Interactive comment on "A meta-analysis of groundwater contamination by nitrates at the African scale" *by* Issoufou Ouedraogo and Marnik Vanclooster

Anonymous Referee #1

Received and published: 26 April 2016

General Comments

Ouedraougo and Vanclooster (2016) provide an interesting meta-analysis of groundwater nitrate studies across Africa. They build a simple multiple linear regression model to explore the potential factors affecting observed groundwater nitrate concentrations. The paper is interesting and within the scope of HESS. The novel contribution is the first synthesis of nitrate data across Africa. Unfortunately, the use of English through the paper is regularly strange and difficult to understand. I have included a few examples in the technical corrections but there are many more. It is suggested the paper is fully reviewed by a native English speaker prior to publication.

The issue of bias in the observed nitrate datasets analysed is not discussed in de-

tail. It should be acknowledged explicitly in the text that a number of studies analysed have been investigating specific groundwater quality issues and thus the dataset may be biased towards higher concentrations. If possible, the number of studies that address specific groundwater nitrate contamination issues should be quantified against the number of more general groundwater hydrochemistry studies. I assume there will also be bias towards studies on aquifers which are productive and used for water supplies and this should also be noted.

A large number of datasets discussed in the paper are given as available "on request" from the author. Please provide these datasets as supplementary information.

Specific Comments

Title: I suggest "statistical modelling" is included in the title somewhere to better reflect the contents of the paper

P3L78 – I would be inclined to add a subheading in here for the section on methods for assessing groundwater vulnerability

Table 2 – It would be helpful to add another column showing for each study whether this is a peer reviewed journal article, book or other grey literature. As per the general comments, it would be helpful to detail for each study whether the study is addressing a nitrate contamination issue or is a more general hydrogeochemical study. This could be in the form of another column in the table.

P8L282-286 – I do not agree that increasing nitrate concentrations are observed with increasing recharge. If anything, they appear to decrease – is this due to dilution of nitrate in recharge?

P10 L357 – The probability plot in figure 10 shows a close to normal distribution but the points do not fall exactly on the straight line. The text should be changed to say that the distribution is close to normal.

L11 L414-422 The issues of lag in nitrate transport through the unsaturated zone and

denitrification are not well explained and should be re-written taking into account recent work on nitrate in the unsaturated zone. "Also, given the larger travel times associated with the recharge of deep groundwater systems, there is an enhanced opportunity for denitrification" – Do you mean there is more opportunity for denitrification in the unsaturated zone? Or in the saturated zones of deep confined aquifers? The evidence for unsaturated zone denitrification is limited (Kinniburgh et al., 1994; Rivett et al., 2008) and I do not think this should be used to explain why deeper aquifers have lower nitrate concentrations. There is a substantial body of literature showing evidence for nitrate accumulation in the unsaturated zone (Ascott et al., 2016; Wang et al., 2016; Worrall et al., 2015)– it may be that nitrate concentrations are lower in deeper aquifers because recharge from periods of high fertiliser use have not reached the water table yet.

Technical Corrections

P2L41 – remove "However,"

P2L59 – change "no comprehensive and synthetic study" to "no comprehensive synthesis of"

P2L63 – Define UN SDGs on first use

P2L67 – change "non-homogeneity" to "heterogeneity"

P9 L320 – do not need to explain how p-values work.

Subscript for 3 in NO_3 not used consistently.

Figure 3 legend reports nitrate concentrations to 2 decimal places. This is not necessary – just report whole numbers.

P12 L426 – Humps – do you mean groundwater mounding?

Figure 8 looks stretched horizontally – please correct this. Please label each sub-figure (a), (b), (c) and (d) and refer to them in both the figure legend and text

References

Ascott, M.J., Wang, L., Stuart, M.E., Ward, R.S., Hart, A., 2016. Quantification of nitrate storage in the vadose (unsaturated) zone: a missing component of terrestrial N budgets. Hydrological Processes, DOI: 10.1002/hyp.10748

Kinniburgh, D.G., Gale, I.N., Gooddy, D.C., Darling W.G., Marks R.J., Gibbs B.R., Coleby L.M, Bird M.J., West J.M, 1994. Denitrification in the unsaturated zones of the British Chalk and Sherwood Sandstone aquifers. British Geological Survey, Keyworth, UK.

Rivett, M.O., Buss, S.R., Morgan, P., Smith, J.W., Bemment, C.D., 2008. Nitrate attenuation in groundwater: a review of biogeochemical controlling processes. Water Research 42, 4215-4232.

Wang, L., Stuart, M., Lewis, M., Ward, R., Skirvin, D., Naden, P., Collins, A., Ascott, M., 2016. The changing trend in nitrate concentrations in major aquifers due to historical nitrate loading from agricultural land across England and Wales from 1925 to 2150. Science of The Total Environment 542, 694-705.

Worrall, F., Howden, N.J.K., Burt, T.P., 2015. Evidence for nitrogen accumulation: the total nitrogen budget of the terrestrial biosphere of a lowland agricultural catchment. Biogeochemistry 123, 411-428.