World Academy of Science, Engineering and Technology
International Journal of Mathematical and Computational Sciences
Vol:12, No:05, 2018

# Modeling Spatio-Temporal Variation in Rainfall Using a Hierarchical Bayesian Regression Model

**Authors :** Sabyasachi Mukhopadhyay, Joseph Ogutu, Gundula Bartzke, Hans-Peter Piepho

**Abstract :** Rainfall is a critical component of climate governing vegetation growth and production, forage availability and quality for herbivores. However, reliable rainfall measurements are not always available, making it necessary to predict rainfall values for particular locations through time. Predicting rainfall in space and time can be a complex and challenging task, especially where the rain gauge network is sparse and measurements are not recorded consistently for all rain gauges, leading to many missing values. Here, we develop a flexible Bayesian model for predicting rainfall in space and time and apply it to Narok County, situated in southwestern Kenya, using data collected at 23 rain gauges from 1965 to 2015. Narok County encompasses the Maasai Mara ecosystem, the northern-most section of the Mara-Serengeti ecosystem, famous for its diverse and abundant large mammal populations and spectacular migration of enormous herds of wildebeest, zebra and Thomson's gazelle. The model incorporates geographical and meteorological predictor variables, including elevation, distance to Lake Victoria and minimum temperature. We assess the efficiency of the model by comparing it empirically with the established Gaussian process, Kriging, simple linear and Bayesian linear models. We use the model to predict total monthly rainfall and its standard error for all 5 * 5 km grid cells in Narok County. Using the Monte Carlo integration method, we estimate seasonal and annual rainfall and their standard errors for 29 sub-regions in Narok. Finally, we use the predicted rainfall to predict large herbivore biomass in the Maasai Mara ecosystem on a 5 * 5 km grid for both the wet and dry seasons. We show that herbivore biomass increases with rainfall in both seasons. The model can handle data from a sparse network of observations with many missing values and performs at least as well as or better than four established and widely used models, on the Narok data set. The model produces rainfall predictions consistent with expectation and in good agreement with the blended station and satellite rainfall values. The predictions are precise enough for most practical purposes. The model is very general and applicable to other variables besides rainfall.

**Keywords :** non-stationary covariance function, gaussian process, ungulate biomass, MCMC, maasai mara ecosystem
**Conference Title :** ICMSCS 2018 : International Conference on Mathematics, Statistics and Computational Sciences
**Conference Location :** Barcelona, Spain
**Conference Dates :** May 17-18, 2018