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Solid Earth Discussions

Interactive comment on "Use of rare earth oxides as tracers to identify sediment source areas for agricultural hillslopes" *by* C. Deasy and J. N. Quinton

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In general, the paper is well structured and written. Introduction is fairly comprehensive, methods are correct, and data interpretation and discussion are appropriate. However, more detailed methods and procedures are needed to facilitate better understanding of the experiment results.

We thank the reviewer for their positive comments and for their suggestions to improve the paper.

Table 1, is the runoff duration in hours correct? The duration seems too long.

The runoff durations are correct. Runoff durations in response to natural rainfall events were determined within the relevant sampling events (Event I: spraying date 25/01/08 to 14/2/08; Event II: 14/02/08 to 19/03/08. Event III: 19/03/08 to 02/04/08). Runoff started when the first tip was recorded in any hillslope tipping bucket in response to a rainfall trigger, and ended when the last runoff was recorded in any tipping bucket. Runoff responses were generally much longer than would be expected for surface runoff, with low volumes of runoff sustained for many hours after rainfall had ended. Runoff was not always continuous, and multiple peaks were recorded in some events. It is possible that return flow may accounts for the long durations of rainfall measured. This type of monitoring is novel, and this finding is interesting in itself, but falls outside the scope of this manuscript. We are working on a separate paper discussing these runoff responses. Figure S3 in supplementary material clearly shows the length of runoff responses in relation to rainfall triggers.

Section 2 Methods: present average slope steepness for each slope segment (top slope, middle slope, and lower slope), as it has significant impact on measured soil loss rates.

The middle and downslope segments were of uniform slope (approximately 6°), while the upstream segments were more convex and slightly shallower (approximately 2°). The segment slopes for different monitored hillslope areas were similar.

Is the entire slope segment tagged with REO? Is there any measurement on the spay uniformity, such as by collecting spaying solution or sampling soils after spraying?

Yes, the entire slope segment was tagged with REO. We used a calibrated sprayer and the spray rate was controlled. Any variability in spraying application was therefore due to user control (walking pace) and local conditions (wind and drift). We feel that the application rates can be considered to be even over the large areas sprayed.

How about REO interception by wheat canopy? Describe the statistical method used in the data test and analysis.

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Some physical interception of REO by the crop canopy will have occurred. We did not measure this but expect it to have been minimal. As seen from figure S1 in Supplementary material, the crop cover was not close to 100%, and the crop was only a few cm high at the time of REO application. As there were no differences in crop cover between the different hillslope areas or segments, any interception would have been constant throughout the experiment.

P200L22, elaborate on how the depletion rate (%) and soil loss rate (kg/ha) are estimated here. You may need to include the supplemental materials here.

These calculations were not shown here in order to keep the paper more concise. We believe that the descriptions given 'depletion rates (%) or ratio of total mass of depletion of an element to mass of the applied element for a hillslope, and estimated erosion rates (kg ha-1) using tracer proportions, were calculated for each hillslope area within tracer-tagged hillslope lengths (See Section S1 in Supplementary Material)' are adequate, with full details provided in the Supplementary material section. These calculations use the standard approach and similar calculations have been presented many times in other publications, many of which are referenced in this paper.

Section 3.2.2. 1st paragraph, discuss why more soil erosion occurred in the top slope. Is the top segment steeper? If the whole hillslope has uniform slope, the soil loss rate, in principle, should increase downslope as runoff concentrates.

We consider that the explanation and discussion given already covers these points: 'The main source of sediment eroded from the hillslope in each event was the upslope area, implying that the wheel tracks, the main route of runoff and sediment transport within the arable hillslope, are principally conduits for hillslope erosion, and not highly active sites of erosion during the monitored events. This is consistent with the absence of observed rilling within the wheel tracks on the eroding plots during the study. The upslope area appears to act as a runoff generation zone, with water and sediment transferred to the wheeling channel via the connection of ponded areas. Although sed-

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iment eroded from the midslope and downslope areas would involve smaller transport distances, these areas do not appear to be as well-connected to the base of the slope as the upslope area, which was slightly shallower and more convex, and where wheel tracks may be less incised. Studies using 137Cs as a tracer have shown that the severity of erosion, and hence erosion sources, can depend on slope shape, with greatest loss on convex slopes (Montgomery et al., 1997).'

Section 3.2.3. 1st paragraph, stated strong endorsement of the spraying method, but lack of strong experimental support. 'Visual' judgment is not strong enough. Measurements by directly collecting spraying solution or soil samples following spraying would be preferred.

We discussed in the methods section that the sprayer was calibrated, and state here that 'An even application rate was reliant on the ground coverage rate of the sprayer, but this was controlled by ensuring that all spraying was undertaken by the same user, and that up and downslope ground coverage rates were carefully timed.' It was impractical to collect soil samples from within the sprayed area as walking on the hillslope removed applied REO solution and disturbed the sprayed area. We are confident that the sprayer tests and application rate tests we undertook in the laboratory prior to the fieldwork ensured the spray rate was as even as necessary over the large areas sprayed. âĂČ

Interactive comment on Solid Earth Discuss., 2, 195, 2010.