Investigation on distribution of radioactive substances in Fukushima
(8) Optimizing Long-term Monitoring of Radiation Air Dose Rates at Regional Scale

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Abstract: In this study, we have developed a methodology for optimizing the monitoring locations of radiation air dose rates. It is based on (1) a Gaussian mixture model to diversify locations across the key environmental controls that are known to influence cesium mobility and distributions, and (2) a Gaussian process model to capture the heterogeneity of radiation air dose rates across the domain.

Keywords: radiation air dose rates, data integration, monitoring optimization

1. Introduction

Radiation air dose rates near the Fukushima Daiichi Nuclear Power Plant (NPP) have been monitored extensively over the past eight years since March 2011. The monitoring program is expected to transition from emergency responses to long-term monitoring. The objectives of long-term monitoring are (1) to confirm system stability and the continuing reduction of hazard levels, (2) to detect any anomalies and critical changes, (3) to provide assurance for the public, and (4) to accumulate the basic datasets for scientific knowledge and future prediction. To achieve such sustainable and effective long-term monitoring, we need the methodology to determine the number and locations of monitoring posts and surveys.

2. Method

In our methodology, we use the integrated dose-rate map from the Bayesian geostatistical method as the reference map and distribute the sampling in such a way as to capture the heterogeneity of the reference map (Wainwright et al., 2018). Three steps are taken in order to determine monitoring locations: (1) prioritizing the critical locations (schools etc), (2) diversifying locations across the key environmental controls that are known to influence contaminant mobility and distributions (a Gaussian mixture model), and (3) capturing the heterogeneity of radiation air dose rates across the domain (a Gaussian process model).

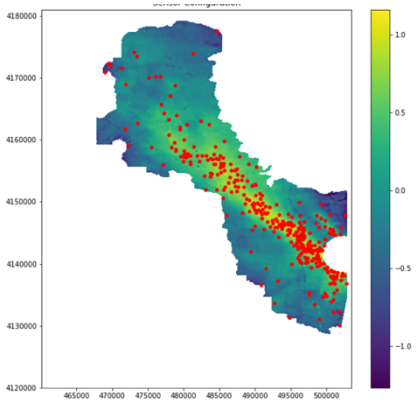

Figure 1. Selected monitoring post locations overlaid on the integrated radiation dose rate map in 2016 (log-microSv/hr)

3. Results and Conclusion

We applied this methodology to reduce the number of monitoring posts within the former evacuation zone area (as of 2017). The algorithms were applied to the actual monitoring post locations, and selected 100 locations among the existing 255 locations in this region (Figure 1). We confirmed that the root-mean-squared error converges around 100 locations, which are considered to be sufficient for capturing the heterogeneity in the radiation dose rates.

References

[1] Wainwright, H. M., Seki, A., Mikami, S., & Saito, K. (2018), Characterizing Regional-Scale Temporal Evolution of Air Dose Rates After the Fukushima Daiichi Nuclear Power Plant Accident, Journal of Environmental Radioactivity, 189, 213-220.