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Iron oxidation kinetics and phosphate immobilization along the flow-path from groundwater into surface water

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S.1 Meteorology and Discharge

The monthly averaged temperature during the field experiment varied between 2.2 and 17.9ºC and the monthly precipitation varied between 15 and 114 mm (Table S2). The year 2008 was with an average temperature of 11.1ºC and a total precipitation of 889 mm a normal climatological year. The in-stream reservoir discharge (resembling the combined discharges of overland flow, interflow, direct precipitation and groundwater inflow towards the ditch) varied between no flow and 0.9 $l.s^{1}$ (Van der Velde et al., 2010) (Fig. S2). The reservoir volume varied between zero and 5500 l (Fig. S2). During several periods with high precipitation intensities, the reservoir discharges showed high peaks, especially for in-stream reservoir 3. Overland flow and interflow through macro-fauna burrows (‘biopore flow’) towards reservoir 3 was visually observed during the January event. Overland flow towards reservoir 2 was observed to a smaller extent. No overland flow or biopore flow was observed towards reservoir 1. Apart from the intense peaks in reservoirs 2 and 3, as indicated with arrows in Figure 3, all discharge to the reservoirs originated from groundwater inflow and direct precipitation (Van der Velde et al., 2011). No water quality samples were taken on days with intense discharge peaks so the effect of overland flow or biopore flow on the concentrations observed was minimal.

Monthly cumulative discharge of the reservoirs showed an increase in the groundwater inflow into the reservoirs from reservoir 1 to reservoir 3 (Table S2). Reservoir 3 was constructed at the lowest part of the field (Fig. 1) which explains the higher groundwater inflow in this reservoir. Differences in groundwater inflow may also have been caused by spatial heterogeneity in the hydrologic conductivity of the thin aquifer. In the period Nov. 2007 – Aug. 2008 the monthly averaged inflow into reservoir 2 was 1.3 to 4.5 times higher than into reservoir 1, while the monthly averaged inflow into reservoir 3 was 2.4 to 11.1 times higher than into reservoir 1. The groundwater inflow into the reservoirs was lower in summer (April – Sept.) than in winter (Oct. – March).

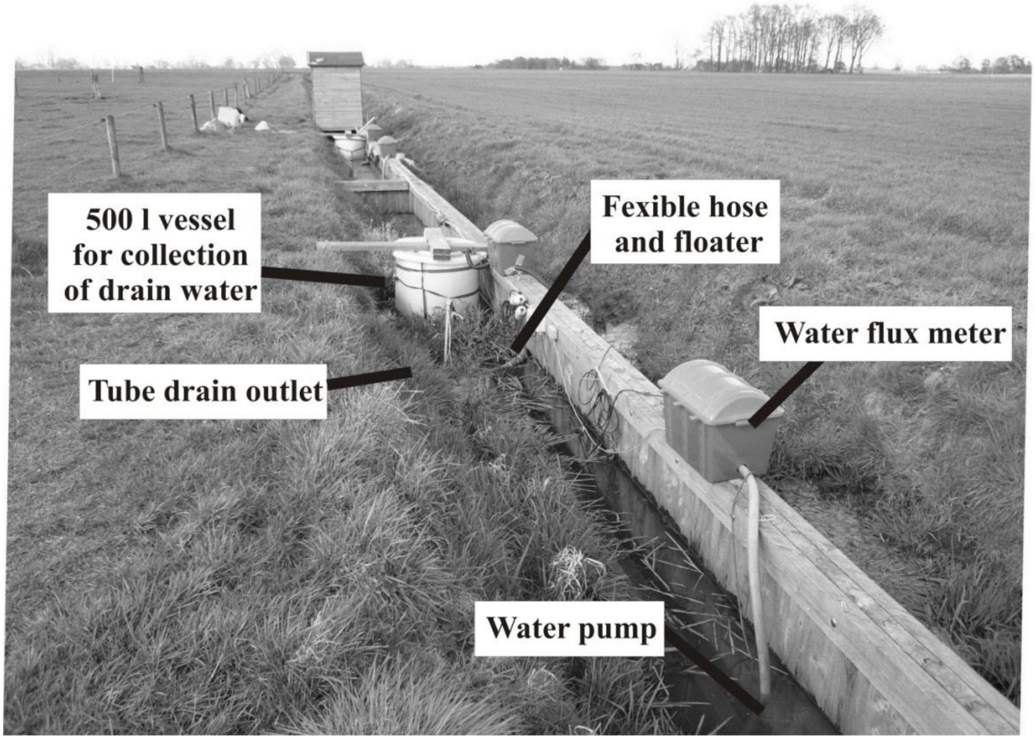

Figure S1. Measurement setup with collector vessels for drain discharge, pumps, and water flux meters. The shed in the back houses the data acquisition and control equipment (from Van der Velde et al., 2010).

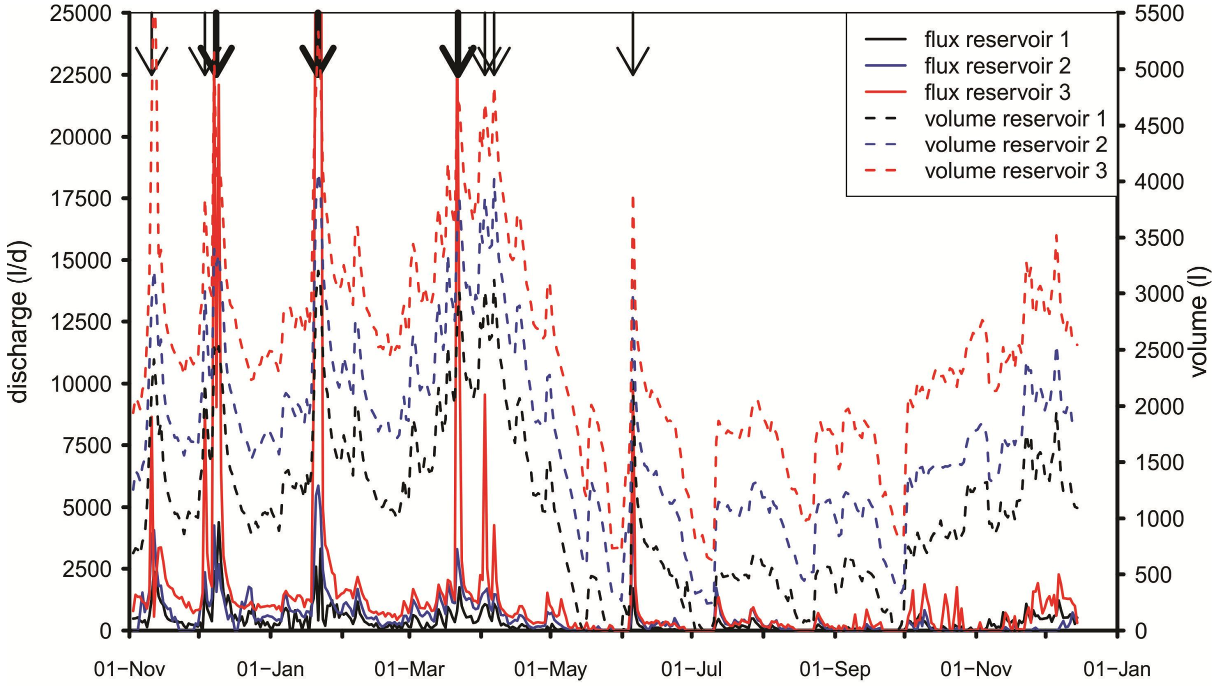

Figure S2. Daily average value of hourly measured in-stream reservoir discharge and reservoir volume. Arrows indicate discharge events on which overland flow and interflow towards the reservoirs occurred (bold arrows multiple day events, thin arrows one day events).

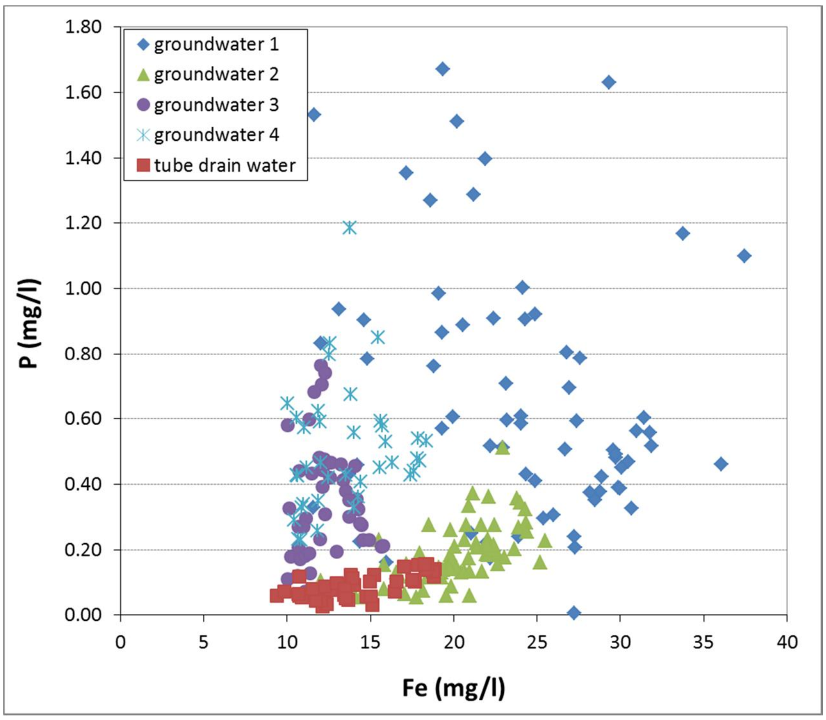

Figure S3. Measured Fe and P concentrations in groundwater and tube drain effluent samples with Fe concentration exceeding 10 mg/l.

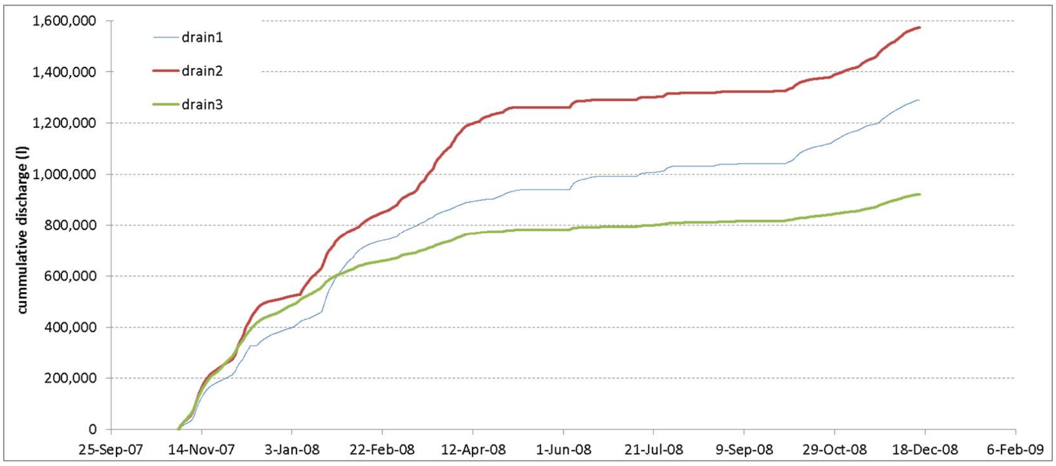

Figure S4. Measured cumulative discharge of three tube drains, until early Dec. 2007 the discharge of tube drain 3 equals the discharge of tube drain 1. Afterwards, the discharge of tube drain 3 decreases. The increase in Fe concentration of tube drain 3 ends early Dec.

Table S1. Aqueous composition of a representative groundwater sample

Compound	Unit	Value
pH		6.4
Elec. conductivity	µS/cm	363
Cl	mg/l	19.98
NO_3	mg/l	< 0.1
SO_4	mg/l	48.65
NH_3	mg/l	0.92
P	mg/l	0.33
Alkalinity	mg/l	107.8
Na	mg/l	19.96
K	mg/l	9.74
Ca	mg/l	27.54
Fe	mg/l	14.5
Mg	mg/l	10.94
Si	mg/l	5.62
Al	mg/l	0.5

Table S2. Monthly averaged meteorological data (derived from KNMI) and groundwater inflow to the in-stream reservoirs.

month	year	temp avg	precipitation sum	sum discharge reservoir 1	reservoir 2	reservoir 3
		°C	mm	m^3	m^3	m^3
11	2007	6.11	71	16.2	21.7	41.2
12	2007	3.15	74	17.3	22.9	41.8
1	2008	4.33	114	15.1	27.0	54.4
2	2008	4.67	29	9.5	17.4	30.3
3	2008	5.37	99	12.8	29.9	40.7
4	2008	8.34	49	6.8	15.8	24.7
5	2008	14.95	48	0.7	3.0	7.5
6	2008	16.48	76	2.2	7.5	9.6
7	2008	17.87	93	4.5	11.0	10.9
8	2008	17.25	61	1.8	4.0	5.6
9	2008	13.13	53	1.0	-	4.2
10	2008	9.72	52	5.0	-	16.6
11	2008	6.20	56	11.3	-	12.5
12	2008	2.16	15	8.4	-	17.4