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REVIEW

on a dissertation for obtaining the scientific degree "Doctor of Science" in the field of higher education 6 "Agricultural Sciences and Veterinary Medicine", professional field 6.5. "Forestry", scientific discipline "Forest Management Planning and Forest Inventory"

Author of the dissertation: Assoc. Prof. Dr. Ivailo Ivanov Markoff

Title of the dissertation: "Research on forest valuation in the Republic of Bulgaria"

Member of the scientific jury: Assoc. Prof. Dr. Konstantin Nikolov Kolev, University of Forestry, Sofia.

1. Brief presentation of the candidate

Assoc. Prof. Dr. Ivailo Ivanov Markoff is born on October 2, 1953. In 1980 and 1982 he acquired the educational qualifications "Master of Computer Science" and "Master of Applied Mathematics". In 2017 he defended his doctoral dissertation in the field of higher education 6. Agricultural Sciences and Veterinary Medicine, professional field 6.5 "Forestry", scientific specialty "Forest Management Planning and Forest Inventory" on topic "Norms and planning of timber harvesting". He speaks German, Russian and English.

From 1981 to 1994 Ivailo Ivanov Markoff worked as a researcher in Agrolesproekt, Sofia and Balkancar-Progress Institute, Sofia. Since 1994, the candidate is working at Forest Research Institute at the Bulgarian Academy of Sciences (BAS). He has held the academic positions of Assistant Professor (1994-2017) and Associate Professor (2018-). From 2019 Assoc. Prof. I. Markoff is the head of the section "Forestry and Forest Resources Management" at Forest research Institute - BAS. In addition, he is a member and/or team coordinator in more than 20 national and international scientific and applied projects. At present Assoc. Prof. Ivaylo Markoff is an academic supervisor of three doctoral students at Forest Research Institute – BAS.

The scientific interests of Assoc. Prof. Ivailo Markoff are in the field of mathematical modeling – forest growth – forest biometrics – forest planning – forest economics – monetary valuation of forests. He has published five books and 141 articles in this field. In peer-reviewed journals are published 59 articles.

2. General characteristics of the dissertation - volume and structure

The dissertation presented for review has a volume of 215 pages and is structured in six parts: I. Introduction; II. Brief review of the literature; III. Basic concepts and methods; IV. Results; V. Discussion; VI. Conclusions. The text includes 32 tables and 18 figures. Towards the dissertation there are list of the contributions, publications connected with the topic of the dissertation and used literature.

In the introduction on 4 pages are presented - subject and object of the research, purpose and tasks, scientific thesis, materials and methods of the research, actuality of the problem. In the second part on two pages are presented the origin and development of the discipline "Forest Valuation", the leading authors in Europe, North America and Bulgaria in different time periods. In the third part of the dissertation "Basic concepts and methods" on 20 pages are presented the financial basis of the discipline "Forest Valuation" in the form in which they are applied in the dissertation. The fourth and fifth parts of the dissertation "Results" and "Discussion" contain respectively 164 pages and 4 pages. The results are processed by mathematical methods, originally interpreted and appropriately illustrated with figures and tables. Based on the obtained results, the conclusions and contributions are clearly and objectively formulated. The text is written on high scientific style and logically connected. The dissertation demonstrates fluency in terminology.

3. Actuality of the problem

The actuality of the dissertation is indisputable. On one hand the existence of a rational procedure for forest valuation is a prerequisite for adequate settlement of relations between forest property owners, government agencies, economic entities, financial institutions, etc., and on the other hand for balancing the raw material and ecological function of forests. For these reasons, the selection, adaptation and justification of appropriate for the Republic of Bulgaria methods for valuation of forest properties is essential.

4. Knowledge of the literature on the problem

The author has studied a significant number of literature sources, a total of 113, of which 62 in Cyrillic and 51 in Latin demonstrating in-depth knowledge of the research problems.

5. Methodical approach

For the purposes of the research are used the method of the mathematical analysis, financial concepts and principles, the models of forest biometrics and norms, grounded on the method of deduction from our and foreign legislative norms in forestry.

The used methodology is appropriate. The obtained results support its adequacy.

6. Significance of the achieved results, interpretations and conclusions

The justified achievements of the dissertation are presented in part IV "Results". It consists of 16 sections, in which the set research tasks are consistently solved. On this basis, the achieved results can be systematized in four groups: methodological; related with land valuation; related with valuation of forest stands; related with damage valuation in forestry.

The general methodological results are achieved in the first, second and eleventh sections. *The first one* focuses on the classical theory of evaluation. Faustmann's formula for the value of land, the formula for the value of stand, the so-called expectation value and the costs value are derived. The *second section* "Positive Theory of Income Value" presents modifications of Faustmann's formula by Künkele, Ostwald, and von Spiegel. Spiegel's formula is financially justified. It is derived from the theory of income value when forestry is financed through stumpage prices and fund for silvicultural activities. It is proven that Faustmann's formula is valid for high income forestry in which soil rent $r > 0$ is the criterion defining the boundaries of intensive plantation. In *the eleventh section* in order to treat some borderline cases - the so-called forest fruit plantations on the basis of the theory of income value formulas for evaluation of agricultural permanent crops are derived. It is proven that the Ordinance of the basic market prices of permanent crops has not been methodically sound and due to this some corrections are proposed.

Results related with valuation of land are obtained in the third, fourth, fifth, sixth and seventh sections. The *third section* "Practical valuation of forest land" presents two approaches to land valuation. The first one is based on the felling value of the timber on root in the cutting age, and the second one on the value of the growth. It is interest free and is achieved from Faustmann's formula based on the supposition that the discount rate is inversely proportional to the cutting age. In the *fourth section* "Potential construction site" the formula of the discounted probability is proven. On this basis some simple formulas are proposed through them the first versions of attachments №3 and №22 of the Ordinance are calculated. The discounted probability formula is used by the candidate to justify Weimann's formula. The advantages of the last one are that it is market result, which does not depend on the suppositions for probabilities and interest rates. In the *fifth section* the attention is focused on the market valuation of forest land. It is stated that the difficulties with it are due to the fact that the purchases and sales of forest properties are rare and in most cases are incomparable with the valuated property. In this regard, some "equivalence" methods are briefly presented, which derive the value of forest land from the value of agricultural land taking into account the differences in the two subsectors.

For Bulgarian conditions the application of the Hessen method of Prof. Weimann is substantiated. The method is derived from the theory of income value and is characterized with the imperfection that it is unusable in lands with low market prices. Because of that it gives negative values. This drawback demands the borders of methods scope of application to be studied and combined method by which the identified shortcoming is overcome to be proposed. In *sections six and seven* are discussed two quick and practical methods for forest properties valuation. In first method the price of the forest property is determined by the difference between the average local price of the regulated land properties and the necessary costs for converting the property into construction site. At the same time the second one proposes and justifies an approach for determining the market value of construction sites on the basis of buildings market prices as they are bought and sold more often than undeveloped places. The method aims to assist forest property appraisers in cases when local data about the sales of land are missing.

Results related with valuation of forest stands are obtained in the eighth, ninth, tenth and twelfth sections. In *eighth section* the efforts are focused on substantiation of Blume's formula for valuation of forest stands and deriving the tables necessary for its use. On the basis of Blume's formula in *the ninth section* "Accuracy of valuation" is proven that precise valuation is reasonable when the forest stand is under 5 years and when it is over 60-70 years. In *the tenth section* the financial and forest stocking rate are analyzed. The formula expressing the dependence between them is derived and it is established that they differ significantly only in thin forest stands whose age is far away from cutting age. In *twelfth section* are presented the developed in co-authorship monetary growth tables, monetary volume and assortment tables. The first ones give the expectation value by tree species, ages and production. The second ones give the cutting value as a function of diameter and other parameters while the third ones give the value of separate assortment. The developed tables are suitable and inexpensive instruments for valuation when high accuracy is not required.

Results related with damage valuation in forestry are solved in sections thirteen and fourteen. In *section thirteen* by means of scenario formula is derived formula for monetary valuation of randomly taken tree. In *section fourteen* based on the expectation value formula is proposed formula method for forest damage valuation, which allows the development of applied software and the adaptation of internationally recognized methods toward our conditions. Due to the fact that the valuation of forests is derived from other values in *section fifteen* are studied issues about data from state forest territories for timber prices, the amount of extraction costs and afforestation costs. It is concluded that due to the absence of prices bulletin the valuation activity in our country is unnecessarily complicated.

The drawn up conclusions are results from solved research tasks and confirm the research thesis defined in the introduction. They are a good basis for improving the current regulatory framework for

forest valuation in the Republic of Bulgaria.

7. Contributions in the dissertation

In the dissertation there are enough evidences for scientific and methodological contributions, applied contributions and implementations. The most significant of them might be presented as follows:

➢ Scientific and methodological contributions

- In an accessible way abstracting from the specifics of the respective immovable property, the formulas of the classical theory for valuation of any real estate are derived. Subsequently, after replacement, the specific formulas for valuation of forests, agricultural properties or other immovable property are obtained. This way of deriving allows to reveal both the general logic of the real estates and the differences between them.

- An adaptation of the classical theory to the practice of self-financing of forestry through stumpage prices and LKM (sylvicultural activities) fund is proposed. On this basis the empirical formula of v. Spiegel for land valuation is proven.

- The formula of the discounted probability, which is applied for valuation of potential construction terrain is proven.

- The Weimann's method is theoretically substantiated and its scope of application is clarified – lands with a high level of land prices. The limited use of the method is overcome by proposing the so-called combined method.

- Formulas for determining the market value of the land of the valuated forest property are derived on the basis of the average local price of the regulated land properties and the requirements of the current ordinance for appraisal of land properties in the forest territories.

- A formula for determining the market value of construction sites is derived on the basis of building market prices.

- Through Blume's formula the error of valuation is studied and recommendations about the accuracy of the measurements are done.

- Formula, which presents the functional dependence between the financial and stocking rate of forest stand is derived. Furthermore the applicability of the German tables for financial stocking rate in Bulgaria is proven.

- Formula about the monetary value of separate tree is derived.

• Method based on formulas for valuation of forest damages is proposed. The method can be applied by using monetary tables.

➢ **Applied contributions**

- The normative base of the Ordinance for valuation is developed: prices used in the valuation; age factors required to apply Blume's formula; monetary growth and assortment tables.

➢ **Implementation**

- Ordinance for valuation of forests in the Republic of Bulgaria from 1999 to 2003.
- Software for valuation of forests.
- Software concerning the reports in forestry.

8. Critical remark and recommendations

- Significant critical remarks towards the dissertation are not found, except some recommendations with technical nature, which I suppose will improve the quality of the research: first, it is not necessary to explain through examples the nature of discounting, prolongation, compound interest, some traditional methods for assessing the financial efficiency of the investments (NPV, IRR, PBP, etc.) as well as the method for risk assessment (scenario analysis); second, some of the structural parts and sections have the same names, which creates difficulties for the reader; third, it would be good the used formulas to be numbered.
- How objectively the average prices of timber and harvesting costs, that are issued as applications towards the Ordinance and updated with its changes (1999, 2001, 2003, 2011), reflect the market relations in forestry in the different regions of the the country?
- I will recommend to the candidate in his future researches to focus his efforts on developing and adapting methods for valuation of forest ecosystem services.

9. Evaluation of the quality of scientific publications

The candidate has presented 12 publications on the topic of the dissertation, of which 3 reports and 9 articles. The papers have been presented at national and international scientific cönferences and have been published in collections of papers. The articles are published by reputable publishers indexed in international databases. The above provides a public presentation of research results in the scientific literature and in relevant scientific forums. Additionally Assoc.

Prof. Dr. Ivailo Markoff has presented 14 publications related to the issues discussed in the dissertation. There are established 34 citations in peer-reviewed journals. The specific requirements of the Forest Research Institute at the Bulgarian Academy of Sciences for the award of the scientific degree "Doctor of Science" are met and even exceeded twice.

10. Personal contribution of the candidate

The contribution of the candidate is indisputable and is proven by the applied methodology and the achieved results. Moreover it is confirmed by the 12 publications towards the dissertation, one of which is independent, and in nine of them Assoc. Prof. Dr. Ivailo Markoff is the first author.

11. Estimation of the paper on the dissertation

The paper on the dissertation is 52 pages. It is structurally sound and correctly reflects the logic and sequence of the dissertation.

CONCLUSION:

Based on the different research methods learned and applied by the candidate, the correctly performed experiments, the summaries and conclusions made, I believe that the presented dissertation meets the requirements of the Law for development of the academic staff in the Republic of Bulgaria and the Regulation of conditions and order for acquiring scientific degrees and for holding academic positions in the Bulgarian Academy of Sciences, which gives me reason to evaluate it **POSITIVELY**.

I allow myself to propose to the esteemed Scientific Jury to vote positively and to award Assoc. Prof. Dr. Ivailo Ivanov Markoff the scientific degree "Doctor of Science" in the field of higher education 6. Agricultural Sciences and Veterinary Medicine, professional field 6.5. Forestry, scientific specialty "Forest Management Planning and Forest Inventory".

February, 2021

REVIEWER:

(Assoc. Prof. Dr. Konstantin Kolev)