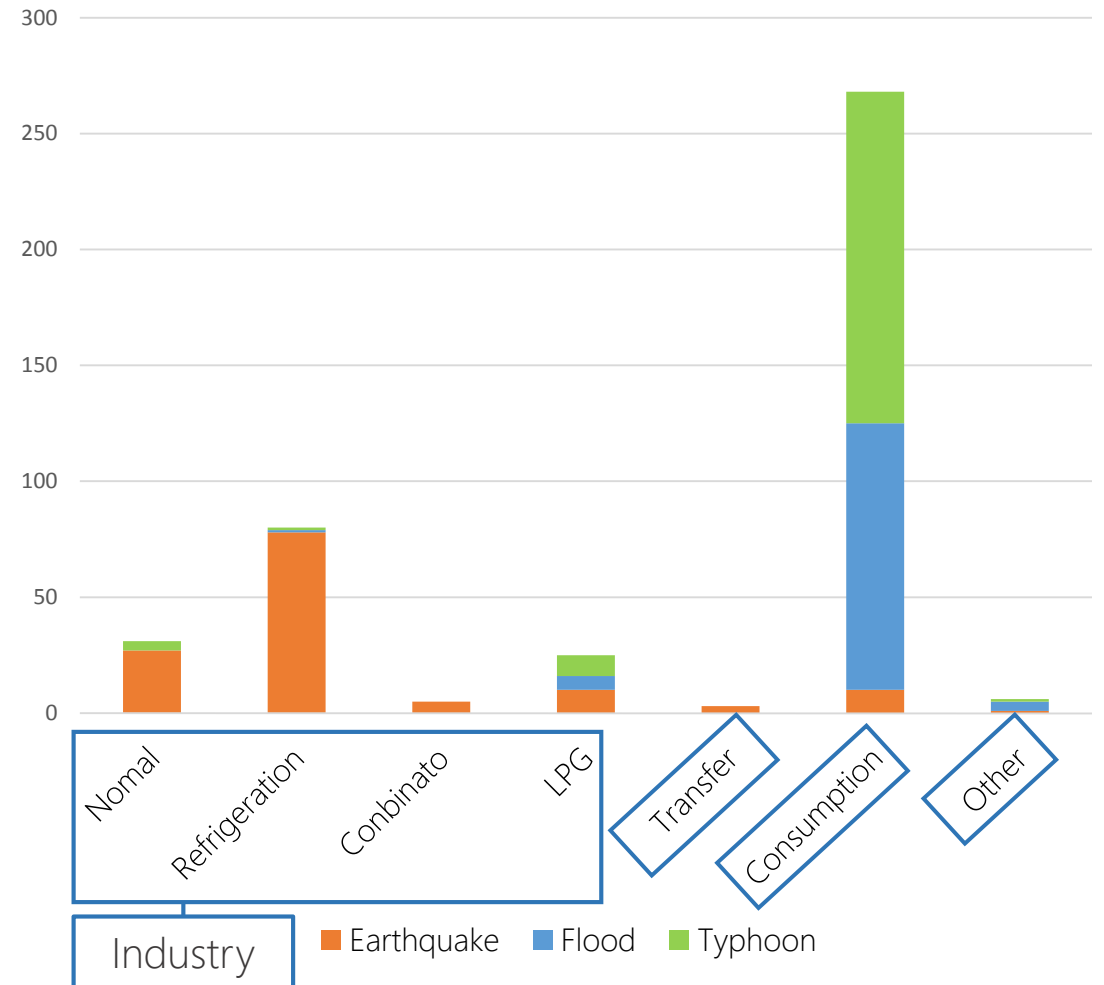


Figure 8. Distribution of Earthquake Natechs by type of accident

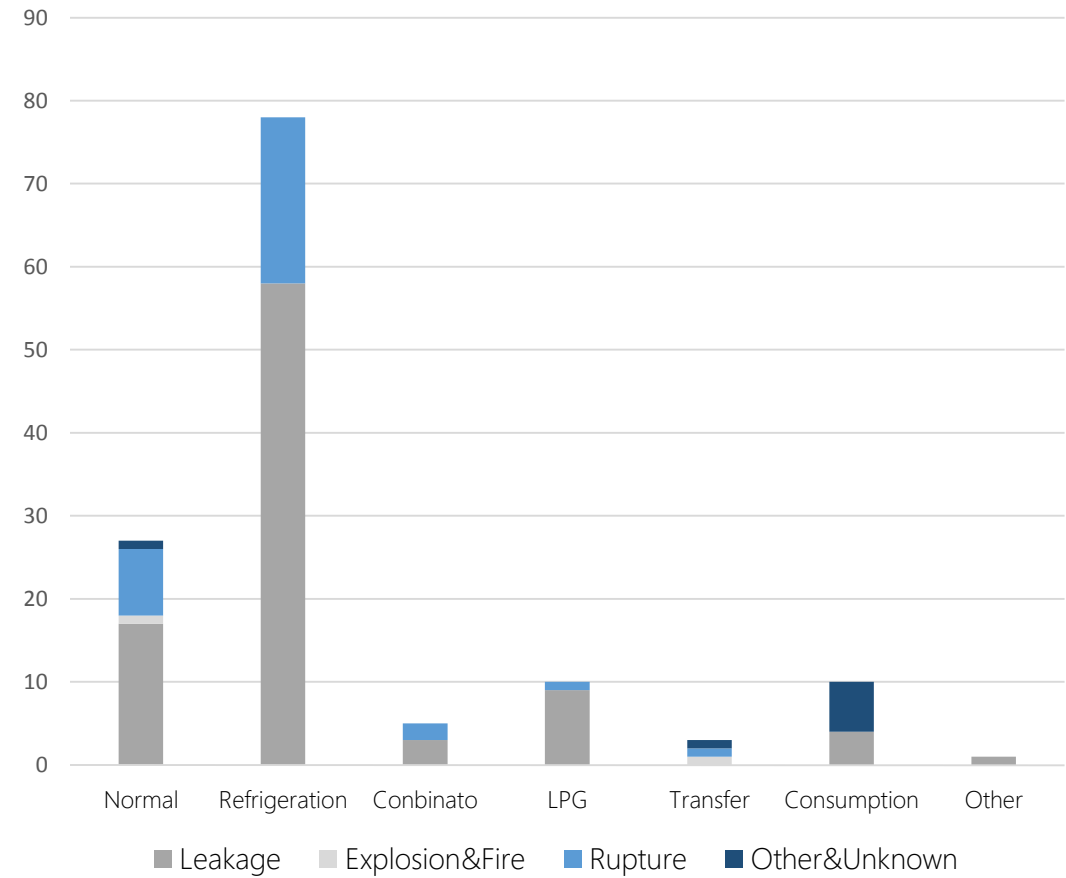
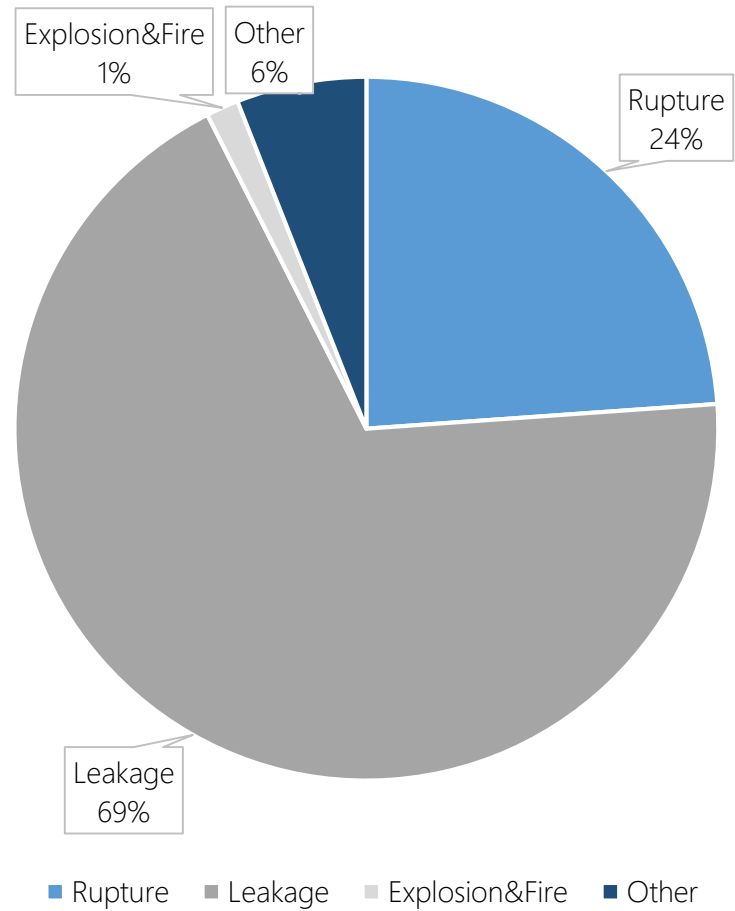


Figure 9. Earthquake & Tsunami Natechs / the Great East Japan Earthquake

- 86 accidents (64.2% of the total earthquake natechs) were caused by the Great East Japan Earthquake in 2011.

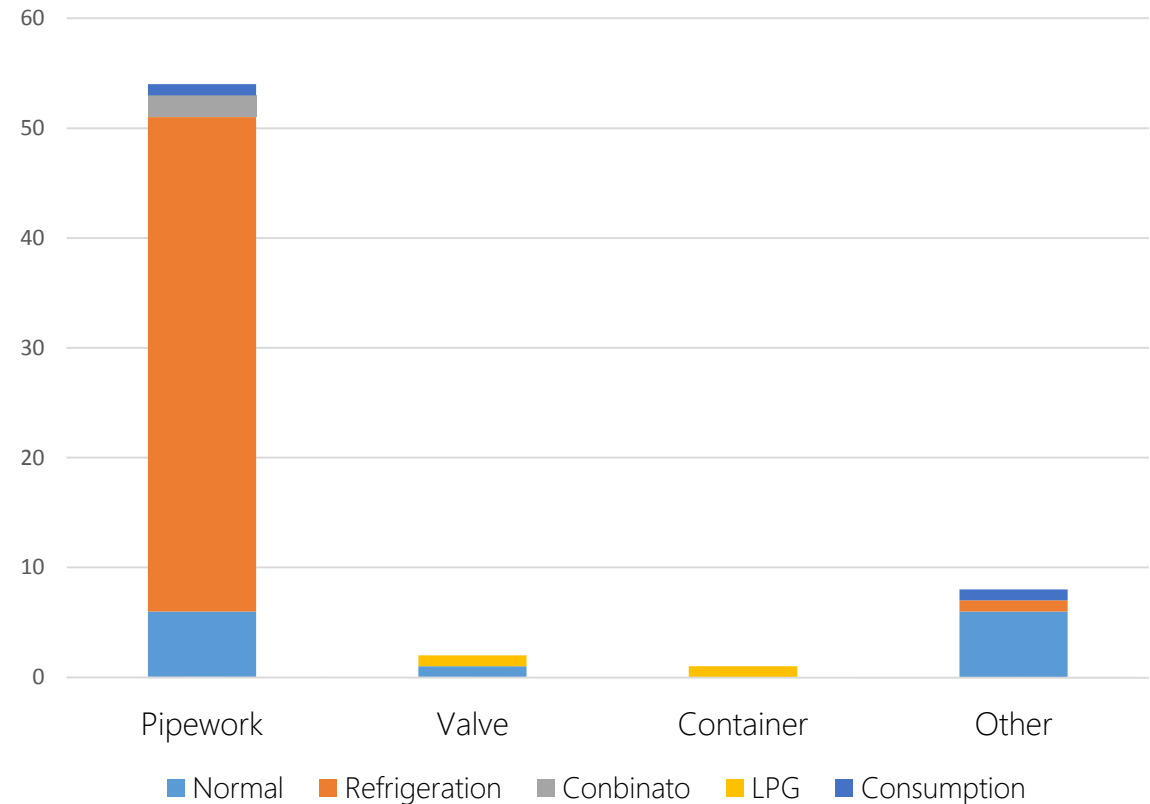
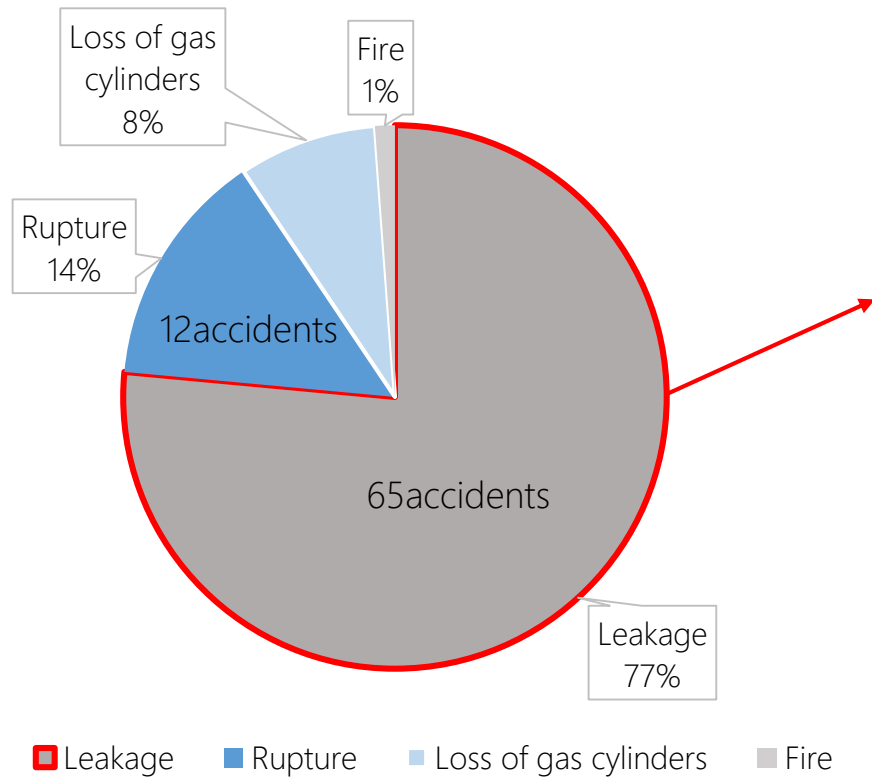


Figure 10. Earthquake & Tsunami Natechs / the Great East Japan Earthquake

- Types of released materials

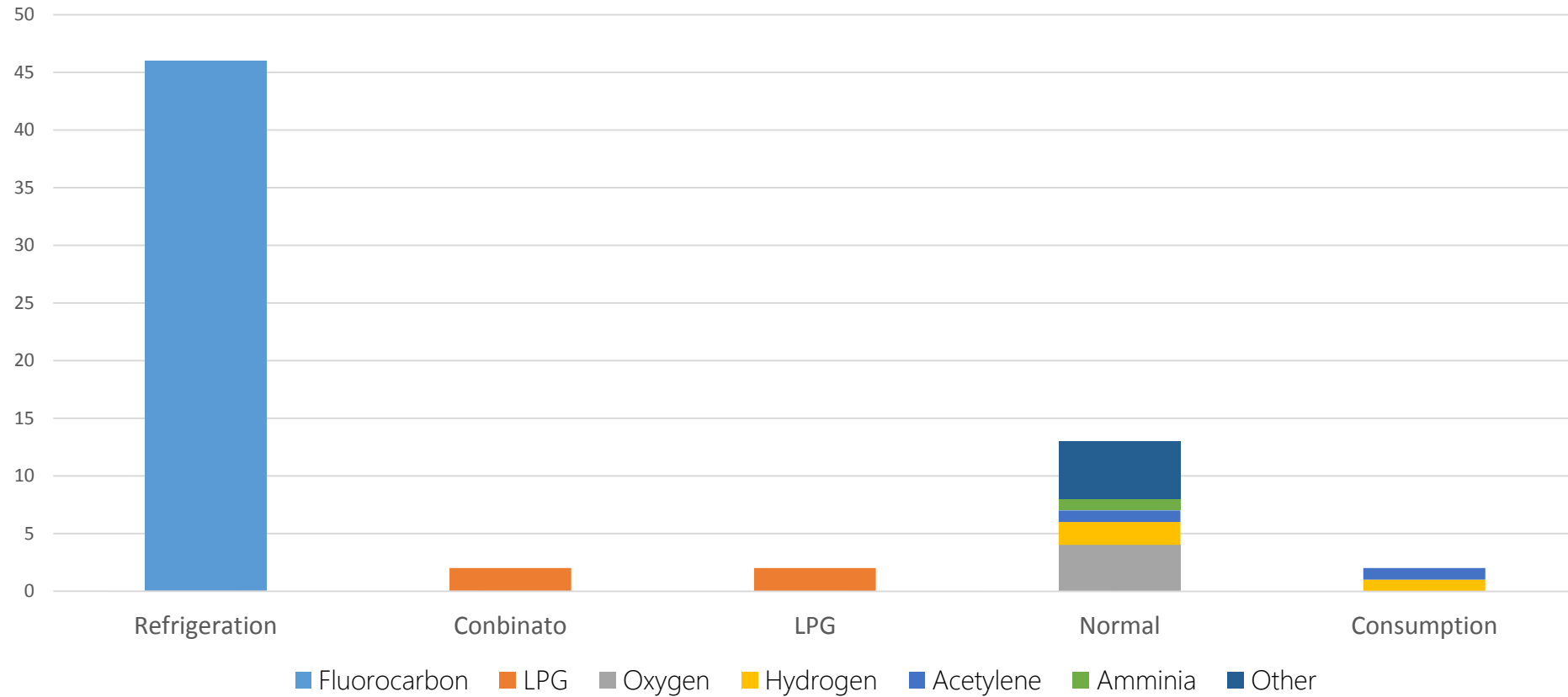




Figure 11. Earthquake & Tsunami Natechs / the Great East Japan Earthquake

- Number of accidents released hazardous materials

Quantity of released materials (kg)	Refrigeration	Conbinato	LPG	Normal	Consumption
Moderato	1				
1~15	2				
16~50	10				
51~100	5				
101~150	17				
151~500	5				
5000	1				
5,227,000		1			
9000			1		
Unknown	6	1	1	12	2

LPG, at Cosmo oil refinery in Chiba

LPG, at LPG station in Miyagi

Figure 12. Distribution of Flood Natechs by type of accident

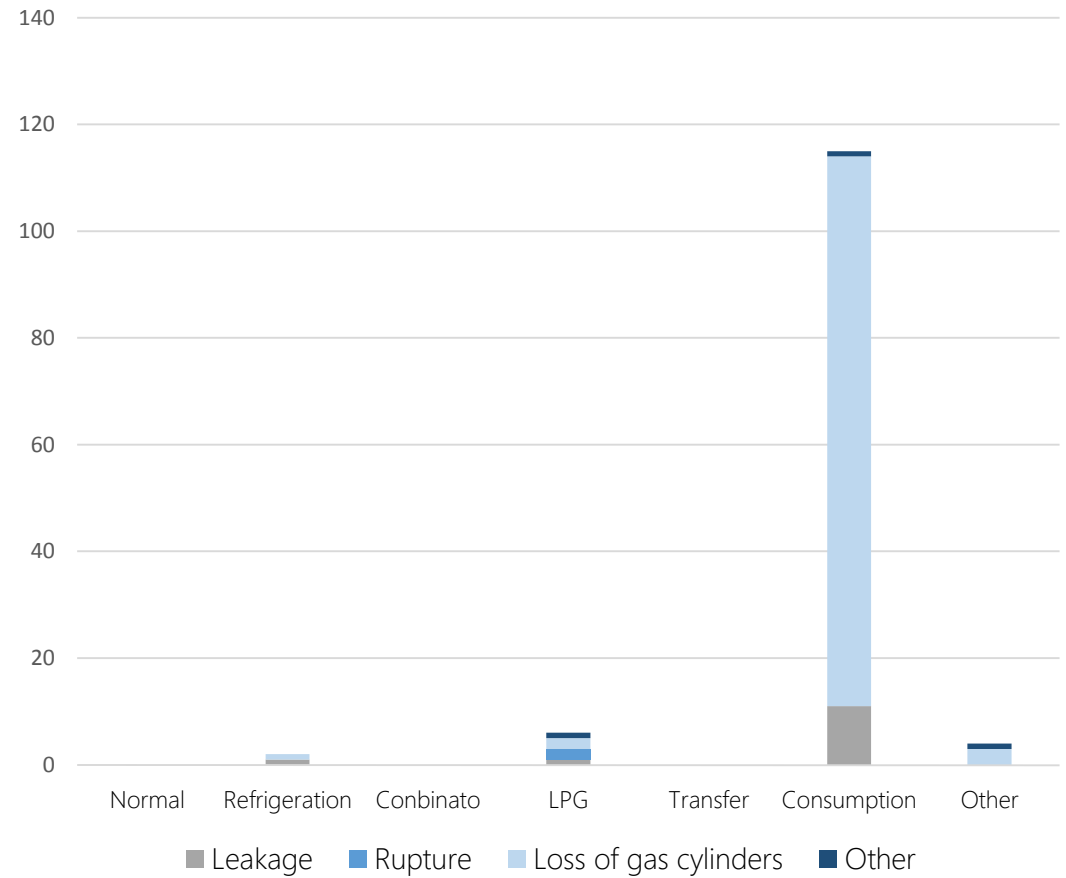
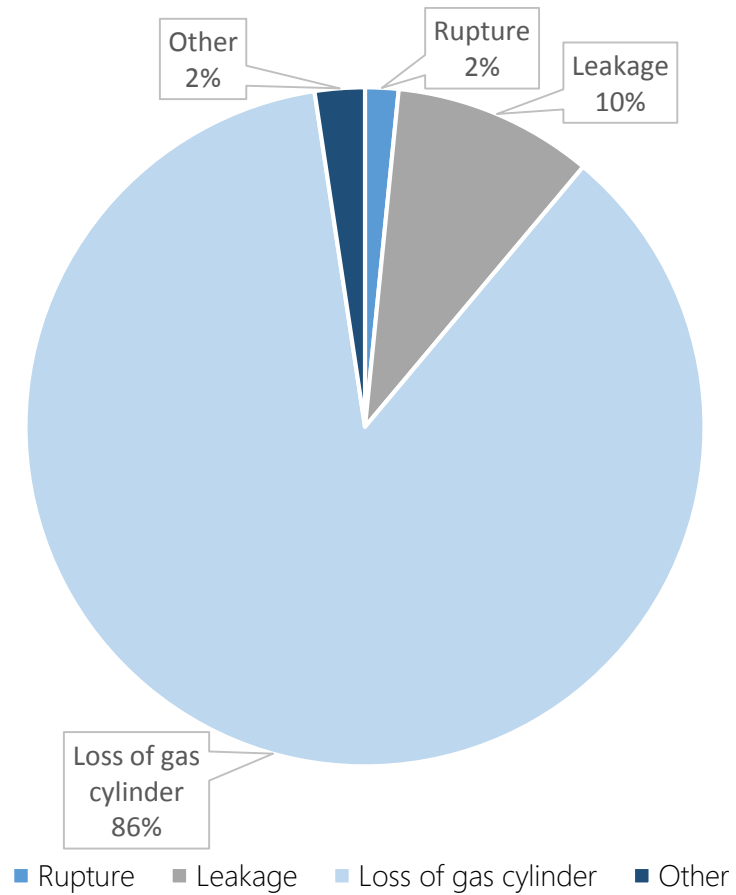
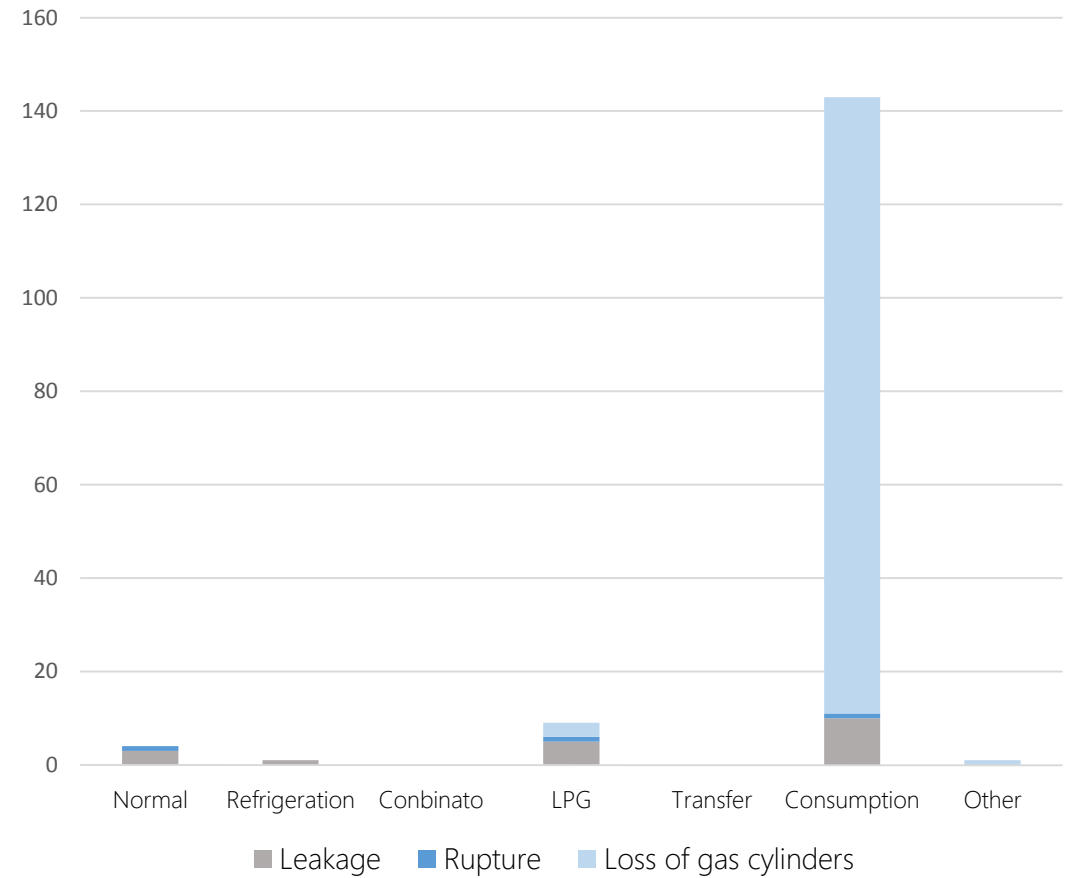
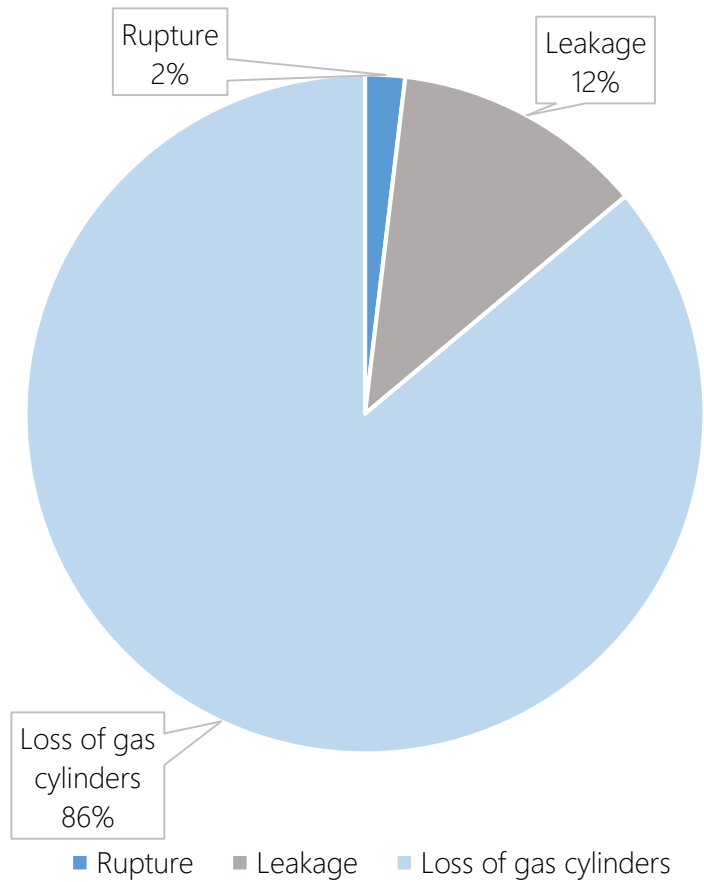


Figure 13. Distribution of Typhoon Natechs by type of accident



## 6. Conclusions

- In recent years, the number of accidents related to the High Pressure Gas Safety Act caused by natural hazard events in Japan has been increasing. (This is worrying because Japan is one of the most disaster prone countries in the world.)
- Earthquake related Natechs caused rupture and leakage (93% of the total), and these accidents mainly occurred in industry (88% of the total).
- Flood and Typhoon related Natechs caused loss of gas cylinders, and these accidents mostly occurred at service and distribution stations.

## 6. Conclusions

- Flooding and Tsunami caused loss of gas cylinders due to floating off at service and distribution stations.
  - Improvements concerning anchoring and fixing mechanisms are needed.
- Earthquakes mainly damaged pipelines.
  - Use of flexible pipes.
  - Improvements to pipe supports and chains.
- Accidents reports are made per facility.
  - Some accidents involved multiple accidents.

## 7. Future works

- Understand why accidents and Natech accidents are increasing since 2000.
- Better understand why some prefectures with seemingly little industry have many accidents (ex. Wakayama and Nara).
- In this study I analyze primary accident. It is interesting to analyze secondary accidents.
- This study analyzed accidents related to the High Pressure Gas Safety Act, but future studies should also investigate other chemical accident databases.