DEVELOPMENT OF A DECISION-MAKING SYSTEM FOR USE AGAINST THE INTRUSION OF BIOLOGICAL AGENTS INTO WATER SYSTEMS

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The feasibility of monitoring open-channel water systems as an early warning of the accidental or intentional release of biological agents was investigated. An extensive literature survey and results are summarized in a recent report (Choi et al., 2003). Critical steps in this recent study included (i) evaluations of the quantity of pathogens that would be released into the sewer system, (ii) how these organisms would be distributed in an open-channel system (accounting for dilution and dispersion), and (iii) how well they could be quantified at a single location.

We developed and examined prediction models using computational tools such as CFD (Computational Fluid Dynamics) and ANNs (Artificial Neural Networks) for water distribution and collection systems though analyses of the collected data. The models were designed (i) to forecast microbial dispersion patterns in each system, (ii) to estimate dispersion time, and (iii) to recommend detection methods, sampling frequencies, and sampling locations. Based on a series of field experiments, those computational models which proved effective were designed to provide us with an impetus to establish an optimization technique for real-world situations. Field experiments and numerical simulation data were essential to evaluate the validity of the developed model. The use of ANNs for spatial and temporal identification of biological agents was conducted based on the particular characteristics resulting from pH, turbidity, and conductivity data corresponding to *E. coli* concentration over time.

Overall, the simulation results for the two purposes for using ANNs, parameter estimation (Fig. 1) and feature classification, were highly satisfied ($R^2 = 0.77$-0.96). It was concluded that ANNs could be effectively used for multiple tasks, such as prediction of the dispersion pattern of *E. coli* using its surrogates. In addition, various characteristics of the time-series concentration of *E. coli*, flow rate, inlet position, distance from an outlet, etc., were well-considered to classify the release location and concentration.

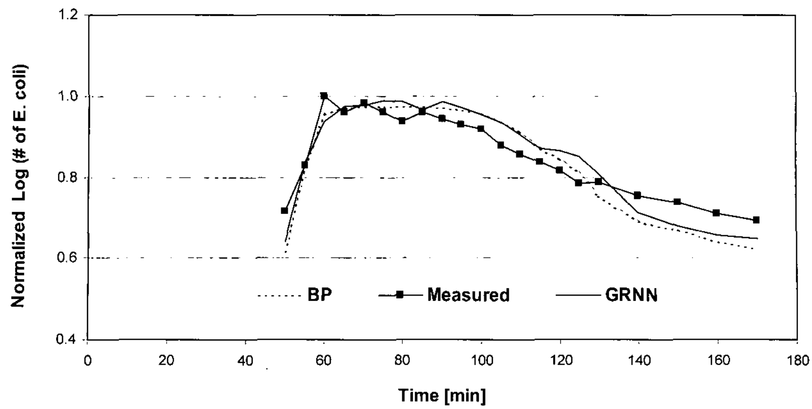

Fig. 1 Parameter estimation of time-series data
(Correlation coefficients, $R^2 = 0.96$ for Backpropagation (BP) and $R^2 = 0.95$ for Generalized Regression Neural Networks (GRNN), respectively)

REFERENCES

Choi, C., C. Gerba, and M. Riley. 2003. Environmental Dispersion of Biological Agents in Sewer Systems. Final Report, DARPA Project No. 806345617.