

# Investigation on Distribution of Radioactive Substances in Fukushima

## (4) Study on the Ecological Half-lives of Ambient Dose Rates Using Car-borne Survey Data with Fused LASSO Algorithm

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### Abstract

Ecological half-life has been widely used to describe the long-term decrease of ambient dose rates in addition to radioactive decay. With large-scale car-borne survey, the overall ecological half-lives have been studied in previous works. In the present work, we introduce a new, robust, and efficient numerical method to extract space-dependent ecological half-lives from car-borne survey data.

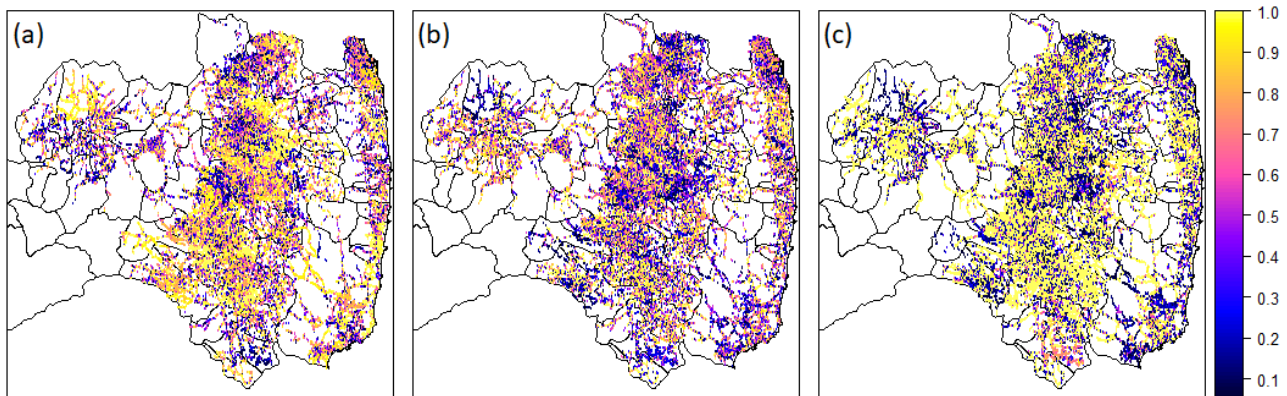
**Keywords:** ecological half-life, ambient dose rate, car-borne survey, fused LASSO

### 1. Introduction

The present work aims to develop a new fitting algorithm to extract space-dependent ecological half-lives from car-borne survey data [1]. To achieve high efficiency and numerical stability, we utilize a graph-based fused LASSO method, which has been applied in various fields such as image denoising, signal processing, bioinformatics, etc.

### 2. Methodology and preliminary results

Our fitting algorithm consists of a linear sparse model for non-linear fitting, Bayesian background dose, graph representation for measurement data, and fused LASSO [2] for spatial correlations, which could simultaneously fit space-time information with linear time complexity. Fitting results using KURAMA data measured at 199547 locations in Fukushima prefecture between 2011 and 2016 are presented below, where the normalized relative weights of ecological half-lives in ranges 0.1 to 2 y, 2 to 10 y, and 10 to 100 y are shown in figures (a), (b), and (c), respectively.



### 3. Conclusion

The fitting results indicate some interesting spatial patterns of ecological half-lives. For instance, figure (a) shows relatively fast decrease of ambient dose rates in urban area. We will focus on validating the model as well as further studying the cause of these spatial patterns in future works.

### References

- [1] Saito, K. et al. Summary of temporal changes in air dose rates and radionuclide deposition densities in the 80 km zone over five years after the Fukushima Nuclear Power Plant accident. *Journal of Environmental Radioactivity* (2019).
- [2] Barbero, A. and Sra, S. Modular proximal optimization for multidimensional total-variation regularization. *Journal of Machine Learning Research* **19**, 1-82 (2018).