

Interactive comment on “Economic optimal nitrogen application rates for rice cropping in the Taihu Lake region of China: taking account of negative externalities” by Y. Xia and X. Yan

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General comments

The submitted article addresses the evaluation of nitrogen application rates considering the whole life cycle of mineral fertilizer applied on rice cropping systems in the Taihu Lake Region. Environmental impacts induced by production, transport and application of fertilizer N and considered in the applied life cycle analyses comprise acidification, global warming and eutrophication. The study assumes that yield, N₂O emissions, amount of NH₃ volatilization and N losses by leaching and runoff can be described by regression equations relating named variables to fertilizer N applied. Regression

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equations are derived from long term trials (Xia and Yan, 2011) and are assumed to be representative for the whole Taihu Lake Region. It remains unclear if indirect N₂O emissions induced by fertilizer application are considered in this study. To achieve comparability between environmental impact categories (resource consumption, acidification, global warming, eutrophication) characterization factors (evaluation within an impact category) and specific monetary valuations (for each impact category) are used. Both variables play a key role for the results of the study. Therefore it would be important to describe the derivation of the applied values and underlying assumptions more in detail. The results highlight the importance of fertilizer N production within the scope of global warming and indicate that N use efficiency impacts emissions of GHG via production more effective than related nitrous oxide emissions from soil which are difficult to quantify because of their high spatial and temporal variability. Costs arising from acidification and eutrophication are mainly assigned to the farming processes. The authors conclude that a decrease of prevailing application rates would be beneficial when taking all relevant influences of fertilizer production, transport and use into account. Studies, like conducted in this paper demonstrate how LCA could be used as integrative assessment tool evaluating impacts of production processes and efficiencies of mitigation strategies. The combination of LCA and ecological models that describe the dynamics of the CN cycle with respect to management could serve as a powerful tool for evaluating environmental impacts of agricultural practice. The paper is clearly written and most aspects of the applied method are presented in a transparent way. However, some questions arise which are mentioned below. Response: Thank you for your positive comments. You mentioned a good question of indirect N₂O emissions induced by fertilizer application, which are no available as there is no experimental data currently. However, we could calculate indirect N₂O emission using IPCC methodology based on the quantities of NH₃ volatilization and N leaching and runoff. We have supplemented this calculation in the revision.

Specific comments: Page 6282 line 1: The first three sentences are difficult to understand. Page 6286: line 11 Is this of importance? If so, I would suggest a more detailed

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explanation. Response: We have rewritten the first three sentences to make it clear and logical. Original "Page 6286: line 11" has been deleted for its less importance.

Page 6287: line 3: The references in Table 1 are incomplete (Ao 2006, Xu et al.2006,: :) The values of table 1 refer to 1 kg rice. How can you use fixed values (example: energy exploitation for fossil fuel) if the relationship between N fertilizer rate and yield is nonlinear (equation 4)? Response: The references in Table 1 now are completed. As we supposed the mean N application rate is a fixed value of 300 kg N ha⁻¹ for a single rice season in the Taihu Lake region (Ju et al., 2009), we could calculate the total marginal rice production and N losses using the nonlinear or linear functions. The inventory data of 1 kg rice at 300 kg N ha⁻¹ was then supposed to the total marginal quantities divided by the marginal rice production. We have made this point clear in the revision.

Page 6287 line 22: I suppose that EF_{pro} and EF_{raw} are rather emission factors than emissions. Response: Agreed and revised accordingly.

Page 6288 equation 2 and 3 the units of the variables does not end up to EF [g/kg] Response: As reminded by the reviewer, we thoroughly checked the equations and units. We found that each of the environmental emissions of energy consumption (g kg⁻¹) could be easily obtained by their emission factors (g GJ⁻¹) related to caloric multiply by low calorific value of the fuel (GJ kg⁻¹) (Zhang et al., 2009). We have revised this in the revision.

Page 6288 line 11: the cropping area that your idealized typical system represents is large. How representative is your idealized typical system with respect to the influence of soil properties, climate, and regional management? How many field trials have you examined and do they represent the Taihu Lake region? Response: In the Taihu Lake region, soils are typically formed from alluvial loss deposits and can be classified as Typic Epiaquept (USDA, 2000). Climate and management details are almost similar in this region. The rice production system analyzed in this study is an idealized typical

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system based on 10 long-established field experiments from 1995 to 2008 within the hotspots of the Taihu Lake region. As each of the experimental fields represents the local, our collected field trials should represent the Taihu Lake region. More corresponding soil properties, climate, regional management details could be found in (Xia and Yan, 2011) and its supplements, which is received for publication now.

Page6288 line19: Does equation 5 consider indirect N₂O emissions and if so how did you measure it? Response: Currently there was no measured data of indirect N₂O emission. As reminded by the reviewer, we calculated indirect N₂O emission using IPCC methodology based on the quantities of NH₃ volatilization and N leaching and runoff in the revision.

Page 6290 line 12: In Fig 2. you present the costs of different categories as fixed values. I assume this represents the actual situation (300 kg/N applied).Because the dependence between N input/yield and N_{input}/N₂O are nonlinear Response: yes, we have added this information in the corresponding figure note.

Page 6289 line17: Your characterization factors you present in table 3 come without any explanation or reference. Response: we have added the corresponding references to characterization factors in table 3.

Page 6290 line 3: The derived costs of managing one ton of each material and the environmental effect in table 3 need some explanation because they are of major importance for the results (marginal benefit, EONR) and comparison between impact categories. How did you derive them? Response: As suggested by the reviewer, the derived method was now summarized in the revision.

Page 6291 line14: Why you mention CH₄ emissions from farming. How are they related to N fertilization? Response: In the Taihu Lake region, most of studies found that CH₄ emissions were related to N application, but the reason was unknown currently. For example, Xiong et al. (1999) and Wassmann et al. (1992) found that the use of urea increased the emission by 10 %; 70 % in the Taihu Lake region. Therefore we

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mentioned CH₄ emissions from farming as our study was based on these literatures.
More details please see also the references.

Please also note the supplement to this comment.

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<http://www.biogeosciences-discuss.net/8/C3373/2011/bgd-8-C3373-2011-supplement.zip>

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