DEVELOPING CANAL REACH HYDRAULIC SENSITIVITY INDICATORS FOR OPERATION ASSESMENT

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The sensitivity analysis approach might be considered as an efficient technique for apprising irrigation system operation by providing practical information for irrigaion network managers. In this paper an analytical framework to address sensitivity of irrigation systems is presented. The paper focouses on establishment of hydraulic sensitivity indicators at local and reach levels. Three sensitivity indicators for a canal reach, i.e. reach sensitivity of water depth at response time, reach sensitivity of conveyed perturbation, and reach sensitivity of delivered perturbation were introduced. The hydraulic sensitivity of a hydraulic structure is defined as relative or absolute variation of output hydraulic parameter to that of input one. accordingly, using an analytical approach, the sensitivity of the delivered flow rate to flow depth variation upstream of offtake(i.e., offtake hydraulic sensitivity-$S_{hq(o)}$), and water depth sensitivity to the discharge of cross regulator(i.e., regulator hydraulic sensitivity-$S_{qh(R)}$)could be presented as follows, respectively:

$$S_{hq(o)} = \frac{dq/q}{dH_{US}} = \frac{\alpha}{H'_E} \tag{1}$$

$$S_{hq(R)} = \frac{dH_{US}}{dq/q} = \frac{H'_E}{\alpha} \tag{2}$$

where q , dq =discharge and discharge deviations through the structure, respectively; dH_{US} =water depthl deviations in parent canal upstream of structure; α =hydraulic exponent in discharge equations, and H'_E =head loss through the structure that could be defined as follows:

$$H'_E = (H_{US} - H_{DS}) + \alpha/\beta (H_{DS} - H_{REF}) \tag{3}$$

At reach (Fig. 1), the flow governing equation for the perturbation, is given as:

$$\Delta Q_{in} = \Delta Q_d + \Delta Q_{out} \tag{4}$$

Where ΔQ_{in} =variation of discharge entering a reach; ΔQ_d =variation of discharge delivered within a reach, and ΔQ_{out} = variation of discharge leaving a reach.

In this study, it was assumed a linear relationship between the variation of water depth at the location of each offtake within a reach, $\Delta H_{US(i)}$, and that occurring at the upstream side of the cross-regulator in the downstream end of the reach, $\Delta H_{US(R)}$. Consequently, three sensitivity indicators for the reach level might be defined. If the reach-response time to a hydraulic perturbation, $T_{RH(res)}$, is known, a sensitivity indicator for water depth associated with this reach-response time, $S_{R(H_{(i)})}$, could be defined as follows:

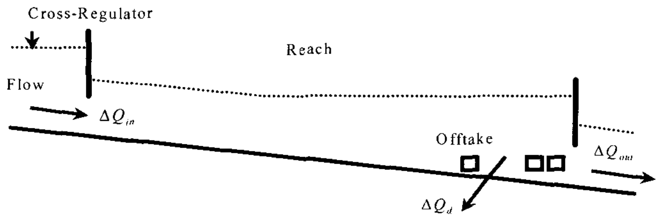

Fig. 1 Schematic representation of canal reach.

$$S_{R(H_{(i)})} = \frac{\Delta H_{US(R)} / T_{RH(res)}}{\Delta Q_{in} / Q_{in}} = \frac{Q_{in} / T_{RH(res)}}{\left[\sum_{i=1}^{n} L_i . S_{hq(o)i} . q_{(o)i} + Q_{out} . (S_{qh(R)})^{-1} \right]} \tag{5}$$

The Ankum's relation(2004) was reevaluated for small perturbations (up to 5% of the reach design discharge) based on the results of Sobek hydrodynamic model which were run for different reaches in this research. The results indicated that Eq. 6 suits small perturbation cases more than Ankum's relation, therefore it was employed for evaluating reach-response time in this study.

$$T_{RH(res)} = 3/2 \left[\frac{2 \Delta V_{dyn}}{\Delta Q_{in}} - T_w \right] \tag{6}$$

Where T_w =wave travel time along the reach, ΔV_{dyn} =deviation of storage wedge within reach. Two other sensitivity indicators were also defined and used in this study. The first, called reach sensitivity of conveyed perturbation and denoted by $S_{R(C)}$, is defined as the ratio of outgoing perturbation from the reach to incoming one and presents the proportion of the original perturbation that leaves the reach (Eq. 7).

$$S_{R(C)} = \frac{\Delta Q_{out}}{\Delta Q_{in}} = \frac{Q_{out}}{S_{qh(R)} \left[\sum_{i=1}^{n} L_i . S_{hq(o)i} . q_{(o)i} + Q_{out} (S_{qh(R)})^{-1} \right]} \tag{7}$$

where n= number of offtakes in the specified reach; $q_{(o)i}$ =delivered discharge in offtake'i'; $S_{hq(o)i}$ =offtake'i' hydraulic sensitivity and, L_i is coefficient of water depth variation within backwater curve(at offtake 'i').

$$S_{R(D)} = \frac{\Delta Q_d}{\Delta Q_{in}} = 1 - S_{R(C)} \tag{8}$$

The second is called reach sensitivity of delivered perturbation and denoted by $S_{R(D)}$ (Eq. 8).These indicators are to aid in providing the necessary information system for practical canal operation management.

REFERENCES

Ankum P. 2004. Flow Control in Irrigation Systems. IHE, Publication No. HH532/04/1, Delft, The Netherlands.