WATER RESOURCES RESEARCH GRANT PROPOSAL

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Title: Bacterial ratios and neural networks for modeling Kentucky River water quality

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Principal Investigators:
Gail Montgomery Brion
Assistant Professor, University of Kentucky

Srinivasa Lingireddy
Associate Professor, University of Kentucky

Abstract

There is an abundance of fecal material in our nations surface waters as is indicated by high concentrations of fecally associated bacteria. Runoff contains a multitude of pathogens and pathogen indicators that can suddenly change the intake quality at water treatment plants. Treated and untreated human waste and runoff impact the Kentucky River, water source for Lexington and other municipalities, resulting in greater than desired concentrations of fecal bacteria and sharply peaking concentrations. To avoid peak pathogen loadings, reduce risk to the public consuming potable water derived from surface waters, and to be able to optimize water treatment processes under changing conditions, new types of indicator systems need to be developed. These systems should be able to work in real-time and indicate when large quantities of fresh fecal material are at the intake of water treatment plants. Currently, real-time systems are not possible because of the nature of microbial tests, which provide results hours to days after the microbial peak has started. Adding to this difficulty is that current indicators are not able to provide information on fecal source or age. However, it is generally accepted that aged fecal material contains fewer pathogens than fresh material and fresh human sewage should be avoided.

Until recently, the age of fecal material in water was not known from the bacterial indicators measured. Recent research by the PIs has indicated that the ratio of atypical to typical coliforms from the total coliform test (AC/TC) can indicate the freshness of fecal material in surface runoff relative to human sewage. However, few water treatment facilities routinely monitor the bacterial quality of their intake water, and even fewer still monitor intakes for total coliforms. The Kentucky American Water (KAW) company is one of the few facilities that has monitored their intake for a range of bacterial indicators and therefore presents local researchers with a rare opportunity. The historical database KAW has kept is incomplete, with the peak numbers of bacteria often missing due to inadequate dilution. Bacterial concentrations are not linearly distributed, and predicting these missing values is problematic. Research by the PIs has proven using multiparameter databases and applying advanced neural network programming can predict peak microbial concentrations from other water quality measurements. It is the objective of this

study to use neural networks to fill in the holes in the historic KAW database. To support this effort, aging studies on the AC/TC ratio in human sewage and surface water will be done to model this relationship over time. These results will be compared to existing databases containing microbial concentrations of local surface runoff and first flush events that the PIs have obtained. Both lab studies and the environmental databases will be used to train and validate the neural network predictions for missing microbial datapoints. The resultant KAW Kentucky River database, containing information on fecal age and water quality measures, will be key to future research efforts that are planned to develop new neural network models as the basis for real-time early warning systems based upon on-line surrogate parameters, predicted bacterial concentrations, and hydrological events within the Kentucky River.