

Mathematics

This department is interested in mathematical and statistical modeling of various natural and social phenomena. We primarily focus on environmental assessment and cancer control programs.

Associate Professor
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1. Environmental assessment by mathematical modeling

We have developed mathematical and statistical modeling procedures for forest resource management. In particular, we are conducting research on two topics: (1) growth modeling to evaluate carbon fixation capacity in forests and (2) natural disaster risk assessment. Regarding (1), based on nonlinear growth functions, we developed robust estimation independent from the initial parameter settings and the optimal selection method for the growth function by improving the information criterion. For robust estimation of parameters, we apply the concept of ridge estimate. Figure 1 compares residual-based and ridge estimates for the two parameters included in the Bertalanffy growth function. Meanwhile, Figure 2 shows the results of applying the improvement of information criterion in the growth function to the real growth data. Furthermore, combining them with cluster analysis methods such as k-means makes it possible to classify growth patterns beyond the growth function. Regarding (2), the discrete regression approach (logistic or multinomial regression) is adopted to evaluate risk probability. By identifying risk factors using variable selection based on the information criterion, recommendations can be made for optimal intervention practices and management to minimize disaster risk. In research themes (1) and (2), theoretical improvements are validated through numerical experiments and real data analysis.

Figure 1
 (Estimate for scale parameter)

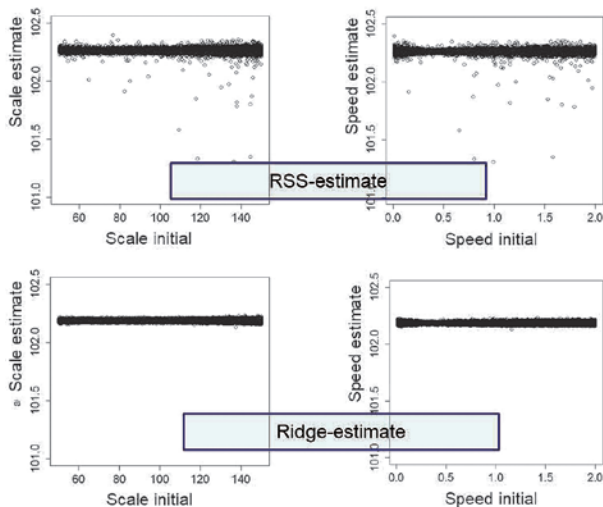
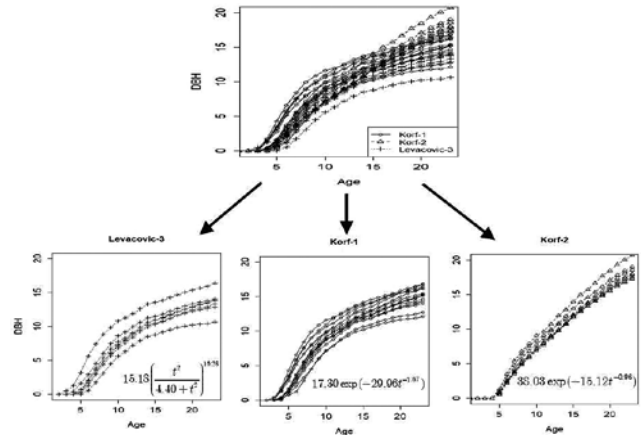


Figure 2
 (Growth classification by growth function)



2. Microsimulation for evaluating cancer risk

Microsimulation can be used as a numerical tool to evaluate interventional cancer control programs based on various scenario settings. Although there are many advanced microsimulation projects involving policy-making in other countries, they are still being developed in Japan. We have attempted to construct a colorectal cancer microsimulation model in Japan. Once the microsimulation system is set up, several forecasts for cancer behavior can be estimated. For example, by setting several rates for screening, we can evaluate the reduction in cancer mortality. For colorectal cancer screening, if the rate for fecal immunochemical testing is improved by 50% and colonoscopy by 90%, then the reduction in mortality is estimated as 9.4% for males and 6.2% for females. In addition, we can compare the benefits and harms of screening with a microsimulation program, for example, the upper bound setting for screening. Once the microsimulation system has been set up, the useful macros and estimation methods established for colorectal cancer can be transferred to other types of cancer.

List of Main Publications (September 2018 to August 2023)

See 2D Barcode below

