How to Cope with Global Change? On the Potential of Ecological-Economic Modelling for Institutional Design

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How to cope with Global Change ? On the potential of ecological-economic modelling for institutional design

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Introduction Ensuring sustainability in face of the multitude of ongoing processes of Global Change (e .g . climate change , land use change , social change , institutional change) represents one of the grand challenges of the future . This is especially urgent in the context of rangeland management in semi-arid regions . Strategies and policies are needed that allow coping with the impacts of Global Change on rangelands such as the increasing scarcity and variability in the precipitation , population growth , or globalization . The development of such strategies , however , requires insight into the relationship between institutional settings , management decisions and the long-term ecological-economic effects on the rangeland induced and into the impacts of the processes of Global Change on the functioning of the overall system . With such a dynamic understanding , key factors of sustainability can be determined and conclusions regarding the design of appropriate institutional settings for rangeland management can be drawn . The paper aims to demonstrate that ecological-economic modelling is a powerful approach to contribute to the development of sustainable solutions .

Methods and material We present an ecological-economic model that combines an ecological model for the rangeland dynamics (climate , vegetation , livestock , management system) with an economic model for the decision process in dependence on the ecological and socioeconomic conditions on the rangeland . This model provides insight into the interplay between ecological and socioeconomic factors and its effect on the rangeland dynamics and on several ecological and economic criteria of sustainability . Moreover , several scenarios (climatic conditions ; vegetation types , population density ; resource accessibility regimes) are considered and assessed in terms of their effects .

Results and discussion Starting point of the analysis is question of the relevance of temporal resting" for the sustainability of rangelands . Using the model , it is shown that its relevance depends on two things : the vegetation type and the climatic conditions . The relevance increases with decreasing vegetation growth as well as with decreasing mean or increasing variance in the precipitation . In these cases , temporal resting is essential for the regeneration of the entire system . This indicates that climate change can alter the relevance of resting . It also clarifies that ensuring mobility is only one side of the sustainability coin ; ensuring resting can be as important . By taking this finding as a basis , several consequences of population growth on the rangeland management and its sustainability are discussed . The necessity of ensuring temporal rests in spite of population growth (causing increasing pressure on the rangeland) indicates the importance of appropriate forms of co-ordinated rangeland management . Using the model , different forms of co-ordination are assessed in terms of their effects on sustainability .

Conclusions The model analyses reveal that climate change and population growth can alter the entire dynamics of the social-ecological rangeland system and , in the result , the requirements on both the management system and the institutional settings governing rangeland management decisions . This means that they can drive institutional change . As resting has been found to be an ecological-economic buffer mechanism and a key factor of sustainability , it can be used as a yardstick for assessing the appropriateness of existing institutions (Do they support or impede resting ?) . This particularly includes assessments of the relevance of elements of traditional forms of rangeland management . Because of its explicit ecological-economic structure , the presented modelling approach provides insight into the interplay and combined effects of various processes of Global Change and their long-term consequences for sustainability . Based on this , critical trends but also options for designing institutions for fostering sustainability can be identified .

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