Discussion of "Effect of Channel Shape on Time of Travel and Equilibrium Detention Storage in Channel" by Tommy S. W. Wong

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The discussers appreciate the author for investigating the effect of channel shapes on travel time and detention storage and would like to add a few points to the valuable results of the technical note that might be of interest. The influence of kinematic wave parameters on the time of travel and the detention storage are of a special practical importance and the methodology presented by the author prepared a suitable base for developing relative sensitivity indicators of travel time and detention storage. Such indicators could be useful for investigating error propagation, which is of a practical importance in many circumstances such as the application of the kinematic and diffusive waves in irrigation and drainage networks (Vatankhah 2008).

Sensitivity indicators are defined as the relative variation of the time of travel (or the detention storage) to the relative variation of kinematic wave parameters (i.e., α or β coefficients). The relative sensitivity indicators of the travel time and detention storage to α equal $-1/\beta$, hence the travel time and the detention storage are relatively sensitive to α. That is, rough determination of α would not drastically affect the time of travel and the detention storage estimation. Therefore, relative sensitivity indicators of the travel time and the detention storage to β are presented herein for two shapes—circular and wide rectangular channels.

Relative Sensitivity Indicator of Travel Time to β

Relative sensitivity indicator of travel time to β, $S_{\beta t_t}$, is mathematically defined as

$$S_{\beta t_t}=\frac{\partial t_t/t_t}{\partial\beta/\beta}=\frac{\beta}{t_t}\frac{\partial t_t}{\partial\beta} \tag{1}$$

Taking logarithm from Eq. (1) of the original paper yields

$$\ln(t_t)=\frac{1}{\beta}\ln(L)-\frac{1}{\beta}\ln(\alpha)-\left(1-\frac{1}{\beta}\right)\ln(q)+\ln[(\lambda+1)^{1/\beta}-\lambda^{1/\beta}] \tag{2}$$

Differentiating Eq. (2) and multiplying by β yields

$$S_{\beta t_t}=\frac{1}{\beta}\left(\ln\left(\frac{\alpha}{Lq}\right)-\frac{(\lambda+1)^{1/\beta}\ln(\lambda+1)-\lambda^{1/\beta}\ln\lambda}{(\lambda+1)^{1/\beta}-\lambda^{1/\beta}}\right) \tag{3}$$

In channels with circular cross section, solving Eqs. (8) and (20) in the original paper for Lq yields

$$Lq=\frac{w^{8/3}s^{1/2}}{n(\lambda+1)}\frac{(\theta_e-\sin\theta_e)^{5/3}}{2^{13/3}\theta_e^{2/3}} \tag{4}$$

Also in wide rectangular channels, solving Eq. (9) in the original paper for Lq yields

$$Lq=\frac{w^{8/3}s^{1/2}}{n(\lambda+1)}\frac{\mu_e^{5/3}}{(1+2\mu_e)^{2/3}} \tag{5}$$

Sensitivity Indicator of Travel Time for Circular Channels

For circular channel substituting Eq. (4) and Eqs. (42*a*) and (42*b*) (from the original paper) into Eq. (3) yields

$$\begin{aligned}S_{\beta t_t}=0.8\ln\left[\frac{0.501(\lambda+1)}{W^{5/2}}\frac{2^{13/3}\theta_e^{2/3}}{(\theta_e-\sin\theta_e)^{5/3}}\right]\\-0.8\left[\frac{(\lambda+1)^{0.8}\ln(\lambda+1)-\lambda^{0.8}\ln\lambda}{(\lambda+1)^{0.8}-\lambda^{0.8}}\right]\end{aligned} \tag{6}$$

Sensitivity Indicator of Travel Time for Wide Rectangular Channels

Likewise for wide rectangular channel, substituting Eq. (5) and Eqs. (37*a*) and (37*b*) (from original paper) into Eq. (3) yields

$$\begin{aligned}S_{\beta t_t}=0.6\ln\left[\frac{(\lambda+1)}{W^2}\frac{(1+2\mu_e)^{2/3}}{\mu_e^{5/3}}\right]\\-0.6\left[\frac{(\lambda+1)^{0.6}\ln(\lambda+1)-\lambda^{0.6}\ln\lambda}{(\lambda+1)^{0.6}-\lambda^{0.6}}\right]\end{aligned} \tag{7}$$

Relative Sensitivity Indicator of Detention Storage to β

Relative sensitivity indicator of detention storage to β, $S_{\beta D_e}$, is defined as

$$S_{\beta D_e}=\frac{\partial D_e/D_e}{\partial\beta/\beta}=\frac{\beta}{D_e}\frac{\partial D_e}{\partial\beta} \tag{8}$$

Taking logarithm from Eq. (24) in the original paper yields

$$\begin{aligned}\ln(D_e)=\ln\left(\frac{\beta}{1+\beta}\right)+\frac{1}{\beta}\ln\left(\frac{q}{\alpha}\right)+\left(1+\frac{1}{\beta}\right)\ln(L)\\+\ln[(\lambda+1)^{1+1/\beta}-\lambda^{1+1/\beta}]\end{aligned} \tag{9}$$