

GEOMORPHOLOGICAL ANALYSIS OF MARINE ACCIDENTS HOTSPOTS IN KOREA

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CONTENT

1. Research Background and Research Objective
2. Data and Methodology
3. Patterns of the Marine Accidents Occurred in Korea
4. Geomorphological Characteristics of the Hotspots
of the Marine Accidents
5. Conclusion

1.1 Research Background

- Marine accident means all types of accident happened on the sea surface.
- In Korea, the number of the marine accidents has consistently been increased since 1980
- It multiplies nearly tenfold from 1980 to 2016

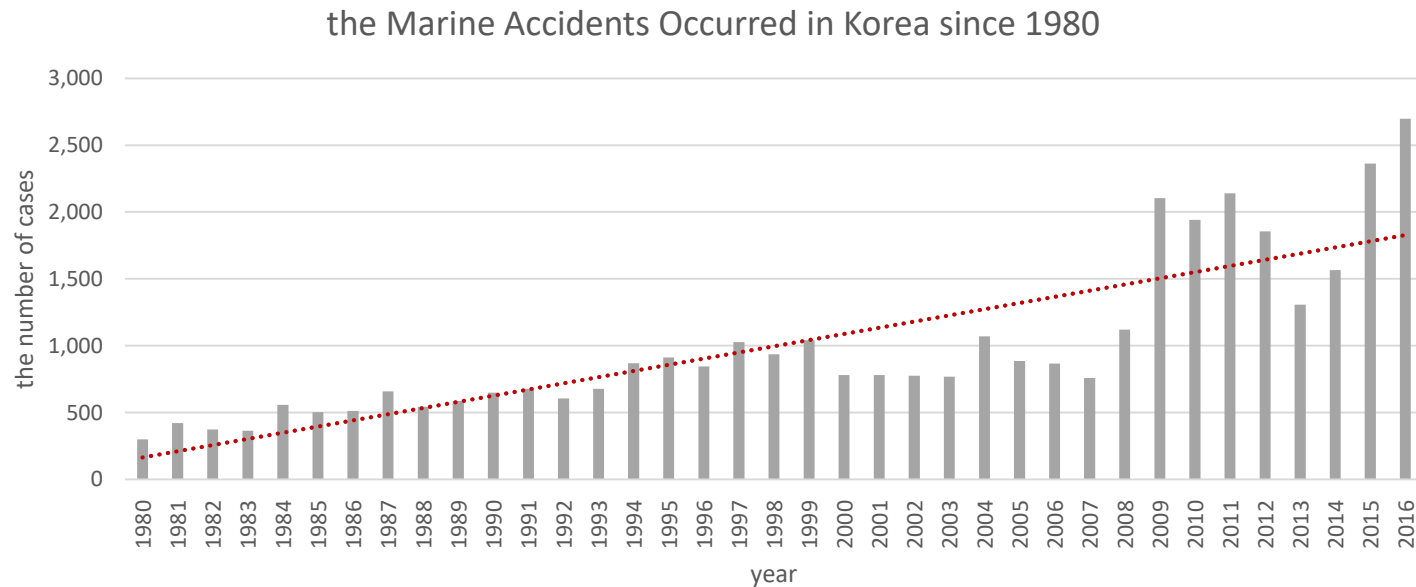


Figure 1 Marine Accidents Occurred in Korea since 1980
(data source: KOREA TRANSPORT DATABASE,)

1.1 Research Background

- Also, many researches about factors on marine accidents have been conducted. But mostly, the researchers focused on human factors. (Lee, 1969, Lim, 1974, Park, 1007, Yang, 2013, Jeong, 2016).
- However, it is essential to take account various factors including natural environmental elements(Lee et al., 2011, Jeong et al., 2013, Marty et al., 2005, Jackson et al., 1985, Uluscu et al., 2009).
- Out of many aspects that cause marine accident, this study is focused on geomorphological factors.

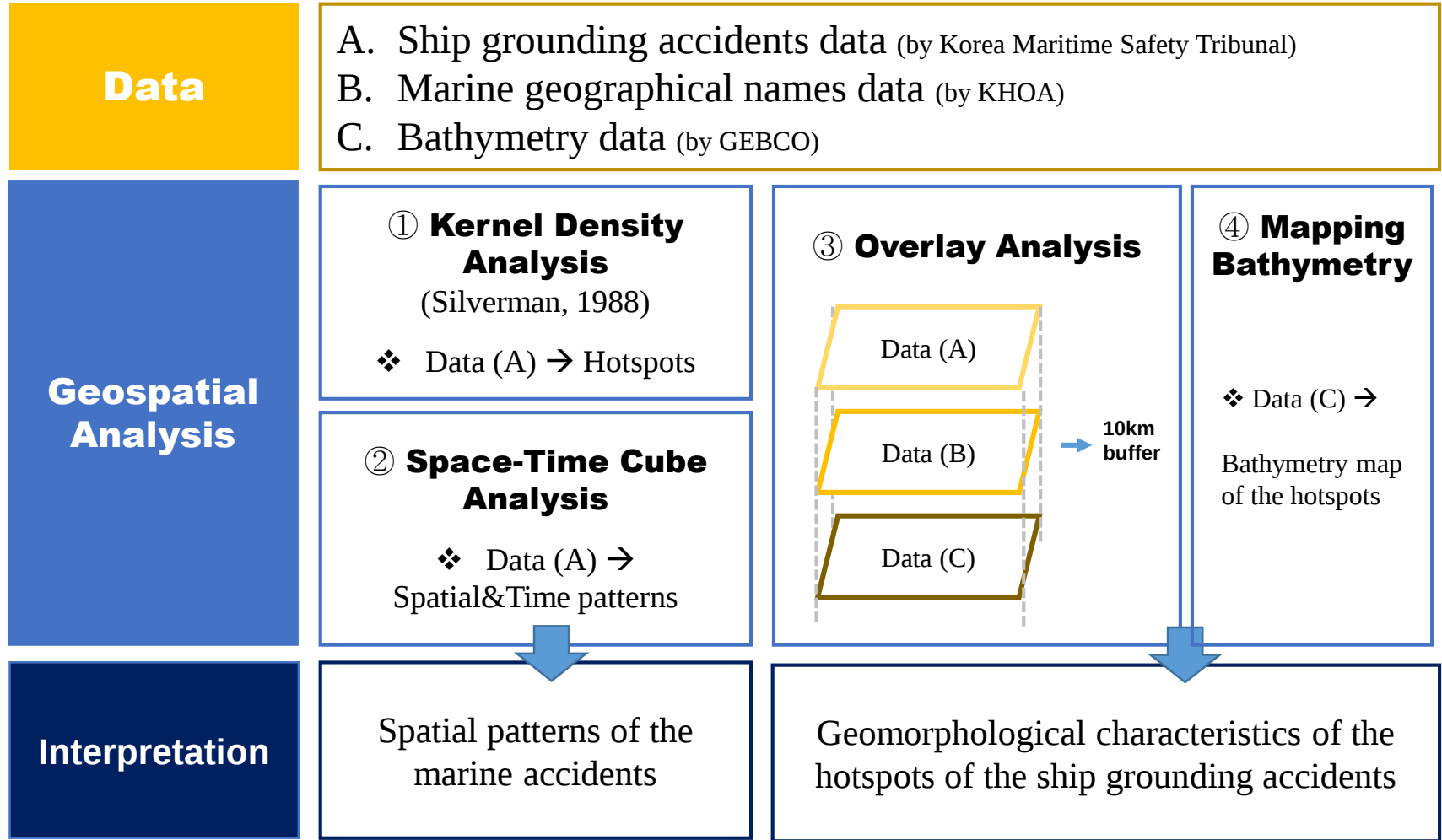
1.2 Research Objective

- The aim of the study is;

- A. to analyze **space-time patterns** of the marine accidents
- B. to find **geomorphological characteristics** of the hotspots of the marine accidents

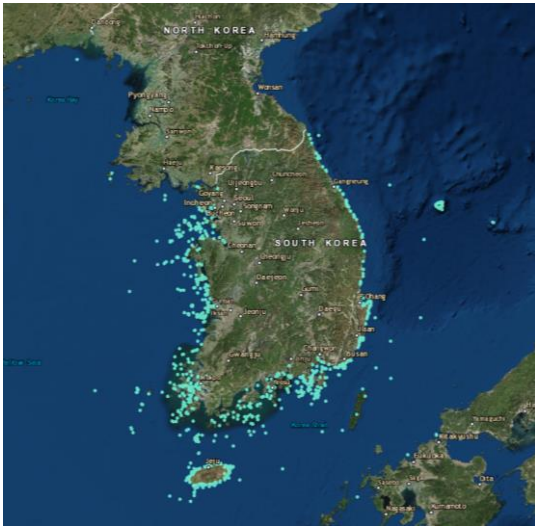
- There are various types of the marine accidents from collision to fire on the ship.
- However, this study is concentrated on ‘ship grounding’ among types of the marine accidents, which the cause is not researched enough in Korea.

2. Data and Methodology



2. Data and Methodology

Data (A)
(KMST)



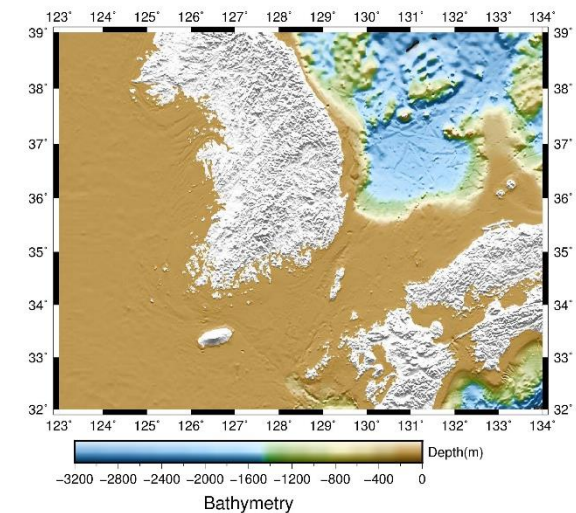
- Location of marine grounding accidents
- Time : 1997-2016
- Around 1,000 Point data

Data (B)
(KHOA)



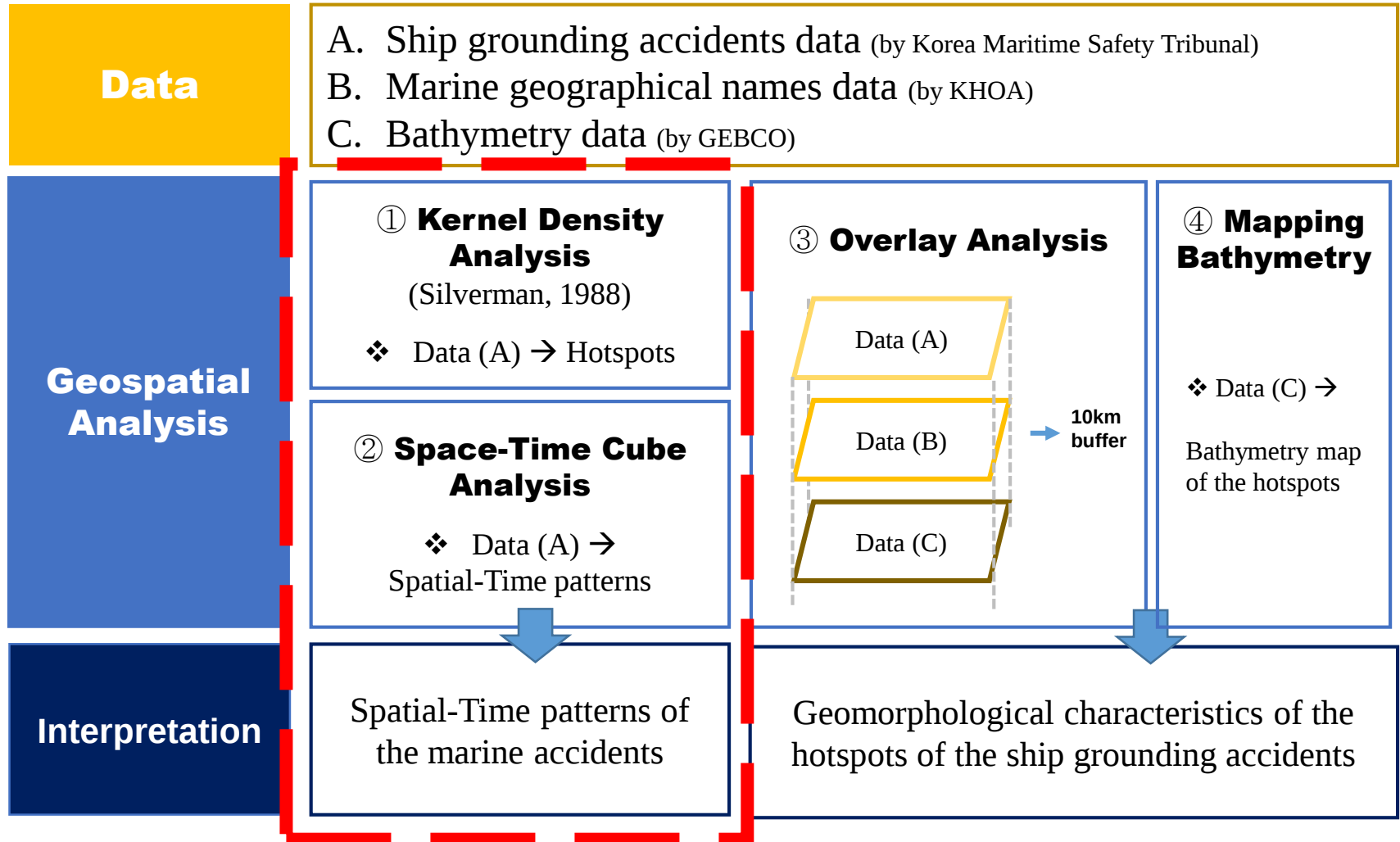
- Location of marine geographical names
- Generic Terms: Sea, Gulf, Bay, Strait, Passage, Rock, Reef etc.
- Around 960 point data

Data (C)
(GEBCO)



- Bathymetry data around Korea

2. Data and Methodology



2. Data and Methodology

- Kernel Density Analysis (ArcGISpro 1.4)

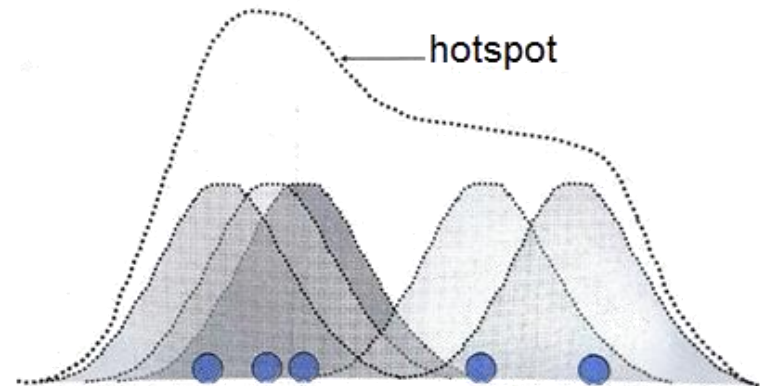
The kernel density analysis is based on the quartic kernel function(Silverman,1986).

$$\hat{f}_h(x) = \frac{1}{nh} \sum_{i=1}^n K\left(\frac{x - x_i}{h}\right)$$

$$K(x) = \frac{3}{4}(1 - x^2), |x| \leq 1$$

$$K(x) = 0, x > 1$$

h is the bandwidth,
x-X_i is the distance to each village with anthrax *i*.
K is the quadratic kernel function.



Density is estimated using two different distance parameters in the respective kernel functions

2. Data and Methodology

- Space Time Cube and Emerging Hot Spot Analysis (ArcGISpro 1.4)
 - The Hot Spot analysis method is calculating the Getis-Ord G_i^* statistic.

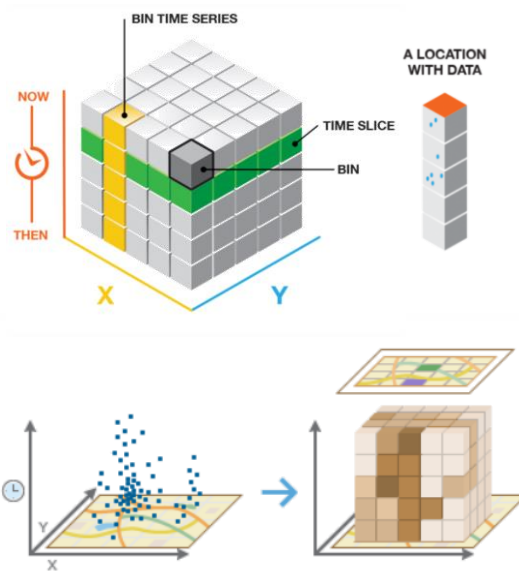


Figure 2 Illustration of space-time cube
(pro.arcgis.com)

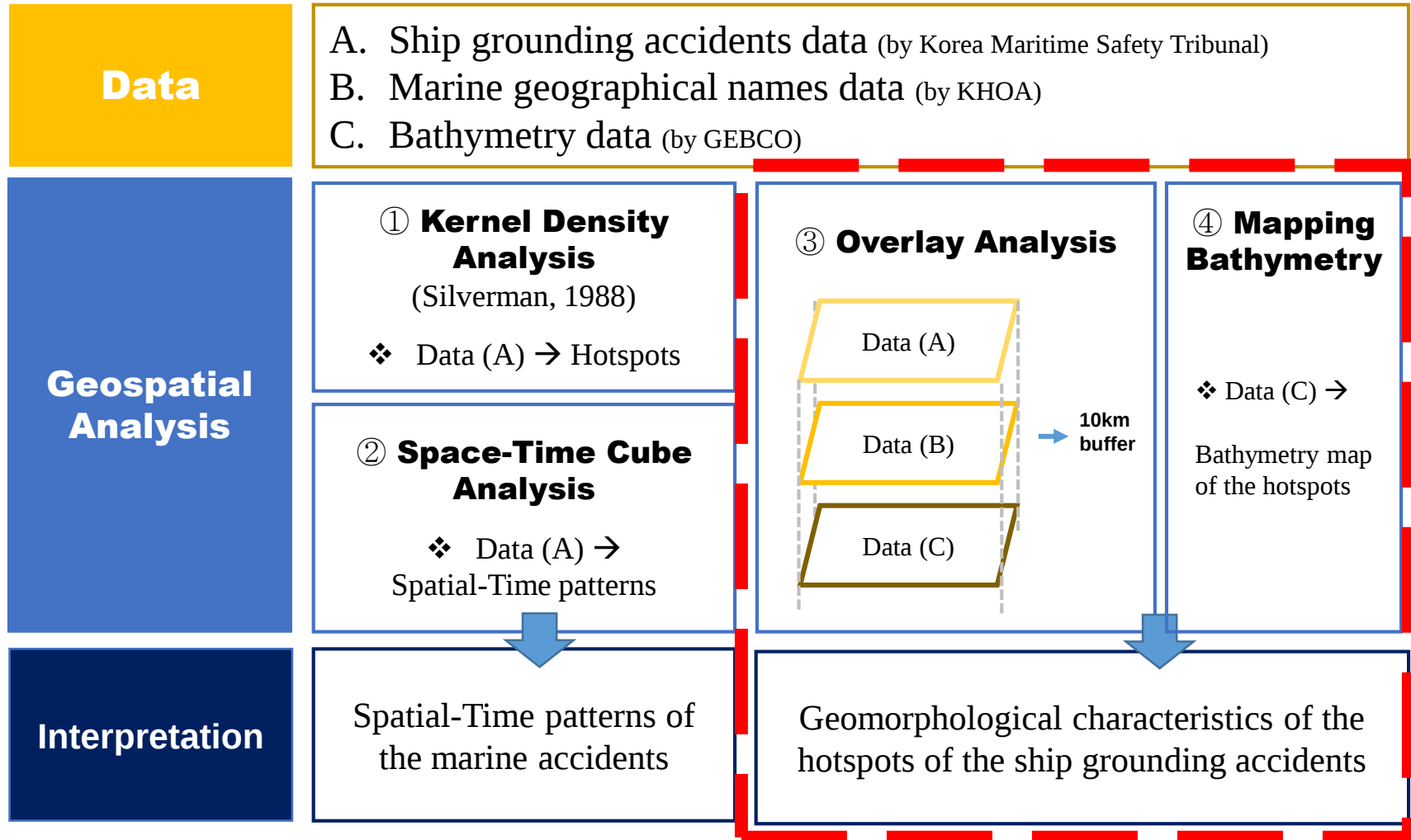
$$G_i^* = \frac{\sum_{j=1}^n w_{i,j} x_j - \bar{X} \sum_{j=1}^n w_{i,j}}{S \sqrt{\frac{n \sum_{j=1}^n w_{i,j}^2 - \left(\sum_{j=1}^n w_{i,j} \right)^2}{n-1}}}$$

$$\bar{X} = \frac{\sum_{j=1}^n x_j}{n}$$

$$S = \sqrt{\frac{\sum_{j=1}^n x_j^2}{n} - (\bar{X})^2}$$

x_j is the attribute value for feature j
 w_j is the spatial weight between feature i and j .
 n is equal to the total number of features

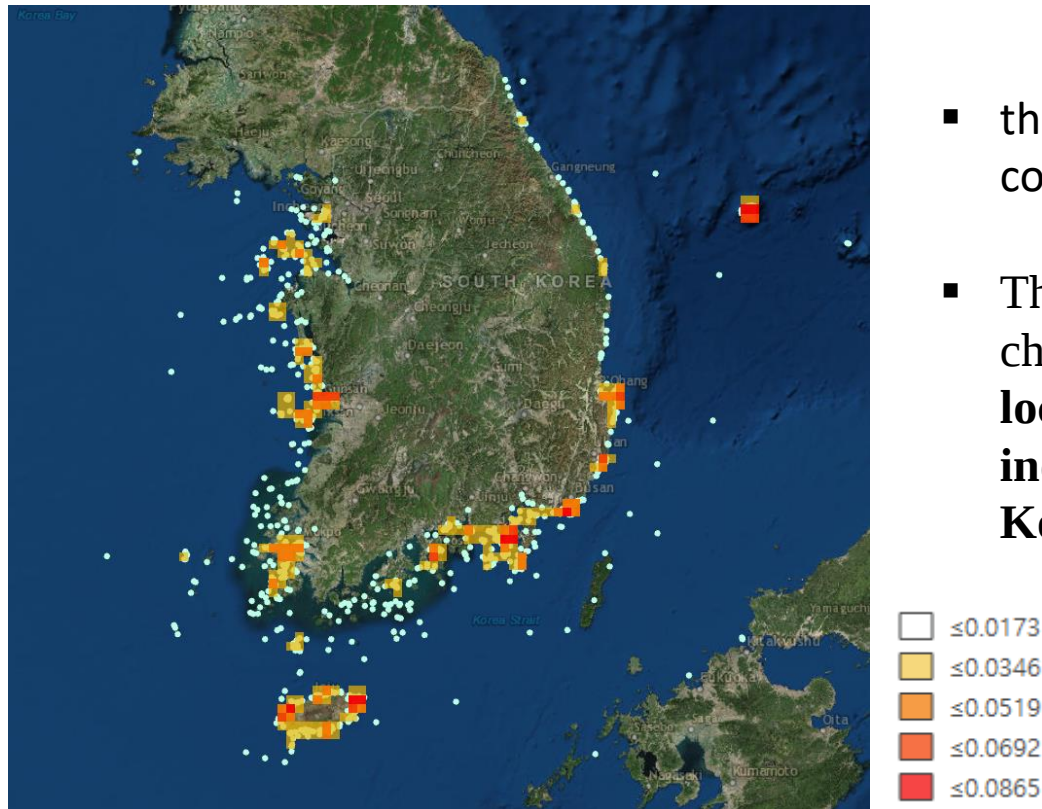
2. Data and Methodology



3. Patterns of Marine Accidents Occurred in Korea

3.1 Kernel Density map

- The figure 3 is Kernel Density map of the grounding accidents



- the Yellow Sea and southern coast of Korea
- The Hotspots were characterized by **major port location** and **port-based industrial distribution of Korea.**

Figure 3 Kernel Density map of the Marine Accidents.
(bandwidth of 15 km with an output cell size of 100km²)

3. Patterns of Marine Accidents Occurred in Korea

3.1 Kernel Density map

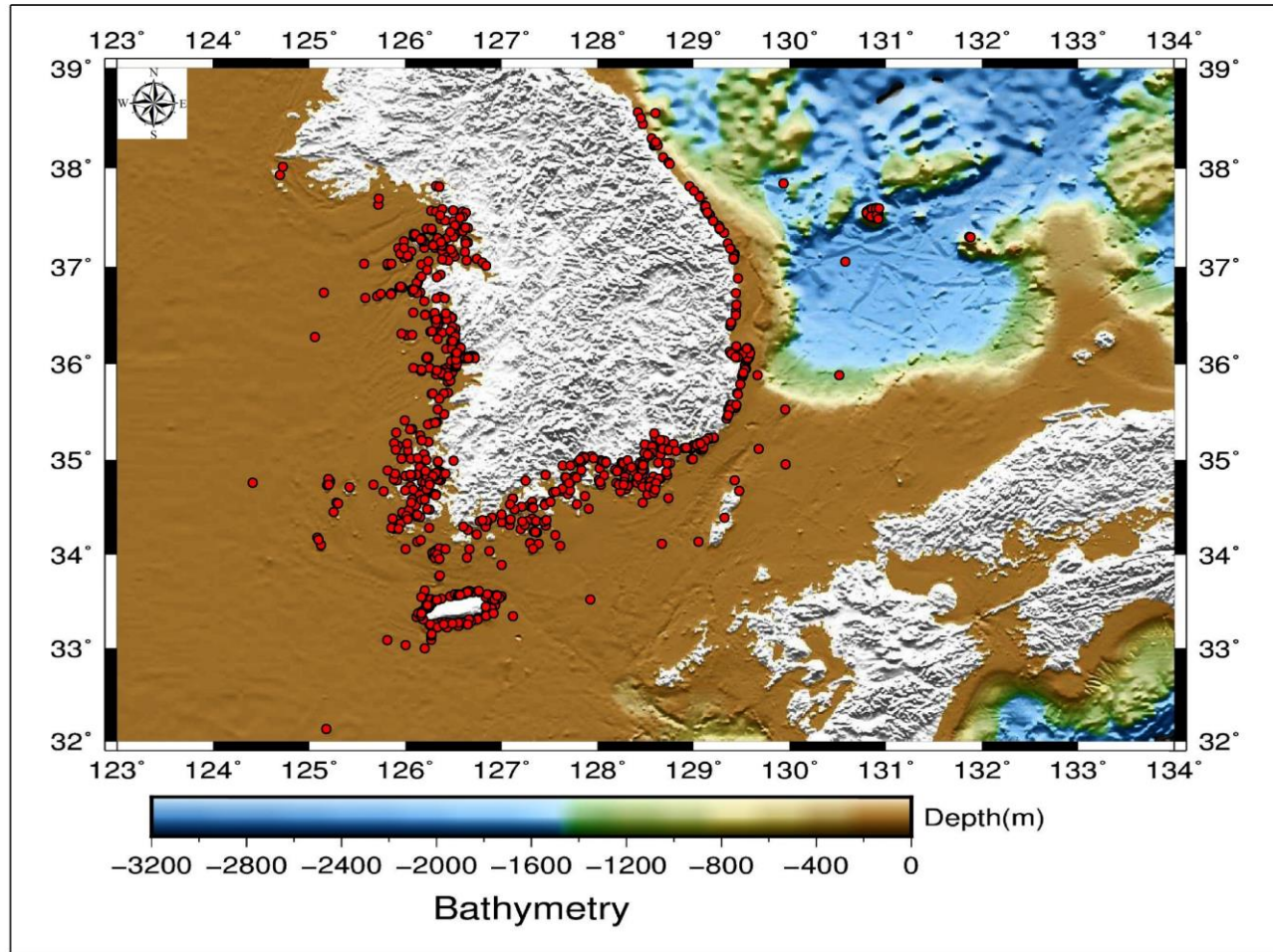


Figure 4 Basic Bathymetry Map of Korea

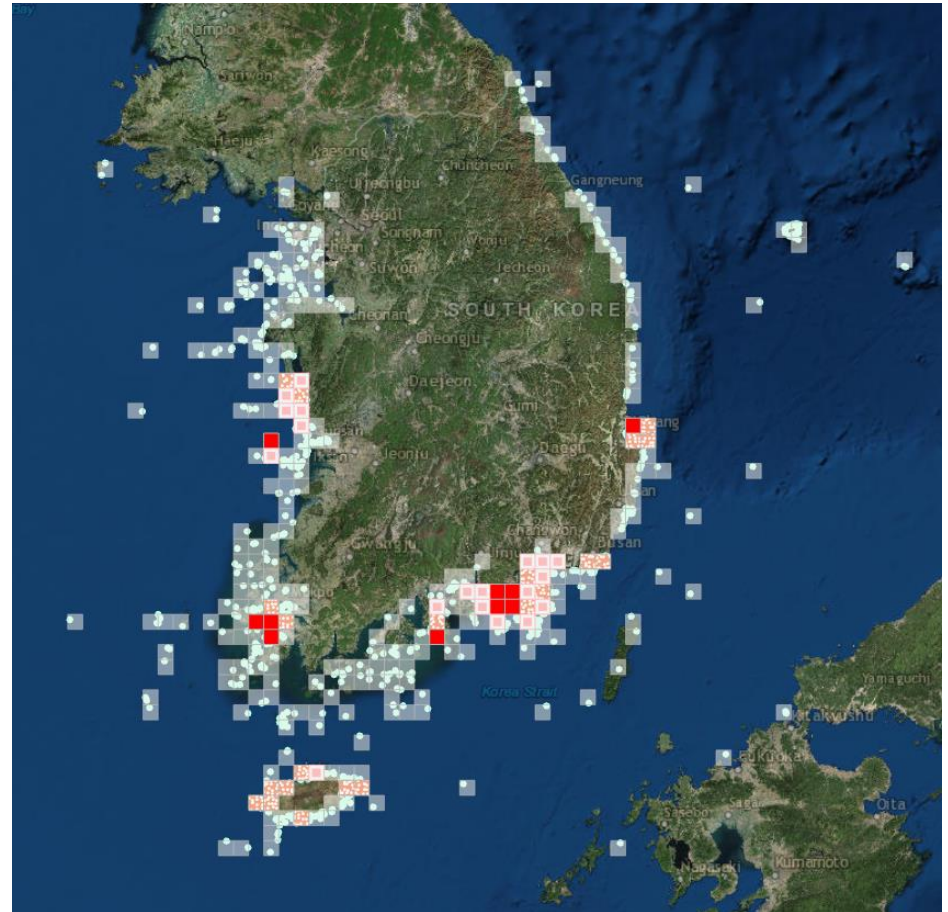
3. Patterns of Marine Accidents Occurred in Korea

3.2 Space Time Cube and Emerging Hot Spot Analysis

- Emerging hot spot analysis based on STC was performed
- There are three types, new, sporadic and **consecutive** hot spot.



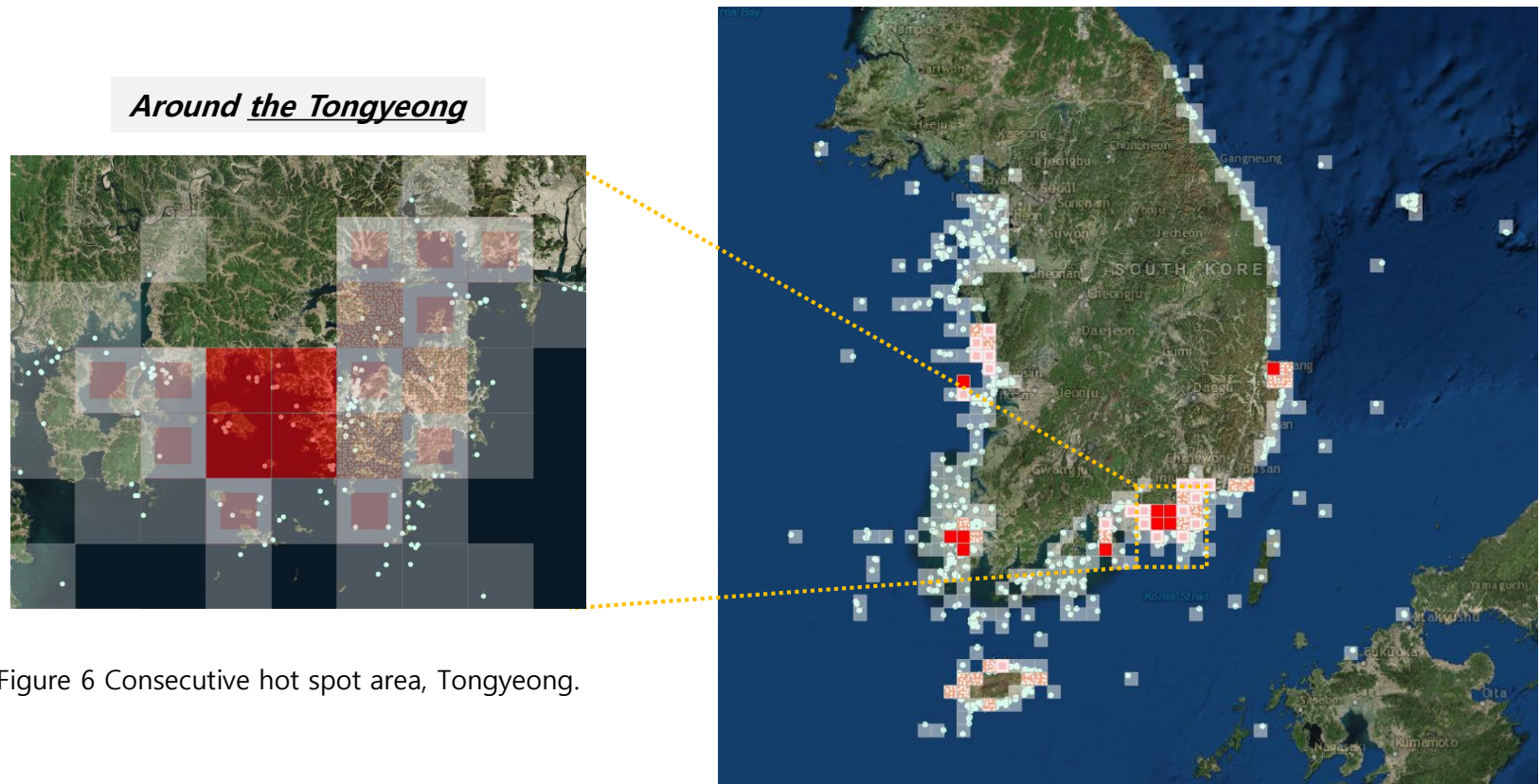
Figure 5 Hotspots analysis map of the grounding accidents based on space time cube by a year.



3. Patterns of Marine Accidents Occurred in Korea

3.2 Space-time pattern of the marine accidents

- The red cell means ‘**Consecutive Hot Spot**’ where the grounding accidents have been continuously occurred.



3. Patterns of Marine Accidents Occurred in Korea

3.2 Space-time pattern of the marine accidents

- On the other hand, monthly differences of the accidents **did not appear** clearly.

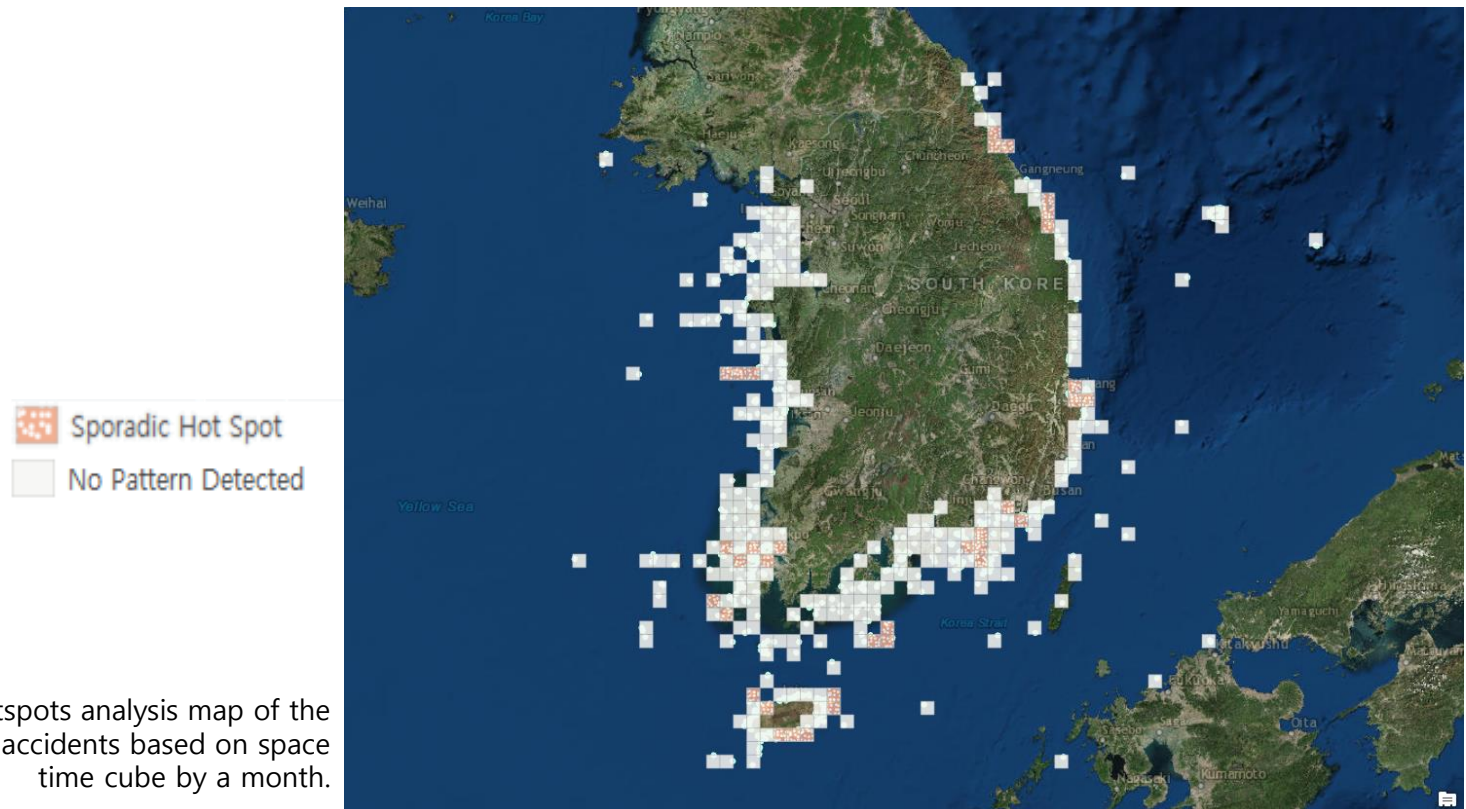


Figure 7 Hotspots analysis map of the grounding accidents based on space time cube by a month.

4. Geomorphological Characteristics of the Hotspots of the Marine Accidents

- Overlaying the marine accidents layer with the marine geographical names layer.
 - The geographical names consist of the specific and the generic term.
 - We could infer a geomorphological characteristics through **the generic term**.
- 10km buffer polygons of the grounding point were created.

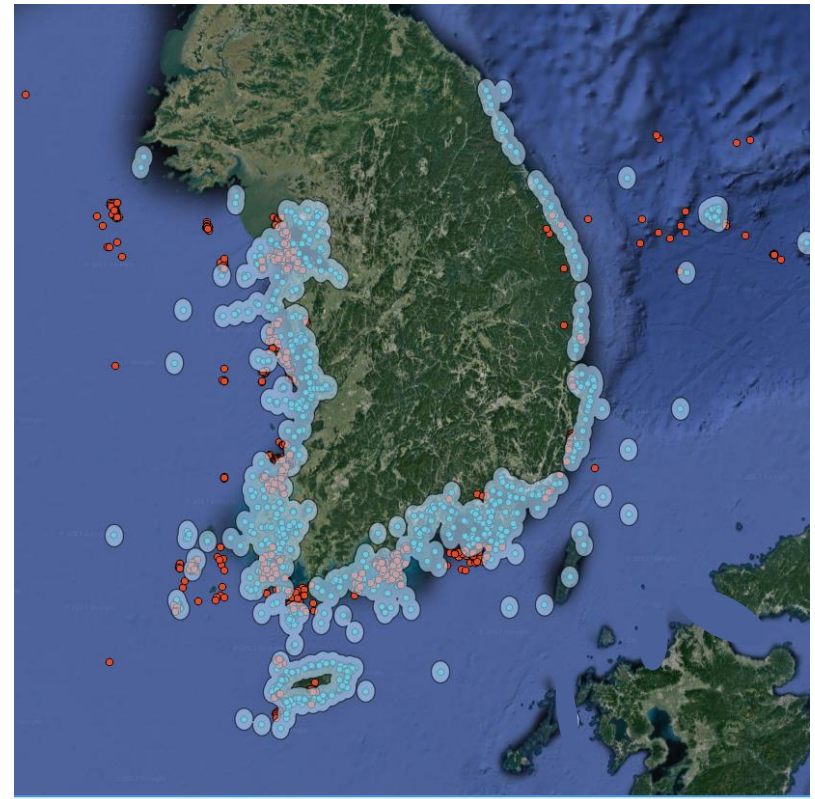
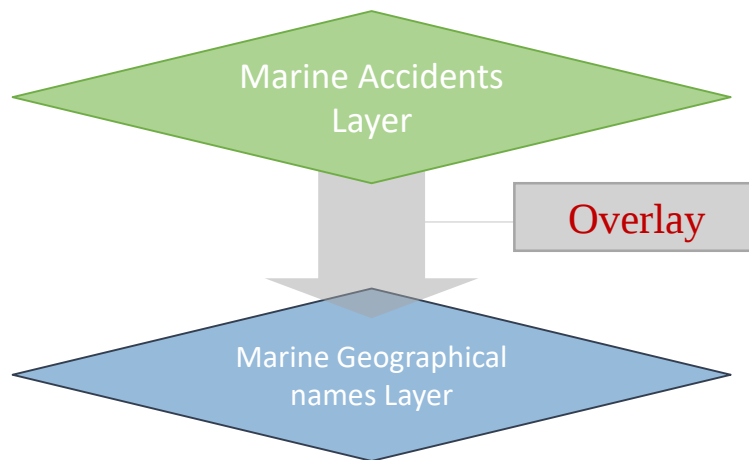


Figure 8 Overlaid the marine accidents layer and the feature names layer.

4. Geomorphological Characteristics of the Hotspots of the Marine Accidents

- After, the percentage of which generic terms in the buffer zones around the Tongyeong was calculated.

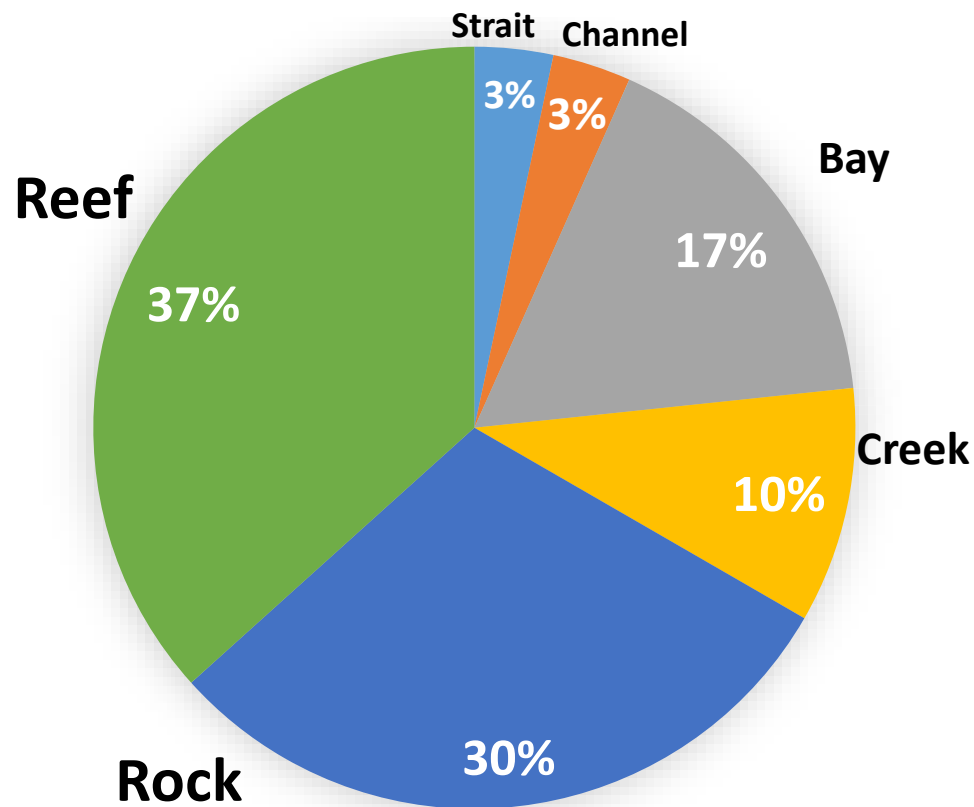
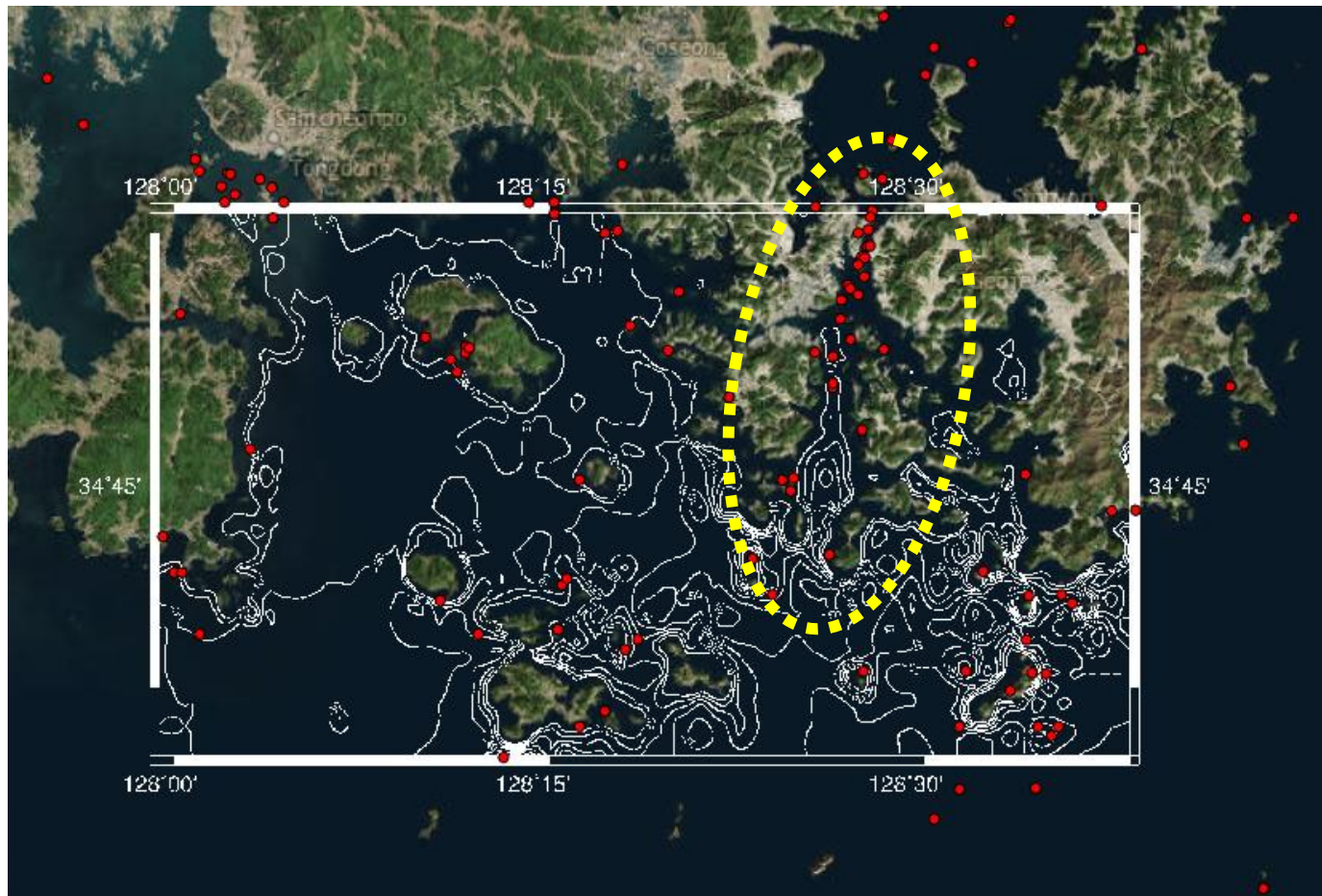


Figure 9 the percentage of the generic terms in the buffer zones.

4. Geomorphological Characteristics of the Hotspots of the Marine Accidents

- The bathymetry map of around Tondyeong was constructed(GMT 5.1.0).



5. Conclusion

- The area near the Yellow sea and the southern coast of Korea shows high kernel density.
- The area around the Tongyeong is the ‘consecutive hot spot’ as a result of Space Time Cube analysis.
- As geomorphological characteristics, the ‘Reef’ and ‘Rock’ are mainly found in the hotspot areas among generic terms of undersea feature names.
- In addition, many ship groundings have occurred in the channel, especially in area with narrow width and shallow depth.

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Q & A

Thank you
for your attention