Supplement A

Collection of undisturbed soil monoliths (1 x 0.5 x 0.4 m)

Site selection and delimitation

Mowing and removal of cuttings

Placement and driving in of sampling frame

Gradual removal of soil around frame

Repeat until frame is even with surface

Digging at the front side to create space for the rack and pinion jack

Application of guiding rail on sampling frame

Create an abutment for the rack

Placement of the bottom plate

Complete insertion of bottom plate to isolate soil monolith

Building a ramp using plywood plates

Attaching a lashing strap around the sampling frame

Towing the monolith onto the trailer using a winch

Securing the monolith and transport

Cutting and re-combination of soil monoliths

Positioning of monolith within plywood box

Removal of front plate and addition of a second plywood box

Creating an abutment for the rack

Fixation of side parts

Pushing monolith to the middle of the combined plywood boxes using a rack and pinion jack

Constructing a guiding rail for the cutting board

Insertion of cutting board and wooden impactor

Cutting the monolith in half by carefully hammering down the cutting board

Re-positioning of plywood boxes

Wetting of both front surfaces

Application of soil-water-mixture using autochthonous soil material

Pushing the two soil blocks together using a rack and pinion jack

Re-attachment of the front plate and fastening all plywood parts for a tight fit

Removal of fixation

Surface application of thin soil-water-mixture at the cut

Supplement B

Infiltration experiments with water glass

The setup consisted of three small soil monoliths (30 x 30 x 15 cm) taken from the same grassland site as the main experiment. Monoliths were put in plywood boxes; the bottom plate had a hole in the middle to allow seepage. A cylinder (Ø 15 cm) was placed on top of the monoliths and filled with water to a height of 17 cm, which corresponds to a volume of 3 l. The height of the water in the cylinder was measured periodically to calculate the remaining water volume. Water outflow was measured by collecting seepage water with buckets, which were weighed periodically.

Four trials have been made with each monolith. After Trial 1, a metal plate was stuck into the soil which was supposed to mimic the metal frame of the main experiment (same thickness, same penetration depth). Trials were conducted on water saturated soils. For this, the monoliths were transferred to a water pool over the weekend. Trials 1+2 took place on the first day, Trial 3 on the second day, and Trial 4 on the third day. Water glass was also applied on the day before the experiment. Monoliths were transferred back to the water pool in between trials.

Trial 1 | without metal plate / without water glass application

Trial 2 | with metal plate / without water glass application

Trial 3 | with metal plate / with water glass application at the contact areas of cylinder/metal plate with the soil

Trial 4 | with metal plate / application of water glass on whole soil surface inside the cylinder

The results suggest that **I**) inserting a metal plate does not promote a faster infiltration, indicating that also the metal frame of the main experiment would not negatively affect flow pathways; **II**) the application of water glass significantly delays infiltration up to a complete sealing of the soil (Block #C, Trial 4); **III**) although they were taken side by side, there is substantial variation among the small soil monoliths, exemplifying a general inherent heterogeneity of the soil.

Fig. S1: Setup of infiltration experiment. The right image shows the inserted metal plate.

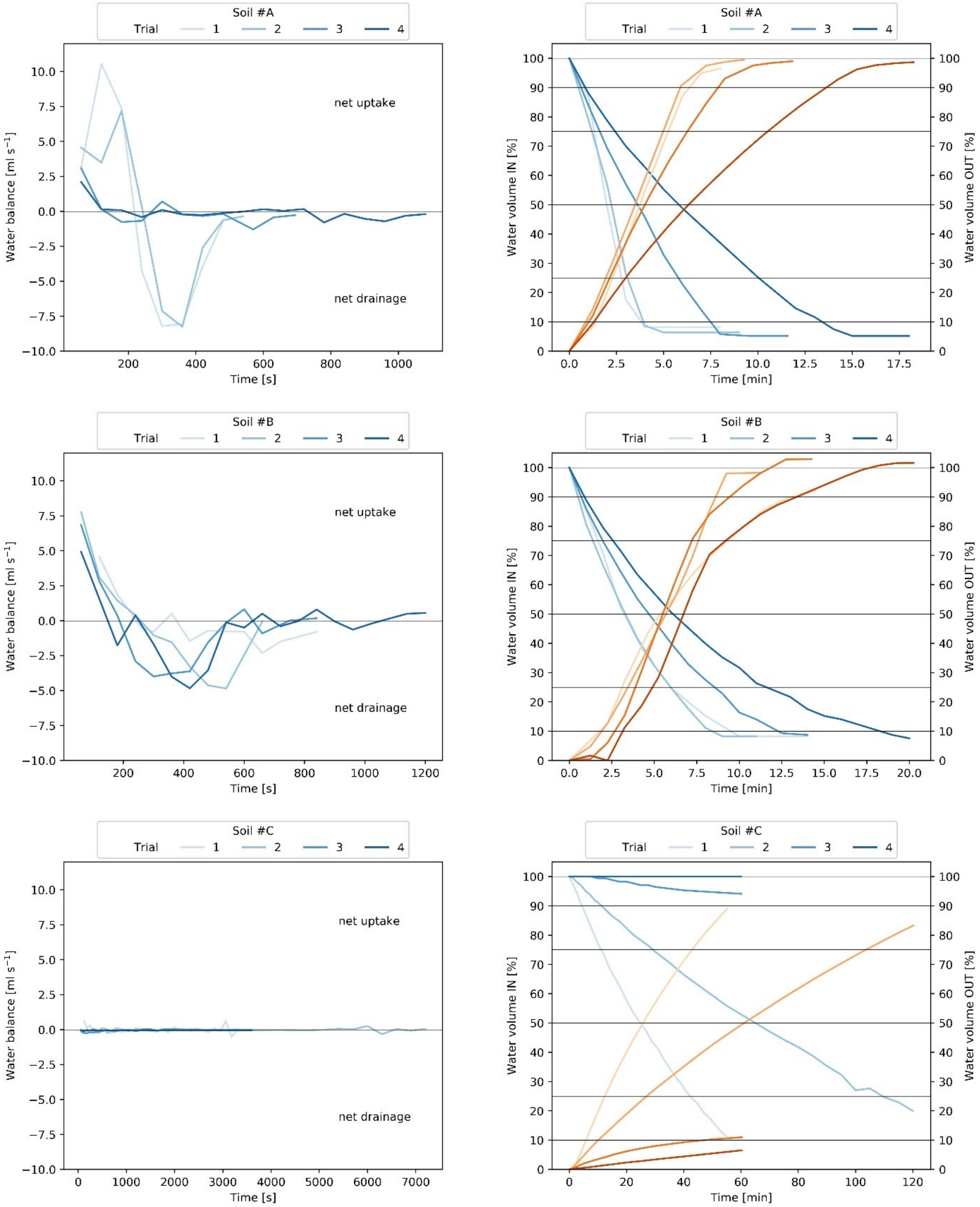


Fig. S2: Left: Water balance of the three small soil monoliths (#A-C) during the trials. Positive values mean a net water uptake of the soil, negative values a net release. Note that x-axes are differently scaled. Right: Development of water volume in cylinder (infiltration IN, blue) and relative volume of seepage water (OUT, orange). 100 % are the initial 3 litres in the cylinder. Colours indicate trials; first trial – lightest colour, last trial – darkest colour.

Supplement C

Tracer experiment for surface flow velocity

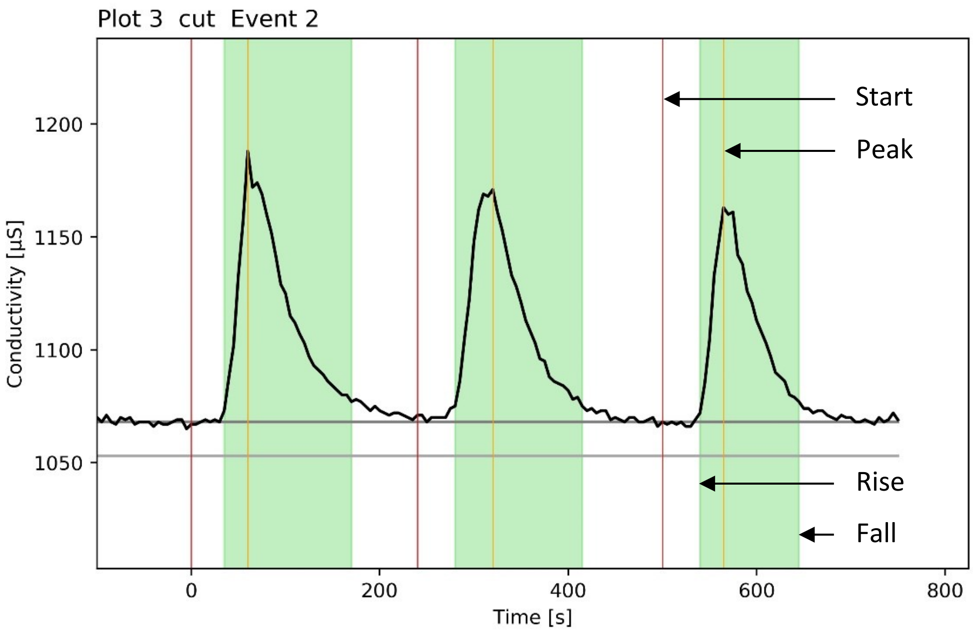


Fig. S3: Example of a salt tracer passage with characteristic time values (block #3).

Conductivity probes were placed in the overflow tank at the upper end of the plot (i.e., baseline conductivity; IN, light grey line) and in the surface runoff collector at the lower end of the plot (OUT, black line). Conductivity was logged every 5 seconds.

Black: Measured conductivity (σ).

Light grey: Mean of the conductivity measured at the upper end of the plot (σ_{IN}).

Dark grey: Mean of the conductivity measured at the lower end of the plot (σ_{OUT}), averaged over first 10 measurements before the first trial started and the last 10 measurements after the last trial (i.e., quiescent value). Note that conductivity measured at OUT never reached the baseline values measured at IN due to autochthonous salt compounds in the soil.

Red: **Start**; Timepoint of salt tracer addition.

Orange: **Peak**; Timepoint of conductivity maximum.

Green: Duration of tracer passage. Thresholds for beginning (rise) and end (fall) of a tracer passage were defined as follows:

Rise: once the rate between the measured and the mean conductivity at the end of the plot is larger than one percent $\sigma/\sigma_{OUT} > 0.01$ (dashed line in Fig. C2).

Fall: once the rate between the measured and the mean conductivity at the end of the plot is constantly lower than one percent $\sigma/\sigma_{OUT} < 0.01$

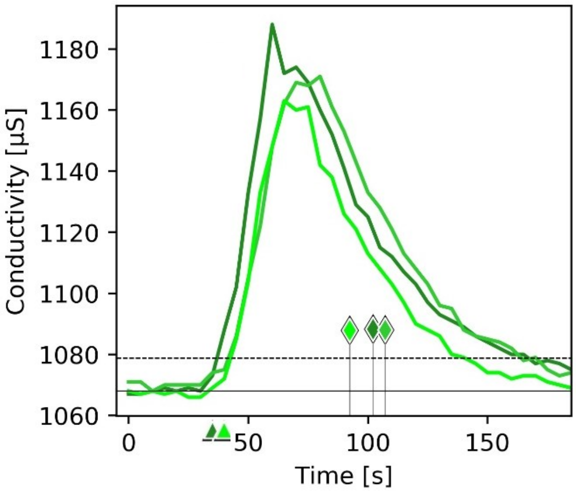


Fig. S4: Example of a salt tracer passage overlay with time values used for calculation of leading edge and centroid velocity (block #3). Different trials in different shades of green from dark to light. Triangles indicate start of amplitude rise; diamonds indicate centroid of graph.

Triangles: Last timepoint before conductivity was consistently higher than the threshold value (Rise criteria).

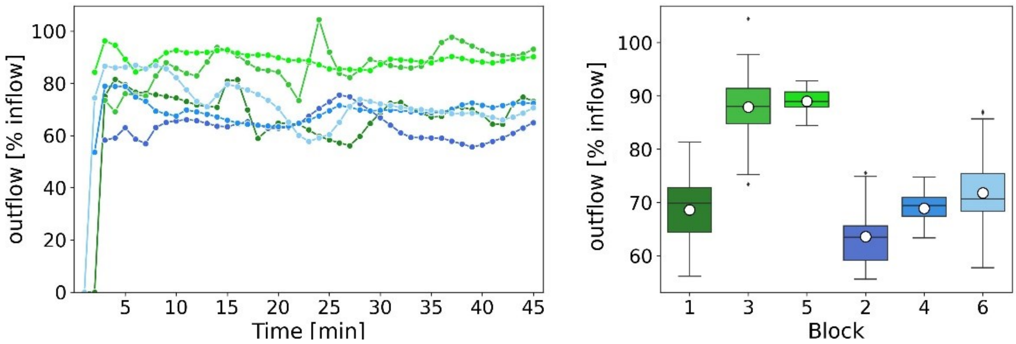
Diamonds: Calculated centroid of the graph (following Abrantes et al., 2018).

The **leading edge** and **centroid velocity** were calculated by dividing the length of the monolith (1 m) by the Rise and Centroid timepoint, respectively. Leading edge velocity approximates the surface velocity of the flow; centroid velocity approximates the mean flow velocity in the runoff profile (Abrantes et al., 2018).

Supplement D

Results from first experimental set

Surface runoff SRF



Subsurface interflow INT

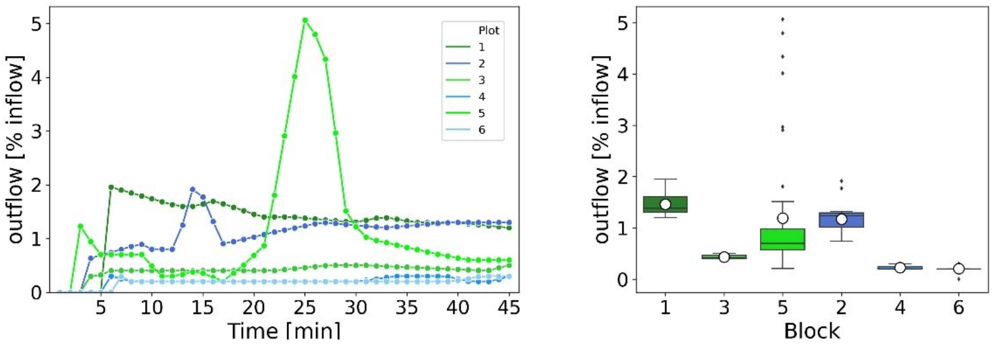


Fig S5: Relative outflow rate for surface runoff and subsurface interflow, interpolated for every minute (experimental set 1). Green – re-combined monoliths; blue – uncut monoliths. White circles – mean; black line – median; box – 25-75 percentiles; whiskers – 5-95 percentiles; diamonds – outliers.

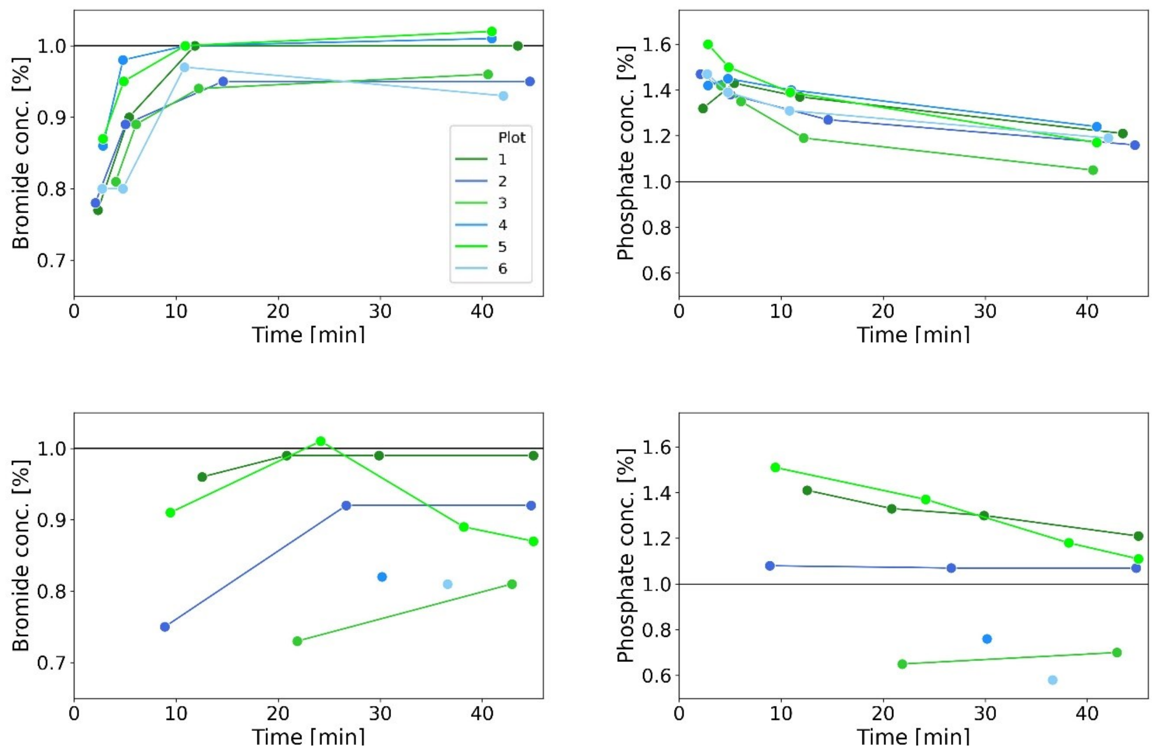


Fig S6: Course of bromide and ortho-phosphate in surface runoff and subsurface interflow (experimental set 1). The black line indicates 100 % of inflow concentration.

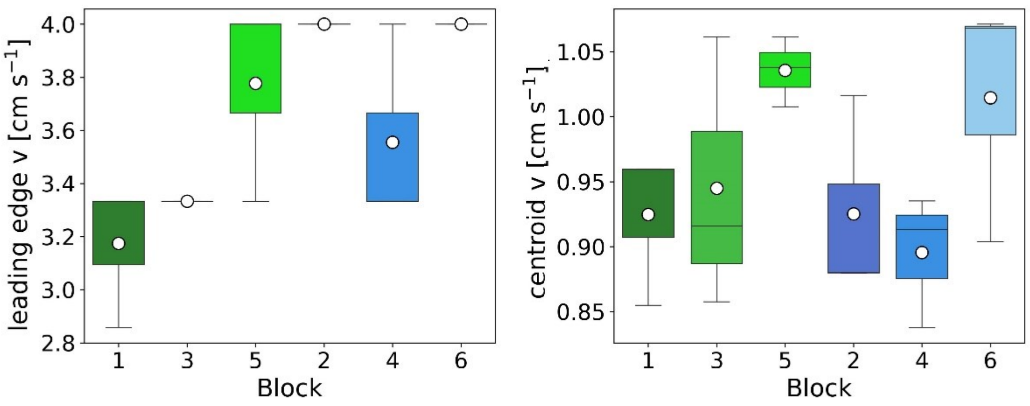


Fig S7: Boxplots of leading edge and centroid velocity (experimental set 1). White circles – mean; black line – median; box – 25-75 percentiles; whiskers – 5-95 percentiles; diamonds – outliers.

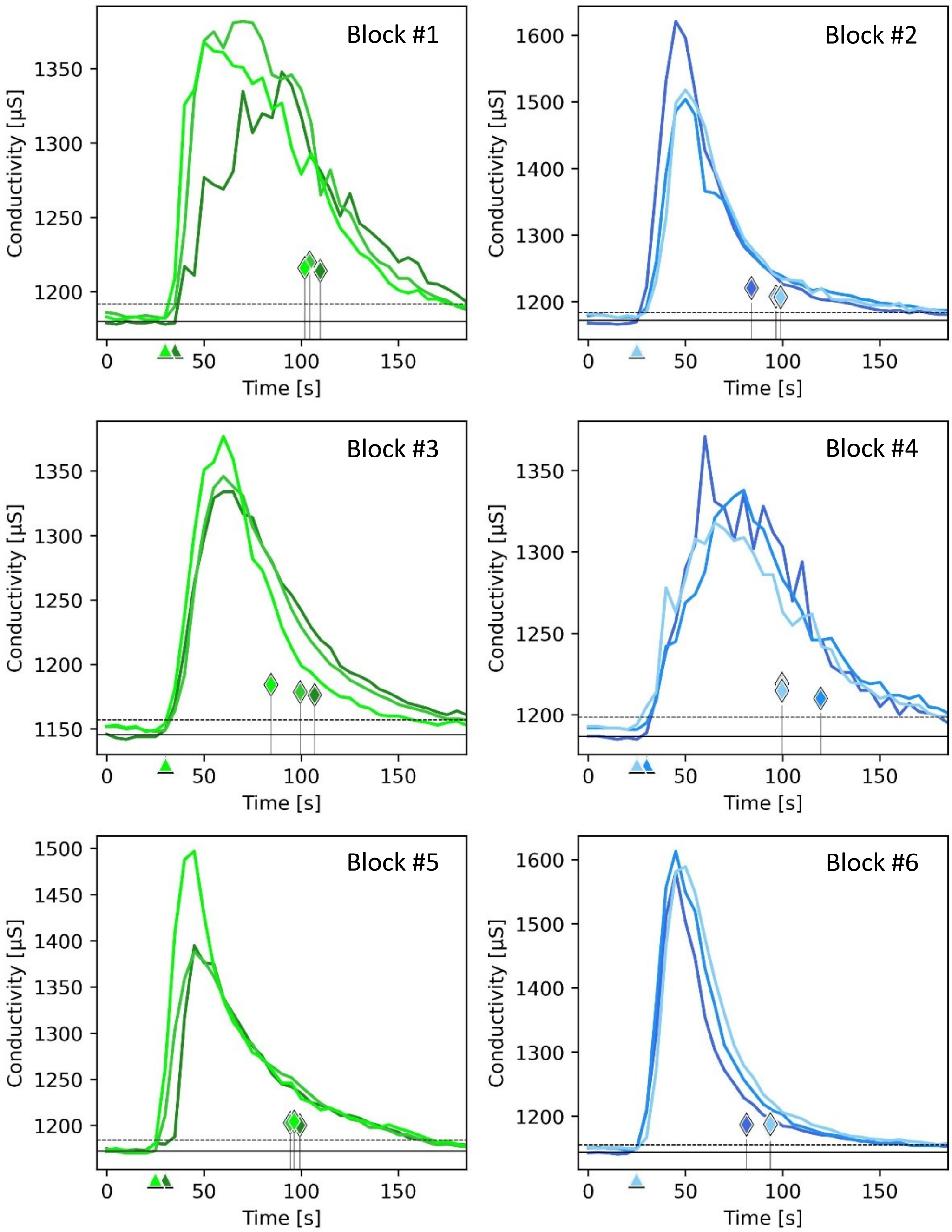


Fig S8: Tracer amplitude of re-combined (green) and uncut (blue) monoliths (experimental set 1). Triangles denote timepoint of leading-edge passage; diamonds are centroids. Different shades of green and blue indicate different replicate trials (1-3).

Supplement E

Post-hoc tests

Table S1: Bonferroni-corrected P-values obtained from Dunn's post-hoc tests, illustrating statistically significant differences between individual blocks (experimental set 2). Colours denote significance: yellow – p < 0.05; green – p < 0.01; dark green – p < 0.001.

	re-combined			uncut		
Surface runoff SRF						
Plot	**1**	**3**	**5**	**2**	**4**	**6**
1	-	0.004	< 0.001	< 0.001	1.000	< 0.001
3		-	1.000	0.003	< 0.001	< 0.001
5			-	0.278	< 0.001	0.001
2				-	< 0.001	1.000
4					-	< 0.001
Subsurface interflow INT						
Plot	**1**	**3**	**5**	**2**	**4**	**6**
1	-	< 0.001	0.010	0.030	0.010	0.080
3		-	< 0.001	< 0.001	< 0.001	< 0.001
5			-	< 0.001	1.000	< 0.001
2				-	< 0.001	1.000
4					-	< 0.001
Percolating water PER						
Plot	**1**	**3**	**5**	**2**	**4**	**6**
1	-	0.007	< 0.001	< 0.001	0.001	< 0.001
3		-	0.001	< 0.001	1.000	< 0.001
5			-	< 0.001	0.008	0.005
2				-	< 0.001	1.000
4					-	< 0.001
Laterally exported water LAT						
Plot	**1**	**3**	**5**	**2**	**4**	**6**
1	-	1.000	0.010	< 0.001	< 0.001	< 0.001
3		-	0.063	< 0.001	< 0.001	< 0.001
5			-	< 0.001	< 0.001	0.605
2				-	0.150	0.013
4					-	< 0.001

Supplement F

Bromide and phosphate concentrations

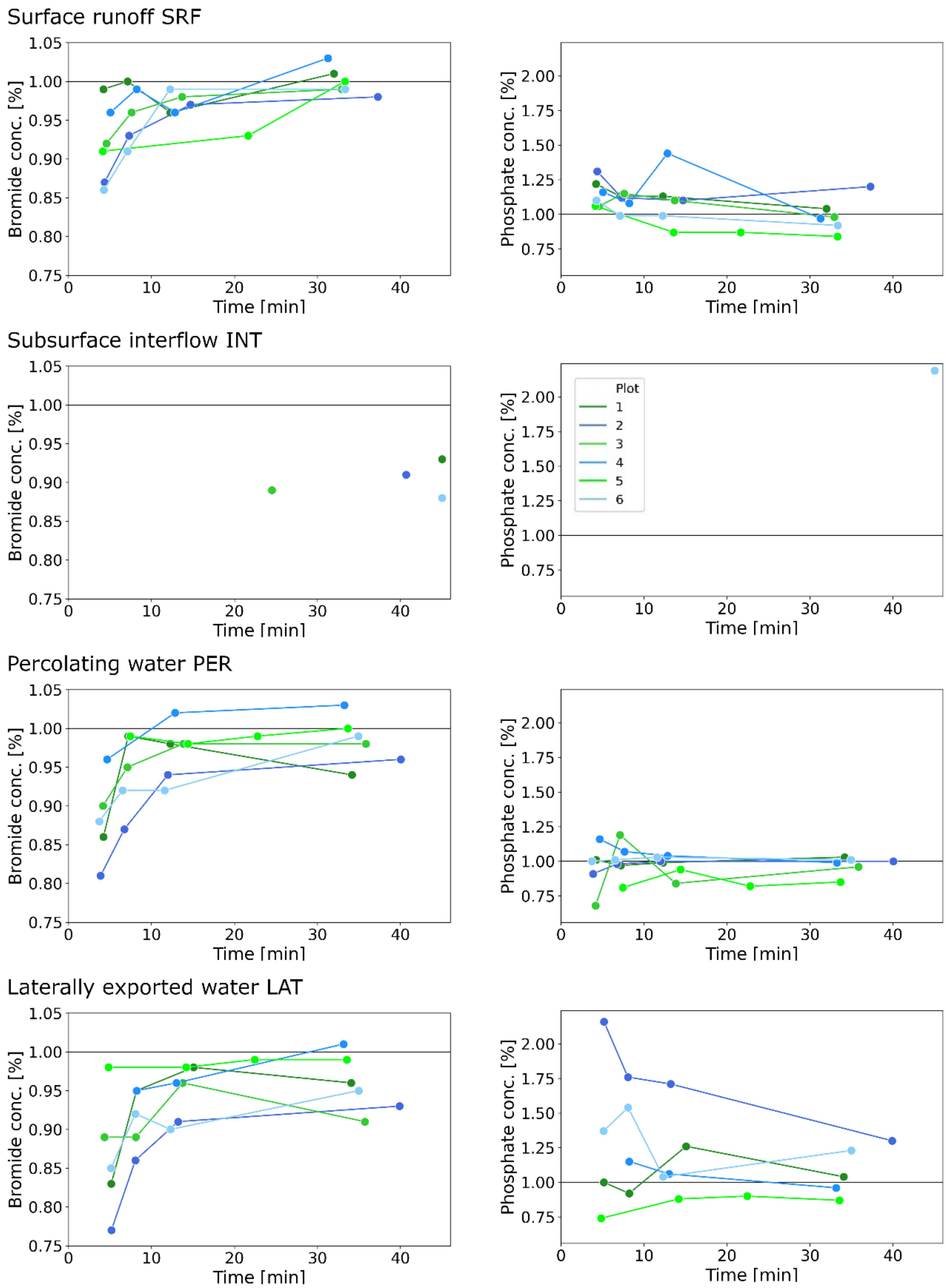


Fig S9: Course of bromide and ortho-phosphate concentrations in the outflow of the respective flow pathways (experimental set 2). The black line indicates 100 % of concentration in the inflow. Green – re-combined blocks, blue – uncut blocks.

Supplement G

Leading edge and centroid velocity

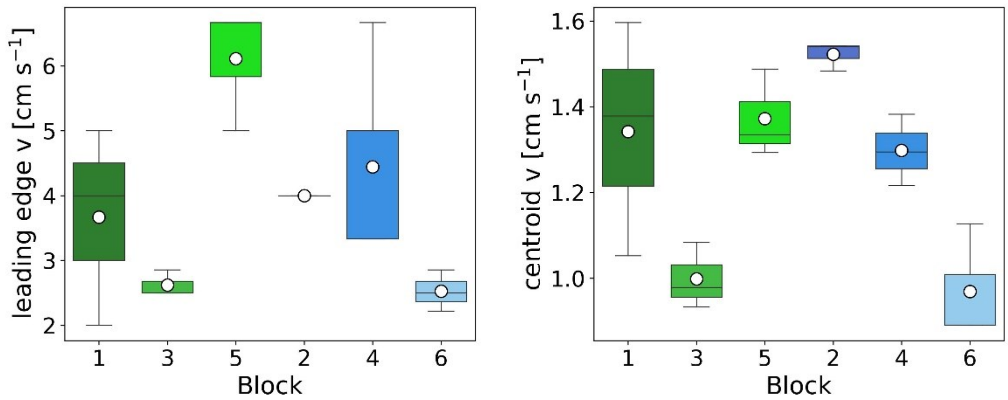


Fig S10: Boxplots of leading edge and centroid velocity (experimental set 2). White circles – mean; black line – median; box – 25-75 percentiles; whiskers – 5-95 percentiles; diamonds – outliers.

References:

Abrantes, J. R. C. B., Moruzzi, R. B., Silveira, A., and de Lima, J. L. M. P. (2018). Comparison of thermal, salt and dye tracing to estimate shallow flow velocities: Novel triple-tracer approach. *J. Hydrol.* 557, 362–377. doi:https://doi.org/10.1016/j.jhydrol.2017.12.048.