Dear Reviewer,

We appreciate the time and effort that you dedicated to read our manuscript and for the valuable comments, you have provided. We answer your comments, suggestions and questions below and have incorporated them into the manuscript. Your constructive comments have significantly improved the quality and clarity of our manuscript.

Please find below our point by point response to each of the comments.

Best regards,

Buruk Kitachew Wossenyeleh
On behalf of all authors

Part I: General Comments:

Point 1: Dear authors, the paper is very interesting, and it is appreciated that in general is well-structured and written. I enjoy reading it! However, there is still room for improvement in the language and some typos. Please be careful in how the type of drought and its impacts is written through the text. Since sometimes these concepts are mixed up. The methodology applied is well explained. Even though the results and discussion chapter should include more balanced discussions with other authors, concepts and related/similar work. Please add it.

Response 1: Thank you for the positive feedback of the paper and your recommendation. We agree discussing the results of other authors would add value to the manuscript and have added some discussion about the suggested point. We also encourage similar studies to be done in other regions. We included the following discussion in the result and discussion part of the revised manuscript.

Line [387-399] During drought propagation in the hydrological cycle, the multi-year meteorological droughts of 1981 – 2013 propagate to groundwater recharge drought. This propagation continues to the groundwater system. The groundwater drought propagation analysis showed that even though the number and severity of drought events observed in discharge to the wetland is lower than for recharge, the wetland is still vulnerable to groundwater drought. This is also reflected in the lower groundwater level measurements between 2006 and 2008. This vulnerability could be because of the shallow water table and limited thickness of the aquifer in

the study area, resulting in a quick response to changes in hydrological stresses such as droughts. The drought propagation towards a wetland studied by Fang and Pomeroy (2008) also showed much lower discharge to the wetland from the basin groundwater and snowmelt runoff developed in drought years. Moreover, Drexler and Ewel (2001) performed a field experiment during the 1997–1998 ENSO-related drought and found that the mean water table level in the wetlands lowered by 12 to 54 cm. This could also be explained by drought propagation from the meteorological to the groundwater system.

Part II: Specific comments:

Point 1: P1, L14- 16. Please rewrite the sentence; it is hard to read.

Response 1: Agree and changes made in the revised manuscript.

Line [15-17] Furthermore, meteorological drought and groundwater drought on recharge were compared to investigate drought propagation in the hydrological cycle.

Point 2: P1, L20. Change or delete the word drought after the groundwater recharge

Response 2: Agree and changes made. We included the following rewritten sentence in the revised manuscript.

Line [19-20] The number and severity of drought events on groundwater discharge events were smaller than for groundwater recharge.

Point 3: P2, L28-29 and L32. Add references

Response 3: Agree and changes made. We included the references in the revised manuscript.

Line [29-32] Drought can be described as a temporary decrease in water availability over a significant period and caused by deficient precipitation. Droughts propagate through the hydrological cycle and affect both surface and groundwater resources (Bloomfield and Marchant, 2013; Calow et al., 1997; Mishra and Singh, 2010; Wilhite, 2000).

Point 4: P2, 41. Please specify for which type(s) of drought(s) the author made the assessment

Response 4: Agree and changes made. We included the type of drought in the revised manuscript.

Line [41-42] The meteorological drought periods were defined as the number of consecutive days without significant precipitation (less than 0.5 mm) for the six hottest months of the year.

Point 5: P3, 53. Add reference, for the readers would be interesting to know more about the 2018 drought and its implications.

Response 5: Agree and changes made. We included the references in the revised manuscript.

Line [55-57] Droughts such as the one experienced in the summer of 2018 may have a significant impact on the groundwater discharge that is feeding such vulnerable systems (Ridder et al., 2020).

Point 6: P3, L69-73 It should be stated here that also meteorological indicators are part of the assessment

Response 6: Agree and we revised the aim of the paper. We included the meteorological drought in the aim of the paper as follows:

Line [75-79] This paper aims to investigate drought propagation in the hydrological cycle by developing and applying a method for simulating meteorological drought, groundwater drought, and its propagation in the aquifer, particularly focusing on assessing its impact on groundwater-fed wetland ecosystem.

Point 7: Please introduce the acronym GroWaDRISK and the other acronyms.

Response 7: Agree and changes made.

Line [105-107] Spatially distributed groundwater recharge generated in the GroWaDRISK (Drought-related vulnerability and risk assessment of groundwater resources in Belgium) project funded by Belgian Federal Science Policy Office (BELSPO) was used.

Point 8 P7, L137. Why are you using SPI 1 if you are only focusing in long term meteorological drought? Please clarify.

Response 8: In our study, meteorological drought was analyzed using SPI 1 and SPI 12. Moreover, the study also investigates drought propagation from meteorological drought to groundwater drought. Because of the hydrological response of the study area, SPI-1 is more convenient for the study of drought propagation. It helps to see the short term drought propagation in hydrological cycle.

This explanation was stated in the manuscript as:

Line [248-249] Therefore, SPI-1 is more convenient for the study of drought propagation in a quickly responding hydrological system, like in the Doode Bemde nature reserve.

Point 9: P10, L172. Why did you choose an "initial value of hydraulic conductivity of 7 m/d for the Brussels sand formation" despite the wide range? Please also clarify on the text.

Response 9: Agree and changes made. This initial hydraulic conductivity is selected from the hydraulic conductivity ranges found by different researchers. This value is optimized during the calibration of the model. The optimized parameter value is stated in the results part of the manuscript. We included these explanations in the revised as follows:

Line [177-181] Therefore, from these ranges, an initial value of hydraulic conductivity of 7 m/d for the Brussels sand formation (HK1) was used in this study. Similarly, the hydraulic conductivity range for the Quaternary formation was found to be 1 m/d to 10 m/d (Vandersteen et al., 2014). An initial hydraulic conductivity of 1 m/d was adopted. These initial values of hydraulic conductivities are optimized during the calibration of the model.

Point 10: P11, L202. Specific yield needs to be introduced as the other parameters before.

Response 10: Agree. It is already introduced in the model as well as in the manuscript.

Line [206-208] Relative sensitivities of the model parameters: hydraulic conductivity, drain conductance (Cdrn), **specific yield (Sy)**, and river conductance (Criv) were executed for the Brussels sand formation and Quaternary loam formation to select parameters for calibration.

Point 11: P11, L211. Specify the year period you used.

Response 11: Agree and changes made.

Line [216-218] A groundwater drought analysis was performed on the groundwater recharge (R(t)) and the groundwater discharge (Q(t)) time series of 34 years (1980-2013) to investigate the propagation of groundwater drought in the aquifer and its effect on the wetland.

Point 12: P12, L221. The sentence is missing

Response 12: Agree and changes made.

Line [227] For each month, the 80th percentile of recharge and discharge were calculated.

Point 13: P13, L230. Is missing the discussion with other authors about the differences when using SPI-1 or 12 for drought assessments.

Response 13: Agree and changes made. Our aim in this part of the analysis is to choose convenient SPI accumulation period for drought propagation from meteorological to groundwater. Based on your recommendation we include the following sentence in the revised manuscript.

Line [249 - 251] Cammalleri and Barbosa (2019) also showed a short period SIP calculation is suitable for a quickly responding hydrological system.

Point 14: P16, L297. In the chapter Groundwater drought. Why did you exclude minor drought events in each of the subchapter analysis? How do you select the threshold to ignore those minor drought events for each subchapter?

Response 14: Agree and changes made. All drought events are included in the analysis of the subchapter. The sentence is rewritten in the revised manuscript as follows:

Line [304-306] Groundwater recharge deviation from the threshold and groundwater recharge drought events from 2003 to 2013 are shown in Fig. 12. Within this analysis period, seven drought events with a severity higher than 5 mm of cumulative deficit recharge were observed.

Point 15: P19, L331-332. Please, reconsider changing this sentence to "drought events on groundwater recharge were more severe than groundwater discharge". As you are talking about drought impacts on groundwater discharge and recharge.

Response 15: Agree and changes made.

Line [336-337]: drought events on recharge were more severe than groundwater discharge.

Point 16: P20, L341. Why are you showing results here until 2010, if your assessment was performed until 2011?

Response 16: Agree and changes made. We change 2010 to 2011 in the revised manuscript.

Point 17: P23, L402-408. This paragraph fits better on the discussion.

Response 17: Agree and changes made. This conclusion part moved to the discussion part in the revised manuscript.

Part III: Technical corrections:

Response Part III: Agree and all corrections are made.