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Interactive comment on "Landscape scale remediation reduces concentrations of suspended sediment and associated nutrients in alluvial gullies of a Great Barrier Reef catchment: evidence from a novel intensive monitoring approach" *by* Nicholas J. C. Doriean et al.

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GENERAL COMMENTS FROM REFEREE 2:

General Comments 1. Overall, I considered this paper to be a suitable study for HESS and a useful contribution to our knowledge of alluvial gully remediation strategies. In my opinion this is suitable for publication with minor/moderate revisions.

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RESPONSE: Acknowledge.

The authors acknowledge this positive comment and have undertaken specific reconsideration to address the other key points raised by the Referee (see below).

SPECIFIC COMMENTS FROM REFEREE 2:

Specific Comment 1. "What was the cost of remediation? I think for a global audience this is important."

RESPONSE: Accept.

Note, Referee 1 also mentioned this as an important factor to include in the manuscript. The authors agree that the cost of remediation provides important context for the global audience of the Journal and will include discussion regarding the cost of remediation in the revised manuscript.

Specific Comment 2. "Placement of devices in the gully catchments: catchment 3 PASS is not on a drainage line but catchment 1 and 2 are (assuming blue lines in Figure 1 are drainage lines found using some routing method?). This seems to have an impact on measured sediment concentrations (for catchment 3 the upper SSC is 3556 while catchment 1 and 2 are 563 and 1517, respectively). Given the focus of the paper is on measurement methods I think a little more discussion about the placement of sensors would be good. I think some more discussion of this is important because it seems to have important implications for your conclusions. Taking the lower end estimate of TWA SSC from the control gully gives 4453 and the upper estimate from the hillslope in catchment 3 is 3556 which is ~80% of what is seen in the control gully. Without a larger sample it's hard to know whether this is representative or not but for me it suggests the possibility that hillslope erosion, in this environment, is a considerable source of fine sediment (potentially almost equal to gully erosion?). Given that, I think it warrants a little more discussion around possible ways to address the influence of sensor locations with respect to process interpretation."

RESPONSE: Acknowledge/clarify.

The Referee makes a good point regarding the need for more detailed description of overland flow sampling methodology. Please note that the blue draining lines show in Figure 1 are only indicative of the actual overland flow characteristics observed at the site. Other factors (e.g., vegetation, natural debris, and termite mounds) influence water flows in ways that are not perceived by airborne Lidar-derived flow lines. The overland flow sampling locations were chosen based on observing locations that had consistent flows and were as close as possible to the transition of catchment to gully. The sampler located at catchment three was placed in a different location to the drainage line indicated in Figure 1 because of the presence of termite mounds and vegetation. The authors thank the Referee for making this observation and will provide commentary in the caption of Figure 1 to provide context for the blue flow drainage lines. The authors will also revise the text in the methods (Lines 181-185) to include more detail and photographs of overland flow at the sampling locations (these will be provided as supplementary information). The referee makes a good point by comparing the suspended sediment dynamics of the catchments and gullies, specifically for catchment vs. gully sediment sources in the control gully. The authors caution the Referee against comparing catchment/gully suspended sediment sample concentrations collected from different locations (i.e., comparing the remediated gully catchment to the control gully outlet). This is not appropriate given there is suspended sediment sample data collected from a location that represents the majority of the catchment water draining into the Control gully. Furthermore, Section 3.2.2 Relationship between SSC and flow provides discussion and detailed examples from the data indicating that subsurface erosion processes are the dominant source of suspended sediment flowing from the Control gully. However, the Referee makes a good point that erosion processes in the catchment, possibly sourced from surface erosion, appear to be a major contributor of suspended sediment flowing through the gully systems and that the collection of accurate and representative catchment monitoring data is very important to understanding these dynamics. The authors will revise the existing commentary on

catchment suspended sediment contribution, in the Results and Discussion and Conclusions sections, to provide emphasis on the importance of monitoring locations for the purpose of collecting representative catchment overland flow samples.

Specific comment 3. " Also, how do the catchment areas compare? The total catchment area of the remediated gully is ∼13ha but what is the catchment area above each PASS sensor in the sub-catchments and how does this play into the results? And the catchment area for each sub-catchment of the remediated gully."

RESPONSE: Acknowledge.

The aim of measuring suspended sediment in water flowing overland into the gullies was to understand their contribution, in terms of suspended sediment concentration and particle size distribution, to the suspended sediment measured at the gully outlet. Because of this, the size of the catchment is less important as ensuring that the major catchment drainage inputs into the gully are monitored. For example, the remediated gully catchment drains into the gully from three separate locations, later mixing at a confluence within the gully. Thus, three monitoring locations were required to account for the majority of overland flows draining from the catchment. In contrast, the majority of catchment overland flows into the control gully drain through one location, thus, it was monitored at one location up-stream of the gully head. Evaluation of the influence of sub-catchment area on the contribution of suspended sediment to the gullies would require the estimation of suspended sediment loads from these sub-catchments. As discussed in the manuscript (Lines 290-295 and 463-466) the estimation of loads from these highly ephemeral systems, and their catchments, is very challenging and was not feasible for this study. The authors acknowledge the importance of the catchment area regarding overland flow sediment contributions and will provide commentary on this in the Results and Discussion section.

Specific comment 4 . "If possible, I think a before remediation and after remediation DEM image (or DEM of difference maybe) would be a useful addition."

RESPONSE: Accept.

Note, Referee 1 mentioned that before and after photos of the remediated gully would be beneficial to the manuscript. The authors agree that a before and after digital elevation map (DEM) would also be beneficial. The authors will include a figure with before and after photos and DEM images of the remediated gully in the revised manuscript.

Specific comment 5 . "Figure 7 and 8 seem to suggest that the fine fraction is coming from the catchments more so than the gullies? But there isn't much discussion about this? Maybe I'm interpreting the results wrong but if this is the case, I think it's one of the more interesting findings for discussion."

RESPONSE: Clarify.

Figure 7 and 8 demonstrate that the distribution of fine sediment (0.1-30 μm) in the suspended sediment samples collected from the catchments and gully outlets are similar. However, further investigation (e.g., geochemical tracing) would be required to differentiate the sources of fine sediment in the gully outlet sample. The authors agree with the referee's observation that the catchments samples appear to consist of mostly fine sediment as is indicated by in Figures 7 and 8 and Table 3 (d90 < 36 μm for all overland flow samples collected). Given this it could be suggested that the catchments contribute some of the fine suspended sediment measured at the gully outlet. This is discussed in Section 3.2.3 Particle size distribution, Lines 356-368: "The suspended sediment PSD characteristics of control gully catchment PASS samples was notably different to the gully outlet PASS samples (Table 3). This indicates the contribution of slightly coarser suspended sediment from gully erosion (d50 10.8 μm) is greater than the suspended sediment contribution of the catchment (d50 4.29 μm) in the control gully. In contrast, the PSD characteristics of suspended sediment samples collected from the outlet of the remediated gully (d50 of 5.84 μm) and samples collected from Catchments 2 (d50 of 5.52 μm) and 3 (d50 of 5.06 μm) of the three catchment areas draining into the gully were very similar (Table 3) (Figure 8). This suggests there is a

notable contribution of sediment entering both gullies from their respective catchments."

Specific comment 6. "In your abstract and conclusions you present a value of 80% as the sediment reduction achieved but it's not clear how this number is calculated? Is it the (SSC control – SSC remediated) / (SSC control)? Or some other number?"

RESPONSE: Clarify.

The sections the Referee mentions, state the following: Lines 22-23: "Suspended sediment concentrations were ∼80% lower at the remediated site compared to the control site,. . ." and Lines 460-463: "The multiple lines of evidence from this water quality study indicate the application of intensive landscape-scale remediation on actively eroding alluvial gullies has the potential to reduce average suspended sediment concentrations by more than 80%." These statements imply that the SSCs of the different gullies were compared and the difference in concentration between the two was ∼80%. This comparison is discussed in further detail in Section 3.2.1 Suspended sediment concentration. It is not uncommon to see statements such as these without detailed explanations of the exact formula used in the abstract conclusion sections of a scientific journal article.

Specific comment 7. "[Line] 52: "There are various types of gullies present in the GBR catchment region (e.g., hillslope, colluvial, ephemeral, and soft-rock badlands), however, alluvial gullies likely represent the largest source of sediment, accelerated by land use change, to the GBR." - Reference?"

RESPONSE: Clarify.

The text immediately following this sentence uses the same reference. Thus, the reference is provided at the end of the paragraph. The references used are: Brooks et al., 2013; Brooks et al., 2016; Brooks et al., 2019. The authors acknowledge that some time has passed since this the submission of this manuscript and shall review the scientific literature for findings that support or contradict the statement.

Specific comment 8. " [Line] "90: "The study site topography is relatively flat." - Would be good to know average slope?"

RESPONSE: Accept.

The authors agree that description of the average slope of the site would help with visualisation of the site conditions and will ensure it is included in the revised manuscript.

Specific comment 9. " 101: "Erosion rates derived from repeated airborne LiDAR between 2009 and 2015 (before remediation activity), indicate the control gully produced slightly more sediment (61 t -1 ha-1 yr-1) compared to the remediated gully (50 t-1 ha-1 yr-1), based on gully catchment area." - Per unit area of gully or catchment?"

RESPONSE: Clarify. The authors reference the sediment yields estimated by Brooks et al., 2016, where the unit area was inclusive of the gully and its associated catchment area.

Specific comment 10. [Line] "102 – 103: t-1 ha-1 yr-1 Âż t . ha-1 . yr-1 mass shouldn't be a reciprocal here.

RESPONSE: Accept.

The authors accept this comment and will revise the qualifiers in the text to read x number of t/ha/yr (i.e., x number of tonnes per hectare per year).

Specific comment 11. [Line] "103: "Note, LiDAR does not account for the surface erosion generated from the catchment area of each gully, which would be expected to be comparable on an area normalised basis. Hence, the difference in specific yields between the treatment and control would be less than indicated by the LiDAR data alone (Brooks et al., 2016)." - I find this statement a little confusing. I think you either need to be clearer about what this means or not include it.

RESPONSE: Accept.

The authors included this statement to provide context, in the form of empirical data,

that the gullies, normalised for area, were contributing comparable sediment yields. The authors thank the Referee for the observation and will ensure this statement is clearer in the revised manuscript.

Specific comment 12. [Line 169]: “time weighted average (TWA) SSC” – I can take a guess at what this is but it would be nice to have an equation.

RESPONSE: Accept.

The authors thank the Referee for pointing out this oversight and will ensure an example formula for the calculation of time-weighted suspended sediment concentration is included in the Methods section.

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