Review of Croissant et al., *Pulsed carbon export from mountains by earthquake-triggered landslides explored in a reduced-complexity model* resubmitted to Earth surface dynamics

I had found the previous version of the manuscript to be very clear, and I like the new additions that were made. In my second read-through, I particularly focused on the derivation of model equations that I commented on during my last review. It was great to see the model equations being re-explained. Unfortunately, I was still confused by the derivation of the quantities and found them hard to track. After some pondering, I believe that I found the reason for my confusion, but I acknowledge that I might still misunderstand something.

I believe the main confusion stems from a lack of clarity in distinguishing between expressions that quantify the mass remaining in a deposit versus the mass that is removed by river erosion or oxidation. There are two layers to this.

- First, Equations 8 – 15 are almost all expressed in terms of mass remaining in the deposit whereas the final equations (17-19) track the mass removed. This made it hard for me to immediately understand the final equations from the preceding paragraphs.
- Second, the definitions are not consistent (to me). Many quantities that seem to track the mass remaining in the deposit are described as mass removed. In addition to having a number of subscripts and jumps between these, I ended up being confused for a while about what was expressed where.

I try to illustrate this confusion below. This is a long comment which is not meant to be patronizing in any way. Rather, I had to write the equations out for myself in order to be able to structure my thoughts. Perhaps it helps to illustrate my confusion. Importantly, the changes needed to address these points seem very minor. In particular, I suggest to come up with a notation scheme (maybe combining subscripts and superscripts) that makes it very clear whether a given variable tracks the mass removed from the deposit versus the mass remaining under either oxidation, river erosion, or both. Further, you could consider at each step to systematically give expressions for both the mass removed and the mass remaining. Finally, when you get to the final equations, it would really help to clearly say which equations you are combining to arrive at these expressions. This would require adding a couple of expressions for the mass removed which are currently missing.

I hope that my comments are clear. Please feel free to contact me directly if you have any questions about them.

Notations

For the purposes of this review, I use the following notation. I don't want to necessarily suggest to use these particular notations in the manuscript, but hopefully they illustrate what I mean by separating the different masses more systematically. I use upper case M to track mass remaining in the deposit, and lower case m to track masses that are being removed (there might be a better solution).

I follow the manuscript and use subscripts to designate the type of mass

- $M_{oc},\ m_{oc}$ designate a mass of organic carbon
- $M_{ls},\ m_{ls}$ designate a mass of fine sediment

I use superscripts to designate the method of removal

- M^{riv}, m^{riv} is the evolution of a mass under river erosion
- M^{ox}, m^{ox} is the evolution of a mass under oxidation
- M^{riv+ox}, m^{riv+ox} is the evolution of a mass under both oxidation and river erosion

I follow the manuscript and use qualifiers to the subscript to designate the point in time

- $M_{oc,t},\ m_{oc,t}$ designate a mass of organic carbon at time.

On a side note, I find the use of t_0 to describe the time it takes to erode the entire landslide volume slightly confusing. In all other cases, the subscript 0 refers to some initial point in time (e.g. the initial mass mobilized by landsliding), so intuitively, I'd think of t_0 as the time when the landslide occurred – it is a minor point, but you could consider expressing this differently.

Particular equations

P7 L4 and equation 8: Here, equation (8) is described as: "the mass of fine sediment (M_{ls}) being exported by river" (note, there is a 'the' or 'a' missing). To me, M_{ls} and equations (8&9) describe not the mass exported by rivers, but the mass remaining in the deposit – or more fully, the mass remaining in the landslide under the condition that the mass is removed by fluvial erosion. It would still be useful to give the mass removed, because you end up using the mass removed to obtain equation (17), I think. I.e.

- Mass of sediment removed at any point in time: $m_{ls,t}^{riv} = \overline{Q_s} = \frac{M_{ls,0}}{t_0}$
- Evolution of sediment remaining in the deposit: $\frac{dM_{ls}^{riv}}{dt} = -m_{ls,t}^{riv} = -\overline{Q_s}$ which then solves to yield the mass remaining in deposit at any point in time $M_{ls,t}^{riv} = \overline{Q_s}(t_0 - t)$.

P8 L18 and equation 10: Here you could define the mass more clearly: M_{oc} is the mass of OC remaining in the landslide as far as I understand.

P9 L18-22 and equation 11: Here, you solve equation (10), but all of a sudden, the subscript of the quantity that is solved changes from M_{oc} in equation (10) to M_{ox} in equation (11). Also, the definition of the quantity changes from the mass remaining in the landslide to the mass that is oxidized in the landslide. This jump is not clear and it is not clear why the same expression would describe the mass removed and the mass remaining. Maybe it is just a typo, because you have it expressed correctly in equation (16). In any case, I think it would help a lot to be consistent in your definitions of mass removed and mass remaining and then give both quantities. I.e.

1. Mass that is oxidized at any point in time: $m_{oc,t}^{ox} = k_{ox}M_{oc,t}$
2. Evolution of OC mass in the landslide under oxidation only: $\frac{dM_{oc}^{ox}}{dt} = -m_{oc,t}^{ox} = -k_{ox}M_{oc}$, which when solved gives the mass that is remaining in the landslide under oxidation only: $M_{oc,t}^{ox} = M_{oc,0}e^{-k_{ox}t}$.
3. Therefore, the mass that is oxidized at any point in time: $m_{oc,t}^{ox} = k_{ox}M_{oc,0}e^{-k_{ox}t}$. This is different from equation (11) by a factor of k_{ox}

P9 L27 – P10 L3 and equations 12 & 13: Again, the way that these equations are parameterized, the quantity $M_{riv,t}$ seems to describe the mass of organic carbon that is remaining in the landslide under the condition that mass is removed by fluvial erosion. However, it is described in the text as "the mass of OC exported by rivers". Again, there seems to be some inconsistency between definition and equation. Moreover, the subscript _riv is not very intuitive for a mass of OC remaining in the deposit. Finally, in equation (17) M_{riv} is actually the mass removed. In other words, the parameter M_{riv} in equations 12/13 and the same parameter in equation 17 describes two different quantities. Finally, I would, again, consider giving both mass removed and mass remaining, because you need the latter to get to equation (17). I think it would be:

- Mass of OC removed at any point in time: $m_{oc,t}^{riv} = \overline{Q_s}\frac{M_{oc,t}}{M_{ls,t}}$

- Evolution of OC in the deposit $\frac{dM_{oc,t}^{riv}}{dt} = -m_{oc,t}^{riv} = -\overline{Q_s}\frac{M_{oc,t}}{M_{ls,t}}$ which then solves to yield the mass of OC remaining in the deposit at any point in time assuming removal by river erosion: $M_{oc,t}^{riv} = M_{oc,0}\left(1 - \frac{t}{t_0}\right)$

NOTE that there seems to be a minus sign too many in equation (13), the solution to equation (12)

Equations (17)-(18). For these two equations, I suggest to consider explicitly building them from the equations and definitions you give before. This would require to give expressions for the masses removed. For example, equation (16) seems to be the integral of $m_{oc,t}^{riv} = \overline{Q_s}\frac{M_{oc,t}}{M_{ls,t}}$ and then substituting $M_{oc,t}^{riv+ox}$ from your equation (15) and $M_{ls,t}^{riv}$ from your equation 9 – and then integrating the equation between t_{con} and t_0 with the initial mass that is modulated by the oxidation during the unconnected phase. It took me quite a bit of time to make that connection, probably in part because I was confused about tracking the masses. However, I think it would have helped me to have the derivation explicit.

For both equation (17) and (18), shouldn't the integral be from the connection time rather than time zero? I.e. $\int_{t_{con}}^{t_0} dt$ instead of $\int_0^{t_0} dt$?

Finally, I got confused about M_{land} – in particular, why we need another parameter here. M_{land} is defined as the mass of sediment remaining in the deposit. In that sense, what is difference between $M_{land,t}$ and $M_{oc,t}$ as defined in equation (15)? I understand that in equations 17-19, these quantities are now the total quantities integrated across time. However, when integrating up to t_0, which, per definition, is the time to remove the entire deposit, shouldn't M_{land} per definition be just zero? I may be missing something.