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Interactive comment on "The impact of road and railway embankments on runoff and soil erosion in eastern Spain" *by* P. Pereira et al.

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Received and published: 23 January 2016

Pereira et al. In review. The impact of road and railway embankments on runoff and soil erosion in eastern Spain. Hydrology and Earth System Sciences.

General comments:

This article deals with a topic of widespread relevance to readers interested in soil erosion, water quality degradation, runoff development, and the effects of land development (roads in particular) on hydro-geomorphic processes. I commend the authors for their detailed-accounting of their work and findings described in this paper. There is no doubt in my mind that this article may be accepted for publication after some changes, but I would like to invite its authors to consider my recommendations for im-

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proving its readability and some of its analyses. I will provide detailed comments and recommendations below but most of these can be summarized in these few points.

First, it would be useful for the paper to provide a better understanding of what are the particular issues related to runoff development and erosion in this region of Spain. What was the driver for this, and all other runoff-erosion studies, that have been conducted in this area. There is a hint of an issue related to flooding and accumulation of sediment, but these are mentioned in the conclusions. I strongly recommend adding some text commenting on the justification for the study from a water resources, ecologic, and/or infrastructure perspective, and/or whatever other theme that might be relevant or important.

Secondly, there are too many details and the main findings are hard to extract. These become a bit clearer in the discussion section but still I believe that they are not properly highlighted. Part of the problem might be the large number of dependent variables that the study is trying to explain. I believe that some of the crucial ones that merit special attention are total runoff & runoff coefficients, steady state infiltration capacities, and soil erosion rates. The other dependent variables discussed I believe are secondary to these and do not add too much to the physical understanding of runoff and sediment generation.

Third, the presentation of data is concentrated in tables which is ok, but the paper might benefit from displaying some of these as graphs. For example, basic comparisons of runoff coefficients displayed in a column-style (bar) graph by surface type will help drive the point that more runoff is generated from embankments than orchards and shrubland, in addition to providing an easily interpretable idea of the magnitude of the differences. Also, since the data is already presented in a table format, addition of these values within the text is unnecessary and makes it more difficult to read.

Fourth, a potentially clear format to present the statistical analyses (the regression analyses in particular) and key findings might be to have these laid out explicitly as

equations. Runoff = f (X, Y, Z). These might be embedded between paragraphs or in a table format but this could serve as a way to make the findings more clear.

Fifth, the authors make the point that vegetation cover is the key factor controlling runoff and erosion, but the study design does not allow for isolating this factor from the potential effects of slope, coarse fragment abundance, bulk density, etc.

Lastly, there might be a bit of over-citation. I recommend reducing the number of citations listed whenever possible, as oftentimes the long interruptions associated to these got in the way of the flow of the article. I would not mind revising an edited version of this article if the editor deems it is necessary.

Detailed comments

Abstract: Line 6: Including transport and deposition in this sentence hints that these will be attended to in this study, but they are not. Consider deleting these. Lines 13-15: Numbers within parentheses might be unnecessary here. Line 15: . . .more active. . . Instead consider higher, faster. Line 16: Are these in order from highest to lowest? Somehow explicitly state so here. Line 16: The term 'non-sustainable' might have some implications (e.g., soil productivity) that are not relevant to this study. Replace with a more relevant term or delete. Line 17 & 22: Units should be Mg ha-1 hr-1, right? Line 18: "runoff connectivity" This term in itself is full of ambiguity although there have been many attempts to define it. None of the terms I am familiar with allude to your suggested use particularly in such a small area. I strongly encourage to not try to explain the short time frame between ponding and runoff yield by using this term.

Introduction Line 1: instead of 'are' use: '. . .have been heavily influenced by humans for millennia.' Line 7: There roads 'likely' resulted? Line 8: There seems to be an abrupt shift from historical road network development to modern without an appropriate transition. Line 14: I much rather being the introduction with this paragraph and only have a brief reference to historical landscape alteration. Lines 19-25: Reduce the number of citations. Line 25: Delete: ". . .as we will demonstrate here." Line 27: Not

clear what is meant by roads creating new 'landforms'... erosional features, a steep scarpment?. Also, reduce number of citations. Somewhere in here there should be an explanation as to why this is important in this region of Spain. Line 4, p. 12951: What is meant here by 'ecosystem'? The embankment? Line 9: This seems to be discussing work done elsewhere (not in Spain). Lines 9-16: First, many citations make reading this paragraph difficult. Second, not clear to me what the point is here. Have any of these studies quantified the role of embankments and compared these to other portions of the road prism or other eroding surfaces? Make a quantitative assessment of the importance of embankments as sediment sources in other studies. Lines 17-25: The combination of references from Spain with those from abroad make understanding this paragraph difficult. Stating that little quantitative information exists on erosion from embankments and in the effectiveness of erosion control practices should be stated more concisely. What are 'exact quantifications' and why do you need them to implement erosion control strategies? Line 28: "...are or even bare..." Awkward wording. Lines 28-29: Sentence seems to be repeating what has been stated previously. Page 12952; Line 1: This contradicts what you have mentioned previously that little work has been done. Lines 4-7: What is the rationale behind these comparisons? Is shrubland meant to provide a 'control'? Why the comparison with citrus plantations? Also, you may explicitly state that this is being done by way of rainfall simulations and at a small plot scale. General comment on intro section: It might be useful here to begin setting up your study design here by citing references that provide a backdrop to the factors you consider to be important in runoff and erosion.

Materials & methods Section 2.1 Line 13: Why are citrus sites considered 'reference' sites? Line 15: Before beginning to describe which site characteristics you measured, it is necessary to have previously justified them by indicating that these have been found to control erosion rates by other studies. This can be done in the intro section. Line 25: Are these bounded plots? A picture of one of these setups would be useful. Also, pictures of all of the four surface types would also be useful. Page 12953; Line 1: How did you control precipitation intensity to be equal for all of your runs? Did you measure

precipitation onsite? This paragraph should be shortened. Lines 15-17: What does 'higher' imply here? This last sentence seems unnecessary. Line 18: How did you measure runoff? Line 20: Calculation of sediment yields is not clear. What is meant by 'weighing'? I assume you multiplied sediment concentration by runoff rate, but that does not come clear here. Line 29: Term 'connectivity' here. As described above, it is problematic. Page 12954; Line 1: How was total rainfall determined? Line 3: Not clear what the Horton equation refers to here. Lines 4-5: Why go back to describing how sediment yield was calculated. This method section would benefit from editing to make it more orderly and shorter.

Section 2.2 Line 6: All data? All dependent and independent variables? Line 10: 'The remaining variables. . .' Not clear what is meant here. All variables must be clearly stated at some point within the text or in a table. Page 12955; Section 3.1; Lines 11-20: I would delete all values in parentheses. The statistical significance requirements have been stated previously so there is no need to give the actual F and p values. Also, the values for the variables are already shown in Table 1.

Section 3.2; page 12956; Why a different section for these? Include as 3.1? Line 1: Soil moisture represents conditions existing prior to the experiment, right? Clarify. Lines 1-15: Delete all values as these are already shown in Table 2. Line 6: Delete 's' so that it reads 'content'

Section 3.3 Line 20 (and elsewhere): There appears to be too many significant figures in some of these values. Line 26: '. . .prevented allow runoff generation." Awkward wording. Delete 'allow'? Page 12957; Line 4: Delete 'c' so that it reads 'shrublands'

Section 3.4 Line 8: Significant instead of Significantly? Showing some of these results in a graphical format (column chart) would be useful. Section 3.5 Lines 24-Page 12958, Line 2: The wording of these two initial sentences make understanding your key finding difficult. Basically, all dependent variables were well explained by the combination of controlling factors you considered. Entire section: It is very hard to pull out the

essential results here. Can you concentrate the findings on some key values such as runoff coefficient, steady state infiltration rates, and erosion? Also, what are the relationships between the factors and the dependent variables… directly related or indirectly related? For example, as rock fragment increases did runoff decrease or increase?

Section 3.6 Too many details and the overall finding is lost. Check the units (g and not g m-3; Mg ha-1 hr-1 and not Mg ha-1) I am at a loss with the whole concept of the groups. What does being included in a group mean? Line 26: Without displaying the hydrographs, how can you convince the reader that what you mention are steady state infiltration rates are truly steady state? Line 27-28: Regarding Figure 3b, why do you need this analyses. Didn't you already establish that the plots were different with regards to soil properties, etc. in Sections 3.1 and 3.2? In general, I am at a loss as to which factors are important in controlling hydrologic and erosion response. Are these factors the same for all surface types? Which factor(s) seem(s) to be the most important? The general comment is that the key findings are hidden behind too many details.

Discussion; page 12959; Intro paragraph Reduce the number of citations A key finding that is highlighted later is the role of vegetation density, yet there is no section in the discussion devoted to it. Also, how does a plot of erosion rate versus vegetation density for the entire dataset look like? Line 21: Replace 'land' with 'vegetation' Line 24: 'Unsustainable' why?

Section 4.1; Page 12960; Lines 1-7: How do you differentiate between the effect of rock fragments and slope in this case? Aren't the embankments significantly different in terms of their substrates? By that I mean, aren't these steep cuts exposing a combination of soil and bedrock, while the citrus shrubland sites consist of soil? Lines 1-29: Again, I fail to capture the key finding here. There are too many details. In your study, rock fragments appears to be a factor leading to higher runoff and sediment production, but this does not agree with the literature. The literature indicates that if the

rock fragments are embedded. . . Simplify your statements. Begin with your finding and then problematize it by comparing it to the literature. Line 27: I would not use the term 'ecosystem' to describe this.

Section 4.2 Page 12961; Lines 7-8: ". . . as it shows the initiation of runoff generation is related to soil erosion and infiltration rates. . ." Wording is not clear. Also, why not expand on this if this seems important. Why is it important? Time to ponding says something about the initial infiltration rates. Line 20: The fact that higher infiltration rates were related to areas with higher vegetation cover can be used as proof that vegetation cover thus have an impact on runoff generation but says little about its ability to improve soil biota, porosity, etc. These are inferences, so the wording here should be edited accordingly. Line 26: What is your evidence suggesting that organic content is the key factor? Your study design does not isolate allow you to isolate this factor. Why not slope? Why not the abundance of coarse rock fragments? Why not bulk density? Why not vegetation cover density? Page 12962; Lines 10-25: Why not leave this sort of discussion to Section 4.4?

Section 4.3 I sincerely do not think that this topic merits a section. As I have explained above, the term is problematic and I do not think this adds much to the article's contribution to our understanding of runoff and erosion processes in this region. The study cannot contribute to the literature of 'connectivity' as it is only based on small scale observations.

Section 4.4 Lines 3-8: I believe this sentence is unnecessary Line 8: Better proof of vegetation cover being the key factor must be given. Was there any attempt to evaluate the importance of interaction terms in the regression analyses. It might be that vegetation shows up as important for particular surfaces or for particular conditions and not others. Since the study design did not include any embankments with a dense vegetation cover, it is hard to prove that promoting vegetation cover on these surfaces will result in lower runoff/erosion rates. Line 14: You have previously mentioned that vegetation does not naturally recover on these steep embankments.

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Section 5 Line 23: This is the first time that depth of soil is mentioned in the article. Line 24: You can definitely say that infiltration capacities for shrubland exceed 78 mm hr-1. Line 25: Connectivity term used again here. Page 12965 Line 2-3: I believe that the study does not highlight the need to reduce impacts. It does show that embankments erode at a high rate relative to even disturbed agricultural land, but nothing can be said about its overall impact. Lines 4-5: You have implied on a solution to the problem in the discussion: improving vegetation cover. Why not insert that in here? Table 5: Delete where it reads "Check journal name." Figure 2 & 3: I do not see the value of displaying these figures. Figure 4: What does the gray area represent?

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 12, 12947, 2015.