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Interactive comment on "Delineating incised stream sediment sources within a San Francisco Bay tributary basin" *by* P. Bigelow et al.

Anonymous Referee #2

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1 General Comments

This is an original and interesting study. The well-structured and well-written paper describes an empirical approach of assessing (potential) sediment yield using topographic and vegetation information from airborne LiDAR data. Slope, convergence and the local (!) contributing area are combined for each raster cell into a 'generic erosion potential' index. The analysis is restricted to a buffer zone around the channel network within a c. 500 sqkm catchment where incision and bank failure and erosion present issues for sediment management. Measured mean sediment yield is used to 'translate' the GEP index into estimated sediment yield that is reduced based on an empirical relationship of vegetation coverage and yield reduction; vegetation coverage is assessed using first vs last pulse returns of airborne LiDAR data. The authors use

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the pixel-based data for upscaling to various scales, e.g. channel reaches and sub-catchments. My biggest concern is the fact that the contributing area beyond the 3x3 neighbourhood of each raster cell, and potential decoupling of sediment sources and the channel network (and also within or along the channel network) are apparently not accounted for. A more thorough and reproducible description of some of the methods used would help resolve possible misunderstandings on my part. In all, I think that moderate revisions will make this contribution an interesting paper, not only for the scientific community but especially for practicioners.

2 Specific Comments

- p1 l23: common erosional cycle suggest that this is a totally natural, authigenic phenomenon; however, as you elaborate in the following lines, this kind of erosional phenomenon represents the response to environmental or anthropogenic changes. I'd like to suggest you emphasize more the 'reaction to change' aspect; if you insist on the 'common erosional cycle', please give a reference
- p2 l14: with 'shallow failures' you mean bank failures ?
- p2 l16: The virtual watershed system or software is only named and explained in the methods section (p3 l 36); here, the reader might wonder if it is a purely virtual experiment , not a study using data from a real landscape. You also mention a 'synthetic river network' the reader might possibly misinterpret along the same lines. I suggest you shift the short explanation of the virtual watershed system from the methods section to the introduction.
- p3 l8f: if you have aggrading channel reaches in your area, then the approach of dividing the outlet sediment yield by the size of the incised area+buffer is probably affected by this: The sum of sediment delivery from the channel banks could be

larger than the measured sediment yield due to intermediate sedimentation. I feel you should discuss this where you explain the transfer from the GEP to sediment delivery

- p3 l28: A figure with one or more 'typical' cross-sections through the valley, maybe one in the lower and one in the upper reaches, could help visualise and justify your statement that the valley floors and hillslopes are not eroded, and the choice of your buffer width. Moreover, I could only guess that the 6times bankful width refers to the total buffer width and not its radius to both sides.)

- section 3.1: the description of how you produced the channel network is too vague, it only refers to the literature; please add at least a brief description of the (major) steps involved. E.g., how did you identify the channel initiation points for the 'synthetic' network ? Another weakness here is that the reader does not know how you delineated the segments: manually ? automatically ? On what basis or using which criteria ?

- section 3.2: l27ff lack the description of S and its unit (percent ? degree ?). You only give a reference for the derivation of b, I feel that you need to describe the major steps at least. I cannot figure out how GEP could be constrained to values between 0 and 1 as long as I do not know the range of S and b. For example, if the slope on a raster cell is steep, and if it has, say, 5 contributing neighbours, the product of S and aL is supposed to be quite large; if you divide it by b which is only said to be 'around 1', GEP will be larger than 0, right ? Moreover, the contributing area of a raster cell can be MUCH larger than just the up to 8 surrounding pixels, what about the mouth of a small tributary rill cutting the riverbank ? Above, I understood that you're linking the contributing areas to the channel network using flow accumulation (and direction) within the buffer zone; and I do not think you can exclude the contributing area of a cell when assessing erosion potential (c.f. stream power index)... Moreover: Would you agree that a

pit with 8 contributing neighbours is prone to erosion ? Well, the slope is 0 inside a pit, but depending on the slope derivation algorithm this is not always the case. It may be that I misunderstood parts of the description, but I feel it has to be more extensive in order to be reproducible; the reader shouldn't have to read Miller and Burnett (2007) first.

- section 3.3: I can understand the need to include a parameterisation for vegetation effects, and deriving this using the LiDAR first+last signal approach is fine for me. However, I think that how you arrive at the erosion reduction factor is poorly describe. You mention 'supporting literature' and 'own observations', but it is not clear how you got the percentage reductions used in Fig 2 to derive equation 2. In line 26 I can only guess why the vegetation height derived from first+last pulse should also represent vegetation density; please write a sentence to explain. Line 31: In my opinion you do not normalize the vegetation height, but you apply equation 2 to the 'elevation height' raster.

- section 3.4: As stated earlier, I feel you should be (more) explicit about some assumptions: (i) within the buffer zone, no intermediary barriers or buffers exist that decouple sediment sources from the channels (ii) there is no intermediary deposition or aggradation on the longer timescale within the whole channel network. This (at least) has to be assumed, because the measured sediment yield at the output is related to the entire size of the buffer zone. However, I agree that such simplifications have to be implemented, especially when the aim of setting up a practicioner-friendly tool. Moreover: Please reconsider if a linear relationship of GEP and sediment yield is appropriate. Statistical relationships contributing area and discharge or sediment yield have a sort of power law...

- section 3.5: In lines 19 and 23 (also Fig. 4, 5 and 6), I think that what you're computing is the specific sediment yield, because you divide the sediment yield by the upstream drainage area. Furthermore, please be explicit here if you divide

by the total upstream drainage area or only by the 'buffered' part of it. For the channel segments (Fig. 6), would it make sense to report and discuss sediment yield instead of specific sediment yield ?

- section 3.6: Similarly to the vegetation height index, you could report here the range of the storage potential index within the study area
- section 4.1: p7l10 suggests that you selected c. 50 percent of the catchment area for visual qualitative validation. How did you infer 'much more stable banks' from satellite imagery, except by the presence of vegetation ? Strictly speaking: As vegetation is detected by LiDAR data analysis and included in your index, you simply observe the effect of the index computation (what would be a verification of your approach) rather than validating the GEP index by observing eroded vs. stable banks. You could shortly discuss here a validation in similar, perhaps neighbouring catchments with available sediment measurements to check the transferability of your index at least for comparable catchments.
- section 4.2: A question to discuss: A patch of high GEP-pixels would only be contributing if there is a continous sediment pathway towards the channel. Can you exclude that there are intermediary flat areas or other buffers that decouple the sediment source (which your index may correctly identify) and the channel ? How do you deal with the channels that you know are aggrading ? I like the discussion of average yield vs episodic character of erosion.
- section 4.3: Check if 'summed and area weighted' sediment yields could not be better termed 'specific sediment yields'. In l8, I suggest you replace 'total load' by 'total sediment yield at the outlet'.
- section 4.4: This section is particularly important for practicioners who want to implement the approach. In the first subsection, please add a sentence on whether and how also the 'raw' i.e. pixel-scale index could be useful once a river reach or

subwatershed has been identified as priority. The second subsection is too short I think, because the results of the storage index are not presented in any detail; you could, for example, highlight one or two parts of the catchment where the storage potential is particularly high or low, and explain why. Moreover, the question pops up how the floodplains that should be reconnected are disconnected at the time being; you could include this information in the study area section, for example, or where you explain the storage potential index. What measures would have to be taken to reconnect floodplains to (heavily incised !) channels ?

- chapter 5: Personally, I would prefer if the two proposals for potential improvements were part of the discussion section, with a (slightly longer) proper conclusion chapter 5. Regarding the second improvement: Can one really think of a (even average) ratio bedload vs suspended load, given different forcing magnitudes, and also given the episodic character of events in the study area that has already been mentioned ? Does the ratio of fine and coarse sediment within the sediment sources equal the ratio of fluvial sediment in transport or at the outlet ? References to that end ?
- p9 l34f: The reviewer explicitly joins the authors in this statement of gratitude ;-)

3 Technical Corrections

- p1 l25: 'increase transport capacity relative to...' instead of 'increase transport relative to...'
- p2 l2: delete 'could be applied'
- p2 l14: (GEP=Generic Erosion Potential)
- p2 l16: downstream

- p3 l5: either 'sediment...is now supplied' or 'sediments...are now supplied'
- p5 14: Split the sentence here: 'or infer generalized relationships. For example, Pelletier...'
- p6 l19: write 'outlet' rather than 'bottom'
- p6 l20: might be picky, and might be due to me not being a native speaker: Sediment is not eroding, it is being transported or transferred to a channel reach, after having been eroded or mobilised.

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