Tsunami Shelter Location Allocation by Applying a Heuristic Algorithm to Residential and Floating Population Data

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ABSTRACT: Recently, the Korean Peninsula is no longer a safe area for tsunamis because of frequent earthquakes in neighboring countries. Tsunami can cause heavy casualties, and in order to reduce heavy casualties, seismic tsunami shelters must be selected in the right place. Various studies have been conducted on the location of tsunami shelters, but most studies have conducted the study based on the population data of residential areas. Therefore, in this study, the location of shelters was selected using floating population data and residential population data, and the results were compared and analysed. Resident population data is based on approximately 500 people, and the floating population data is based on by time average data of 50m grid on every month. The data of the floating population data was used at 6 pm in July, where the largest number of the floating population is located in the study area. Guideline for the resident evacuation plan of tsunami in Korea requires that the tsunami shelter preferably be located within 600m of the shoreline and above 10m above sea level, so this study conducted a study according to the guideline. Genetic algorithms have been used to allocate shelter location and genetic algorithms have already been applied to many shelter location- allocation studies. Genetic algorithm is algorithms based on the law of survival of the fittest. Parent generation generate the next generation with genes that are more suitable for achieving objective functions through selection, crossover and selection processes. The objective function of the genetic algorithm was selected as the number of evacuees, and the elitist preserving selection method and the roulette wheel selection method were used as selection operators and the onepoint crossover was used as the crossover operator. As a result, the results of using floating population data showed that shelters were also allocated around tourist sites that were not selected when using residential population data. However, in some areas, it was confirmed that the location of the shelter was not selected due to the area of 10m below sea level. Later studies will include buildings with seismic design, which will be used to select shelters at more appropriate locations.

1. INTRODUCTION

Every year, natural disasters are increasing worldwide. Recently, the frequency of earthquakes has increased on the Korean peninsula, and in 2018, 115 large and small earthquakes occurred. In addition, there is a high possibility of tsunamis caused by neighboring countries where earthquakes occur frequently. Indeed, there were cases of earthquake in Japan in 1983 and 1993 that caused great casualties and property damage on the east coast. In order to reduce casualties from special natural disasters such as tsunamis, shelters should be allocated in an appropriate location that can be evacuated quickly.

Recently, various researches on allocating shelters have been conducted, and many studies using genetic algorithm, one of heuristic algorithms, have been published. Park et al. (2012) conducted a genetic algorithm to select a high-rise building as an evacuation site for tsunami shelters. Hu et al. (2014) proposed a new crossover operator for genetic algorithms to select tsunami shelters and service areas. Kongsomsaksakul and Yang (2005) conducted the research using the genetic algorithm to automatically select the location of flood shelter and evacuation route according to the number of evacuation shelters, and You et al.(2018) also used genetic algorithms and network analysis to select the location of the evacuation facility at the border.

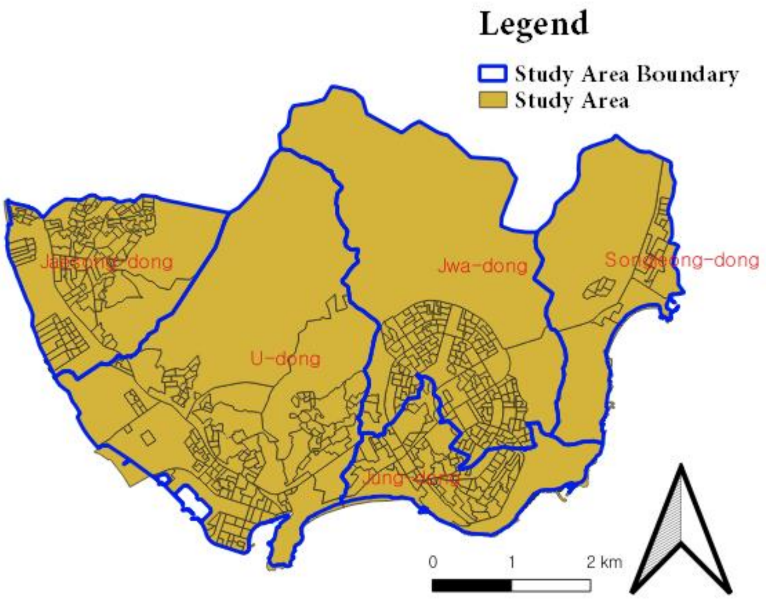
However, previous studies used residential population data to allocate shelter which it is not suitable during daytime when there is a large number of floating population. Therefore, this study used the floating population data and residential population data to derive the optimal location of tsunami shelters and analyzed the both result.

2. Study Area and Data

2.1 Study Area

The study area was selected as Jaesong-dong, U-dong, Jwa-dong, Jung-dong, and Songjeong-dong, Haeundae-gu, Busan Haeundae-gu is frequently visited by many tourists in summer, and as in Fig. 1, Jasong-dong, Udong, Middle

East and Judong are areas adjacent to the coastline and the river.



2.2 Data

Residential population data is census block data divided by approximately 500 persons.The floating population data of the study area was provided by SK Telecom & SK Geovision, and The data are provided with monthly average flow population data in a 50m grid by hour. The floating population data in this study used the 18:00 data of July 2015.

3. Methodology

3.1 Allocating Shelter According to Guideline for the Resident Evacuation Plan of Tsunami in Korea

According to the Giudeline for the resident evacuation plan of tsunami in Korea, tsunami shelters should be designated as areas within 600 meters of the possible coastline, areas above sea level of 10 meters, and areas where tsunami evacuees can reach within 10 minutes (National Law Information Center, 2017).

3.2 Allocating Tsunami Shelter by Genetic Algorithm

Genetic algorithm is a technique to solve optimization problems based on the evolutionary process of life, and it is based on Darwin's theory of survival of the fittest where objects with strong characteristics survive (Goldberg, 1989). After the initial generation setup, the genetic algorithm determines the next generation's production or the end of the algorithm, depending on whether the objective function is achieved through the selection, production, crossover, and variation processes.

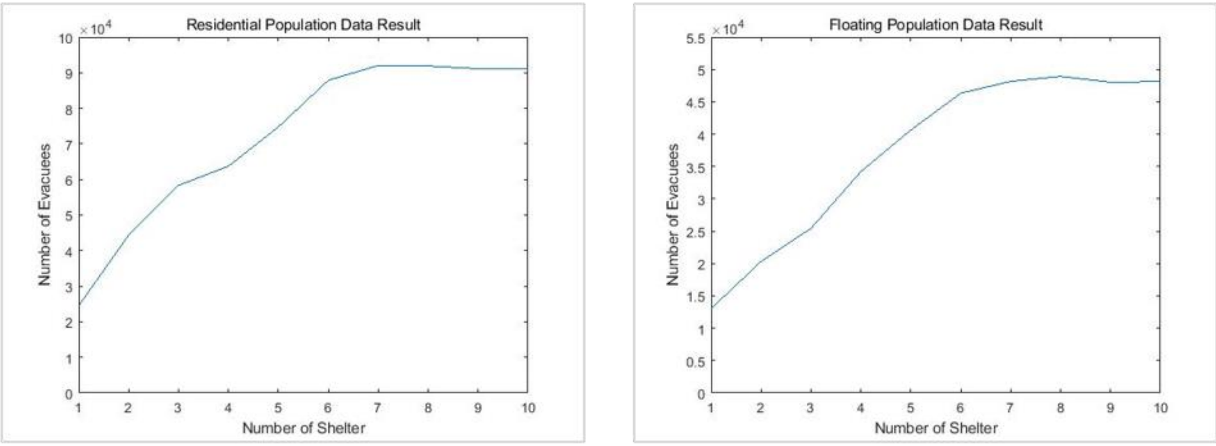
Elitist preserving selection and roulette wheel selection were used for selection, and onepoint crossover was used for crossover. Basic parameter setting needed to implement genetic algorithm was selected as Table 1 through experiment on each data.

Table 1 Parameter setting result

Parameter	Residential Population	Floating Population
Number of generation	300	100
Number of population	100	100
Selection rate	40%	40%
Number of Elitist	10	10
Crossover rate	80%	90%
Mutation rate	2%	2%

4. Result

Figure1 shows the result of applying genetic algorithms to allocating new tsunami shelter using two data, and shows the number of evacuees depending on the number of shelters. For the Residential Population data, it was found that 7 shelters were the most efficient if selected and when floating population data was used, it was most efficient when 7 shelter was selected.



(a) (b)

Figure 1 The number of evacuees according to the number of shelters; (a) residential population data , (b) floating population data

Figure 2 shows where seven new shelters were selected when using residential population data. Figure 3 shows where seven new shelters were selected when using floating population data. Comparing the two results, it was confirmed that the evacuation shelters were selected near the residential area and tourist spots. However, it was confirmed that shelters were selected only around the general residential area.

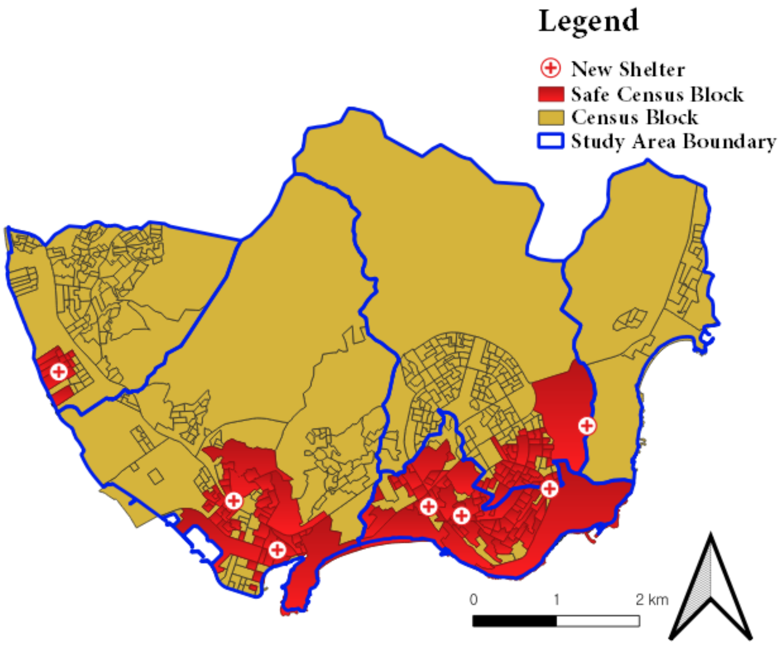


Figure 2 Location of new shelter and safe census block

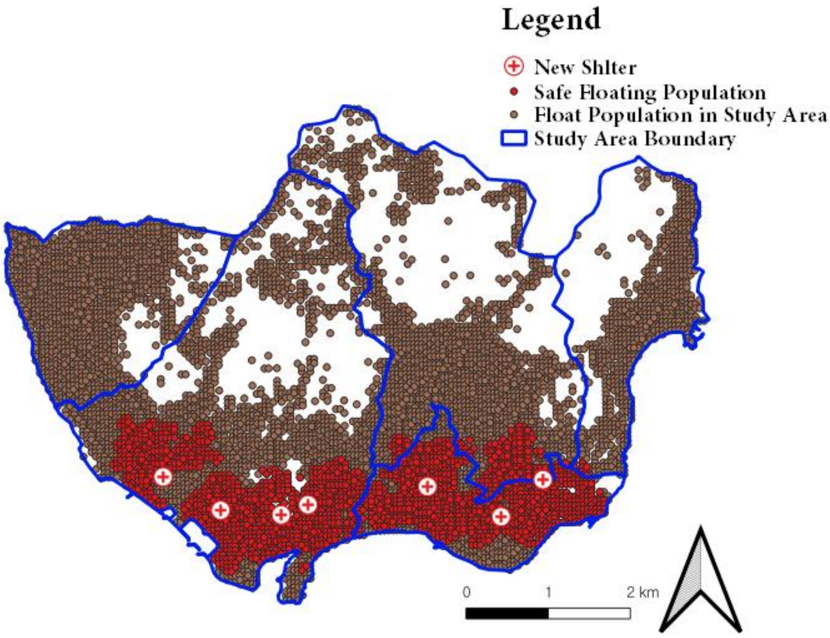


Figure 3 Location of new shelter and safe floating population

5. Conclution

In this study, a tsunami shelter was selected based on the area adjacent to the coastline and the river in Haeundae-gu, Busan, to reduce the casualties in the event of a tsunami. The location of shelter was selected using residential population data and floating population data, and the genetic algorithm, which is an optimal search method, was selected within 600m of coastline and 10m above sea level according to the guidelines for evacuation plan for tsunami. Evacuated personnel were used as the objective function of the genetic algorithm.

According to the analysis of the research results, it was most efficient to allocate seven shelters when the residential population data were used, and when the floating population data were used, it was most efficient to allocate seven shelters. Shelter was selected only near the residential area when the residential population data were used, but when floating population data were used, it was confirmed that the shelter was selected not only in the general residential area but also in the tourist area.

Acknowledgement

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