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Hydrology and Earth System Sciences Discussions

Interactive comment on "Tracing the spatial propagation of river inlet water into an agricultural polder area using anthropogenic gadolinium" *by* J. Rozemeijer et al.

J. Rozemeijer et al.

joachim.rozemeijer@deltares.nl

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Thanks for your review! Our responses are preceded by a "#"

Abstract - Do not use the word 'diverted' river water. Instead, take inlet water or river water for water inlet purposes or water with a different chemical composition as compared to local drainage water

We removed 'diverted'.

- Use 'chemical surface water quality'

Changed according to suggestion

Ch 1 Introduction - reference to legislation and policy measures are not very relevant, skip text

We removed this paragraph as suggested.

- use 'inlet water management'

It's not clear from this comment where we should use this expression

- mass balance studies can provide insight, it is just a matter of scale at which these studies are applied to - information about the penetration of inlet water to the water system can in detail be derived from simulation models, but also from detailed mass balance studies (see above)

We agree that a mass balance approach that includes sub-balances for smaller parts of the polder may provide insight into the spatial propagation of inlet water. We changed the text into: "This information could be obtained from more detailed water and mass balances or from process-based hydrological water and solute transport modeling."

- the objectives are: 1) obtain a spatial image 2) improve interpretation of chemical water quality data 3) evaluate the results of simulation models on surface water hydrology and quality -basically, you are trying to track all different sources of the surface water present

We think it is an excellent suggestion to extend the objectives. We changed the objectives into: "The objectives of this study were (1) to obtain a spatial image of the contribution of river inlet water to the water composition in the channels and ditches of a hydrologically complex polder system and (2) to apply this information for the interpretation of chemical water quality monitoring data and for the evaluation of an integrated water and solute transport model."

Ch 2 Methods 2.1 - add section on the Gd element here (present/not present; signifi-

cant difference between river and polder water, waste water treatment plant, etc., show some typical concentrations and/or anomalies

We added: “Rabiet et al. (2009) considered Gd-anomalies lower than 1.4 uncontaminated by anthropogenic sources, as Gd-anomalies up to 1.3 have been found in natural waters. In waste water treatment plants, Gd-anomalies up to 1680 have been reported in literature (Bau and Dulski, 1996). In rivers, Gd-anomalies may vary in time and space and depend on the number of MRI patients and on the contribution of effluent from waste water treatment plants to the total discharge. For the German rivers Weser, Ems, and Elbe, Kulaksiz and Bau (2007) reported Gd anomalies around 5.”

2.2 - check number of monitoring locations (22 or 23)

22 (1 flow proportionally, 6 weekly, 15 monthly. Changed accordingly.

2.3 - add text on further processing Gd(ano) data, how do you proceed from the end of the paragraph

There is no further processing to be mentioned here. We directly presented the calculated Gd-anomalies on maps (figure 3).

2.4 - was the surface water stream velocity zero at the moment of sampling? should be for better results - at/before 5-8-2010, was Q discharge zero and Q inlet>0? provide information - at/before 22-10-2010, was Q inlet zero and Q discharge>0? provide information

The discharge at the outlet is never zero (water is discharged in summer as well). In addition, the inlet continues year-round, although in winter the (relative) amounts are less.

- at end of paragraph, add text on why pre-concentration procedure was not followed

We reached sufficient accuracy with the presented setup. Pre-concentration would have been much more labor-intensive and expensive. We changed the text into: “This

setup enabled accurate measurements (with a reproducibility limit of ca. 10%) without the frequently applied labor-intensive pre-concentration procedure.”

Ch 3 Results 3.1 - add Gd Meuse data if present, check monitoring network rivers in NL

The Gd-anomalies measured at the two direct Meuse water inlets are representative for the Meuse Gd-anomaly at the moments of sampling.

- can you quantify the mixing proportions at this stage? (x=local drainage water, y=inlet water; calculate x:y)

We deliberately only presented the Gd-anomalies and not the mixing proportions. The anomalies were directly derived from measurements and are objective. By presenting mixing proportions we would introduce several assumptions and uncertainties (e.g. variable residence times, variable Gd anomalies at the inlets). In addition, the difference in the Gd-anomaly between the direct inlets and the inlets from the eastern polders would be a problem when presenting inlet water proportions.

- please compare data for 5-8-2010 and 22-10-2010: 1)spatial pattern 2) absolute concentration and/or anomaly level

This has already been described from p1420 l6 – p1421 l22.

- check flow direction at/near waste water treatment plant outlet; provide information through water board

This has been discussed with several specialists at the Water Board. They agreed on the possible explanations that we give in the paper (p1420 l26-p1421 l2 and p1421 l15-19). Flow directions and residence times are highly variable in time and space and not known for the smaller ditches.

3.2 - to compare the chemical surface water quality data with Gd(ano): did you take the right monitoring data for the comparison? Regular samples taken at Q inlet>0 or at

Q inlet=0?

We compared all year-round measurements and did not select data from periods with or without water inlet or from dry or wet periods.

- what was your hypothesis on chemical surface water quality data?

Our hypothesis was that the inlet water contribution affects the chemical water composition at the monitoring locations.

- to my opinion, Ptot, NO3 and EC only are significantly different, stick to these three variables in your text

We will add a statistical test on the differences. We will add a table with test results and significance levels and refer to this in the text.

- at the end of paragraph, go back to Gd(ano) and proportions, show calculated proportions first, then show calculated fractions, and finish with comparison

We have rewritten this section and refer back to the Gd-anomalies at the end of the paragraph

3.3 - are these modeling results and/or Gd(ano) data?

These are modeling results as follows from (among other places) p1422 l16-17.

- I do not understand arguments on parametrization and weir crest levels. Please add more/better information on reasons why it did (not) work, find better arguments

We do not know why the modeled inlet water proportions in the northern part of the polder are relatively low. As explained in the study site description “the local flow directions are complex and only marginally known. The local flow directions depend on the precedent weather conditions, weir crest levels, and on the intermittent influence of several small-scale pumping stations.” Therefore, we stated that “The low inlet water proportions in the northern part of the polder are probably caused by an incorrect

parameterization of a small-scale pumping station or an incorrect weir crest level.” We cannot give more information or a better explanation.

- % mentioned, 51% and 5.1% looks very accurate, my proposal is to use 50% and 5%

Changed according to suggestion

Ch 4 Discussion and conclusions - no results here, you already mentioned those: skip first three paragraphs - please discuss: method, monitoring programme on Gd, and results - please draw conclusions on the objectives (see introduction) - please refer to the previous papers by other authors and check whether their conclusions and recommendations are valid and/or rejected - relevance of policy measures not clear/do not bring more weight in the text; Ptot may also decrease - your assumptions or hypotheses?

We agree that the first part (P. 1423, lines 5-24) is a too long summary of the results. We reduced this section to 2 sentences to summarize our main results/ draw conclusions on the objectives: ”In this study, we obtained a spatial image of the propagation of diverted river water into a hydrologically complex polder system during dry and wet conditions. We applied this information for the interpretation of chemical water quality monitoring data and for the evaluation of an integrated water and solute transport model.”

We extended the rewritten discussion with: a discussion on the magnitude (and significance) of the differences and the implications (2) a comparison with results from the literature.

- reference of Hendriks (1990) was for a groundwater seepage area, results might be different from the location that you studied

Quarles van Ufford is also a seepage area. We agree that differences in the hydrological situation may give different results. Still, the study by Hendriks shows that our concept of Figure 7b is valid.

Figures: please complete the captions, so that these will be explanatory by themselves;

arrows blue and red; use larger number fonts; add text to Fig. 6 as 1) = . . . and 2) = . . .

Changed according to suggestions

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 9, 1411, 2012.