

## REVIEW

ON DOCTORAL DISSERTATION TITLED "**OPTIMIZATION OF NON-URBAN LAND USE IN SKOPJE REGION SPATIAL PLANNING PROCESS WITH AIM TO DECREASE LAND DEGRADATION**", PREPARED BY MSC. ENG. DUSICA TRPCEVSKA-ANGELKOVIC, SUBMITTED FOR THE FACULTY OF FORESTRY

The Scientific – Teaching Council of “Ss. Cyril and Methodius” University - Faculty of Forestry, with the Decision no.0201-387/11 from 16/06/2014 on the IV<sup>th</sup> session established the Commission for evaluation of the doctoral dissertation specified above. Members of the Commission are:

1. PhD. Ivan Blinkov, full time professor at “Ss. Cyril and Methodius” University in Skopje, Faculty of Forestry,
2. PhD. Makedonka Stojanovska, associate professor at “Ss. Cyril and Methodius” University in Skopje, Faculty of Forestry,
3. PhD. Dusko Mukaetov, associate professor at “Ss. Cyril and Methodius” University in Skopje, Agricultural Institute – Skopje,
4. PhD. Stanojko Angelov, full time professor at “Ss. Cyril and Methodius” University in Skopje, Faculty of Forestry, retired
5. PhD. Aleksandar Stojmilov, full time professor at “Ss. Cyril and Methodius” University in Skopje, Faculty of Natural Sciences and Mathematics, retired.

After examining the submitted doctoral thesis, the Commission has the honor to submit to the Scientific – Teaching Council of the Ss. Cyril and Methodius University - Faculty of Forestry, the following

## REPORT

The doctoral dissertation of MSc. Eng. Dusica Trpcevska - Angelkovic, titled "**Optimization of non-urban land use in Skopje Region spatial planning process with aim to decrease land degradation**" is made in accordance with the regulations. The thesis contains a total of 274 pages of basic text in normal spacing, 11 previous pages, 261 pages of basic text and 2 pages attached. It is presented in a contemporary scientific approach, using methods recognized internationally.

In addition, a geospatial database for the research area and geospatial models regarding the topic is created as a background material of the dissertation.

The material presented in the thesis is divided into:

Previous article:

1. Title and gratitude, on 2 (two) pages;
2. Abstract in Macedonian and English on two (2) pages;
3. Contents of 3 (three) pages;
4. List of tables and figures on 4 (four) pages;

And

Basic text which is divided into:

1. Introduction on 23 (twenty three) pages;
2. Institutionally legal and strategic planning aspects in land use and land management on 34 (thirty four) pages

3. Conflicts in land use and land management on 18 (eighteen) pages;
4. Chronological analysis of land use in Skopje Region and intensity of soil sealing on 47 (forty-seven) pages;
5. Adaptability of worldwide land use optimization models in the Republic of Macedonia on 20 (twenty) pages
6. Geospatial model of land use in Skopje Region on 43 (forty three) pages
7. Optimization of land use model in Skopje Region on 50 (fifty) pages
8. Conclusions and recommendations on 10 (ten) pages and
9. References on 16 (sixteen) pages.

The basic characteristic of the structure of material is that apart the first and the eighth chapter, all other chapters are structured as independent parts that contain all the subtitles: introduction, theoretical review, methodology, results and discussion and conclusions.

The subject of this thesis is very complex and multidisciplinary that refers to special methodological principles and research methods for different research issues. Therefore, the study is structured in this way, recognized in international complex and multidisciplinary studies.

In the **Abstract**, in accordance with the standards for writing of scientific thesis, the most important parts of all the sections of the thesis are presented in Macedonian and English.

The working context is established over the **Introduction Chapter**. These chapters provide answers to the basic questions of such thesis: What is being studied? Why is this an important issue? What did we know about this issue before we made this thesis? How will this study advance our knowledge?

Then, in the introduction part of each chapter all the previous issues are explained. The structure of the Introduction is set correctly starting from the general information and definitions about the issues (land use, land degradation, spatial planning and processes' modeling) and gradually going further by explaining the issue, focusing finally on the specific problem that is studied.

Land use, as a background for primary production, development of human settlements and space for many economic and other activities, is an integral and interdisciplinary process that includes many disciplines with different needs, goals and interests. Unsustainable and unsuitable land use produces many problems and conflicts between the users, then often results with different types of land degradation.

Finding the solution for these problems is an essential need worldwide, in order to protect this unrenewable resource with extraordinary value for the human race and its keeping for the needs of the next generation.

The covering of the soil surface with impervious materials as a result of urban development and infrastructure construction is known as soil sealing. Sealed areas are lost to uses such as agriculture or forestry while the ecological soil functions are severely impaired. In addition, surrounding soils may be influenced by change in water flow patterns or the fragmentation of habitats. Current studies suggest that soil sealing (development of settlements, building infrastructure, industrial and other constructions) is nearly irreversible. The greatest impacts of soil sealing are observable in suburban areas. Optimization of land use planning is needed to mitigate the damages caused by soil sealing.

Commonly optimization is defined as the process or procedure aimed to achieve the best results (in different research areas) respecting forced restrictions. The rapid socio-economic

development has produced enormous material interests; however, the unreasonable land use allocation has also led to a series of serious resource and environment problems, and affected seriously sustainable land use. Thus, developing a spatial optimization allocation model of land use will have great significance to scientific planning and rational land management.

The main objective of this thesis is to find an optimal model of land use in Skopje Region, based on application of up-to-date models and approach in GIS technology that is a part of decision support system and gives spatial planning solutions, based on sustainable development principles. The model that emerges from this study should facilitate and visually approach the information of land use that it would be used in the process of planning /decision making.

To get to the main goal – defining the optimal land use model in Skopje Region, several research issues are set as follows:

1. What is the legal and institutional framework in land management like and does it produce some restrictions?
2. Which are the main problems or reasons in land use and land management that cause conflicts (disagreements)?
3. What are the ways or approaches in conflict solving?
4. What is the state of land use in Skopje Region like and does it evoke conflicts?
5. What is the intensity of soil sealing?
6. Are the worldwide methods of decision support in land use planning adaptable in planning in the Republic of Macedonia?
7. Which are the procedures and methods of land use planning that are adaptable in Macedonia?
8. How does the geospatial model of decision support in land use in Skopje Region look?
9. Which sustainable model of land use in Skopje Region would be optimal in order to minimize land degradation?

In the Introduction part of the second chapter titled *Institutionally-legal and strategic-planning aspects of land use*, the candidate presents the types of land use resources management followed by a comparison of the main characteristics of the management system in the Republic of Macedonia and the system of integral recourse management. The main methodological approach in this chapter is the method of content analyzes of different data sources. This method is used for research of written documents. The historical method is also used in this chapter, for the analysis of development of the process of land use and land management, as a national interest, delivering responsibilities and organization structure of responsible institutions in the period from the establishing of independency of the Republic of Macedonia. This analysis aim to describe the way of functioning, relations and responsibilities, as well as the problems in responsibility effectuating and conflicts among the actors. The method of comparative analysis is used to compare same and similar phenomena, classifications and categorizations, related to the research subject. This method is used to define the weaknesses that should be upgraded with the purposed model of optimal land use.

On the basis of wide-ranging analysis from the aspect of relevant legislation, responsible subjects and organization and structure of responsibilities, we can conclude that land use and land management in the Republic of Macedonia is regulated with several legal acts and regulations, mostly regarding to different branches. This is the reason for having unclear responsibilities, lack or overlapping the same responsibilities, i.e. delegating the same responsibilities to different subjects. According to different law regulations, responsibilities are delegated to several subjects on national, regional and local level. This situation additionally complicates the realization of the responsibilities

and often produces different view-points, approaches and interests that can be the reason for conflicts (disagreements, misunderstandings...) among the responsible subjects, different land users and also among the subjects and users too. Regarding the planning documents, for land use and recourse protection, the author also concluded that mostly they are not integral in their analysis, researches and planning solutions. As a result of this, there are disagreements and sometimes contradictory solutions for the same area, or the same resource. This situation also produces several problems and conflicts in sustainable land use and sometimes is the reason for degradation appearance.

Next chapter, *The conflicts in land use and land management*, is dedicated to conflict research (battle, competition, tensions, incompatibility, strategic behavior and interaction). In the first part the author theoretically elaborates on the problems through analysis of various authors, of which primarily Walker&Daniels, in order to analyze the dimensions and aspects of conflict.

The qualitative method has been used in order to detect the problems in land use, which includes "face to face" interviews with members of previously identified struck sides which have given primary data that confirms or revokes what has been ascertained through secondary data analysis. The interview was conducted based on a previously half constructed questionnaire.

Theoretical analysis and certain researches **undoubtedly** show that conflicts in land use are an existent element in our planning practice, implementation of plans and land management. Lack of agricultural land is existent as a result of intensifying the soil sealing with different structures. Therefore, the basic priority of entire regional development should be degradation process control and preventing, firstly the aspect of soil sealing that is directly influenced of spatial planning process. A tool needed in order to realize this primary goal is land use conflict management. The success in conflict management could only be guaranteed by integral conducting the conflict management on all levels of planning (national, regional, local), implementation and monitoring.

The forth chapter, *Chronological analysis of land use in Skopje Region and soil sealing* intensity is necessary in order to define the intensity of degradation due to incompatible land use planning. The first part offers a theoretical review of different land use classifications. The methodologies being used (CORINE LCU and cadastral classification) according to different classifications in the Republic of Macedonia result in difficult comparison of data from various sources.

The basic methodological approach in this chapter is the qualitative and comparative analysis of various data sources, first of all European Environment Agency data concerning land use, as well as different sources such as: State statistical office, national strategic documents, planning documents, and other documents on national and regional level concerning management and land use altogether and different land recourses (agricultural land, forests, pastures, water, mineral recourses, natural heritage).

The historical method has been applied to this chapter, in order to define the modifications in land use, analyze the development of land use and management as a national interest. The comparative analysis method is used to compare identical and similar phenomena, categorizations and classifications related to the research subject. Due to the differences in data used from various or even same sources, as a result of changing methodologies, data processing and presenting as well as the differences in presenting levels (national, regional, local), the method of comparative analysis is used to determine the compatibility of data from different sources.

Soil sealing is the most serious type of land degradation that exists in Skopje region in the last 50 years. The main reason for soil sealing appearance is unsustainable, inappropriate land use as

a result of planning process. The territorial extend of the city of Skopje is taking place mostly in suburban zones, where interests and conflicts regarding the land use are most evident.

Based on the analyzed statistical and other data from a large number of planning documents, enhancement of unproductive land in Skopje region has been recorded in the period between 1965 – 2010, as a result of permanent transformation of productive (soil sealing) in total 11 920 ha (63,02%) which comes to an annual average of 0,14% of the total region area, which basically represents the annual rate of soil sealing.

Reducing the amount of agricultural land comes to an astonishing annual rate of 0, 52%. A negative trend has been noticed concerning all categories of agricultural land, but mostly concerning pastures and arable land contrary to orchard and vine yards, whilst only meadows show a trend of enhancement with an annual rate of 0,8%.

Forests and forest land also show an average annual enhancement of 0,37%. This is a result of transformation of pasture land to forest, due to pasture abandonment and fast growth of woody vegetation, intensive afforestation of bare land and other ameliorative activities, especially in the period of 1971-1990, changes in methodology of processing and presenting data from institutions in charge. This also results in having land in transit meaning grass and sparsely vegetated land used for cattle grassing included in the pastures category.

Analyzing the trend of productive land transformation in unproductive land as a serious situation especially concerning the Skopje surrounding is a result of territorial development of the city and the settlements in suburban zones, but also as a result of building industrial, touristic and other zones, infrastructure systems and accumulations. The territorial development of Skopje, in the period from the catastrophic earthquake to present days has resulted in transformation of productive (especially high quality arable land) to unproductive land. Due to the previous, the urban area boundary of Skopje has been extended for almost 80% i.e. from 4711,42 ha (in 1965) to 8464,08 ha (in 2012).

The fifth chapter, *Adaptability of worldwide models of land use optimizations in the Republic of Macedonia*, analyses various land use optimizations models and approaches.

Land use optimization is currently not a part of the Republic of Macedonia spatial planning approach. Due to the lack of such examples in Macedonian literature the author has analyzed models and approaches presented in international studies, which refer to regions in Europe, USA and Asia. The selected 17 studies with various approaches have been valuated from the aspect of adaptability in Macedonian land use planning system, according to following criteria: data availability, number of goals and purposes in the model, local adaptability and scope of study. The given conclusion about the complexity of creating an optimal model of land use have been confirmed by the various defects in the analyzed studies which have also been found by the authors themselves.

None of the analyzed studies has been valorized as completely adaptable in our conditions, because of lack of relevant data and local adaptability. Most models and approaches were valorized as partly similar and part of the methodological tools, approaches and actions of optimizations are adaptable in Macedonian conditions. Such are: GIS technique utilizations, evaluation of land capability for various uses, multicriteria approach, generating an optimal model by index of adaptability valorization, conflict management and analysis of spatial conflicts of participative approach and integration of socio economic methods with land use models in a form of Integrated Spatial Decision Support System. Most of these methods and approaches have been applied in the development of the geospatial model of this research.

The sixth chapter, *Geospatial land use model in Skopje region* has been divided into the two parts of which, the first part is presenting a developed basic geospatial database in which a compatible reclassification and adding numeric values and with the help of various mathematical operations a so called geospatial land use model has been created in the GIS-software.

The geospatial land use model has been created based on the Land capability analysis using the multicriteria approach with GIS technique. The land capability analysis has been executed based on previously defined priorities and criteria, using some of Velkovic and Budinovski's research as a role model. The first priority in land use model defining is purposing agricultural land for agricultural production. The land capability analysis for agricultural purposes has been executed concerning following criteria: slope, attitude and soil type. Valorizing agricultural land for a primary cropping is executed using the method of scoring every criteria separately.

The total valorization has been executed using the multicriteria analysis method based on all three basic criteria: slope, attitude and soil type, with the help of hierarchically ranking of scores and their synthesis in a unique index.

Based on the geospatial model analysis has been made in order to define the basic parameters of geospatial statistics in compatible software. The results of this analysis show that:

- 53% of total agricultural land of the region is valorized as most compatible for farming based on the three adopted criteria and 28,53% as compatible, which gives a total of 82,53% of the total land valorized in the two most compatible classes;
- only 18,47 % of the total agricultural land comes as incompatible, less compatible and middling agricultural land.

The incompatible agricultural land is a subject for additional land suitability analysis for farming various crops which can grow on incapable land, with the use of special agricultural including erosion control measures. If the results of this analysis still show incompatibility of this agricultural land category, it can be used as forest and pasture land, but only if it satisfies the remaining criteria (attitude and soil type) or as unproductive land (for urban and other public interest purposes).

The geospatial model has excellent opportunities for achieving the integral approach goals. Combined with the multicriteria analysis it gives an opportunity of putting behind the weaknesses of classic models, through:

- Application of a big amount of goals, purposes and criteria;
- Creating various scenarios, their analysis, overlap and choosing the optimal;
- An excellent visualization and creating various sector and integral graphic display;
- Accurate and fast mathematical analysis, calculation and balance sheet.

However this is not a final land use model in the Region because it does not include analysis and measures that will help transcend the land use conflicts and different interests, but it does conclude a phase in the process of creating an optimal land use model, and it represents a vial decision making support.

The final optimal model reunites all data and conclusions from previous chapters as presented in the seventh chapter, *Optimization of the land use model in Skopje region*.

The final land use model throughout the optimization process should overcome barriers, conflicts and different interests of land users in order to come closer to the optimal model. The process of optimization of the geospatial model has been realized through phases which incorporate the following:

- Land use restrictions,
- Degradation endangered land,

- Conflict management,
- Directions and articles for special land use regime.

The created geospatial land use model incorporates restrictions related to the following:

- zones and localities of natural and cultural heritage,
- protected zones and areas of water bodies,
- protected areas of infrastructure corridors,
- proposed areas for protection (natural heritage)).

Incorporation these land use limitations results with consciousness agricultural, forest and pasture land presence in the borders of protected areas of natural heritage, water bodies, (springs, rivers and accumulations) as well as protected areas of infrastructure corridors (roads, railway, pylon, pipe line and gas line). Planning the use of such surfaces should incorporate protection measures posited with sector regulations (laws, decisions and other documents for declaring protected areas, zones) and separate planning documents (spatial plans, management plans, valorization or revalorizations studies and other relevant documentation).

The conflict management is executed through phases as: functional analysis, interested parties incorporation, organizing public debates, presentations, work shops; and consensual decision making with contribution of all participants.

Only an integral approach and incorporation of all measures and dispositions could grant a sustainable land use and perpetual protection. When declaring new protected areas the focus should be on defining the protected area borders in accordance to different laws.

Some natural dangers, which are dispersed in the space, especially erosion, floods, fires, rockslides and landslides have been treated in the process of the land use model optimization. Other authors 'previously developed models concerning these phenomenon have been incorporated in the system.

The initiatives for land transformation in the period of 2005-2014, as results of started and executed activities related to urban and rural area development and economic and non-economic zones building, infrastructural systems and accumulations in the region, would lead to increase of unproductive land to 110.6%. The dynamics and intensity of these activities should be in the focus of institutions in charge in the agricultural land transformation decision making process.

The last chapter, *Conclusions and recommendations* briefly presents partial conclusions from previous chapters. Based on all analysis the candidate introduces the procedure of optimal land use model development which consists of:

- determining the state of land use in the Region, as a result of a wide range analysis of legislative, strategic and other planning documents and different types of data;
- deflection of land use conflict among different users and discovering the processes of degradation, as a result of conflicts and incompatible land use and management;
- creating a geospatial land use model using a multicriteria approach (Land capability analysis), in GIS platform, unit and total valorization of arable land according to defined priorities and criteria;
- Geospatial land use model optimization incorporating land use restrictions, degradation endangered surfaces, conflict management and defining special land use regimes.

The adaptability of the model in the spatial planning system of the Republic of Macedonia would mean theoretical and practical upgrade in function of thoroughness, complexity and interdisciplinary all in favor of making correct decisions and development land use strategies which will be economically efficient, socially applicable and ecologically acceptable.

## CONCLUSION AND SUGESTION

From previously stated one can conclude the doctoral dissertation titled: **OPTIMIZATION OF NON-URBAN LAND USE IN SKOPJE REGION SPATIAL PLANNING PROCESS WITH AIM TO DECREASE LAND DEGRADATION**, prepared by MSc. eng. Dusica Trpcevska- Angelkovic, represents an original and independent scientific study, which is actually multidisciplinary one, because it covers not only related areas of the research but also, more research areas spaced in three research fields (natural and mathematical sciences, technical-technological sciences and biotechnical sciences) which gives a significant contribution to science and practice. An approach and procedures defined within this research are general and applicable for the whole state and wider.

The results obtained in the studies, the findings and conclusions of them certainly have a special significance for the science of the area of land and water, and is associated with spatial planning, forest environment, water economy, land policy, and geo-information, but also for the practice in these areas.

The research in this study opens a new phase in the spatial planning process and related researches which it contains, that characterizes with applying modern techniques of numeric-graphic modeling necessary for establishing an effective decision making support system in the Republic of Macedonia.

Considering all of the aforementioned, the Commission positively evaluated the doctoral dissertation and has the honor and pleasure to propose the Scientific-Educational Council of the Faculty of Forestry - Skopje, to accept it as an original and independent scientific study and to initiate proceedings for its public presentation.

1.7.2014

### COMMISSION

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