We thank the first referee for valuable comments on our manuscript. All comments are summarized with a numbering style and corresponding responses were followed by an arrow symbol (➔). The line numbers (Line) referenced will be changed for the final version of the revised manuscript.

Reviewer #1

Specific comments:

1.1. It looks like that the given work is the follow-up of Sharifi et al. (2016) and Lee et al. (2016) published on Catena and PLOS ONE. However, authors did not really mention much about it which I think they should. The general readers will be a lot more interested in a series of research efforts instead of a single piece.

➔ Please note that we cited most related previous work - Lee et al. (2016) published in PLON ONE (See Line 126, 128, 175, etc) and Sharifi et al. (2016) published in Journal of Hydrology in Line 126 and 128. As suggested, we will provide references to the earlier studies upfront, so that the readers can be aware of a series of research efforts made in this study site by the authors.

1.2. Based on the knowledge of 1., the given work was conducted by adding (changing) climate data with the use of the SWAT model. In the Introduction (Ln. 84), it was mentioned that other work did not demonstrate climate change impacts on hydrology and nutrient cycles. However, I actually can find some work online by using the keywords of: Climate Change, Chesapeake Bay, SWAT. I understand there may be some differences between your work and others, but I think authors should better explain/justify the uniqueness of the propose research.

➔ As pointed out, there are several previous studies investigating climate change impacts on the Chesapeake Bay Watershed region (Howarth et al. 2006, Najjar et al., 2009 and 2010, Meng et al., 2010, Lee et al. 2015). However, those previous studies showed regional-level hydrologic responses to climate change or focused on potential changes on aggregated watershed responses (e.g., stream flow and nutrient loads at the outlet of the watershed). In addition, previous studies that consider climate change impacts on agriculture did not fully consider the agricultural (including cropland location) happening at the local catchment. Generalized findings from previous studies could not provide site specific information and guideline for the coastal agricultural watersheds to reduce nutrient and sediment runoffs via best management practices.

In the CB, nutrient runoffs from agricultural coastal watersheds are one of the major causes of the water quality degradation. Hence, this study aims to investigate the climate change impacts happening at the cropland scale (including crop growth, water and nutrient cycling at the site), and their transport processes to the catchment outlet (we referred this as “internal” watershed response) considering detailed agricultural management practices. As the catchment response to the climate change can be site specific, we presented the simulation results from two adjacent catchments with contrasting hydro-geological characteristics at multiple spatial scales, describing the internal watershed processes to guide site-specific management plan to aid conservation decision making. These two watersheds showed the typical site characteristics in the coastal plain, in terms of topographic and soil characteristics, and the agricultural practices we used in simulation are commonly used in the region. Hence, the findings from this study can be applicable to other catchments in this region. We will highlight our unique contribution in the revised manuscript, as suggested by the reviewer, and further provide implication on other coastal watersheds within the CBW.

➔ We illustrated the novelty of this research in Line 106 – 120 and potential implications based on our novelty in Line 561 – 568.

1.3. I agree with Reviewer#1 that the given work was using CMIP3 data instead of the latest climate projections of CMIP5 may be a very big issue. I suggest authors should run the scenarios accordingly (by CMIP5). I know it may sound frustrating but it's difficult to justify your work by not using the latest data.

➔ As suggested, we re-run the SWAT model using the CMIP5 data and updated all methods and results with new simulations. New results will be provided in the revised draft.

➔ Sections 2.5.2 and 3.3 have been fully updated with new results. Abstract, implication, and conclusion were also revised based on new results.

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Reviewer #2

General comments:

2.1. 1) First, given that changes such as increase in CO2, temperature and precipitation are likely to occur simultaneously, what is the rationale for assessing the effects separately? This seems particularly tricky given that often temperature and precipitation can have opposite impacts on streamflow and nitrate loads. More justification of this choice would be helpful, as well as some discussion on how separating these changes might impact the results of the paper. 2) The GCMs do include multiple changes simultaneously, but because the change in precipitation and temperature in the GCM runs are different from those in the "sensitivity runs", it is difficult to understand the impacts of the difference in changes versus the consideration of simultaneous changes in multiple factors. For example, it would helpful to know if there an increase in temperature that would cancel out simultaneous increases in precipitation?

➔ **1)** This paper analyzed the climate change impacts on crop growth and related nitrogen cycling/transport processes in an agricultural catchment, the typical representative of the coastal watershed in the CBW. The climate change impacts were represented by two steps (sensitivity and GCM scenarios). The first step was to investigate the individual effects of the key climate factors on the crop biomass, water and nitrate cycling. This step was to develop in-depth knowledge and understanding on how each climate factor affects these underlying processes (Wolock and McCabe, 1999). The second experiment (e.g., simulation with the GCM output) was to quantify and predict these crop effects on water and nitrogen cycling at the local catchment level, with respect to the foreseeable climate changes. We used the GCM projections to describe foreseeable changes, as the combination of climate factors and their interactions could not provide complete climate change/variability information (including seasonal and inter-decadal variability, Mearns, 2001). For example, crop growth and agricultural nutrient loadings (e.g., fertilizer-driven nutrients) are highly sensitive to inter-monthly variations of the climate system. However, such variations in climate system could not be captured by a combination of three climate sensitivity scenarios. In our revision, we will clarify the purpose of the study design in the introduction as suggested by the reviewer.

➔ We illustrated the rational for assessing the effects separately and simultaneously in Line 143 – 155.

➔ **2)** As requested by other reviewers, we replaced the existing GCM data with the state-of-the-art GCM data (CMIP5) and these data indicate increases in temperature and precipitation compared to the baseline scenario (see Figure 7). Thus, we did not consider the precipitation decrease sensitivity scenario because the climate pattern shown in new GCM data well matched with the sensitivity scenario.

➔ Sections 2.5.2 and 3.3 have been fully updated with new results. Abstract, implication, and conclusion were also revised based on new results.

2.2. Second, how general are these results–for different parts of the Chesapeake Bay Watershed and/or for different climate scenarios (or simultaneous changes in different CO2 or weather factors)? In some ways, the paper might be seen as a case study. More explanation of why these two watersheds can allow us to draw broader conclusions beyond them could help to address this issue.

➔ The results of this study have implications for agricultural watersheds on coastal areas. Our analysis fully considers climate change impacts on croplands (crop growth, water and nutrient cycling) and their transport mechanisms (we referred this as "internal" watershed response) with considering detailed agricultural management practice. The two watersheds showed the typical site characteristics in the coastal plain, in terms of topographic and soil characteristics, and the agricultural practices considered in simulation are commonly used in the CBW region. Hence, the findings from this study can be applicable to other catchments in the CBW region. We highlighted this implication on section 4 in the manuscript (Line 561 - 568).

2.3. Third, including the statistical analyses is a nice idea, but it is important to ensure that the tests are appropriate. Do these samples meet the assumptions of the tests that were used (such as independence)?

➔ We improved our statistical analysis (Line 361 - 365) to address the issue raised by a reviewer as below:

We conducted a statistical analysis to test if the simulation results under climate sensitivity and GCM scenarios were statistically different from those under the baseline scenario using parametric (paired t-test) and nonparametric (Wilcoxon signed rank) methods. Note that we used monthly outputs (168 samples over 14 years) for this analysis. The statistical significance for the difference was indicated by *p-value*.

Specific comments:

2.4. Abstract: Perhaps mention the analysis of crop growth changes in the abstract?

➔ As suggested, we briefly mentioned crop growth in the abstract (Line 34 – 36 and 39 - 41) as followings:

Using SWAT model simulations from 2001 to 2014, as a baseline scenario, the predicted hydrologic outputs (water and nitrate budgets) and crop growth were analyzed at multiple temporal scales.

Crop biomass increased by elevated CO_2 concentration while it decreased by precipitation and temperature increases.

2.5. Might be good to include some discussion of: How representative of historic climate was 2001-2014? Or, more specifically, the calibration years of 2001-2008? Was any cross validation done to assess the sensitivity of the selection of these groupings and time periods?

➔ We did not conduct any analyses to select the calibration period. Due to unavailability of observations before 2001, the calibration and validation periods were set from 2001. However, the calibration period (2001 - 2008) likely include representative wet, dry, and average climate conditions as recommended by the model guideline (Arnold et al., 2012). Compared to the distribution of past 30-year annual precipitation data (1981 - 2010), 8-year precipitation data over calibration period fully accounted for three representative climate conditions (Figure 1). However, validation period tends to include wet conditions.

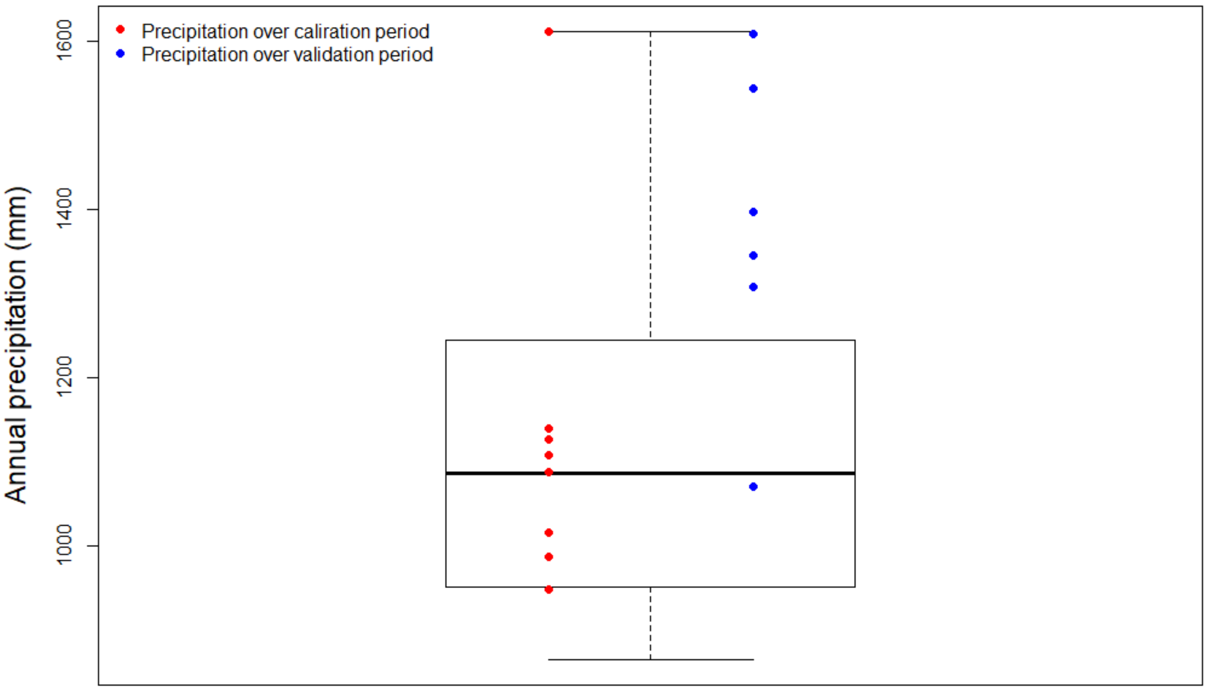

Figure 1. Comparison annual precipitation between past 30 years and calibration/validation. Note: The box plot was drawn using annual precipitation over past 30 years (1981 - 2010). The red and blue dots indicate annual precipitation over calibration and validation periods, respectively.

➔ We stated the brief discussion of climate conditions over the calibration and validation periods in the revised manuscript (Line 263 - 267) as below:

It should be noted that due to unavailability of observations before 2001, model calibration and validation were initiated from 2001. Compared to past 30-year precipitation data (1981 - 2010), climate condition over the calibration period (2001 - 2008) was shown to include representative wet, dry, and average climate conditions while the validation period (2009 - 2014) was dominant by wet conditions.

2.6. How were the two levels of increase in temperature and precipitation selected? From results in Najjar et al 2009?

➔ Based on the results from Najjar et al. (2009), two levels were selected. We improved the description of climate sensitivity scenarios in the revised manuscript (Line 308 - 312) as below:

We used the maximum increase rate (and value) for 2040 – 2069 (precipitation: 11 % and temperature: 2.9 °C) and 2070 – 2099 (precipitation: 21 % and temperature: 5.0 °C) to set the precipitation and temperature sensitivity scenarios. For example, the baseline precipitation increased by 11 % and 21 % for Scenario 3 and 4, respectively, and 2.9 °C and 5.0 °C were added to the baseline temperature for Scenario 5 and 6, respectively (Table 4).

2.7. Likely impact of using humidity, wind speed and solar radiation from the built in weather generator? Is this commonly done?

➔ When those three climate values were available from GCM data, a weather generator has been widely used in previous studies (Jayakrishnan et al., 2005; Ficklin et al., 2009; Wallace et al., 2017). Wang et al. (2009) also stated that *"the use of weather generators for downscaling monthly GCM data is actually not uncommon"*. Therefore, use of a weather generator can be regarded as one of potential ways to prepare humidity, wind speed, and solar radiation.

2.8. How much nitrate data was used and/or how often were the nitrate grab samples taken? Are there studies assessing the accuracy of using USGS LOAD ESTimator?

➔ The LOADEST is used commonly to generate continuous data from grab sample data (Lee et al., 2016). We used 133 samples to make continuous monthly data over the simulation periods of 168 months. Jha et al. (2013) reported that the LOADEST performed well in predicting water quality variables (e.g., nitrogen and phosphorus) with R^2 ranging from 0.97 to 99. This point has been addressed in the revised manuscript (Line 239 - 245) as below:

The USGS LOAD ESTimator (LOADEST, Runkel et al. (2004)) was used to generate continuous monthly nitrate loads from nitrate grab sample data (133 samples over the simulation period) that were obtained from the Chesapeake Bay Program (CBP, TUK#0181) for the TCW, and obtained from USGS gauge station data (USGS#01491000) for the GW. The LOADEST is used commonly to generate continuous data from discrete data and it was shown to accurately generate water quality variables (Jha et al., 2013; Lee et al., 2016b).

2.9. How was the 2-year warm-up period used in the SWAT modeling?

➔ The simulation started from 1999 to 2014 using observed precipitation and temperature (humidity, solar radiation, and wind speed were generated from a weather generator). The simulation results from 2001 to 2014 were only analyzed and the simulations over the 2-year warm-up period was not considered. The warm-up period is generally set to achieve equilibrium states and the model outputs are more reliable when setting up the warm-up period (Rahman and Lu, 2015).

2.10. Good that a number of statistics were used to assess model performance. Since NSE in real space more heavily weights the larger flow values, how well were the low flows captured? (Estimating NSE of the natural logarithms of the streamflows can also be helpful for this.)

➔ As suggested, we calculated the NSE for the natural logarithm of stream flow to evaluate the model predictability on low flows (Kiptala et al., 2014). Model performance measures indicate "Satisfactory" to "Very Good" for the two watersheds as shown in the table below. Therefore, low flows were also well depicted by our calibrated model.

Table 1. NSE for the natural logarithm of stream flow

Period	Variable	Stream flow	
		TCW	GW
Calibration	NSE	0.828***	0.719**
Validation	NSE	0.556*	0.727**

Model performances were rated based on the criteria of Moriasi et al. (2008); * Satisfactory, ** Good, and *** Very Good; Satisfactory (0.5 < NSE ≤ 0.65), ** Good (0.65 < NSE ≤ 0.75), and *** Very Good (0.75 < NSE ≤ 1.0).

➔ We briefly discussed this analysis in the method (Line 281 - 283) and result (Line 380 – 382 and Table 5) sections as below:

Method section*: We also calculated NSE for the natural logarithm of stream flow to evaluate the model predictability for low-flows (Kiptala et al., 2014).*

Result section*: The model performance measures for low-flows (NSE for the natural logarithm of stream flow) also indicated "satisfactory" to "very good" (Table 5).*

➔ The NSE for the natural logarithm of stream flow has been added to Table 5.

2.11. Line 324-327: 1) I'm a little unclear on this method and what ensemble is referring to here Are you taking the average across the whole time period predicted? Or are there multiple simulated outputs per monthly, seasonal, annual time period? "The range of changes in simulated outputs was represented with the ensemble mean to show overall responses of watershed hydrological processes to climate change (Shrestha et al., 2012; Van Liew et al., 2012)." 2) Also with regards to the 95 PPUs estimated – some more explanation of the sample of simulations used would be helpful.

➔ **1)** With new GCM data, we calculated the ensemble mean by averaging the delta-change values of the five GCM projections with equal weight.

We illustrated this process in the revised manuscript (Line 341 - 344) as below:

We calculated the ensemble mean by averaging the delta-change values of the five GCMs with equal weight because substantial variations existed among the GCM projections (Shrestha et al., 2012; Van Liew et al., 2012). Then, the SWAT model was simulated using the ensemble mean to predict hydrological processes under future climate conditions.

➔ **2)** We improved the description of 95 PPU in the manuscript (Line 284 - 287) as below:

The 95 PPU was computed based on all simulated outputs generated during the calibration process (1,000 sets). The 95 PPU was represented as the range of values between the 2.5 and 97.5 percentiles of the cumulative distribution of simulated outputs.

2.12. Line 378-380: specify what "good" or "very good" meant numerically or list some numbers from the table.

➔ We briefly specified the numerical meanings of model performances (e.g., Satisfactory, Good, and Very Good) only using NSE in the revised manuscript because the note of Table 5 fully illustrates the numerical meanings of each performance.

2.13. Figure 3: Do you know why there is such a difference between the two watersheds in terms of the 95 percent prediction uncertainty?

➔ This was likely due to the difference in soil characteristics between the two watersheds. The TCW and GW are dominated by well- and poorly-drained soils, respectively, and therefore "groundwater" is the major water transport pathway for the TCW while "surface runoff" is for GW.

Hence, our calibration shows TCW was more sensitive to the parameters pertaining to "groundwater flow" (ALPHA_BF, GW_DELAY, GW_REVAP, RCHRG_DP, and GWQMN; see Table 3) but GW was more sensitive to the parameters related to "surface runoff" (e.g., CN2 and SURLAG; see Table 3). As these parameters were calibrated in different allowable ranges, the uncertainty bands for two watersheds were naturally different.

2.14. Figure 4: perhaps connecting the ET with a line would help? It's a bit difficult to interpret

➔ Yes. The dotted graph has been changed to a line graph as suggested.

2.15. Line 404: Since you are presenting p-values, do these predictions meet the assumptions of the statistical tests?

➔ Please see the answer 2.3 – Note that tests were done with sufficiently large sample using both parametric and nonparametric methods.

2.16. Figure 5: Wouldn't CO2 and temperature likely both increase simultaneously? How would this effect plant growth?

➔ As answered in 2.1, this paper examined the individual impacts of CO_2, temperature, and precipitation investigate the individual effects of the key climate factors on the crop biomass, water and nitrate cycling. And this paper disregarded the combinations of two or three climate sensitivity scenarios because those combinations cannot provide foreseeable changes and complete climate change/variability information (including seasonal and inter-decadal variability). Therefore, analyzing simultaneous increases in CO_2 and temperature is the beyond the scope of this study.

2.17. Figure 6: Since these are relative to the baseline, consider plotting pluses and minus relative to that value to better illustrate the changes?

➔ One of goals in this paper is to compare water and nitrate transport patterns between two watersheds. Therefore, visualizing absolute values for each pathway can better represent the difference between the two watersheds in terms of the major pathway for water and nitrate fluxes.

2.18. Section 3.3: Did the GCM model runs include changes in CO2?

➔ Yes. We set CO_2 concentration of 936 ppm for the GCM data as stated in the section 2.5.2.

2.19. Line 492-497: Should this section be sooner as it also impacts the results presented previously for the one-by-one simulations?

➔ We put the paragraph explaining the overestimation of CO2 impacts in the SWAT model in the section 3.2.1 (Line 402 - 412) as suggested.

Technical corrections:

2.20. Line 24-25: Should the first line of the abstract perhaps read “be exacerbated by” rather than “exacerbate under”?

➔ It has been changed in the revised manuscript as suggested.

2.21. Line 65-65: The Chesapeake Bay is the largest estuary in North America and thus the US, not just within the mid-Atlantic region. Maybe this sentence could be restructured along the Line of: “Located in the Mid-Atlantic region, the Chesapeake Bay (CB) is the largest and most productive estuary in the United States (US).”

➔ The sentence has been changed as suggested in the revised manuscript.

2.22. Line 118: These two sentences seem to be saying the same thing as one another (and reference the same papers) – maybe cut one of the sentences?

➔ The first sentence has been deleted in the revised manuscript.

2.23. Line 376: I would use the word “outside” or something similar rather than “beyond” which might imply higher than (when the reality is that predictions are lower).

➔ The sentence including “beyond” has been removed.

2.24. Line 533 Section 4: I think this should read “Implications” with an “s” at the end?

➔ It has been changed in the revised manuscript.

2.25. Line 607: typo: “five GCMs data”

➔ As requested by another reviewer, we revised the climate change scenario to GCM scenario and the word, “five GCM data”, will be deleted in the revised manuscript.

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Short comment #1

General comments:

The authors studied the effect of winter cover crops on nitrate loadings using SWAT. However, the authors were not able to clearly explain and visualize their findings. In addition, there are quite a few technical and organizational issues that the reviewer would like to focus on, as given below:

3.1. **(1)** First, purpose of the study design is not clear. I assume the authors were planning to isolate the individual impacts of CO2, temperature, and precipitation, and the GCM simulations were to quantify the interacting impacts of the climate factors. However, if this is the purpose, the GCM simulations were not necessary because the authors can simulate the interacting effects in the sensitivity simulations by combing climate factors. (**2**) In addition, CMIP3 data were used in the future climate scenario simulations, instead of the latest climate projections of CMIP5. Using the out-of-date climate data make the projections unnecessary.

➔ (**1)** This aim of this paper was to quantify the climate change impacts on crop growth and related nitrogen cycling/transport processes in an agricultural catchment, the typical representative of the coastal watershed in the CBW. The simulation study was designed as a two-step on purpose. The first step was to investigate the individual effects of the key climate factors on the crop biomass, water and nitrate cycling. This step was to develop in-depth knowledge and understanding on how each climate factor affects these underlying processes. The second experiment (e.g., simulation with the GCM output) was to quantify and predict these crop effects on water and nitrogen cycling at the local catchment level, with respect to the foreseeable climate changes. We used the GCM projections to describe foreseeable changes, as the combination of climate factors and their interactions could not provide complete climate change/variability information (including seasonal and inter-decadal variability, Mearns, 2001). For example, crop growth and agricultural nutrient loadings (e.g., fertilizer-driven nutrients) are highly sensitive to inter-monthly variations of the climate system. However, such variations in climate system could not be captured by a combination of three climate sensitivity scenarios as suggested by the reviewer. In our revision, we will clarify the purpose of the study design in the introduction as suggested by the reviewer.

➔ We illustrated the purpose of the study design in Line 143 – 155.

➔ (**2**) We fully agree on your point using the latest climate projects to make prediction. As suggested, we finished the SWAT model using the state-of-the-art GCM data (CMIP5). We will present updated the method and result sections with new simulations in the revised manuscript.

➔ Sections 2.5.2 and 3.3 have been fully updated with new results. Abstract, implication, and conclusion were also revised based on new results.

3.2. Second, discussions were not sufficient. (1) I cannot agree with the authors that increased N export resulted from litter input. (2) Forest is an important land cover in both watersheds. However, the authors only focused on cropland, but paid insufficient attention to forests.

➔ (**1)** Increased litter from crop residue can contribute to increasing inorganic N in soils for crop fields, especially after harvesting crops (i.e., during winter seasons). Through harvesting practices, below-ground crop biomass and the portion of above-ground biomass remain on fields as “crop residue”. Remaining crop residue was shown to increase soil nitrate through mineralization during winter seasons for this region (Lee et al., 2016). Contribution of crop residue to soil nitrate during winter seasons has been identified by previous studies (Goss et al., 1993; Gentry et al., 2001; Randall et al., 2008). As shown in the table below, our simulation showed that the amount of mineralized nitrate during summer seasons was similar for the baseline and CO_2-elevated scenarios. However, during winter seasons (no crops on the field) a great difference in mineralized nitrate was observed between the two scenarios because elevated CO_2 concentration increases soil water contents, which promotes mineralization. If there are growing crops on the fields, nitrate from mineralization would promptly be taken up by crops. This point has been clarified by updating Fig A3, by showing mineralized nitrate during winter seasons (Line 422 and 425).

Table 2. The amount of mineralized nitrate fluxes during summer and winter seasons for the baseline and elevated CO_2 concentration scenario

	Summer (Apr. – Sep.)	Winter (Oct. – Mar.)
Tuckahoe Creek Watershed		
Baseline	26 kg ha^{-1}	26 kg ha^{-1}
Elevated CO_2 concentration	27 kg ha^{-1}	33 kg ha^{-1}
Greensboro Watershed		
Baseline	16 kg ha^{-1}	18 kg ha^{-1}
Elevated CO_2 concentration	17 kg ha^{-1}	22 kg ha^{-1}

➔ (**2**) As we pointed out in the introduction, nutrients from agricultural lands are the major threat to water quality degradation in this region. Hence, we focused on understanding climate change impacts on agricultural lands (e.g., implication on crop growth, water and nitrogen cycling at the crop field, and their transport mechanisms occurring across catchment). The SWAT modeling was conducted with detailed agricultural practices and crop rotation patterns in order to provide reliable prediction and assessment. While forests ecosystem plays a key role in water and nitrogen cycling, its response to the climate change and implication to water quality was not in the scope of this paper. We will clarify this point in the revised manuscript.

As the reviewer commented, forests are another important land cover for both watersheds (>30 % of the catchment areas). While this land cover is not the focus of this study, we will include a brief discussion to explain how forests effect on the water and nutrient cycling is simulated. In this discussion, we will address the limitation of SWAT to represent the ecological responses of forests to nutrient cycling and litterfall (Yang et al., 2016 and Zhang et al., 2014), hence its limited capability to predict the forest impacts in water and nutrient cycling with climate change.

➔ We illustrated forest setting in this study and SWAT limitations in Line 577 - 584.

Specific comments:

3.3. Line 75 cycle → cycling

➔ The word has been changed in the manuscript.

3.4. Line 88, missing space 17and

➔ The space has been added in the manuscript.

3.5. Line 99, this paragraph is too long. Consider to split it to two.

➔ We divided the paragraph into two (Line 99 – 115 and 116 - 138) in the manuscript.

3.6. Line 113 - 115, do you mean their investigation was not spatially-explicit

➔ No. We intended to point out limited understanding of climate change impacts on internal watershed processes (water and nitrate transport mechanisms) because previous studies commonly examined climate change impacts on aggregated watershed responses (e.g., stream flow and nutrient loads at the outlet of the watershed). For clarification, the sentence has been modified in the revised manuscript as a follow: *previous studies did not demonstrate climate change impacts on internal watershed processes considering detailed agricultural management practices.*

3.7. Line 127, are conductive

➔ For clarification, we used “favorable” instead of “conducive” in the manuscript.

3.8. Line 130, remove ‘areas of’

➔ It has been removed in the manuscript.

3.9. Line 137, would → are expected to

➔ The word has been changed in the manuscript.

3.10. Line 138 - 139, this paragraph repeated what you stated in the previous paragraph. Consider to reorganize it, or delete it.

➔ It has been deleted in the manuscript.

3.11. Line 144, effects → impacts

➔ The word has been changed in the manuscript.

3.12. Line 147, climate change scenario does not include changes in co2, precipitation and temperature?

➔ No. The GCM-based climate change scenario fully considers changes in CO_2, precipitation and temperature as described in the section 2.5.2. When simulating the model with the GCM-based climate change scenario, we set CO_2 concentration as 936 ppm as stated in Line 347. We clearly stated the GCM scenario considers three climate factors in Line 147 - 150.

3.13. Line 161, should cite the figure after insert to the text

➔ As per the journal guideline, we placed all figures and tables right after in-text citation of figures and tables.

3.14. Line 177, results → result

➔ The word has been changed in the manuscript.

3.15. Line 198, this sentence is not necessary

➔ The sentence has been removed.

3.16. Line 196 - 209, does leaching occurred with the previous three water fluxes?

➔ Yes. Leaching takes place simultaneously (Neitsch et al., 2011). We improved the description of water and nitrate transport in the revised manuscript as a follow:

Water infiltrated into soils is either delivered to streams through lateral flow or further percolated into groundwater when soil water content exceeds its field capacity. The groundwater portion is then either transported to streams, percolated into the deep groundwater aquifer, or discharged to the soil profile. The amount of nitrate in soils increases by nitrification, mineralization of soil organic and crop residue, biological N fixation, and fertilization, but decreases through denitrification and plant uptake (Neitsch et al., 2011). Nitrate fluxes move via surface runoff, lateral flow, percolated water, and groundwater flow. Nitrate concentration in the mobile water (i.e., surface runoff, lateral flow, and percolated water) is first determined and then the amount of nitrate in the mobile water is calculated based on the nitrate concentration and the amount of mobile water. Nitrate in groundwater is re-distributed in four ways: remain in the groundwater, recharge to deep groundwater, move to streams, or discharge to the soil profile. Nitrate removal by biological and chemical processes in groundwater is simulated by first-order kinetics. Refer to Netisch et al. (2011) for further details.

3.17. Line 209, should make clear why present equation 2 here, since it is similar to equation 1. A bit confusing here

➔ To avoid confusing, Equation 2 remained as it represents climate change impacts on stomatal conductance and Equation 1 has been be deleted. Equation 2 indicates the key physical process explaining the reduction of stomatal conductance by elevated CO_2 concentration (Field et al., 1995). Accordingly, we revised the manuscript (Line 210 - 220) to reflect this revision.

3.18. Line 240, what is a grab sample?

➔ A grab sample is the discrete data collected at a specific timing over a long period. We added brief information of our grab sample data to the revised manuscript as a follow: *nitrate grab sample data (133 samples over the simulation periods)*

3.19. Line 261, to my understanding lots of key swat processes have a daily step. How did you conduct your simulation at the monthly step

➔ Yes. The SWAT was simulated at a daily time scale, fully simulating daily hydrological and nutrient transport processes with daily climate data. The SWAT also provides the monthly or annual outputs aggregated from the daily simulation results. We used the monthly outputs provided by the model. For clarification, we added the sentence below to the manuscript (Line 262 - 263):

The SWAT model was simulated at a daily time step based on daily climate input, and daily outputs were aggregated for monthly outputs.

3.20. Line 307, I suggest to add more information how temperature and precipitation change scenario were prepared.

➔ As suggested, we improved the description of temperature and precipitation sensitivity scenarios in the manuscript (Line 308 - 312) as below:

We used the maximum increase rate (and value) for 2040 – 2069 (precipitation: 11 % and temperature: 2.9 °C) and 2070 – 2099 (precipitation: 21 % and temperature: 5.0 °C) to set the precipitation and temperature sensitivity scenarios. For example, the baseline precipitation increased by 11 % and 21 % for Scenario 3 and 4, respectively, and 2.9 °C and 5.0 °C were added to the baseline temperature for Scenario 5 and 6, respectively.

3.21. Line 390, represented → presented

➔ It has been changed in the manuscript.

3.22. Line 398, is ET increase here comparable with other studies?

➔ Yes. The reduction rate of ET in response to elevated CO_2 concentration was within the range reported by previous studies (Ficklin et al., 2009; Pervez et al. 2015). We briefly compared our results with previous studies in the manuscript (Line 395 - 398) as below:

The reduced rate of ET (driven by CO2 concentration of 850 ppm) demonstrated in this study is supported by previous studies using SWAT, such as Ficklin et al., 2009 (- 40 %; 970 ppm) and Pervez et al., 2015 (-12 %; 660 ppm).

3.23. Line 417. This does not make sense. N in litter were originally from inorganic N in soil. Increased litter means more uptake of inorganic N from soil, which decrease inorganic N in soil. Attribution of the increased N export resulted from the increased litter inputs were groundless.

➔ Please see the answer in 3.2.

3.24. Line 486, I am wondering why denitrification, which is sensitive to temperature, is not considered in explaining changes in N load

➔ In the SWAT model, denitrification takes place when a soil water content exceeds the threshold value. Although warmer temperature facilitates denitrification, reduced soil water content by warmer temperature lowered denitrification. We briefly stated why temperature increase rarely influenced the denitrification in the manuscript (Line 482 - 484) as below:

Denitrification was rarely affected by temperature increase because reduced soil water content by increased ET through higher temperatures prohibited denitrification.

3.25.Line 540, how do you know fertilizer use will increase.

➔ We improved the description of potential increase in fertilizer use for the future in the revised manuscript (Line 540 - 542) as below:

Fertilizer application might increase in the future because increased extreme climate conditions (e.g., high intensity rainfall and flooding) might lead to increased risk of nutrient loss to leaching and runoff, reducing the fertilizer use efficiency of field crops (Suddick et al., 2013).

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