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A numerical analysis on generating process of intermittent debris flow surges

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The generation of debris flow has some causes. This researche is on intermittent debris flow surges and due to mathematical approach of wave equation by numerical analysis. The following wave equation was obtained based on the momentum equation of shallow water.

$$\frac{\partial \eta'}{\partial \tau'} + a_1 \eta' \frac{\partial \eta'}{\partial \xi'} - a_2 \frac{\partial^2 \eta'}{\partial \xi'^2} + a_3 \frac{\partial^3 \eta'}{\partial \xi'^3} = 0 \tag{1}$$

where, $a_1 = (3/2){c_0}'^2$, $a_2 = (1/2)\left(1/{c_0}'^2 - 1/2\right)\tan\theta\,({c_0}'/{u_0}')$, $a_3 = (1/2)\left\{(2+{c_0}'^4)/(2{c_0}'^2) - 3/2\right\}$, ${u_0}' = u_0/c_0$, ${c_0}' = c_0/v_{p0}$, $c_0 = \sqrt{gh_0\cos\theta}$, $\eta' = \eta/h_0$, $t' = tv_{p0}/h_0$, $\xi = \epsilon^{1/2}(x - v_{p0}t)$, $\tau = \epsilon^{3/2}t$, $\xi' = \xi/h_0 = \epsilon^{1/2}(x' - t')$, $\tau' = \epsilon^{3/2}t'$,
u_0, h_0 : velocity, depth of steady uniform flow, x : axis of flow direction, t : time, η : variance of flow surface from depth h_0, θ : slope angle of the channel, g : acceleration due to gravity, ξ, τ : the Gardner-Morikawa transformation of x axis and time, ϵ : parameter of perturbative expansion, v_{p0} : phase velocity, c_0 : long wave velocity, $'$(with prime) : non-dimensional variable.

η' of equation (1) changes depending on the values of a_1, a_2, a_3 on same section of ξ' and τ', and a_1, a_2 and a_3 are function of ${c_0}'$. ${c_0}'$ is ratio of long wave velocity and phase velocity, and ${c_0}' = 1$ when phase velocity is equal to long wave velocity. For ${c_0}' = 1$, then $a_3 = 0$, the equation (1) becomes Burgers Equation, the waves deform to a wave of wave number one with increased phase velocity on progress at time. Therefor, the wave parts from Burgers equation and becomes the one that depend on equation (1) , KdV-Burgers equation. When the new phase velocity is grater than 1.04 times ${c_0}'$ (long wave velocity), waveform behaves as a solitary wave. This research shows these processes by some numerical solutions of equation (1).