A study on the search method for similar typhoons in the past using typhoon path and attributes

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Abstract:

Korea suffers a lot of socio-economic damage from typhoons every year. The damage caused by typhoons accounts for 44% of the total disaster damage. Recently, with the development of sensors such as typhoon observation techniques and satellite images, the accuracy of the prediction of typhoon paths using numerical models has been increased (Rüttgers *et al*., 2019; Gao and Chiu, 2012). Searching for past typhoons similar to the approaching typhoon is an important act in the stage of disaster prevention. When a typhoon occurs, similar typhoons that have occurred in the past are announced along with the predicted route through the mass media, emphasizing the importance of prevention and preparation. Related research is mainly based on the search method based on the typhoon path. However, the attributes of typhoons continue to change over time, such as typhoon intensity and direction of strong winds. Therefore, a search method using attributes such as typhoon grade and intensity as well as typhoon path could improve the search results.

To solve this issue, we proposed a similar typhoon search method that considers both the typhoon path and attributes. The final ranking was determined by deriving spatial similarity and attribute similarity, respectively. For the result of spatial similarity, the ranking between typhoon paths was derived using the node-link shortest distance method. The node-link shortest distance method is a method in which the shortest distance from the node of the current typhoon to the link of the past typhoon is continuously summed to determine the typhoon that is the most similar to the typhoon with the smallest sum of distances (Choi, 2011). Next, the sequence alignment method was used to calculate the attribute similarity. The sequence alignment method can quantitatively calculate the similarity of sequences in the form of sequence (Joh *et al*., 2002). Typhoon grade, storm direction, strong wind direction, land landing, and movement direction, which are the most representative attributes of a typhoon, were selected for attribute comparison. The similarity of attribute changes was calculated by converting the attributes of 5 typhoons recorded in 6-hour units into a continuous sequence. Finally, the results of analysis were visualized. We used historical typhoon data provided by the Japan Meteorological Agency since the agency provides all attributes we needed. From 2001 to 2021, 501 typhoons have been developed. In this study, 128 typhoons that affected the Korean peninsula were used.

Typhoon MITAG(1918), which caused a lot of damage to Korea in 2019, was chosen as a case typhoon. Simulations were conducted by dividing Typhoon MITAG into two days (48 hours) before landing in the Korean peninsula, one day (24 hours) before and the first landing time. The analysis results for each of the three periods are as follows. 48 hours before landing, the spatial similarity results was in the order of Typhoon MALAKAS (1616), BAVI (2008), and KUJIRA (0302). The attribute similarity was 54% (MALAKAS), 28% (BAVI), and 40% (KUJIRA). The second time point, 24 hours before landing, the spatial similarity results was in the order of Typhoon BAVI (2008), TEMBIN (1214), and KALMAEGI (0807). The attribute similarity was 45% (BAVI), 52% (TEMBIN), and 36% (KALMAEGI). At the last time point, spatial similarity results was in the order of typhoon TEMBIN (1214), BAVI (2008), and DANAS (1905). The attribute similarity was 45% (TEMBIN), 50% (BAVI), and 44% (DANAS). Considering the above results, Typhoon BAVI (2008) was the most similar typhoon with the case typhoon, MITAG, both in spatial and attribute similarity in all periods.

Searching for past typhoons similar to the approaching typhoon is important in disaster prevention. The method proposed in this study has high utility because it can search for typhoons within seconds. Methods to further utilize various typhoon attributes to determine the similarity of typhoons should be discussed. In addition, it will be necessary to be objective to determine the ranking of typhoon similarity. The results of this study will be used as basic input data for typhoon forecasting models or enable decision support.

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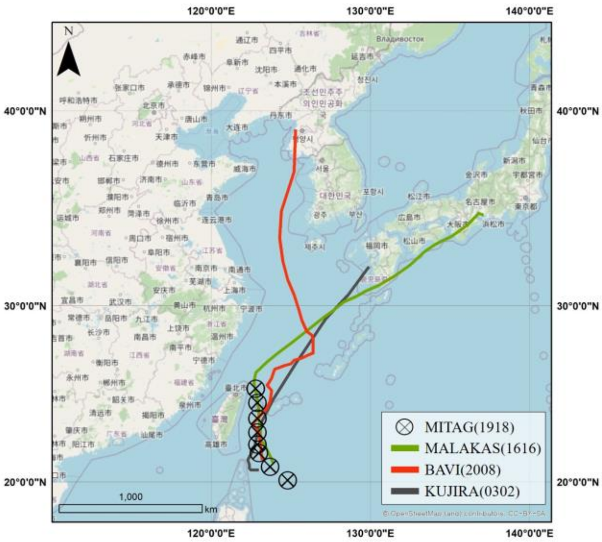
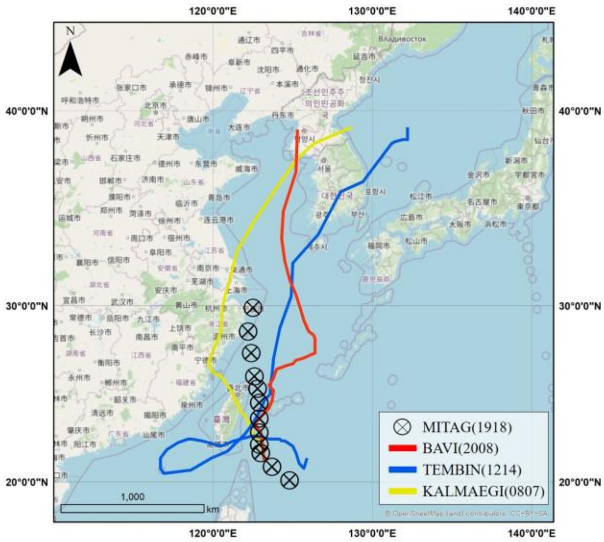
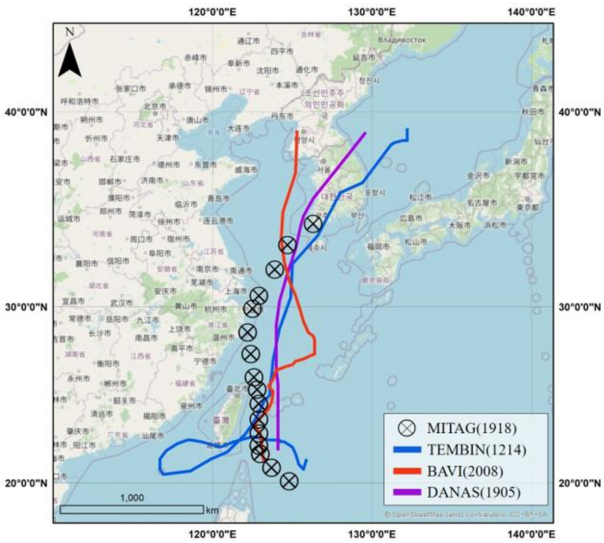
(a) 48 hours before landing



(b) 24 hours before landing



(c) 0 hours before landing



(d) Attribute similarity by observation period

Observation period	Typhoon	Attribute similarity (%)	Rank
(a) 48 hours before landing	MALAKAS(1616)	54	1
	BAVI(2008)	28	3
	KUJIRA(0302)	40	2
(b) 24 hours before landing	BAVI(2008)	45	2
	TEMBIN(1214)	52	1
	KALMAEGI(0807)	36	3
(c) 0 hours before landing	TEMBIN(1214)	45	2
	BAVI(2008)	50	1
	DANAS(1905)	44	3

Figure 1. Simulation results of Typhoon MITAG(1918) by observation point

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