Ecologic-Economic Modeling of Agricultural Land Use for Policy Decisions: An Integrated Model Implemented for North East Region of Germany

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Abstract: This article presents an integrated ecologic and economic model to study landscape and land use change, using the Spatial Analysis Modelling Tool (SAMT). The study involves integrating these models to analyse landscape and land use changes in Quillow region of North East Germany. Different price and premium scenarios were implemented to indicate the likely effect of policy change. Results of the study shows that if prices received by farmers go up by 20% while subsidy remains at the same level, gross margin would increase by about 16% and a higher crop coverage. However, a 20% rise in premium received by farmers would significantly lead to lower crop coverage in the region. The results of the study have important policy implications considering EU CAP policy and the World Trade Organisations (WTO) negotiations.

1 Introduction

Land and land resources are important factors on which human existence and economic development are based. Some of the most profound changes in the landscape have arisen from direct decisions by man concerning land use; from changes in cropping patterns, afforestation and deforestation to modification of water courses. These in turn have affected both the quality of environmental resources and the sustainability of a lasting diversified food chain. Given the multidisciplinary nature of landscape and land use issues, and given that these issues involve the interplay of ecologic and economic factors, the challenge therefore, is how to couple ecologic and economic models in order to analyze the multidimensional issues and data involved in land use studies.

Sustainability aims at use and preservation of private and public goods for current and future survival of mankind with high level of probability. Measurement of environmental sustainability should then include selection of quantifiable sustainability indicators which can be used to describe the behaviour and performance of environmental production system across space and time. A key process to attaining sustainability in agricultural production and environment is to assess the impacts of land use as well as changes in policy on ecologic and economic variables. Whereas land use studies received much attention in the literature, the issue of how to formalize quantification of land use systems and integration of ecologic-economic variables into the models, especially at regional scale, has only been addressed to a limited extent.

2 Integrated Model Applied to North East Region

The integrated model consists of the following parts: (i) Economic module, which involves linear programming model to describe the economic decision behaviour of farmers. Linear programming (LP) is the most common optimization tool in agricultural land use studies. The LP has received wide applications in land use decision analysis ([Za03], [BNH99], [CAC98], [KVV99]). The output from the LP model is combined with soil data to produce land use map. (ii) Ecologic module which involves modeling the physical environment of agricultural production activities. Also included in the ecologic component are the following (iii) Erosion model which uses the DGM 25, the soil loss equation was derived using rainfall erosivity factor, soil erodibility factor, slope and slope length factor, vegetative cover factor and conservation practice factor.

The Spatial Analysis Modelling Tool (SAMT) computer software [Wi04] was used to implement the integrated model. SAMT is a computer programme for landscape and land use spatial analysis. SAMT is linked to a large database, which describes the regional agricultural practices in great details. In the database, there is comprehensive description of crop production practices. Detailed description of SAMT is given in [Wi04]. Detailed description of data and study region is provided in [Aj04].

3 Results and Discussions

Gross margins were calculated based on inputs and outputs relationship. Prices and subsidies were considered to be at the level of 2002 in the study area. Machinery costs and working hours were calculated according to standard data [KT02]. Ecologic and economic effects of different scenarios were analyzed. The Scenarios include: (a) Base scenario, representing current land use (b) 20% increase in price while premium remains the same (c) 20% increase in premium while price remains the same (d) Current price maintained with no premium. The results of analysis show that if prices received by farmers go up by 20% while subsidy remains at the same level, gross margin would increase by about16%. On the other hand, if subsidy received by farmers goes up by 20% while prices remain at the same level, then the gross margin would go up by 11%.

However, with zero premium, the gross margin derived from farm would decline by 11.1%. The GIS maps in figures 2 (a-d) show that changes in price and premium policies would result in different crop coverage for the area. Combining the results from the economic model with that of the ecologic model produces the potential erosion risk of the current land use and predict the future erosion potential. While there is presently low erosion potential risk in the study region, there is high erosion potential risk by the year 2030 (figure 2(e). These results seem to be realistic as they are consistent with the current land use and erosion situation in the study area.

4 Conclusion

The results obtained in this study is an indication that the current subsidy being enjoyed by European farmers has serious impact on their income and any change in policy concerning subsidy payment will not only affect the income of the farmers but would have serious implications on land use and landscape changes in the region.

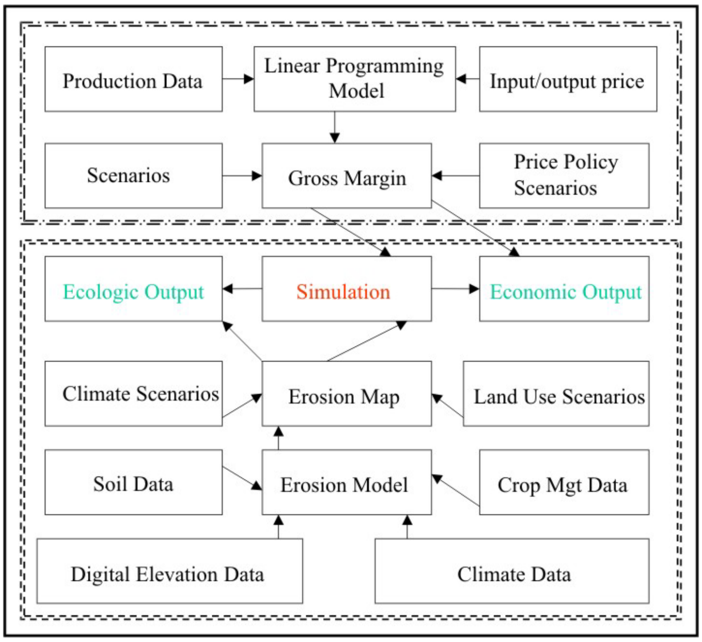

Figure 1: Typology of the Implemented Integrated Economic-Ecologic Spatial Model

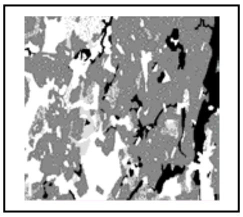

Figure 2a: Coverage (base scenario)

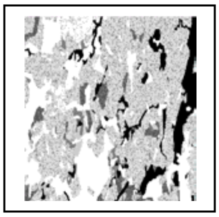

Figure 2b: Coverage at 20% rise in price

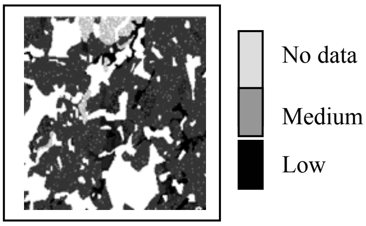

Figure 2c: Coverage at 20% rise in premium

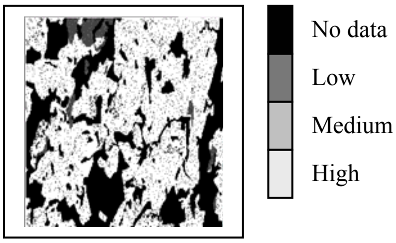

Figure 2(d): Crop coverage (no premium).

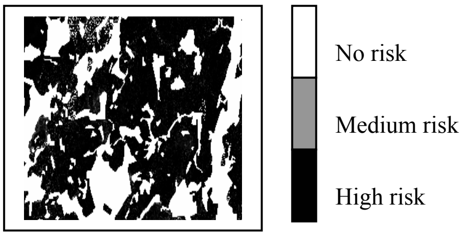

Figure 2(e): Future Erosion potential (Year 2030)

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