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# Modeling Tool Improves Watershed Analysis

SANREM CRSP researchers have developed an economic model that provides policy makers with a tool to measure potential successes and failures of proposed economic reforms. Using this tool, researchers and policy makers can anticipate a reform's impacts on a region's economy and natural resources, leading to the implementation of more effective reforms and improved natural resource management. This model was developed and tested using data collected in the Manupali watershed in the Bukidnon province in the Philippines. The Manupali watershed is an effective location to test such a model because economic and environmental linkages between lowland and upland farms provide an optimum test platform. On a more general scale, a model that predicts the impacts of reforms on their regions of interest provides policy makers with a more informed basis for decision-making by indicating potential levels of economic and environmental impact for households, zones, and watersheds.

Photo courtesy of Vel Suminguit

**The Manupali watershed is an optimum location to test this model.**

## Model considerations

The structure of the model considers three connected components:

1. *Upland* households growing crops in the Manupali watershed.
2. *Policy* parameters that influence economic decisions such as crop specific taxes and subsidies, household-specific interventions, and alterations of price variability in all or specific crops. Policy effects on: land use; farm income; erosion; sediment accumulation and damage; and public sector budgets are simulated.
3. *Lowlands* are affected by the physical changes (such as erosion) generated by upland farming practices, as well as the budgetary implications of policy changes.

**Functions of the model**

- Conduct "what if" exercises focusing on the potential impacts of agricultural policy changes.
- Assess the impact of induced land use changes on the budget and human welfare.
- Simulate the physical effects that flow from upland to lowland areas.

## Creating the model

The model was developed as a representation of the area's agricultural production in order to simulate reform impacts on the region's economic and environmental conditions. By first establishing a set of reference conditions that reflect the economy without changes, researchers can simulate reforms like additional taxes or subsidies to measure their impacts. In the case of the Manupali watershed, researchers established a 10-year time horizon and assumed that the policy change would be sustained for that time period. The reference conditions also account for optimal crop combinations for each representative farm. Under a scenario in which reference conditions are unchanged, most incomes will decline because of soil losses and declining yields. In some cases, erosion rates fall slightly because of household decisions to implement a gradual shift from vegetables to corn.

## Policy changes

For the simulations, the researchers established four policy scenarios and applied each to the model to see how the policy changes would impact the economic and environmental stability in the region. The impacts of policy reform on upland farmers are mainly economic and environmental. The impacts of reform on lowland farmers can be seen in the changing levels of erosion and other environmental

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alterations. All results are in comparison to the reference conditions established above.

Intervention 1: *10 percent output price subsidy for white corn*

This subsidy creates incentive for farmers who grow corn to shift land from yellow to white corn production. Individual household income is significantly improved, while the environmental impacts depend on the shifts in cultivation. If a farmer reduces the area of coffee farmed in favor of corn, erosion increases by 16 percent. On the other hand, a decrease in vegetable area coupled with a simultaneous increase in corn area results in reduced erosion rates. Overall, farms focusing on shifting their corn production experience an income gain and no change in erosion rates; however, this scenario places a burden on the public budget.

Intervention 2: *10 percent input cost subsidy for vegetable producers*

This scenario subsidises subsidy vegetable production costs (fertilizers, seed, etc.), resulting in increased vegetable production. The short-term benefits of such a decision create higher net incomes for farmers; however, vegetable production results in reduced soil quality and lower vegetable and corn yields in the long-term.

Intervention 3: *10 percent output price tax on vegetables.*

This tax discourages vegetable production, which slows the rate of soil degradation and maintains higher levels of vegetable and corn yields. Incomes also fall, but by less than the amount of the tax. With this tax, the model estimates a nine percent reduction in soil erosion.

Photo courtesy of SANREM CRSP Phase II.

**Certain changes in policy could promote increased corn and vegetable production.**

Intervention 4: *10 percent reduction in price variance for all crops*

By lowering price and income variability, this reform encourages a slight shift towards vegetable production and reduces risks associated with farming. Income variability is measured by the effects of improvements in elements such as physical infrastructure on the savings created within the marketing channel. For example, improvements in a bridge or road can reduce the risk of transport failure, which creates cost savings throughout the marketing channel. This reduces the risks the farmer has to face. The overall impact is small, but important. In households growing a combination of coffee and corn, the price reduction (and ultimate reduction in risk) encourages more coffee production, resulting in a slight improvement in environmental quality through reduced erosion.

**Modeling the impacts of reforms provides policy makers with a basis for more informed decision-making.**

## What does it all mean?

Using the model to provide simulations of reform impacts and the potential magnitude of changes can improve the dialogue and debate regarding land management changes in the Manupali watershed. By evaluating a variety of scenarios, researchers, farmers, and policy makers can determine which reforms are most feasible and likely to improve agricultural livelihoods and water quality and availability for both upland and lowland residents.

With location-specific modifications, this model can be used in other areas to simulate similar reforms. As this model is adapted for a specific population, it will be important to:

- dialogue with policy makers and farmers in the community to calibrate the model to community decision-making parameters and
- couple this model with models of regional hydrological processes to increase the accuracy of erosion control impacts.

This comprehensive model can quantify the potential positive and negative impacts of alternative policy scenarios on the watershed's economic and environmental stability. Conducting such "what if?" exercises in a simulation environment can substantially improve the quality of natural resource management discussions and decisions. ■

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**For more information, see:**

Shively, Gerald and Ian Coxhead. 2004. Conducting economic policy analysis at a landscape scale: examples from a Philippine watershed. *Agriculture, Ecosystems, and Environment 104:* 159-170.

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