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Hydrology and Earth System Sciences
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Discussions

Interactive comment on "Continuous in-situ monitoring of nitrate concentration in soils – a key for groundwater protection from nitrate pollution" *by* Elad Yeshno et al.

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We thank the reviewer for the encouraging statement on the importance of real time monitoring of nitrate to improve agricultural productivity while reducing water resources pollution potential.

General comments Comment 1: Continuous suction of pore-water from unsaturated porous medium (and bringing it up to surface in small diameter tubing) must impose some limitations of minimum water-content (soil-texture dependent) in which this apparatus can work (what suction pressures are imposed on the cups?). A TDT for water content monitoring was installed in the experimental setup, therefore I am sure the au-

thors have some understandings considering the soil moisture conditions effects on the nitrate monitoring possibilities that are of interest for the HESS readership. Therefore, I encourage the authors to elaborate on this issue.

Reply to general comment 1: The efficiency of the nitrate monitoring system is indeed depended on its ability to extract a stream of soils solution, from the soil pores and into the sensor's optical flow cell. Accordingly, the system operation effectivity is depended upon the soil water potential. However, in agricultural soils, where the system is designed and intended to be installed, the water content is usually high enough to allow root uptake, and as such is sufficient enough to enable efficient operation of the monitoring system. Nevertheless, at low water content (water potential), as may happen between growing seasons or during dry periods, both water flow and nitrate transport is decrease dramatically, and consequently the potential for nitrate leachate out of the root zone to deep unsaturated zone is limited, thus reducing groundwater pollution potential. During the column experiments the hydraulic and suction parameter were set to represented typical agricultural soils condition for sandy loam, and were set to water content levels between 15 – 16.5 %. The porewater suction pressures levels were set between 600 - 800 mbar while typically the soil water pressure in these water contents is in the range of 830 - 950 mbar (figure 1) (Filipović et al., 2016). The manuscript was revised accordingly to account for the soil water potential impact on the measurement efficiency (lines 181 - 186). The sampling tube diameter (1.9 mm) and length (<10 m) did not impose limitation to pore-water stream from the porous interface to the optical cell.

Comment 2: The use of the term "absorbance intensity" throughout the text, figures and supplements instead of absorbance is somewhat inadequate. Absorbance is defined as the log of a ratio of light intensities. Change throughout.

Reply to general comment 2: The comment is accepted, and the manuscript was revised accordingly in all relevant places.

Specific comments:

Comment 1: L 20 “untreated” do you mean non-disturbed?

Reply to specific comment 1: The term "untreated" in line 20 is referring to soil solution and is mentioned to emphasize that the sampled soil solution was not filtered, diluted or spiked with reagents. For clarification the manuscript was revised and corrected accordingly (line 21).

Comment 2: L 40 I would suggest to enhance the arguments for this type of monitoring saying: Nitrate uptake was observed and modeled as passive uptake with a threshold root-zone concentration (Cmax) from which the roots can up take only S*Cmax (S - root water uptake, e.g. Simunek and Hopmans, 2009 (Ecological Modeling)). This mechanism imposes a jump in deep leaching of nitrate at times when C>Cmax, hence monitoring of nitrate concentration can serve as controller leading to increasing N use efficiency and decreasing groundwater contaminations. Values of Cmax for different crops were reported between 20 to 45 mg/l NO3-N, (Kurtzman et al., 2013; Levy et al., 2017 (HESS)).

Reply to comment 2: Comment is accepted, and a summary of the review’s suggestion had been added (lines 39 and 47).

Comment 3: L 90 – “second derivative spectroscopy” is not a clear phrase for most of the hydrology readership. 1-2 sentences defining this term will help.

Reply to comment 3: Comment is accepted, and the manuscript was enhanced to better describe the second derivative spectroscopy technique (Lines 92 – 96).

Comment 4: L 200 – With small sample size (4-7 points) it would help to add to the R2 values also the P values of the slopes of the regression models, to enhance the sense of their significance.

Reply to comment 4: Comment is accepted, the P-values for each curve was added in the body of figure 3. Additionally, the methods section was revised to account for

the R2 and their corresponding P values analyses MATLAB liner regression fitting tool (Lines 157 – 159).

Comment 5: L 238, L 240 “1.3 m” should be 1.3 m below surface or a depth of 1.3 m. Same for 13.3 m.

Reply to comment 5: the comment is accepted, and the manuscript had been corrected accordingly, lines 219, 233 and 236.

Comment 6: L 310. I would start this paragraph with something like: A high R2 can be achieved also with wavelengths in which the sensitivity of the absorbance to nitrate concentration is extremely high, and absorbance could not be used for estimating nitrate concentrations. Therefore, the variance of the absorbance values that correlate well with the range of nitrate concentrations is a second criteria for choosing the best wavelength. Starting the paragraph with “Variance..” is ambiguous.

Reply to comment 6: The comment is accepted and the suggested comment by the reviews had been addend to the manuscript (lines: 305 – 308).

Comment 7: Figure 8 or L 337. Where are the calibration equations? Put them in the text or on the Figure.

Reply to comment 7: The comment is accepted and the corresponding equation for each curve had been added to figure 8.

Comment 8: L 417 delete “-based”.

Reply to comment 8: accepted, the word "based" had been deleted from the manuscript (line 402).

Comment 9: Figure 9. It would be better not to use the calibration data (red points) in this analysis, and draw the predicted-observed regression lines (and R2) only for the validation points of the 3 later sampling dates. That would give a better estimation of the performance of the method.

Reply to comment 9: comment accepted, the data points from August – 2015 was removed from the plot and the regression lines are now account for the data of the remaining 3 sampling dates.

References:

Filipović, V., Ondrasek, G. and Filipović, L.: Modelling Water Dynamics, Transport Processes and Biogeochemical Reactions in Soil Vadose Zone., 2016.

Please also note the supplement to this comment:
https://www.hydrol-earth-syst-sci-discuss.net/hess-2019-198/hess-2019-198-AC1-supplement.pdf

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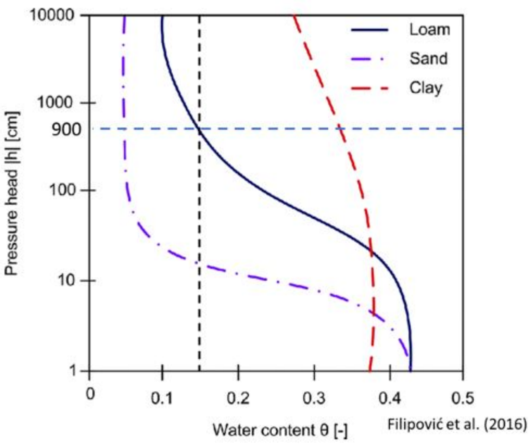

Figure 1 – Loam, sand and clay soil's retention curves (Filipovic et al., 2016). The dashed lines mark the matric potential for Loam at about 15 % water content, and which is about 900 cm (equivalent to ~880 mbar).

Fig. 1.