Dear Editor,

Thank you for the thorough and constructive comments on the manuscript. We have addressed each of the points raised and amended the text accordingly and feel the manuscript is much improved as a result. Below is a point-by-point response to the points raised, with the original comments in roman black text, and our responses in italicised red text. In our response we have highlighted the line numbers in the revised manuscript at which point we have made edits to the text. We also note here that we have added the © Google Earth copyright icon as requested by the file validity check, to figure 2.

Yours faithfully,

Dr Chris Hackney (on behalf of all authors)

Line 100 – Please explain why a 100 m buffer? What is the typical channel width – useful to specify here in the context of that buffer

We agree the rationale behind the 100 m buffer was not clear and the text (Line 106 – 111) has been amended to better reflect the choices behind this decision. The reason a buffer is applied is to remove vessels from the analysis which may be moored on the bank and therefore not active in any mining operation on the day the satellite image was capture. The mining vessels have a mean length of 60 m (see line 95 in the revised manuscript and also figure 2), although the longest vessels my reach up to 75 m in length. The 100 m buffer was chosen to ensure that if moored perpendicular to the bank, that the vessel would be fully contained within the buffer. From visual observations it has also been noted that active mining operations do not occur along the near bank zone, and so it is unlikely that a buffer of 100 m would capture active operations. Along the reach of the river in the study area, the channel width varies between 600 m at its narrowest to 2,500 m at its widest – although typically channel widths are around 900 m. A 100 m buffer on each bank, therefore accounts for between 8 and 33% (though typically 22%) of the channel width ensuring the majority of the channel, and the areas that are actively mined remain accounted for.

Line 111 – The density seems low for quartz sand, or does this value already account for porosity?

The density value (1,600 kg m^3) used here was taken from the previous study of sand extraction from the Mekong (Bravard et al., 2013) to ensure comparability between the estimates arrived at. This values is for dry sand. We have amended the text at line 128 in the revised manuscript to make it clear that we have used the same density value for comparison with Bravard et al.'s estimates and also commented that varying the density to that of quartz sand (2,650 kg m3) would result in a 65% increase in tonnage estimates.

Line 133 – How variable is this sand fraction likely to be?

We note that this relates to suspended sand fraction which is perhaps less important with respect to the morphological impacts when compared to bedload sand transport, but is still important for overall riverine sustainability and in calculating the sand deficit. Prior fieldwork across a range of discharges (14,500 to 55,000 m^3 s^{-1}) and a range of study sites located (reported in Hackney et al., 2020, Nature Sustainability) within the study region shows that the range of sand fraction within the water column does range from 1 to 14% (averaging out across the study area at 7%). Thus it is likely that the sand fraction varies spatially and temporally (as discharge varies). We acknowledge that this variation will lead to substantial changes in the estimates of the deficit (as mentioned in the comment below) and that locally, sand deficits may be greater and lower depending on the availability of sand in suspension. We have added comments on this to the revised manuscript (Line 151 in the revised manuscript). However, we also note that in terms of a reach scale assessment of the impacts of sand mining on river morphodynamics, it is necessary to report an average value as it is difficult to assess the spatial variations in deficit without more spatially explicit estimations of bed load transport.

Line 135 – Say something about how good this empirical bedload transport model performs based on the previous work?

We agree with the editor that more details as to the performance of the bedload transport function used here are needed. We direct the reader to Hackney et al. (2020) where the model is first presented for full details but note in the revised manuscript (lines 164 - 168) that the empirical bedload function used is based on that of Bagnold (1980). Statistically, the model has an r2 consistent with that of Bagnold's (1980) model and other empirical bedload transport functions widely used ($r^2 = 0.22$, $P < 0.1$) based on 12 observations across a range of discharges covering 78% of all bedload transport events during the period 1980 - 2015. As such, given the ever difficult nature of characterising bedload sediment transport, we have confidence that the model used here is appropriate for the study reach. Given the small fraction of the total sand load that is bedload (< 1%, see Hackney et al., 2020) the uncertainty in bedload transport estimates calculated using the 95% confidence intervals around the transport predictor fall within the adjusted values of sand content resulting from varying the sand fraction transported in suspension (see comments above and below). Thus, the error associated here is contained within the new error bars presented in Figure 4 and 5 (see comment below). We have added text in the manuscript detailing this, and also commenting that it is the sand fraction in suspension that is the biggest source of uncertainty in estimating the influx of sand through natural transport processes (line 169 - 171 in the revised manuscript).

Line 159 – What is the M9 instrument? Its acoustic emission frequency?

As stated in Line 176 of the revised manuscript, the M9 instrument is an acoustic Doppler current profiler. We have specified the manufacturer (Sontek) in line 159 to better reflect that this is a brand and allow the reader to search for the instrument if they wish. The bathymetry was collected using the 1 MHz vertical beam on the instrument and this detail has been specified in the text of the revised manuscript (line 179).

Line 185 – How likely is it that he 7% sand has varied, this has some leverage in these calculations. For instance, could it be double or half that value (i.e. 10.9 Mt sand becomes 21 Mt at 14%). Or put another way, its clear the deficit is there, but what is the major uncertainty source on the sediment flux estimate, and is it likely to be conservative or not?

We agree that this value is important to accurately quantify and constrain the sand deficit. As mentioned in the response to the editor's prior comment, the suspended sand fraction does vary in space and time, from 0 to 14 % (averaging out at 7%). To reflect this and highlight the importance of this variation in the estimation of natural sand transport, we have added error bars on to Figure 4 and added shaded error areas to Figure 5 (and altered the text reporting these results) to reflect this uncertainty and highlight the potential natural sand transport that would occur if the estimate of suspended sand varied from 0 – 14% (as our prior work suggests is possible). As noted in the comment above re bedload transport estimates, it is this fraction which provides the greatest uncertainty in estimating natural sediment loads. This point is further highlighted in the text (see comment above for details).