Eco-hydrologic and economic trade-off functions in watershed management

Breuer L, Huisman JA, Steiner N

Weinmann B, Frede H-G





Justus-Liebig-University Giessen, Germany

Institute for Landscape Ecology and Ressources Management

Introduction



ITE²M - Integrative Tool for Ecological & Economic Modelling

- → Developing land use concepts for marginal regions within the Sonderforschungsbereich SFB 299 (Collaborative Research Centre)
- → Integration of various scientific disciplines such as agroeconomy, biology, soil science, hydrology or sociology
- \rightarrow Integrated modelling approach of ProLand, SWAT-G and ANIMO

Prediction of changes in land use and landscape services

ProLand



The agro-economic model ProLand

- ... is based on information on climate, soil type, biological, economic and social conditions (25 x 25 m grid)
- ... assumes maximization of land rent for each grid cell
- ... land rent is the sum of monetary yields and subsidies minus costs, depreciation, taxes, employed capital and labour
- ... various production systems can taken into account

... ProLand does not use information on actual land use distribution but rather calculates an optimized land use given the economic and ecologic background of the region



The cellular automat ANIMO

- ... refers to each habitat with its own species inventory
- ... derives landscape γ -diversity by multiplying the species number of a cell (α -diversity) with the dissimilarity between cells (β -diversity).

SWAT-G

- ... accounts for lateral flow, which is an important water pathway in the basin by a nearly impermeable bedrock layer and an anisotropy factor (Eckhardt et al. 2002)
- ... warm-up period 01/1983-10/1986, calculation period 11/86-10/88

ITE²M concept



Research area: Aar catchment

Size ~ 60 km² Mean annual precipitation 817 mm Mean annual temperature 8.0 °C 42 % forest
25 % agriculture
20 % pasture
10 % fallow
3 % settlement

Outwintering suckler cow management



General conditions for the outwintering suckler cow scenarios:

Extensive pastoralism instead of intensive dairy and cropland production

Forests are not subject to clearcutting

Objective: Which areas are most efficient to introduce outwintering suckler cow managment



Control

Outwintering suckler cow management



Outwintering suckler cow management





Economic effects



SFB 299

Increase of land rent [%]

Ecological effects





Increase of land rent [%]

Economic-ecological trade-offs



Economic-ecological trade-offs



control



Consultancy of farmers based on spatial information to improve land rent and reach an optimized regional land use

Consultation within the SDSS has to focus on sites where land rent optimization is most effective

multidisciplinary optimum at 20-35 % scenarios



16-18 % dairy 7-14 % suckler cows 13-18 % cropland

20 % dairy 3 % suckler cows 20 % cropland

Conclusions



- → Economic measures and biodiversity show a pronounced reaction to outwintering suckler cows management whereas hydrological components remain fairly constant.
- → Integrated assessment of economic and ecological objectives in landscape modelling can be used as spatial decision support systems.
- → ITE²M can be applied to investigate land use and management options for scenarios such as variation in field size, pasture management or organic agriculture.



PlaPaDa

Plant Parameter Datadrill

Albedo [a] Stomatal conductance [g_{s max}] Canopy hight [H_{max}] Root depth [RD_{max}] Maximum/minimum LAI Base temperature [t_{base}] Interception [I_{max}]



http://www.uni-giessen.de/~gh1461/plapada/plapada.html