Can more irrigation help in restoring environmental services provided by upper catchments? A case study in the northern mountains of Vietnam

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Ecosystem services (ES) supplied by upper catchments in northern Vietnam, such as biodiversity reservoirs and catchment regulating functions, are under increasing pressure. Decollectivisation and the following redistribution of land, the liberalisation of markets and population growth are the main drivers (Folving and Christensen 2007). In particular, slash-and-burn cultivation, practised with shortening fallow periods and without compensating inputs, is posing a threat to these important ES.

To maintain or restore the ES, authorities are proposing that farmers set aside some of their cultivated sloping land in order to re-establish forests. This is far from easy for the small landholders, since it reduces the already scarce land available for food production. Moreover, it can increase the food insecurity and financial instability of most landholders, whose objectives are to produce enough to eat and sell the surplus. Larger landholders are more integrated with markets and are more able to give up some land. Re-establishment of forests would provide various ES such as biodiversity restoration, flood regulation and diminution of erosion loads on irrigation systems and towns downstream (Krieger 2001). Compensation for the additional services rendered would increase uplanders' incentives to participate in ES programs. This is the principle underlying 'payment for environmental services', or PES (Engel et al. 2008).

The main objective of this abstract is to analyse the impact of an alternative land set-aside program for forest regrowth. This program involves compensating farmers for retiring some of their sloping agricultural land to natural forests by terracing part of their sloping rainfed land, with access to irrigation during 1 cropping season per year. (In this abstract, we consider only the case of natural forest, meaning that farmers are not expecting revenues from these newly forested areas in either the short or medium term.)

We expect that this program would allow farmers to increase production of staple crops on their remaining land and thus directly compensate for production losses caused by the reduced cropping area. We did not consider an increase in irrigated lowland area a realistic compensation mechanism, as most of the easily irrigable lowlands have already been appropriated.

In contrast, a substantial proportion of the existing sloping fields could be developed into terraces. We recognise that there are known physical limitations to the conversion of sloping land into terraces, such as soil type, soil depth and steepness, and do not anticipate a complete conversion of the sloping area into terraces. Yet the possibilities of terracing have often not been exhausted, on account of the large costs of linking additional terraces to water sources for individual farmers.

A recent analysis conducted in the mountainous Van Chan district in Yen Bai province identified 6 farm types contrasted by their access to land and water (Jourdain et al. 2011). Using mathematical programming, we developed farm models for those types. We investigated scenarios where farmers set aside, but still own, some land in the sloping areas of the catchment for forest regrowth, while some of their sloping land is transformed into terraces.

We first calibrated and validated the farm models against farm-level data collected in 2008 in 4 villages of the same district. Then we simulated the level of participation of the different types of farms in PES for different values of terraced area per area of land set aside. Participation was measured by the area of land converted into forest. For each scenario, we analysed the trade-offs between sloping land and terraces and the impacts on land use and revenues at the farm and village levels.

Our study contrasts with previous work in at least 3 ways. First, we have modelled a context in which most agricultural land is privately owned and where farmers cannot expand their agricultural land by deforestation, as it is now the case in large parts of the mountainous regions of northern Vietnam.

Second, a sizable proportion of farms in the mountainous areas of Vietnam practise some form of 'composite swiddening', an agroecosystem that combines upland crop and fallow rotation and downstream permanent wet rice fields into a single household resource system (Vien et al. 2009). In contrast, most PES analyses seem to concentrate on pure rainfed agriculture. Our model is designed to integrate pure rainfed agriculture and small portions of rainfed lowland rice agriculture.

Third, many PES case studies in mountainous areas consider mainly land diversion programs, whereby some land is set aside for reafforestation with financial compensation. Our study contributes to the existing literature on PES (Engel et al. 2008) by proposing different PES scenarios in which the farmers set aside some uplands in return for additional irrigation water from a public scheme built with external funds. Here, the use of external funds is justified by the additional provision of the 'common good' ES. The rationale behind providing more water instead of financial reward is that many farmers are still facing market imperfections and are really concerned about their food security.

In this context, compensating retired land by financial rewards may be less attractive than providing the means to maintain food production. Irrigation as practised in those mountainous areas relies mainly on gravity (the idea is to tap water flowing downhill instead of pumping water uphill), whereby irrigation of these new terraces would be limited to 1 cropping season per year.

This leads to a more sustainable PES scheme than yearly financial rewards for maintaining forest protection.

Results show that, given the assumptions of the model, increasing access to irrigated terraces as a way to compensate for land conversion to forest increases the participation of the poorest farmers in PES schemes and is more cost efficient than pure cash payments. This suggests that the present program, which is biased against the smallest landholders of the region, can be transformed into a win–win program that increases the forested areas and reduces inequalities.

Short-fallow rotations on sloping land, with their enhancement of erosion, can be abandoned under the proposed program. Fewer cash and food constraints allow farmers to develop more intensive cultivation with some use of external inputs. When practised on the new terraces they should not increase erosion. However, results suggest that continuous intensive maize cultivation would also take place on the remaining sloping land, creating more problems for lowlanders than the previous rotations. The net balance in terms of environmental services will therefore depend on the positive impact of increased forested and terraced areas versus the intensification on the remaining sloping land.

Keywords

Farm household modelling, ecosystem services, mathematical programming, landscaping

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