

Response to Reviewer 1

General comments

I would like to thank the authors for all the hard work they put into the revision of this manuscript, which has been improved much. My questions and comments have largely been answered satisfactorily. A list of some minor suggestions can be found in the specific comments. Once they are answered, I recommend publication of the article.

We appreciate the reviewer for his confirmation and his contribution for improving the manuscript in the previous and the current revision.

Specific comments

1. L99: A bracket is missing before '2019'

Agreed. Added "(" before "2019".

2. L100: change 'catchments' to 'catchment'

Agreed. Changed "catchments" into "catchment".

3. L102: change '...pattern on the nutrient N...' to '...patterns of the nutrients N...'

Agreed. Changed "pattern on the nutrient" into "patterns on the nutrients".

4. L103: change 'since 1990s...' to 'Since the 1990s...'

Agreed. Added "the" before "1990s".

5. L107: Please expand 'NAP' once. The explanation given in the first version is not necessary.

Agreed. Added ", NAP: Normalized Amsterdam Peil" after "NAP".

6. L108: Please remove the full stop between the brackets.

Agreed. Removed "." between "NAP)" and "(Fig.2".

7. L203: In the answers to the comments a value of 1.5 mm was given for the seepage. In the manuscript, a value of 2.0 mm was given. Which one is true?

We apologize for this discrepancy. Indeed '1.5 mm per day' was typed in our previous response to the reviewer, see Reply to Reviewer 1 comment 34. However, '2 mm per day' as presented in the manuscript was the value taken in our calculation based on the behavior of the mixing model and calibration using the measured water levels (Figure 3).

8. L211: Please correct the formatting of the text after the variable.

Changed accordingly.

9. L246: change 'significant' to 'significantly'

Agreed. Changed "significant" into "significantly".

10. L271: Change 'The coefficients of determination (R^2 "Pearson method used)... to 'Pearson's coefficient of determination (R^2)...'

Agreed. Replaced "coefficients of determination (R^2 "Pearson method used)" by "Pearson's coefficients of determination (R^2)".

11. L325: It is no wonder the model cannot capture the short-term peaks of TP, since the model runs with a daily time step while the measurements were hourly. It would be better to aggregate the hourly measurements to daily averages and compare them to the model results for all parameters. Which of the sub-daily values were used for model comparison, anyway? Noon time? Midnight?

The time step of our model is as well an hour, which is the same as the measurements (The measurements are aggregated from 5 min (EC), 10 min (NH₄), and 20 min (TP) intervals to an hour). It means we compared two datasets both with hourly interval.

The time for the sub-daily values used for model comparison were set at 10:00 am, as that usually is the time the samples were measured in the field or collected and preserved for later analysis in the lab.

12. L378-384, Figure 4 and 5: Please add the unit to the turbidity axis, the SW level, water temperature and EC.

Agreed. Figure 4 and 5 were changed accordingly. Please see the manuscript for the new version of these two figures.

13. L412: A bracket is missing before 'Fig 2' and a full stop after 'Fig'.
Changed accordingly.

14. L393-431: There are still a lot of repetitions in chapter 4.1, e.g. the sentence in lines 426-428 was already used in lines 324-326. Please remove the repetitions and consolidate the text.

Agreed.

Line 324-326 changed into *"During this particular period the minimum measured TP concentrations are captured nicely by the conservative model, but the distinct peaks up to 3 mg L⁻¹ are not."*

Section 4.1 now reads as below:

"4.1 Hydrological mixing between groundwater and rainfall

In a highly manipulated low-lying urban catchment like Geuzenveld, mixing between rainwater and groundwater in the ditches is fast due to the high fraction of impervious area and the installation of both a rainwater and a groundwater drainage system that transport these contrasting water types efficiently to the ditches (Yu et al., 2019; Walsh et al., 2005). Runoff in Geuzenveld has EC of about 166 μS/cm (Yu et al., 2019), which is lower than the groundwater EC (1746 μS/cm on average). As a relatively conservative water quality parameter (Figure S2), mixing between rainwater and groundwater should be the main process for EC. This presumption is supported by the agreement between the modelled and the measured EC dynamics for the period between May to November 2016. Precipitation events diluted the EC values at the pumping station, and the magnitude of dilution depended on the intensity of precipitation; heavy rainfall resulted in low EC values (Fig.2D and Fig.4). In periods with the absence of rainfall, the EC values follow a recovery curve that resembles a linearly mixed reservoir with concentrations increasing to values that approach the EC of the continuous groundwater supply of around 1500 μS/cm. After November 2016, EC was underestimated by the model. The sudden increase of the measured EC around Nov 20th coincides with an intensive pumping event after the first intensive rainfall that happened after a prolonged period of cumulative water deficit. This may be related with a first flush from the drain system that starts to be activated more strongly, thus removing clogged material and lowering the overall resistance of the drain system for shallow and deep groundwater inflow (van der Velde et al., 2010). It suggests that this triggered the

inflow of somewhat more mineralized groundwater relative to the period before, creating a shift in the EC towards ~250 $\mu\text{S}/\text{cm}$ higher values that continued during the remainder of the monitoring campaign. It appeared that it raised the EC, but did not change its amplitude or dynamics during the remainder of that period (Fig. 2 and 3, Table S6). The elevated EC may alternatively due to the application of road salts in winter which starts from November. But we did not find any evidence for the prolonged effects of road salts, as the chloride concentrations in the grab samples only showed two higher measurements, one in December 2016 and one in January 2017 (see Supplement, Figure S2). The mixing process can explain part of the dynamics of NH_4 and TP in the wet season, but insufficient for explaining the dynamics during the dry season due to the presence of biological and chemical processes. Compared with groundwater, which carries around $8 \text{ mg L}^{-1} \text{ NH}_4$ and $1.6 \text{ mg L}^{-1} \text{ TP}$, rain and runoff have much lower nutrient concentrations, which makes groundwater the main nutrients source (Yu et al., 2019). Nutrients derived from groundwater mix with rainwater in the ditches through direct seepage and the efficient groundwater drainage systems. Clearly, NH_4 is diluted during the rain events and a gradual increase of NH_4 starts after each rain event during the wet season showing slopes that resemble the model reconstruction. The overestimation of the modeled NH_4 in general indicates a probable lost to transformation processes, especially in the spring of 2017. Concentrations of TP are also generally far below the conservative model reconstruction. The distinct peaks up to 3 mg L^{-1} are not captured by the model and must be determined by different physical or chemical processes. ”

15. L553-555: There is something grammatically wrong in this sentence.

Agreed. Deleted “and”, added “the” before “observations”

16. L604: ‘...New Orleans, Shanghai and Dhaka.’ Are there any references for this?

We added the following references after “...New Orleans, Shanghai and Dhaka” :

“ (Li et al., 2009; Nahar et al., 2014; Jones et al., 2016; Stahl, 2019)”

The full information of the references was added in the reference list as below:

Jones C.E., An K., Blom R.G., Kent J.D., Ivins E.R., and Bekaert D.. Anthropogenic and geologic influences on subsidence in the vicinity of New Orleans, Louisiana. JGR Solid Earth, 121(5): 3867-3887, 2016.

Li X., Chen M., and Anderson B.C.. Design and performance of a water quality treatment wetland in a public park in Shanghai, China. Ecological Engineering, 35: 18-24, 2009.

Nahar, M.S., Zhang, J., Ueda, A. et al. Investigation of severe water problem in urban areas of a developing country: the case of Dhaka, Bangladesh. Environmental Geochemistry and Health, 36: 1079-1094, 2014.

Stahl M.O.. Groundwater pumping is a significant unrecognized contributor to global anthropogenic element cycles. Groundwater. 57(3) : 455-464, 2019.

15. Figure S3: The caption states ‘Hourly time series of TP and turbidity...’ but only turbidity is shown in the graph.

Agreed. Deleted “TP and”.

Responses to Reviewer 3

Revision of this paper was deeply performed by the authors. Conclusions are now well-supported by statistical tests, and the modifications performed on the text clarified all issues raised in the previous evaluation report. I only have minor comments which are only made to help improving the presentation and reading of this work.

We appreciate the confirmation from the reviewer, as well as his/her previous contribution into improving the manuscript.

1. L25: replace “algae” by “algal”

Agreed. Replaced “algae” by “algal”.

2. L33: add a comma before “we”

Agreed. Added “,” before “we”

3. L51: not clear ; to be re-worded: “NH₄ is the preferred N-form by microbes in some cases...” ?

Agreed.

Added “In estuaries,” before “NH₄ is the preferred..”.

Changed “by” into “for”.

Deleted “in some cases like in estuaries”.

4. L55: is a climate-active gas; not clear, to be re-worded

Agree.

Replaced “, or denitrified” by “It may also be denitrified”.

Added “under such condition” after “N₂O”.

5. L99: to be revised

Agreed. Changed “The groundwater seepage is a continuous source of anoxic, iron and nutrient rich slightly brackish waters.” Into “The groundwater seepage is a continuous source of slightly brackish, anoxic, and iron and nutrient rich water.”.

6. L245: add, .."after seasons, ...and statistical tests.”

Agreed. Added “and their significance test results” after “..seasons”.

7. L246: should read “significantly”

Agreed. Changed “significant” into “significantly”.

8. Table 2: please indicate in the footnote the type of statistical tests performed

Agreed. Added footnote after “ $p < 0.05$ ”: “Wilcoxon rank-sum test. The tests were performed in Rstudio (version 3.6.1), wilcox.text() in package “stats”.”

9. For legends of Fig. 2 & 4 – a link with the “connected” supplementary tables or figs would facilitate a quick reading / e. g. “see Table S1, 2, 3 for the correlation tests performed on the datasets, and ...” Etc

Agreed.

Added “See Table S1-S3 for the correlation tests performed on the dataset” at the end of the caption of Figure 2.

Added *“See Table S4-S6 for the correlation tests performed on the dataset”* **at the end of the caption of Figure 3.**

Added *“See Table S7-S10 for the correlation tests performed on the dataset”* **at the end of the caption of Figure 4.**

Added *“See Table S11-S14 for the correlation tests performed on the dataset”* **at the end of the caption of Figure 5.**

Added *“See Table S15-S19 for the correlation tests performed on the dataset”* **at the end of the caption of Figure 6.**

10. L390: add: “... we start with the presentation of the ...

Agreed. Added *“the presentation of”* **after** *“...we start”*.

11. L413: to be revised; “... November, 2016 on, » ??

Agreed.

Line 412, added *“(“* **before** *“Fig.2”*.

Line 413, replaced *“An alternative reason for the higher EC starting from November, 2016 on, would be the application of road salts during the winter period.”* **by** *“The elevated EC may alternatively due to the application of road salts in winter which starts from November.”*