II-236　NUMERICAL MODEL OF WATER QUALITY IN HYDRAULIC NETWORK

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1. Introduction

There is an important need in lowland such as the Saga Plains to study on integrated water management . Open channel network(creek) in Saga is necessary for drainage, irrigation, drinking water and etc. Recently, however, water pollution is a serious problem in the channel network because of household wastewater is discharged. It is necessary to research on property of water quality in the channel systems and to develop numerical water quality model for water management in hydraulic network systems for improving water quality.

The main purpose of this study is to establish the integrated water management of complicated channel network in lowland as creek in Saga. A newly developed computer model based on "Flows Model" developed at Delft Tech. Univ. is used to examine the property of water quality and water management in the hydraulic network systems in Saga.

2. Numerical Model

2.1 Numerical Model for Flow Computation

A set of two equations is used for flow computation in network system. That is, the momentum equation and the continuity equation.

$$\frac{\partial Q}{\partial t} + \frac{\partial(Q \cdot v)}{\partial x} + g \cdot A \cdot \frac{\partial h}{\partial x} + J(Q, h) = 0 \qquad \frac{\partial B}{\partial t} + \frac{\partial Q}{\partial x} = 0 \qquad (1)$$

where, Q:discharge in one-dimensional channels, v:mean velocity, A: the flow cross section, g: constant of gravitation, J: the slope due to friction, multiplied by gA, B: the total wetted cross section

The water level in each node, adjacent the branches, has to be defined as ($HI(m) = h_{1,m}$、$HJ(m) = h_{2,m}$). It is assumed that there is no storage at the node, ΣQ for each node is 0.

Therefore, finally, a set of linear equations with the unknown water levels of the nodes is as follows:

$$\sum_{j=1}^{jmax(i)} M_{i,j} H_j + M_{i,0} = 0 \qquad (2)$$

where, i: node number, j: dummy variable, j(max)i: total branch number

The water levels can be obtained by using this equation. Branch discharge can be given from the water level. "Computation Model" for water flow is described in more detail in the original report of Flows Model.

2.2 Numerical Model for Water Quality

The concentration of water quality is assumed to be uniform at both transverse and vertical direction. The basic equation is as follows:

$$\frac{\partial BC}{\partial t} + \frac{\partial S}{\partial x} - P = 0 \qquad (3)$$

where, C: average concentration at cross section, S: mass transport rate, P: production (reduction or reaction) rate, D: dispersion coefficient

The numerical model is based on the Galerkin Method (so called FEM method). After integrating the basic equation along one branch, the general equation at the branch can be shown as follows:

$$S1^{*} = N_{m,1} \cdot CI^{*} + N_{m,2} \cdot CJ^{*} + N_{m,3} \ 、\quad S2^{*} = N_{m,4} \cdot CI^{*} + N_{m,5} \cdot CJ^{*} + N_{m,6} \qquad (4)$$

$\Sigma S = 0$ for each node, due to no storage of materials at the node.

From eqs.(4) and $\Sigma S=0$, therefore, linear equations with the unknown concentration of nodes are as follows:

$$\sum_{j=1}^{Jmax(i)} M^{*}_{i,j}\ C_j + M^{*}_{i,0} = 0 \qquad (5)$$

From eq.(5), the unknwon concentration of the nodes can be defined. Then the concentrations at the ends of branch and mass transport rate (concentration flux) can be obtained.

3. Results and Discussion

Simulation on BOD for the open channel network in Saga is carried out in order to confirm the newly proposed computer model. Drainage basin is divided into 7 blocks for simplifying the computation. Fig.1 shows the node numbers and observed discharges for the numerical computation. Each block is set up with one node connecting the each branch. The boundary nodes are the influent points from Tafuse River and the influent and effluent points from Omizo channel. Total discharge pollutant in a block is loaded as the point source to the node.

Fig.2 shows the calculated result of concentration at steady state. The observed values in field survey are averaged on the each block. The calculated values (● mark) agree with the observed values. It is confirmed that the newly proposed computer model is possible for examining water quality in hydraulic network systems. In fig.2 ○ mark is the results when BOD reduction coefficient equals to 0 (in case of neglecting settlement and decomposition of BOD). It is shown that there are almost no differences between the results of reduction rate =0 and 2.4. Therefore, the water quality mainly depends on the pollution load(household wastewater).

The possibility of the proposed model, further study is needed, will be shown in developing integrated water management in lowland.

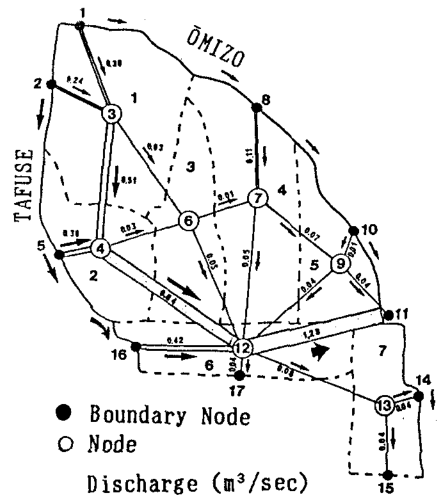

Fig.1 Discharge in Block

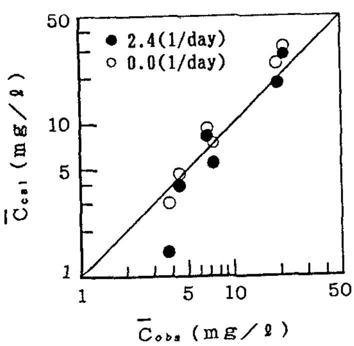

Fig.2 Calculated Result of Concentration (BOD Reduction Coefficient = 0.0, 2.4)

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