

## ***Interactive comment on “Understanding soil erosion impacts in temperate agroecosystems: bridging the gap between geomorphology and soil ecology” by C. Baxter et al.***

### **Anonymous Referee #2**

Received and published: 16 July 2013

**General comments** This paper considers the relationships between soil erosion processes, slope hydrology and redistribution of soil biota. It is a very interesting, thought provoking paper, which highlights the gaps in our knowledge of erosion / soil biota relationships. It explores a number of novel ideas, and it acknowledges that the scientific, empirical evidence base is lacking. The paper presents general statements and suppositions, with limited original data and no testable research questions (hypotheses). The paper is well written with few typographical errors. In places, some repetition requires editing.

It is pleasing that the different forms of soil erosion (water, wind, co-extraction, tillage) and their impacts on redistribution of soil biota are explored (this differentiation could

C3509

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Discussion Paper



be included in the abstract). More reference could be made of the effect of soil biota on soil erosion processes (i.e. cause and effect relationships), as well as the impact of soil erosion on soil biota.

The scope of the paper is defined well at the outset, but as the paper develops, the emphasis is on hydrological processes in general affecting soil biota rather than soil erosion processes specifically. It is not clear if the authors are considering redistribution of biota through soil erosion (detachment and transport of mineral and organic material i.e. solid phase) or through hydrological processes (runoff, through flow etc. i.e. aqueous phase). This confusion undermines the evidence base that is being presented: the relationship between soil erosion and biota redistribution may be spurious – the true determinant is runoff generation rather than soil erosion per se. No empirical evidence of soil erosion and biota transport is presented, although data are given regarding biota transport by runoff and rainsplash, but these are not necessarily associated with soil erosion directly. There may be a relationship between soil erosion and redistribution of biota, but the explanatory variable is likely to be runoff / hydrological processes. Analysis of eroded sediment and biota composition and structure would support this hypothesis.

Indeed, the mechanisms by which soil biota are transported (in the solid and/or aqueous phase) are not explained in depth. Are the biota eroded with the soil fraction or simply associated with events where soil erosion processes occur? Where is the evidence that soil biota are redistributed by soil erosion (might it be just through runoff processes, i.e. not associated with soil?) Is this just assumed? 'erosion can passively disperse soil biota' (335), but where is the scientific evidence (data) to support this? The paper would benefit from more discussion of the bio-chemico-physical connection of soil biota to eroding / eroded material. For example, if nematodes are aquatic (line 350) are they truly eroded with the soil, or simply washed away by hydrological processes, not necessarily associated with the eroded material per se. Just because soil biota may have the same size and mass as soil particles (line 377), they may not be

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subjected to the same erosion processes.

The paper contains a number of contradictions that should be addressed: a) Is the transport of soil biota a selective process (as soil erosion is)? Are different organisms more or less susceptible to detachment and transport? No evidence is presented to support the assumptions that loss of biota by erosion is non-selective (line 325). Whilst this might be likely, it would be a relatively straight forward experiment to ascertain if this had scientific evidence to support this assumption. Also this assertion is contradicted later (line 365) that erosion selectively transports based on size or mass of biota. Also work by Villenave et al (2003; line 388) showed selective transport of different types of nematode. The authors talk (442) of different groups being more or less susceptible to different sets of erosion processes. b) Line 383: Nematode entrainment occurs at discharges lower than that for soil particles – doesn't this undermine the hypothesis that soil erosion processes and loss of biota are linked? c) Line 256: Microbiota in niches (=voids?) within microaggregates, so this implies they are eroded with microaggregates (not with primary particles)?

The references are useful and comprehensive, although the authors are referred to another paper linking ecology and geomorphology that might be complementary: Osterkamp, W. R. Hupp C. R. and Stoffel, M. 2011. The interactions between vegetation and erosion: new directions for research at the interface of ecology and geomorphology. *Earth Surf. Process. Landforms* 37, 23–36 (2012). DOI: 10.1002/esp.2173

Specific comments Line Comment 15 Elevated erosion and transport – by definition erosion includes the detachment and transport of soil particles and aggregates. 19 Climate change will affect erosivity of eroding agents as well as the susceptibility of soil to erosion. 22 Erosion and consequent impacts on soil biota. . . and vice versa? 26 . . . redistribution. . . of soil and associated . . . biota? 62 Why nematodes in particular? 68 This paragraph is not very clear and interrupts the flow of the text. 71 An example of improved good practice would be helpful here 79 Soil particles and aggregates 80 How are soil biota associated with soil particles – in the soil matrix rather than individual

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10, C3509–C3514, 2013

Interactive  
Comment

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particles? 87 So if the majority of sediment remains in storage is this really a 'loss'? What impact does this have on associated biota? 92 Loss of organic matter through oxidation and removal during harvest is also a factor determining higher erosion rates in arable systems 96 Comma missing after 'wetting' 104 ...selective detachment, entrainment, transport and deposition. ... 111 English needs attention here 112 Where is the evidence that biota are eroded (at greater rates) with soil during rill erosion? 114 Reference to gully erosion rates being greater than rills and sheet erosion 117 Mass movements are not very common on agro-ecosystems due to limited slope gradients on arable fields ...few exceed 20o (due to limitations of farm mechanisation) 117-121 Suggest the section on landslides on arable land is omitted. 127 Where is the evidence of erosion rates having a 'direct effect on the redistribution of soil biota'? 133 Is Verheijen et al (2009) the best reference for wind erosion processes? 138 Why does wind erosion pose less risk in Europe than most other regions? 147 2 processes are being described here a) displacement and b) break down of aggregates. 150 Greater compaction may lead to higher shear strengths so reducing susceptibility to water and wind erosion 153 ...severity of erosion...only tillage erosion or all forms of erosion? 165 Again, where is the a priori reasoning that there is a simultaneous loss of soil biota during erosion events? 168 Not clear how Figure 1 was derived – original data sources? 169 Not all processes in Fig 1 will have associated runoff rates e.g. wind erosion 172 ...across hill slopes. In contrast... 173 Where is the evidence that the magnitude of biota transport is greater in rills? Is this selective? Is it directly related to soil loss or does it occur at a different rate? Is erosion a selective process for soil biota losses? 173 Why is delivery 'inefficient'? 175 Reference needed to state <10% eroded to channel network 182 Upward movement of soil biota following rainfall...but what of movement downwards due to leaching / infiltration / flushing of rainwater? 184 Not sure the section on soil erosion and climate change is necessary – certainly not central to the main focus of the paper. 195 ...impacts on soil biota. ... 196 To be specific, should this be 'soil erosion'? Should this read impacts 'on'?...and follows in next section Soil biota = soil micro biota? 207-209 Some repetition here 209 Decomposition of

C3512

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10, C3509–C3514, 2013

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what? 210 Maintaining environmental quality is rather vague 222 .... (Verheijen et al., 2009). Therefore erosion..... 223 ..rates in Europe can be at least. ... 241 Five scales of soil biota function? 244 Is it possible to put a quantified spatial scale to all 5? 252 Links between the different spatial scales are not very clear /tangible. 255 Some repetition here 256 Microbiota in niches (=voids?)within microaggregates, so this implies they are eroded with microaggregates (not with primary particles)? 268 Space needed after 2006. Why do macro biota have increased mobility? 270 / 279 Evidence that macro biota are able to move away from such perturbations? 273 Quantify the 'relatively small...organisms' 275 Moving along rather than up? Concept of energy / effective erosion depth continuum is not clear. 281 Soil erosion leads to loss of habitable space. ...but what if deposited sediment downstream provide a new habitat for organisms? 301 Comma after 'sand dunes' 303 Out of airborne sand? This mechanism is not clearly described. 309 Rainfall may have been identified as a passive dispersal mechanisms of PPNS...but this says nothing of soil component and how biota loss is associated with this 312/315 Flooding does not necessarily include soil erosion. 317 ...provide 320 Net loss of biota and physical restructuring of habitats are 2 (albeit linked) processes 325 Transport of biota by erosion is unlikely to be selective to particular species – evidence? Where is the evidence to support this statement? 326 No substantial evidence that key drivers of ecosystem services will be lost? 328 What if compensating species are actually resistant to erosion processes? E.g. associated with non-eroding soil fractions? 332 Offset by irrigation and improved crop varieties too. ...but these compensations may not be sustainable especially use of chemical fertilisers. 333 Impacts 'on' rather than 'to' soil biota? 333/334 Repeats section above. 339 Relevance of the jerky conveyor belt analogy? 343 Erosion v depositional areas – if depositional environments improve the quality of habitats for soil biota, might the net effect of erosion on soil biota be a positive one? Is erosion beneficial to soil organisms in that the newly eroded profile may be a better habitat for certain species? 344-349 Relevance to soil erosion and soil biology? 350 If aquatic, how does this relate to erosion of soil material? 361 Disturbance includes erosion

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presumably 365 Contradicts assertion in line 325 369 Effect on what? 373 Interesting that the title to 5.1 talks of rainfall runoff but not erosion. 376 Water borne – not soil borne? 377 381 Detachment of what? Sol? Nematodes? Or both? 383 Nematode entrainment at discharges lower than that for soil particles – doesn't this undermine the hypothesis that soil erosion processes and loss of biota are linked? 385 More beneficial than what? 391 Not clear how this demonstrates selectivity. . .do you mean concentrations of these different groups varied through the soil profile? 395 Runoff water rather than solid material i.e. soil erosion. 398 From nematode erosion or soil erosion? 416 . . .question of. . . 426 Direction of movement will depend on the process by which soils become saturated? 432 436 Even if nematode come from soil habitats it doesn't mean they are associated with soil erosion. . .they may be transport by hydrological processes alone. 443 . . .erosion = soil erosion? Or not? 451 Not immediately clear what the 2 issues are 458 Rainfall induced transport is not necessarily soil erosion 461 Erosion risks = soil erosion risks? 465 . . .erosion = soil erosion? Figure 1 Source of the figure and the values for each erosion process. IS this just conceptual or based on empirical evidence? Labels should be more self-explanatory so the figure can stand alone. Caption should use 'soil erosion' rather than 'erosive' Figure 2 X axis - Time = recurrence interval? Y axis - m<sup>2</sup>? Implies erosion processes are linked to size of biota that can be redistributed. . .but this contradicts a comment in the paper that erosion of biota is non-selective.

Please also note the supplement to this comment:

<http://www.biogeosciences-discuss.net/10/C3509/2013/bgd-10-C3509-2013-supplement.pdf>

Interactive comment on Biogeosciences Discuss., 10, 7491, 2013.

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