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Interactive comment on "Decision support for the selection of reference sites using ^{137}Cs as soil erosion tracer" *by* Laura Arata et al.

Anonymous Referee #1

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In this paper the authors explored an important issue in the application of the 137Cs technique that relates to the choice of a reference site. They proposed a decision support tool (CheSS) to check the suitability of a reference site using repeated measurements of 137Cs undertaken in 2013 and 2015 on the same sites and measurements of 239+240Pu carried out in 2015. The basic assumption is that suitable reference sites are expected to present no significant temporal variation in their decay corrected 137Cs depth profiles. The authors individuated four main causes of possible variation in the inventory. These are (1) small scale variability connected to the non-homogeneus fallout (see areas affected by Chernobyl), (2) signs of erosion and/or deposition, (3) artefacts due to sampling and measurements, (4) turbation processes. The authors screened their six reference sites in the Urseren Valley (Switzerland) based on this assumption and tried to individuate the suitable reference site. The paper seems to me very in-

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terested and I think it should be published but some more details need to be added and/or discussed in this version.

Specific comments Introduction – The authors explain briefly the basic assumptions of the 137Cs with the help of Fig. 1. I agree with the explainations reported in the text but I think Figure 1 is a little bit misleading for people that are not familiar with the technique. In fact, what they depict as 'reference site (R)' is a valley bottom and, as is, it can be a depositional site. Also, what they depict as 'depositional site (D)' is a foot-slope and it may not necessarily be a 'depression' where deposition occurs. I suggest to redraw this figure in a more proper way (see my example below)

Fig. 1 (modified)

2.1 Repeated sampling strategy and calculation of inventories This is a very important point. More work must be done to establish how long the time period between two sampling campaigns should be. This depends on the 137Cs inventory of the reference site and on its spatial variability. If the inventory is low, it is difficult to understand if the difference between the two sampling campaigns should be attributed to decay or to erosion and/or deposition or to the detector efficiency. In this case, a period of at least 10-15 years could be necessary. If the inventory is high and it is affected by the Chernobyl fallout, we could expect that the small scale spatial variability and the temporal variability are of the same order of magnitude and it is difficult to distinguish the relative contributions. Something like that is suggested by the data that the authors show in their Fig. 6. The inventory provided in 2015 are all higher than those obtained two years before (in 2013) with the only exception of Ref 6. This is not unexpected because it is not possible to relocate exactly the same sampling points. Clearly, more samples are necessary in this case. But also, a time period of two years between two sampling campaigns could not be enough. The authors can add some comments here.

Node 2: No significant temporal variation of the 137Cs depth profile I agree with the test related to the total inventory as explained in Node 1. However, I found node 2 too severe. I agree that the shape of the reference profile is important but, I think the test should be done on the entire profile not on the single layers. In many years of experience, I have never seen two profiles collected in the same site being identical. Maybe a practicle example can clarify my thoughts. Below there are 3 potential reference profiles characterised by the same total inventory (2510 Bq m-2), so they passed Node 1. They can be fitted by the same exponential model (same shape parameter h0 = 70 kg m-2 and same surface concentration A0 = 35 Bq kg-1). The values of cesium activity and mass depth for each layer are reported below.

Figure (My example)

Using the Sutherland range as a test (see suggestions in Node 2), in 5 cases out of 10 (see my values in red) the CV is greater than 35% (which is the upper limit suggested by Sutherland). If I have understood well, this result would suggest that the site where these profiles have been obtained is not suitable as reference site. I do not think I can agree with that because they show the same exponential decline with depth, and the difference between each single layer can be attributed to other factors (the authors mentioned some of the other causes later in the paper). On the contrary, if we use a t-test or other statistical tests to compare mean and variance of these three profiles, I may be wrong, but I did not find any statistical difference. I think the authors should think about it and add some comments.

There is another limitation in the application of this procedure suggested by the authors. In my example I have considered the same value of mass depth increment for the 3 profiles. This is an ideal case. In reality, due to differences in soil type, land use, presence of stones etc., it is difficult to obtain equal values of mass depth for the corresponding layers of different profiles. This makes this comparison not possible. In the end, I find more useful to check the shape of the entire profile.

Node 4 - Signs of disturbance associated with erosion and deposition processes I agree with the explaination in the text but, Figure 3 shows only the case where the

137Cs profile is perfectly exponential. In many places, profiles obtained in reference sites show a peak below the surface due to migration processes downward. In this case, the profile shown in figure 3b can be an undisturbed reference profile and, consequently, sheet erosion and deposition processes modify the shape accordingly. I suggest to improve their figure 3 considering both the possible cases (see my example below).

Fig. 3 (modified)

Page 7 – Line 21-22 – The authors say 'If information on the depth distribution of another FRN is available, this might provide a reliable confirmation'. I agree with this statement, but an example is necessary. The use of 210Pbex proved to be very effective in combination with or in alternative to 137Cs. In fact, good relationships exist between the results obtained with 137Cs and 210Pbex. I am sure the authors want to add some comments here maybe recalling some of the works done in this field (see for example Porto et al., 2006; 2013).

Porto P., Walling D.E., Callegari G. and Catona F. (2006). Using fallout lead-210 measurements to estimate soil erosion in three small catchments in Southern Italy. Water, air and soil pollution: focus 6, 657-667 Porto P., Walling D.E., Callegari G. (2013). Using 137Cs and 210Pbex measurements to investigate the sediment budget of a small forested catchment in Southern Italy. Hydrological Processes 27(6), 795-806.

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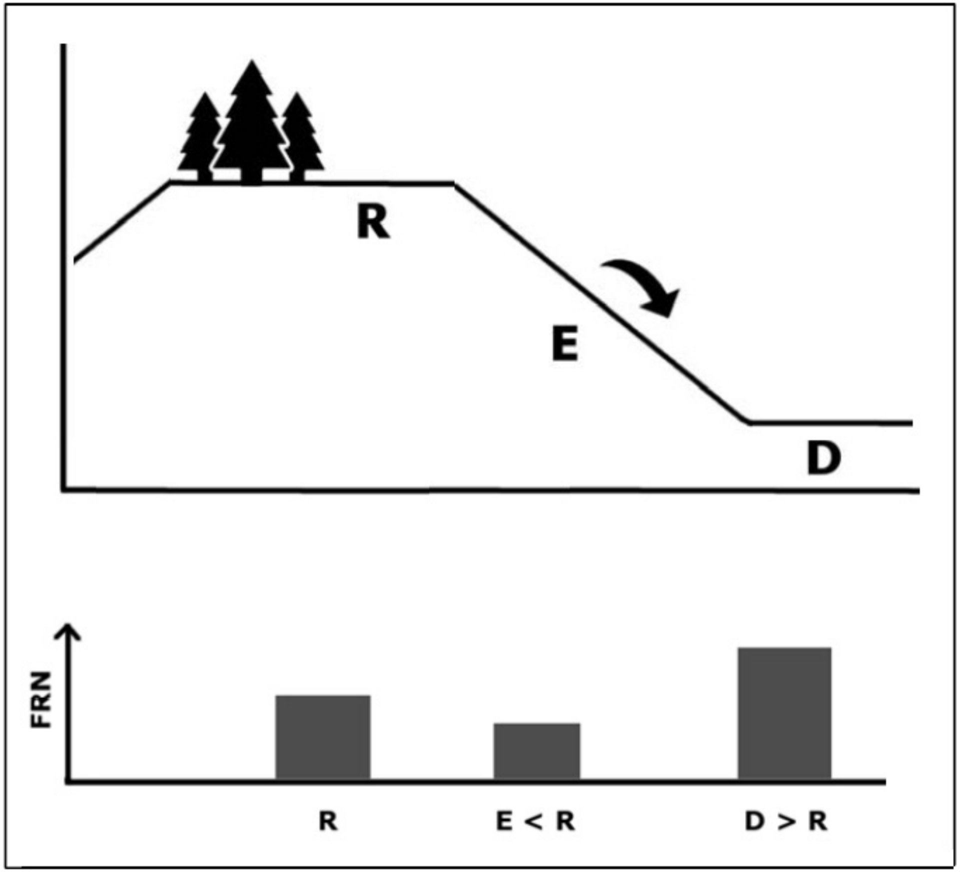

Fig. 1. Fig. 1 (modified)

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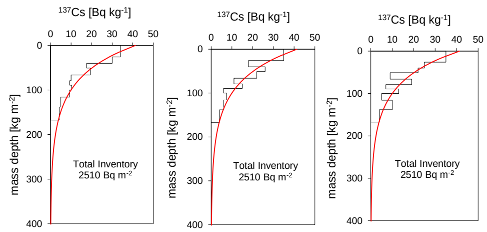

Profile 1 ^{137}Cs (Bq kg^{-1})	Profile 2 ^{137}Cs (Bq kg^{-1})	Profile 3 ^{137}Cs (Bq kg^{-1})	Mass depth (kg m^{-2})	μ	σ	CV (%)
34.0	35.0	35.0	25.9	34.7	0.6	1.7
30.0	18.0	25.0	40.1	24.3	6.0	24.8
17.6	26.0	22.0	50.7	21.9	4.2	19.2
19.4	22.0	9.0	66.3	16.8	6.9	40.9
10.0	11.0	19.0	79.0	13.3	4.9	37.0
9.3	15.0	7.0	89.2	10.4	4.1	39.4
10.2	6.0	13.0	100.0	9.7	3.5	36.2
9.3	7.4	5.1	115.8	7.3	2.1	29.1
5.0	6.1	10.0	138.2	7.0	2.6	37.4
4.2	4.0	4.0	167.4	4.1	0.1	3.2

Fig. 2. Figure (my example)

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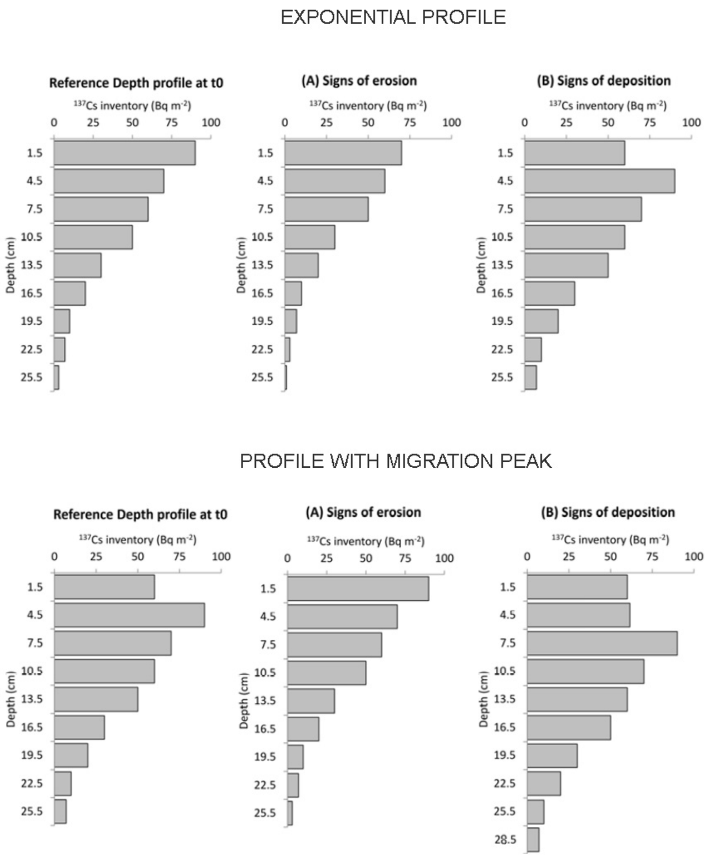

Fig. 3. Fig. 3 (modified)

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