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Comment on esurf-2022-31

Anonymous Referee #2

Referee comment on "The Entire Landslide Velocity" by Shiva P. Pudasaini, Earth Surf. Dynam. Discuss., https://doi.org/10.5194/esurf-2022-31-RC2, 2022

This article presents a synthetic physical model describing the propagation of a landslide over a slope and details analytical solutions of the equations in various cases.

My main concern regarding this work it that, though many results are said to be useful to practitioners, overall they are presented in a very abstract way, which makes it particularly difficult for the reader to see their relevance and potential applications. The solutions that are exhibited all derive from initial configurations that appear as very arbitrary, and the results are not related to any concrete examples. Nor is any comparison made to simple benchmarks (either numerical, experimental or field-based) that might be available in the literature. I understand that the given examples are useful to demonstrate the possibilities of the model, but they do not tell about its relevance or validity. Furthermore, all calculations account for the velocity field but at no point do the results include the landslide's volume, thickness or shape, which are obviously quantities of interest for practical applications: is it implicit that the thickness is constant and uniform? or what does the model predict for its variations with x and t?

In consequence, I think that the manuscript would be easier to follow and more suitable for publication in ESurfD provided that more effort is made to relate its conclusions to (even simple) physical/geological configurations.

Below are some more precise remarks and questions about the manuscript:

Section 2

Presentation of the model in section 2 is rather confusing. In the following 'Results' sections, eqs (1) and (2) are referred to as radically different (though they only differ by a sign convention), and it looks like eq (1) stands for 'accelerated' and eq (2) for 'decelerated'. However from section 2, one gets the impression that equation (1) covers all cases (l.119 'we have the following two situations' and l.129 'alpha^a<0') and eq (2) is a subcase.

It would be much clearer to start from the beginning with either two distinct equations (say (a) and (d)) that include only positive coefficients, or (perhaps even simpler) a unique equation with two cases (alpha>0 and alpha<0). Additionally, a sketch presenting the physical system modelled by these equations would be most useful.

-l.89: Is the solid fraction supposed to be constant (and independent on the local velocity or other varying parameters)? if it is indeed the case it should be precised. Similarly, h_g is included among the other 'external' parameters, but it has to be intrinsically linked to the landslide dynamics: can the author detail the assumptions made here?

-l.95: please associate more explicitely each term in alpha to its physical meaning. What does the term 'liquefaction' cover here?

-l.121: 'the initial velocity u_0': doesn't is depend on the position x? Where is the condition verified?

-l.131: what is the 'decelerating velocity', and why is it obviously always larger in the case II.1 than II.2?

Section 3

-l.166: the similarity between equations (5) and (6) would be more obvious if expressed in a more uniform way (e.g. not switch from 1/exp(A) to exp(-A) and keep the same first factor)

-l.186: I do not understand here what the travel time is (from where to where? what is a sector?)

Section 5

-l.265: if I am not mistaken, equations (1) and (2) are not dimensionless. Coefficients alpha and beta should therefore be given units.

What justifies the ranges adopted here? (and should the range for beta read 0.001-0.0025 or rather 0.0025-0.01?)
And how realistic are these values? Perhaps the author can give an example of common values for each physical control parameter (slope, gamma, mu...) and the resulting value of alpha.
Same comment for beta: what values for the viscous drag coefficient are commonly used, typically in the abundant literature about shallow-layer ('Saint-Venant') models for landslides?

-l.282-286: please introduce earlier (maybe within a sketch) what the 'lower portion of the track', 'transition zone', 'fan region' are regarding to the model.
The whole paragraph is written in such a way that it is very hard to make out the concrete situation that is modelled here. Maybe this can be reformulated starting from the example that is actually computed in figure 1, for which I do not understand the initial configuration (what is the length of the sliding mass? is the velocity u0 uniform?)

-figure 1: if I am not mistaken, at this point of the analysis, u is a function of both space and time. If so, I do not understand what is plotted here: in figure (a) is it the velocity at a given position (and which), and in plot (b) at a given time?

In this figure as in the others, units are missing for u_0, alpha and beta.

-l.307: I guess that 'ascending' and 'descending' refer here to the velocity, but 'ascending sector' sounds like it refers to an upward slope.
'Accelerating' and 'decelerating' might be more appropriate.

-l.312: please justify the transition from alpha=3.5 to alpha=-1.2: what would physically cause such a transition (kink in the slope for instance?)

- figure 2: same question as for figure 1 (and as for figs 3,4,5): to what position (a) and time (b) do the plots correspond?
In the caption, the coordinates are given without units in two different coordinate spaces.

-l.332: what is a 'variable track'? Please give a physical example that would produce the results presented in the following figures (for instance, all other parameters being constant, what shape of the slope would lead to such successive values of alpha).

-l.344: repetitive explanations of all ascending/descending connections do not seem necessary, terms being self-explanatory.

-l.357: I do not understand the sentences 'alpha values are relative to each other' and 'perceived as relatively negative to alpha^a'.

-l.363-370: the velocity is observed to change dramatically at the major kink, but this sounds intuitive if we impose a dramatic change in the value of alpha. Is this a realistic case?
The paragraph is concluded with the sentence 'this can be a scenario for a track': the section should start with the example of such a scenario, that is investigated here: what physical configuration (e.g. with alpha being controlled by the slope profile only) would lead to a brutal transition from alpha=6 to alpha=-0.15?

Overall, all situations studied here (figures 3,4,5) appear rather arbitrary and abstract. Though it is useful to demonstrate the capacities of the analytical model, it would be more convincing to apply them to concrete configurations: a first step would be to plot the slope profile that would lead to each calculated dynamics. Even better would be to compare the outcomes (e.g. runout distance) to other models in known, simple configurations (such as a constant slope followed by a horizontal plane). Numerical works of Mangeney et al. with Saint-Venant equations and Staron et al. with DEM simulations, experimental works on inclines or even simplified versions of field cases should be used as benchmarks to validate the results obtained here.

- figures 3 and 4: I am not convinced that the list of all kink coordinates brings much to the results (especially since their positions are imposed). Focus should be brought upon travel time or runout distance.

- figure 5: though keeping the same colors is useful, the two different solutions have to be distinguishable on the plot (e.g. dotted vs plain lines).
Why is the second case totally unrealistic? Some landslides are known to travel more than 3.5 km and alpha could keep getting beyond that point.

-l.480: here again 'ascending' and 'descending' are equivocal and one might think that they refer to the shape of the front (i.e. h(x) and not u(x)), whose evolution it would be most interesting to plot here.

-l.485: for the reader unfamiliar with the previous work, on what basis are these initial velocity profiles chosen? Once again concluding that the runout distance differ is most useful, but it is hard to relate the arbitrary 'initial' configurations to a practical situation (or, for that matter, to previous examples such as figure 5). Starting with the release of a given mass at zero velocity, how does the landslide end up in the 6a rather than 6b configuration?

-section 5.2.3: the predictions of the model regarding the geometry of the deposit would indeed be of much interest, but the link between the results (velocity profile only) and the geomorphology (that is, the thickness profile of the deposit) remains only implicit here.