Dear Anonymous Referee #2

We would like to thank you for reading our manuscript and the helpful comments and suggestions, and for pointing out some unclarities. These comments will help us to improve the manuscript. We respond to the individual comments in blue font below.

This study used hydrological measurement network consisting of 14 small 60 runoff plots (1 m x 3 m) across the 20 ha Studibach catchment in the Alptal, Switzerland to analyze the occurrence of OF and TIF, their controlling factors and threshold. One of the major concerns is that at plot-scale, soil properties mainly governs the runoff dynamics, however, this study didn't discuss role of soil characteristics (texture, hydraulic conductivity and parameters of soil water retention curve) in explaining variation of OF and TIF.

> Thank you for this remark. The entire catchment is underlain by gleysols and flysch bedrock. Therefore, we don't expect large scale or systematic differences in the soil properties due to differences in geology.
>
> One of the main reasons that we didn't focus much on soil properties is that our study aimed to see how site characteristics that can easily be determined across a catchment, influence OF and TIF. Slope and vegetation are two of the main factors affecting the soil properties (considering the similarity in geology, climate and age across the catchment). Therefore, we would expect a large part of the potential effect of differences in soil properties to be included in the relations with slope, TWI or vegetation. Previous studies have shown that groundwater levels and vegetation in the catchment are both highly related to the topographic position (e.g., Rinderer et al., 2014), and therefore we would expect soil properties to also be (at least partly) related to topographic position and vegetation.
>
> Nevertheless, we have determined the soil properties based on soil cores (Hyprop method), and the saturated hydraulic conductivity (K_{sat}) of the surface soil based on double ring infiltrometer measurements. However, the number of measurements is small (1 per plot) and the variability is relatively large (in part due to the high organic carbon content for some cores). We think that a large part of the observed variation in soil properties would also be observed if we had taken multiple samples per plot (but don't have the data to show this).We don't see any systematic variation in the soil properties with vegetation (Tables 1 and 2) and only the carbon content (based on the loss on ignition) and the porosity (based for a soil core) are weakly related to TWI (Table 2). Note that the carbon content and porosity were highly correlated themselves (r_s= 0.95; p = 8.2 x 10^{-7}).
>
> We, nevertheless, calculated the Spearman rank correlation (r_s) between the runoff ratios and the soil properties. Table 3 shows for how many events these correlations were statistically significant ($p<0.1$). Overall, the correlations are very low, significant for only a few events, and that the direct relationship is often not consistent from event to event. The exception is the relation between clay content at 10-15 cm and the runoff ratio for OF which was significant for 11 of the 27 events. This can largely be explained by the low clay content but high silt content for two samples (Figure 1), one from a plot located in the forest and one from a plot in a wetland. Both plots have a high moss cover and frequently produced OF, leading to the negative relation between the runoff ratio for OF and clay content for some events, particularly events that did

not produce a lot of OF at the majority of plots. We think that this result is a spurious correlation because the two samples have a low clay content but high silt content. It is well possible that the silt content in these samples is higher than expected based on the other samples because they did not completely disaggregate (leading to a measurement error and overestimation of the silt content), or because they may fall on different sides of the boundary between silt and clay. The two plots did not have an abnormal clay content at 2-7 cm and had, as explained in the paper, high OF ratios for different reasons. For the forested plot, OF occurred through or below the moss as biomat flow due to hydrophobicity of the underlying soil when it was dry and in the wetland OF occurred frequently due to the low storage capacity and frequent saturation, as well as return flow.

We will add some discussion on the correlations with the soil properties to the revised manuscript and add a table (similar to Tables 1 and 3 in this response), to the supplementary material.

Table 1: Average values and range (min-max) for the soil properties for forested and grassland plots, as well as the number of measurements für each property (n). Note that we grouped the plots in the forest and clearings and the plots in the grasslands and wetlands for this analysis because of the small number of samples (i.e., low n).

	Depth (cm)	**Forest and Clearing**			**Grassland and wetlands**		
		Mean	**Range**	**n**	**Mean**	**Range**	**n**
Porosity (%)	2-7	83	78-94	9	84	73-92	3
	10-15	78	67-94	8	75	52-91	4
Water content at field capacity (%)	2-7	54	33-75	9	69	65-73	3
	10-15	51	41-78	8	64	49-73	4
Water content at wilting point (%)	2-7	30	20-43	9	28	16-37	3
	10-15	31	15-52	8	30	20-34	4
Drainable porosity (%)	2-7	22	8-42	9	11	8-17	3
	10-15	19	4-35	8	24	1-68	4
Carbon content (%)	2-7	28	19-69	8	43	32-54	2
	10-15	22	11-48	8	21	3-43	4
Sand content (%)	2-7	11	6-22	7	25	-	1
	10-15	14	6-28	6	20	18-21	2
Silt content (%)	2-7	38	31-44	7	40	-	1
	10-15	35	32-55	6	53	41-66	2
Clay content (%)	2-7	52	47-57	7	35	-	1
	10-15	52	18-58	6	27	15-39	2
Bulk density (g/cm^3)	2-7	0.5	0.15-0.57	9	0.52	0.21-0.78	4
	10-15	0.6	0.16-0.86	8	0.57	0.23-1.27	5
K_{sat} (mm/h)		122	8-320	6	345	-	1
Depth A (cm)		17	10-20	9	12	5-15	5
Depth B (cm)		35	30-40	9	37.2	31-42	5

Table 2: Spearman rank correlation (r_s) between the soil properties measured at 10-15 cm depth and the topographic wetness index (TWI) and vegetation (ordered as in the manuscript: 0: forest, 1: clearing, 2: grassland, 3: wetland). Statistically significant correlations ($p<0.1$) are indicated in bold font. The number of data points used for the correlation is given in parentheses after the soil properties.

	TWI		**Vegetation**	
	r_s	**p-value**	**r_s**	**p-value**
Porosity (13)	0.55	0.05	0.30	0.32
Water content at field capacity (13)	0.41	0.17	0.16	0.60
Water content at wilting point (13)	-0.25	0.42	-0.31	0.30
Drainable porosity (13)	-0.21	0.50	0.02	0.94
Carbon content (13)	0.56	0.05	0.30	0.33
Sand content (9)	0.21	0.61	0.24	0.57
Silt content (9)	-0.12	0.78	0.43	0.29
Clay content (9)	-0.55	0.16	-0.50	0.20
K_{sat} (7)	-0.14	0.76	0.42	0.35
Depth A (14)	0.42	0.14	0.02	0.96
Depth B (14)	0.22	0.45	0.14	0.63

Table 3: Number of events (out of 27) for which there was a significant positive or negative significant ($p<0.1$) Spearman rank correlation between the soil properties measured for a core taken at either 2-7 or 10-15 cm below the soil surface and the runoff ratio for OF or TIF.

Flow pathway	**OF**				**TIF**			
Depth	**2-7 cm**		**10-15 cm**		**2-7 cm**		**10-15 cm**	
Positive (+) or negative (-) correlation	+	-	+	-	+	-	+	-
Porosity	2	0	6		2	0	3	0
Water content at field capacity	1	0	2	1	0	0	0	2
Water content at wilting point	0	4		2	0	1	0	3
Drainable porosity	0	1	0	0	0	1	0	0
Carbon content	3	2	5	0	1	1	4	0
Sand content	4	0	6	0	1	1	0	4
Silt content	3	0	6	0	0	0	2	0
Clay content	0	4	0	11	1	0	0	0
K_{sat}	0	0	0	0	0	0	0	0
Depth A	3 (+); 1(-)				3(+); 1 (-)			
Depth B	0				2 (+)			

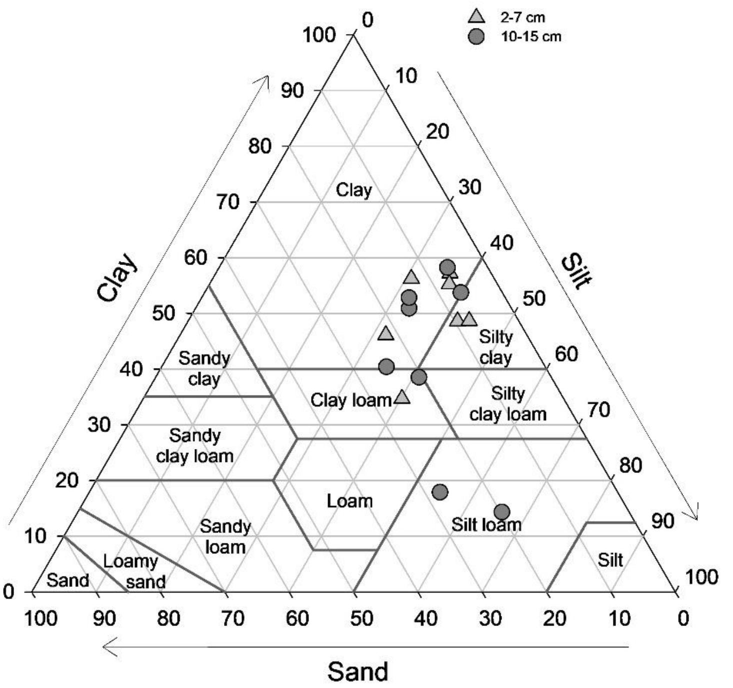

Figure 1. Texture triangle for soil samples taken from the plots.

Further, It is not very clear how TIF was measured in the field. Please explain it.

Thank you for pointing this out. We described this on lines 133-136 but now realize that we accidentally may have confused the reviewer by referring to **lateral subsurface flow** here. The lateral subsurface flow through the topsoil is **TIF**. We will make this clearer in the revised manuscript:

*"At the lower end of the plot, we dug a trench until the depth of the reduced clay layer (generally at ~ 40 cm below the soil surface; Table 1), where there are only very few visible roots. We put drain foil on the trench face to block the **lateral subsurface flow through the topsoil** and a drainage tube at the bottom of the trench (rolled into the foil) to collect this **TIF** and channel it via a hose to an Upwelling Bernoulli Tube."*

Additionally, we will add the following figure to the supplementary material.

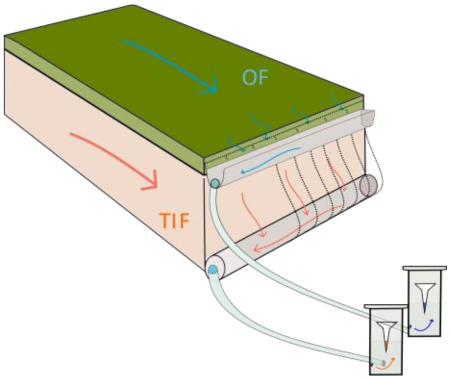

Figure 2. Schematic representation of the collection system at the bottom of each plot with the gutter to collect overland flow and biomat flow, and the drainage mat and drainage tube in the trench to collect TIF, and the routing of the water to the Upwelling Bernoulli Tubes

Line 194: On what basis authors divided the low-, medium-, and high- intensity rainfall ranges.

Thank you for your comment. We realize that this was not well explained and admit that this is a bit arbitrary. We looked at the distribution of the mean intensities for the different events (see Figure 3) and selected three different ranges so that each intensity class would include several events. These intensity classes are similar to the precipitation intensity ranges for 12 hour events given by Meteoswiss for different danger classes for the northern part of the Alps: 1.7 mm h^{-1} (danger level 2), 2.9 mm h^{-1} (danger level 3), and 5 mm h^{-1} (danger level 4), but are slightly different in order to ensure a more even spread of the events among the three classes. We will make this clearer in the revised version of the manuscript.

https://www.meteosuisse.admin.ch/dam/jcr:fbd1f425-1050-4558-852b-7be7604b63fe/descriptiondangers.pdf Page 6.

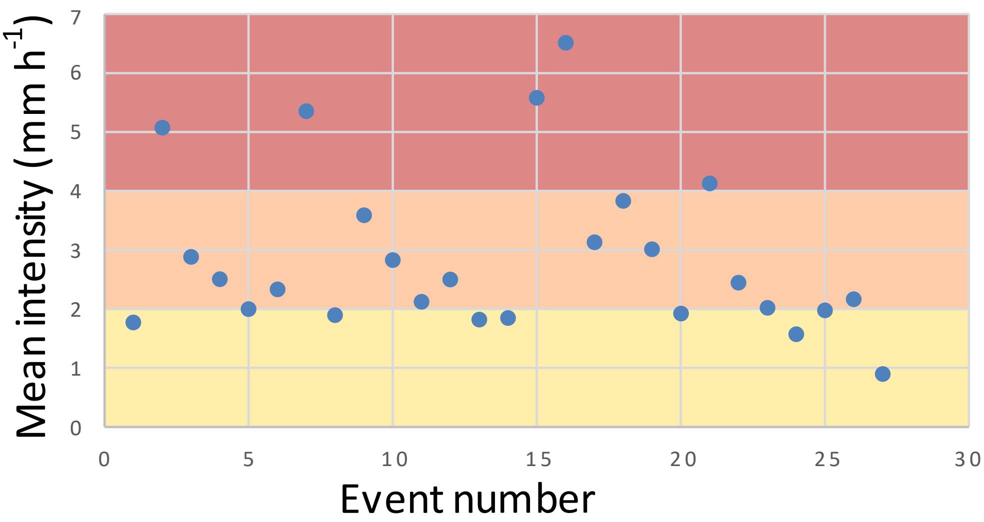

Figure 3 Mean intensity for the different events. The shading indicates the three intensity classes used in this study.

Topsoil interflow (TIF): at what depth TIF takes place?

TIF refers to the lateral flow through the topsoil (i.e., the more permeable layer with a lot of roots) above the reduced dense clay. More specifically it takes place between the foil that was inserted close to the surface to collect OF (~ 3 cm depth) and the bottom of the trench, which is about ~ 40 cm deep (see depth B in Table 1). The exact depth at which the TIF enters the trench is not known as it is likely a combination of lateral flow over the clay layer and flow from different preferential flowpaths. We will add a better description on how we collected TIF and highlight the depth TIF occurrence more clearly as well.

Line 435: "Indeed, the Spearman rank analysis indicates that ROF was negatively correlated to ASI for plots with a low TWI and positively correlated for plots with a high TWI (Figure S5)": what would be the possible reason?

Thank you for this question. We forgot to mention the relation with the fraction of OF (P_{OF}), which helps in understanding the processes. R_{OF} and P_{OF} are negatively correlated with ASI for plots with a low TWI and positively correlated with ASI for plots with a high TWI (see Figures S6 (with ASI+P) and S7 (with ASI+P) in the supplementary material). The most likely reasons are:

- For the dry plot (low TWI), the fraction of OF decreases from dry to wet antecedent conditions. It means that during dry conditions, the water tends to flow more at the surface or through the biomat, and does not infiltrate to the topsoil. We hypothesize that this might be due to the hydrophobicity of the (forested) soil during dry conditions, which would promote OF and biomat flow. When the soil is wetter (less hydrophobic), more water infiltrates, leading to more TIF, and a lower fraction of OF (P_{OF}). In parallel the R_{OF} decreases as more infiltration leads to less OF because OF at the dry sites is not due to saturation excess.
- For wet plot (high TWI), we expect no hydrophobicity and the fraction of OF increases with wetter antecedent conditions. It means that during dry conditions the water infiltrates to produce TIF. When ASI is higher (and the antecedent conditions are wetter), the soil becomes saturated more quickly, leading to a higher fraction of saturated overland flow and R_{OF}. Thus, they would be positively correlated for wetter sites.

  We will add more details about the mechanisms in the manuscript to make this clearer.

Line 490: The fast response of both flow pathways highlights the importance of preferential flow and suggests considerable interaction between OF and TIF. How the fast response of OF highlights the importance of preferential flow.

Thank you for your comment. The high runoff ratios (particularly those >1) suggests that there is return flow coming from outside the plot that leads to OF. The fast response suggest that the return flow is most likely due to preferential flow as the response for preferential flow is faster than for matrix flow. Furthermore, we observed water coming out of larger pipes or mouse holes and that this water flowed over the surface as OF to the gutters. If OF consists mainly of exfiltrating soil water, there must be interaction between the water fluxes in the ground and at the surface. We will rewrite this section in the revised manuscript and explain this more clearly.

Add legend titles to Figures 2 and 3.

We will make the titles of the legends clearer.

Add legend titles to Figures S8 and S9

We will add titles to the legend in the next version of the manuscript. Thank you for pointing this out.