



EGUsphere, referee comment RC1
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Comment on egusphere-2022-1233

Anonymous Referee #1

Referee comment on "El Niño–Southern Oscillation (ENSO)-driven hypersedimentation in the Poechos Reservoir, northern Peru" by Anthony Foucher et al., EGU sphere,
<https://doi.org/10.5194/egusphere-2022-1233-RC1>, 2023

General comments

The manuscript by Foucher et al. aims to “understand the sedimentary cascade” in northern Peru, and is based on original sedimentological and geochemical information from a sediment core taken in a manmade reservoir. The data was further processed to obtain sedimentation rates, and to unravel sediment sourcing. The results were then linked with ancillary information on ENSO-related climate variability and land use change in the region. The manuscript can be strengthened by clarifying the rationale of the study, and by embedding the results in the existing knowledge on the impact of ENSO events and land use change on sediment dynamics. Below, I provided a list of specific comments that might be helpful for strengthening the paper.

Specific comments

ENSO: Over the past two decades, there has been an impressive amount of research on ENSO activity in the Eastern Pacific and its impact on precipitation in the arid western coast of South America. These studies by e.g. Takahashi and Martinez (2019), Carréric et al. (2020) have related ENSO regimes with SST anomalies in the tropical Pacific Ocean, and proposed two new indices to describe the ENSO regimes: the “E and C index”. Given the strong focus of the study by Foucher et al. on sedimentation rates-sources and ENSO regimes, a revision of the introduction is necessary to account for recent findings on ENSO events. The use of one index (i.e. “E index”) instead of the two indices (“E and C”) merits to be clarified and eventually revised. When revising the manuscript, it is recommended to use internationally agreed abbreviations for specific ENSO events like “extreme El Niño events” or “eastern Pacific ENSO” instead of introducing new abbreviations like EENE, CENE (L55-60).

Land use and legacy sediments: The arid western coast of Peru has been home to agriculture-based societies for several millennia, and they have profoundly modified the landscape. There exist several studies on legacy sediments, for example, in the Chicama Valley that showed how farmers adapted the local environment through e.g. irrigation and farming infrastructure (see e.g. Caramanica, 2022). In the study, Foucher et al. highlight “management phase...soil disturbance which may exacerbate the transport of sediment to lower river sections... (L65-66)”, but it is not clear if they refer to recent farming activities

or also account for legacy of historical occupations.

Clarification of concepts: In the manuscript, the authors refer to the "sedimentary cascade", "sediment sources", 'sediment dynamics', "soil and water resources' and 'accelerated soil erosion". The authors intermix these terms in the introduction, without clear demarcation of the study. It is therefore not clear if they will "...estimating...sedimentation rates...sediment sources..." (L82-83) or if they will analyse "...the sedimentary cascade..." (L85). The study by Mettier et al. (2009) on sediment sources in the region might be useful, as it contains several illustrations of the channel systems.

Description of the region and study area: the Catamayo-Chira basins are probably amongst the ones that are most studied in the region. The current description of the study area is very much focused on the land cover map of 2016, and some qualitative statements on recent deforestation. Please have a look at Oñate-Valdivieso (2010) for a quantitative assessment of land cover change, Arteaga-Marín (2022) for soil erosion estimates and Morera et al. (2017) and Rosas et al. (2023) for an overview of spatial variation in sediment yields along western Andes.

Methods: The rationale behind some of the methods is not entirely clear, and needs further explanation.

This concerns the sampling procedure. For example, it is not entirely clear where the sediment core was taken (with respect to the sediment body in the reservoir), and how representative the core was for deriving reservoir sedimentation rates. What about reworking/remobilisation of sediments in the reservoir? Also, the source sampling is not clearly described. It is unclear where the samples were taken with respect to geology, land cover, and topography. Also, why did the authors target soil samples when the material that is transported in the stream is also sourced from deeper via deep-seated landsliding, bank erosion and gullies?

The rationale behind the establishment of the core chronology is not clear. By directly correlating core characteristics with ENSO variability for the age-depth model, the study already imposes a relationship between sediment characteristics and ENSO events, and hence sedimentation rates. The FRN data are not helpful as independent control, but the uncertainty on the age-depth model should be reported and accordingly discussed as this has an impact on the following results.

Interpretation of results: the variability in sedimentation rates and sediment sourcing are interpreted in terms of climate and land use change. The link between climate variability and sedimentation rates and sources is somehow difficult to assess in the current version of the manuscript because of the lack of an independent age control on the core. Therefore, an uncertainty analysis might be useful. Also, land use is cited to be triggering sediment transport in the lower part of the basin, mainly as a result of agricultural activities and deforestation. It would be useful to link these observations with land use change maps or data, to verify the extent and the location of the land use changes. Although previous studies have shown how land use can accelerate soil erosion in the tropical Andes, it is not yet clear how this impact is noticeable at larger spatial scales (see e.g. Vanacker et al., 2022 or Tote et al., 2011).

Abstract : The abstract contains a number of specific terms that would need to be introduced and defined beforehand. This concerns – for example – the definition of « extreme el nino events » or « coastal el nino events » or « C and E index ». Also, please check if the use of abbreviations is necessary, and not overloading the text.

Please check the language and writing style of the document, particularly the use of

capitals for nouns like « Volcanic (L97) », « Economically Active Population (L103) » etc.

Please check formatting of the references throughout the text (e.g. L107)

Technical corrections

L1-3 : title sounds very dramatic « ... threaten soil and water resources through hyper sedimentation ». Can you rephrase into a more objective statement, for example, indicating how much sedimentation rates increased during these events ?

L11 : Can you be more precise here ? You state that « EENE have always impacted hydrology in South America » but is this the case everywhere in South America, or more specific for the arid western coast of South America ? And what do you mean with « hydrology », does this also include sediment transport ?

L12-13 : Not clear to me what you mean with « EENE ... their intensification by global warming and their association with changes in human activities and land cover ». How are EENE's associated with land cover ? Do you refer to land cover change after EENE events ?

L14 : rephrase « freshwater originating from large dams » What is the origin of the fresh water ? Where are the sources ?

L21 : Is the « dry forest biome » contributing more sediments than the andean uplands where agricultural activities were traditionally concentrated ? Can you specify the land cover of the « forest biome » ?

L22 : Can you directly associate « warm periods » with « ENE » ?

L43-46 : These references supporting the increase in soil erosion, muddy floods and transport of contaminants after land use change are from studies in Western Europe with a different land use legacy. There have been multiple studies in South America on this topic, also in Peru, and it would be relevant to include also references to South American studies here.

L52-53 : What is your evidence that Peru is the country in South America that is most impacted by extreme rainfall events, and more particularly with land cover changes ? Are the overall rates of land use change in Peru higher than in other countries ? Can you support this with some data, and/or add a reference ?

L53 : please check writing «the North Peru »

L60: please avoid using terms like "deleterious"

L62-65: Can you support this with a reference to the scientific literature? Also, this is an area of legacy land use (see e.g. Caramanica, 2022), what about historical land use activities?

L67: Can you indicate which network this study refers to? "...data available from a network..." How many data gaps exists?

L82: Is it necessary to refer here to the "tropical forest biome"? How would sediment processes be different in this biome?

L86: Please check the use of 'sedimentary cascade', this refers to something very different

than "sediment sources" and "sedimentation rates".

L91: check writing: "Northern" but then "western" and "eastern"

L98: what is the source of the data presented here? What is the reference for the geology? And the ecoregion map? What is the reference for the land cover map?

L107: You might want to add reference to land use change analyses that were done for the region. See e.g. Oñate-Valdivieso (2010)

L115: When referring to the erosion and sediment problems, you might want to refer to studies on soil erosion for the region (e.g. Arteaga-Marin et al., 2022; Morera et al., 2017; Rosas et al. 2023; Tote et al., 2011)

L118: Please refer here to the numbers published in Morera et al. (2017)

L122: Where was the core located with respect to the entrance/outflow of the reservoir? Was the core taken on the sediment delta? Can you indicate its location on a bathymetric map of the sediment core? How representative is one core for deriving sedimentation rates of a large lake?

L137: Can you also specify how samples were treated for grain size analysis? What is the basic principle that the Malvern Mastersizer uses to determine grain size distribution?

L156: Why is the core chronology not based on an age-depth model with the FRN? By linking the core density with the "E-index" you cannot do an independent analysis of sediment characteristics with the ENSO variability.

L160: Which kind of correlation analyses was done? Parametric or non-parametric? And how to deal with autocorrelated data?

L177: In how far are the sedimentation rates robust, given the uncertainty on the age-depth model? The paper could be strengthened by quantifying and reporting the uncertainty on the rates? Are these rates conform with what is reported from bathymetry?

L190: What is the uncertainty on these ages? Can you report them?

L194: It is not entirely clear why K is such an important element for the sediment fingerprinting. The K concentrations in the soil typically vary based on soil weathering degree, and would be much higher in sediments than in weathered soil material. Same thing for Ca concentrations that could vary between soils and sediments.

L204: The rationale behind the selection of these two "sources" for the fingerprinting of the sediments is not clear, and would need further explanation. Previous work by e.g. Tote et al. (2011) pointed to differences in sediment dynamics pre- and post-ENSO events, whereby the material was quickly transported to the reservoir during ENSO events, and sediments were accumulating in the upstream alluvial plains of the lower basin during post-ENSO events. What is the expected difference in geochemistry between the "dry forest" and the "upstream sources"? Why contrasting the geochemistry of the soils with sediments, when the FRN on the sediments show that the material is probably sourced from much deeper.

L246-247: Are the data on the sedimentation rates robust as to identify different periods of sedimentation (with tipping points)? Can you validate your results using the information published by e.g. Tote et al. (2011)?

L255-258: can you comment on the sediment transport mechanisms in the area? Is the sediment transport mainly supply or transport limited? Tote et al. (2011) refer to the wide availability of sediment in the alluvial channels pre-ENSO events, and this would imply sediment transport limited systems in the lower part. Can you specify if farmers are redistributing sediments within the floodplain, or bringing sediments from elsewhere?

L278: There are recent studies showing the sensitivity of reservoir sedimentation to climate variability in Peru. You might have a look at Rosas et al. (2020).

L283: The study does not demonstrate quantitatively that there is a direct impact of land use change on the sedimentation rates or sediment sources. Please reconsider this sentence

L285 & following: This is a valid point and concerning for the region. You can have a look at recent work by e.g. Vanacker et al. (2022) and the references herein to under build your statement.

Figure 1: Can you add latlong coordinates to the figures? The caption for the left figure mentions the USGS SRTM but there is no information on the elevation visible on the figure. Can you please check? The right-hand figure shows the land cover map of 2016. Can you indicate its source?

Figure 2: Are the data corrected for eventual sediment compaction? Or is this not an issue?

Figure 3 & 6 : What is the source of the data on the climate: Where is the E-index coming from? And what is the source of this data?

Table 1: Can you report uncertainties on the measurements?

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