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Reply on RC1

Yen-Lien Kuo et al.

Author comment on "Are the Rich less Prone to Flooding? A Case Study on Flooding in the Southern Taiwan during Typhoon Morakot and Typhoon Fanapi" by Yen-Lien Kuo et al., Nat. Hazards Earth Syst. Sci. Discuss., <https://doi.org/10.5194/nhess-2022-38-AC1>, 2022

We did not have the flooding probability of villages before the project. However, as the title of this study, we did prove that those 2006 high income (10%) villages had less flooding probability than 2006 non-high income villages during 2009 and 2010 typhoons in Southern Taiwan. Rent-seeking is one of the reasonable and possible mechanism because the village's rainfall is totally exogenous and the rainfall, terrain, population, and house price of the village were paired by PSM to be no significant difference between high income and non-high income villages. We had used T-test to check the mean difference of variables of treatment group and control group was insignificant including elevation. The T-test results can be added to be an appendix. Rubin's B and Rubin's R were also adopted to check the balance of matching and fitted with its standard. Since the risk reduction efforts toward more population and high real estate price area are democratic and economic (cost-benefit analysis) mechanisms, respectively, rent-seeking is a possible mechanism.

Concerning flooding causing migration, the difference in income growth rates between 2006 to 2016 of flood-prone villages (flooded both during 2009 typhoon Morakot and 2010 typhoon Fanapi) and non flood-prone villages were insignificant. Please check Page7, Lines 173-178. As flooding does not seem to be a significant factor affecting income and the relocation of the residents of the flooded villages in Taiwan.

Concerning flooding reducing income, typhoons in 2009 and 2010 can deteriorate 2006 income. Besides, the following losses estimation and the victim's survey of Typhoon Morakot showed the damages suffered by victim households were not huge.

"There were 140,424 households with flooding depths of more than 50 cm during Typhoon Morakot according to an investigation report conducted by the Typhoon Morakot Post-Disaster Reconstruction Commission of the Executive Yuan, Taiwan. A total of NT\$5.31 billion in damages nationwide and an average of NT\$37,814 per household were caused by Typhoon Morakot according to the 2009 annual report of the NCDR. Comparing those to the average annual household income of NT\$1,074,180 in 2009, the damages suffered by victim households were not huge. Lastly, changes in income after the disaster were investigated. According to the "Social Impacts and Recovery Survey of Typhoon Morakot (Phase 1)" conducted by the NCDR, where a questionnaire survey was carried out on

Typhoon Morakot victims (i.e. households whose houses were so severely damaged that they had become uninhabitable), income of 56% of the victims remained unchanged, whereas 17.9% of the victims showed income increases and 25.4% income decreases. The unemployment rate of the affected households increased by 4.2%. Overall, flooding did not cause too severe an impact on household income."

Those two events were quite extreme. Typhoon Morakot is the most serious typhoon (the highest losses) in the history of Taiwan. Nevertheless, 2009 and 2010 typhoons cannot affect 2006 income. Besides, the losses caused by other smaller events during 2006 to 2010 were much smaller than that by typhoon Morakot. The above description can be added to the manuscript.

More than half of the total budget of the Project was provided to these southern parts of Taiwan. The budget was mainly for structural flood protection, such as levees, pumping stations, and detention ponds. Almost all rivers already had some sort of levees before the project. Due to the Project, the local governments decided the priority and the allocation of enhancing levees and building detention ponds. We used a community/village which is the lowest administrative entity to have a large sample size.

At least, studies of social vulnerability to flooding concerned the poor but this study analyzed 10% high income villages. PSM had been adopted for the first time to find villages with similar rainfall, population, house price, and terrain, and found that high income villages are less prone to flooding during 2009 and 2010 typhoons.