An overview of the posters presented at Watermatex 2000. I. New models/integrated urban wastewater systems/ time series analysis

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Abstract This paper presents an overview of the posters presented in the sessions 1, 6 and 9 of the Watermatex 2000 conference. The first session focused on the development of new models in different areas of environmental technology, e.g. wastewater, ground pollution, sewers, etc. The sixth session dealt with integrated urban wastewater systems. Session 9 focused on the application of neural network modeling and principal component analysis in time series analysis. Rewarded posters are mentioned and selected for full paper publication in this issue of *Wat. Sci. Tech.*

Keywords New models; integrated urban wastewater systems; time series analysis

Poster session 1: new models: WWTP, river quality, sewer

Simulation of the natural attenuation of phenol in groundwater at Four Ashes (Li *et al.*)

Coal tar and products from early plant and tank storage facilities cause significant groundwater pollution at Four Ashes. The objectives of this research were to assess the effects of the chemical and biological degradation of phenol during the migration in groundwater. Three computer codes, Visual Modflow, MT3D and BioRedox were used to simulate and predict the distribution, transport and degradation of phenol. Based on the field investigations and laboratory studies, processes such as sorption, reduction and oxidation and biodegradation affect the migration of phenol in groundwater at the Four Ashes site. The analysis showed that natural attenuation will play an important role in the removal of phenol from groundwater.

Exact and approximate modelling of convection-diffusion and reaction-diffusion problems (van der Wielen and Keesman, 2000)

The problem of modelling convection-diffusion phenomena with (bio)chemical reaction in reactors is considered. For reactions with zeroth- or first-order kinetics or for problems with piece-wise constant inputs along the reactor system the theory of linear partial differential equations is sufficient to describe the dynamics in the reactor. However, usually complex models will result. The authors transform these linear infinite-dimensional systems and represent them in terms of a so-called non-rational transfer function in the frequency domain. For fast computations a rational transfer function is desired. Consequently, an optimization-based method to approximate the system, obtained from prior process knowledge only, by a rational transfer function has been developed and applied to an example.

Modelling benthic macro-invertebrate communities in Flanders using artificial neural networks (Gabriels *et al.*, 2000)

Artificial neural networks (ANNs) to predict benthic macro-invertebrates are presented. These models were calibrated with a data set of sampling sites on different unnavigable watercourses in Flanders, Belgium. Abiotic variables were used as input variables. Eight neural networks, each for predicting whether one taxon is present or not, were tested with

Water Science and Technology **Vol 43 No 7 pp 377–380**

an independent validation set. This provided, on average, 77.5% correct predictions. This test was repeated with eight similar ANNs, where each taxon was expressed as *pseudospecies*. The pseudospecies code was predicted correctly for, on average, 47.2% of the validation sites. The authors give some suggestions to improve the model.

Compartmentalization of a surface-aerated circulation basin using a 3-D velocity field (Hunze *et al.*, 2000)

A compartmentalization approach is used for describing surface-aerated circulation basins. The aim of the presented approach is to integrate gradients over the depth of oxygen concentrations in zero-dimensional simulation models. Such gradients, which can be observed in the basins, influence the occurring processes on a large scale. In order to obtain a realistic description of the conditions prevailing in the basin, it is necessary to consider these gradients in a model description. The approach is based on a 3-dimensional velocity field. This field allows the authors to compute the compartments as well as the volume flows between them. The simulation results show the suitability of the presented method for describing the essential phenomena of circulation basins. The quality of the presented method is apparent when comparing the simulation results with measured data.

Evaluation of pH inhibition on activated sludge by the pseudo toxic concentration (C_{PT}) concept model (Ko *et al.*, 2000)

- rewarded: full paper publication -

Modelling of a reactive primary clarifier (Gernaey *et al.*, 2000)

- rewarded: full paper publication -

Long term pollution simulation in combined sewer networks (Masse *et al.*, 2000)

- rewarded: full paper publication -

Poster session 6: integrated urban wastewater systems

Probabilistic modelling of a combined sewer-WWTP-river system: case study of the Witte Nete at Dessel (Belgium) (Willems and Berlamont, 2000)

The impact of the combined urban drainage and WWTP system of the village of Dessel (Belgium) on the Witte Nete receiving water has been modelled both in terms of emissions and immissions. The hydrodynamic and water quality modelling has been performed both in a deterministic and probabilistic way. For the deterministic modelling, detailed physically based and simplified conceptual models have been used in a complementary way. In the probabilistic modelling, the different uncertainties in the deterministic model were classified in input-, parameter- and model-structure uncertainties. The probabilistic simulation results can be used in risk analysis and management, for the determination of the major uncertainty sources and priorities in model improvement, for model bias elimination and for efficient model calibration.

Integral water quality modelling of catchments (Van Griensven and Bauwens, 2000)

- rewarded: full paper publication -

Poster session 9: time series analysis

Multivariate analysis of activated sludge process (Tomita *et al.*, 2000)

In this contribution 12 original physical variables of an activated sludge wastewater treatment system were considered. These cross-correlated variables are transformed into new ones that are not correlated by the use of PCA, a powerful tool for analysis, monitoring and

diagnostics of wastewater treatment processes. Just one principal component, the first, explains most of the system total variability, that is, 52% of total variance. The first three principal components explain 78% of the total variance. The ability to describe the overall characteristics of the process using only three principal components will make the analysis, monitoring and diagnostic of wastewater treatment systems easier. Another result is the detection of three groups of variables characterizing the system. The first group identifies variables that represent microorganisms and inert particulate matter arising from cellular decay, while the second group refers to substrates and total flow rate. The third group contains ammonia nitrogen and alkalinity related to the pH of the system. Principal components are also used to build a control chart. Based on these results of percentage variance, control charts and grouping analysis, it is shown how to enlarge the interpretation of the characteristics of activated sludge wastewater treatment systems.

Time series analysis and neural network classification of the secondary settler in the wastewate plant (Yoo *et al.*, 2000)

An efficient operation of the secondary settler is very important since it separates the biomass from the treated wastewater and is a key mechanism determining effluent quality in biological wastewater treatment. An adaptive process modeling scheme that uses an autoregressive exogenous (ARX) time series model is introduced to predict the sludge volume index (SVI). The estimation of the ARX model parameters uses the RLS (recursive least square) method and updates the model parameters adaptively at each obtained data point. The basic idea is that the ARX model parameters have features that allow one to classify the current state of a secondary settler. The capability of clarifier state monitoring is utilized within a neural network predictor, for which a hybrid Genetic Algorithm (GA) was used to decide on the number of hidden nodes of the network. From the application to a full-scale wastewater treatment plant, it was indicated that the prediction model with adaptive processing described the dynamics of the secondary settler very well and that a neural network classifier combined with an adaptive scheme is quite adequate for the monitoring of the secondary settler.

Multivariate time series modelling of algal blooms in freshwater lakes by machine learning (Recknagel *et al.*, 2000)

This contribution discusses applications of artificial neural networks and genetic algorithms for modelling of algal blooms in freshwater lakes. Despite the complex and nonlinear nature of limnological data, artificial neural networks allow seven-days-ahead predictions of timing and magnitudes of algal blooms with reasonable accuracy. Genetic algorithms possess the capability to evolve, refine and hybridize numerical and linguistic models. Examples presented in the paper show that models explicitly synthesized by genetic algorithms not only perform better in seven-day-ahead predictions of algal blooms than artificial neural network models, but provide more transparency for explanation as well.

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