Point-to-point rebuttal and reply

General comments by S. Ziegler

This paper focused on the export of DIN and DIP from three small catchments contrasting in cultivation impacts in Taiwan. The study captured two years of data and included three typhoon events enabling an investigation of seasonal (dry vs. wet), events, and landuse effects on nutrient export from these catchments. The results of this work are significant and useful to the readership of Biogeosciences and the watershed biogeochemistry field at large because the work captures these fluxes for (1) a globally significant region (Oceania) where exports for large rivers are known to be significant and increasing, (2) smaller catchments which represent lotic environments that are the most vulnerable to landuse activities while at the same time critical to our understanding of source inputs to larger river systems, and (3) typhoon events of varying strength enabling some assessment of how fluxes behave during these events which are likely to continue to change with climate variation.

We really appreciate that reviewer can point out the significance of our study and provide constructive and valuable suggestions. The three above suggestions were added into Introduction as the goals of this study. We also followed the three guidelines to modify our new version to highlight the scientific significance of our paper. By the way, as suggested the units for nitrate and phosphate throughout this manuscript were changed to [μM] to reduce confusion.

Overall, I believe the approaches used are sound though there are critical details missing from the methods section that make it a bit difficult to determine this absolutely (see detailed comments below). I found, however, that the results and discussion sections were not distinct enough which contributed to a lack of development of the contributions this dataset provides regarding the points listed above. I have made some suggestions below on reorganization, however, it is important to emphasize that a clearer discussion of the mechanisms responsible for the differences in how DIN and DIP behaved in relationship to landuse and hydrology (seasonal and event driven) is sorely needed. If the mechanisms were provided with a clear linkage to the findings the final conceptual figure would be put to better use (after corrections of course). For example, by the time one gets to the discussion of Fig. 9 it is not abundantly evident why the patterns of soil/deeper versus surface NO3- and PO42- concentrations or DIN:DIP loading would be as provided in that figure. Further details on the discussion points and conclusions are provided below.

We restructured as suggested without changing its main story.

According to Dr. Ziegler's major suggestions and comments above, we made changes as the list below.

We found old Figure 6 is not informative enough, thus we created a new figure (Figure 8) to provide more information. Besides, we broke the old Table 2 into two new tables (i.e. Table 3 and 4) which contain more detailed information in the tables. (Please see the update manuscript in the supplement)

The new Figure 8 is for the rating curves using typhoon samples taken at three stations (see new Figure 8 and new Table 3). This version, we apply them to precisely estimate nutrient export for all typhoon periods (4 typhoon periods in 2007 and 4 in 2008) and properly estimate the fractional contribution from typhoon events. In previous version, only monitored typhoon was estimated. However, for the non-typhoon periods, we still used flow-weighted method (See 3.2 and 4.4). Therefore, more precise numbers in the new version are given.

We clearly separate all descriptions into Results and Discussion as suggested. In this version, the Discussion section starts with **5.1 Importance of human activity on nutrient export**, then **5.2 Hydrological control on nutrient exports**, **5.3 Differential transport for DIN and DIP**, and **5.4 Significance of Oceania streams**, which basically follows Dr. Ziegler's constructive suggestions.

We add more in-depth discussions in Results, Sections 5.1 and 5.2, thus readers can easily understand and directly link the transport mechanisms to the changes of nutrient status in the stream that illustrated in our conceptual model (Figure 9).

Because we made significant changes, particularly the Results and Discussion section, all mentioned inappropriate sentences or paragraphs no longer exist.

Detailed comments by section. Abstract. Authors should consider points made in the Conclusion section when editing their abstract. Some major points are provided in that section that really belong in the abstract as that conclusion section reads just like an abstract.

We rewrote the Abstract and Conclusion.

Line 32. Provide the units for yields to clarify what is being presented there.

The units of DIN and DIP are kg-N/ha/yr and kg-P/ha/yr, respectively. However, the values changed because of the refined calculation of nutrient export (see the reply above).

Line 33. An easier comparison among the catchments could be made by providing these ratios in terms of whole numbers such as 24, 104, and 79, repectively. Then state high DIN yields were in fact observed in all three and comparable to intensively disturbed rivers around the world.

In Abstract, rather than ratios we would like to provide absolute values of DIN and

DIP yields to readers' for comparison. It now becomes "Results showed the DIN yields in the pristine, moderately cultivated (2.7%), and intensively cultivated (8.9%) watersheds were 8.3, 26, and 37 kg-N/ha/yr, respectively. For the DIP yields, they were 0.36, 0.35, and 0.56 kg-P/ha/yr, separately."(**Lines 32-35**)

Line 39. Need to clarify the difference in the DIN and DIP ratios reported here and more clearly describe what they mean in terms of the cultivation gradient.

We change our highlight in the Abstract to express our differences compared to global rivers. "The DIN yield to DIP yield ratio varied from 97 to 410, higher than the global mean of ~18, indicating a P-limiting condition in stream and downstream aquatic environment."(**Lines 42-43**)

Section 4.3 contains more detailed description about the difference in the DIN:DIP and its relations to cultivation gradient. (**See from line 269**).

Line 41. What other evidence supports this statement of N saturation in these watersheds.

In this version, we are more cautious about the speculation of nitrogen saturation, therefore, removed this statement in Abstract, and draw more reference numbers regarding N input-output budget for discussion. After comparison we found N storage (~7000 kg-N/ha) in forest soil is ~200x the atmospheric N deposition and ~1000x the N export in the pristine watershed. Thus, the part about N-saturation turns to "In the pristine watershed (Sta. G), net increase of DIN inventory is likely occurring in the system. Beside the surplus in input-out budget, the DIN leaks out of the forest in growing season (DIN concentration follows air temperature) may also represent a syndrome of nitrogen saturation. However, this speculation is difficult to evaluate due to the much larger N pool in the soil; meanwhile the rates of N mineralization, nitrification (Owen et al., 2010), retention (Fang et al., 2008), and gaseous N losses (Koba et al., 2012) are influential to nitrogen dynamics and cycling. Whether N is saturated needs further investigations on N:P in plant foliage (Tessier and Raynal, 2003) and monitoring extra N budget terms such as gaseous nitrogen in the watersheds in Taiwan." (**Lines 361-368**)

Line 42. "fundamental clues" is a bit too vague. There are some important conclusions provided in the conclusion section that belong here in the abstract. Also please consider the main three important aspects listed above in the general comments when revising the abstract.

It is now "Our study advanced our understanding about the role of cyclone, which exerts hydrological control, and landuse on nutrient export in Oceania region

benefiting watershed managements under the context of climate change."(**Lines 46-48**)

We put the three aspects in the end of Introduction as our study goals. "The study is useful to the watershed biogeochemistry field because our work captured these fluxes for (1) the Oceania, a globally significant region where exports from Oceania Rivers are known to be significant and increasing; (2) smaller catchments which represent lotic environments that are most vulnerable to landuse activities while at the same time critical to our understanding of source inputs to larger river systems; and (3) typhoon events of varying strength enabling some assessment of how fluxes behave during these events which are likely to continue to change with climate variation."(**Lines 95-101**)

Introduction. Line 55. Replace "the increase of DIN and DIP" with "this increase.."

We changed the entire sentence to "The increasing discharges of dissolved inorganic nitrogen (DIN) and phosphorus (DIP) from rivers may subsequently induce eutrophication in freshwater and coastal marine ecosystems (Turner et al., 2003; Duan et al., 2007; Conley et al., 2009) resulting in seasonal hypoxia, harmful algal blooms, and losses in fishery production in aquatic ecosystems (Lu et al., 2011; Billen and Garnier, 2007; Diaz and Rosenberg, 2008; Howarth et al., 1996; Rabalais, 2002)."(**Lines 59-63**)

Line 59. The word emission makes me think of releases to the atmosphere. Consider export or loading.

We changed to "export".(**Line 64**)

Line 59. Be sure to clarify form of N and P being discussed here and specify the phrase "deteriorating the ecosystem". That phrase is vague and not informative.

DIN and DIP are used in the study. We re-phrased the old sentence to "Moreover, the imbalanced export of DIN and DIP from land/soil that cause a change in the riverine DIN:DIP ratio may alter phytoplankton community structures, consequently, deteriorating the ecosystem (Justic et al., 1995; Howarth et al., 1996; Rabalais et al., 1996; Elser et al., 2009)."(**Lines 63-66**)

Lines 60-62. End the sentence after the (Howarth et al. 1996; Elser et al. 2009). Start new sentence omitting "that is," with "For example," and omit the word ratios and add more information on these impacts such as distribution of phototrophs (benthic to more pelagic), harmful algal blooms. Here there needs to be a stronger

argument regarding the impact of N:P. I certainly agree there is but this could be stronger in the introduction.

As replied above.

Line 63. It would be helpful to very briefly define the Oceania River region here so clear for rest of the paper.

We defined the Oceania in the beginning of this paragraph, and introduced the characteristics of Oceania Rivers (see below).

"Oceania is a region centered on the islands of the tropical Pacific Ocean. Oceania ranges from the coral atolls and volcanic islands of South Pacific to the entire insular region between Asia and the Americas, including Australasia and the Malay Archipelago. Oceania Rivers accounts for 4.5% of the total land surface area on earth and exports up to 12% and 35% of the global water and sediment discharge, respectively (Milliman et al., 1999). High precipitation, steep slopes, small basin areas, and frequent flood events can induce high erosion rates on Oceania islands (Kao and Milliman, 2008)."(**Lines 67-73**)

Line 65. Place Seitzinger et al ref at end of sentence.

We revised the old sentence and combined with another sentence.

"Model studies have demonstrated that Oceania Rivers are significant sources of global DIN and DIP export (Seitzinger et al., 2005; 2010) and projected that the riverine N flux in Oceania will increase to over 10% by 2030 (Bouwman et al.,, 2005)."**(Lines 76-78)**

Line 66. Rewrite – suggest "Moreover, tropical cyclones, which induce: : :"

We removed this sentence and had more discussion about hydrological controls on nutrient export in Discussion.

Line 68. Rewrite – suggest "abundant nutrients may also disturb in-stream and coastal ecosystems that are associated with nutrient uptake (references)."

Thanks for reviewer's suggestion. We changed the old sentence to "The mass flux from such small rivers might also have unique biogeochemical significance since many of these rivers discharge material onto narrow shelves and canyons, facilitating material bypass to the deep sea (Milliman 1995; Nittrouer et al. 1995; Carey et al. 2002; Lyons et al. 2002; Kao et al. 2006; Leithold et al. 2006)." **(Lines 73-76)**.

Line 76. Suggest "a pristine, moderately: : :"

We rephrased the sentence to “The nitrate and phosphate concentrations were measured in three headwater catchments representing different cultivation extents.”**(Lines 93-94)**
The description of the study sites are in section of Study site.

Line 77 Suggest “catchments were monitored during a 3-day: : :”

Done as advised.**(Line 94)**

Line 80 suggest “12-month period and the significance of typhoons in altering this pattern; and: : :”

We removed this statement and replaced the original goals with the three above-mentioned aspects**.(Lines 95-101)**

Study site. Line 90. Need to refer to Table 1 and clearly define these “levels” of cultivation.

Done as advised.**(Lines 113-116)**

For example, don’t see reference to cultivated lands other than orchard in Fig.1 but do see small % in Table 1. Seems secondary forest is really the component that differs among the watersheds. This point needs to be clarified so as to understand the relevance of the differences in these catchments both regionally and internationally.

To make it clearer, in Figure 1 we re-named “active/inactive vegetation” to “active/inactive farm” which stands for currently-growing and expropriated farms, respectively. The active and inactive farms are represented by the polygons in red and dark red, respectively in Figure 1.
Reviewer is right about the secondary forest. However, in this study we focus on the effects of agricultural landuse on stream nutrient. Besides, our previous study showed (Huang et al., 2012) the secondary forest did not influence nitrate yield significantly compared to active/inactive farm and orchard.

Line. 93. Suggest rewording “75% of the precipitation falls during the wet season (may to Oct), primarily due to typhoons.”

We rewrote the old sentence.
“The annual runoff is ~3300 mm, and ~75% of the runoff occurs during the wet season (May to Oct), primarily during the typhoon periods.”**(Lines 106-108)**

Line. 94. How was discharge measured by these two gauges?

"Two hydrologic gauges (Fig.1) monitor water levels, one for Yusheng Creek and one for the entire Chichiawan (all three creeks). The consecutive water level will be transferred into hourly water discharge via a rating curve of water discharge against water level, which is calibrated each year."**(Lines 124-127)**

Line 95. Suggest rewording "The discharge for the pristine watershed (Gaoshan Creek) was derived from that of the : : :"

We rewrote the old sentence.

"The most downstream gauge (Chichiawan) subtracts the discharge from Yikawan Creek will be the discharge for the Sta. K. The discharge for G is derived from area proportion of Sta. K (Kao et al., 2004; Huang et al., 2011)."**(Lines 127-129)**

Because the steep slope and short flowing distance leading to the quick response of runoff to rainfall, the area proportion method works well in the headwater catchment. Kao et al. (2004) has successfully used the same skill on estimating nutrient fluxes in Lanyang Creek in Taiwan. The potential of the application of area proportion method in the headwater catchment could be also found in Huang et al. (2011)

Line 96. Need to clearly justify this approach of using the larger Chichianwan to predict the Gaoshan. This is particularly important for interpreting the loads among these catchments. What is the point of providing the average daily discharge for Chichiawan and Yusheng? How was the discharge of Yikawan determined?

As replied above.

Line 105-106. What does "similar environmental background" mean?

We changed "background" to "features" which indicate precipitation, atmospheric deposition, and geology. **(Line 141)**

Line 107. Need to provide a bit more clarity and/or evidence to support this last statement that these creeks are good sites for revealing the relationship between nutrient export and landuse.

We rewrote the old sentence.

"The three adjacent creeks have similar environmental features, i.e. precipitation, atmospheric deposition, and geology, with varying cultivation gradients providing us a good experimental ground to explore the nutrient dynamics and differentiate anthropogenic alteration from natural background." **(Lines 140-143)**

Materials and methods.

Line 118. Is this month/day, looks to be that way but it might be better to clarify this.

"Three among the four in 2007, Pabuk, Sepat, and Krosa during 6-8 Aug., 16-19 Aug., and 4-7 Oct., respectively, were sampled intensively at a 3-hour interval for 62 to 87 hours."**(Lines 148-150)**

Line 122. How was nitrite and ammonium determined and what were the detection limits?

"Nitrate, nitrite and ammonium content was determined by ion chromatography (IC) using a Dionex ICS-1500 instrument with a detection limit of 0.2, 0.2, and 0.4 μM, respectively. For all samples, nitrite and ammonium concentrations were lower than the detection limit."**(Lines 156-159)**

Line 125. What colorimetric method was used in the flow injection analysis conducted? How was total suspended matter determined? How was temperature monitored?

"Phosphate, dissolved inorganic phosphorus (DIP), was determined with standard Molybdenum blue method with the detection limit of 0.01 μM (Parson, 1984). During typhoon period, total suspended matter (TSM) was determined gravimetrically using pre-combusted 0.7 μm GF/F filters. The mean of the blank, calculated from ten replicates, was 0.05±0.01 mg/l. This blank value was well below the weight of sediment on the filter (generally >10g/l)."**(Lines 160-164)**

"Three precipitation gauges maintained by the Taiwan Power Company are located in this area (Fig.1). The most west gauge monitors air temperature as well."**(Lines 123-124)**.

Lines 131-132. "Flux estimations are often essential: : :" sentence is awkward and difficult to follow – suggest clarify.

We changed the expression.

"We need flux estimator to derive the flux within a given period when there are limited samples."**(Lines 169-170)**

Line 136. Define C-Q first time used.

Done as advised.**(Line 171)**

Line 140. Suggest clarify what is meant by flow-weight method. Define the term

“Load” used in equation 1 so distinct from “Load” in equation 2. These need distinct and descriptive terms that should be maintained throughout the paper. This was difficult to follow here and in the paper itself.

We added subscripts to make it distinct. **(See section 3.2)**

Line 142. Provide the units for the conversion factor. Where does it come from? That is not provide here and should be.

We clearly explained the equation and added references in the text.

“The formula for the flow-weighted method is shown below (Dolan et al., 1981; Coats et al., 2002).

$$Load_{NT,m} = K_1 \frac{\sum_{i=1}^{N_m} C_{i,m} Q_{i,m}}{\sum_{i=1}^{N_m} Q_{i,m}} \times Q_{t,m} \qquad ,m = 1 \sim 12 \qquad (1)$$

where K_1 is the conversion factor (=10^{-3}, converting [*g*] to [*kg*]) used to calculate $Load_{NT,m}$ [*kg*] for a month, m.“**(Lines 179-183)**

Line 160. “could be as much as three” Was it or not? Should clearly state actual results, wording like this is a bit confusing.

We rewrote the sentence.

“The discharge shows a spiky feature ranging over three orders of magnitude, which is common and mostly attributed to typhoons, characterizing small mountainous rivers (Milliman and Kao, 2005; Kao and Milliman, 2008).”**(Lines 201-203)**

Lines 162-164. Last sentence here sounds like part of the methods not the results.

We removed the last sentence and explained the “running average” in the caption of Figure 2.

Line 170. Here is an example of different terms used for the events associated with the typhoons. In this case “rainstorm”. Upon first read I found it difficult to follow the paper because I was not sure if events or rainstorms coincided with the typhoons or not – so I was always trying to figure this out. Might help to stick with one term for these perhaps typhoon rain events.

We removed the sentence.

From the Results section, the manuscript has been remarkably modified. Hence, some of the sentence/paragraphs may no longer exist.

In the revised version, rainstorm is less frequently used because typhoon is the major

contributor to the flood. Rainstorm and typhoon both could trigger flood which means extremely high flow. In the Results section “typhoon” would be used more often because only typhoon samples were taken. In the Discussion section, two terms are used together because the flood, hydrological control, triggered by rainstorms and typhoons could influence nutrient dynamics.

Lines 173-183. This entire section reads like discussion material should be moved and integrated into a reorganized discussion.

Done as advised.

Line 181. Clarify the sources of these different N pools in the surface and subsurface. This is an issue when it comes to understanding the mechanisms behind differences found in these datasets by element, catchment, and flow regime.

We moved this sentence to the end of Section 5.3 and revised it as “Various proportions of different flow pathways determine the behaviors of stream nutrient concentration (Mulholland and Hill, 1997; Katsuyama et al., 2001; Poor and McDonnell, 2007).” **(Line 466-468)**

Readers would straightforwardly understand the expression when they get to this paragraph because we already talked about the landuse effects, hydrological controls, and different transport mechanism of DIN and DIP in the previous section.

Line 185-187. Suggest rewording “ The irregular application of fertilizer likely caused a decoupling between nitrate concentration and discharge noted in this watershed (fig. 5).” This, however, doesn’t necessarily fit here unless a reorganization of the results is made based upon NO3- which includes both the fluxes in addition to the relationships with discharge. So either move this or integrate the discharge relationships into this section. This would reduce redundancy in the results section.

We removed this old sentence.

However, we now integrated the discharge relationships into temporal variation section and became “4.1 Temporal variation of nitrate and concentration-runoff relation” section to reduce redundancy.

Line 189. Example of terminology associated with the typhoon events. Here the term “flood period” is used.

As replied above. Flood could be triggered by either typhoons or rainstorms, indicating extremely-high flow condition.

Line 190. Suggest reword – “In the intensively cultivated watershed: : :”

We revised the old sentence and became “The observed concentrations at this station sometimes surpassed the criterion for drinking water quality, ~160μM.”**(Lines 232-233)**

Line 191. Looks like NO3- levels are actually higher than 10 ppm.

Yes, reviewer is right. As replied above.

Lines 192-194. Looks like discussion not results.

Moved to Discussion section.

Line 198. Clarify phrase “have insignificant seasonality” should this read “did not vary with season or seasonally?”

Done as advised. “Overall, phosphate did not vary seasonally as significantly as nitrate.”**(Line 240-241)**

Lines 199- Discussion material.

Moved to section 5.4.

Lines 200-202. Repetitive, consider integrating these statements into one.

We removed the old sentence.

Line 203. Suggest reword – “Increasing phosphate concentration, however, accompanied the increase in discharge, congruent with the hydrologic controls on the enhancement of phosphate concentration in other watersheds (refs; Fig 5). Again this is a bit like discussion material: : :

Done as advised and moved to Discussion section. “Increasing phosphate concentration accompanies the increase in discharge, congruent with the hydrologic controls on the enhancement of phosphate concentration in other watersheds (Sharpley and Menzel, 1987; Correll et al., 1999, Fig. 4b).”**(Lines 415-418)**

Lines 206-207. Discussion material to be moved.

Relevant descriptions were now addressed in Disucssion.

Lines 208-211 Starting with “In a year, the phosphate : : :” and ending with (Green and Finlay, 2010) reads like material for discussion. Should consider integrating with discussion.

Done as advised and moved to Discussion section.

Lines 211-214. Starting with “The scattered phosphate..” Need to state more clearly as results and compare with the nitrate.

The sentence no longer exists.

Line 216. If keep separate section “Hydrological controls” need to remove reference to relationships to discharge in the proceeding sections to avoid repetition. In this section it would helpful to first provide the basic results (1) what were the relationships between NO3- and discharge; (2) How did this relationship vary among catchments; (3) How did this also vary between nontyphoon and typhoon periods? Repeat this line of organization for PO42- so can clearly state the differences.

Inspired by reviewer’s suggestion, we now integrated temporal nutrient concentration and hydrological controls into one section, i.e. 4.1 Temporal variation of nitrate and concentration-runoff relation and 4.2 Temporal variation of phosphate and concentration-runoff relation, to reduce redundancy because it is difficult to separate hydrological controls while addressing temporal variation.

Lines 225-226. “is that the source area of the phosphate is proportional to the: : :” this line of discussion is a bit unclear and I think this issue may be analogous to that highlighted above for line 181. Getting this information including any evidence for sources is important to the later interpretation of these results.

We removed the old sentence. The mechanism for phosphate transport is now in Discussion **(see Lines 413-423).**

Line 226-227. Sentence starting “From those concentration and discharge..” This sentence needs to more clearly explain the patterns by N then by P then state the differences.

We removed the old sentences. As replied above, we integrated nutrient dynamics and hydrological controls into 4.1 and 4.2 for nitrate and phosphate, respectively.

Lines 228-229. This last sentence is the kind of basic results material that belongs up front in this section.

Done as advised.

Discussion.

Overall there is a great deal of results provided in this discussion section which made it difficult to wade through. One telling example of this are the discussion

section titles which read much more like results sections and less like actual findings and/or their interpretation. I tried here to identify many of the examples of the results in this section so can see what could be moved/reorganized. I also wonder if the authors would consider organizing this section using titles such as: (5.1) Hydrologic controls different for DIN and DIP. In this section the differences in how DIN and DIP concentrations and loading could be discussed using the different levels of hydrology investigated (e.g. seasonal and event driven). So first focus on flux and export. Then yield and discuss the mechanisms likely responsible for DIN versus DIP. (5.2) Importance of landuse activity on nutrient export and differences in their proportions from Oceania streams. (5.3) Differing mechanisms for DIN and DIP export, potential mechanisms and consequences. I would suggest starting of the section with a paragraph that introduces the pathway of this discussion and with this sort of organization and the ending focused on the conceptual model the conclusion section would not likely be needed.

As replied above.

Lines 234-239. This whole section contains results that were not provided in the results section.

We moved relevant paragraph to Results section **(see line 314-319).**

Lines 239-243 Suggest rewording "Although the nitrate concentration was diluted during the typhoons, the increase in discharge by three orders of magnitude compensated for the dilution effect and led to the transport of more nitrogen during these periods as compared with the low flow period on an annual basis."

We modified the old sentence and moved to Discussion.

"Although the nitrate concentration is diluted during typhoon periods, the increase in discharge by three orders of magnitude compensated the dilution effect (~one-order magnitude decrease in concentration) and leads to greater transports (Table 3 and Table 4)."**(Lines 404-406)**

Line 242. Is the phrase "directly proportional to the discharge magnitude" accurate? I did not see any direct tests of this in the results but perhaps I missed something.

We removed the old sentence and provided new Figure 8 illustrating the positive correlation between nutrient flux and discharge magnitude. The relevant descriptions are now in **Lines 304-309**.

Line 244. What is meant by the phrase "recovery of nitrogen is fast."

Recovery is not a good term thus we modified the old sentence. We speculate the unceasing nitrogen export from the watershed may partially be attributed to the fast supplement of nitrogen to the watershed system.
"This may imply either the nitrogen storage in the watershed is sufficient to afford frequent flooding or the supplement of nitrogen to the watershed system is fast."**(Lines 409-410)**

Lines 245-246. Report these in the results.

Done as advised. **(See Lines 314-319)**

Lines 247- The mechanism vaguely eluded to here is really interesting an important but not quite clear enough I am afraid. In this first section I found three typhoon events were referred to but not always as in some places only two were reported on. Need to clarify this. Overall need to discuss potential mechanisms for increase in nutrients with frequency of events. Why is this not simply due to greater discharge in later events. How can size of events be separated from frequency in these data in order to make such statements?

As replied above, in this version we precisely estimated nutrient export for every typhoon period (4 typhoon periods in 2007 and 4 in 2008, announced by Central Weather Bureau). Hence, we could pin down the influence of individual typhoon on the nutrient export.

Line 254 Suggest rewrite as "The nutrient fluxes were converted into yields to illustrate the export rate of DIN and DIP per unit watershed area: : :(here more specifically state why). " Also given that this is a topic sentence in the discussion should indicate what this suggests.

It is now "The nutrient loads were converted into yield per area to illustrate the production rate of DIN and DIP (represented by DINy and DIPy, respectively), eliminating the watershed size effect in convenience for comparison (Table 4)."**(Lines 320-322)**

Line 257. Add "captured by these catchments" after "cultivation gradient: : :"

Done as advised. **(Line 324)**

Line 258. Place (Caraco and Cole) reference at end of sentence.

We removed the sentence and added more into Discussion.

Lines 259-262. What evidence is there specific to the watersheds investigated in this study?

We removed these sentences. In Discussion (5.4) we have more discussion and comparison about the differences among Oceania Rivers and global rivers derived from two references **(please see section 5.4)**

Line 260. In this phrase "High nitrogen yields were also noticed in China " provide information on type of system.

As replied above.

Lines 263-264. Belongs in results.

Moved to the Results.

Line 264. Suggest rewrite "Phosphate yields in these streams were also larger than most: : :" and include other examples – that is compare to other systems in addition to Changjiang River. Overall there needs to be some clarity on how to compare these smaller tributaries to the larger rivers systems we typically have more information on. This is an important point that would be helpful to clarify in this discussion but is currently not included.

As replied above. More discussion and comparison (in terms of nutrient yield) between small and large river systems are in section 5.4.

The reviewer also highlighted an important point that small rivers often have limited information unlike larger river systems, demonstrating the significance of our study.

Lines 272-275. Example of where the small vs. larger river comparisons should be made.

As replied above.

Line 280. Need to clarify what evidence is derived from this study then back up with interpretation of the data using evidence from elsewhere. The section above this is difficult to follow I think because of the lack of clarity on what was found here and how other work relates and helps to interpret these new findings. What evidence is here for N saturation (this phenomenon?).?

After re-organization, we put our findings in **Lines 338-346**, and referred our results to other modeling works in **Lines 347-355**, in which major differences in between were discussed. As for N saturation, we added more discussion in **Lines 356-368**.

Lines 282-285. Good example of where the argument gets lost in the writing and needs clarification.

See reply above.

Lines 286-289. Material that needs to go into the results and taken out of discussion.

Done as advised.

Lines 289-292. Indeed the seasonal and event driven hydrology forcing on the NP ratio is really important but need to make a better link with the dataset. What are the different mechanisms at play here?

See **Lines 424-434.**

Lines 292-294. Clarify the terms used here (i.e. immediately recovered, responds quickly) in terms of catchment, the pristine and intermediate cultivation catchments response was not so obvious from what I could tell whereas the intense cultivation catchment see a longer recovery 6-7 months (See Fig. 7).

We elaborate more about the shorter-term and longer-term responses in **Lines 440-442** and **Lines 276-290**. The term "recovery" is not proper as indicated.

Line 297. Be sure to clearly define N:P ratio throughout the paper. Some reminder of this when first used in the discussion is important. Is this load based or concentration? This also needs to be rewritten to provide the major point of this section of the discussion.

We applied both which were clearly defined by adding subscripts "c" and "y" to represent concentration and yield, respectively.

Lines 298-300. Results material here that needs to be removed.

Done as advised.

Lines 300-302. Don't see this in Fig. 8 where the lower N:P is shown in (d) which is the most cultivated catchment and largest variation in the most pristine catchment (b).

We refined Figure 8 , added legends and refined captions to avoid confusing.

Line 303. Were the N:P vs. PO42- concentration relationships similar among the three catchments? I don't agree with that.

We rewrote the whole paragraph. We removed the statement.

Line 303 Suggest reword ". In dry season, the N:P ratios were maintained around the annual average". Again these lines read like results and less like discussion. What are the likely mechanisms?

We elaborate more about the temporal variation in N:P in Discussion **(Lines 424-443)** and refined our conceptual model of N:P regulation, which is mainly controlled by flow path and the difference in undergound nutrient storages between pristine and cultivated areas.

Lines 305-307 Very important finding. What is the significance?? That needs to be included here.

We add more discussion how this imbalanced N:P export may influence downstream P-limiting freshwater system and N-limiting marine environments. **(Lines 526-535)**

Lines 313-314. The information stated in sentence starting "However, the surface flow had abundant: : :" is not what is depicted in the conceptual figure. Which is correct?

This question is raised due to our mistake in concentration profile in the old conceptual model. The problem had been fixed.

Line315. Suggest reword by eliminating "most nitrates depleted and adding "is depleted in nitrate" after "the surface runoff,"

We now changed the sentence to "During the typhoon or rainstorm flood (Fig. 9c), stream discharge, dominated by surface runoff in which nitrate is depleted, decreases nitrate concentration in the river. But the surface runoff containing abundant particle-associated phosphate increases phosphate concentration, resulting in significantly lower DIN_C:DIP_C (Fig. 8)."**(Lines 461-464)**

Line 316. How are ratios diluted? Need to clarify this.

Review is correct. We changed our entire statement in **Lines 461-464.**

Line 318. Not sure if I follow this high N:P during the typhoon events? Wasn't it actually lower? What is the role of the deeper soil water contributions during such events. This is just an example of the need for clarity around the relationship between the findings of this study and the most plausible mechanisms to explain

them.

We refined our description. Please refer to the new section 5.3.

Conclusion.

Reads too much like an abstract. In fact there are elements in this section that should be considered for the abstract. Here in this section I noted very important statements on the role of hydrology and the potential role of land use in regulating nutrient export. These should be used in constructing a new organization for the discussion.

One really important finding that I think is lost in this discussion and that needs to float to the top is the diffences in the N:P exported by these smaller catchments (in both value and variation) as compared to larger rivers where these values are so well constrained.

All abovementioned suggestions are now in Discussion section. We still keep our Conclusion section to summarize our findings and implications.

Figure 1. Define K1, C2, and Y1 here.

Figure 1 has been redrawn. We clearly described our sampling sites (now G, K and Y) in the figure caption.

Figure 2. Need to include what the solid circles and triangles represent (baseflow vs. typhoon). Nitrate values presented as running means where n=5 (if that is correct need to add to caption as well).

Thanks for your suggestion. In this new version, we clearly defined our symbols in the figure caption.

Figure 3. Why is log scale used in (d)? Need explanation in caption.

The fluctuation of phosphate concentration at this site is so large that log scale could help on illustration. However, we changed the way of illustration to rescale the y-axis above 1μM and explained it in caption. To maintain the consistency through the entire manuscript, the unit of nutrient concentration has been converted into [μM].

Figure 4. Need to include statistics for the least-square linear regression provided. This is a real problem in the paper overall where results of these are not really provided.

We believe that the new version of the manuscript has been significantly improved

according to the reviewers' comments and suggestions. This old Figure 4 is now Figure 5, and the statistics for the linear regression are shown on the plot.

Figure 5. Same issue as above Figure 7. Define the N:P ratio here along with what the shaded boxes represent (in the caption). Indicate that this is a box-whisker plot and what the "x" and bars refer to.

We re-drawn old Figure 5 (now Figure 4) and removed the linear regression lines which we do not think they play crucial role in our story.

Old Figure 7 is now Figure 6 (we removed old Figure 6). We have modified our plot accordingly.

Figure 8. Define N:P ratio here.

We have modified old Figure 8 (now Figure 7) accordingly.

Figure 9. Need to go over these trends as I found some inconsistencies with the text. For example the little NO3- and high PO42- doesn't agree with text.

In this new version, we have modified Figure 9 and made it consistent with the text. We believe that Figure 9 now could stand alone and illustrate the mechanism of nutrient transport.

Table 2. These are average values for what period/frequency.

We have made the caption clearer now. "Table 2. The means and coefficients of variation for nitrate, phosphate, and TSM concentration of water samples at three sites, including typhoon and non-typhoon samples. No TSM concentration was measured for non-typhoon samples. Non-typhoon samples were taken twice per week from 2007 to 2008 and typhoon samples were taken during three typhoon periods in 2007. See more detail in the text."