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基于系统动力学的土地利用结构多目标优化

Multi-objective Optimization of land use structure in western Jilin province based on system dynamics

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中文摘要:

土地利用结构优化是编制土地利用总体规划的基础和核心。该文以吉林省西部为例,利用2000年和2010年2期TM遥感影像数据,结合野外调查及社会经济统计年鉴数据,基于经济-生态双重目标,利用SD-MOP(system dynamics-multi-objective programming)整合模型,对2020年吉林省西部土地利用结构进行了仿真与优化。结果显示,到2020年,在经济效益、生态效益分别增长7.43%、3.09%条件下,建设用地和耕地分别增加了349.89和2705.74 km²,而林地、草地、水域、未利用地分别减少了12.75、11.51、270.43和2772.56 km²;与利用单目标SD(system dynamics)模型优化方案相比,建设用地、耕地增幅分别下降了31.55%、14.97%,而林地、草地、水域和未利用地减幅分别下降了42.70%、20.99%、42.68%、29.34%。研究表明,SD-MOP优化方案优于单目标的SD优化方案。

英文摘要:

Abstract: Optimizing land use structure is the foundation and core of the overall plan for land use. At present, domestic scholars have mostly used system dynamics (SD) model, multiobjective programming (MOP) model to optimize land use structure. In order to overcome the limitations of single model, achieve the compensation of mutual advantages, and to raise the accuracy, reliability, feasibility and operability of date of prediction scheme, this article combines the SD model with the MOP model and constructs SD-MOP integrated model. First, combining the research purpose, it defines the system boundary and establishes the level and rate variable system, divides the system into 3 subsystems: population system, economic system and land use structure system, and utilizes Vensim software platform to establish the causality graph of land use structure system and constructs the SD model of land use structure system, then makes initial simulation of land use structure according to historical data. Second, it utilizes sensitivity model to identify the sensitive factors of land use structure. And takes the sensitive factors as the decision variables, while relying on the SD model to establish objective functions of economic benefit and ecological benefit, forming constraint conditions of objective functions to construct MOP model, and solves it. Finally, puts the solution into SD model to optimize land use structure. In the case of western Jilin in this article, we utilized 2 periods TM remote sensing images of the year 2000 and 2010 and combined with the field investigation, we interpreted the remote sensing images accurately, the accuracy of interpretation was approximately 90%-95%. Take the interpretation as the source of land use structure data and the Statistical Yearbook of the Socio-economic as the source of economic data, we then simulated and optimized the land use structure of western Jilin using the model of SD-MOP based on the objectives of economy and ecology. The result shows that: if we utilize the SD model, by 2020 the growth rate of economic benefits will reach 12.35% compare to the 10.33% of 2015, the economic benefits will increase remarkably, but the growth rate of ecological benefits will go down to 0.61% compare to the 3.43% of 2015, yet the eco-efficiency will not improve. Although it would promote the economic development of western Jilin, it would also lead to the deterioration of the ecological environment and influence land ecological balance, it would make the utilization of land resources unsustainable and finally influence the development of regional economy. So the SD scheme is unfeasible. If we utilize SD-MOP model to optimize the land use structure of western Jilin province, with an increase of 7.43% in economic benefit and 3.09% in ecological benefit, cultivated land and construction land will be increased by 2705.74 km² and 349.89 km² respectively, but woodland, grassland, water area, unutilized land will be decreased by 12.75 km², 11.51 km², 270.43 km² and 2772.56 km² respectively. Compared with Single objective model of SD, the increase amplitude of the cultivated land will be decreased by 31.55% and 14.97% respectively, and the woodland, grassland, waters and unutilized land will be decreased by 42.70%, 20.99%, 42.68%, 29.34% respectively. It will not only develop the economy and protect the ecological environment, but also will improve the land use efficiency and realize the sustainable utilization of land resources. The conclusions are: SD-MOP scheme is better than SD scheme of a single objective. The SD-MOP integrated model is worth popularizing since it would optimize land use structure scientifically and systematically and the optimized results is objective and reasonable.

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