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Interactive comment on “An improved coupling model for water flow, sediment transport and bed evolution (CASFE v.1)” by S. He et al.

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Dear Editor and Reviewer

First of all, I would like to thank the reviewer for spending time to review this manuscript. As comments from Phairot Chatanantavet, the boundary is fast evolving and there is actually a thin layer which connects the flow and the fixed bed. The sediment material is scoured and instantly mixed with the flow and transferred to the downstream. The velocity U_b refers to the velocity that we transfer the static sediment to a finite velocity. In addition, refer to the paper by Iverson (2012), a limited velocity at the location just above the fixed bed is generally adopted to derived the depth-integrated conservation equations, as shown in Figure 1. Based on this schematic illustration, the velocity U_b is ranging from 0 to the averaged stream velocity, which is dependent on the flow char-

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acteristic. In addition to Iverson (2012, 2013), we can find several papers (Fraccarollo and Capart, 2002; Papa et al., 2004; Le and Pitman, 2009) which have similar limited velocity assumption just above the fixed beds. In fact, the deep-rooted consciousness and misunderstanding from researchers of river mechanics precisely proved the significance of this manuscript. It was found several authors have ignored or re-considered the momentum exchange term as they didn't try to strictly derive the depth-integrated shallow water equations. When the depth of the flow is shallow, the quantities of the momentum exchange term are comparable with the ones of the gravitational term. Emphasizing the importance of the momentum exchange is essential for both theory and application. The writing of this manuscript may cause parts of readers misunderstanding and it will be definitely prevented in the new version. We will also invite several experts and native English speakers to revise this manuscript. I would like to thank the reviewer's again and any more discussion is very welcome.

Papa, M., S. Egashira, and T. Itoh. "Critical conditions of bed sediment entrainment due to debris flow." *Natural Hazards and Earth System Science* 4.3 (2004): 469-474.

Iverson, R.M., 2012. Elementary theory of bed sediment entrainment by debris flows and avalanches. *Journal of Geophysical Research* 117, F03006.

Lê, L., Pitman, E.B., 2009. A model for granular flows over an erodible surface. *Siam journal on applied mathematics* 70, 1407-1427.

Fraccarollo, L., and H. Capart. "Riemann wave description of erosional dam-break flows." *Journal of Fluid Mechanics* 461 (2002): 183-228.

DISCUSSION: Numerical study on the entrainment of bed material into rapid landslides. M. PIRULLI and M. PASTOR (2012). *Géotechnique* 62, No. 11, 959–972, <http://dx.doi.org/10.1680/geot.10.P.074>

Iverson, R.M., Ouyang, C., under review. Bed-sediment entrainment by rapidly evolving flows at Earth's surface: 1 review and reformulation of depth-integrated theory. under review of *Reviews of Geophysics*.

Interactive comment on *Geosci. Model Dev. Discuss.*, 7, 2429, 2014.

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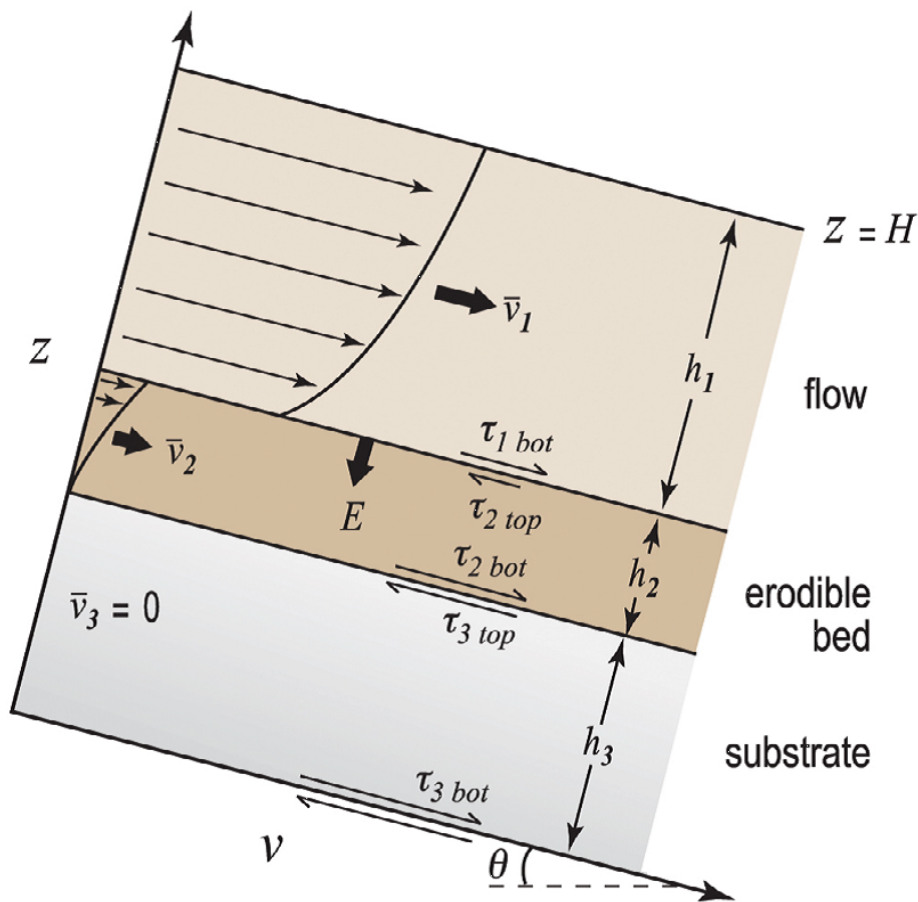
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Fig. 1. Figure 1. Schematic illustration of velocity profiles (Iverson, 2012)

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