Interactive
Comment

Interactive comment on "Effects of mountain agriculture on nutrient cycling at upstream watersheds" *by* T.-C. Lin et al.

Anonymous Referee #3

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The authors have carried out a study to examine the effects of agriculture on watershed nutrient cycling in a mountainous area of northern Taiwan. Ion concentrations (NO_3^-, K^+, SO_4^{2-}, Ca^{2+}, Mg^{2+}) were measured in stream water and precipitation every 2 weeks in four subwatersheds representing a gradient of agricultural activity (0.4% agricultural to 22% agricultural). The authors explore the relationship between agricultural activity and nutrient retention across this gradient.

Although the authors have compiled an interesting dataset and ask interesting questions regarding the impact of agriculture on watershed nutrient cycling, the manuscript is significantly weakened by the lack of a coherent and detailed presentation of watershed-scale mass balance data. In particular, all discussion of input-output ratios in Section 3.3 is presented out of context, with no discussion of how inputs and out-

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puts are calculated. To make the paper suitable for publication, the authors must work to provide a clear accounting of relevant nutrient inputs and outputs, provided details regarding their methodology in the methods section, and then place their discussion in the context of this quantitative analysis.

Other issues to address:

p. 4786, line 15 Is it a novel finding that a dilution effect would occur when a non-agricultural watershed with low nitrate concentrations is present downstream from a high nitrate-yielding agricultural catchment? You may want to qualify this discussion, saying "As expected. . ."

p. 4786, lines 18-20 Your estimate of nitrate contributed from agricultural land (400 kg/ha-y) is indeed high, but so are the fertilizer N input values that you give later in the paper. You may find it useful to place this analysis in terms of a NANI-style analysis (see Howarth et al. 2011, Hong et al. 2013, Boyer et al. 2002), where you analyze the relationship between riverine N output and your calculated net N inputs.

p. 4787, line 6 Can you clarify your point about the impact of agriculture on ecosystem services?

p. 4787, lines 10-11 You say that the impacts of agriculture are "likely" exacerbated by steep slopes and high precipitation, but give no references. Can you give more context and literature support to your hypothesis that the impacts of agriculture have unique impacts on the surrounding ecosystem in a mountain environment?

0. 4787, line 18 You make the point here about the impact of nutrients on atmospheric deposition. In general, your treatment of the atmospheric deposition portion of the analysis in the paper is weaker than the analysis of stream data. You make the point, for example, that most NH3, for example, is "scavenged by precipitation" and then redeposited. If what is going up (NH_4^+) simply comes down again, what do we actually learn from this analysis of the deposition data?

p. 4788, lines 11-12 You refer to heavy use of fertilizers, but don't give a range. The input values are crucial here, so it is important to give real numbers.

p. 4788, line 21 You say that agriculture will have a negative effect on nutrient retention, but how are you defining this retention? Are you talking about a percent retention or absolute magnitude? And for N, for example, what constitutes retention? If N is being denitrified, is this included in the retention term?

p. 4789, line 20 Again, you say fertilizers are heavily applied, but don't give values. Please quantify.

p. 4791, line 13 You say that you use a paired t-test to establish whether there is a statistically significant difference between watersheds. Is there a reason that you used a paired test? It seems that an unpaired t-test might be more appropriate here.

p. 4792, section 3.3 This section regarding output-input ratios needs more explanation. You are reporting results regarding these ratios, but there is nothing here that tells the reader how you have obtained these results. You should consider adding a section to Materials and Methods which details the methodology for whatever calculations you have done.

Line 4796, section 4.5 Your calculations here need to be better explained. You say that you subtract nutrient output at F1 from that at A1 to estimate the N and P output from agriculture at A1, but the logic behind this isn't clear. It would be helpful here to have a table of your calculated inputs and outputs for each watershed.

Line 4800, lines7-10 In your conclusion you describe the effects of agriculture on these mountain watersheds, and conclude that "agriculture activities have a more pervasive impact on watershed nutrient cycling than previously recognized." There is a very large body of literature detailing the impacts of agriculture on watershed nutrient cycling, so this statement seems unwarranted.

p. 4800, lines 19-21 You report that agricultural lands in your study are contributing 400

kg/ha-y N, and comment on the uniqueness of the finding. You don't, however, provide the context for these outputs (very high fertilizer inputs, >700 kg/ha-y). You also don't fully explain how you can estimate rates of P output (260 kg/ha-y) that are more than three times the estimated inputs (75 kg/ha-y). Again, spending more time on developing and explaining your nutrient mass balance for the watershed would strengthen your conclusions. This may also involve explaining the unique fertilizer requirements of a tea plantation and the typically very large fertilizer inputs.

Although the paper is generally well written, there are some problems with grammar that should be corrected. Some examples include:

"high precipitations" (p. 4787, line 10) "scarifying socioeconomic benefits" (p. 4787, line 25) "is characterized with high rainfall" (p. 4788, line 10) "without any preserves" (p. 4790, line 27)

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