REVIEW OF THE ARTICLE "DYNAMICS AND MECHANICS OF TRACER PARTICLES" (MANUSCRIPT ESURF-2014-12), BY C.B. PHILLIPS AND D.J. JEROLMACK

1. General comments

Line and page numbers refer to the "friendly printed" version.

a. Summary of the article

This paper presents a bedload tracing experiment in a small watershed located in Puerto Rico. Tracking results are linked with hydrological and hydraulic data, in order to provide further insight of particle individual displacement at flood scale and annual timescale. The influence of shear stress distribution and downstream sorting according to grain size are also considered.

b. General comments

This study addresses the challenge of understanding what is happening "during the flood" for individual coarse particles. In trying to explain this question, this really interesting study provides useful new field-based data that show good agreement with laboratory experiments. Thus, it provides strongly argumented results to support the ideas that most particle transport occur with single step within one flood (i.e. partial transport of bedload) and that particle displacement is only weakly correlated with particle size at flood scale but that particle sorting appears at annual timescale. In addition, this study presents "the first active field confirmation of the selective deposition theory".
The authors highlight that results presented here could be site-specific and thus call for further confirmation in other river systems. However, I think that this study presents a great attempt to provide explanation of bedload dynamics at different timescales. Since the new methodology used is carefully detailed, the publication of this paper will enable other studies to further test the hypothesis presented in other river systems and thus could significantly improve our understanding of river morphodynamics.
In addition, as a field-based study providing insights on bedload transport processes in river systems, this paper addresses relevant scientific questions within the scope of ESurf.
Because of these reasons, I think that this paper is **suitable for publication** in ESurf after moderate revision.
In addition to specific comments and technical corrections, it would be useful to provide quick information on the probable reasons explaining missing tracers From a morphological point of view (for one survey a flood occurred before the survey was completed; but is there a main reason explaining missing tracers, such as burial; transport further than the prospection zone?). Also, I would recommend to adjust the title a little bit, to better emphasize that the aim of the paper is to better understand coarse particles behavior. For example: "Dynamics and mechanics of bedload tracer particles".

M. Chapuis

c. Manuscript evaluation criteria

1. Does the paper address relevant scientific questions within the scope of ESurf?
Yes
2. Does the paper present novel concepts, ideas, tools, or data?
Yes
3. Are substantial conclusions reached?
Yes

4. Are the scientific methods and assumptions valid and clearly outlined?
Yes
5. Are the results sufficient to support the interpretations and conclusions?
Yes
6. Is the description of experiments and calculations sufficiently complete and precise to allow their reproduction by fellow scientists (traceability of results)?
Yes
7. Do the authors give proper credit to related work and clearly indicate their own new/original contribution?
Yes
8. Does the title clearly reflect the contents of the paper?
Yes – see suggestion for title modification
9. Does the abstract provide a concise and complete summary?
Yes
10. Is the overall presentation well structured and clear?
Yes
11. Is the language fluent and precise?
Yes (I am not a native speaker reviewer but this paper is clear to me)
12. Are mathematical formulae, symbols, abbreviations, and units correctly defined and used?
Yes
13. Should any parts of the paper (text, formulae, figures, tables) be clarified, reduced, combined, or eliminated?
See comment for figure 12b that is too small
14. Are the number and quality of references appropriate?
Yes (but I did not check them all)
15. Is the amount and quality of supplementary material appropriate?
n/a

Principal Criteria	Excellent (1)	Good (2)	Fair (3)	Poor (4)
Scientific Significance: Does the manuscript represent a substantial contribution to scientific progress within the scope of Earth Surface Dynamics (substantial new concepts, theories, methods, or data)?	X			
Scientific Quality: Are the scientific approach and applied methods valid? Are the results discussed in an appropriate and balanced way (consideration of related work, including appropriate references)?	X			
Presentation Quality: Are the scientific results and conclusions presented in a clear, concise, and well-structured way (number and quality of figures/tables, appropriate use of English language)?	X			

2. Specific comments

Line 6 p. 431: "The rate of bed load transport is known to vary both spatially and temporally due to turbulence and granular phenomena such as clustering, bed forms, compaction, grain protrusion, and collective motion […]": only granular phenomena are listed as examples. You may want to add the influence of the discharge variability to account for "water-related" factors (cf. what you explain in line 17 p. 435)? In addition, it is not clear what difference you make between clustering and compaction. I would also suggest to talk about "grain protrusion/hiding". Does "collective motion" refer to the influence of a mixed bed material (influence of sand on gravel mobility for example) or only to the "shock effect" between pebbles? Generally speaking, you may want to detail/rework this sentence a little bit.

Line 12 p. 431: "where the dominant transport regime is partial bed load transport, in which only a fraction of the bed is actively mobile at any time during a transporting event": then you don't take into account for "bursts" related to turbulence effects? And also you don't take into account the statistical definition included in the definition of "threshold of motion" (cf. Parker 2004). You may want to rework this sentence to make it more precise since your are explaining it in the section 2.1.

Line 15 p. 431: "Further confounding this issue is that gravel streams are well known to adjust their geometry to an effective discharge (Wolman and Miller, 1960), which occurs at a flow slightly above the threshold of motion for the median grain size (Parker, 1978; Parker et al., 2007); indicating that partial transport is the dominant transport regime within gravel rivers.": I agree that gravel streams adjust their geometry to an effective discharge that is above the threshold of motion for the median grain size (although do you have any reference for that? It would be useful for the reader to have an order of magnitude to refer to instead of saying "slightly above"). But I don't agree with the statement that partial transport is the dominant transport regime: in my opinion, it all depends on the hydrology of the river system, i.e. what is the "dominant discharge" frequency relative to the "morphogenic discharge" (the one "slightly above the threshold of motion") frequency. You may want to rework this sentence to clarify it.

Line 26 p. 431: you should also refer to active tracers (e.g. Busskamp, 1994, Chacho et al., 1989, Emmet et al., 1990, Ergenzinger et al., 1989 or Schmidt & Ergenzinger, 1992).

Line 6 p. 432: "long term observations": refer to multiple morphogenic events surveys to be clearer, since "long term" point of view depends on the dynamics of the river systems.

Line 1 p. 435: you can also refer to Liébault et al., 2012 for field measurements with RFID tracers.

Line 19 p. 436: I think it would be worth specifying in which cases this statement applies (e.g.: no armouring, no sediment transport discontinuity).

Line 5 p. 438: specify how many tracers were equipped.

Line 20 p. 439: specify on how many particles you made the Wolman pebble count.

Line 24 p. 439: instead of giving the numbers in the text, I would suggest to make a table out of them (columns: field site, D50 bed, population #, D50 tracers, deployment date, survey dates, recovery rates); same suggestion for line 7 page 440.

Line 1 p. 440: what do you mean by "following flood"? I guess you refer to a flood that prevented to complete the survey, but try to make it clearer

Line 12 p. 440: since detection limits greatly depends on the wand type and RFID tag type (cf. Chapuis et al., DOI: 10.1002/esp.3620), it would be useful to specify the series number of the wands and RFID tags used in this study.

Line 21 p. 440: "Statistical values for the tracers represent the spatial average at the center of eight linearly spaced bins, where the number of bins was determined to ensure enough tracers within each bin for accurate statistics": this sentence and its aim are not very clear to me. Maybe you could reformulate it?

Line 6 p. 441: you assume steady and uniform flow: do you take into account the influence of this strong hypothesis in your analysis?

Line 21 p. 441: starting from this line, maybe the rest of the paragraph should be moved to the discussion section.

Line 26 p.443: I doubt the accuracy of Q is as high as 0.01 m3/s. you may want to reduce the number of decimals accordingly.

Line 18 p. 445: “Despite the second population of tracer particles being less embedded in the stream bed, its <X/D> follows the same trend as the first population when plotted against I*”: do you infer from this result that the “embeddedness” of tracers does not influence their displacement? Can we go further and hypothesize that particle settling does not affect the “first displacement” data?

Line 22 p. 445: “Using all permutations of tracer surveys does require the assumption that the sequence of floods does not exert substantial control on the mechanics of particle displacement”: this assumption is pretty strong indeed, is there a way to find what could feed this assumption (in fig. 8 for example)? Also, explain what in fig. 9 does not support this assumption.

Line 12 p. 447: “When we compare the displacements during a flood to the expected step length calculated from Eq. (1); it is clear that large particles have displacements that are close to the expected step length, while a significant number of small particles have much longer displacements (Fig. 11b)”: I am not sure to agree with the interpretation of results of fig. 11b, especially I don’t find it “clear”: there are fewer “coarse” particles compared to “fine” ones (comparing with the D50), which explain why there are few coarse particles that had long displacements. But there is a large number of “fine particles” that experienced a single step. Although I agree that your following explanation about “large particles experiencing one single step while fine particles experience multiple steps” (line 18) is “convenient”, I am not convinced. Maybe you could try to discriminate between particle which D>D50 and those which D<D50 and see if the difference in Xi/XS ratio is statistically significant to support your interpretation?

3. Technical corrections

Line 27 p.430: suggested change: “While […], coarse bed load transport sets the limiting rate […]”

Line 13-14 p. 432 and in the whole text: “mobile fraction” instead of “fraction mobile”

Line 2 p. 433: “hydrologic forcing quantification” instead of “quantifying hydrologic forcing”

Line 4 . 433: “at particle scale” instead of “at the particle scale”

Line 17 p. 434: “at field scale” instead of “at the field scale”

Line 20-21 p. 435: is there a typo? A word might be missing: “by the product of shear stress magnitude and duration, the impulse”

Line 12 p. 439: “A smaller population of 51 tracers was installed” instead of “A smaller population of 51 tracers were installed”

Line 9 p. 441: “effect”: is that a typo for “affect”?

Line 24 p. 441: is there a missing worf after “critical”?

Line 13 p. 447: “calculated from Eq. (1), it is” instead of “calculated from Eq. (1); it is”

Line 11 p. 447: I would suggest rephrasing the sentence “At the single-flood scale there does not appear to be a significant dependence of displacement length on particle size”, for example as follows: “at single-flood scale displacement length does not significant depend on particle size”.

Line 1 p. 452: “we have” instead of “we’ve”

Line 14 p. 452: I would suggest completing the end of the sentence with something such as “but more work is needed [to support this hypothesis]”; if possible, it would be useful if you could also describe how you would further explore this explanation.

Line 20 p. 454: “sorting seems to result” instead of “sorting seems to results”?

Figure 1: you may want to specify flow direction in the legend of fig. 1e (e.g. from left to right) since the South-North direction is not obvious compared to the channel direction.

Figure 2: it would be useful to indicate when deployments and surveys occurred.

Figure 2b: do the gray lines correspond to periods where no flood occurred? If so, I would make them clearer (they are difficult to see). But if it is likely that large stage variations occurred, I would suggest deleting them to make sure the reader is not misled.

Figure 6: there is a typo in (b): “(b. inset)” instead of “(c. inset)”

Figure 11b: add the n (number of tracers) corresponding to red crosses. What do you mean by “single tracer” or “multiple tracer”?

Figure 12b is too small, it is difficult to read.

4. Useful references

Busskamp R., 1994. The influence of channel steps on coarse bed load transport in mountain torrents: case study using the radio tracer technique "PETSY", in P. Ergenzinger and K.-H. Schmidt (eds), *Dynamics and Geomorphology of Mountain Rivers*, Lecture Notes in earth sciences 52, Berlin : Springer-Verlag, pp. 129-139

Chacho E. F. Jr., R. L. Burrows and W. W. Emmett, 1989. Detection of coarse sediment movement using radio transmitters, in *Proceedings of the XXIII Congress on Hydraulics and the Environment, IAHR, Ottawa, Canada*, pp. B-367-B-373

Chapuis M., C. J. Bright, J. Hufnagel and B. MacVicar, 2014. Detection ranges and uncertainty of passive Radio Frequency Identification (RFID) transponders for sediment tracking in gravel rivers and coastal environments, *Earth Surface Processes and Landforms*, doi: 10.1002/esp.3620.

EmmettT W. W., R. L. Burrows, F. Edward and E. F. Jr. Chacho, 1990. Coarse particle transport in a gravel-bed river, in *Third International Workshop on Gravel-bed Rivers*, Firenze, Italy, 24-28 Sept.

Ergenzinger P., K.-H. Schmidt and R. Busskamp, 1989. The pebble transmitter system (PETS) : first results of a technique for studying coarse material erosion, transport and deposition, *Zeitschrift fur Geomorphologie*, vol. 33 (4), pp. 503-508.

Liébault F., H. Bellot, M. Chapuis, S. Klotz and M. Deschâtres, 2012. Bedload tracing in a high-sediment-load mountain stream, *Earth Surface Processes and Landforms*, vol. 37, pp. 385-399.

Parker G., 2004. 1D sediment transport morphodynamics with applications to rivers and turbidity currents, *e-book*, available at [http://hydrolab.illinois.edu/people/parkerg//powerpoint_lectures.htm?q=people/parkerg/powerpoint_lectures.htm].

Schmidt K.-H. and P. Ergenzinger, 1992. Bedload entrainment, travel lengths, step lengths, rest periods – studies with passive (iron, magnetic) and active (radio) tracer techniques, *Earth Surface Processes and Landforms*, vol. 17, pp. 147-165