Change in the spatial distribution of the air dose rate in the riverside park affected by decontamination and floods

*Takuhei Yamasaki[1], Satoshi Suzuki[1]

1. Fukushima Prefectural Centre for environmental Creation

Introduction

The accident at the TEPCO’ s Fukushima Dai-ichi nuclear power plant resulted in the release of a large amount of radionuclides in the environment. To assess the impact of the radiation dose to the human health, air dose rate has been measured widely in and around Fukushima prefecture. Air dose rate at the riverside park often decreases by the erosion/deposition of the sediments during floods as well as the decontamination work, radiocesium migration through soil, and physical decay. Moreover, topographic conditions such as elevation and undulations affect the change in the air dose rate.
Walking survey can easily get the spatial distribution of the air dose rate. However, each data by the walking survey has different acquisition positions due to the automatic records during measurement. To evaluate the temporal change in the air dose rate by the walking survey spatially, correction to match the comparison positions is needed. Kriging would be an effective tool for the interpolation of data having the spatial correlation such as air dose rate. The objective of our study is to evaluate the spatial patterns of the change in the air dose rate at the riverside park by using walking survey and kriging interpolation technique.

Methods

Study site was a riverside park facing the Niida River, located in Minami-Souma city, Fukushima prefecture. The radiocesium deposition by the accident was estimated to 300-600 kBq m-2. Remediation work against the radiation dose was conducted in 2016, and 3 typhoons (Etau in 2015, Lan in 2017, and Hagibis in 2019) attacked and river bank has been damaged by the typhoons in 2015 and 2019. We started walking survey measurement just before the attack of the typhoon Etau to January 2020. Gamma plotter H (Mimura et al., 2012) was used to measure the air dose rate at 1-m and 5-cm height. Time constant was set to 3 s, and measurement interval was 5 s.
Experimental semivariogram was calculated by using the Stanford Geostatistical Modeling Software. Lag separation and lag tolerance was set to 1 m and 0.2 m, respectively. Anisotropy was not considered. The spherical semivariogram model was fitted to the experimental one. Ordinary kriging was applied for the interpolation with ArcGIS ver. 10.5.1. Cell size of the grid was set to 2 m. Analysis area was limited to the inside of the riverside park.

Results and discussion

Among the semivariogram parameters, sill decreased with time, which reflects the temporal attenuation of the air dose rate. On the other hand, range did not changed with time. Range of 1-m measurement data was longer than that of 5-cm. This agrees with the fact that the air dose rate closer to the ground surface was affected by the radionuclides deposited on the narrower area.
The median value of the interpolated air dose rate always decreased with time faster than the rate by physical decay of radiocesiums. Especially, the typhoon events and the decontamination work accelerated the decrease in the air dose rate compared to the migration in soil due to the rainfall. The decrease in the air dose rate due to the floods was greater at the position near the river, while those by the decontamination occurred mainly in the west of the park with gardens or covered with grass.

Keywords: air dose rate, kriging, decontamination, flooding

