

Biogeosciences Discuss., referee comment RC3  
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## Comment on bg-2022-1

Anonymous Referee #3

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Referee comment on "Reconciling the paradox of soil organic carbon erosion by water" by Kristof Van Oost and Johan Six, Biogeosciences Discuss.,  
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The manuscript submitted by Kristopf van Oost attempts to be a review of the state of the research on the role of soil erosion for the global Carbon cycle. Depending on the study, erosion is seen as either a source or a sink of organic Carbon. Kristof van Oost and Johan Six argue, as in most of their previous work in the past 20 years, that soil erosion moves Carbon from the atmosphere into long-term geologic sinks.

I have reviewed a manuscript by the two authors with the same title for another journal approximately a year ago. Apparently, the manuscript has been rejected by that journal. Comparing the two manuscripts reveals no major changes in both argument and literature. The key conclusion of this manuscript, as in the other publications by the authors on the topic is that the uptake, or dynamic replacement, of atmospheric Carbon at sites of erosion compensates for a part of the Carbon loss caused by erosion. In addition, eroded Carbon is deposited in long-term permanent sinks, leaving a negative net balance for atmospheric Carbon caused by erosion. Since many field scale studies show a major negative impact of erosion on soil Carbon, the sink caused by dynamic and deposition in long-term sinks has been questioned. Kristof van Oost and Johan Six argue that the negative impact observed in field-scale and process studies does is balanced when taking a large-scale, long-term perspective. There are three key problems with this argument. First, soil erosion rates are poorly constrained on a global scale. In their contribution to Nature Communications, Borelli et al. (2017, DOI: 10.1038/s41467-017-02142-7) showed that an increase of the resolution in their global scale erosion model by reducing raster cell sizes to 250 m reduced the estimated global erosion rate approximately by half. This would imply that also only half of the soil Carbon is eroded than previous models suggested, which in turn significantly reduces the potential for Carbon uptake at the sites of erosion. The number of studies currently published on improving the representation of topography in erosion (e.g. Panagos et al. 2015 10.3390/geosciences5020117, Schmidt et al. 2019 doi.org/10.1016/j.mex.2019.01.004) supports the position that the quality of Carbon flux modelling for regional to global scales currently is still poor. A second problem arises from the lack of a geographically comprehensive data set on the actual impact of erosion on soil Carbon. The lack of reliable data on soil Carbon, especially from rangelands, has been acknowledged in many studies, including a 2014 paper in Nature that was co-authored by Johan Six (Pittelcow et al. doi.org/10.1038/nature13809) where the authors admit that the data on soil Carbon and from large parts of the planet are poor,

mostly concentrated on European and American cropland, and thus the assessment of impacts of farming practices on soil organic matter are highly uncertain for most of Earth's agricultural land. The final major uncertainty in the argument for an erosion-induced C sink is the lack of data on the past soil and sediment organic matter content. Kristof van Oost and Johan Six argue that over long periods of time and large spatial scales, the sink effect dominates. To my knowledge, there is no source-to-sink study on a higher order catchment scale that traces eroded soil organic from slope to ocean, nor has this been attempted for the past. Individual sink reconstructions exist, but they lack information on original soil C source which has been eroded or at non-eroding sites, been modified by land use. This leaves the balance Kristof van Oost and Johan Six want to solve with more than one unknown.

In the light of these uncertainties in the data on Carbon erosion and deposition in space and time, the conclusions drawn by Kristof van Oost and Johan Six appear biased towards the Carbon sink argument. It is also not new, Sandermann and Berhe already made a similar argument in 2017 in their paper on *The soil carbon erosion paradox* in *Nature Geoscience* (10.1038/nclimate3281), also referring to Wang et al. (2017) and Chapell et al. (2016). This leaves the key statements of the manuscript presented by Kristof van Oost neither novel nor substantiated by new or more reliable data. Furthermore, the small size of the potential C-sink induced by soil erosion has been accepted in the scientific literature for about 15 years (e.g. Berhe et al. 2007 doi.org/10.1641/B570408) and the IPCC has followed this argument in its reports on climate change. This leaves the discussion on the impact of erosion on the global Carbon cycle with a small effect, but a large uncertainty. A review should therefore in my mind point out the uncertainties and identify the research needs, rather than developing a conclusion. I therefore cannot help but think that this review, in particular the submission of a previously rejected manuscript to a different journal, is an attempt to preserve the legacy of the previous research of the authors rather than being open to the arguments made by reviewers. I therefore suggest to reject the paper.