The black and blue texts are comments from reviewers and author's responses respectively.

Comments from Reviewer #2,

This manuscript presents relationships between water budget (precipitation and discharge) and weekly hydrochemical data in four watersheds within the Feitsui Reservoir Watershed (FRW) in northern Taiwan. The dataset spans three years and encompasses eleven Typhoon systems. The authors use these data to draw inference about distinct hydrochemical response during typhoon vs. non-typhoon times, both in terms of variability and direction. Additionally, the watersheds differ in size and relative proportion of agricultural land - in this case largely heavily fertilized tea plantations – and they use this difference to examine the effect of land use change on response to typhoon events.

The authors have an interesting and appropriate dataset to address their questions, and additionally seem to have chosen an ideal location to elucidate dependence of hydrochemical response on storm intensity. Their methods are logical and results indicate striking differences between watershed response during typhoon and non-typhoon times. I have two suggestions for review I would characterize as "major," along with multiple minor suggestions and comments, which are delineated below. Given response to these suggestions, this paper seems like a good candidate for publication in Biogeosciences.

1. Discharge estimation and enhanced hydrologic analysis: The author's use of the "area-ratio" method of estimating discharge is far from ideal, although it seems to be unavoidable in the absence of other gauging stations within the study watersheds. It is surprising they did not at least perform weekly in-situ measurements of discharge (area-velocity or dilution gauging) in conjunction with their chemistry sampling. Additionally, they present no hydrography or additional hydrologic analyses, for example runoff ratio at annual and storm scales, which may help interpret their weekly data and results.

1a. I would like to see a more thorough explanation of both their method for estimating discharge (rather than requiring the reader to reference to one of the author's previous publications) and a discussion of the method's limitations. This should not be long or intensive, but should be sufficient to help the reader understand the reasons for doing so and the potential effects on the analysis.

Reply: We agree that the area ratio method is not ideal and re-estimated stream discharge using the Hydrologiska Byråns Vattenbalansavdelning (HBV) model. We updated all the figures and tables based on the new calculations. The basic patterns do not change but some details are different. The following detail is added to the Materials and Methods section.

"Stream discharge of the four ungauged watersheds was also simulated by the HBV model processed through TUWmodel (ver. 0.1-8) (Parajka et al., 2013). Five daily rain gauges, maintained by Water Resource Agency (WRA), and five metrological stations, maintained by the Central Weather Bureau of Taiwan (CWB) with hourly observed rainfall, temperature, wind speed, and solar radiation were used to estimate daily rainfall and potential evapotranspiration. The daily evapotranspiration is also observed by Taipei Feitsui Reservoir Administration (TFRA, Taiwan) at the Feitsui meteorological station. The observed rainfall, temperature and evapotranspiration were applied into 20 sub-catchments with Thiessen polygon method. Daily discharge was monitored in three main tributaries of Baishi Creek by TFRA. In the calibration against the observed values, parameters were generated by the package DEoptim (ver. 2.2-4) (Mullen et al., 2011). Three objective functions, Nash Efficient Coefficient (NSE), its power of 2 and log scale, were used to adjust the model to suit normal, extreme, and low flow conditions. The validation gauge is located in the inflow of dam of reservoir. The modelled daily discharge was aggregated into weekly discharge." We updated all the figures and tables based on the new calculations. The basic patterns do not change but some details are different. The cited references are listed below.

Parajka, J., Viglone, A., Salinas, R. M., Sviapalan, M., and Blöschl, G.: Comparative assessment of predictions in ungauged basins - Part 1: Runoff-hydrograph studies, Hydrol. Earth Sys. Sci., 17, 1783–1795, doi:10.5194/hess-17-1783-2013, 2013.

Mullen, K. M., Ardia, D., Gil, D. L., Windover, D., and Cline, J.: "DEoptim: An R Package for Global Optimization by Differential Evolution, J. Stat. Softw., 40, 1–26, doi: 10.18637/jss.v040.i06, 2011.

1b. The author's should strongly consider including standard hydrographs coupled with their hyetographs for context, and potentially also include annual and a storm-by-storm analysis of runoff coefficients. The latter may require some time, but would be very valuable in interpreting their dataset from the standpoint of variable runoff generation processes due to intensity. Additional context such as intensity-duration curves with differentially colored typhoon and non-typhoon events would also help make points they make primarily in text.

Reply: We added standard hydrographs to the results and calculated weekly runoff ratios and examined their relationship to precipitation. The following information is added to the revision. "*During the sampling period, weekly precipitation ranged from 1 mm to 470 mm while weekly streamflow ranged from 10 mm to 446 mm (Fig. 2)*". We also calculated weekly runoff ratio and the mean runoff ratio for typhoon period and non-typhoon period. In the Results section, we added "*The weekly runoff ratio was negatively related to precipitation quantity and was highly variable during the non-typhoon period but varied much less during the typhoon period (Fig. 2)*".

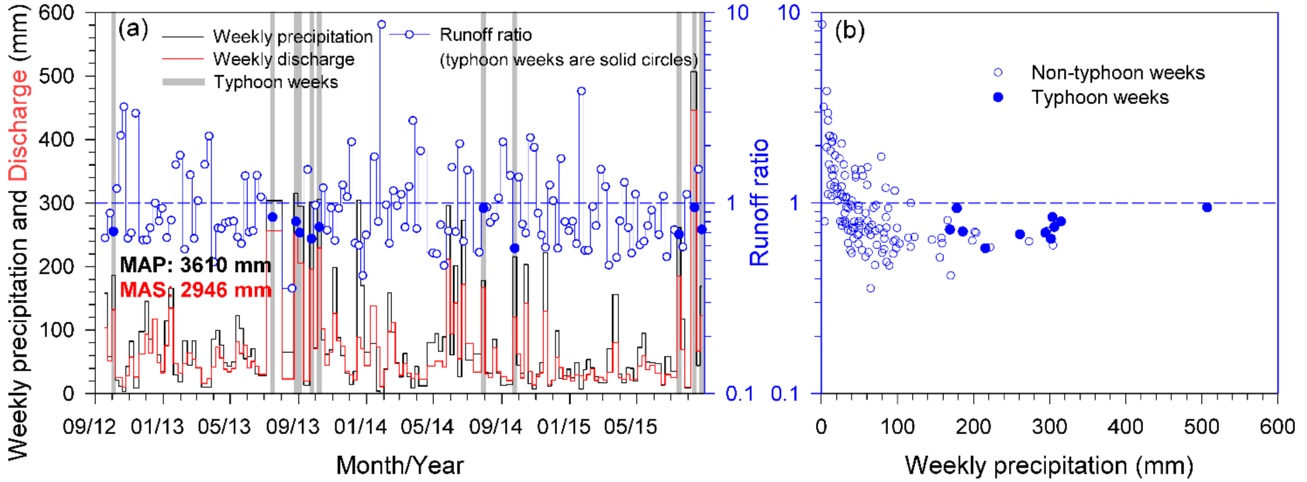

Figure 2. Mean weekly precipitation, discharge and runoff (a), and the relationship between mean weekly precipitation and mean runoff ratio (b) of the four studied watersheds combined. MAP: Mean annual precipitation, MAS: Mean annual stream discharge.

2. Process-based discussion: With the richness of their chemical dataset, I expected the discussion to be an ideal opportunity to discuss the observed non-linearities in hydrochemical response in the context of physical and biogeochemical process. The authors rightly make no claim at their ability to rigorously distinguish the physical or biogeochemical processes responsible for the dynamics the observe, but there is a rich literature within watershed hydrology and biogeochemistry addressing each of these chemical constituents which would appropriately be used to contextualize their findings. What do the nutrient dynamics suggest about stream response to extreme events? Does stream productivity or nutrient saturation factor in to the differences between A and F watersheds? Does the response of weathering products suggest activation of distinct flowpaths in non-typhoon vs typhoon events? Any of these or more would be appropriate discussion points and would help the reader move past observation to interpretation.
Reply: We substantially extended our discussion to include possible explanations to the differences in the patterns between typhoon and non-typhoon periods. The following is added to the discussion. In the Discussion section, we added “*Stream discharge originates from three sources, surface runoff, subsurface runoff and groundwater discharge. Among the three sources, groundwater discharge was more important during low than high flow periods, whereas the contribution from surface runoff should be more important during heavy storms than small storms. The contribution from subsurface flow probably dominated the discharge at our study site, especially in F1 and F2 because a study at a natural forest*

12 km Southeast from our study site indicated that even during a heavy typhoon storm, with precipitation near 700 mm in two days, there was no observable surface runoff (Lin et al., 2011). The contribution from groundwater and subsurface runoff to total discharge likely resulted in the very high runoff ratios for weeks with small amount of precipitation. For example, in 28 January 2014, the weekly precipitation and discharge were 1.5 mm and 13 mm, respectively, which led to the highest runoff ratio, 8.7, for the entire study period (Fig. 2). Groundwater is enriched with ions derived from rock weathering such as K^+, Ca^{2+}, and Mg^{2+}. In addition, pre-storm subsurface runoff has a longer contact time with soils that are also rich in these cations and SO_4^{2-}. Thus, the greater contributions from groundwater and subsurface runoff in the non-typhoon period likely contributed to the greater (positive) slopes between discharge and flux of these ions for the non-typhoon period than typhoon period (Figs. 4 and 5). The second possible reason for the greater slopes between discharge and fluxes of many ions during the non-typhoon period is the differences in ion concentration between typhoon and non-typhoon storms. Clear sky characteristic of the one or two days before a typhoon is typical because the outskirt air masses of the typhoon "blow" away most air pollutants. As a result, precipitation associated with typhoons have low concentrations of ions with terrestrial sources (Lin et al., 2011). In our study, mean concentrations of all ions were lower during typhoon period than non-typhoon period (Table S3) and this diluted precipitation ion concentrations overrode quantity effect and contributed to the smaller increase in ion flux with increasing discharge (Figs. 4 and 5)."

Lin, T. C., Hamburg, S. P., Lin, K. C., Wang, L. J., Chang, C. T., Hsia, Y. J., Vadeboncoeur, M. A., McMullen, C. M. C., and Liu, C. P.: Typhoon disturbance and forest dynamics: lessons from a northwest Pacific subtropical forest, Ecosystems, 14, 127–143, doi: 10.1007/s10021-010-9399-1, 2011.

Table S3. The mean (one standard deviation) concentrations of ions (mg/l) in precipitation during non-typhoon (Non_Ty) and typhoon periods

	H^+	Na^+	K^{2+}	Ca^{2+}	Mg^{2+}	NH_4^+	Cl^-	NO_3^-	SO_4^{2-}	PO_4^{3-}
A1										
Non_Ty	0.06 (0.06)	4.15 (8.35)	0.64 (1.36)	0.84 (1.36)	0.59 (1.04)	0.85 (1.35)	9.43 (22.9)	3.97 (6.27)	5.18 (7.26)	0.04 (0.15)
Typhoon	0.02 (0.02)	3.78 (3.51)	0.43 (0.45)	0.48 (0.36)	0.51 (0.41)	0.12 (0.14)	6.05 (5.21)	0.40 (0.70)	1.54 (1.57)	0.01 (0.02)
F2										
Non_Ty	0.04 (0.06)	3.37 (8.17)	0.61 (1.66)	0.84 (1.91)	0.55 (1.08)	0.55 (1.18)	7.96 (23.9)	2.56 (9.10)	4.84 (10.2)	0.01 (0.05)
Typhoon	0.01 (0.02)	3.36 (2.75)	0.37 (0.39)	0.32 (0.23)	0.46 (0.36)	0.14 (0.17)	5.03 (3.96)	0.39 (0.53)	2.11 (2.80)	0.002 (0.003)

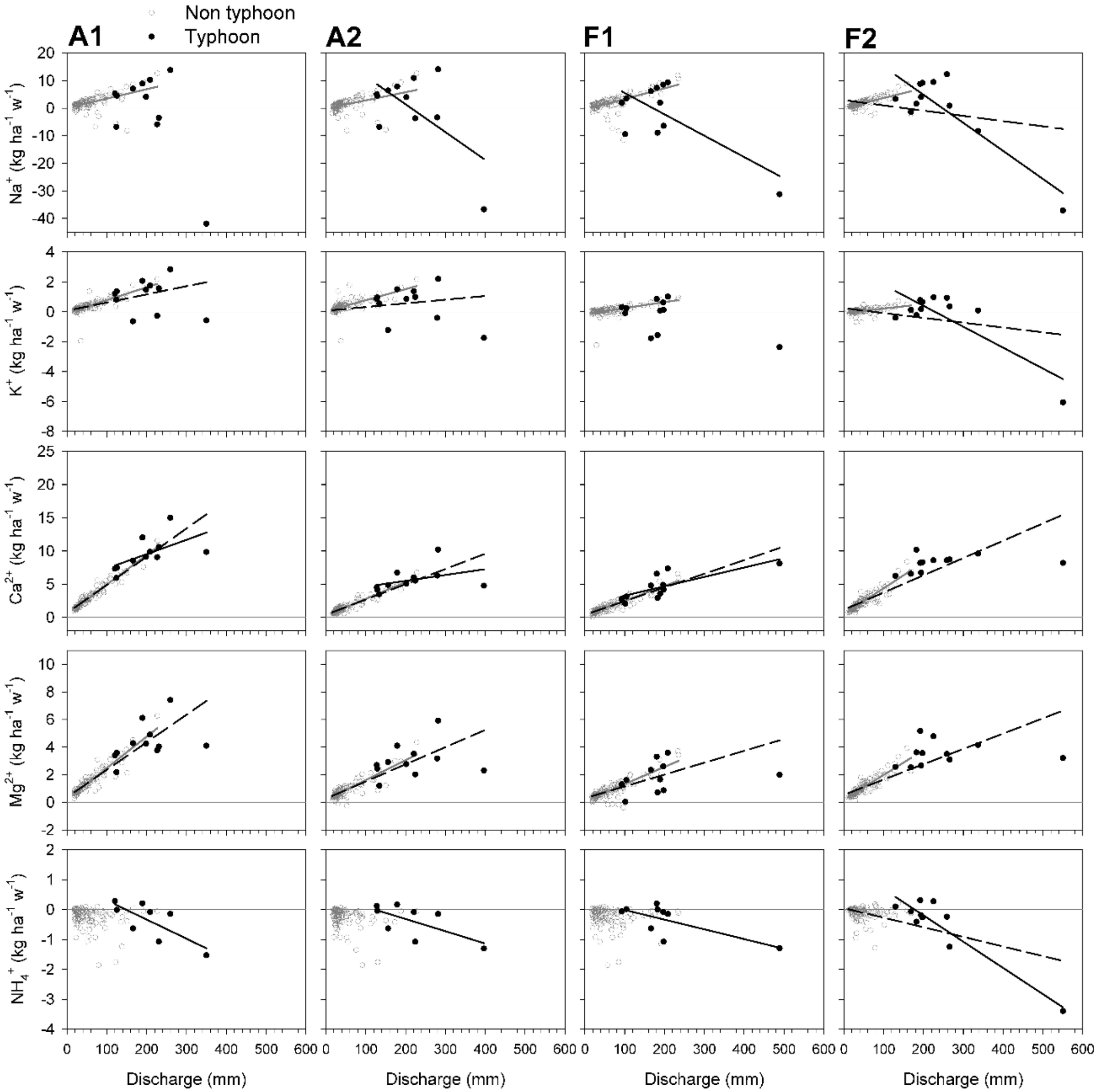

Figure 4: Relationship between stream discharge and nutrient budget (stream output – precipitation input) of cations (Na^+, K^+, Ca^{2+}, Mg^{2+}, and NH_4^+). The gray, black, and dash lines indicate significant linear regressions between discharge and ions budgets for non-typhoon, typhoon and all data, respectively. Please refer to Table S2 for the regression models and R^2s.

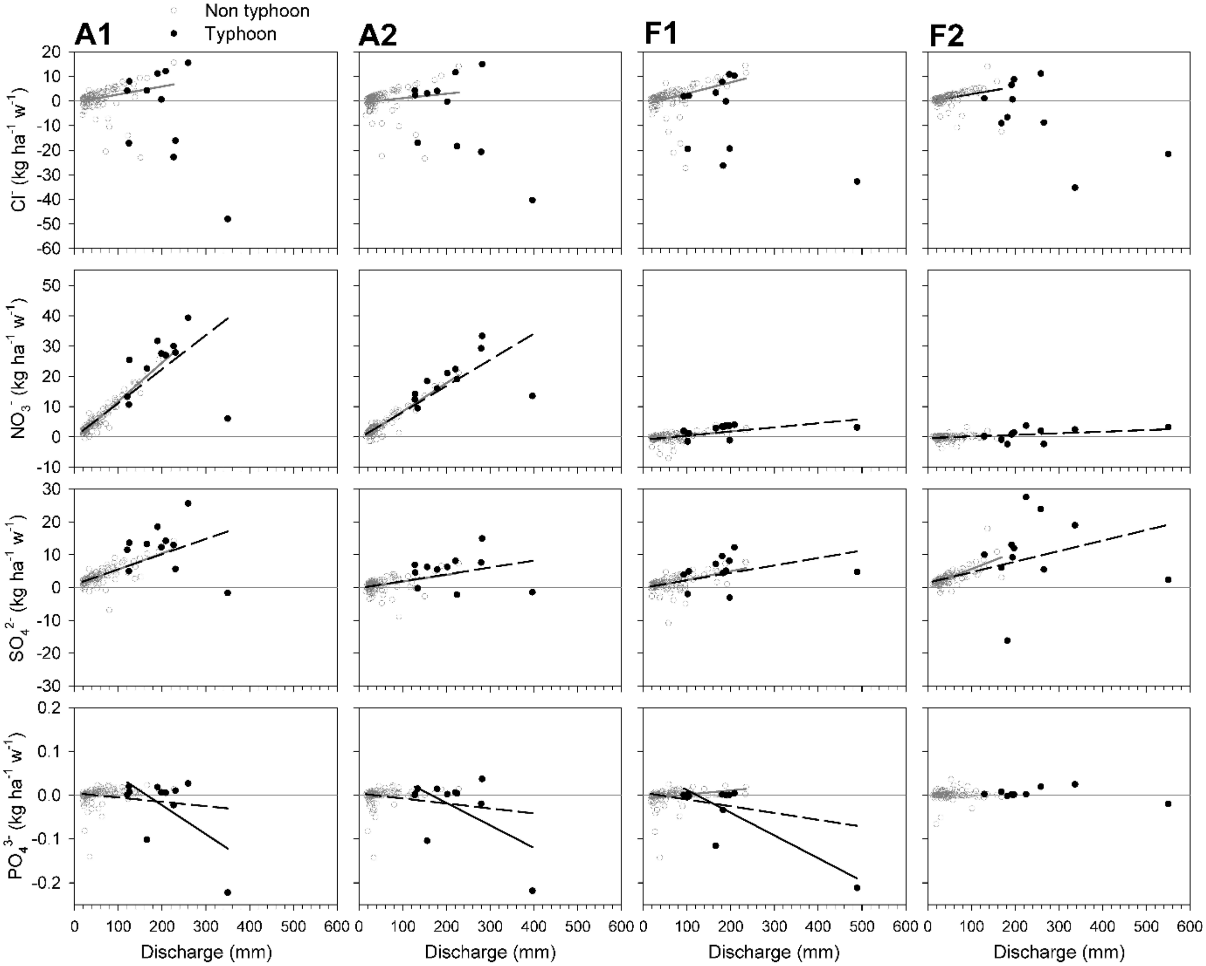

Figure 5: Relationship between stream discharge and nutrient budget (stream output – precipitation input) of anions (Cl^-, NO_3^-, SO_4^{2-}, and PO_4^{3-}). The gray, black, and dash lines indicate significant linear regressions between discharge and ions budgets for non-typhoon, typhoon and all data, respectively. Please refer to Table S2 for the regression models and R^2s.

See below for minor suggestions and comments delineated by page and line number:
P2 L25-37: More descriptive climatic information would help the portion of the audience not familiar with the location: annual precipitation, climate zone, seasonality, etc. L30-31 could include actual quantification.
Reply: Following the general description, we added the following information: *"The FRW region is characterized with humid subtropical climate. The mean annual precipitation is 3765 mm between 1991 and 2001 (Chen et al., 2006), with approximately 68% occurring between May and September (Chang and Wen, 1997). However, due to the rough topography, precipitation is highly variable, ranging from 3500 mm in the southwest portion of the FRW to more than 5000mm in the northwest during 2001–2010 (Huang, C. J., unpublished data)."*

Chen, Y. J., Wu, S. C., Lee, B. S., and Hung, C. C: Behavior of storm-induced suspension interflow in subtropical Feitui Reservoir, Taiwan, Limnol. Oceanogr., 51, 1125–1133, doi: 10.4319/lo.2006.51.2.1125, 2006.
Chang, S. P., and Wen, C. G.: Changes in water quality in the newly impounded subtropical Feitsui Reservoir, Taiwan, J. Am. Water Resour. Assoc., 3, 343–357, doi: 10.1111/j.1752-1688.1997.tb03514.x, 1997.

P3 L3-6: This watershed description could go more appropriately in the previous section as study area description.
Reply: We moved this paragraph to 2.1 Study region.

P3 L7: At what frequency? Or was it recorded continuously?
Reply: It was on a weekly basis. We changed the sentence to "*Weekly samples were collected with a 20-cm diameter polyethylene (PE) bucket. Weekly stream water samples were collected by immersing a PE bucket into the stream."*

P3 L9-10: Could the authors explain more about how they handled their samples, particularly with regard to the nutrients? As described their methods may be problematic with regard to nutrients. Particularly in what I would assume is a relatively warm, high productivity system, samples should be field-filtered or chemically stabilized and then frozen as soon as possible. Alternatively they may be analyzed immediately upon return from the field. If they did neither, it might be appropriate to include some discussion of the effect of uptake on their samples. For example, in the lower NO3, F watersheds there may have been more relative uptake after sampling than in the presumably eutrophic, potentially saturated, A watersheds. NH4 is also challenging because it is so readily nitrified.

Reply: The samples were filtered the same day of collection after pH and conductivity measurements. The samples were analyzed within two weeks. Due to the high agricultural export of NH_4^+, it is possible that some NH_4^+ may be nitrified. However, the much higher concentrations of NH_4^+ in A1 and A2 than F1 and F2 (Lin et al., 2015) suggest that nitrification between sample collection and analysis did not lead to changes in the patterns we reported in this study. In addition, a study of nitrogen processes at a mountain watershed 12 km Southeast from our study site indicated that NO_3^- and NH_4^+ concentrations were not different between split samples, half left in the site for one week and half brought back to the laboratory and analyzed immediately (i.e., the same day of collection) (Lu et al., 2017). Thus, we believe that the changes in water chemistry between collection and analysis should not be substantial. We added the following to the revision. *"After the measurement of pH and conductivity, samples were filtered (0.45 µm filter paper) mostly within eight hours of sample collection."*

Lu, M. C., Chang, C. T., Lin, T. C., Wang, L. J., Wang, C. P., Hsu, T. C., and Huang, J. C.: Modeling the terrestrial N processes in a small mountain catchment through INCA-N: A case study in Taiwan, Sci. Total Environ., 593, 319–329, doi: 10.1016/j.scitotenv.2017.03.178, 2017.

P3 L15-20: More is needed here. As mentioned above, I'd like to see a better description and justification for the discharge scaling method they used.
Reply: Please see our response to the general comment 1a for a comprehensive response to this comment.

P3 Section 2.4: Here the authors spend significant time discussing another potential source of error; something similar is needed for discharge.
Reply: We changed the method for the estimation of discharge from area ratio to HBV model (please see reply to comment 1a). We also added the following to acknowledge the potential error associated with the estimation. *"Although the HBV model has been successfully applied in northern Taiwan (Chang et al., 2017a), due to the lack of in-situ measurements of discharge, the estimates are subject to some uncertainty."*

Chang, C. T., Wang, L. J., Huang, J. C., Liu, C. P., Wang, C. P., Lin, N. H., Lixin, W., and Lin, T. C.: Precipitation controls on nutrient budgets in subtropical and tropical forests and the implications under changing climate, Adv. Water Resour., 103, 44–50. doi.: 10.1016/j.advwatres.2017.02.013, 2017a.

P4 L20-21: This seems like an interesting finding, rather than differences in regression direction, since many of the regressions for typhoon periods have very low predictability.
Reply: We agree that this is an important finding and that is why we put it at the very beginning of our results following the “Basic storm information”.

P4-5 Section 3.3: Reiterating above, the change in direction of the regression is less compelling to me than the dramatic change in spread of the point cloud between non-typhoon and typhoon periods (i.e., much lower predictability).
Reply: Yes, we agree that this is an important finding and that is why we put the unpredictability during typhoon period at the very beginning of our results following the “Basic storm information”.

P6 L9-10: I’d be interested in a comparison of extreme, non-typhoon events with comparable typhoon events. Do the authors feel that it is merely the high intensity of the typhoons that cause the unique hydrochemical response? Or is there something unique about typhoons? High winds or variable winds that can damage forests and farms that change delivery of ions to streams?
Reply: We added nutrient budget of large non-typhoon storms into the comparison of nutrient budget (New Fig. 6). We selected weeks with precipitation greater than the minimum typhoon-week precipitation (160 mm). *“The mean budget of most ions of large non-typhoon storms was between the budget of typhoon weeks and regular non-typhoon weeks, but there were fundamental differences (Fig. 6). For example, the negative budget of Na^+, Cl^- and PO_4^{3-} was only observed during typhoon weeks (Fig. 6).”* We also added the following to the discussion. *“The striking differences between typhoon and non-typhoon periods and the lack of predictability of stream discharge on the budget of several ions are possibly due to damages to the forests and farms by the storms. Damages to trees may affect the level of foliar nutrient leaching and nutrient uptake by roots and thus the nutrient export (Lin et al., 2011). The poor correlation between maximum wind velocity and precipitation quantity reported by Lin et al. (2011) means that precipitation quantity is not a good predictor of the magnitude of typhoon influences on nutrient input-output budget and likely contributed to the low predictability of discharge on ion budget during typhoon period.”*

Lin, T. C., Hamburg, S. P., Lin, K. C., Wang, L. J., Chang, C. T., Hsia, Y. J., Vadeboncoeur, M. A., McMullen, C. M. C., and Liu, C. P.: Typhoon disturbance and forest dynamics: lessons from a northwest Pacific subtropical forest, Ecosystems, 14, 127–143, doi: 10.1007/s10021-010-9399-1, 2011.

P7 L8-10: To reiterate a point from the methods, I would encourage the authors to think through the potential effect of nutrient uptake after sampling, if indeed there was no filtering or other stabilization and there was a period of multiple days before analyzing the samples. If the F and A watersheds have distinct nutrient regimes, it is also reasonable to expect they may exhibit distinct uptake responses, which could differentially affect each set of samples.
Reply: We did filter the samples the same day of collection and mostly within 8 hours of collection. Although this could not rule out the possibility of some nutrient uptake by microbes, we do not think this would be substantial. In addition, a study of nitrogen processes at a mountain watershed 12 km Southeast from our study site indicated that NO_3^- and NH_4^+ concentrations were not different between split samples, half left in the site for one week and half brought back to the laboratory and analyzed immediately (i.e., the same day of collection) (Lu et al., 2017). Thus, we believe that the changes in water chemistry between collection and analysis should not be substantial. We added the following to the revision. *"After the measurement of pH and conductivity, samples were filtered (0.45 µm filter paper) mostly within eight hours of sample collection."*

Lu, M. C., Chang, C. T., Lin, T. C., Wang, L. J., Wang, C. P., Hsu, T. C., Huang, J. C.: Modeling the terrestrial N processes in a small mountain catchment through INCA-N: A case study in Taiwan, Sci. Total Environ., 593, 319–329, doi: 10.1016/j.scitotenv.2017.03.178, 2017.

P7-8 Section 4.3: The authors provide some interesting, process-based context for their findings in this section! This is the type of discussion I would like to see throughout with respect to all of their findings.
Reply: We have substantially expanded our discussion to include process-based context for the findings, with special focus on the differences between typhoon and non-typhoon periods. Please see our response to general comment #2.

Tables 1 and 2: These could go in a supplementary section
Reply: As suggested, we have moved the two tables to supplementary information.

Figures 2 and 3: The authors did a good job of making their figures interpretable in grayscale by choosing their colors and using open vs closed circles. They could further improve this by doing something similar for the regression lines shown here, perhaps dotted lines for the black, total dataset regressions? Purple and blue lines should be distinguishable in grayscale
Reply: As suggested, we have change the figures to grayscale.
