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RESEARCH ARTICLE

Usability of the Various Land Use Optimization Models for the Spatial Planning Purposes in the Republic of North Macedonia

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ABSTRACT

The land use optimization process uses different models generally belonging to two groups: mathematical models and heuristics models. A variety of models have been developed for various purposes. Each has its positive and negative sides, advantages and disadvantages. This research aims to define the usability of different land use model optimization for spatial planning in the Republic of North Macedonia. The basic methodological tool in this chapter covers the collection, study, and comparative analysis of relevant literary data and the evaluation of selected research. In the absence of domestic literature, mostly literature from several countries from Europe, the USA, and Asia was analyzed. Then 17 models were selected for detailed analysis. To examine the possibilities of applying the optimization models described in the analyzed research. An evaluation was performed according to the following criteria: a) availability of the data used by the model, that is, the possibility of providing the data used in the model from official sources; b) the number of optimization goals; c) the number of land uses; d) local adaptability, which implies conformity of the goals, purposes, influencing factors, limitations and other specifics of the model with those in our conditions; e) scope of the research. More of the reviewed papers on the analyzed optimization models and methods, marked by the authors, clearly indicate the fact or exceptional difficulty in determining the optimal land use model. The most appropriate model are as following: M15 - Integrating Socio-Economic and Land Use Models to Support Urban and Regional Planning; M14 - Functional analysis and valuation as a tool for assessing land use conflicts in planning for sustainable, multifunctional landscapes, by Rudolf de Groot; M16 - Spatial conflict management in urban planning, by Athina Santorineou, John Hatzopoulos, Katy Siakavara, Climis Davos; and M11 - GIS-Based Multi-Criteria Approaches for Land Use Suitability Assessment and Allocation.

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1. Introduction

The theory and practice of land use know in many models. Each of them has its positive and negative sides, advantages and disadvantages. Land use planning is a very complex process consisting of a multitude of activities, activities, actors and policies. Inadequate approaches and patterns of use give rise to numerous conflicts that are often the cause of the emergence and development of various forms of land degradation. Creating an optimal land use model is a very complex process. That is why the use of land in modern conditions tends to the optimization of the models, which implies a continuous direction of the process toward achieving better, more rational, and sustainable solutions. The aim of this research is to be defined usability of various land use model optimization for the

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purpose of spatial planning in the Republic of North Macedonia.

2. Theoretical Review

The optimization of land use implies a spatial allocation to different purposes that will enable a rational and efficient use of land, taking into account the numerous and different restrictions. It is a very complex process that needs to respect not only numerous spatial factors, attributes, and constraints but also numerous and often conflicting objectives (Cao et al., 2011; Chen et al., 2010). Therefore, finding effective decision-making methods to determine the effects and costs of solutions in different spatial scenarios is becoming more important (Loonen & Koomen, 2007).

Numerous optimization methods are used to solve the problem of spatial allocation of land uses, which can be categorized into two groups: mathematical models of programming and heuristic methods.

A mathematical model represents a description of a system or process through the use of "mathematical language" A mathematical model can be defined as a set of mathematical relationships that describe or define the relationship between certain physical quantities of the observed process. A mathematical model is a more or less simplified way that the real relationship between the values that characterize the process and the important characteristics of the process are expressed. Mathematical models can be divided into: a) linear or non-linear; b) deterministic or stochastic (probabilistic); static or dynamic, discrete or continuous. Depending on the area and the available database, an appropriate model is selected (Blinkov et al., 2011). Mathematical programming models (such as the linear models of Campbell and Aerts and mixed models require that all variables, constraints, and objectives have an exact mathematical definition (Crohn & Thomas, 1998). The spatial allocation of land uses is a complex geographical process that includes a large number of constraints, complex spatial relations and decision-making by stakeholders and therefore cannot meet the conditions set by mathematical models. This led to the incorporation of scientific methods into the optimization process and scientists into optimization teams.

A heuristic is a technique for solving either faster than conventional methods, or finding approximate solutions when traditional methods cannot find an exact solution. In heuristic approaches, at the expense of sorting speed are optimality, completeness and accuracy. Heuristics include methods and techniques of problem solving, learning, and discovery that are based on experience. A heuristic model is a method that leads to new discoveries and insights. For certain concepts, hypotheses and theories, it is emphasized that they have a primary heuristic meaning, which means that, regardless of their authenticity, they can serve as a good incentive to find new facts, as well as to produce new research and theoretical discussions. The goal of heuristics is to quickly come up with a solution that is good enough to solve the problem. This solution is not always the best or may even be only close to the correct solution. But such a solution is valuable, because it does not consume too much time.

A trade-off criterion is used to decide for or against the use of a heuristic for a given problem, and this includes the following: a) - Optimality: When there are multiple solutions to a given problem, if the heuristic guarantees finding the best solution? Do we have the best solution? b Completeness: If there are multiple solutions to a particular problem, does the heuristic find all solutions? Do we even need all the solutions? Many heuristics find only one solution. c) Precision and accuracy: Can the heuristic provide a confidence interval for a putative solution? Is the solution error too large? d) Execution time: Is this the best heuristic for this type of problem? Some heuristics converge faster than others, while some are only marginally faster than conventional methods.

A heuristic can be a result itself, or it can be used in combination with an optimization algorithm, in order to improve their efficiency (Blinkov, 2011). Heuristic methods provide different possibilities for the formulation of variables, constraints and objectives and provide many alternative solutions for subjects making spatial decisions, according to the optimization objectives (Loonen & Koomen, 2007).

Many researchers use heuristic algorithms, such as genetic algorithms by Stewart et al. (2004) and Cao et al. (2011), which, combined with multi-objective optimization techniques, can generate land use scenarios that support the decision-making process. Such research promotes a completely new approach to solving spatial allocation problems (Cao et al., 2011). Genetic algorithms, first introduced by Holland as it described in more detail by Goldberg and Holland (1988), provide a different, much more effective way of searching for complex spatial solutions in a variety of applications and have been shown to be very effective in finding the optimal solution across a range of applications. The combination of genetic algorithms with GIS technology opens up possibilities for numerous spatial analyzes and searches and the creation of various maps and graphical presentations of spatial solutions that significantly improve the visual characteristics of the models enrich the database and enable compatibility between different models and spatial solutions.

To solve multi-objective problems, the so-called "Pareto method" ("Pareto front based method", Legriel et al. (2010)) and the method of weighted sums. All optimization models are based on one of these methods.

The development of computer technology and GIS offers strong technical support for spatial data analysis in making spatial decisions for land use optimization. The combination of mathematical models with GIS has become the focus of this research and also promotes the development of scientific research on land use.

The process of optimization of land use by defining an optimal model of allocation of purposes, as one of the methods for achieving sustainable development, should ensure the achievement of numerous goals in the field of economy, society and the environment. Although economic benefit is a key factor, social and environmental aspects are also significant driving forces for sustainable development. In that sense, in recent years many attempts have been made to integrate socioeconomic models with land use models. Integral models are constituted in the form of an integrated decision support system (Integrated Spatial Decision Support System - ISDSS), which enables the evaluation of the impacts of different political options (related to spatial planning, infrastructure development and economic initiatives) using a set of social, economic and environmental indicators and testing these political alternatives in different conditions/. Sustainable development in conditions of high demand for land from different stakeholders with often conflicting goals and interests indicates the necessity of including multi-objective and multi-criteria analysis in optimization models. Conflict resolution is a crucial segment of the optimization process that guarantees acceptability of solutions by stakeholders and guarantees the absence of obstructions in the process of implementing spatial solutions. For security acceptability, it is necessary to include conflict analysis and conflict management in the optimization process (De Groot, 2006).

We have known for nearly two centuries that economic theory can be successfully used in the process of land use allocation. The ideas of Von Thunen, cited in Heady and Hall (1968), and others who dealt with this problem were described with the simplest equations and graphic illustrations, until the computer was discovered. The computer enabled reality testing of these models.

3. Methodology

The basic methodological tool in this chapter covers collection, study and comparative analysis of relevant literary data and the evaluation of selected researches. In the absence of domestic literature, mostly literature from several countries from Europe, USA, Asia was analyzed. First, a study of the general theoretical framework related to the optimization process was carried out, followed by special specialist studies and research related to different methods, models and approaches in the optimization process. A comparative analysis of all studied papers was made, in order to perceive the positive and negative aspects of each paper separately. Based on the evaluation of the analyzed research, according to several criteria, an assessment was given for the possibility/impossibility of applying the presented optimization models in the subject research.

To examine the possibilities of applying the optimization models described in the analyzed research. An evaluation was performed according to the following criteria:

1. Availability of the data used by the model, that is, the possibility of providing the data used in the model from official sources. The evaluation according to this criterion has 4 levels:

- minimal (availability up to 30% of the total amount of data),
- partial (availability of 30% - 60%),
- satisfactory (availability of 60% - 90%),
- complete (90% - 100% availability);

2. Number of optimization goals, with 3 levels:

- small (up to 3 targets),
- medium (3 – 5 goals),
- large (over 5 goals);

3. Number of land uses, with 3 levels:

- small (up to 3 purposes),
- medium (3 – 5 uses),
- large (more than 5 uses);

4. Local adaptability, which implies conformity of the goals, purposes, influencing factors, limitations and other specifics of the model with those in our conditions. The evaluation according to this criterion has 3 levels:

- low (up to 30%),
- medium (30 % - 60%),
- high (over 60%);

5. Scope of the research, which is related to the methodological approach, the program, the goals and tasks, the purposes and the nature and character of the research, as well as the solutions it offers. According to this criterion, the evaluation has 2 levels:

- sectoral, which is contrary to the methodological approach of this research),
- integral, which methodologically corresponds to the research in question.

The overall evaluation in relation to all the described criteria cannot be represented by a quantitative assessment or calculation, due to the nature and character of the optimization process in which the qualitative assessment has a crucial importance. Because of that, some of the models are rated as unsuitable, even though they have relatively high scores according to different criteria. Data availability is insufficient if it is a model with a small number of goals and uses or low local adaptability. Also, some of the sectoral models are evaluated as partially eligible, although they are contrary to the integral approach which is essential in this research, because it is evaluated that some of the analyses, methods and tools they contain can be successfully applied in models with an integral approach, but only in certain aspects of the research.

4. Results and Discussion

4.1. Essence of Selected Models

Land use optimization is one of the basic research aspects in planning that is increasingly becoming a key measure for achieving sustainable land use. Within the framework of the research, several studies on the topic of optimization of allocation of land uses have been analyzed. Most of them refer to selected regions, locations and cities in China, then Vietnam, Netherlands, Greece and the USA. From the analyzed research, 17 were selected for more detailed analysis and evaluation. At the national level, there are no suitable papers in this area.

M1. Spatial multi-objective land use optimization: extensions to the non-dominated sorting genetic algorithm-II by Cao et al. (2011).

The subject of this study is the search for optimal scenarios for land use, based on the application of a model of multi-objective spatial optimization of land uses with genetic algorithms, known as "NSGA-II-MOLU" model. The model was developed for Tongzhou New Town in China and addresses three conflicting objectives: - minimization of costs for land use conversion, - maximizing accessibility and - maximizing the compatibility of different uses. The long-term goal of the model is to achieve sustainable development, as a balance between economic development, environmental protection and efficient use of natural resources. The model uses genetic algorithms that are particularly effective for searching complex spatial solutions in various applications. This model is useful as a tool to support the planning process for the optimization of land uses in complicated conditions of interaction of spatial objectives and variables.

M2. *Sustainable land use optimization using Boundary-based Fast Genetic Algorithm* by Cao et al. (2012).

The model applied in this study consists of more comprehensive objectives and is more effective and efficient than the one applied in the previously described research and is called the BFGA - MOLU model, which is applied to a case study in Tongzhou Newtown, Beijing, China, Newtown, a central urban area of Tongzhou, which promises to become a major urban area of Beijing in the future. The land uses in this research are simplified into 5 main types: residential land, industrial land, commercial land, green spaces and land with no purpose. The following parameters were used in the optimization process: area, repetition, population, overlap, mutation, generation. The BFGA–MOLU model was obtained from 5000 iterations using the following parameters: 8 objectives, which include: maximization of GDP, minimization of land conversion, maximization of geological stability, maximization of environmental suitability, maximization of affordability, maximization of clause impact for non-concurrency, maximization of compactness and maximization of compatibility; certain restrictions.

M3. Spatial optimization method for sustainable multiobjective land use allocation (Ligmann-Zielinska et al., 2008).

The model uses GIS techniques to construct a digital elevation model of the terrain, from which a pattern of slopes and land uses is extracted. Based on that model and additional environmental and other factors, an evaluation of the suitability of the land for certain uses was made. The research area is divided into 4 optimization zones (developmental, main, restricted and prohibited).

M4. Simulating Multi-Objective Spatial Optimization Allocation of Land Use Based on the Integration of Multi-Agent System and Genetic Algorithm by Zhang et al. (2010).

The model of multi-objective spatial allocation of uses (MOSO) model, based on the application of the so-called multi-agent is applied to solve a practical multi-objective spatial optimization of land use allocation in Changsha region, China, where land use in urban areas is characterized by inefficient low density and extensive land use patterns. The general goal of the MOSO model is saving natural resources and achieving environmental suitability. To improve the operability of the model, appropriate sub-goals and constraints are set.

M5. Modeling and Supporting Multi-Actor Spatial Planning Using Multi-Agents Systems by Ferrand (1996)

This research is very similar to the previous one. Here too, the application of Multi-Agents Systems (MAS) is proposed, in that unlike the previous research, two approaches are presented here: - the first is based on the use of multi-reactive agent systems (Multi-Reactive -Agents Systems) to optimization, which are encountered when trying to ensure the least impact on the environment from the infrastructure;- the second, uses multi-cognitive agent systems (Multi-Cognitive-Agents Systems), to support and simulate changes and dynamism of spatial phenomena and policies, taking into account general political values, specific spatial limitations, and social characteristics and relationships between actors.

M6. Land-use Spatial Optimization model based on particle swarm optimization by Shifa et al. (2009).

This research promotes a spatial optimization model based on an evolutionary particle swarm algorithm, which is an advance over previous algorithm-based models and largely overcomes their shortcomings. Particle swarm optimization is a type of evolutionary algorithm, which is capable of analyzing multidimensional discrete spatial decision data in parallel. This model is suitable for spatial optimization of uses, because it can be used at the micro level, as a point (place, location) of use.

M7. Global-to-local modeling of land use dynamics in Vietnam Potential effects of high climate impact and high economic growth scenarios by Rutten et al. (2012).

In this study, the global to local approach is implemented, which is a combination of the macroeconomic model, MAGNET (Modular Applied General Equilibrium Toolbox) and CLUE (Conversion of Land Use Change and its Effects) land use model. The research concerns Vietnam and actually represents the connection of the global economic simulation model with the spatially explicit land use model. Two scenarios are considered that aim to quantify the impact of global and national driving forces and policies on land use in Vietnam by 2030.

M8. Optimization of Land use suitability for agriculture using Integrated Geospatial model and Genetic Algorithms by Mansor et al. (2012).

In this study, a geospatial model of land use allocation is developed from a position of biological autonomous environmental adaptability and infrastructural advantages. The model is based on a multi-agent genetic algorithm. Tailored to accommodate a set of constraints in the research space, such as resource conservation and environmental suitability. Then, the model is applied to solve a practical multi-objective optimization of land use allocation in the Menderjan Basin region of Iran.

M9. Land use allocation optimization models applied to future use in the u.s. doe's major nuclear weapons sites by Greenberg (1999).

This research was carried out for one of the so-called "Departments of Energy" (DOE), with a national mission to develop, test and produce nuclear weapons. Today, the planning and use of land is changing in these areas as well, so certain uses that were not thought of at all during the cold war (such as recreation) have now become part of the efforts to domesticate these spaces and incorporate them into the plans. for land use and management. Included in the survey are 5 potential types of uses and a series of constraints related to land availability.

M10. Multipurpose allocation of areas with intensive production of wood products and maintenance of fauna and biodiversity by Mincev (2007).

This is a research concerning regions in Northern Italy, based on conflicting objectives: achieving intensive wood production and maintaining fauna biodiversity. The process of multi-objective allocation (MOLA) is performed with the support of IDRISI Kilimanjaro software.

M11. A GIS based multicriteria approaches to land use suitability assessment and allocation by Mendoza (1999).

This document aims to create an integrated GIS model based multicriteria approach for land suitability analysis, to achieve optimal allocation of the most suitable uses for each type of land. The GIS environment enables a spatially explicit evaluation of land suitability and the application of various measures of suitability to specific geographical areas. Such an integrated model combines the spatial capabilities of GIS with the analytical power of multi-criteria analysis allows at the same time analytical planning and optimization of land use decisions at different levels.

M12. A solution to the Land Allocation problem integrating multicriteria analysis, fuzzy logic, and GIS by Miranda (2004).

In this research, the application of GIS systems is integrated with two techniques: fuzzy logic and multicriteria analysis. The paper presents a test with real data to solve an allocation problem in a specific geographical area in Guaria, Spain for sugarcane cultivation.

M13. Model of land use spatial optimization based on a knowledge guide genetic algorithm by Yaolin et al. (2013).

This model, based on GA as a knowledge guide is proposed to overcome the shortcomings of previous studies. The model is a modification of traditional GA with local land use knowledge consisting of spatial characteristics and land use change rules. The research concerns Gaoqiao Town, an area located in the northern part of Fuyang City, in Zhejiang Province, in China.

*M14. Function-analysis and valuation as a tool to assess land use conflicts in planning for sustainable, multi-functional landscapes***,** by De Groot (2006).

This paper, which advocates for ensuring sustainable development in conditions of high demand for land and natural resources from different actors (stakeholders) with often conflicting interests, indicates the necessity of including environmental, economic and socio-cultural values in the process of planning and decision making. It offers a comprehensive framework for the integral assessment of ecological values and services and the socio-economic benefit of natural ecosystems and landscapes. That framework can be implemented at different levels and for different ecosystems and basically consists of three steps:

- functional analysis (reducing ecological complexity to a limited number of ecosystem functions that in turn provide a range of goods and services),

- functional valorization (which includes ecological, socio-cultural and economic valuation methods),

- conflict analysis (involving interested parties with participation methods, in order to facilitate the application of functional analysis and valuation at different levels). A comprehensive cost-benefit analysis for different options (alternatives) of land use is essential for achieving sustainable use of land and resources and maintaining "natural capital".

*M15. Integrating socio-economic and land-use models to support urban and regional planning***,** by Van Delden et al. (2011).

In this research in the field of finding optimal land use models, there are several attempts to integrate socio-economic models with land use models, which mostly apply a one-way relationship between the two models. The model presented in this paper enables a more dynamic integration of the two processes, which enables feedback of land use models on economic models. To facilitate its application in planning and policy building, the integral model is constituted in the form of an integrated decision support system (Integrated Spatial Decision Support System - ISDSS), which enables the evaluation of the impacts of different political options (related to spatial planning, infrastructure development and economic initiatives) using a set of social, economic and environmental indicators and testing these political alternatives in different conditions (mainly demographic and macroeconomic). This model is applied to the Wellington region in New Zealand. One of the main results of this approach is that the feedback incorporated into the system shows that socio-economic development is a significant driving force of land use change, but limited natural resources also have an impact on economic development and limit economic growth which is the most of the economic models predict it. The simulation model starts from the current land use map for the initial year and, applying a set of driving forces and factors, calculates future development. The model uses an application based on a grid of cells in which each cell has a specific land use. Reassignment is not based only on the state in neighboring cells (as in most previous models), but on local characteristics, such as availability of infrastructure, suitability of the location for a specific purpose and spatial planning applied to different locations.

*M16. Spatial conflict management in urban planning, b*y Santorineou et al. (2008).

In this research, an effort has been made to develop a methodology for making spatial decisions, to support urban planning. The focus is placed on the management of spatial conflicts - interests, use and valuation that are created by land use change options, so that the final decisions should ensure sustainable development. The research area is the coastal urban belt of the Perama region in Athens, Greece, with an area of 243 ha. The proposed methodology, referred to as Spatial AGORA, integrates elements of participatory conflict management algorithm AGORA (Assessment of Group Options with Reasonable Accord), GIS and CA (Cellular Automata), which use Multicriteria Evaluation Methods, Basic Theory and Game Theory. The GIS is used to collect, analyze and manage all the necessary data for the researched area in total and defined sub-areas that are used as decision units. Mobile automata have been used for the land use change simulation model. Stakeholders from the decision units are the main participants in the application of the purpose model.

M17. Pine Nut Allotments (NV) Land Use and Development Procedural Plan, Land Use Suitability Analysis (Working Paper, Pine Nut Allotments (NV), 2009).

In this paper, an analysis of the suitability of the land is elaborated, based on the following criteria:

• Topography (slope and height);

• Access (distance to the road infrastructure and access to an existing road);

• Services, i.e., communal services (energy and communications, underground water potential, the possibility of sewerage - wastewater treatment;)

• Soil (suitability for construction, construction materials, land management, development of recreation and sanitation services);

• Ownership (number of plot owners)

This analysis was done for an area of 176 parcels in Douglas County, Nevada. For each of the criteria, the pilot space is evaluated in several (5-8) categories (well, humble, poor, very poor, unfit, etc.). Then, by integrating the eligibility of the parcels according to the defined criteria, the most suitable ones for certain purposes according to all or most of the criteria are selected.

A characteristic of single-purpose models is the generation of only one solution, which is a disadvantage of the model from several aspects: efficiency, effectiveness, economic justification and lack of support in planning.

Therefore, in the process, multi-objective models are applied, which require the introduction of more variables in the model, which, together with the relations between them, have qualitative characteristics and cannot be included in linear models. The introduction of more variables and the relationships between them increases the complexity of the models and makes them non-linear. The application of GIS tools is necessary for such models.

In fact, the shortcoming of all traditional optimization models is the inability to effectively unify the quantitative and spatial structure.

Regardless of the method used, the complexity of the optimization process grows, not only because of the large number of variables, but also because of the growing number of objectives. It is simply impossible for planners to think, evaluate different possibilities, or solve any problem without a numerical method.

In the last few decades, scientists have been actively involved in designing optimal solutions For example in the research “Pine Nut Allotments (NV) Land Use and Development, Procedural Plan, Land Use Suitability Analysis” as a result, genetic algorithms were introduced, which are used to search for complex spatial solutions in various applications. Genetic algorithms (GA) are suitable for solving multi-objective optimization problems by applying the "Pareto front based method", step by step.

The advantage of genetic algorithms is in the efficient applicability of many variables and their mutual relations and relations, as a result of which a multitude of configurations with almost the same characteristics is obtained in a relatively short time. This is particularly attractive to politicians, who can evaluate alternative deployment configurations, each with their own specific socio-economic impacts, and still achieve optimal results.

Although genetic algorithms represent a great advance in optimization, they also have several drawbacks that limit their application, especially in our conditions as follow.- the use of complicated maps instead of coding, which makes the program difficult to implement and with little ability for spatial correlation; limited number of targets used in these models, which reflects their sustainability; application of network units, or cells for which the optimization is investigated, which excludes the application of these models at the macro level; the time required to obtain a clear and good solution, which makes it difficult to apply this method in planning support; absence of inclusion of local specifics, factors and influences in the research (the so-called "trapping of the GA in the local specifics of the space").

These shortcomings of the models have been ascertained in most of the analyzed research (models M1-M9 and M13), which makes them unsuitable for application in the research in question. A serious drawback of most of the analyzed papers is the research area, which is mostly an urban area, as well as the small number of goals and purposes that are included in the model. Functional analysis and valorization of the space with ecological, socio-cultural and economic valuation models, as well as the comprehensive cost-benefit analysis for different options (alternatives) of land use, which is essential for achieving sustainable land use are advantages of some of the analyzed models, but inapplicable in our conditions due to the unavailability of the data needed for the analysis.

The greatest progress in this research is the combination of mathematical models with GIS tools and GA. The positive characteristics of the analyzed models, which can be partially applied in our conditions, refer to:

- Application of a digital elevation model of the space in GIS technique and evaluation of suitability of the land for certain purposes;

- Multi-criteria approach in evaluating the suitability of land for certain purposes and creating an integral model of purpose in GIS;

- Generation of an optimal purpose model obtained by valorization with suitability indices.

4.2. Final Evaluation of Analyzed Models

Some of the models are rated as unsuitable, even though they have relatively high scores according to different criteria defined in the methodology. A comparative analysis of the optimization models was performed in order to evaluate their suitability for application in our conditions.

According to the value of each of the particular models and approaches (Table 1), no one is fully applicable to our planning system. The most appropriate are as following:

- M15. Integrating Socio-Economic and Land Use Models to Support Urban and Regional Planning, by Van Delden et al. (2011), an integrated system for spatial decision support - ISDSS), which enables the assessment of the impacts of different political options using a set of social, economic and environmental indicators and testing these political alternatives in different conditions (mainly demographic and macroeconomic). The fact that planning in our country is largely under political influence, that is, spatial planning decisions are also political decisions for making plans and for expectations from those events in a case of conflicts.

-. *M14. Functional analysis and valuation as a tool for assessing land use conflicts in planning for sustainable, multifunctional landscapes,* by De Groot (2006) *and M16. Spatial conflict management in urban planning,* by Santorineou et al. (2008) - which must inevitably be part of planning theory, taking into account the different and often conflicting interests in land use of the different stakeholders, who impose a necessary need for the same inclusion of the conflict so that a sustainable and generally accepted solution can be reached for all the parties concerned.

-. *M11. GIS-Based Multi-Criteria Approaches for Land Use Suitability Assessment and Allocation* by Mendoza (1999) – and this is a good part of GIS spatial analyzes based on our methodology, in which an unlimited number of factors and aspects of valuation and analysis of a specific area can be included; it also includes multi-criteria analyses, which in our case is related to the characteristics of the natural features and natural assets of the country, due to the demographic situation that is the basis for planning.

Part of the methods and models applied in the models evaluated as certain eligible, have been applied in the process of creating an optimal model of the use on the territory in the Skopje region by experts and stakeholders, conflict management and integration of socio-economic and land use models in the form of an integral DSS decision support system.

Table 1. Evaluation of optimization models for application in spatial planning in the RNM.

Model	Data availability	Number of targets in the model	Number of Method Usage	Method	Local adjustability	Scope	Evaluation
M1	minimal	small	medium	GA	low	sectoral (urban)	ineligible
M2	minimal	small	medium	GA	low	sectoral (urban)	ineligible
M3	minimal	small	high	GA+GIS	low	sectoral (urban)	Partially eligible
M4	partial	small	medium	GA+GIS	low	sectoral (urban)	ineligible
M5	minimal	small	medium	GA+GIS	low	sectoral (urban)	ineligible
M6	minimal	small	medium	GA+GIS	low	sectoral (on micro level)	ineligible
M7	partial	small	small	economic	medium	sectoral	ineligible
M8	minimal	small	small	GA+GIS - land suitability	high	sectoral (agriculture)	ineligible
M9	minimal	small	medium	-linear	low	sectoral (urban)	Partially eligible
M10	satisfactory	small	single	-land suitability -GIS	high	sectoral (forestry)	Partially eligible
M11	partial	small	high	-land suitability, GIS -multicriteria approach	medium	integral	Partially eligible
M12	satisfactory	small	single	-multicriteria approach, GIS, fuzzy logic	high	sectoral (agriculture)	ineligible
M13	minimal	small	medium	GA -conversion of land use	low	sectoral (urban)	ineligible
M14	partial	small	medium	-functional analysis - functional valorization - conflict analysis -cost benefit analysis	medium	integral	Partially eligible
M15	partial	medium	small	-decision support system, - macroeconomic, environmental and social model with restrictive scenarios	medium	integral	Partially eligible /ineligible for long-term planning
M16	partial	medium	small	- multicriteria evaluation, GIS - game theory, - conflict management	medium	sectoral (urban)	Eligible
M17	partial	high	small	- land capability	medium	sectoral (urban)	Partially eligible

5. Conclusion

The reviewed papers on the analyzed optimization models and methods, marked by the authors, clearly indicate the fact or exceptional difficulty in determining the optimal land use optimization model.

The list of terms of application therein, bearing in mind Anna's limitations in terms of ensuring accuracy and relevance respecting broad specifics and great differences, economic social and political sense concerning geographical aspects, which refer to the analyzed models, only revealed the finding that the optimization of land use is a really serious challenge for every country.

Additional geographic specifics that sometimes mean convenience, but sometimes also limit land use, economic and social conditions have a very significant place in the concept of land use.

The most of models for land use optimizations, i.e., nine (9) are assigned as ineligible, seven (7) are partially eligible and only one (1) model could be eligible for spatial planning purpose in the country.

Thus, optimization should primarily ensure well-being, but respecting social requirements, standards and constraints. For the country in the main factors should be in harmony with political decisions, creating an optimal model is a complex and difficult task, for a long time, the optimization model should be long-term, sustainable and realistic, the power to implement within the framework of various political creations.

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Conflict of Interest

The authors declare that they have no conflict of interest.

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