Point-by-point response Referee #2

Understanding the role of water and tillage erosion from 239+240Pu tracer measurements using inverse modelling

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We highly appreciate the comprehensive and very valuable review carried out by Olivier Evrard, thank you! The reviewer positively highlights the study design and efforts made but has concerns about the conclusions on the contribution of soil degradation before the 1960th. We revised the manuscript accordingly. Please see the detailed answers (in italics) to the comments below:

Abstract:

L14: Something wrong here; *we rephrased the text as follows, "The majority of soil redistribution studies focus on water erosion,[…]"*

L17: why 'whereas'?; *we changed whereas to "where"*

L19: Suggestion, types; *thanks, we follow the suggestion*

L19: Suggestion, individual; *thanks, we follow the suggestion*

L20: Suggestion, soil redistribution patterns; *we would like to keep this phrase. The effect of lateral soil translocations on the (regular) soil distribution (soil pattern) in landscapes is meant here, not the process dynamics/rates.*

L23: Suggestion, this; *we changed the text to: "[…]the study catchment[…]"*

L24: Unclear why you refer to this 'kettle hole' for the 1st time here; *we introduce the kettle hole in the study area description*: *"The aim of this study is to understand the contribution of water and tillage*

erosion leading to soil patterns found in a small hummocky ground moraine kettle hole catchment under intensive agricultural use."

L26: I would clarify this sentence to make it more explicit... Do you mean that tillage erosion started before the mechanisation in the 1960s?; *We follow the recommendation and reworded the sentence as follows: "Hence, tillage erosion already started before the onset of intense mechanisation since the 1960s."*

L28: could be more explicit what you mean here; *we know from other studies that tillage erosion is the dominant driver of soil properties (SOC, SIC, N, texture, micro- & macro aggregates) and finally crop yields in the region. However, within this study we focus on erosion patterns derived from FRN distributions that does not explicitly deal with fertility or other soil properties. Hence, we would like to avoid statements that are not covered by our analysis. We reduced the sentence as follows: "In general, the study stresses the urgent need to consider tillage erosion as a major soil degradation process that can be the dominant soil redistribution process in sloped arable landscapes."*

Introduction:

L34: I agree with you but I think that this is more general than related with EU WFD... in many countries and regions, soils/agricultural land are managed by different authorities than waterbodies, which complicates the design of integrated approaches at the catchment scale where the connection between cultivated hillslopes and river systems would be taken into account...; *thanks for this comment. We agree that an integrated catchment management is also limited due to administrative barriers. We changed the text as follows: "Within the European Union, the focus on off-site erosion effects is partly caused by the definition of the goals of the EU Water Framework Directive (EU 2000/60/ES) that focuses mainly on water bodies and floodplains but not on a fully integrated catchment management that would call for complex shared responsibilities between different administrative units."*

L36: not very clear; *We reformulate the text as follows: "Thereby, other soil erosion drivers like tillage and wind are somewhat out of the scope of most studies."*

L39: Unclear; *We changed the text as follows: "Particularly areas of a hummocky topography with short summit-footslope distances, such as young morainic areas, […]"*

L41: Suggestion, associated; *thanks, done*

L50: Internal redistribution within the catchment?; *To be more specific, we changed the text as follows: "[…]address catchment internal redistribution."*

L53: Suggested change: "cannot provide a reconstruction of soil redistribution changes throughout time?"; *we changed the text as follows: "However, these beforehand applied tracers and change monitoring methods cannot provide a reconstruction of soil redistribution of the past."*

L53: Unclear what you mean here?; *we agree and removed that part of the sentence: "Natural or anthropogenic tracers in soils can be used to understand soil redistribution."*

L55: Parsons and Foster 2011, not sure this is the most appropriate article to support your statement here!; *thanks, you are right. We remove this reference.*

L56: Could be rephrased here to clarify; *we rephrase the sentence as follows: "The force of atmospheric nuclear weapon tests transported radioisotopes outside the troposphere, where circulation led to a globally almost homogeneous spatial distribution and subsequent fallout on soils by rain (Alewell et al. , 2017)."*

L57: Why 'limited' test ban treaty and suggestion to write it in capitals; To our knowledge , t*he Limited or Partial Test Ban Treaty still allowed underground detonations. In 1996 all kind of nuclear weapon tests were banned by the Comprehensive Test Ban Treaty. However, as atmospheric tests and the year is named, we think we can only refer to the Test Ban Treaty to avoid confusion by the word "limited". We changed the text as follows: "[…]while the Test Ban Treaty caused[…]"*

L59: Of note, there was (much less) but still significant fallout after 1963, until the early 1980s. We've recently figured out that a lot of radionuclide atmospheric monitoring data is lacking for documenting this fallout, mainly for the periods between 1954-1959 and 1967-1976 (see Evrard et al., 2000,Fig. 1-2 and associated text; https://doi.org/10.1016/j.geomorph.2020.107103).; *Thanks, we moved from rapid end to "rapid decrease" and refer to the paper.*

L60: […]which enables the use of radioisotopes as redistribution tracers in soils. Reference missing here.; *Thanks, we added Meusburger et al. 2016*

L61: Suggestion to restrict the reference list to three items, (e.g. Van Oost and Govers, 2006; Porto and Walling, 2012; Zhang, 2015; Greenwood and Meusburger, 2019; Srivastava et al., 2019); *we followed the suggestion: (e.g. Porto and Walling, 2012; Chartin et al., 2013; Evrard et al., 2020)*

L66: I disagree with you unless you add 'in those areas that received significant Chernobyl fallout' (is this what you mean?); *the fallout of the Chernobyl disaster shows a high spatial variability but the majority of regions in Europe were to some extent affected. As the unmixing of the 1960th and Chernobyl ^{137}Cs is complex, we think the use of ^{137}Cs is in Europe subject to uncertainties. However, it is not our intention to say that the use of ^{137}Cs in Europe is generally impossible, however, requires special care. To indicate this, we changed the text as follows: "Hence, the use of ^{137}Cs as a soil redistribution tracer in Europe is associated with uncertainties and requires special attention concerning a potential Chernobyl contamination (Evangeliou et al., 2016)."*

L67: Could you quantify this in %? (if you calculate the decay between 1963 and 2000); *thanks, for this good idea. We added in brackets that about 70% of the global fallout has been reduced.*

L69: Does not make sense to refer to the half-life of a sum of radionuclides, does it?; *thanks for this hint, we changed the text as follows: "[…]the half-life of ^{239}Pu and^{240}Pu is long […]"*

L70: Could you be more explicit here?; *we provide the radius of pronounced ^{239}Pu and ^{240}Pu contamination surrounding Prypiat, Chernobyl: "(<100 km; Kashparov et al., 2004; Matsunaga and Nagao, 2009)"*

L74: Unclear, please rephrase; *we rephrased the text as follows: "However, the use of radioisotope tracers integrates all types of soil redistribution processes and does not provide information on the relative contribution of the driving processes at play (e.g. water, tillage, wind)."*

L75: Suggestion, Unravelling the respective contributions of these different processes […]; *thanks, done*

L77: Unclear; *we rephrased the text as follows: "There are only few models that take both water and tillage erosion processes into account. Physically oriented models like MCST-C (Wilken et al., 2017b)*

and LandSoil (Ciampalini et al., 2012) simulate individual erosion events and are developed to enhance process understanding, while conceptual USLE based models (WaTEM/SEDEM: Van Oost et al., 2000; Van Rompaey et al., 2001) aim at a robust prediction of long-term soil erosion rates (Alewell et al., 2019).”

L82: Range/variation? is this what you mean?; *we want to point out that a model to unravel the role of water and tillage erosion over more than 50 years should be based on an easy to understand and available parameter set (space). For instance, within this study a single tillage erosion and two water erosion parameters were iterated. We changed the text as follows to avoid confusion: “[…]with a limited parameter space covered by available input data[…]”*

L85: Suggestion, objective; *thanks, done*

Methods:

L92: Unclear what you mean here, as I would say that this is the case for any catchment; to indicate that the small catchment shows high morphological variability; *we changed the text as follows: “The study area is part of a kettle hole catchment (4.2 ha; Fig. 1) showing a high morphological variability covering convex hilltops, steep slopes and flat areas.”*

L97: Suggestion, are explained by land consolidation programmes implemented in the 1960s[…]; *Thanks, we followed the suggestion.*

L98: How large were the farming structures?; *We provide the following information in the text: “In 1939, large farms that manage more than 100 ha of arable land cultivated 7% of the total arable area of Germany. In the present-day federal states of Mecklenburg-Pomerania, Brandenburg and Saxony-Anhalt, large farms cultivated 30% of corresponding arable land (Wolz 2013).”*

L100: We would almost need a sketch with the location of the different soil types along the catena: *we follow the recommendation and add an idealised catena to the study area description (Fig. 1b).*

L108: Suggestion, take place each year?; *thanks, we followed the suggestion*

L111: Do you mean 'per transect line'? maybe add that it is to avoid 'boundary effects'?; *we changed the text as follows: "The soil sampling design was organised according to a regular 20 m x 20 m grid with at least one sampling point of the transect line exceeding the spatial extent of the catchment under study (Fig. 1) to avoid boundary effects."*

L112: This is cool!! *Thanks for appreciation!*

L118: Suggestion, ranging; *thanks, we follow the suggestion*

L122: Sorry if I missed something, but I think that you shouldn't use the term 'replicate' if you collected one single core at each of these 10 different locations, right?; *We took at 209 locations 219 cores. The replicate cores were taken at ten selected sites in direct proximity to each other (max. 50 cm apart) and were supposed to be representative for the same location. This was basically done to achieve more soil material for additional analysis like the high resolution 5 cm increment vertical resolution measurements. The replicate cores are not critically relevant for the analysis. Hence, we decide to reduce the information to avoid confusion: "Closed soil cores, using a steel drill containing a plastic liner (4.6 cm inner diameter), were driven by a percussion corer (Cobra TTe; Atlas Copco Power Techniques GmbH, Stockholm, Sweden) into the ground down to a depth of 50 cm at 209 sampling points."*

L127: Suggestion, n=3; *thanks, we follow the suggestion*

L129: Suggestion, air-dried; *thanks, we follow the suggestion*

L133: Suggestion, measured for their; *thanks, we follow the suggestion*

L133: I guess that you did not want to reduce the inventory of samples, but instead the number of samples for which the analysis results would be under the detection limits, right?; *Yes, sure, thanks for pointing at this error. We reformulated the text as follows: "This was done to reduce the number of samples with Pu activities below the detection limit."*

L134: Suggestion, higher-resolution; *thanks, we follow the suggestion*

L154: Suggestion, equations; *thanks, we follow the suggestion*

L158: What about the undisturbed sites? You did not refer to these sites when described the sampling plan?; *We are using a potential range for the reference concentration based on reference measurements of a study that was carried out nearby. We explain this in the implementation section. To indicate this, we point at the corresponding section in the text: "undisturbed sites in Bq m^{-2} (see implementation section 2.5)"*

L168: SPEROS-C and/or SPEROS-Pu?; *Both SPEROS-C and SPEROS-Pu use the same tillage erosion module. However, as the description is for SPEROS-Pu, we only name this version in the text. Thanks, for pointing at this.*

L175: Suggestion, 10-cm depth layers?; *thanks, we follow the suggestion*

L176: Unclear what you mean here?; *Thanks! The word "same average" might have been caused the confusion. We remove the word "same" to indicate that the plough layers have the average $^{239+240}$Pu activity of the two topsoil layers: "[…]have the average 239+240Pu activity of the upper[…]"*

L179: Something missing here; *thanks, we changes the text as follows: "Soil erosion processes lead to a reduction of the $^{239+240}$Pu inventory per m^2 due to soil and associated $^{239+240}$Pu loss, which causes mixing in of non-contaminated subsoil."*

L183: Suggestion, topsoil?; *thanks, we follow the suggestion*

L183: Suggestion, was?; *thanks, we follow the suggestion*

L185: Ok, based on how many measurements; *Calitri et al. 2019 determined the reference value based on four sites that showed no geochemical and soil profile morphological (e.g. soil profile truncation) indications for erosion or deposition. We changed the text accordingly: "The reference inventory of undisturbed sites follows the value determined by Calitri et al. (2919) who found a $^{239+240}$Pu inventory of 43±3 Bq m² based on four sites that did not show profile morphological or geochemical indication for soil redistribution at a location 8.5 km apart from the study area."*

L186: Please rephrase; *we changed the text as follows: "To address the uncertainty inherent to the reference measurements, a reference range from 40 to 46 Bq m² was accounted for in the simulations."*

L191: Suggestion, a decametre scale?; *thanks, we follow the suggestion*

L191: Something wrong here in the sentence? & missing word here?; *We rephrase the sentence as follows: "Different block sizes were tested for the kriging approach. A block size of 20 m was selected that matches the sampling resolution and did not to cause over-smoothening of the interpolation result."*

L208: Suggestion, goodness-of-fit?; *thanks, we follow the suggestion*

L217: Please provide the manuscript section number instead; *thanks, we follow the suggestion*

Results:

L222: Important, do they correspond to those points having the lowest Pu inventories in topsoil layers?; *Yes, the subsoil locations that fall below the detection limit show low inventories below 40 Bq m². Please note that we excluded 30% of the subsoil samples that showed the lowest topsoil activities. Hence, for locations of the lowest inventories, no subsoil measurements were carried out. However, to indicate this relationship we add the following sentence: "Those seven samples are all located at positions with $^{239+240}$Pu inventories below the lower reference boundary (40 Bq m^{-2})."*

L225: unclear why you use 'in turn' here?; *we changed the text as follows: "All high-resolution depth profiles (5 cm increments) at erosional sites show a sharp reduction of the $^{239+240}$Pu activity below the plough layer (Fig. 3), while depositional sites show more complex depth distributions."*

L227: Suggestion, reflect; *we changed the text as follows: "[…]with depth that is potentially caused by Pu enrichment processes[…]"*

L232: Suggestion, water and tillage soil redistribution processes?; *thanks, we follow the suggestion*

L232: Sorry; maybe again I miss something here, but isn't there a contradiction between the first and the second sentences here?; *we fully agree that these two sentences are confusing. We simplified the text as follows: "At 14 (of 209) sampling locations, a higher subsoil than topsoil $^{239+240}$Pu activity was found, which points at deposition of $^{239+240}$Pu depleted sediments. The majority of these locations show enriched $^{239+240}$Pu activities in the subsoil (11 of 14).*

L236: Suggestion, induce?; *we changed the word to "cause"*

L239: Unclear what you mean here... Furthermore, I had the impression that you assimilated the tillage depth to 20 cm (2 layers of 10 cm depth) in the above-mentioned text?; *we determined the tillage depth at each sampling location, which was found at an average depth of 23.5 cm. As the model takes 10 cm layers into account, the tillage depth was set to 20 cm in the implementation. We think the information is not critically important why we removed it to avoid confusion.*

L239: Isn't it a bit short here? Why would the enrichment be worse at these 5 locations compared to others? Including those highly enriched locations exceed the methodological maximum of detectable deposition; *As these locations are clearly subject to enrichment processes that cannot be adequately addressed, we think it is better to remove them and interpolate them from the surrounding information. Furthermore, these points were exclusively located near the kettle-hole border which does only exclude small areas. To make this clearer, we changed the text accordingly: "As the enrichment processes inherent to these five locations cannot be corrected, the locations were excluded from the analysis."*

L247: Suggestion, soil redistribution; *thanks, we follow the suggestion*

L248: Seems to be part of the discussion?; *Our motivation to introduce this before the discussion section was to support the reader to understand the step of analysing classes. However, from a manuscript structural perspective this is indeed not correct, which is why we remove the sentence.*

L252: Suggestion, illustrates the good agreement...?; *thanks, we follow the suggestion*

L255: Description of the MEF in the methods; *we think it helps the reader to see the description of the MEF in direct proximity to the numbers. Furthermore, the MEF is rather a standard parameter that might be familiar to the majority of readers. Hence, we would prefer to keep the short description in the results section.*

L261: could you clarify what you mean here?; *we changed the text throughout as follows: "[...]geomorphological dynamics[...]"*

L262: Suggestion, reach; *thanks, we follow the suggestion*

L263: ?; *we changed the text as follows: "Soil erosion at hilltop locations is shown to reach up to 14.9 cm (43 Bq m^{-2} reference; 40 Bq m^{-2} reference: 14.1 cm; 46 Bq m^{-2} reference: 15.6 cm), while deposition can build a colluvium layer with a maximum thickness of 21.5 cm (43 Bq m^{-2} reference; 40 Bq m^{-2} reference: 24.9 cm; 46 Bq m^{-2} reference: 18.6 cm) over the past 53 yr."*

Discussions:

L271: this remains questionable in my opinion (see my general comment), general reviewer comment: Importantly, the advantages of using Pu-239+240 inventories (compared to Cs-137 inventories) for reconstructing soil redistribution between 1964-2016 should be better justified in the text, in my opinion. Of note, analysing Pu-239 and Pu-240 requires time-consuming chemical sample preparation steps that are not required for analysing Cs-137 ('simple' physical measurement). A reason for using Pu isotopes could be that the study area received significant Chernobyl fallout in 1986 (in addition to the global fallout with a peak in 1963-64), which would complicate the temporal reconstruction. However, this is not specifically addressed by the authors (nor supported by their measurement of both Pu-239 and Pu-240, the ratio of which should directly provide the answer?) Of course, there could also be other (good) reasons to use Pu isotopes instead of Cs-137, but their clarification in the text would be appreciated.; *Thanks for the comment and suggested discussion points. We include a section at the beginning of the discussions:*

"4.1 $^{239+240}$Pu methodological benefits and limitations

The use of fallout radionuclides to determine soil redistribution patterns and rates over the past decades has been used in many studies in various study areas around the world (see reviews: Mabit et al., 2014; Alewell et al., 2017; Evrard et al., 2020) and contributed substantially to understand soil degradation processes. However, the most frequently used fallout radionuclide ^{137}Cs faces upcoming limitations (Chernobyl fallout that adds on the global fallout over large parts of Europe and ongoing decay below detection limit of standard measuring devices; also see section 1) in the use as a soil redistribution tracer (Evrard et al., 2020). The fallout radionuclide $^{239+240}$Pu has demonstrated its suitability to determine the recent soil redistribution history (since the 1960s; see review Alewell et al., 2017 and is a potential

alternative for ^{137}Cs as a soil redistribution tracer (Mabit et al., 2013; Alewell et al., 2017). In Europe, where large parts were re-contaminated by ^{137}Cs fallout of the Chernobyl accident (Evangeliou et al., 2016), additional information on the spatial change on the inventory is needed to derive accurate soil redistribution rates. Particularly in the area of the former GDR, almost no information that can be used for a correction on the ^{137}Cs Chernobyl re-contamination are available (Evangeliou et al., 2016). The $^{239+240}$Pu fallout caused by the Chernobyl disaster was very local (approximate radius of 100 km) and has a distinct fingerprint based on the 239Pu/240Pu ratio. While the 240Pu/239Pu ratio of global fallout in the Northern Hemisphere is 0.180±0.014 (Kelley et al., 1999), the 240Pu/239Pu ratio soils that received high Chernobyl fallout is about twice as high (0.408±0.003, determined for soils within the 30 km exclusion zone of the Chernobyl reactor; Muramatsu et al., 2000; Boulyga and Becker, 2002). The 95% interval of confidence and average of the ^{240}Pu/^{239}Pu ratio found in the soil samples of this study were 0.281 and 0.199, respectively. Hence, a relevant $^{239+240}$Pu re-contamination by Chernobyl fallout can be ruled out for the study area. Another limitation for the use of ^{137}Cs as a soil redistribution tracer is the ongoing decay due to short half-life times that has already caused a substantial reduction of the inventory. Due to lower activities, measuring devices of much higher complexity are needed in the future (Evrard et al., 2020). Decay is not an issue for ^{239}Pu and ^{240}Pu as both nuclides have long half-life times that allow for a quasi-unlimited use, however, it needs to be mentioned that sample preparation for $^{239+240}$Pu ICP-MS measurements is much more laborious compared to the standard procedure of physical measurement ^{137}Cs measurements."

L276: OK, I agree with you, but in the real landscapes, maybe the situation is a bit more nuanced, with the redistribution of organo-mineral complexes across landscapes?, *we fully agree and added the following information to the text: "However, it needs to be mentioned that radionuclide associated particles are typically not transported as primary particles but in soil aggregate complexes (Hu and Kuhn, 2014; Hu et al., 2016), which has a pronounced effect on enrichment processes (Wilken et al., 2017b)."*

L281: Suggestion, = enrichment in fine particles containing Pu-239+240?; *we slightly modified the suggestion: "enrichment in fine particles of relatively high $^{239+240}$Pu activity"*

L286: OK but is this reasonable if the max erosion depth is 14.9 cm (previous section) and that radionuclide have been homogenized in the entire tilled layer (~25 cm)?; *Yes, we think this is very likely as these highly eroded sites have a reduction of their inventory down to 12 Bq m^{-2}, which means 28% of their reference inventory (43 Bq m^{-2}).*

L291: Suggestion, flow across?; *thanks done*

L294: Suggestion, was exceeded at 4 sampling locations?; *thanks done*

L299: Suggestion, managed; *thanks done*

L302: Suggestion, both water and tillage erosion processes; *thanks done*

L303: Suggestion, zone/area; *we changed the text to: "zone"*

L304: Could you define this concept at some point in the text?; *We changed the wording to: "geomorphological dynamics"*

L304: Do you mean the limited spatial extent where this process takes place?, *Thanks, we follow the suggestion: "As a result of the small spatial extent where this process takes place, […]"*

L306: Suggestion; an active process?, *we changed the text to "important"*

L308: Suggestion, in?; *thanks, done*

L310: Doesn't it seem a bit low compared to the erosion depths that you estimated at hilltop locations? Which 'peat' (in terms of spatial extent) are you referring to here*?; We refer to the inner kettle hole that is not under arable use. Hence, 1.7 cm (53yr)$^{-1}$ of colluvium is just based on sediments that were exported from the arable land, therefore, solely transported by water. To make this clearer we changed the text as follows: "According to the model run using the reference parameterisation for water erosion, a colluvial layer of 1.7 cm (53 yr)$^{-1}$ would have been developed on top of the peat that has been exported from the arable part of the catchment (see Fig. 1) due to water transport over the past decades. Furthermore, we highlight the inner peat area of the kettle hole in the study area Figure 1.*

L313: In turn, ?; *we changed the text to "In contrast, "*

L314: Suggestion, have been; *thanks, done*

L320: Suggestion, cover; *thanks, done*

L323: Suggestion, is partially mixed; *thanks, done*

L325: Suggestion, the most eroded sites; *thanks done*

L326: Suggestion, is found at 102 cm depth on average?; *thanks, done*

L329: Suggestion, have caused extensive soil redistribution over long periods?; *thanks, done*

L332: Suggestion, reconsidered across a range of contrasted agricultural environments?; *thanks, done*

L337: Suggestion, unfrequent extreme events; *thanks, we followed the suggestion but used the word "infrequent" instead*

L338: Do you mean to connect hillslopes with the kettle hole?; *we change the text as follows: "Only infrequent extreme events exceed the critical runoff quantity to connect the arable hillslopes with the inner peat area of the kettle hole (Fig. 1),[…]"*

L338: Suggestion, lead to; *thanks, done*

L339: Why using plural here (you investigated one catchment?); *thanks, you are right. We changed the text as follows: "Therefore, the study catchment shows a very limited hydrological and sedimentological connectivity between the cultivated area and kettle hole."*

L340: This was already written earlier in the text (although slightly differently), maybe avoid repetitions in the text at this stage; *we restructured the text and removed the redundant information as follows: "This statement is supported by surface runoff and sediment delivery monitoring in the study catchment (2015-2019) that has demonstrated that only very few rainfall events caused runoff and associated sediment delivery in the kettle hole (data not shown). Therefore, the study catchment shows a very limited hydrological and sedimentological connectivity between the cultivated area and kettle hole."*

L343: could you be more specific here?; *we intentionally kept this statement loose to remain the interpretation of potential processes to the reader as we did not specifically investigate on these effects. Therefore, we would prefer to keep the statement as is but provide the reader additional literature:*

L344: Suggestion, impact? Extent? Magnitude?; *thanks, we changed the section title to "4.4 Impact of tillage erosion and scientific attention"*

L345: Do you mean above the tolerable soil loss rates?; *thanks, we reformulated the text as follows: "soil erosion in the study area exceeds the tolerable soil loss rates (according to Schwertmann et al., 1990: 6 Mg ha-1 yr-1 in the study region) and is mainly attributed to tillage erosion (Fig. 6 & 7)."*

L346: Suggestion, efficient or productivist?; *thanks, we changed the text to "productivist"*

L347: Suggestion, consolidation; *thanks, done*

L350: Suggestion, is rather large?; *thanks, done*

L350: Maybe rephrase here to facilitate reading?; *we reformulated the text as follows: "The average field size in the region (Quillow catchment: 22 ha) is rather large that has favoured big farming structures that utilises powerful machinery."*

L351: Suggestion; likely does not receive...?, *we would like to keep the statement more a bit more drastic to underline the need and prefer to keep the wording as is.*

L351: Suggestion, its; *thanks, done*

L353: Wide spread?, *we removed the word "wide spread"*

L356: Maybe rephrase to clarify here; *we restructured the text to improve the reading flow: "Globally, tillage erosion has been recognized as an environmental threat in the hummocky young morainic regions that have shallow soils that are subject to dropping yields at hilltop locations (Canada: Pennock, 2003; Tiessen et al., 2007a; Tiessen et al., 2007b, North America: Li et al., 2007, 2008, Russia: Olson et al., 2002; Belyaev et al., 2005 and Northern Europe: Quine et al., 1994; Heckrath et al., 2005; Wysocka-Czubaszek and Czubaszek, 2014)."*

L358: Of note, this issue was investigated using radionuclide inventories and the SPEROS model in agricultural regions of central France (Chartin et al., 2013; 10.1016/j.catena.2013.06.006). Of note, these authors also demonstrated the dominance of tillage erosion processes (>90% of the total erosion) in these agricultural landscapes...; *thanks, for naming this very interesting paper! We included the reference here and mention the results of the study in the introduction.*

L358: Suggestion, indeed*?; thanks, we removed the filler*

L361: Suggestion, the impacts of tillage erosion may not be as visible as those caused by water erosion?; *thanks, done*

L363: Unclear what you mean here?; *we reformulated the text as follows: "[...]needs scientific consideration and implementation in soil conservation management by policy makers."*

L370: I didn't understand this when reading the previous text... do you mean that there would be some kind of 'sapping' process along the borders of the kettle hole? If so, this should be clarified in the text (here and above) and better underlined when describing Fig.7c/d...; *no there is no kind of 'sapping' process. Tillage forms a geomorphological flat area, what we call the 'kettle hole surrounding flat'. Within this area, hydrological sinks are formed by tillage translocation that provide water retention capacity, which leads to a reduction of the flow velocity and therefore deposition of sediments that were transported by water. To clarify this, we reformulated the text as follows: "Furthermore, tillage erosion has a substantial impact on surface runoff. Tillage forms hydrological depressions at the downslope border between the cultivated field and the kettle hole that limits the hydrological and sedimentological connectivity into the kettle hole and causes deposition of sediments that are transported by water."*

L372: Suggestion, on the catchment hillslopes?; *thanks, done*

L375: Maybe you go too far in terms of extrapolation based on your results here? More than 1 m, I don't remember to have seen that above (you show a max of 17% of the profile truncation, if I understood it well?); *yes, the maximum erosion that was determined by using $^{239+240}$Pu is 0.17 m. However, extreme erosion and deposition of more than 1 m has taken place in the study area, which was detected based on lab analysis (e.g. CaCO3) and soil prospection that clearly show buried fossil topsoil layers deeper than*

1 m. Our main argument is that we detected high erosion rates over the past decades (up to 0.17 m), however, those rates can still not explain the current soil degradation stage (>1 m soil profile truncation and burial). To make it clearer that 1 m of erosion or deposition was not determined using FRNs but soil prospection and lab analysis, we clarify this in the text as follows: "[…]soil degradation patterns determined from soil prospection and chemical analysis that show[…]"

L376: Still, your study area can be described as a highly mechanised agro-ecosystem, right? Maybe you go again a bit too far here?; *we see the point but are still convinced that tillage erosion is not just an issue for mechanised agro-ecosystems. Our results indicate an onset of tillage erosion before the main period of agricultural mechanisation (somewhere around the 1960th). We try to rephrase the statement more nuanced: "This indicates that tillage erosion might not be a process that exclusively takes place in highly mechanised agro-ecosystems but is potentially causing pronounced soil degradation in smallholder farming structures."*

L378: Again, I would be more nuanced here as well...; *we agree and changed the text accordingly: "Our results clearly underline that tillage erosion is a critically underrepresented soil degradation process that can be the main soil redistribution driver on catchment scale."*