<div align="center">**Response to the comments**</div>

A brief introduction to the revision of the manuscript (MS) as follows:

The two reviewers' comments were fully incorporated into the revised MS accordingly. The text of the MS was revised by: i) providing more details of the model modifications and the observation methods; ii) reorganizing and rewriting the Materials and methods section; iii) adding the consideration of the productivity in the scenario analysis and the corresponding results and discussion. Furthermore, we recompiled the Supplementary materials by adding Table S1 to present the soil properties of different soil profiles for different land use types and Table S2 to list the information on the observation data applied for model calibration and validation. Last but not least, the results of the simulated effects of no-tillage on soil erosion (i.e., Fig. S5) were added.

Reply on Referee #1

General comments

The improved CNMM-DNDC model enables prediction of water and soil particles and the amount of C, N, and P losses that move with them. The temperature, precipitation, and land use scenario analyses conducted using this model may provide useful information for prioritizing measures for vulnerable areas that are susceptible to soil erosion. The focus of the paper is clear and well organized. However, because the observations in this study were cited from several papers, some of the descriptions were confusing to the reader because they did not fully explain the observation methods or were indistinguishable from the results of this study. Some additions and corrections are necessary and are listed below. I hope you will find them helpful.

>> Agreed and revised. The observation data, which were applied for model calibration and validation, were summarized in the Table S2 in the revised Supplementary. And the description about the method of the lysimeter plot was added in the subsection 2.1. Please see changes in Lines 131−135 in the revised MS. Furthermore, the original Figure S1 and Table S1 and the corresponding results in derived from Li et al. (2022) were removed. Please see changes in Lines 325−329 in the revised MS and the revised Supplementary.

Abstract

L32-33 Another important result is that the upgraded model now estimates more particulate N in TN during periods of high precipitation compared to the original.

>> Response and revised. The original CNMM-DNDC had no capacity to predict the particulate N loss, so we rewrote the comments as "The upgraded CNMM-DNDC demonstrated that more proportion of the particulate N to total N during the period with large precipitations than that during the droughty period (16.2%−26.6% versus 2.3%−12.4%)" to incorporated in the revised MS. Please see changes in Lines 33−36 in the revised MS.

L37 It would be necessary to explain that land use change here means returning the land from an anthropogenic environment to natural vegetation.
>> Agreed and revised. Please see changes in Line 40 in the revised MS.

1. Introduction
L91 There is no description of a biogeochemical module for phosphorus; does this mean using CNMM's module for phosphorus?
>> Revised. Please see changes in Line 101−103 in the revised MS.

L97 Throughout the paper, it seems inadequate the description of productivity is inadequate (especially, L429~). How would you determine the accuracy of the productivity prediction? Productivity seems to have no or negative impacts on S, PC, PN, and PP (Fig. 7), but the trade-off between reducing environmental impact and maintaining or increasing productivity would be better considered in the scenario analysis.
>> Agreed and revised. The productivity was added to be considered in the scenario analysis and some results and discussion about productivity were added. Please see changes in Lines 465−470 and 576−590, Table 2 and Fig. 6 in the revised MS.

L 106-107 There is a description of a soil erosion physics model, but no description of an elemental enrichment module in Introduction section.
>> Revised. Please see changes in Line 88−90 in the revised MS.

2. Materials and methods
L126 For the parameter S_l in equation 1, it would be better to include a slope angle. Also, does this mean that the artificial lands accounts for 15% of the 35 ha?
>> Revised.
 The parameter S_l in Eq. 1 was explained by detail. Please see changes in Lines 162−165 in the revised MS.
 The proportions of the land uses were rechecked and revised in Line 135 in the revised MS.

L 137 It would be better to cite Text S1 here.
>> Revised. Please see changes in Line 152 in the revised MS.

L 172-173 Do you mean each mass balance of water, C, N, and P? Please clarify.
>> Revised. Only the mass balance of soil body was ignored. The upgraded model considered the mass balances of soil water and the elements of C, N, and P, without considering soil body balance. Please see changes in Lines 189−191 in the revised MS.

L183 Even when citing Deng et al. (2011) or Hu (2020), please add description of observation method by lysimeter plot.

>> Revised. The description about the observation methods by the lysimeter plot was added. Please see changes in Lines 140−145 in the revised MS.

L191-193 Is there carbon (or nitrogen or phosphorus) flow between the three pools of litter, between the two pools of microbes, and between the?
>> Response and revised. The flows of carbon, nitrogen and phosphorus among the pools of the labile and resistant organic and inorganic were considered in the CNMM-DNDC. For example, the carbon and nitrogen of the litter, humads and humus pools and the phosphorus of the pools of the active or passive organic P and the inert stable P were flowed to inorganic pools and the microbe pools by decomposition. Please see changes in Lines 213−217 in the revised MS.

L214-216 In relation to Figure 7 and S3 and text S1, please provide a brief description of how the observed data is measured.
>> Revised. The description about the observation methods by the lysimeter plot was added. Please see changes in Lines 140−145 in the revised MS.

L202 There is a lack of information on soil properties and model parameters by land use. Even if derived from Zhang et al. (2018), It would be useful for the readers to include a table where the soil properties (e.g. soil bulk density, soil depth, soil organic C, N, and P, soil hydraulic conductivity, and Q10 value, ...) are listed as Table S2 in the supplement.
>> Revised.

The information about soil properties (e.g., soil bulk density, pH, clay content, field capacity, wilting point, saturated hydraulic conductivity, organic carbon, and total nitrogen and phosphorus contents) of different soil profiles for different land use types, which were the input data for driving the model operation, were added and listed in Table S1. Please see changes in Lines 234−237 in the revised MS and Table S1 in the revised supplementary.

Response and revised for Q10 value. The effects of temperature on biogeochemical processes were only varied on the temperature changes instead of being set by land use types. We provided some examples for the effects of temperature on the biogeochemical processes. Please see the Table S4 in the revised Supplementary and Lines 530 in the revised MS.

L230-233 Is this the baseline scenario? This needs to be clarified.
>> Revised. Please see changes in Lines 248−251 in the revised MS.

L237-238, 240-241 Do you use the abbreviations $T_{air}+$, $T_{air}−$, $P+$, $P−$ anywhere but here?
>> Revised. The abbreviations $T_{air}+$, $T_{air}−$, $P+$, $P−$ used only once here were removed. Please see changes in Lines 262−263 and 265−266 in the revised MS.

L241-242 Is the transition period from cropland to forest considered?

>> Response and revised. The scenario analysis was conducted in one year of 2008, so the of the transition period from cropland to forest was not considered.

L255 I assume the Q10 value will have a significant impact on the temperature scenario, but how will it be set by land use (related to your comment on L202)?
>> Response and revised. The effects of temperature on biogeochemical processes were only varied on the temperature changes instead of being set by land use types in the CNMM-DNDC. We provided some examples for the effects of temperature on biogeochemical processes. Please see the Table S4 in the revised Supplementary and Lines 532 in the revised MS.

L280 closer to 100, not 1?
>> Corrected. Please see changes in Lines 298 in the revised MS.

3. Results
L308-313 Figure S1 shows only total and particulate N loss results. Please add the description of the NH_4^+ and NO_3^- results. Are the results in Figure S1 and Table S1 simulated by the model upgraded in this study? The results in Figure S1 are derived from Li et al. (2022), but are described in the result section as if they were from this study, confusing the reader.
>> Revised. We added the Fig S1 to exhibit the observed and simulated NH_4^+ and NO_3^- losses in the lysimetric plot. And the results in Figure S1 and Table S1 derived from Li et al. (2022) were removed. Please see changes in Lines 333−337 in the revised MS and the revised Supplementary.

L336-337 Regarding the prediction of total N loss by CNMM-DNDC, does it mean that the model underestimated the loss of NH_4^+ (as in L312-313) or dissolved organic N because it successfully predicted the loss of particulate N and NO_3^-?
>> Revised. Please see changes in Lines 367−369 in the revised MS.

L392-394 Why does the cooling scenario have a larger change in sediment yield and particulate C, N, and P loss?
>> Response and revised. The explanation on the larger effects of the cooling scenario on sediment yield and the particulate C, N, and P loss was added in Lines 543−545 in the revised MS.

L429 Losses due to NO3- leaching as well as NO3- runoff are correlated with S, PC, PN, and PP in SU and FL land use (Figure 7). There must be a time lag between NO3- leaching from the soil layer and the other observations, but how can there be a correlation? An explanation of the observation method of the data would be helpful to the reader.
>> Revised. The variables relevant to soil erosion, productivity and C/N losses for the relationship analysis were derived from the model simulation. Please see changes in Lines 462−465 in the revised MS. The relationship between the

variables related to soil erosion and NO$_3^-$ losses through leaching/runoff might be because all these variables were related to the precipitation. Please see changes in Lines 475−476 in the revised MS. The description about the observation methods by the lysimeter plot was added. Please see changes in Lines 140−145 in the revised MS.

L435-L441 The values of r are probably incorrect.
>> Revised. We rechecked the all values of the Pearson correlation coefficient (*r*) and added some explanation about the *r*. Please see changes in Lines 314−318 in the revised MS.

4. Discussion
L479-488 In the CNMM-DNDC model, it is not clear what can and cannot be reproduced by tillage management. Does the current situation mean that there is a vertical mixing effect with respect to soil chemical properties and no such effect with respect to soil physical properties? Results and discussion also cover the "cultivation scenarios" (L425-428, L481-488, etc.), so it would be better to present the results related to the tillage scenario as figures and tables in the supplement.
>> Agreed and revised. We rewrote the ambiguous sentences and added the results related to the tillage scenario as Fig. S4. Please see changes in Lines 522−526 in the revised MS and Fig. S4 in the revised Supplementary.

L498-501 For example, does vegetation coverage fraction affect evapotranspiration rates, thereby changing soil moisture content and affecting sediment runoff rates? A more detailed explanation would be useful to the reader.
>>Agreed and revised. Please see changes in Lines 535−540 in the revised MS.

L508 ER is not explained in the text. enrichment ratio?
>> Revised. We Please see changes in Lines 555−557 in the revised MS.

Figures
What is RA, the land use legend in Figure 1? Is it a residential area?
>> Revised. Please see changes in the footnotes of Fig. 1 in the revised MS.

Figures 4, 5, 6, 7, and S3 are too small to see the text.
>> Revised. Figures 4, 5, 6, 7, and S3 were enlarged in the revised MS.

Figure 5, upland, or cropland?
>> Corrected. Please see changes in Fig. 5 in the revised MS.

For the legend in Figure 7, it would be useful to include a description of the circle size and color intensity.
>> Revised. Please see changes in Fig. 7 in the revised MS.

Tables

In Table S1, it is RMSE, not nRMSE.

>> Corrected. In the revised Table S3, which was the original Table S1, it is nRMSE instead of RMSE. Please see changes in the revised Table S3 in the revised Supplementary.

Text S1

Fig.7 a-h are not found. Is it Fig. S3?

>> Corrected. Please see changes in Text S1 in the revised MS.