Reflections on the Accessibility of Radiological Disaster Evacuation Facilities

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1. Introduction

The Gyeongju (2016) and Pohang (2017) earthquakes in South Korea, once considered an earthquake safe zone, have raised fears of a radiological disaster due to the presence of nuclear power plants near the quake sites. Large earthquakes are often accompanied by tsunamis, and since nuclear facilities are mostly located on the coast, locals fear that a tsunami could trigger a Fukushima-like accident.

In order to safely manage and operate nuclear materials and nuclear facilities and efficiently respond to radiological disasters, Korea has established the Act on the Protection of Nuclear Facilities and Radiological Disaster Prevention Measures (hereinafter referred to as the Radiological Disaster Prevention Act). Currently, the Radiation Protection Act does not contain any provisions related to radiation disaster evacuation facilities, and civil defense evacuation facilities are used as evacuation facilities in the event of a radiation disaster according to the Civil Defense Master Plan.

To protect residents from radiation disasters, the Act on the Protection of Nuclear Facilities and Other Nuclear Disaster Prevention Measures establishes radiation emergency planning areas. However, despite the fact that radiation disasters are different in nature from evacuation centers associated with other disasters, there is no research on whether currently operating evacuation centers are suitable for nuclear accident evacuation.

A radiological disaster is a type of social disaster. A radiological disaster is defined as a situation in which a radiation emergency escalates to a situation that may cause damage to people's lives, property, and the environment and requires a national response. In this case, a radiation emergency is defined as a situation that requires urgent response measures due to the leakage or threat of leakage of radioactive substances or radiation. Depending on the area affected by the radiation leak, it is classified into white (the radiation leak is limited to the nuclear facility building), blue (the radiation leak is limited to the nuclear facility site), and red emergencies, and protective measures are implemented in the event of a red emergency. In the event of a radiological emergency or radiological disaster, an emergency protective action plan zone is an area designated for emergency protective measures for residents based on the results of radiological impact assessment or environmental monitoring, with a radius of 20 km to 30 km.[1]

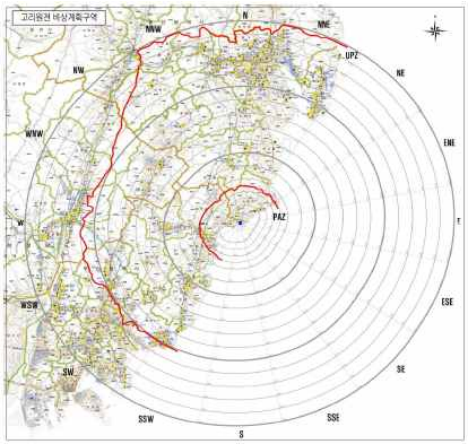

Fig. 1 Emergency planning zone in Kori nuclear power plant

Busan Metropolitan City has defined a radiation emergency zone of 5 kilometers for precautionary protection and 20 to 22 kilometers for emergency protection based on the Kori Nuclear Power Plant, as shown in Figure 1.

In the event of a radiation leakage accident, the government's crisis management system and the direction of activities by agencies are directed by the Standard Manual for Crisis Management in Nuclear Safety, but the behavioral evacuation instructions for individuals are that they should immediately evacuate to their homes or nearby shelters when a disaster warning is issued, and evacuate as far as possible from the contaminated area to reduce the amount of radiation.

2. Methods and Results

2.1 Vulnerabilities

Currently, the Basic Act on Disaster and Safety Management in Korea defines children, the elderly, and the disabled as vulnerable to disasters. Various studies have been conducted on disaster management for these vulnerable groups.[2]

Vulnerable populations, such as the elderly and children, may have weaker physical and mental capabilities than other age groups and may have slower walking speeds, which can make it difficult for them to evacuate quickly. Prior research on walking speeds for vulnerable populations suggests a walking speed of 0.8 m/sec for children and the elderly.[3]

2.2Walking speed

A walking speed of 0.8 m/sec is considered appropriate for use in analyzing the adequacy of evacuation facilities because the distance that can be traveled during a 5 minute evacuation time, which is the standard for building evacuation facilities by the government, is 240 meters, which is less than the minimum walking distance for the elderly.[4]

3. Results and discussion

Currently, there is a lack of evacuation facility location adequacy studies that focus on the specific disaster of a nuclear accident, but there are many studies on evacuation facilities in general. There have been studies on the location of evacuation facilities considering vulnerable populations, such as those that can be reached within five minutes using average walking speeds in Seoul, and those that analyze the evacuation range of evacuation facilities by categorizing walking speeds of children, adults, and the elderly. [5,6]

There are also many studies related to natural disasters and evacuation facilities. Natural disaster evacuation facilities are divided into wind and water disaster evacuation facilities and earthquake and tsunami evacuation facilities. In the case of Samcheok, we analyzed the number of evacuation facilities, access routes, and walking time.

Analyzed the spatial accessibility of earthquake evacuation facilities in Pohang, Gyeongsangbuk-do, considering the designation status of evacuation facilities, regional differences in reachable areas, and the population capacity of evacuation facilities. Conducted a study to analyze the inundation zone during heavy rainfall by setting up a heavy rainfall scenario and selecting optimal evacuation sites.[8,9]

There is also international research on shelter. We used geographic information systems (GIS) to analyze shelter adequacy in South Florida and found that existing shelters are not located in areas where seniors and low-income people live.[10]

Studies have shown that individuals can protect more people by sheltering in place than by evacuating in vehicles, which emphasizes the importance of sheltering in place during a radiological disaster.[11]

While natural disasters such as wind and water disasters occur frequently, radiation disasters have not yet become a major issue, and evacuation facilities related to radiation emergencies are not designated the same as those for earthquakes and tsunamis. However, when a radiation disaster occurs, the damage is different from other disasters and is difficult to predict. Therefore, checking the adequacy of evacuation facilities is essential, which is the most basic measure to minimize damage in the event of a radiation disaster.

In this study, based on the domestic system and previous studies, we set the criteria for the appropriateness of the location of radiation disaster evacuation facilities as follows. In order for an evacuation center to consider the safety of vulnerable people, it should be located within 240 meters, a distance that children and the elderly can travel for 5 minutes. Therefore, 240 meters was set as the service area based on the evacuation centers in the target area, and the ratio of the service area and the number of children and the elderly included in the service area were derived and analyzed.

4. Conclusions

The study found that there is a lack of evacuation facilities that can be evacuated within five minutes in the event of an emergency, and that there is a need to expand evacuation facilities that take into account the distribution of vulnerable groups. Not only is there an overall shortage of evacuation facilities, but the location of evacuation facilities for vulnerable groups such as children and the elderly is also insufficient. Accessibility of evacuation facilities is an important factor to consider for safe evacuation, as vulnerable populations have relatively low economic power and physical challenges. While this study is significant in that it focuses on radiological disasters and quantitatively examines the adequacy of evacuation facility locations by deriving the area that can be evacuated within five minutes and the percentage of vulnerable people, it also has limitations.

Currently, evacuation facilities in Korea lack facilities and functional elements to prepare for radiological disasters, and it is judged that an overall inspection that considers various factors simultaneously as well as the appropriateness of the location is necessary. In addition, this study has a limitation that the evacuation standards for radiological disasters are set as civil defense standards and earthquake/tsunami evacuation standards. In the event of a radiological disaster, there is no separate evacuation standard other than to evacuate as quickly and far as possible, and radiological disasters are expected to be unpredictable unlike conventional disasters. Therefore, in order to prepare for radiological disasters, it will be necessary to secure the location and evacuation standards of evacuation facilities specialized for radiological disasters rather than the evacuation standards of conventional disasters.

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