

Ex ante evaluation of land use alternatives to internalize environmental externalities and increase rural welfare. Design and construction of optimization model to evaluate land use alternatives according with their impact on environmental and socioeconomic watershed conditions and to value environmental externalities

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“Andean watershed” project is seeking to develop and apply capacities related with watershed analysis to support decision-making for proper use and management of lands and therefore, the generation of positive externalities. To achieve this purpose, the project wants to improve the analysis and use their results to implement land uses alternatives through co-investment schemes and water-based finance mechanisms. In this way, tools and methods have been developed and released for watersheds decision makers’ adoption. One of those tools is a model that was designed to understand the interactions between watershed production systems and its effects on socioeconomic and environmental conditions. Thus, the model was structured taking into account the functioning of an agro ecological system in the Andean region. Variables and activities of the system were then interrelated with the net income of farmers, employment generation and the behavior of externalities.

The environmental and socioeconomic variables constraint the agro ecological system (e.g. sediments production, water yield, N, P and CO₂ sequestration, capital availability, labor profiles, etc.) The activities are related with the land uses, management practices, production sales, labor negotiation, among others. The model results are oriented to know which is the best land use alternative means by maximization of net incomes, increment of employment and minimization of negative externalities.

The integrated analysis of alternatives allows establishing the trade offs among competitiveness, sustainability and equity. The results are quantitative and if the benefits and cost are considered then the shadow prices of natural resources and the opportunity cost of alternatives can be determined. These values are the basis for designing mechanisms of payments for environmental services.

“Andean Watersheds” projects supported the creation of this model because it allows:

- Representing agroecological systems and relate it with natural resource management issues, to find out solution alternatives for problems that are often complex.
- Conducting ex- ante impact assessment of land use changes in a given watershed. □ Conducting ex-ante impact assessment for long-term tags because changes in environmental externalities are related with gradual biophysical processes such erosion, changes in soil properties, eutrophication, etc.
- Integrating environmental and socioeconomic variables to evaluate alternatives according with non-environmental impact only, but with its economic performance (increasing net incomes of poor farmers).

- Distinguishing which is the variables state that describes the performance of the system such as environmental externalities (water yield, sedimentation, etc). Thus, it could indicate which is the impact of local actions on the society.
- Re-monitoring variables state once land use alternatives are implemented.
- Carrying out trade off analysis to determine if variables are competitive, substitutive or complementary due to its shared impact on objective function (incomes, employment, etc).
- Providing quantitative information (shadow prices) about how important are system constraints in the economic maximization and the environmental impact minimization.
- Value environmental externalities through shadow prices, if modeling considered economic cost and benefits of evaluated alternatives.

This model and approach are being used in the analysis of pilot Andean watersheds in order to support the identification of land use alternatives and management practices for production systems to allow the internalization of externalities. The main externalities that are subject of analysis and interventions are sedimentation, water pollution, and decrease of water yield in dry seasons and carbon sequestration.