

Interactive comment on “Assessing soil erosion of forest and cropland sites in wet tropical Africa using ²³⁹⁺²⁴⁰Pu fallout radionuclides” by Florian Wilken et al.

Anonymous Referee #1

Received and published: 15 January 2021

This manuscript presents a very interesting study proposing to use plutonium inventories (as a surrogate to cesium) to calculate soil redistribution rates during the post-1960 period at five different sites (including cropland and forest sites) in tropical Africa. This is one of the first studies (if not the very first study) using fallout radionuclides to reconstruct soil erosion/accumulation processes in this region of the world, and it is therefore of large interest to the scientific community in general, and the audience of SOIL journal in particular.

Overall, the study was well designed, and the results are well described using nice figures. However, the text should be clarified at some places and several improvements

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could further increase the potential impact of the manuscript (see the detailed comments below). Therefore, I think that major revisions are required before the potential final acceptance of the manuscript for publication.

Major comments

In the Methods, adding a table comparing the main characteristics of the 5 investigated sites would be very helpful for the readers. For instance, text on page 4 is hard to follow and an additional table would definitely help comparing the site characteristics at a glance.

On L.116, you refer for the 1st time to “subsoil” (which then appears on many occasions in the text). In my opinion, this is misleading as you are referring to footslope locations (you even refer to “colluvial sites” in the text) so that – in my opinion – you expect to find deep accumulations of eroded soil at those locations which likely mainly consist of “eroded topsoil” which may be progressively buried at the footslope » you should rather refer to “deeper soil layers” and avoid using the “subsoil” term. . . This should be corrected throughout the entire manuscript.

Regarding the calculation of soil redistribution rates, I wondered when reading section 2.4 how you took the reference inventories into account, then when reading section 2.5, I likely found the answer: you use it as an important factor in the sensitivity analysis given the large potential uncertainties, right? Do you confirm this?

In the discussion, on pages 10-11, in my opinion, there is one hypothesis lacking to explain the low inventories measured in this study. What about the potential export of soil/plutonium from the hillslope to locations located further downstream? Are the hillslopes connected to lower locations, how is the connectivity between the hillslopes and lower zones? We may imagine that part of the eroded soil and the associated plutonium have been exported from the hillslopes during the last several decades.

Furthermore, on LL.272-280, maybe in addition to rainfall depth, it is important to take

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into account the latitude of the investigated sites, as fallout radionuclide inventories were showed to be strongly latitude-dependent (the location in the Northern or the Southern Hemisphere is also of importance). Finally, in the discussion, maybe adding a sequence on recommendations for future studies using fallout radionuclides in tropical environments would be useful. For instance, the results described on LL.205-209 confirm that, in future, the analysis of L/O horizon samples could be avoided because they contain only negligible proportions of the total plutonium inventories (this would save time to analyse more soil depth increments for instance).

Detailed remarks Title

Maybe the title could be slightly improved, for instance: “assessing soil redistribution at forest and cropland sites. . .” (as you quantified soil erosion and accumulation?)

Abstract

L.18 (and all throughout the manuscript, I didn't list all the word occurrences): conversion INto arable land (instead of in)

L.18 unclear what you mean with “challenging local conditions”

L.21 “a relatively high inventory” » as this is all relative, maybe you could adapt the phrasing; e.g. this is definitely not high compared to the inventories observed in other regions of the world

L.23 “up to 37 and 40 cm” » maybe provide the soil redistribution rates instead ?

L.25 “insight into” instead of “insight on”

L.26 Does world deserve a capital letter here?

Introduction L.33 “low soil cover conditions” » sparse vegetation cover of the soil?

L.35 maybe specify that you refer to ‘CROP yield’

L.35 ‘goes hand in hand’ » maybe consider rephrasing?

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L.37 for THE entire Sub-Saharan Africa?

LL.40-41 “to assess new non-degraded soils” » unclear, please rephrase

L.42-43: “the onset of soil erosion”, maybe specify “at previously unaffected/pristine sites”?

L.45 “loss of potential reforestation” » impossibility of reforestation?

L.48 at suitable locations?

L.50 is detailed information > requires detailed information?

L.50 please avoid the repetitive use of ‘specific’

L.54 “but are important” » although they remain crucial?

L.55 insight of > into

L.55 “internal soil redistribution dynamics” » do you mean at the hillslope scale?

L.58 “overcome by fallout radionuclides” » by the analysis of fallout radionuclides?

L.60 on > into

L.64 of the ^{137}Cs activity until today?

L.64 in tropical and equatorial regions?

L.65 to much lower fallout

LL.66-67 extreme erosion rates. . . » there seems to be a verb missing in this sentence

L.67 Over the past decade. . . » there is a transition missing from the previous sentence here, in my opinion. Maybe add “To overcome these analytical difficulties. . .”?

L.69 their long half-life?

L.69 “without relevant decay” » this is not needed and should be removed

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L.73 provide important insights into. . .

L.74 “where, to our best knowledge, . . .” » and, to the best of our knowledge, none was conducted. . .

LL.76-78 this should be rephrased in my opinion (strange to start with “we follow two major aims”; “exemplarily analysing” does not read well. . .)

Methods L.81 Lake Eduard » Edward?

L.83 conversion of forest into cropland?

L.85 gully > gullies

L.86 sum rainfall? I would remove ‘sum’

L.87 maybe add the range of years during which this precipitation was measured?

L.87 subdivided into two cycles of wet and dry seasons?

L.88 storm events with large rainfall amounts?

L.92 throughout > across?

L.96-97 1950s / 1970s

L.99 “soil cover conditions are very patchy” » please rephrase

L.100 “in direct proximity” » not sure how Fig. 1 really illustrates this issue as I guess that the pixel size on Fig. 1 is not compatible with intra-field heterogeneities within the study sites?

L.110 “in order to understand variation of radionuclide inventories at sites” » do you mean “in order to quantify spatial variations in reference fallout inventories”?

L.112 L and O horizons

L.122 “from the study slope” » unclear what you mean here

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L.171 “different nature” » unclear what you mean here

L.175 processes

L.191 from the literature, i.e. 80 kg m⁻³

Results (please avoid the use of the term “subsoil” in this section)

L.204 it seems that Fig. 3 is cited in the text before Fig. 2, maybe their sequence should be reversed.

L.208 rarely » maybe indicate the % instead?

L.210 Why do you consider subsoil as the layer lower as 60 cm?

L.214 within each forest site?

L.216 ‘that falls in range by two standard deviations of the plateau mean’ » unclear what you mean here, please rephrase

LL.219-224: I have the impression that part of the text here is repeated from the previous paragraphs, please check and avoid repetitions

L.221 “0.019±0.006 Bq kg⁻¹.” » can we really be confident with 3 decimal digit significance here?

L.224 at slope > upslope?

L.233 “similar” » similarly?

L.244 and in contrast . . . using . . . » please rephrase

L.249 “testing the concentrated scenario” » this is probably not the best wording (extreme rainfall scenario?)

L.250 “after 19% less total soil loss” » confusing, please rephrase

L.253 “widely” > strongly?

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L.256 “sloping positions” » unclear

L.256 weaker > lower?

L.261 ‘subsoil’ » deep soil layers?

L.265 selective transport: are you referring to particle size here?

Discussion L.268 “within this study” > in this study?

L.272 “inventory findings” » inventory is found?

L.280 high for conducting soil redistribution studies

L.287 to cover » to include?

L.290 “within this study” > in this study?

L.296 small > low?

L.305 “represent almost the entire 239+240Pu inventory of the global fallout” » are you referring to the reference/baseline inventories here?

L.310 corresponding fallout patterns » are you referring to their heterogeneities in particular here?

L.313 at play not investigated by this study » that were not investigated by this study

L.315 “in subsoil” > with depth

L.317 like that observed for the fallout. . .

L.318 activity in crops » it is particularly very unlikely to find high Pu activities in vegetation 60 years after the fallout. . .

L.330 on the contribution » of the contribution?

L.337 falling below. . . » with activities falling below. . .

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L.340 “varying length” » do you mean “duration” here? Or the period since the conversion of tropical forest into cropland?

L.342 “55 years” » shouldn’t this 55-yr period be adapted depending on the duration since the conversion of forest into cropland?

L.345 “cropland use” » cultivation period?

L.347 were » was?

L.349; what about the occurrence of crop rotations in the different zones of interest?

L.354 “within the region” » observed in the region?

L.355 “The range of observed values at slopes spans from net sedimentation to heavy soil loss in direct proximity to each other” » unclear, please rephrase

Conclusions L.362 usability » feasibility of using/analysing?

L.364 catena > catenae?

L.365 “indicative for little to no soil erosion” » which demonstrates the (almost) absence of erosion?

L.367 “However, the selection of an appropriate reference is critical due to a potential 239+240Pu inventory reduction by harvest erosion in root crop dominated cropland systems.” » it seems to go pretty far in the interpretation here, focusing on the magnitude of root crop erosion, which has not been quantified in the current research; I wonder what would be the importance of sediment export from the hillslope (see comment above)

Figures (overall, your figures are beautiful, congratulations for that!)

Fig. 1 maybe add the latitudes on this map (at least the Equator should be added); what is the source of the land use data?

Fig. 3, caption L.531 » illustrates

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Fig. 4, caption L. 538: “limit of . . . “ » limit with different. . . ?

Fig.5, caption L. 546: were analysed » were used for calculation?

Tables

Table 1; it may seem counter-intuitive to analyse depth increments on the plateau and not at the footslope where sediment accumulates?

Caption L. 513: why not in Rwanda?

Interactive comment on SOIL Discuss., <https://doi.org/10.5194/soil-2020-95>, 2020.

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