Occurrence Characteristics of Marine Accidents Caused by Typhoon around Korean Peninsula

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ABSTRACT

During the period of every summer to early autumn seasons, ships have been wrecked or grounded from effect of a typhoon in the waters around Korean Peninsular. Typhoon Rusa killed more than 100 people in September 2002. Super Typhoon Maemi passed southeast of South Korea in September 12-13, 2003, with gale winds blowing at a record 60 m/s and caused much ship groundings, collisions and sinkings over 3000 in dockyards, harbors and places of refuge. These are things that could have been prevented had there merely been prior warning. The aim of this study is to examine what effect these typhoons had on occurrence characteristics of the maritime accidents in South Korea.

In this work, records of marine accidents caused by a typhoon are investigated for the period from 1962 to 2002. The distribution is also compared with the trajectories of typhoons, passed during the 1990-2003. It is shown that attack frequency of typhoon and number of marine accidents is the highest in August. We use the track data of Maemi such as central pressure, maximum sustained wind speed and area of each 15m/s and 25m/s winds as a case study to draw a map as a risk index.

1. Introduction

Typhoon is a tropical cyclone occurring in the West Pacific or Indian oceans and the intensity of the cyclone is classified as a "tropical depression" (TD, less than 17 m/s), a "tropical storm" (TS, at least 17 m/s), a "severe tropical storm" (STS, at least 25 m/s), a "typhoon" (TY, at least 33 m/s) and a "super typhoon" (ST, at least 65 m/s) according to maximum sustained 1-minute surface winds. During the period of every summer to early autumn seasons, ships have been wrecked or grounded from effect of a typhoon in the waters around Korean Peninsular. Typhoon Rusa killed more than 100 people in September 2002.

Figure 1 shows the trajectory of Typhoon Maemi for the period of 5-12 September 2003, classified as Category 1 typhoon by the Joint Typhoon Warning Center on 7 September 2003. Maemi is the Korean name for a cicada that legend says chirps madly to warn of a coming typhoon. Maemi formed as a tropical depression near Mariana Islands and became a tropical storm (TS) around 16.5°N and 141.4°E at 06UTC 06 September. Moving almost northwestward far east of the Philippines, Maemi developed into a severe tropical storm shortly and became a typhoon at 18UTC 08 September. Soon after reaching its peak intensity at 12UTC 10 September, it passed Miyako-jima around 19UTC on that day, keeping the peak intensity. Maemi then changed its direction from northwest to north (more accurately, NNE), then to northeast gradually. It made landfall on the south coast of the Korean Peninsula with typhoon intensity around 10UTC 12 September. The storm transformed into an extratropical cyclone east of the Korean Peninsula at 18UTC on that day and dissipated. Typhoon Maemi was one of the most intense typhoons ever approached the southern part of Korea.

Typhoon Maemi hit Republic of Korea with gale winds blowing at a record 60 m/s and brought heavy damage to the country. The typhoon's strong winds have left about 100 dead and astronomic property damage in their wake. It also caused much ship groundings, collisions and sinkings over 3000 in dockyards, harbors and places of refuge. These are things that could have been prevented had there merely been prior warning.

Figure 2 shows temporal changes in the number of marine accidents caused by a storm or typhoon in South Korea. The data was extracted from Korean Maritime Safety Tribunal and the number of accident is based on a date judged by the authority.

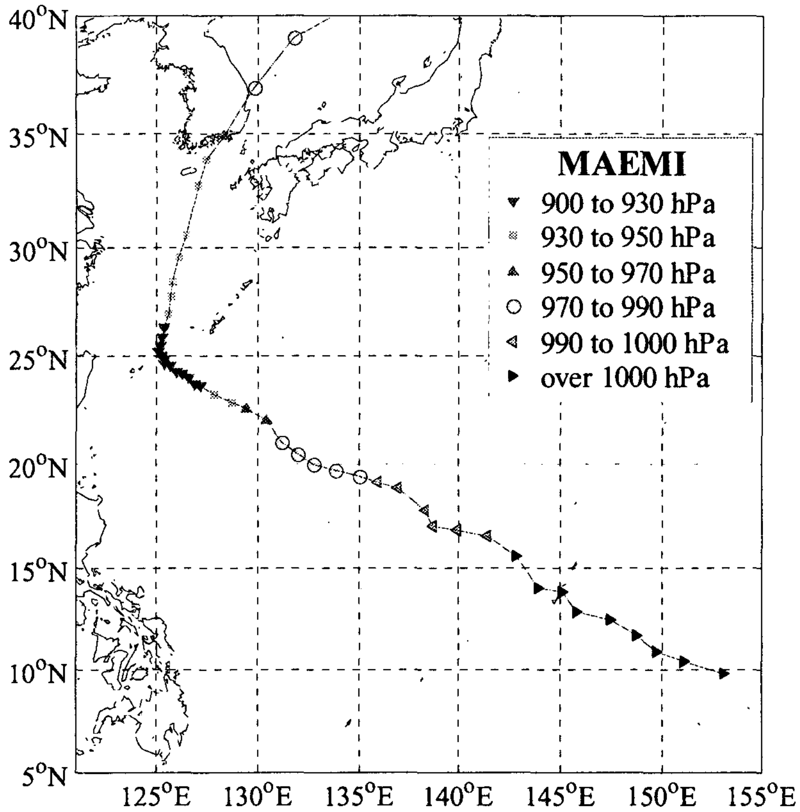

Figure 1 Trajectory of Typhoon Maemi for the period of 5-12 September 2003, classified as Category 1 typhoon by the Joint Typhoon Warning Center on 7 September 2003.

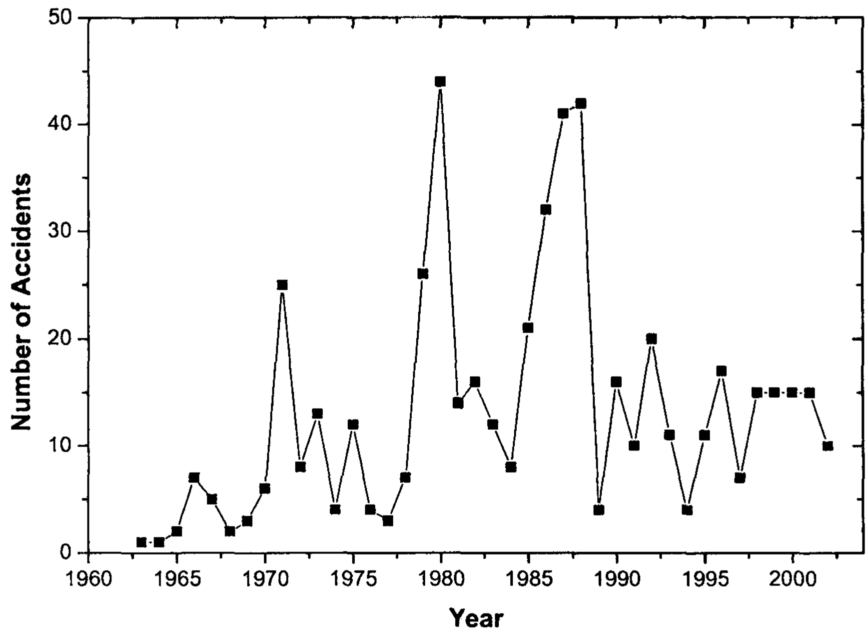

Figure 2 Temporal changes in the number of marine accidents caused by a storm or typhoon in South Korea. The data was extracted from Korean Maritime Safety Tribunal and the number of accident is based on a date judged by the authority.

Although the annual variability in the marine accident is comparatively high, we can say that effect of typhoon on the accident is not less because as it was the number is much higher than that of the inquired accident. For example, according to the National Maritime Police Agency of South Korea, the sinkings and groundings of 3,023 and 1,688 ships, individually, occurred during the passage of Typhoon Maemi, but only a portion of them was sent to the Court of District MST (maritime safety tribunal) for inquiry. In addition to that, the accident number is being kept high recently.

In this work, we present occurrence characteristics of marine accidents caused by typhoon around the Korean Peninsula, based on the marine accident and typhoon data. Tropical cyclone data is archived by the Regional Specialized Meteorological Centers – Tokyo Typhoon Center. Additionally, annual reports by Korea Meteorological Administration and marine accidents inquired by the Korean Maritime Safety Tribunal are used here.

The aim of this study is to examine what effect these typhoons had on occurrence characteristics of the maritime accidents in South Korea and is done as a fundamental research to find a method to bring a ship into a place of refuge and to suggest a suitable anchoring, mooring and navigation for ships in Typhoon.

2. Tropical Cyclones in 1971-2003

A tropical cyclone is formed in the western North Pacific and the South China Sea. On the whole, typhoons move along the west edge of high pressure system, and then progress northeastward at a latitude of approximately 25 degrees north. However, it is difficult to forecast tracks for each tropical cyclone, because typhoons don't take a steady course and their turning points are turning point is ambivalent.

List of names for tropical cyclones is adopted by the Typhoon Committee for the western North Pacific Ocean and the South China Sea and these names are used sequentially.

Typhoons have always been a major threat to the lives and property in shipping. Even if typhoons hit or pass the Korean Peninsula, ships are always affected by them. As a result, they are the major target for us to investigate a typhoon-related accident, analyze a risk in refuge places based on a track forecast of typhoon and induce ships in navigation, mooring, anchoring and so on to a safe measure such as a safe zone, a suitable mooring or anchoring guideline and a refuge place.

Annual and monthly frequency of tropical cyclones of tropical storm (TS) intensity or higher since 1971 were investigated in the western North Pacific and South China Sea, as shown in Fig.3. The thirty-year average is 26.7 for 1971-2000 and 54% of the total (24-year average for 1977-2000) reached typhoon (TY) intensity (Annual Report 2002, 2002).

Figure 4 represents monthly and annual numbers of typhoon passed South Korea of the tropical cyclones formed for 1971 through 2003. In the months from November to April, there was no tropical cyclones of tropical storm intensity or higher which hit or passed South Korea. In addition to that, the tropical cyclone season began in the end of May, but in August tropical cyclones were concentrated. 89 % of the total is generated in the period July to September and 3.3 typhoons hit or pass South Korea every year.

The ratio of typhoon passed the country out of the total tropical cyclones ranges from 0 % (1998) to 24 % (1976) with average of 13 %.

Figure 5 shows trajectories of the tropical cyclones which had a direct effect on the waters around the Korean Peninsula for 1990 - 2003. The data was resampled using the annual report issued by the Korea Meteorological Administration (KMA). The closed circle (•) denotes the genesis point of a tropical cyclone.

The mean formation latitude of 18.5 °N was higher than the 30-year (1971-2000) average of 16.2 °N for the total tropical cyclones, while the mean formation longitude of 136.5 °E was western compared to that average. In summer, genesis points of tropical cyclones are located at the latitudes 10-20 °N and in other seasons the points are lower than 15°N. These tracks are similar to a typical pattern.

3. Marine Accidents Due to Tropical Cyclones in 1963-2002

The distribution of marine accidents caused by typhoon during the period from 1963 to 2002 is plotted in Figure 6. The accident data are obtained from Korean Maritime Safety Tribunal and inquired by the authority.

Marine accidents happened mainly in sea area that connect south coast and Pohang of South Korea but were comparatively distributed broadly from Jeju Island to a western area of Pacific Sea.

Figure 7 shows the detailed distribution (a) in the waters around Korean Peninsula for the same marine accidents shown in Fig. 6 and the accident map in August (b), respectively. It is shown that August map is very similar to a distribution pattern of the total map.

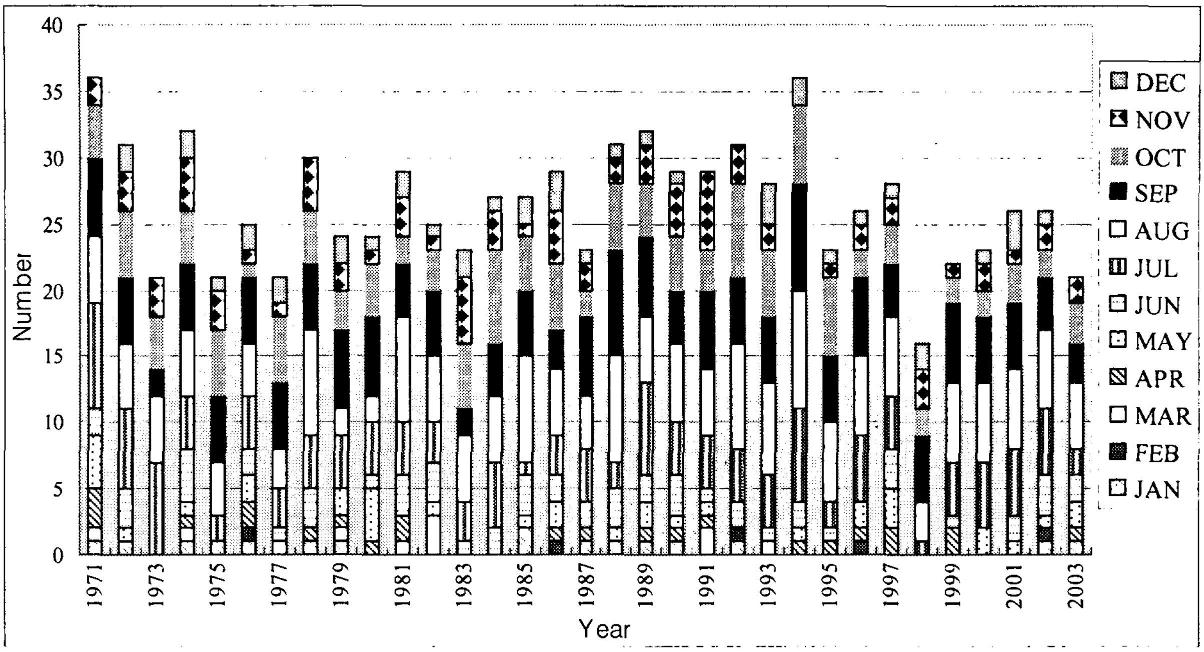

Figure 3 Comparison of the monthly and annual numbers of tropical cyclones that developed as tropical storm (TS) intensity or higher in North Pacific from 1971 to 2003.

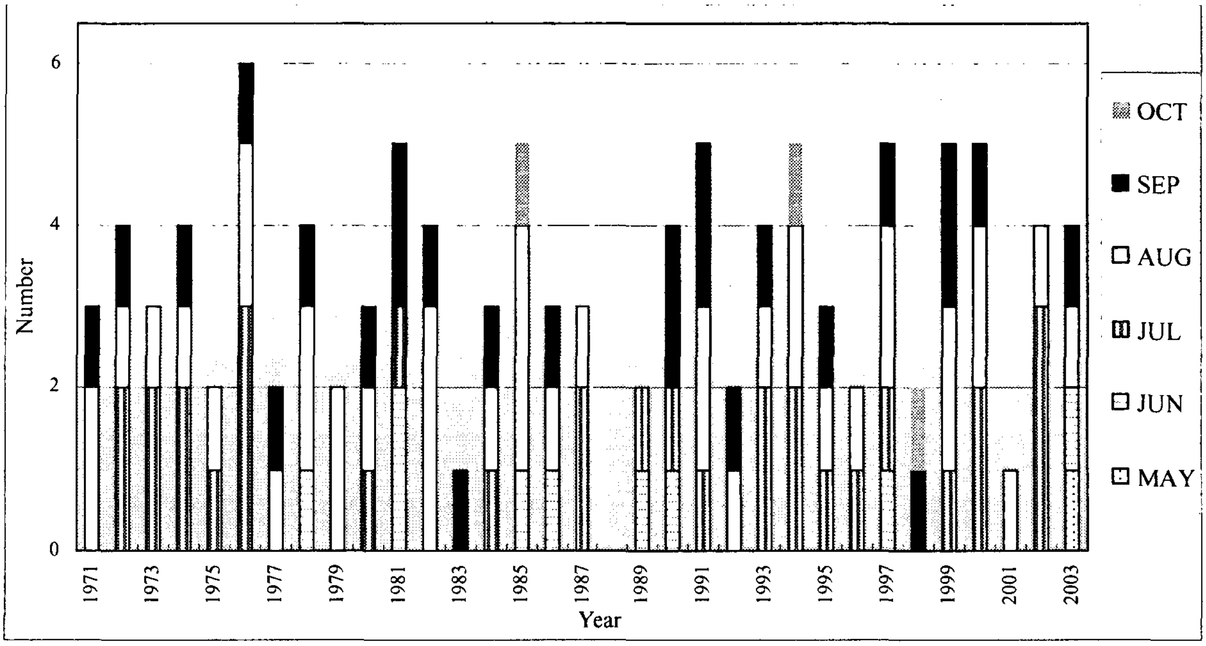

Figure 4 Monthly and annual numbers of typhoon passed South Korea of the tropical cyclones occurred for 1971 through 2003.

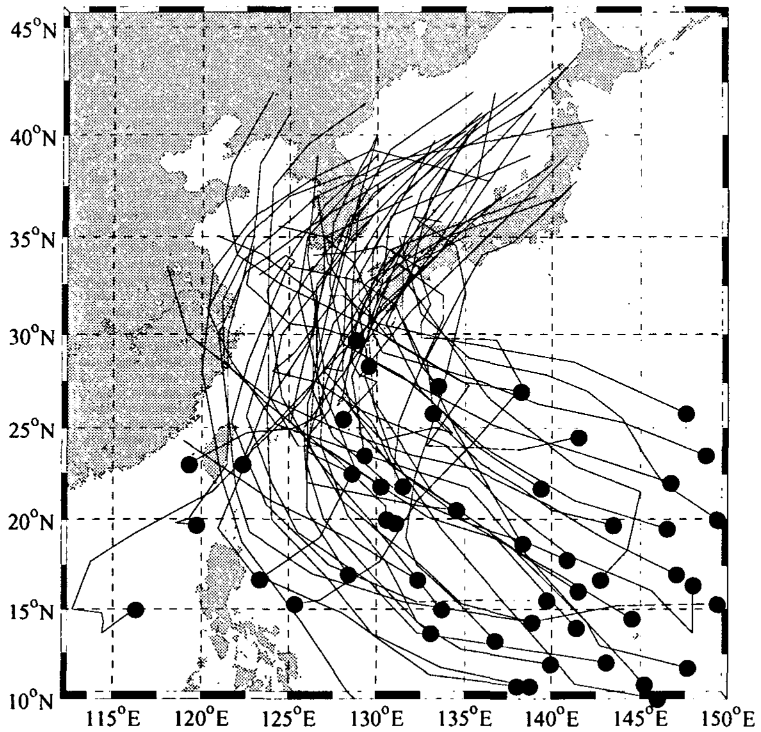

Figure 5 Trajectories of the tropical cyclones which had a direct effect on the waters around the Korean Peninsula for 1990 - 2003. The data was resampled using the annual report issued by the Korea Meteorological Administration (KMA). The closed circle (•) denotes the genesis point of a tropical cyclone.

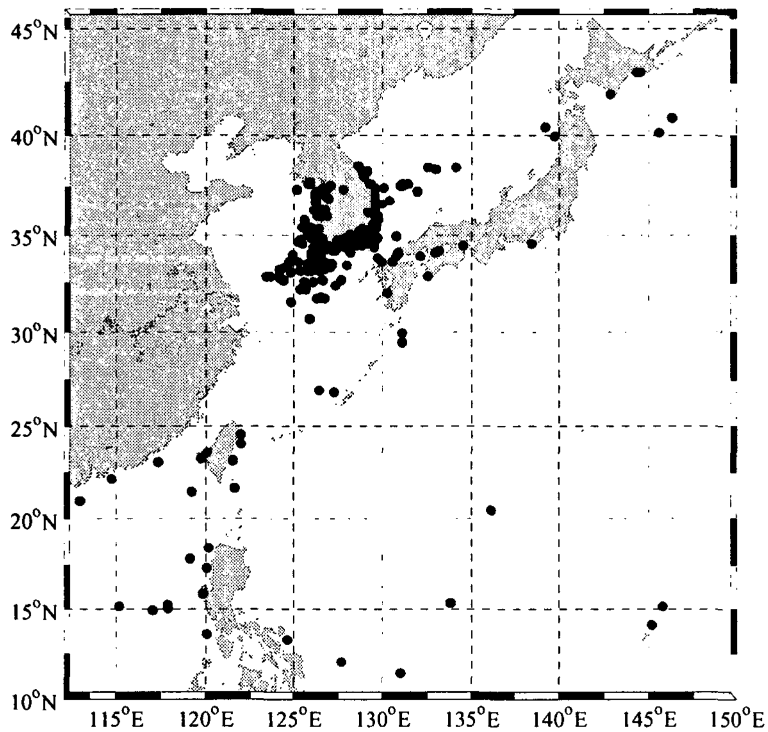

Figure 6 Distributions of marine accidents caused by typhoon during the period from 1963 to 2002. The accident data are obtained from Korean Maritime Safety Tribunal.

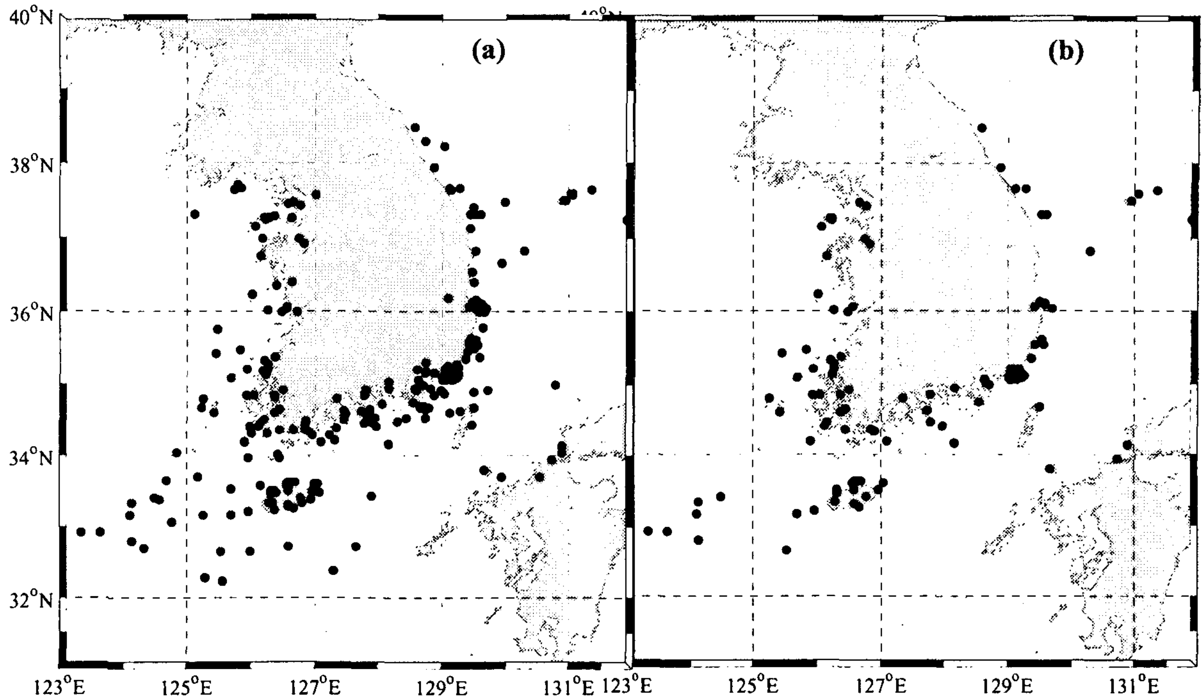

Figure 7 Detailed distributions (a) for the same marine accidents shown in Fig. 6 and the accident map in August (b).

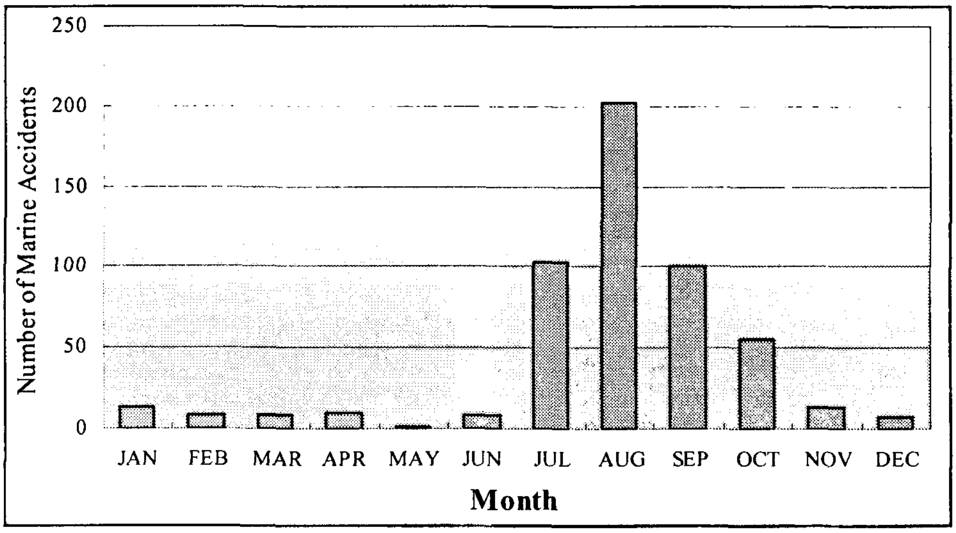

Figure 8 Monthly distribution in the number of marine accidents, related to, directly or indirectly, a typhoon in South Korea, based on the data from Korean Maritime Safety Tribunal in the years 1963 to 2002.

Figure 8 represents monthly distribution in the number of marine accidents, related to, directly or indirectly, a typhoon in South Korea, based on the data from Korean Maritime Safety Tribunal in the years 1963 to 2002. During July through November, the number of marine accidents is 406 that are about 77 % of the total number of accident. The month of August is the highest in the number out of the period. This trend corresponds to a tendency in the arrival frequency of typhoon.

From Fig. 7, marine accident in port or harbour area consists of about 36 %. That is, marine accidents due to typhoon are much more in port and entry waterway while the general marine accident is about 19.5 % in the area. (Yang and Park, 2003) To understand a density of marine accident, the number of marine accidents is accumulated per 0.2° × 0.2° grid box 1963 to 2002 (see Fig.7 (a)) as shown in Fig. 9.

Figure 10 shows an example of a tropical cyclone track (a) and its track (b) interpolated with 0.2° intervals in longitudinal or latitudinal direction. One-dimensional data interpolation adopted linear interpolation method here. The box in (a) figure represents the area passed by the tropical cyclones that reached the Korean Peninsula.

Figures 11 and 12 show contour maps for accumulated central pressures (hPa) per 0.2° × 0.2° grid box using interpolated tropical cyclone tracks, passed through the area shown in Fig.10 (a) out of the total tropical cyclones of tropical storms intensity or higher 1996 to 2003. Figures 13 and 14 represent contour maps for accumulated maximum sustained wind speeds (m/s) per 0.2° × 0.2° grid box using interpolated tropical cyclone tracks, passed through the area shown in Fig.10 (a) out of the total tropical cyclones of tropical storms intensity or higher 1996 to 2003. After summation for each grid, average filtering of 3 × 3 grid was conducted to interpolate the grid data.

Through the two map, we can say that the marine accidents due to typhoon have a close relation to the distribution of accumulated wind and pressure fields.

4. Results and Discussions

Typhoons have always been a major threat to the lives and property in shipping. In this paper, the authors have attempted to demonstrate how marine accidents caused by a typhoon are associated with the trajectories, winds, central pressures of typhoons, passed during the 1990-2003. It is shown that arrival frequency of typhoon and number of marine accidents is the highest in August. We can also say that the marine accidents due to typhoon have a close relation to the distribution of accumulated wind and pressure fields.

Future studies will focus on a detailed record of marine accident due to a tropical cyclone to understand its pattern at sea and anchor.

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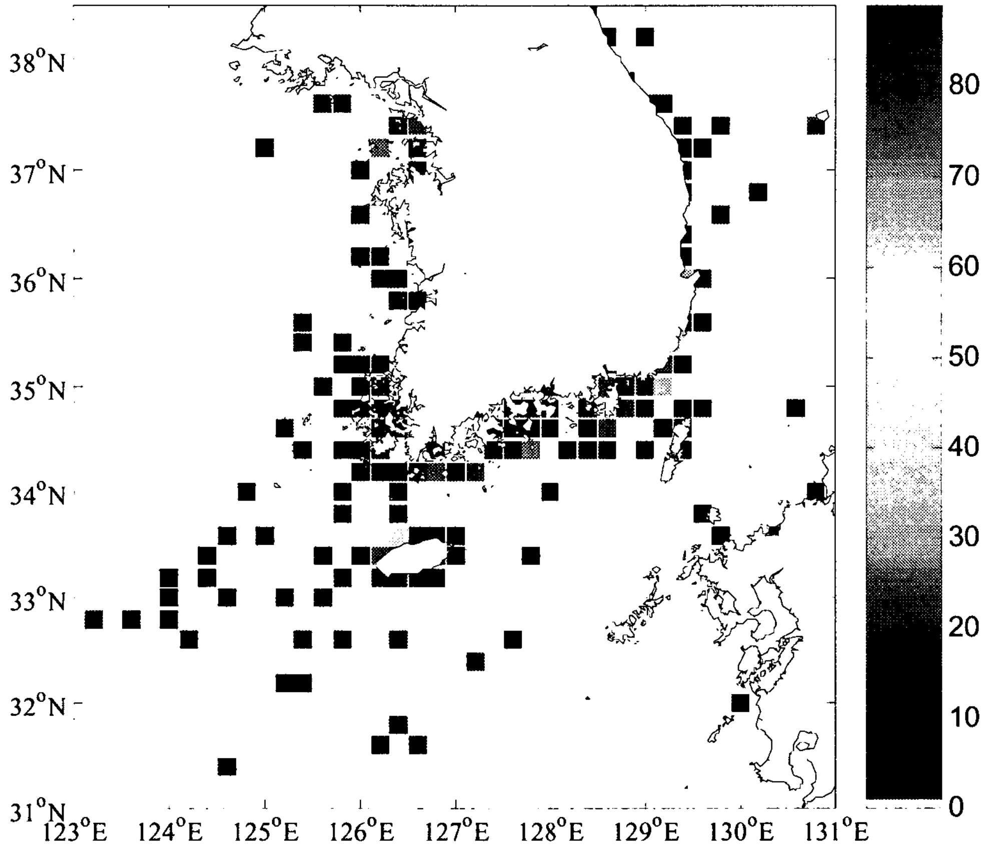

Figure 9 Number of accumulated marine accidents per 0.2° × 0.2° grid box 1963 to 2002. Refer to Fig.7 (a)

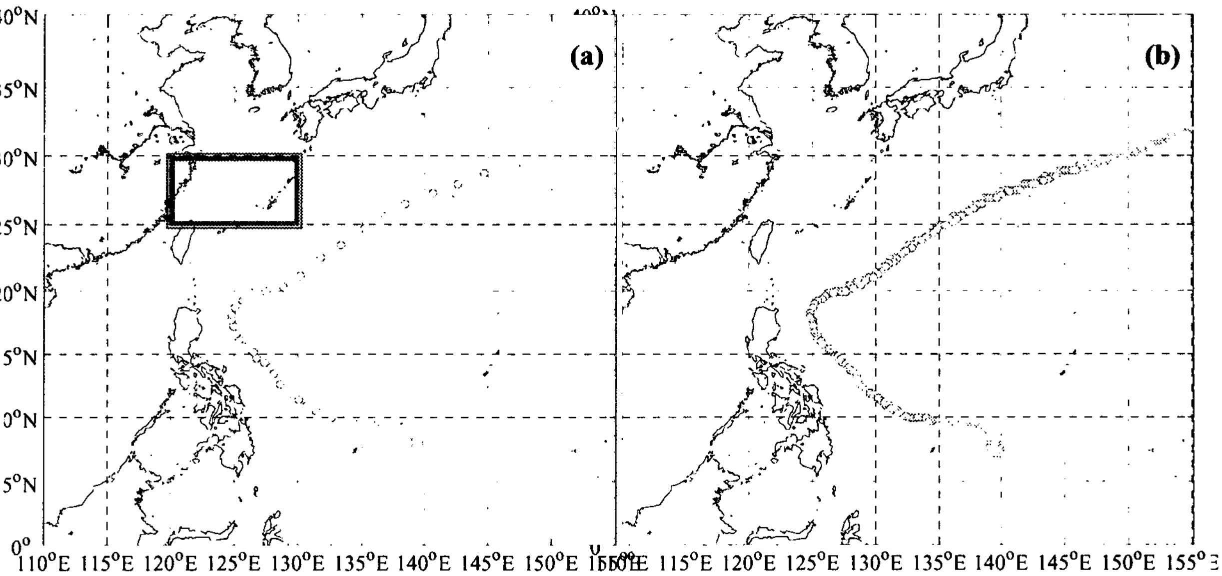

Figure 10 Example of a tropical cyclone track (a) and its interpolated track with 0.2° intervals in longitudinal or latitudinal direction. The box in (a) figure represents the area passed by the tropical cyclones that reached the Korean Peninsula.

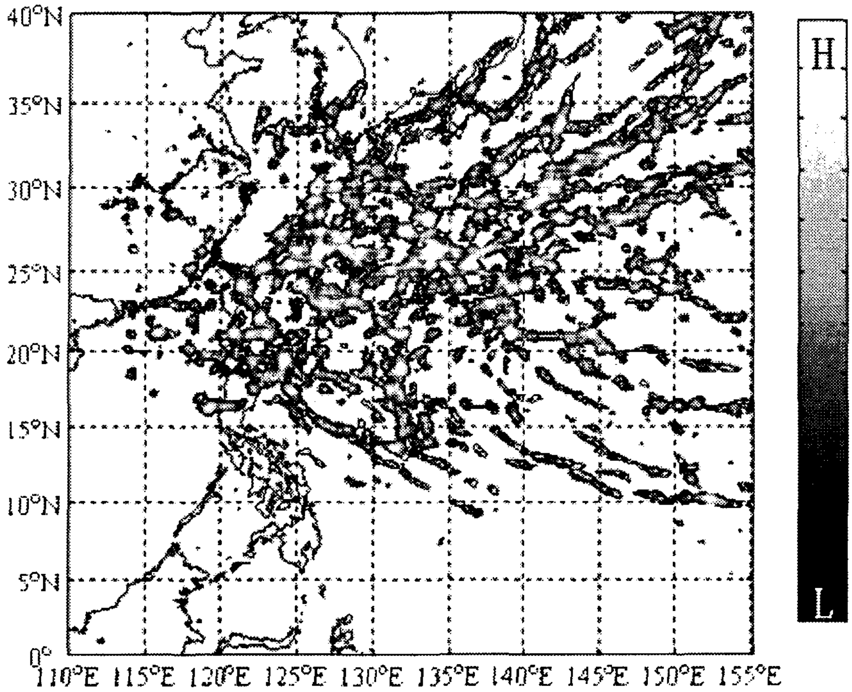

Figure 11 Contour map for accumulated central pressures (hPa) per 0.2° × 0.2° grid box using interpolated tropical cyclone tracks, passed through the area shown in Fig.10 (a) out of the total tropical cyclones of tropical storms intensity or higher 1996 to 2003.

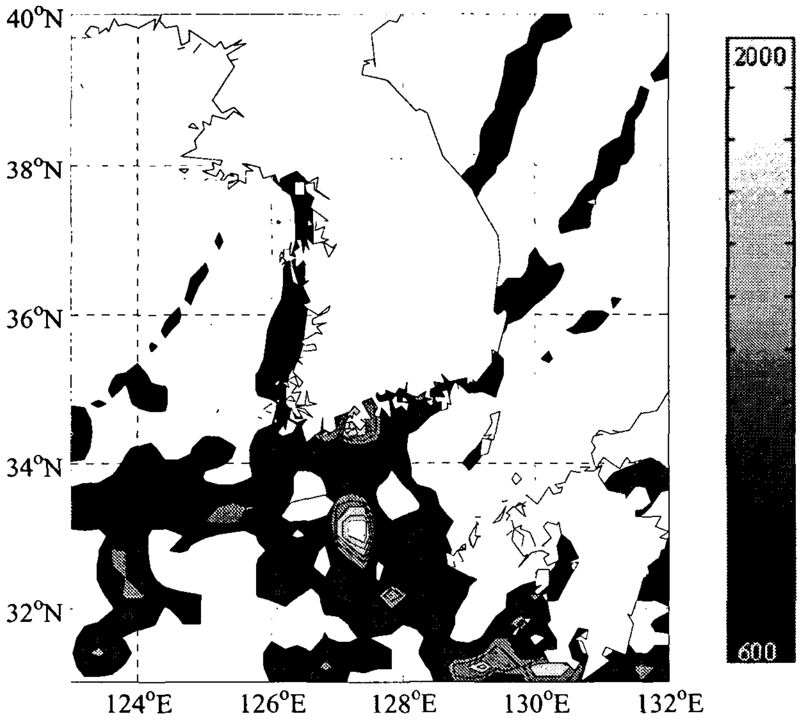

Figure 12 Same as Fig.11, except for the waters around the Korean Peninsula.

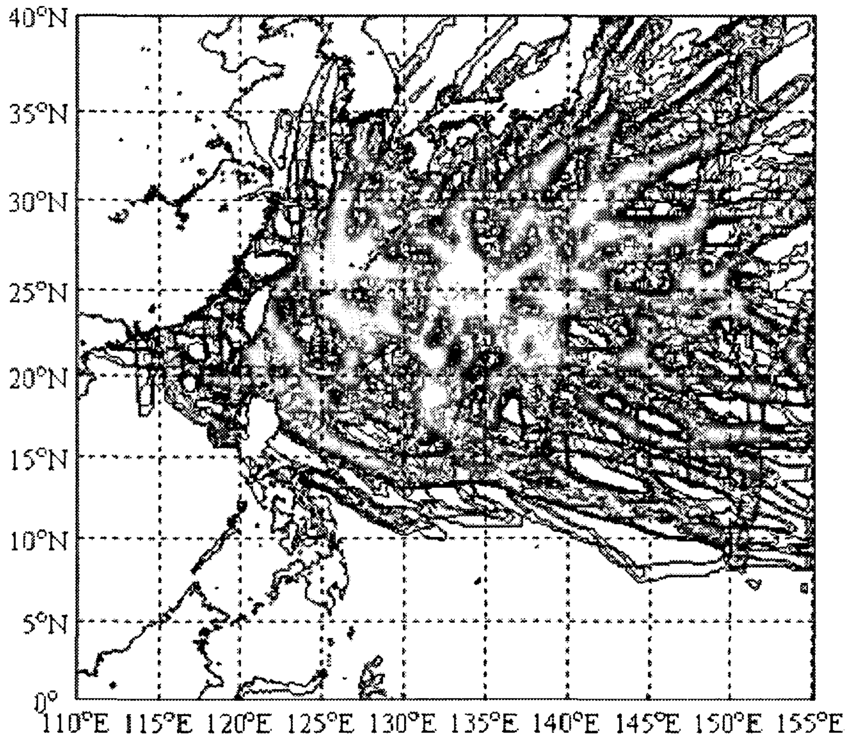

Figure 13 Contour map for accumulated maximum sustained wind speeds (m/s) per 0.2° × 0.2° grid box using interpolated tropical cyclone tracks, passed through the area shown in Fig.10 (a) out of the total tropical cyclones of tropical storms intensity or higher 1996 to 2003.

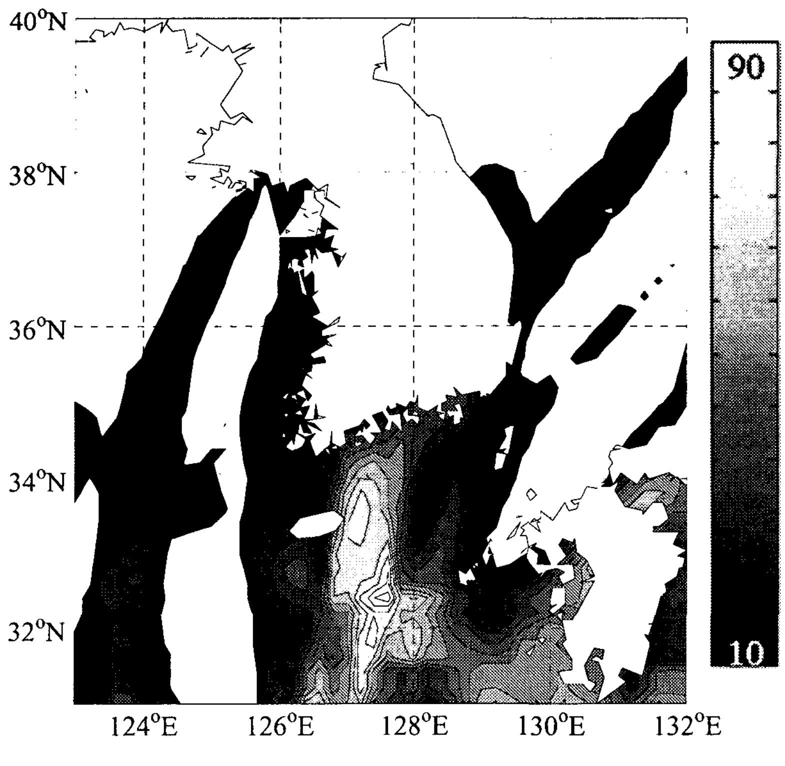

Figure 14 Same as Fig.13, except for the waters around the Korean Peninsula.