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Capturing sediment and nutrients in irrigated terraced landscapes

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Terraces are often promoted as green filters in landscapes, buffering discharge and constituent peaks. For irrigated rice terraces, however, this mitigating potential has not been assessed at the landscape level. Additionally, sediment and nutrient inputs potentially affect soil fertility in agricultural terraces and therefore yield – the extent of the impact depending on the quality and quantity of the captured material. Quantifying such upland-lowland linkages is particularly important in intensely cultivated landscapes, as declining upland soil fertility could alter beneficial hydrological connectivity between terraces and surrounding landscapes. In this study, we therefore quantified the sediment, sediment-associated organic carbon and nitrogen inputs and losses for a 13 ha paddy rice area, surrounded by upland maize cultivation in Northwest Vietnam in 2010 and 2011. Turbidity sensors were used in combination with a linear mixed model in order to obtain continuous predictions of the constituent concentrations. Sediment texture was determined using mid-infrared spectroscopy. Uncertainty on annual load estimates was quantified by calculating 95% confidence intervals with a bootstrap approach. Sediment inputs from irrigation water to the rice area amounted to 48 Mg ha-1 a-1 and runoff during rainfall events contributed an additional 16 Mg ha-1 a-1. Export from the rice terraces equalled 63 Mg ha-1 a-1 of sediments, resulting in a net balance of 28 Mg ha-1 a-1 or a trapping of almost half of the annual sediment inputs. Runoff contributed one third of the sand inputs, while irrigated sediments were predominantly silty. As paddy outflow contained almost exclusively silt- and clay-sized material, 24 Mg ha-1 a-1 of captured sediments consisted of sand. The sediment-associated organic carbon resulted in a deposit of 1.09 Mg ha-1 a-1. For sediment-associated nitrogen, 0.68 Mg ha-1 a-1 was trapped in the terraces. Combining both sediment-associated and dissolved nitrogen, irrigation water provided a total input of 1.11 Mg ha-1 a-1, of which 54% was in the plant-available forms of ammonium and nitrate – an input larger than the recommended application of chemical fertilizer. Rice terraces were net traps for sediment and protected downstream areas by filtering coarse sediments. Combined with the importance of irrigation water as a source of organic carbon and nitrogen for the rice, this connectivity underscores the vulnerability of agricultural terraces to changes in surrounding land use.