Comment on "Characterizing detachment and transport processes of interrill soil erosion, Geoderma 376 (2020) 114549"

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Abstract

Zhang et al (2020) measured soil splashed and washed by rain-impacted flows on surfaces where 4 sections were exposed in sequence during a 1 hour rainfall event. In one treatment, upslope areas were protected by a tarp, and in the other, protected by a gauze screen. Comparison between the amounts splashed and eroded by the rain-impacted flow were used to determine if detachment by surface water flows occurred. In this comment, the conclusion that flow detachment occurred in all the screen experiments and in all the tarp experiments on the 27 % slope and the tarp experiment with 120 mm h-1 rain on the 18 % slope is shown to be unsound for two reasons. Firstly, the conclusion is unsound because it is well known that not all the material mobilized by raindrop impact is lifted into that air and transported aerially over the surface in raindrop splash. Secondly, the conclusion is unsound because the equation used to determine apparent soil loss rates in the screen experiments does not estimate the contribution of erosion in the sections to the sediment discharged from the eroding surfaces.

Discussion (Geoderma)

Comment on "Characterizing detachment and transport processes of interrill soil erosion, Geoderma 376 (2020) 114549"

Introduction

Zhang et al. (2020) report results from an experimental design that was modified from the design reported by Zhang (2019). The experimental design involved the use of two flumes (1.8 x 0.5 x 0.1 m) set side by side with a 2-5 cm gap between them. The flumes were packed with soil having 20.8 % sand, 58.6 % silt, and 20.6 % clay. Rain was applied for one hour using a nozzle type simulator whose intensity was controlled by the frequency of nozzle oscillation. 3 rainfall intensities (60, 90, 120 mm h^{-1}) and 3 slope gradients (9, 18, and 27%) were used. Splashed material was collected in the slot while sediment discharged in runoff was collected at the bottom of the flumes. The soil was the same as used by Zhang (2019) but packed to a bulk density of 1.4 g cm^{-3} as opposed to 1.2 g cm^{-3} used previously. The 1.4 g cm^{-3}bulk density was chosen after trying several alternatives because the authors perceived that it created a detachment-limited regime under high intensities and slopes but a transport-limited regime under lower intensities and slopes.

Two treatments were used in association with the variations 3 variations in rainfall intensity and 3 variations in slope gradients. In one treatment, a screen was suspended 5 cm above the soil surface. In the other, a tarp was placed over the surface to prevent upslope runoff from flowing over the exposed surface. In the first 15 minutes of experiments lasting 1 hour, the bottom quarter of the flumes was exposed to rainfall produced by the rainfall simulator. In the 2nd 15-minute period, erosion by the rainfall occurred on the bottom half of the flumes. Three-quarters of the flume area was exposed in the 3rd 15-minute period with the whole area being exposed in the 4th 15-minute period. In the first hour, 60 mm hr^{-1} rainfall intensity was used. In the 2nd hour, the exposure sequence was repeated with 90 mm hr^{-1} rainfall intensity, and 120 mm hr^{-1} rainfall intensity in the 3rdhour. The screen experiments were designed so that surface water flow conditions did not vary in the bottom section of the 1.8 m long surface as the number of exposed sections varied. Consequently, the transport capacity of the rain-impacted flows in the bottom section remained constant during each 1 hour rainfall event. In contrast, the tarp experiments were designed so that the transport capacity of rain-impacted flows in the bottom section varied as the number of exposed sections varied. The two treatments were applied on 9 %, 18 % and 27 % slopes. Newly prepared surfaces were used for a sequence of 3 one hour rainfalls varying in intensity from 60 mm hr^{-1} to 120 mm hr^{-1} and totalling 270 mm on for each slope gradient. Sediment-laden runoff was collected every 3 minutes

In analysing the data for splash in these experiments, Zhang et al assumed that following Zhang (2019), splashed material per unit area of the slot was equal to the detached and/or previously detached soil material per unit area of the plot. In order to make direct comparisons between event total wash loss and splash, the total splash amounts were upscaled according to ratios of respective area of the flumes and the slot and those values reflected the total loose material available on the soil surface during the entire event. Given that, Zhang at al assumed that if these measured splash amounts exceeded the amounts washed, then transport-limiting conditions existed. Conversely, if the washed amounts exceeded the measured splash amounts, then flow detachment had occurred. Based on this assumption, they concluded that flow detachment occurred in all the screen experiments and in all the tarp experiments on the 27 % slope and the tarp experiment with 120 mm h^{-1} rain on the 18 % slope.

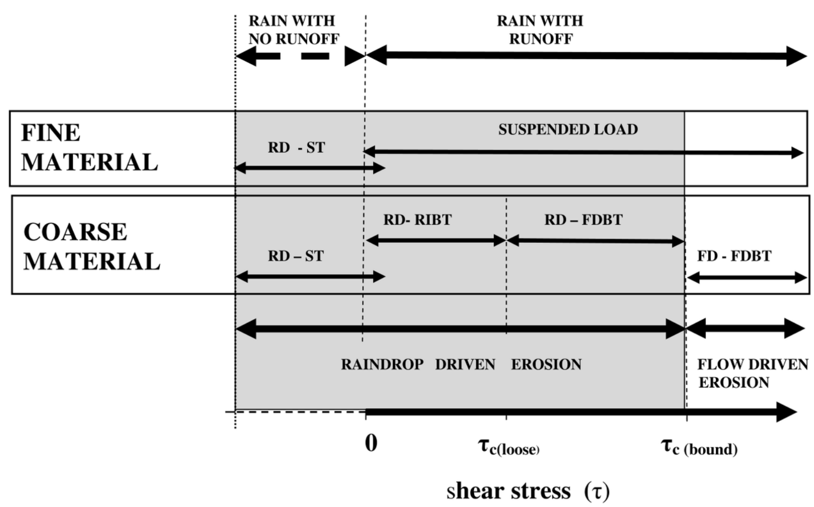

Figure 1. Schematic of the effect of flow shear on the detachment and transport mechanisms in rain impacted flows. RD = raindrop detachment, ST = transport aerially by splash, $RIBT$ = raindrop induced bed load transport by saltation and rolling, $FBDT$ = flow driven bed load transport by saltation and rolling. NB. This scheme is a simplification of what detachment and transport process operate in rain-impacted flows at any given time. It is possible that both raindrop detachment and flow detachment can occur simultaneously in the same area. Many different particle sizes and densities occur and $RIBT$ can occur with the movement of some particles while $FDBT$ occurs with the movement of smaller and less dense particles in the same area.

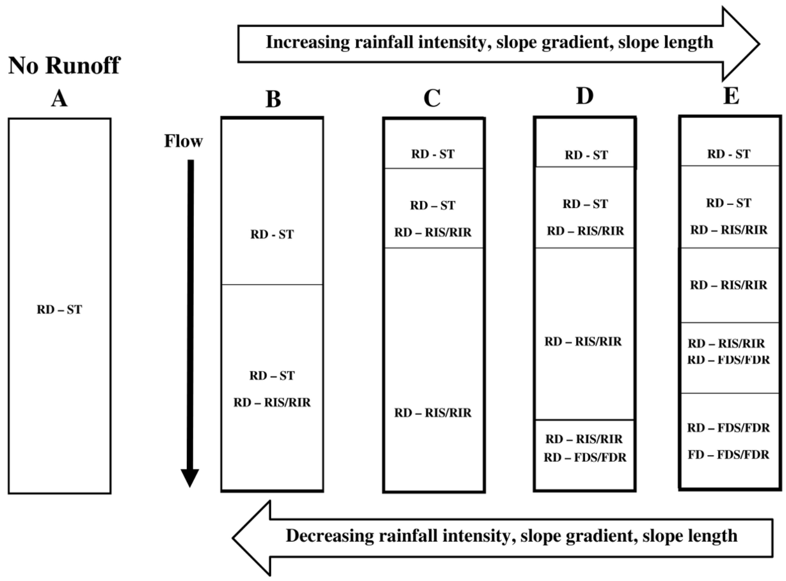

Figure 2: Schematic of spatial variations in the detachment and transport mechanisms operation to move coarse material on surfaces eroding as the result of detachment by raindrop impact and surface water flow. ***RD*** **= Raindrop detachment,** ***ST*** **= transport aerially by splash,** ***RIS*** **= raindrop induced saltation,** ***RIR*** **= raindrop induced rolling,** ***FDS*** **= flow driven saltation,** ***FDR*** **= flow driven rolling,** ***FD*** **= flow detachment.**

For soil erosion to occur, particles must be extracted from being held within the surface of the soil matrix by cohesion and inter-particle friction and then subsequently transported away from the site of the extraction. Detachment is the term used to the process of extraction of particles from the surface of the soil matrix. It is well known that both raindrop impact and surface water flows can cause detachment. However, detachment by flow only occurs once flows possess sufficient energy to cause detachment. Often detachment by flow is considered to occur once the flow has a shear stress that exceeds a critical value ($\tau_{\varsigma(\beta o\upsilon\nu\delta)}$) that is soil dependent. As shown in Figure 1, raindrop detachment can cause erosion when raindrops impact flows that have shear stresses below that critical value. Consequently, as shown in Figure 2, various detachment and transport mechanisms may operate to detach and transport soil material on surfaces like those used by the Zhang et al. The video provided by Zhang at al shows fine material moving in suspension as expected from Figure 1 while the coarse material moved intermittently in direct association with the rainfall pulses as would be expected when situation B or C occurred. If flow detachment occurred in section 1 (situation E), then coarse particles would be discharged in a continuous stream. However, it seems that Zhang et al concluded from comparing wash and splash rates that the situation depicted in E occurred in all the screen experiments and in all the tarp experiments on the 27 % slope and the tarp experiment with 120 mm h^{-1} rain on the 18 % slope. In this comment, this conclusion is shown to be unsound for two reasons. Firstly, the conclusion is unsound because it is well known that not all the material mobilized by raindrop impact is lifted into that air and transported aerially over the surface in raindrop splash. Secondly, the conclusion is unsound because the equation used to determine *apparent* soil loss rates in the screen experiments does not estimate the contribution of erosion in the sections to the sediment discharged from the eroding surfaces.

Splashed material as a measure of detachment

According to Zhang et al. (2020), the amount of splashed material collected in the slot is directly related to the amount of material mobilized by raindrop impact. When drops impacts cause detachment in rain-impacted flows, part of the material lifted into the flow from the soil surface results from detachment by the raindrops impacting at that time and part results from the lifting of loose material sitting on the surface. Loose material is present on the surface because when soil particles are transported by splash or raindrop induced saltation, coarse material falls back on the soil surface where it waits until moved again by a subsequent drop impact. When loose material sits on the surface, some of some of the energy that could be used to detach soil is used to move the loose particles so that M_M , the mass of material lifted vertically, is given by

$M_M = M_D$ (H -1) $+H$ M_{PD} (1)

where M_D is the mass detached directly by the current drop impact if no loose material is present,M_{PD} is the mass of the loose material sitting on the surface lifted when the loose material completely protects the underlying soil surface from detachment, and H is the degree of protection provided by the loose material sitting on the surface (Kinnell, 2005). H varies from 0 to 1. M_D varies with the resistance to detachment associated with the surface of the soil matrix (Kinnell, 2020a), raindrop size and velocity, and flow depth (Kinnell, 2020b).

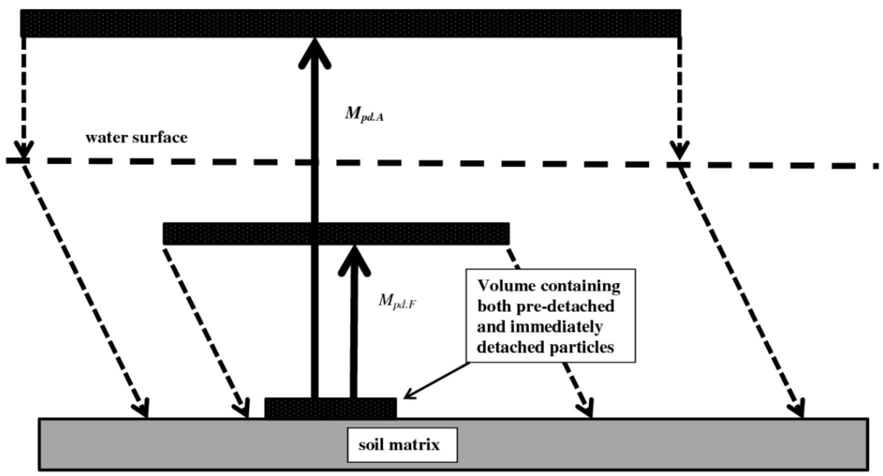

Figure 3: Schematic of the uplift of soil material into the air and into the flow by a drop impact.

It is well known that not all materials detached by raindrop impact become airborne. Figure 3 shows a schematic of the uplift of soil material into the air and into the flow by a drop impact. Theoretically, the mass lifted into the air by a drop impact is given by

$M_{M.A} =$ a M_M (2)

and the mass that remains in the flow

$M_{M.F} =$ b M_M (3)

where $a + b = 1.0$. It has been well demonstrated by Moss and Green (1983) that the ratio of material splashed and material transported by raindrop induced saltation decreases greatly as flow depth increases. Although a tends towards 1.0 as flow depth decreases. its value is not known to be 1.0 in the shallow flows that occur in the Zhang et al. (2020) experiments. Also, when rain falls and produces runoff on any inclined plane, the value of a will vary spatially as flow depths vary down along the plane. Consequently, the amount of material splashed into the slot is not a reliable measure of the amount of material detached by the raindrops that impact the flow during the Zhang et al experiments.

Soil loss from erosion in individual segments

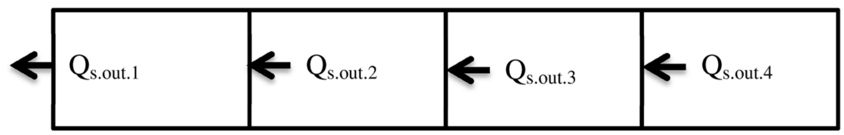

Figure 4. Schematic of the discharge of sediment between sections when the whole surface in the experiments by Zhang et al. (2020) **is exposed to rainfall.** $Q_{s.out}$ **is the amount of sediment discharged from a section during time when the whole surface is exposed to rainfall.**

Figure 4 shows a schematic of the discharge of sediment between sections when the whole surface in the experiments by Zhang et al. (2020) is exposed to rainfall. It applies to both the tarp and the screen experiments in the final 15 mins of each 1 hour rainfall event. It follows from Meyer and Wischmeier (1969), a paper cited by Zhang et al, that when the steady state occurs and the sediment discharge from a section is less than the sediment input into the section from upslope,**all the sediment entering the section passes through the section** , and the difference between the amounts of sediment entering and exiting the section results from erosion in the section . Conversely, when the sediment discharge is less than the sediment input from upslope then deposition occurs. In the both the Zhang (2019) and the Zhang et al. (2020) experiments, only $Q_{s.out.1}$ was measured when each new section upslope of section 1 was exposed during the hour rainfall intensity was held constant. Even so, it can be assumed in the tarp experiments that the amount of sediment discharged into section 1 from section 2 in the 15-30 min period is equal to the amount of sediment discharged from section 1 during the 0-15 min period because there is no water or sediment entering section 2 from upslope during that 15-30 min period. Similarly, when section 3 becomes exposed, the amount of sediment discharged into section 2 from section 3 is equal to the amount of sediment discharged from section 1 during the 0-15 min period, and when section 4 is newly exposed, the amount of sediment discharged into section 3 from section 4 is equal to the amount of sediment discharged from section 1 during the 0-15 min period. As noted above, when the steady state occurs and $Q_{s.out}$ [?] $Q_{s.in}$, **all the material entering a section from upslope is transported through the section** so that the rate soil material is discharged from the whole of eroding area is equal to the sum of the sediment discharges (g $m^{-1}min^{-1}$) from erosion in each of the contributing sections. Table 1 shows the result for 90 mm hr^{-1} rain on 18 % slope in the tarp experiments reported by Zhang (2019) assuming steady state conditions**.** Data for the Zhang (2019) are used here as they are more readily available than for the Zhang et al. (2020) experiments.

Table 1. Estimated sediment discharge (g $m^{-1}min^{-1}$) from erosion (g $m^{-2}min^{-1}$) each section during the four 15-min periods for 90 mm hr^{-1} rain on 18 % slope in the tarp experiments reported by Zhang (2019)**assuming steady state conditions** .

	sediment discharge from whole exposed area	sediment discharge from erosion in sect 1	sediment discharge from
0-15	9.09	9.09	
15-30	18.35	9.26	9.09
30-45	29.36	11.01	9.26
45-60	44.04	14.68	11.01
	sediment discharge from whole exposed area	soil loss rate in sect 1	soil loss rate in sect 2
0-15	9.09	20.2	
15-30	18.35	20.6	20.2
30-45	29.36	24.5	20.6
45-60	44.04	32.3	24.5

In the case of the tarp treatment, Zhang et al concluded that steady state soil loss rates for section 1 during each 15 minute interval could be estimated from

, $S1_{0\text{-}15} = L_{0\text{-}15} / A1$ (4a)

$S1_{15\text{-}30} = (L_{15\text{-}30} - L_{0\text{-}15}) / A1$ (4b)

$S1_{30\text{-}45} = (L_{30\text{-}45} - L_{15\text{-}30}) / A1$ (4c)

$S1_{45\text{-}60} = (L_{45\text{-}60} - L_{30\text{-}45}) / A1$ (4c)

where L is the average steady state delivery at the outlet (g min^{-1}) for the respective time interval, and $A1$ is the projected area of section 1. Eqs 4a-4c provide estimates of soil loss rates (g m^{-2} min^{-1}) that are consistent with the approach that generated the sediment discharges (g m^{-1} min^{-1}) presented in Table 1. However, in analysing the data for the screen experiments, Zhang et al concluded that the steady state soil loss rates (g $m^{-2}min^{-1}$) from each section could be estimated from

$S1_{0\text{-}15} = L_{0\text{-}15} / A1$(5a)

$S2_{15\text{-}30} = (L_{15\text{-}30} - L_{0\text{-}15}) / A2$ (5b)

$S3_{30\text{-}45} = (L_{30\text{-}45} - L_{15\text{-}30}) / A3$ (5c)

$S4_{45\text{-}60} = (L_{45\text{-}60} - L_{30\text{-}45}) / A4$ (5d)

where $S1$, $S2$, $S3$, and $S4$ are the soil loss rates from sections 1, 2, 3, and 4 for the corresponding 15-minute interval in g min^{-1} m^{-2}, and $A1$, $A2$, $A3$, and $A4$ are the projected areas of the respective sections. No theoretical or logical reason was given for Eq. 5. As noted above, the scheme shown in Figure 4 applies to both the tarp and screen experiments when all sections are exposed to rain, Logically, when comparable runoff rates from the screen and tarp experiments occur during the final 15 mins of each rainfall event the spatial variations in soil loss rates in the screen experiments should follow that same pattern as seen in the tarp experiments. However, as shown in Table 2, that does not occur when Eq. 5 is used to estimate the soil loss rates in the screen experiments. Although it is possible that flow detachment did occur in some of the Zhang at al experiments, the conclusion that situation flow detachment occurred in all the screen experiments and in all the tarp experiments on the 27 % slope and the tarp experiment with 120 mm h^{-1} rain on the 18 % slope was based not only an inability to measure detachment by raindrop impact but on dubious data soil loss rates in the screen experiments.

Table 2. Soil loss rates (g $m^{-2}min^{-1}$) in each section during the 45-60 min periods in the tarp and screen treatment on the 18 % slope in the Zhang(2019) experiments estimated using the scheme shown in Figure 4 and Eq. 4. The results for the screen experiments using the scheme shown in Figure 4 assume that the relative contributions of the sections to sediment discharges in the screen experiments follow the same spatial pattern as observed in the tarp experiments. No data exists to determine the actual soil loss rates directly in the screen experiments.

rainfall intensity	sediment discharge from sect 1	Sect 1
(mm/hr)	(g/m/min)	(g/m^2/min)
TARP experiments using Fig. 4 scheme	TARP experiments using Fig. 4 scheme	TARP experiments using Fig. 4 sc
60	25.0	22.4
90	44.0	32.6
120	77.9	66.9
SCREEN experiments using Fig.4 scheme	SCREEN experiments using Fig.4 scheme	SCREEN experiments using Fig.4
60	45.7	40.9
90	75.6	56.0
120	103.9	89.4
SCREEN experiment using Eq.4	SCREEN experiment using Eq.4	SCREEN experiment using Eq.4

rainfall intensity	sediment discharge from sect 1	Sect 1
60	45.65	59.85
90	75.58	151.38
120	103.91	198.38

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Discussion (Geoderma)

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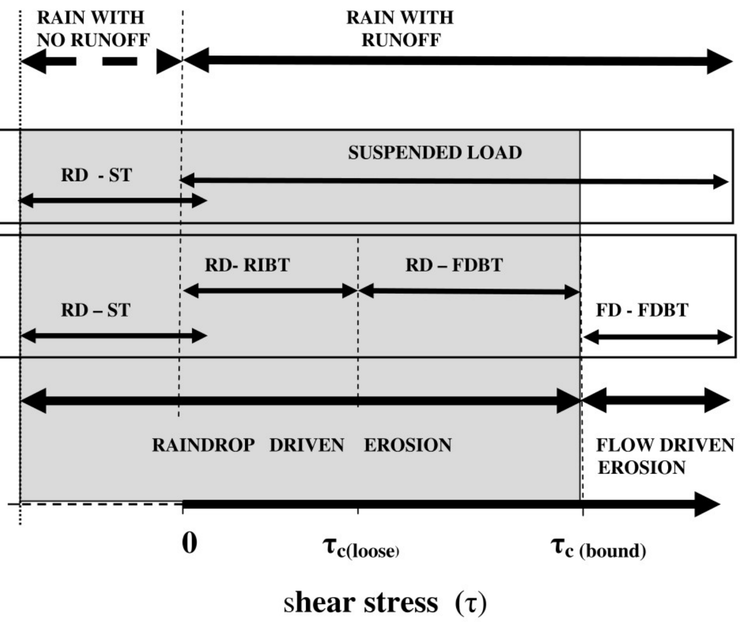
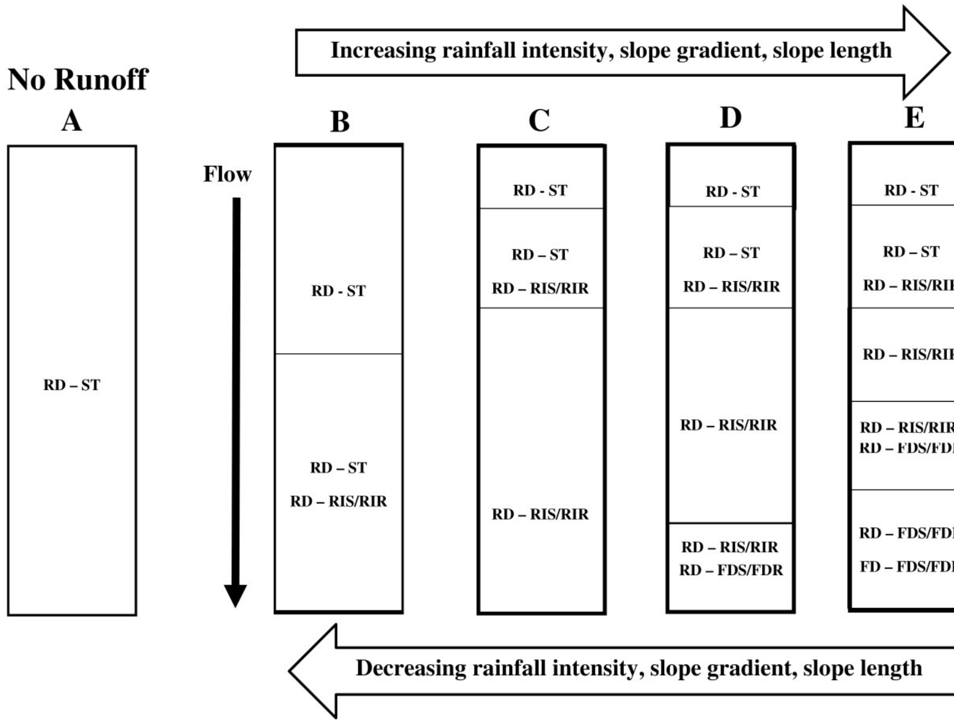


Figure 1. Schematic of the effect of flow shear on the detachment and transport mechanisms in rain impacted flows. *RD* = raindrop detachment, *ST* = transport aerially by splash, *RIBT* = raindrop induced bed load transport by saltation and rolling, *FBDT* = flow driven bed load transport by saltation and rolling. NB. This scheme is a simplification of what detachment and transport process operate in rain-impacted flows at any given time. It is possible that both raindrop detachment and flow detachment can occur simultaneously in the same area. Many different particle sizes and densities occur and *RIBT* can occur with the movement of some particles while *FDBT* occurs with the movement of smaller and less dense particles in the same area.



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$$M_M = M_D(H - 1) + H\, M_{PD} \qquad (1)$$

where M_D is the mass detached directly by the current drop impact if no loose material is present, M_{PD} is the mass of the loose material sitting on the surface lifted when the loose material completely protects the underlying soil surface from detachment, and H is the degree of protection provided by the loose material sitting on the surface (Kinnell, 2005). H varies from 0 to 1. M_D varies with the resistance to detachment associated with the surface of the soil matrix (Kinnell, 2020a), raindrop size and velocity, and flow depth (Kinnell, 2020b).

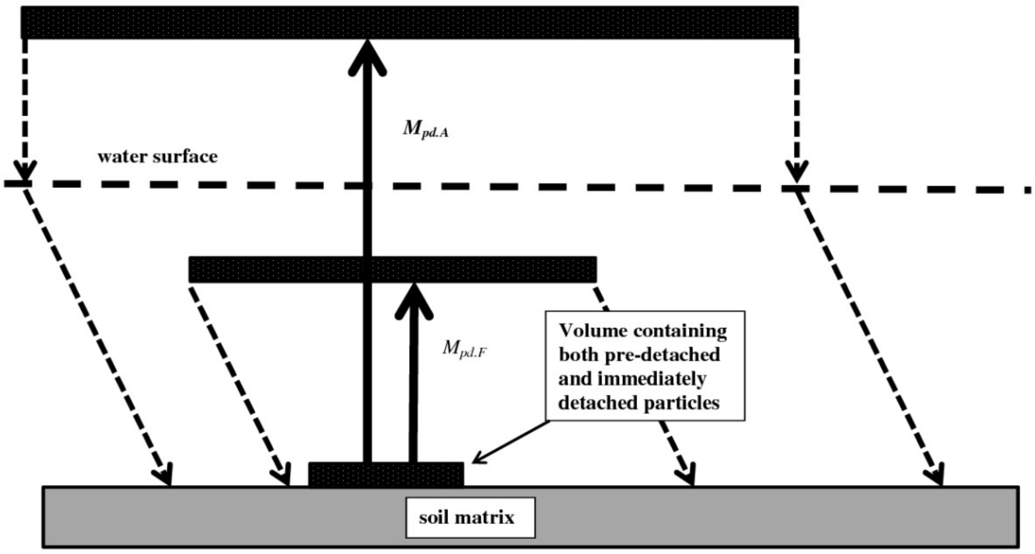

Figure 3: Schematic of the uplift of soil material into the air and into the flow by a drop impact.

It is well known that not all materials detached by raindrop impact become airborne. Figure 3 shows a schematic of the uplift of soil material into the air and into the flow by a drop impact. Theoretically, the mass lifted into the air by a drop impact is given by

$$M_{M.A} = a\, M_M \qquad (2)$$

and the mass that remains in the flow

$$M_{M.F} = b\, M_M \qquad (3)$$

where $a + b = 1.0$. It has been well demonstrated by Moss and Green (1983) that the ratio of material splashed and material transported by raindrop induced saltation decreases greatly as flow depth increases. Although a tends towards 1.0 as flow depth decreases. its value is not known to be 1.0 in the shallow flows that occur in the Zhang et al. (2020) experiments. Also, when rain falls and produces runoff on any inclined plane, the value of a will vary spatially as flow depths vary down along the plane. Consequently, the amount of material splashed into the slot is not a reliable measure of the amount of material detached by the raindrops that impact the flow during the Zhang et al experiments.

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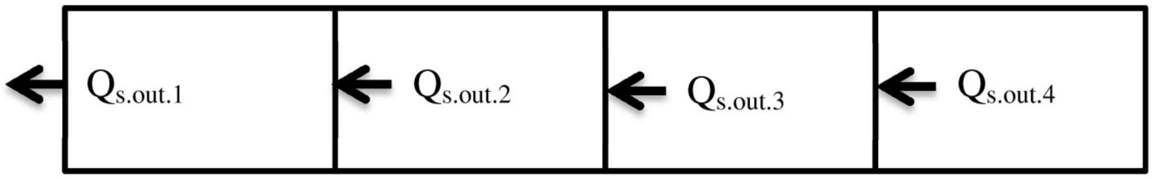

Figure 4. Schematic of the discharge of sediment between sections when the whole surface in the experiments by Zhang et al. (2020) is exposed to rainfall. $Q_{s.out}$ is the amount of sediment discharged from a section during time when the whole surface is exposed to rainfall.

Figure 4 shows a schematic of the discharge of sediment between sections when the whole surface in the experiments by Zhang et al. (2020) is exposed to rainfall. It applies to both the tarp and the screen experiments in the final 15 mins of each 1 hour rainfall event. It follows from Meyer and Wischmeier (1969), a paper cited by Zhang et al, that when the steady state occurs and the sediment discharge from a section is less than the sediment input into the section from upslope, **all the sediment entering the section passes through the section**, and the difference between the amounts of sediment entering and exiting the section results from erosion in the section . Conversely, when the sediment discharge is less than the sediment input from upslope then deposition occurs. In the both the Zhang (2019) and the Zhang et al. (2020) experiments, only $Q_{s.out.1}$was measured when each new section upslope of section 1 was exposed during the hour rainfall intensity was held constant. Even so, it can be assumed in the tarp experiments that the amount of sediment discharged into section 1 from section 2 in the 15-30 min period is equal to the amount of sediment discharged from section 1 during the 0-15 min period because there is no water or sediment entering section 2 from upslope during that 15-30 min period. Similarly, when section 3 becomes exposed, the amount of sediment discharged into section 2 from section 3 is equal to the amount of sediment discharged from section 1 during the 0-15 min period, and when section 4 is newly exposed, the amount of sediment discharged into section 3 from section 4 is equal to the amount of sediment discharged from section 1 during the 0-15 min period. As noted above, when the steady state occurs and $Q_{s.out} \geq Q_{s.in}$, **all the material entering a section from upslope is transported through the section** so that the rate soil material is discharged from the whole of eroding area is equal to the sum of the sediment discharges (g m^{-1} min^{-1}) from erosion in each of the contributing sections. Table 1 shows the result for 90 mm hr^{-1} rain on 18 % slope in the tarp experiments reported by Zhang (2019) assuming steady state conditions**.** Data for the Zhang (2019) are used here as they are more readily available than for the Zhang et al. (2020) experiments.

Table 1. Estimated sediment discharge (g m^{-1} min^{-1}) from erosion (g m^{-2} min^{-1}) each section during the four 15-min periods for 90 mm hr^{-1} rain on 18 % slope in the tarp experiments reported by Zhang (2019)assuming steady state conditions.

	sediment discharge from whole exposed area	sediment discharge from erosion in sect 1	sediment discharge from erosion in sect 2	sediment discharge from erosion in sect 3	sediment discharge from erosion in sect 4
0-15	9.09	9.09			
15-30	18.35	9.26	9.09		
30-45	29.36	11.01	9.26	9.09	
45-60	44.04	14.68	11.01	9.26	9.09
	sediment discharge from whole exposed area	soil loss rate in sect 1	soil loss rate in sect 2	soil loss rate in sect 3	soil loss rate in sect 4
0-15	9.09	20.2			
15-30	18.35	20.6	20.2		
30-45	29.36	24.5	20.6	20.2	
45-60	44.04	32.3	24.5	20.6	20.2

In the case of the tarp treatment, Zhang et al concluded that steady state soil loss rates for section 1 during each 15 minute interval could be estimated from

, $$S1_{0\text{-}15} = L_{0\text{-}15} / A1 \qquad \text{(4a)}$$

$$S1_{15\text{-}30} = (L_{15\text{-}30} - L_{0\text{-}15}) / A1 \qquad \text{(4b)}$$

$$S1_{30\text{-}45} = (L_{30\text{-}45} - L_{15\text{-}30}) / A1 \qquad \text{(4c)}$$

$$S1_{45\text{-}60} = (L_{45\text{-}60} - L_{30\text{-}45}) / A1 \qquad \text{(4c)}$$

where L is the average steady state delivery at the outlet (g min^{-1}) for the respective time interval, and $A1$ is the projected area of section 1. Eqs 4a-4c provide estimates of soil loss rates (g m^{-2} min^{-1}) that are consistent with the approach that generated the sediment discharges (g m^{-1} min^{-1}) presented in Table 1. However, in analysing the data for the screen experiments, Zhang et al concluded that the steady state soil loss rates (g m^{-2} min^{-1}) from each section could be estimated from

$$S1_{0\text{-}15} = L_{0\text{-}15} / A1 \quad (5a)$$

$$S2_{15\text{-}30} = (L_{15\text{-}30} - L_{0\text{-}15}) / A2 \quad (5b)$$

$$S3_{30\text{-}45} = (L_{30\text{-}45} - L_{15\text{-}30}) / A3 \quad (5c)$$

$$S4_{45\text{-}60} = (L_{45\text{-}60} - L_{30\text{-}45}) / A4 \quad (5d)$$

where *S1*, *S2*, *S3*, and *S4* are the soil loss rates from sections 1, 2, 3, and 4 for the corresponding 15-minute interval in g min^{-1} m^{-2}, and *A1*, *A2*, *A3*, and *A4* are the projected areas of the respective sections. No theoretical or logical reason was given for Eq. 5. As noted above, the scheme shown in Figure 4 applies to both the tarp and screen experiments when all sections are exposed to rain, Logically, when comparable runoff rates from the screen and tarp experiments occur during the final 15 mins of each rainfall event the spatial variations in soil loss rates in the screen experiments should follow that same pattern as seen in the tarp experiments. However, as shown in Table 2, that does not occur when Eq. 5 is used to estimate the soil loss rates in the screen experiments. Although it is possible that flow detachment did occur in some of the Zhang at al experiments, the conclusion that situation flow detachment occurred in all the screen experiments and in all the tarp experiments on the 27 % slope and the tarp experiment with 120 mm h^{-1} rain on the 18 % slope was based not only an inability to measure detachment by raindrop impact but on dubious data soil loss rates in the screen experiments.

Table 2. Soil loss rates (g m^{-2} min^{-1}) in each section during the 45-60 min periods in the tarp and screen treatment on the 18 % slope in the Zhang(2019) experiments estimated using the scheme shown in Figure 4 and Eq. 4. The results for the screen experiments using the scheme shown in Figure 4 assume that the relative contributions of the sections to sediment discharges in the screen experiments follow the same spatial pattern as observed in the tarp experiments. No data exists to determine the actual soil loss rates directly in the screen experiments.

rainfall intensity (mm/hr)	sediment discharge from sect 1 (g/m/min)	Sect 1 (g/m²/min)	sect 2 (g/m²/min)	sect 3 (g/m²/min)	sect 4 (g/m²/min)
TARP experiments using Fig. 4 scheme					
60	25.0	22.4	13.5	11.0	8.7
90	44.0	32.6	24.5	20.6	20.2
120	77.9	66.9	41.5	33.1	31.5
SCREEN experiments using Fig.4 scheme					
60	45.7	40.9	24.6	20.1	15.8
90	75.6	56.0	42.0	35.3	34.7
120	103.9	89.4	55.4	44.2	42.0
SCREEN experiment using Eq.4					
60	45.65	59.85	18.86	15.40	7.34
90	75.58	151.38	1.90	10.40	4.29
120	103.91	198.38	16.94	15.19	0.41

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