Answer to Reviewer#2,

General comments

Overall, the study focuses on a relevant topic and presents interesting results and is therefore definitely worth publishing after some modifications and improvements to the current manuscript have been made. This manuscript represents valuable results, and a good approximation to better understand the differences and similarities between different methods to calculate soil redistribution rates and its relationship with some physical properties and soil nutrients.

The study includes interesting findings first reported in these areas of Iran and fits within SOIL scopes. However, in its current state, I think it requires quite a bit more work in terms of rearranging and editing before it is ready for publication. Overall, the study focuses on a relevant topic and presents interesting, results and is therefore worth publishing after some major modifications and improvements to the current manuscript have been made.

Thank you for your appreciation and your positive feedback. We highly appreciate this.

First, I think authors should clarify some of the previous reviewer questions. To avoid some repetition, I have been more focused on specific details. Apart from the general comments about each section, I have included some comments about the figures (14) and the text (17). An additional major issue I see in this manuscript is the enormous number of references included. If I am not wrong, there are more than 100 references. I think it is more than needed for a novel study.

Thank you for all your work. Please see our detailed answer to reviewer 1 and to reviewer 3. We totally agree that 100 references are too many. We thus deleted those, we think, were not absolutely necessary.

Introduction

I think you need to emphasise this work's aims at the end of this section, the authors present an interesting study, but sometimes it is easy to get confused because the aim of the manuscript is repeated trough the introduction section. Thus, it could be useful to be more specific at the end of this section and reorder or rewrite some parts of the introduction.

As suggested, we restructured the introduction in a way that the study site and its related challenges have moved to the last paragraph of the introduction.

Results and discussion

In this section, I would encourage the authors to synthesise the results and focus only on the results. Sometimes it seems that the discussion is a little bit mixed with the results.

Furthermore, I think more than 2800 words for the discussion section is excessive. In this section, authors tend to repeat most of the results, and there is an excessive number of comparisons with other studies. I think the manuscript could be reduced here. This statement is quite clear because authors have included more than 100 references, what it is just disproportionate. Don't you think? For example, 50-60 references are considered a high number of references, still acceptable but high.

As suggested, we tried to separate the results and discussion as much as possible. In total, we reduced the section by 170 words. We agree with Reviewer 2 about the number of the references being too many as well; therefore, we deleted less relevant references.

Conclusions

I think that the text could be improved here (to avoid restricting it to a repetition of what was written before). The first 6 lines did not include a conclusion and just repeated previous parts of the manuscript. After a very rapid summary of the main results, you could stress the potential novel avenues for research in the future.

As suggested by the Reviewer # 2, we added the potential novel avenues for research in the future and rewrote the conclusion as follows (the number of words reduced from 717 to 589):

"Forests and forest soils store carbon and therefore play a decisive role in mitigating climate change impacts. In Iran, over the past decades, a rapidly growing population has induced an increasing demand for food, so one of the most rapid land-use changes, i.e. conversion of land under natural vegetation into arable lands, has been occurring. The present study was undertaken to quantify the impact of deforestation on soil loss using fallout radionuclides and soil physicochemical properties.

The deposition of the ^{137}Cs fallout from different sources (Chernobyl fallout vs. global fallout) could be determined via $^{239+240}Pu$ isotopes since Pu isotopes, as confirmed by $^{240}Pu/^{239}Pu$ atom ratios, originated exclusively from the global fallout. From the $^{137}Cs/^{239+240}Pu$ ratio, it was evident that half of the ^{137}Cs found in the site was Chernobyl-derived. The mean reference inventory of ^{137}Cs at 6152±1266 Bq m^{-2} was higher than previous reports in different parts of Iran. The reasons behind that can be the site being closer to the Chernobyl site than other studied sites in Iran, a higher mean annual precipitation, and relatively high rainfall after the Chernobyl incident. The mean reference inventories of $^{210}Pb_{ex}$ estimated at 6079±1511 Bq m^{-2} was in accord with the reported value in the central part of Iran. The mean reference inventory of $^{239+240}Pu$ at 135 ±31 Bq m^{-2} was higher than values reported in other parts of the globe, which might be attributed to high initial bomb-derived deposition in the study site during 1953–1964. Nevertheless, measurements from other parts of the country are required to confirm the hypothesis of a high initial bomb-derived Pu fallout. $^{239+240}Pu$ proved to be a valuable tool to quantify the relative contribution of Chernobyl-derived ^{137}Cs in contaminated areas, which is a prerequisite for applying conversion models with the ^{137}Cs technique.

Both ^{137}Cs and $^{210}Pb_{ex}$ radionuclides indicated that deforestation has increased annual soil loss by about five times. Notable is that the values obtained by both techniques in each land-use were consistent. Moderately higher net soil erosion rates were estimated by $^{210}Pb_{ex}$ at both sites. $^{210}Pb_{ex}$ is more sensitive to recent erosion events (past 20 years). However, the uncertainties associated with this FRN were high. Thus, the conclusion that erosion increased based on these results cannot be drawn and needs further investigation.

As a result of deforestation, OM content, which is the most important soil quality indicator, has declined significantly at the vineyard hillslope, leading to a carbon stock loss of about 10.1 and 4.2 Mg ha^{-1} in topsoil and subsoil, respectively. Furthermore, the land-use change significantly weakened aggregate stability as the PS approximately decreased by half in the vineyard. PS is identified to be a powerful tool to study soil aggregate stability and soil quality with low costs. Thus, converting forests to vineyards resulted in a significant deterioration in soil quality which will likely impact the soil productivity and food security.

All in all, the results of the present study revealed that deforestation and converting natural vegetation to cropland prompted soil degradation and erosion, deteriorating physicochemical properties of the soil. However, further measurements of $^{239+240}Pu$ in the region are still required to understand the spatial variability of relative contribution of Chernobyl-derived ^{137}Cs. This would assist with producing more

precise maps of spatial distribution of Chernobyl-derived ^{137}Cs input. Further investigations are also necessary to verify if PS is a suitable soil quality indicator in other areas. Furthermore, in order to better understand the impact of deforestation on soil properties and soil loss, it is suggested that they be monitored at different time windows after deforestation."

497 you could specify the location without using brackets, please rewrite the sentence.

The sentence has been modified as follows:

"The reasons behind that can be the site being closer to the Chernobyl site than other studied sites in Iran, a higher mean annual precipitation, and relatively high rainfall after the Chernobyl incident."

496-500 Following table 1, the study pursued in Golestan Province with similar mean annual precipitation (MAP), showed significantly lower values than your study. Do authors think that all the difference could be due to the location even if both are located in the northern part of Iran?

The distance between Golestan (located in Northern east of Iran) and our site (in Northern west of Iran) is around 850 km which is almost half of the distance between our study site and Chernobyl (which is 2000 km). Also, we added two new references i.e. the Gharibreza et al. (2021) and Vahabi-Moghaddam and Khoshbinfar (2012) whose study sites are located in the north of Iran and whose results are entirely compatible with ours (see below).

Table 1: 137Cs baseline inventory and mean annual precipitation (MAP) in undisturbed locations in different parts of Iran (all values were decay corrected to 1/10/2016).

Location	Mean Annual Precipitation (mm)	137Cs inventory at reference site (Bq m-2)	Reference
Kouhin, centre of Iran	330	1956 ± 107	Khodadadi et al. (2018)
Aghemam Catchment, North-East of Iran	482	2714	Seyedalipour et al. (2014)
Rimeleh catchment, west of Iran	696	1544	Kalhor (1998); Matinfar et al. (2013)

Chaharmahal and Bakhtiari Province, West-South of Iran	600	1730± 32	Afshar et al. (2010)
Gorgan River watershed, North of Iran	562	2178	Shahoei and Rafahi (1999)
Golestan Province, North of Iran	700-1000	3840-4062	Gharibreza at al. (2020)
	1000	3570 -5270	Vahabi-Moghaddam and Khoshbinfar (2012)
Gilan Province, North of Iran	1209	6180	Gharibreza et al. (2021)
Zarivar lake watershed, North-West of Iran	991	6152±1266	This study

Figures

Fig. 1 Subcatchment names are blurred and mixed with the division lines. I think you could create a different type of labels such as pin flags, for example.

Sorry for this, visibility has improved, and the names have been changed accordingly.

The scale could be smaller, and a black-white style could fit better.

Done, thank you.

Instead of displaying the lake on the magnified Kurdistan province map, you could display the catchment limits.

We added the catchment as suggested by the reviewer (see below).

Streams or rivers. These terms are pretty much interchangeable, but according to your scale, you have a stream with a length of 2000Km.

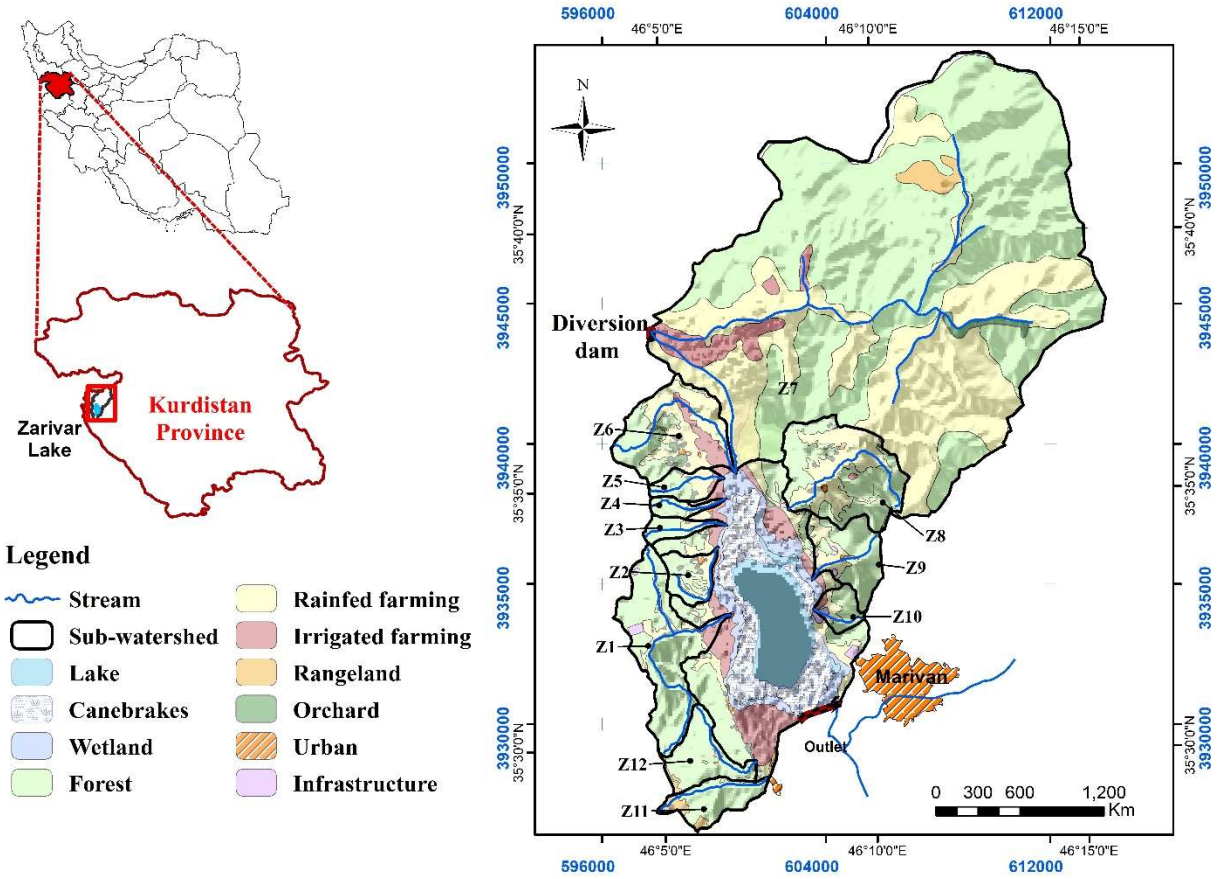


Figure 1: The location of the Zarivar Lake watershed in Kurdistan Province, Iran.

It will definitely help to visualise your study if you could include some pictures of the forest and vineyards.

Thanks for the suggestion! Pictures were added to the Fig. 2 (see below).

Fig. 2 At least in my figure, the legend does not fit with the symbols. Furthermore, it is quite difficult to discern the separation between points. When plotting in Surfer (I think you used this software) the colours suffer a small colour change. Please try to modify your legend accordingly.

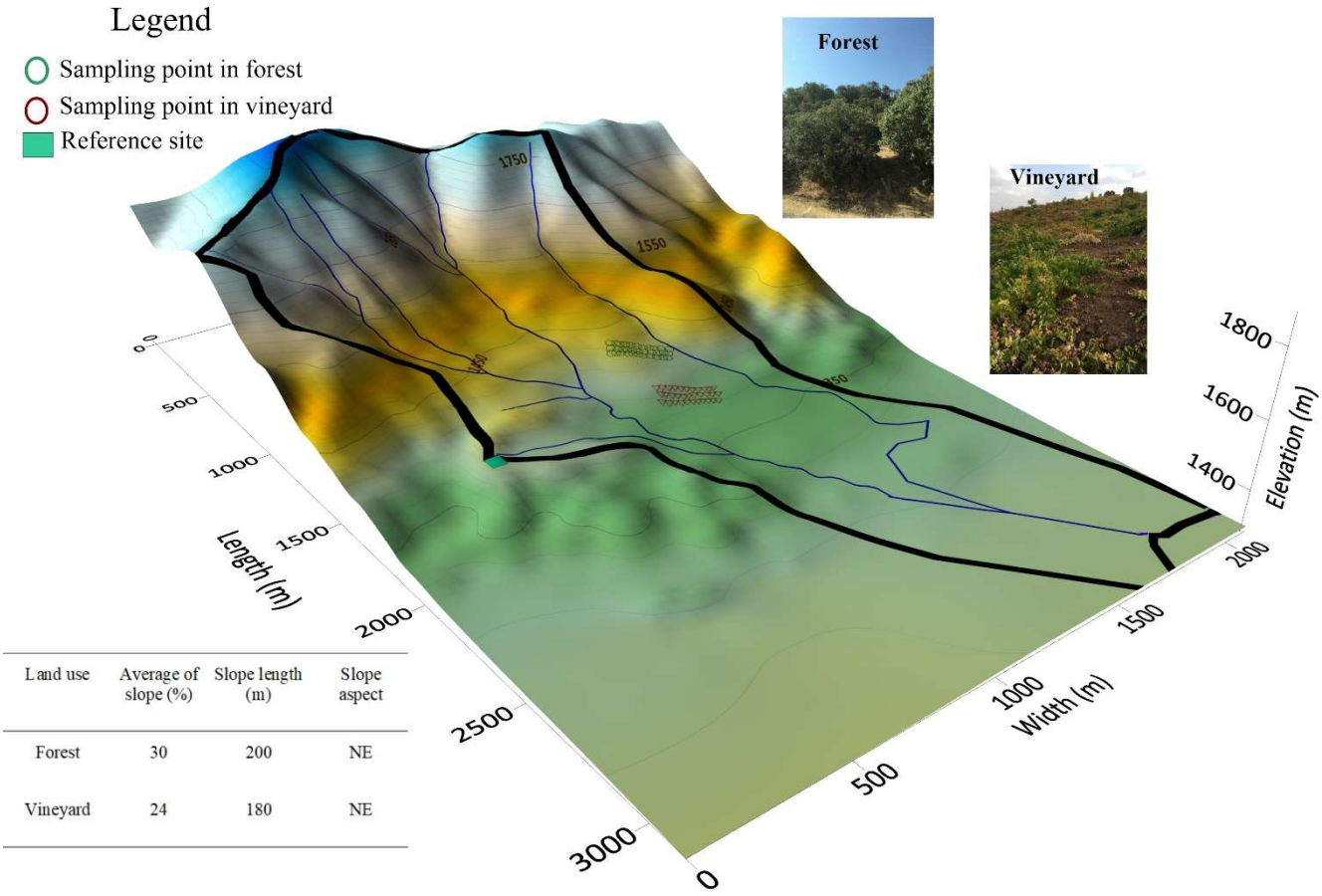
Is it true that your stream/river ends before reaching the outlet?

The height axis was not specified, and the meters cannot be seeing. If it is difficult to modify this in the software used, you could try to modify it by using additional graphical software.

Sorry for these and thanks a lot for these suggestions; we have considered all proposed modifications (see below).

The colour legend about the height is not specified. However, it would be nice to see the land use map over the DEM. It can be done in Surfer.

Since the land-use has already been shown in fig 1, we decided not to add to the second map as well. Hope you agree.



Land use	Average of slope (%)	Slope length (m)	Slope aspect
Forest	30	200	NE
Vineyard	24	180	NE

Figure 2: The location of the reference site and the study hillslopes at Z3 sub-watershed.

Fig. 5 I think you should use the same colour scale for both maps. Thus, you can easily compare them.

Thanks! The legend has been modified (see below).

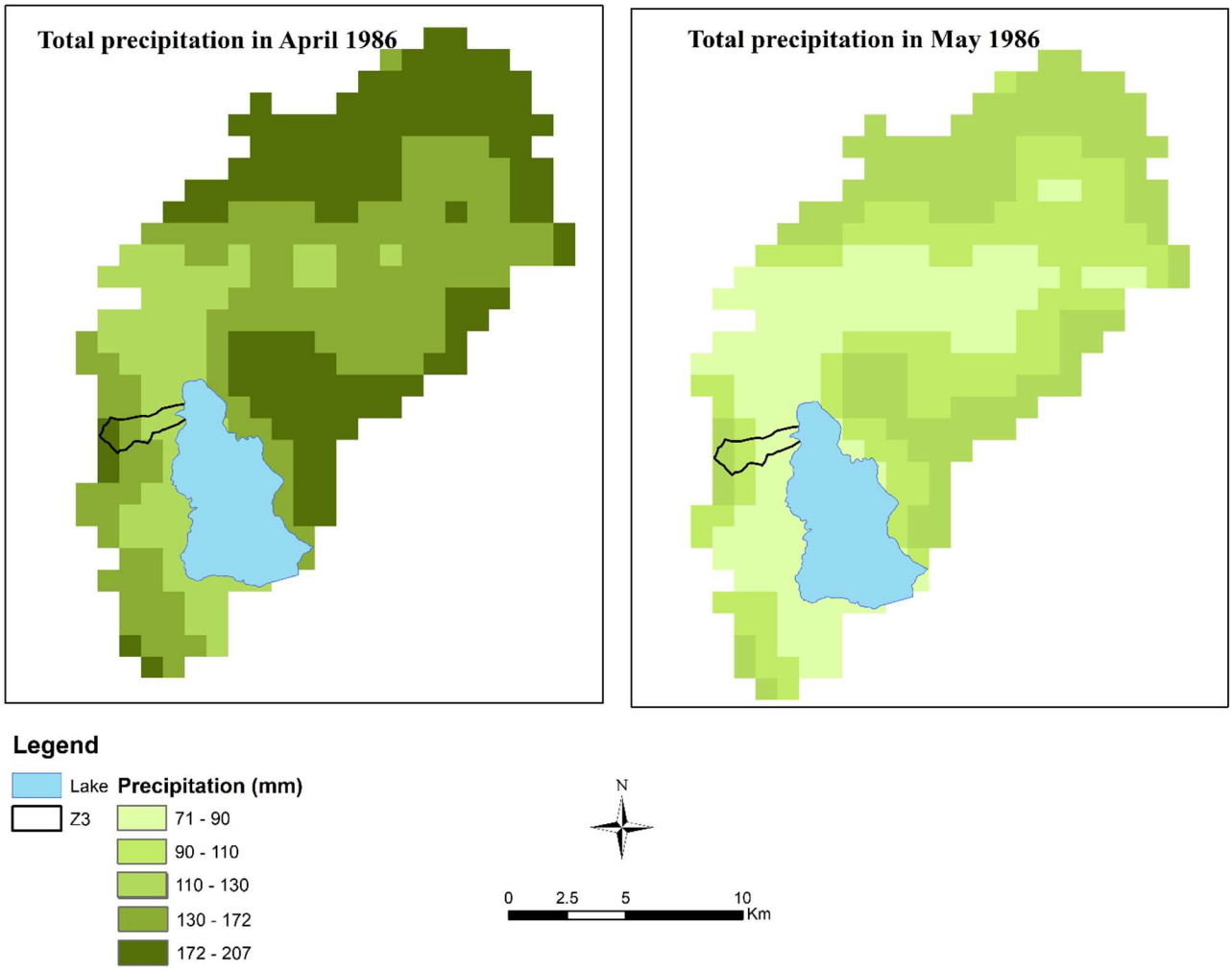


Figure 5: Total precipitation in April and May 1986 (from CHELSA dataset; Climatologies at high resolution for the earth's land surface areas).

Fig. 6 What are the green dots? Please show it also in the legend.

They have been added to the legend (see below).

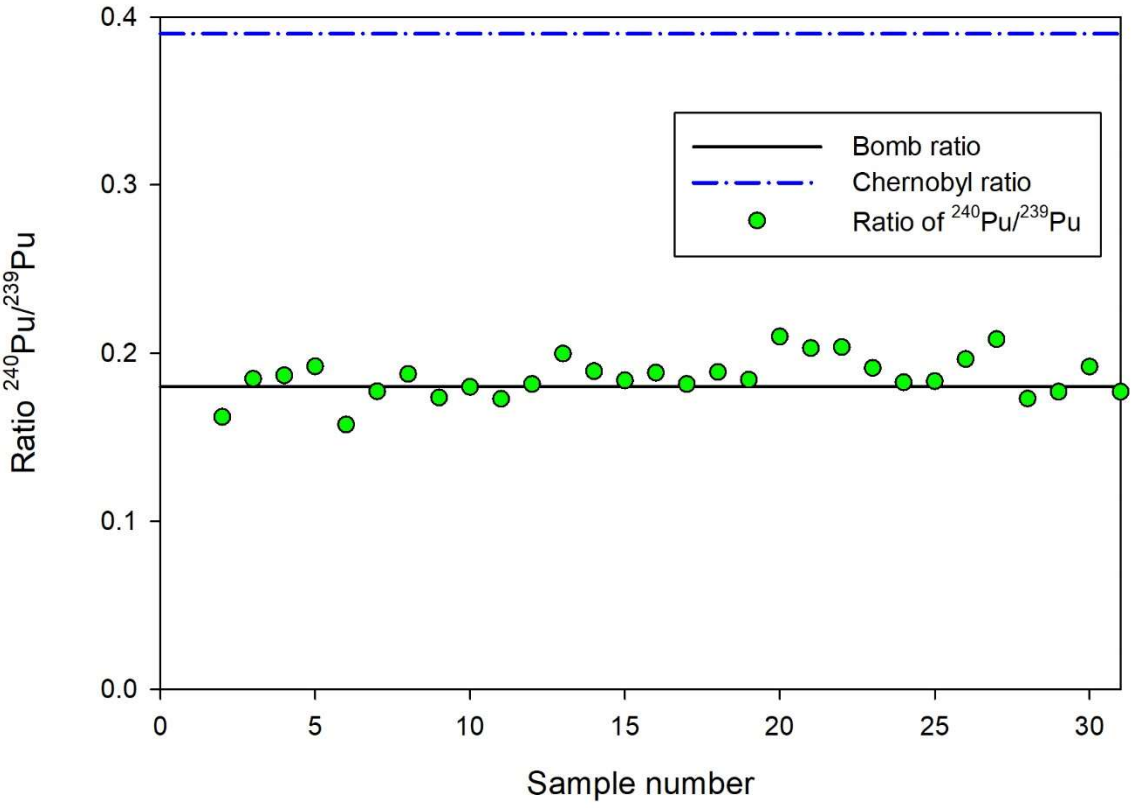


Figure 6: Ratio of $^{240}Pu/^{239}Pu$ of samples at reference site and the forested hillslope.

Fig. 7 It is already nice, but you could improve by giving the equation the colour f the lines. However, do it carefully because maybe the green colour is too light to be correctly visualised.

As suggested by Reviewer #2, the color has been changed in the figure.

Fig. 8 A little bit of colour here it would be nice.

The colors have been altered (see below).

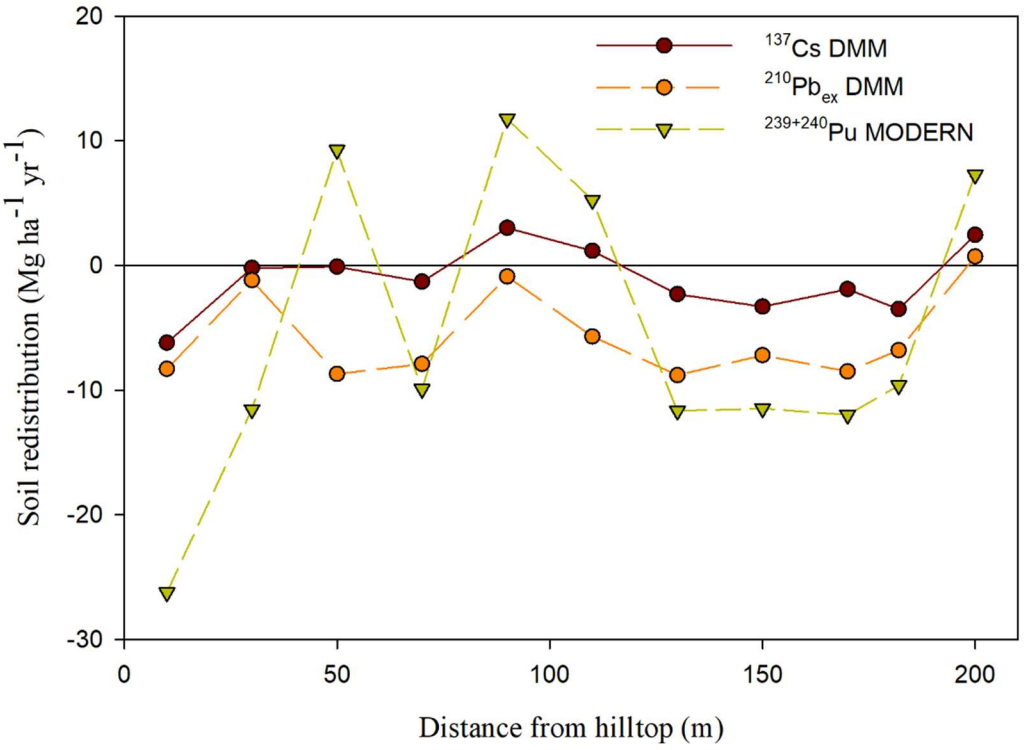


Figure 8: FRNs derived soil redistribution rates in a forested transect using MODERN and Diffusion and Migration model (DMM) (negative values indicate erosion, whereas positive values indicate deposition).

Fig. 9 Same here, but just as a piece of advice.

Thanks, the color of FRNs' depth distributions at the vineyard hillslope has been different from those of the forest site (see below).

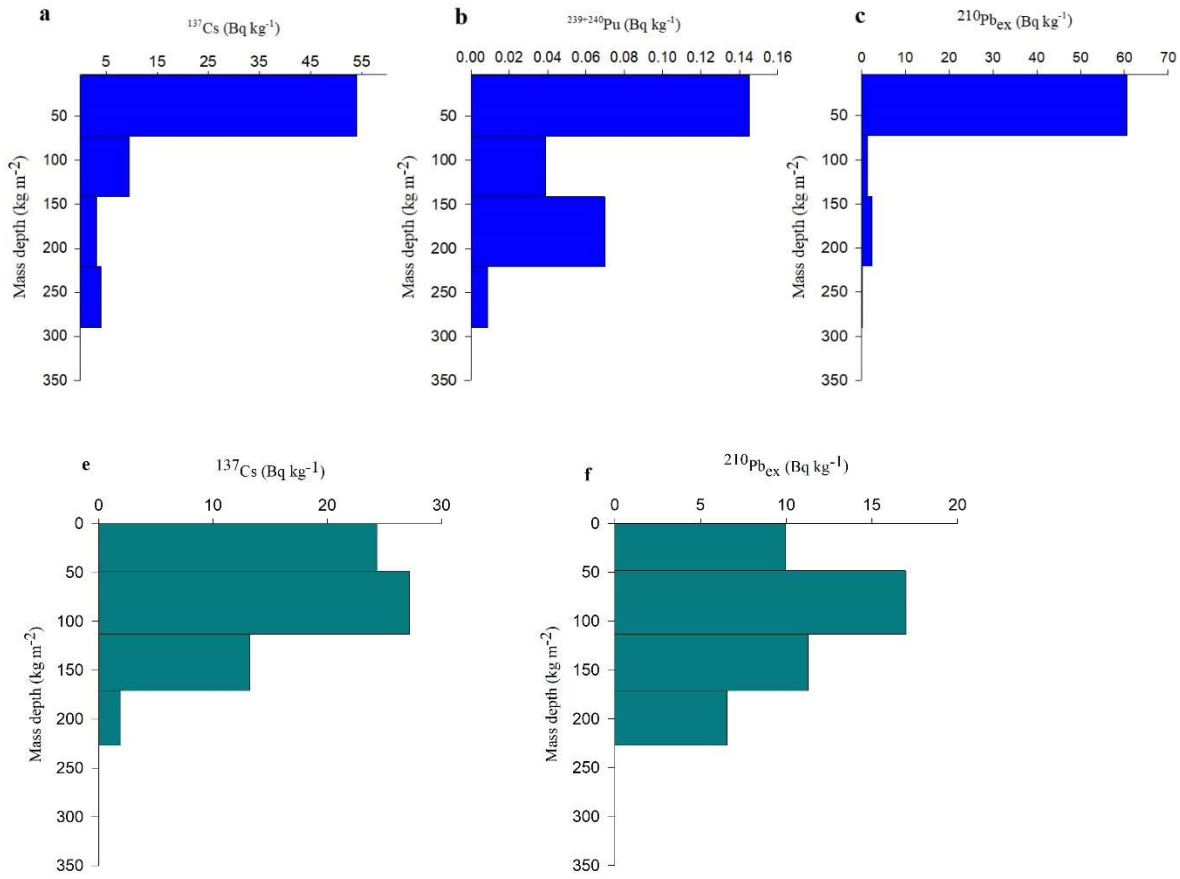


Figure 9: Depth distribution of ^{137}Cs (a), ^{210}Pb$_{ex}$ (b) and $^{239+240}$Pu (c) in an erosional site in forested hillslope and ^{137}Cs (e) and ^{210}Pb$_{ex}$ (f) at an erosional site in vineyard hillslope.

Specific comments and technical corrections

Apart from the general comments, I have added some specific comments about the text and the figures. The authors might find them useful to improve their manuscript. "In my opinion", the inclusion of these points would significantly increase the audience interest of this manuscript that presents an interesting study. Here I have attached some typing error or minor suggestions to improve the text:

Thanks so much for your time and effort to improve this manuscript. Much appreciated.

Line 38-39 I think this could better fit. "The transition/conversion from natural covers to cultivated lands have increased drastically."

It has been modified in the MS.

Line 40 "more rapid than ever before" I think this is too much to state. Maybe something like this "the las century/or centuries" could do the job.

As suggested, it has been added to MS.

Line 55 "and the subsequent increase in soil erosion."

This has been revised in the MS.

Line 55-56 This statement is too general. In the northern part of the Mediterranean region, especially in mountain agroecosystems, recent land-use changes produced just the inverse trend due to the land abandonment (that it is also a land use change). You could find many recent manuscripts using 137Cs and also 210Pb techniques that describe the issue, especially from Spanish an Italian catchments.

Thanks so much; the sentence has been removed.

Line 63, 65, 69 just as a recommendation, I would prefer if you don't use the words "e.g." that much.

They have been corrected in the MS.

Line 100 Did the authors missed a reference?

Thank you! The reference (i.e. Auerswald, 1995) has been added.

Line 104 runoff?

We corrected this mistake in the MS.

Line 111 "deforestation on and soil". Could it be mistyped?

Thanks! It has been corrected accordingly.

Line 120 Figure two shows nothing related to 12 sub-watersheds. I think you should rewrite this paragraph to make it clearer for the readership. It is not very clear.

The sentence has been rewritten as follows: “The watershed was sub-divided into 12 sub-watersheds named Z1 to Z12 (Fig. 1); one of these watersheds called “Z3” was selected for this study.”

Line 121 It would be nice to include the data of max and min altitude here. You have graphically included in the figure, but it has not been specified.

They have been added to the text accordingly (see below).

“The area of the sub-watershed is about 2.97 Km2 with an average altitude of 1518 m a.s.l. (ranging from 1292 to 1876 m a.s.l.) and the landscape topography ranges from gentle to very steep slopes.”

Line 140 Besides,?

As suggested by Reviewer, it has been corrected in the MS.

Line 143-15 A fragment could be missing. For what have they been constructed? I think it is obvious, but it would be nice to specify it; thus, making your point clearer to the readership.

The reason has been added as follows: “However, conservation measures like building terraces and check dams have been taken in some parts of the watershed to mitigate sediment entering the lake during the last decade”

Line 150 Keep the same style. Here you've used italics.

It has been corrected in the MS.

Line 247 This is an important part of the work. Thus, further description is needed.

We added a clearer description: “At our study site, the average atomic ratio of 240Pu/239Pu was 0.184 ± 0.020 ranging from 0.121 to 0.262 (Fig. 6). In addition, to determine the proportion of the 137Cs Chernobyl input at our study site, the mean activity ratio of 137Cs/239+240Pu from global originated fallout was employed using the value reported by Hodge et al. (1996) at 38.4 (as of 1 July 1994) after values being decay-corrected to 1.10.2016, this factor reduced to 22.9. Following this approach, the global derived 137Cs inventory should correspond to 22.9 multiplied by the 239+240Pu reference inventory. The Chernobyl 137Cs was calculated by subtracting the global inventory contribution from the reference site inventories (which includes both global and Chernobyl fallout).”

Line 285 It would be nice to see a correlation matrix between all the properties.

It does not seem valid since the number of samples is very limited (six and seven points in the vineyard and forested hillslope, respectively).

Line 323 You cite a strong study about it, but you could also include the correlation of the data presented in Table 1. It will be only around 0.5 but still could support your discussion.

Thanks, the correlation has been added. Also, newly added references have been considered (see below and table 1 shown above).

“Using data in Table 1, also was observed a significant correlation between mean reference inventories of ^{137}Cs and MAPs ($p<0.01$, $y = 5.25x - 500.02$; $r^2 \sim 0.72$; y and x are ^{137}Cs inventory and MAP, respectively), which reinforced this hypothesis.”