Linking slopes to the wetland: the relevance of interflow processes for water and nutrient input to an inland valley wetland in Uganda

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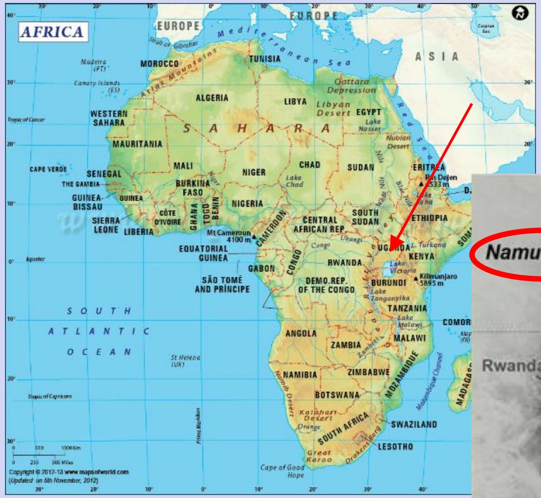

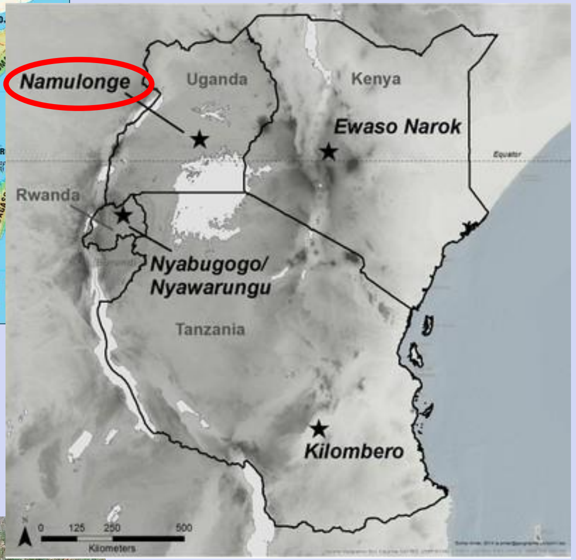

Inland valley wetlands are of increasing importance for small scale farming in East Africa as they are characterised by a prolonged water-availability and high production potential year-round. Yet little is known about the hydrological processes which bring out these favourable conditions, especially when it comes to subsurface contributions from the catchment.

Therefore, this study aims at **characterizing interflow processes and related nutrient transport from the slopes into the wetland**. Thereby we lay the foundation for sustainable management decisions which rely on a solid process understanding which necessarily has to go beyond the wetland.

What did we do?

A field experiment was set up at the slopes of the Namulonge wetland (catchment 31 km^2, wetland 4.5 km^2) in central Uganda. Runoff plots for surface runoff and collection pits for interflow water were installed under three land use types. Soil moisture and nitrate content in the soil water were measured at different slope positions and in the wetland.

A drilling campaign and geoelectrical measurements (ERT) were conducted to characterise the transition from upland to wetland geology.

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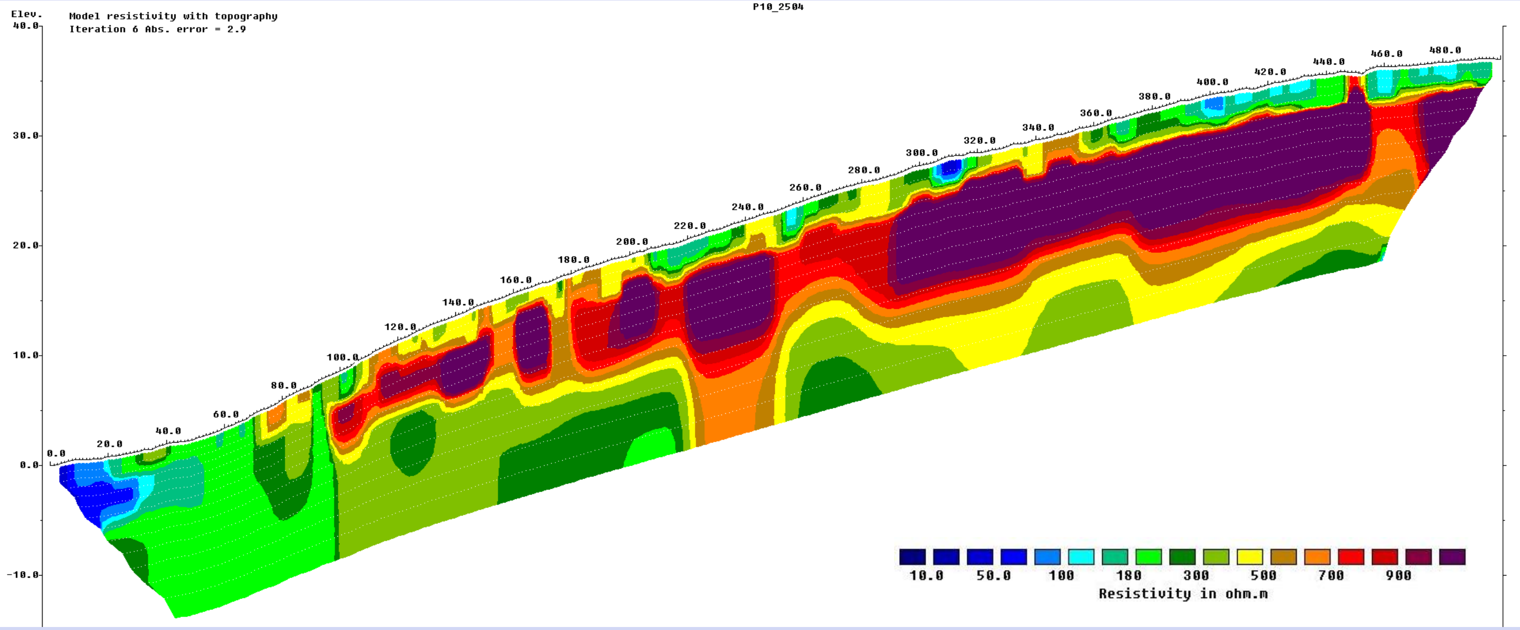
→ **Geology (1/2)**

Fig. 1: ERT profile from the wetland to the hill top showing the differentiation between the upper soil layer, the high skeleton share in the upper saprolite (purple colours) and the underlying finer textured materials as well as the wetland at the slope toe.



Upland geology is characterized by a residual soil layer overlying a highly weathered saprolith whose first 10-15m hold a high skeleton content but at the same time show higher values for ksat than the residual soil. At the **fringe** of the wetland water from interflow can be found at a depth of 50cm in a sandy loam layer and in the first 60cm of the saprolith where it is piled up on horizontally layered muscovit.

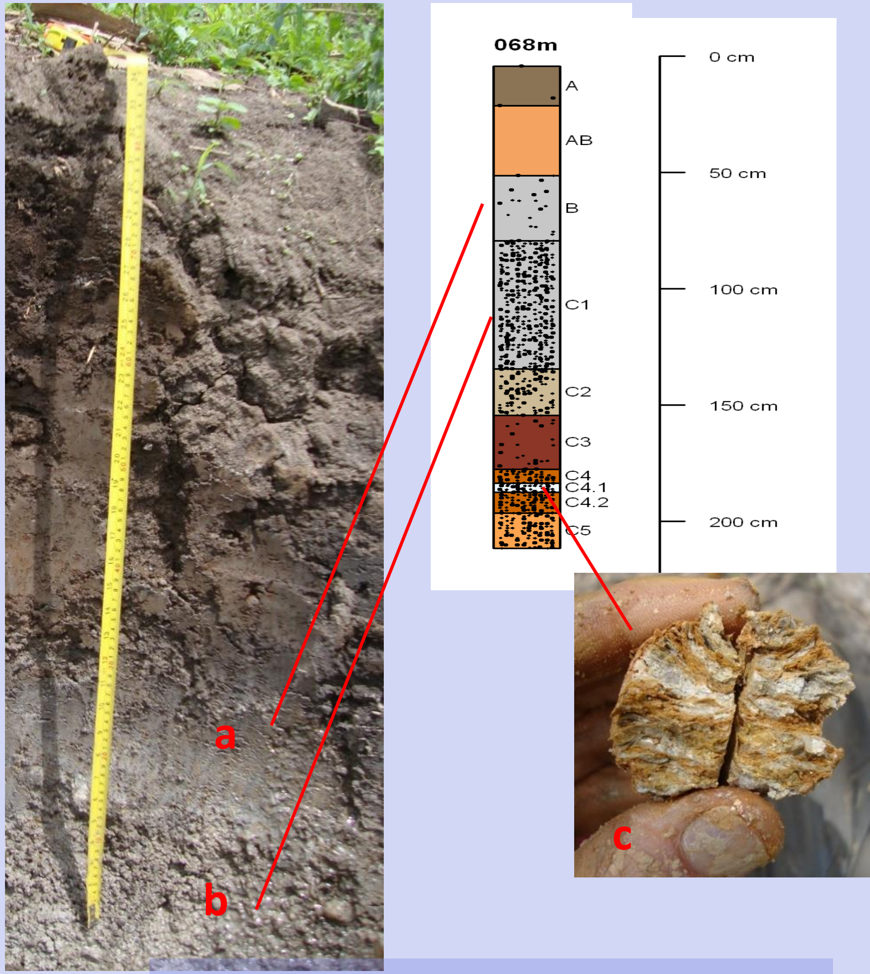


Fig. 2: Soil profile at the fringe of the wetland where interflow from the slopes can be found in a sandy loam layer (a) and in macropores of the upper part of the saprolith (b), (c) showing the horizontally layered muscovit.

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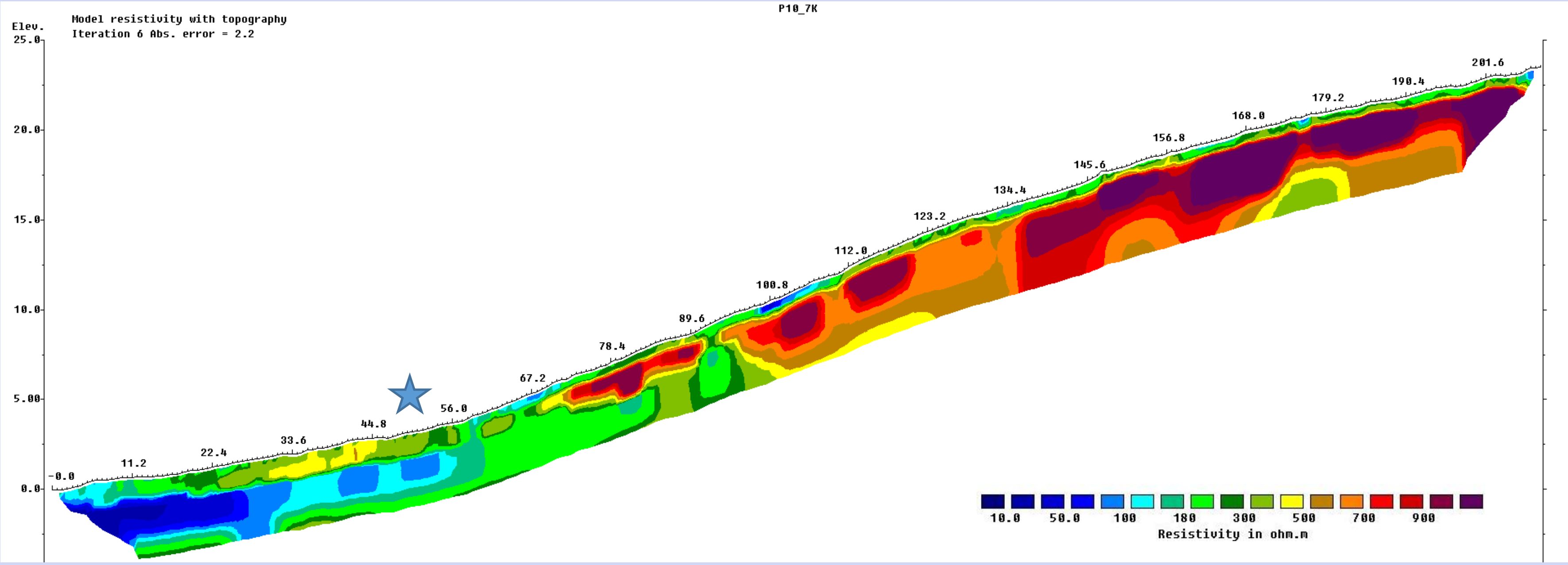
Geology (2/2)

Fig. 3: ERT profile from the wetland to the middle of the slope in a higher resolution as compared to Fig. 1 showing the separation of the shallow aquifer and the soil water in the wetland.



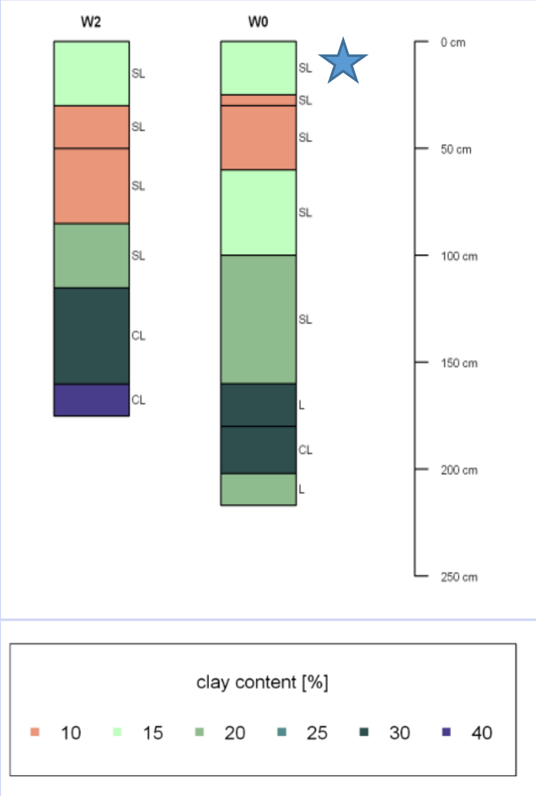


Fig. 4: Clay content and texture at the fringe of the wetland at two sampling points. Note the clay rich layer underlying the sandy loam which connects to the slope toe.

The ERT measurements confirm the hypothesis of Burghof (2017)[1] that a shallow aquifer can be differentiated from the soil water in the wetland. The interflow is connected to both systems, as it enters the shallow aquifer via macropores in the saprolith and the soil water via the sandy loam layer which is separated from the shallow aquifer by a layer with a high clay content.

[1]Burghof, S. (2017): Hydrogeology and water quality of wetlands in East Africa. Case studies of a floodplain and a valley bottom wetland. Dissertation. University of Bonn.

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Interflow and soil moisture

After dry periods interflow **increases gradually** with increasing soil moisture in the deeper soil layers with highest values at soil moisture levels near saturation at 20-40cm depth. At the end of rainy periods interflow **continues** at rather high flow levels. Yet the **duration and level** of interflow during the dry period is determined by the **length and continuity** of the precedent rainy period. As compared to the agriculturally used plots, interflow under semi-natural vegetation **ceases more quickly** in dry periods due to high transpiration of continuous plant cover even in the dry seasons.

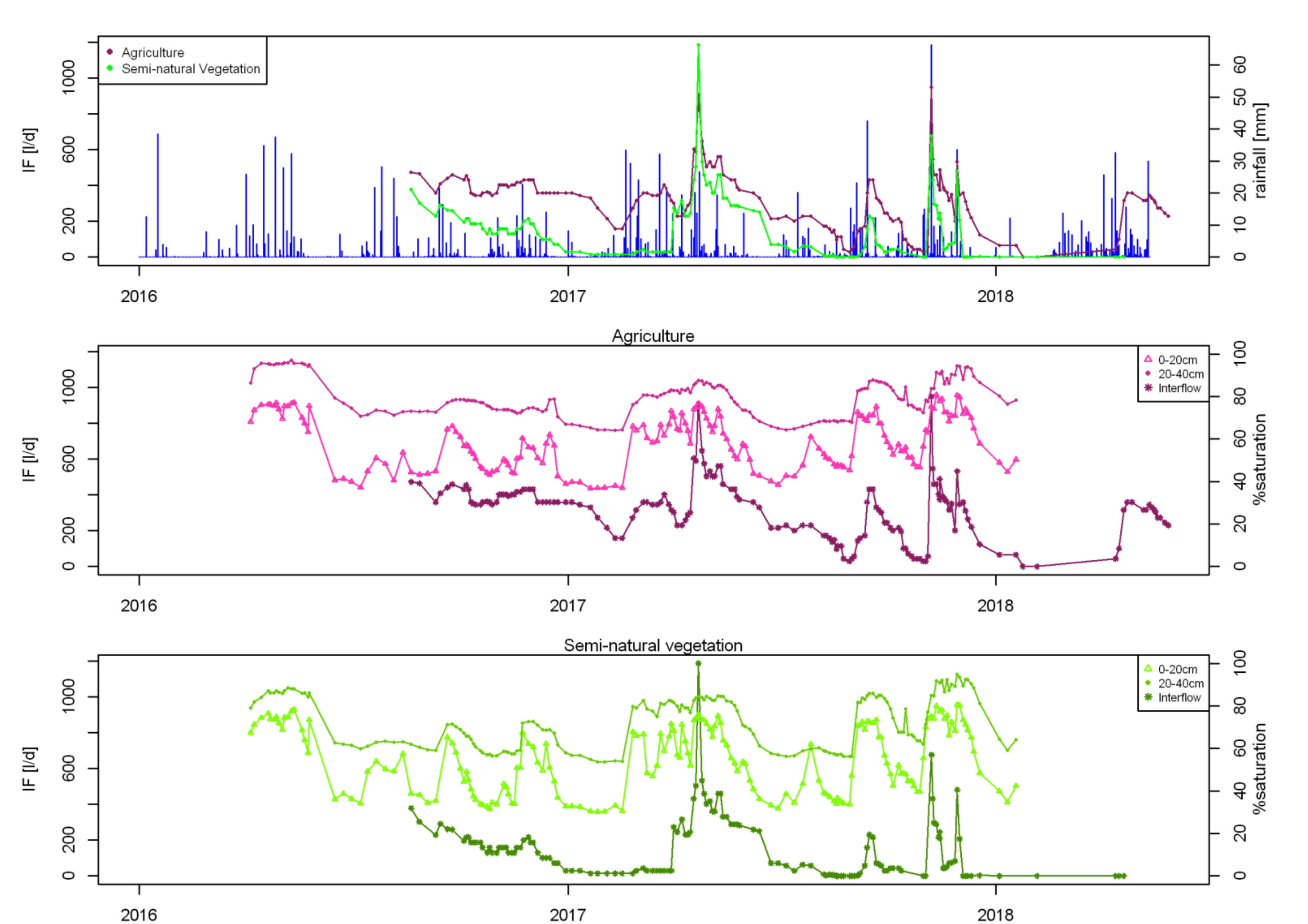


Fig. 5: Interflow levels under agriculture and semi-natural vegetation compared to daily rainfall (top) and compared to soil moisture at the slope (middle and bottom).

Nitrate content in the soil water and in the interflow show a **similar pattern**. Yet nitrate content in the soil water is more **variable** while there is always a **background concentration** of nitrate in interflow water. At the same time there is an **immediate increase** of the nitrate concentration in the interflow after rainfall events. At high soil moisture levels nitrate in interflow and soil water still follow the same pattern but show rather low values for the soil water and comparably high values for the interflow. Land use on the slope has an impact on nitrate concentration in the interflow with **higher values for the unfertilized agriculturally used plots** as compared to semi-natural vegetation.

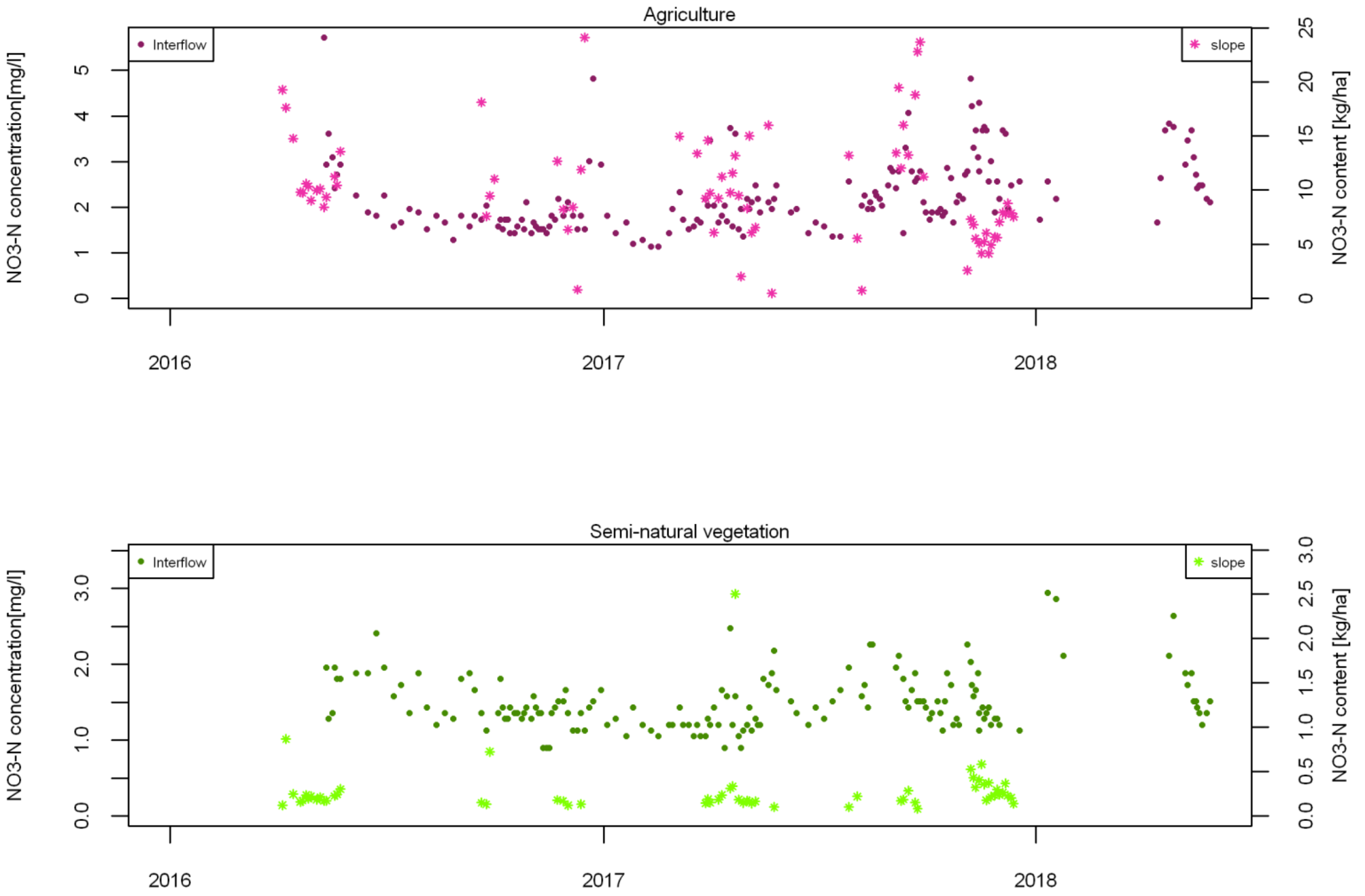
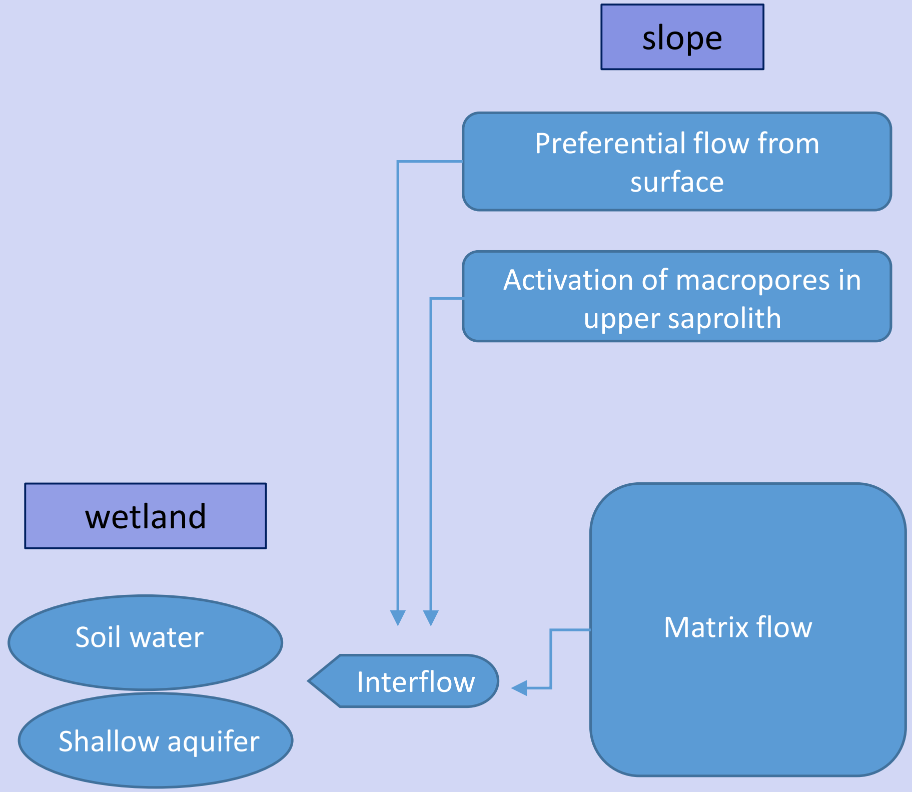


Fig. 6: Nitrate concentration in the interflow and nitrate content in the soil water along the slopes for the agriculturally used plots and plots under semi-natural vegetation.

The concept

Interflow water which feeds soil water and the shallow aquifer of the wetland infiltrates along the slopes. Thereby **different pathways** are active. The background nitrate concentration and the slow increase of interflow after dry periods and longer persistence of interflow after extended and continues rainy periods suggest a component of **matrix flow where a mixing of water** takes place. Yet the immediate response of nitrate concentration in the interflow after rain events suggest **additional preferential flow paths**. Corresponding to high nitrate levels in surface runoff, most likely continuous macropores from the surface are active. At the same time the coarser texture of the matrix and the resulting increase in ksat from the residual soil to the upper saprolith combined with the high interflow levels at high moisture contents suggest an additional activation of macropores at saturation of the residual soil.



Your ideas and suggestions

We are curious about your ideas and suggestions. What do you think?
Do you have any further ideas or experiences with interflow and macropore flow in tropical saproliths?
We are looking forward to your comments and a fruitful exchange during the session, in the comments section or during direct contact via email: clsche@uni-bonn.de