EVALUATING THE HYDRAULIC EFFICIENCY IN ARTIFICIAL WETLANDS

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Surface water wetlands play an important role in management of urban storm water quality. The treatment of the storm water as it flows through a wetland is the outcome of a complex interaction between the chemical, physical and biological processes that occur within the system.

One of the most important factors that has a significant effect on the design of artificial wetlands is the hydraulic efficiency. In simple terms, the hydraulic efficiency of a wetland can be regarded as its capability to treat the water flow through it.

The common method for calculating the amount of hydraulic efficiency introduces the utilization of a tracer to denote the quantity of the outlet concentration against the time. However, this is only possible in some natural wetlands. It is therefore necessary to use numerical methods for simulation and evaluation of various potential physical scenarios.

In the present study, the relationship between the hydraulic efficiency and the wetland shape was initially investigated for simple conditions. A new technique has been suggested for estimation of hydraulic efficiency and comparisons are made and presented for the results obtained by this technique and those obtained by conventional techniques. A two dimensional model for solution of the general shallow water equations has been developed. Finite differences method has been used in the computational procedures of the model to descretise the main equations alongside utilizing the ADI solution technique. The prevailing computational model is capable of simulating the treatment process and predicting the tracer transition. Notable advantage of this method is that the tracer measurement procedures are no longer required.

The aim of this study has been to investigate and quantify the relationship between the wetland shape and the hydraulic retention time distribution for artificial surface water wetland systems. A two dimensional hydraulic model has been developed to investigate the way in which the hydraulic efficiency within a wetland system is influenced by the wetland shape. The technique devised for the solution procedure is novel and results are compared with that obtained by conventional methods.

Under ideal condition, plug flow characteristics can be assumed within the wetland system. Essentially, this means that all of the water that enters the wetland stays in the system. The duration of this stay is referred to as the hydraulic retention time.

An accurate understanding of the relationship between the hydraulic efficiency λ and the wetland shape requires detailed knowledge of the flow characteristics within a wetland system. To accomplish this aim, a tow-dimensional model was written by authors. The model solves the two-dimensional depth averaged shallow water flow equations using an iterative Alternating Direction Implicit (*ADI*) scheme to integrate the equations for mass and momentum conservation in the space-time domain. The equation matrices that result for each direction and each individual grid line are resolved by a double sweep (DS) algorithm. The equations are solved in one-dimensional sweeps, alternating between x and y directions. In the x-sweep the continuity and x-momentum equations are solved. In the y-sweep the continuity and y-momentum equations are solved. At one time step the x-sweep solution are performed in the order of decreasing y-direction, hereafter called a "down" sweep, and in the next time step in the order of increasing y-direction the "up" sweep.

The model uses a rectangular coordinate system and was used to calculate steady flow conditions through each of the model wetland configurations. The finite differences method was used to discretise the equations. The model was run for all of the cases studied.

Comparisons of the model results based on authors' technique with the results presented by Jenkins G.A [1] demonstrate the validity of the method that was used to obtain the hydraulic efficiency (Fig. 1).

The results signify that the hydraulic efficiency of a wetland is strongly affected by the length to width ratio. The curve produced from this study can be used to predict the hydraulic efficiency for any wetland, when the length to width ratio is known.

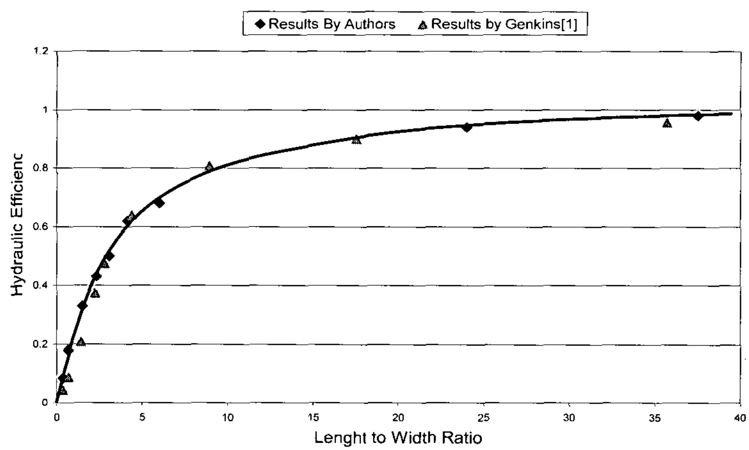

Fig. 1 Hydraulic Efficiency versus Length to Width Ratio for Wetlands

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