УДК / UDC 630
УДК / UDC 635.9
УДК / UDC 674

ISSN 0585-9069

ШУМАРСКИ ПРЕГЛЕД
FOREST REVIEW

МЕЃУНАРОДНО НАУЧНО СПИСАНИЕ
INTERNATIONAL SCIENTIFIC JOURNAL

FACULTY of FORESTRY
1947 - 2012

Шум. преглед (Šum. pregled) Год. 43 Стр. 1-76 Скопје, 2012
For. review Vol. 43 Pag. 1-76 Skopje, 2012

УНИВЕРЗИТЕТ „Св. КИРИЛ И МЕТОДИЈ“ ВО СКОПЈЕ
Ss. CYRIL AND METHODIUS UNIVERSITY IN SKOPJE
ШУМАРСКИ ФАКУЛТЕТ ВО СКОПЈЕ
FACULTY OF FORESTRY IN SKOPJE

ISSN 0585-9069

УДК / UDC 630
УДК / UDC 635.9
УДК / UDC 674

ШУМАРСКИ ПРЕГЛЕД

FOREST REVIEW

МЕЃУНАРОДНО НАУЧНО СПИСАНИЕ
INTERNATIONAL SCIENTIFIC JOURNAL

FACULTY of FORESTRY
1947 - 2012

Шум. преглед (Šum. pregled)	Год. 43	Стр. 1-76	Скопје, 2012
For. review	Vol. 43	Pag. 1-76	Skopje, 2012

ШУМАРСКИ ПРЕГЛЕД
Меѓународно научно списание
Год. 43 / Стр. 1-76
Скопје, 2012

FOREST REVIEW
International Scientific Journal
Vol. 43 / Pag. 1-76
Skopje, 2012

ISSN 0585-9069
УДК 630
УДК 635.9
УДК 674

ISSN 0585-9069
UDC 630
UDC 635.9
UDC 674

Издавач
Универзитет „Св. Кирил и Матодиј“ во Скопје
Шумарски факултет во Скопје
Декан
Д-р Александар Трендафилов

Publisher
Ss. Cyril and Methodius University in Skopje
Faculty of Forestry in Skopje
Dean
Aleksandar Trendafilov PhD

Главен и одговорен уредник
Д-р Љупчо Несторовски

Editor in chief
Ljupčo Nestorovski PhD

Уредувачки одбор
Д-р Марилена Иџојтиќ (Загреб, Хрватска)
Д-р Милосав Анѓелиќ (Подгорица, Црна Гора)
Д-р Милорад Даниловиќ (Белград, Србија)
Д-р Роберт Брус (Љубљана, Словенија)
Д-р Ирена Папазова Анакиева (Скопје, Македонија)
Д-р Чиприан Палагиану (Сучава, Романија)
М-р Бојан Симовски (Скопје, Македонија)

Editorial board
Marilena Idžojtić PhD (Zagreb, Croatia)
Milosav Anđelić PhD (Podgorica, Montenegro)
Milorad Danilović PhD (Belgrade, Serbia)
Robert Brus PhD (Ljubljana, Slovenia)
Irena Papazova Anakieva PhD (Skopje, Macedonia)
Ciprian Palaghianu PhD (Suceava, Romania)
Bojan Simovski MSc (Skopje, Macedonia)

Технички уредник
М-р Бојан Симовски
Д-р Чиприан Палагиану

Technical editor
Bojan Simovski MSc
Ciprian Palaghianu PhD

Корица и насловна фотографија
М-р Бојан Симовски, *Quercus cerris*

Cover page and photography
Bojan Simovski MSc, *Quercus cerris*

Тираж: 500

Copies: 500

Излегува еднаш годишно

Published once a year

Печати
Печатница Европа 92, Кочани

Printed by
Print House Evropa 92, Kočani

Адреса на издавачот
УКиМ Шумарски факултет во Скопје
Редакција на Шумарски преглед
Бул. Александар Македонски бб
(П. фах 235)
1000 Скопје
Република Македонија
Е-пошта: sumpregled@sf.ukim.edu.mk
www.sf.ukim.edu.mk

Publisher's address
UKiM Faculty of Forestry in Skopje
Editorial Board of the Forest Review
Bul. Aleksandar Makedonski bb
(P.O. box 235)
MK-1000 Skopje
Republic of Macedonia
E-mail: sumpregled@sf.ukim.edu.mk
www.sf.ukim.edu.mk

ШУМАРСКИ ПРЕГЛЕД
Меѓународно научно списание
Год. 43 / Стр. 1-76
Скопје, 2012

FOREST REVIEW
International Scientific Journal
Vol. 43 / Pag. 1-76
Skopje, 2012

ISSN 0585-9069
УДК 630
УДК 635.9
УДК 674

ISSN 0585-9069
UDC 630
UDC 635.9
UDC 674

Адреса на издавачот
УКиМ Шумарски факултет во Скопје
Редакција на Шумарски преглед
Бул. Александар Македонски бб
(П. фах 235)
1000 Скопје
Република Македонија
Е-пошта: sumpregled@sf.ukim.edu.mk
www.sf.ukim.edu.mk

Publisher's address
UKiM Faculty of Forestry in Skopje
Editorial Board of the Forest Review
Bul. Aleksandar Makedonski bb
(P.O. box 235)
MK-1000 Skopje
Republic of Macedonia
E-mail: sumpregled@sf.ukim.edu.mk
www.sf.ukim.edu.mk

For. review 43: 1 - 76. Skopje, 2012 ISSN: 0585-9069
Ss. Cyril and Methodius University in Skopje
Faculty of Forestry in Skopje

CONTENTS

For. review 43: 1 - 76. Skopje, 2012
Ss. Cyril and Methodius University in Skopje
Faculty of Forestry in Skopje
ISSN: 0585-9069

For. review 43: 1 - 76. Skopje, 2012
Ss. Cyril and Methodius University in Skopje
Faculty of Forestry in Skopje

ISSN: 0585-9069

FOREWORD

Dear Colleagues and Friends,

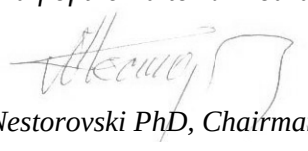
It is a great pleasure to announce the publication of the 43rd Scientific Journal Forest Review. Past 42 issues of the Forest Review were mostly reserved for publishing forestry scientific papers from researches from Republic of Macedonia, and on Macedonian language. Beginning with this number, the journal is becoming international, with international Editorial and Scientific bodies. Nearly sixty years of tradition publishing the scientific work in the Forestry area of the State and Regional researches, gave us the right to go step forward and become international forestry journal.

This year, we have collected 16 papers, from 6 different countries, and we hope that the next edition will be even more diverse. Papers treat different forestry issues, and are peer-reviewed by the significant forestry authorities from even more countries.

We hope that Forest Review will fill the area of several scientific journals in this field, and it will be an opportunity for the researchers to publish their scientific papers in the future, as well as to become a leading scientific journal in the field of Forestry in the region.

Great thanks to all authors, members of the Editorial and Scientific boards, as well as to all peer – reviewers for the great effort and support.

On behalf of the Editorial Board,



Prof. Ljupčo Nestorovski PhD, Chairman

For. review 43: 1 - 76. Skopje, 2012
Ss. Cyril and Methodius University in Skopje
Faculty of Forestry in Skopje

ISSN: 0585-9069

For. review 43: 1 - 6. Skopje, 2012

ISSN: 0585-9069
UDC: 630*9(497.16)
Original scientific paper
Paper submission: May, 2012

MONTENEGRO FORESTRY SECTOR IN TRANSITION

ANĐELIĆ M.
Ministry of Agriculture and Rural Development, Podgorica, Montenegro
Correspondig author e-mail address: milosav.andjelic@mpr.gov.me

ABSTRACT: This paper presents the results we have come to on the basis of five-year' work in legislative and new organizational structure of the forestry sector in Montenegro. The ultimate goal of this activity is to provide for permanent conservation and improvement of existing areas under forests and forest land as well as their functions within the defined frameworks. The principal prerequisites for this are: implementation of measures of prevention and monitoring of forests, their sustainable multi-functional utilization with substantial and more intense implementation of silvicultural works, conservation and improvement of biological and landscape diversity of forests and their environmental quality.
Keywords: Forestry in transition, permanent conservation and improvement of forests, sustainable multi-functional utilization.

1 INTRODUCTION

Total area of Montenegro covers 1.381.200 ha, and according to the first National Forest Inventory, forests and forest land cover 832.900 *ha* or 59.9% of the territory. Other categories (urban areas, water bodies, agricultural land plots, barren land, etc.), which are not forests and forest land, occupy 135.800 *ha* or 9.8%, which together make up for 968.700 *ha*[1] *or* 69.7% of the territory.

State forests and forest land cover 436,641 ha or 52.6 %, while private forests and forest land cover 393,839 ha or 47.6% of the territory. Total stock in forests of Montenegro is estimated at around 117,433 million m^3, of which 31,478 million m^3 in private forests and 85,954 million m^3 in state forests. In total volume, hardwood accounts for 59.8% and conifer trees account for 40.2%. Conifer forests have a special role in terms of their multipurpose functions.

Forests and forestry provide a very important contribution to our society and economy given that around 60% of population is linked to villages and rural areas rich in forests.

According to the relevant data of the National Forest Inventory, ecological, social and economic values of the Montenegrin forests, including their diversity and impact on the environment, taking into account the areas damaged in the past, places the forests of Montenegro amongst the finest forests in Europe. If we take into account the number of inhabitants, the forest coverage is 1.3 ha / capita, and that places Montenegro in the group of European countries with the largest forest cover, together with Scandinavian countries.

If we take into account that the world's forest cover is 30%, and 46% of European (TBFRA, 2000) then by forests Montenegro (59.9%) is in third place, just behind Finland (86%) -4.5 ha / capita and Sweden (67%), and ahead of Slovenia, which has the forest coverage of 58% (0.6 ha / capita), Croatia 37% (0.47 ha / capita), Serbia 29.1% (0.3 ha / capita), Bosnia and Herzegovina 41%, Spain 30%, Austria 38%.

The ratio between state and private forests in some European countries is the following: Austria 17.5%: 82.5%, Bosnia and Herzegovina 78.4%: 21.6%, 75.5% English: 24.5% Czech 84.1%: 15.9%, France 26.2%: 73.8%, 94.6% Romania: 5.4%, Slovenia 30.0%: 70.0%, 28.9% Finland: 71.1% (TBFRA, 2000).

Since forests are resources of general / public interest, it is in the national interest to legally regulate conditions for improvement of the current status of these forests to ensure a balance between protection, ecological, social and economic functions of forests, and to ensure sustainability. On the other hand, Article 1 of the Constitution prescribes that, inter alia, Montenegro is ecological state, which relies on its official Declaration of Ecological State adopted back in 1991 (Declaration of Ecological State of Montenegro).

Montenegro changed its forestry legislation three times in the last twenty years (1990, 2000 and 2010). Having regained state independence, the Government of Montenegro committed further to reforming forestry sector and, for the first time in its history, adopted the National Forest Policy in 2008. The National Forest and Forest Land Policy is actually only the first step in the process of implementing the National Forest Programme of Montenegro, and the basis for this is created by institutional reform defined by the 2000 Forest Law, successfully implemented 2003 Programme for Rebuilding of Forestry and Wood Processing and restitution process which is still ongoing. Based on these reforms, privatization of forestry and wood-processing enterprises was launched and created conditions for starting a new cycle of investments, which should result in stronger competitiveness of timber products from Montenegro at regional and European markets. Institutional reform created Forest Administration as a public forest service, which is undergoing a training process for fulfilling public interest in forests and forestry.

Although the 2000 Law established a clear distinction between administrative and operational functions in forestry, this act has had the Forest Administration face many limitations, given that regulating relations in forestry was not based on market principles. On the other hand, multipurpose forests, relation between state and private ownership was not balanced, and bureaucratic barriers posed limitations before the Forest Administration in developing the sector. For this reason, there was an objective need for some of its provisions to be improved and harmonized with new goals of forest and forestry development, including:

- clearer definition of forest functions and principles of sustainable forest management,

[1] The results of the National Forest Inventory Montenegro - Summary

 ISSN: 0585-9069

- a new improved management planning system in forestry, which ensures a more transparent procedure in developing planning documents,
- a clearer definition of provisions related to forest exploitation and more transparent methods of selling timber, which should leave sufficient flexibility to public services for more comprehensive and multipurpose benefits of forest functions,
- establishment of more flexible provisions related to tree markation and the use of available allowable cut at annual level,
- removing barriers related to dispatching wood assortments from private and state forests,
- building competitiveness in the sector,
- public support to associations of private forest owners and their engagement in decision-making process,
- establishing protected areas in forests within ecological network NATURA 2000 where forest management will be in line with goals of protection and conservation of such areas, i.e. their habitat types,
- incentive policy which is achieved by implementing measures in line with the European Union policy for rural development,
- monitoring of all processes in forests and coordination through National Council and local Forest Councils.

The establishment of these mechanisms will provide for better forest management, higher investments and creating employment opportunities in forestry, improving financial operations of both private and public institutions, better ecological protection and improved management of protected areas and higher benefits for civil society.

Towards the new Forest Law of 2010, within a process of harmonization of legislation with the EU, a number of other regulations have been adopted and they impact regulation of relations in forestry sector such as: Law on Strategic Environmental Impact Assessment (2005); Law on Spatial Planning (2005); Law on Forest Reproductive Material (2006); Law on Agricultural Land (2006); Law on Environmental Protection (2008); Law on Game and Hunting (2008); Spatial Plan of Montenegro until 2020; Law on Waters (2007); Law on Agriculture and Rural Development (2009); Law on National Parks (2009); Law on State Property (2009); Law on Property and Legal Relations (2009); Law on Financing of Local Government (2008); National Strategy of Sustainable Development (2007); National Forest and Forest Land Administration Policy (2008); Concession Law (2009).

Within the process of reform of forestry sector, special attention is paid to matters related to improved permanent forest management as defined by Helsinki Resolution H1 and to contributing to sustainable development (Ministerial Conference on the Protection of Forests in Europe, Vienna Resolution 1). In the context of these initiatives, Montenegro committed to implementing the following activities through the process of National Forest Programme and in line with the National Forest and Forest Land Administration Policy:
- develop National Forest Policy,
- develop forestry and hunting legislation,
- develop programmes for development of forestry sector (strategy and budget),
- frequent participatory monitoring (monitoring) of the programme implementation,
- reform state institutions and services in forestry sector,
- build human capacities at all levels,
- support establishment of sustainable private sector in forestry.

The main principles of existing National Forest Programmes in Europe (participation; inter-sectoral approach; frequent process with long-term obligations; capacity building; consistence with national legislation and policy; integration with national strategies of sustainable development; compliance with international commitments, having in mind common actions of international initiatives and conventions related to forests; institutional and political reform; ecosystem approach; partnership in implementation and raising awareness) are directly integrated in new Forest Law, which certainly is a step ahead in integrating the best European practices in forestry.

With all the above reasons in mind, we think that adopting of the new Forest Law of 2010 and its efficient enforcement will speed up the whole reform of the sector which made significant steps in the previous period as well, which ultimately resulted in a positive trend in almost all activities, starting from: reducing illegal logging, better planning, revitalizing seed and nursery production, developed network of protected areas in forests, equal treatment of forest owners, established mechanisms of coherent control in the process of decision-making, more efficient and more competitive economic entities in both forestry and wood-processing, which resulted in substantially higher financial effects compared to the previous period and provided new employment and training opportunities.

2 FOREST POLICY, LEGISLATION AND INSTITUTIONALISATION OF GOVERNANCE

As a part of recent reforms, and in the view of the EU integrations, the forestry sector of Montenegro has started addressing matters that are crucial for good governance in modern forestry, such as transparency, accountability, rule of law etc. The Ministry of Agriculture, Forestry and Water Management, now the Ministry of Agriculture and Rural Development, recognized how important it was to develop strategic documents, and thus started implementing a systematic top-down approach to forestry development.

1. Forest Policy in Montenegro is a document which was passed/adopted in 2008. As a contribution to meeting the goals and priorities of the National Strategy of Sustainable Development, the document of the National Forest Policy prioritizes five general goals: Ensure and improve long-term resistance and productivity of forests and other ecosystems, and maintain plant and animals species;
2. Management of forests and forest resources ensures sustainable implementation of social, economic and ecological forest functions;
3. Forests contribute to sustainable social and economic development of rural areas;
4. Ensure long-term development and competitiveness of wood industry;

5. Long-term development of forest profession and effectiveness of forestry.

It contains 35 statements, with a list of tasks under each statement. This umbrella document covers issues ranging from the quality status and needs, through social and economic development of the society in the field of forestry and related sectors, together with a vision of a modern and competitive forestry sector. The Forest Policy document is especially valuable given that it was not prepared in the office, it does not assume simple adoption of expert thoughts and experiences from abroad, but is based on the work of seven Working Groups with 49 members representing different organizations, 14 local and international consultants, a number of workshops, preliminary public hearings. It was reviewed twice by the Government Commissions before the Government adopted its Draft, and this was followed by a broad public hearing. Forest Policy fits the framework defined by the following documents: Strategy of Sustainable Development, Strategy of Poverty Reduction, Strategy of Balanced Regional Development, Economic Policy, and National Programme of European Integrations. These documents result from one another, they are complementary and conditional. The National Forest and Forest Land Administration Policy will be implemented through the National Forest Strategy, which along with this Policy relies on recommendations of the Ministerial Conference on the Protection of European Forests in relation to National Forest Programmes. The Strategy defines short-term, mid-term and long-term objectives and programmes for areas of work and regions, addresses critical prioritized issues, defines multi-year budgetary programme and lays the foundation for detailed annual work plans and budgets. Forest Strategy is a document which is missing at the moment, but it will be drafted under ongoing IPA project.

- Special attention is given to the new Forest Law, the relation between state and private ownership which was not balanced, and bureaucratic barriers were a limiting factor for the Forest Administration in developing the sector. For this reason, there was an objective need for some of its provisions to be improved and harmonized with new goals of forest and forestry development, including: clearer definition of forest functions and principles of sustainable forest management,
- a new improved management planning system in forestry, which ensures a more transparent procedure in developing planning documents,
- a clearer definition of provisions related to forest exploitation and more transparent methods of selling timber, which should leave sufficient flexibility to public services for more comprehensive and multipurpose benefits of forest functions,
- establishment of more flexible provisions related to tree markation and the use of available allowable cut at annual level,
- removing barriers related to dispatching wood assortments from private and state forests, according to the Regulation (EC) No. 995/2010 of the European Parliament and the Council of 20 October 2010 laying down the obligations of operators who place timber and timber products on the market,
- building competitiveness in the sector,
- public support to associations of private forest owners and their engagement in decision-making process,
- establishing protected areas in forests within ecological network NATURA 2000 where forest management will be in line with goals of protection and conservation of such areas, i.e. their habitat types,
- incentive policy which is achieved by implementing measures in line with the European Union policy for rural development,
- comprehensive monitoring of all processes in forests.

The establishment of these mechanisms provided for better forest management, higher investments and creating employment opportunities in forestry, improving financial operations of both private and public institutions, better ecological protection and improved management of protected areas and higher benefits for civil society. The main principles of existing National Forest Programmes in Europe (participation; inter-sectoral approach; frequent process with long-term obligations; capacity building; consistence with national legislation and policy; integration with national strategies of sustainable development; compliance with international commitments, having in mind common actions of international initiatives and conventions related to forests; institutional and political reform; ecosystem approach; partnership in implementation and raising awareness) are directly integrated or their concept is clearly presented in the Forest Law, which certainly is a step ahead in integrating the best European practices in forestry. It is the Law which was passed with participation of broad forest audience, within the process which involved local and international experts.

The process of drafting and passing of several by-laws, in the light of the new Law is under way. At this particular moment, when the theoretical vision becomes practical guideline, it is necessary for concrete steps and activities to be defined as simply as possible. That is why the implementation of the Improved Methodology of Forest Management Planning, as a base for most of the forestry related activities that require a lot of efforts, especially considering new approaches in planning documentation development and also in practical / technical sense. Adopting new planning methodology should contribute to more transparent and more responsible forest management, which will be based on principles of sustainable forest management in compliance with ecological, economic and social forest functions.

"Old school" foresters need to refresh their knowledge of participatory techniques and skills needed to work with new devices (GPS, GIS, new methodology planning, Natura sites management, extension service, etc...), and this process is ongoing. Forest Management Planning in Montenegro is performed at several levels. Forest Development Plan implies planning at a level of a municipality, and its development and adoption involves public participation, which was not the case before. Forest Development Plan is enacted by the Government for the period of 10 years, based on previously obtained opinion of the state administrative authority competent for environmental protection and tourism and local self-government unit whose area is covered by the respective

ISSN: 0585-9069

plan. A particularly important provision, which complies with the principle of participation of professional and wider audience in the process of adopting of planning documents, was addressed through participation of stakeholders in drafting and adopting of plans, based on the relevant EU Directive and Regulation, which proved to be very good in adopting of the National Forest Policy in 2008. In relation to this, private forest owners, stakeholders and wider public have the right to participate in the process of preparation and adopting of all planning documents in forestry, which they consider to be of interest to them. The procedure for participation of stakeholders in preparing and adopting development plans and Forest Management Plans are further elaborated (starting from the drafting, implementation of public hearings and a method of their adoption) and deadlines for giving opinion about forest development plans and forest management plans as well. It is defined that prior to defining opinions on submitted objections, proposals and suggestions to the proposed plan, a competent administrative authority is obliged to obtain opinion from the National or Local Forest Council about a Forest Development Plan and a Forest Management Plan. The Law on Local Government does not define municipal responsibility for forests and forestry, but generally prescribes that municipalities are responsible for environment protection, municipal services and spatial planning. The Law on Public Administration also prescribes that certain functions of the state administration, for the purpose of their more efficient and more economic implementation, are legally decentralized to local government, i.e. entrusted to the local government, institutions and legal entities. According to the Law on Local Government, municipalities receive 70% of fees paid for exploitation of forests on their territory. These funds are considered to be a share in natural resources benefits and the support to building and maintenance of local infrastructure in forest areas. The communication between state institutions and the wider public should go both ways, should be open and with clearly defined communication channels for some of the target groups. Better mutual understanding and cooperation between all partners in forestry (Government, NGO, private sector, interested international organisations) are achieved through training programmes for all stakeholders and by regular open forums aimed at exchanging information between partners in the forestry sector. Next level in FMP is Forest Management Plan, which is adopted for the period of 10 years, and prior to its adoption, it is required to obtain opinion of the Agency for Environmental Protection, at the same time containing the guidelines required by the Natura 2000 network. This level also requires cooperation with the Ministry of Tourism and Environment, which is responsible for nature protection, including, establishment of Natura 2000 network, environment protection and tourism development in Montenegro. Operational programs, as a bottom planning level, are adopted yearly and they include intensive communication with private forest owners and their associations.

3 TRANSFER OF KNOWLEDGE BETWEEN EU COUNTRIES AND MONTENEGRO, THROUGH DIFFERENT FUNDS

With the EU membership in view, Montenegro could benefit from regional cooperation with other Balkan countries, especially with member states and other candidate countries. The lessons learned and exchange of experiences in forestry development in these countries could be useful for development of the forestry sector in Montenegro. Improved regional and international cooperation in forestry, especially in education, research and training is considered to be an important instrument for achieving strategic goals in forestry sector. The matter of forest education and training is addressed in a way that competent administrative authority and users of state forests are obliged to create conditions for professional development of employees (courses, exchange, etc.) in silviculture, protection, exploitation of forests in compliance with appropriate plans, which are adopted by a competent administrative authority and users, in cooperation with various stakeholders. Limited and focused partnership, rather than a comprehensive general programmes, are ensuring a successful academic partnership. In Montenegro there are several active international projects/organization in the field of forestry, which are contributing to the development of Forestry. FODEMO Project (Forestry Development in Montenegro) is a donor project, which is establishing communication between international experts and local institutions (Ministry of Agriculture and Rural Development, Forest Administration , environmental institutions, etc.), and supporting the development of various legislation (Forest Law, Forest Policy, by-laws, etc.) and methodological papers/documents (Methodology of the National Forest Inventory, FMP Methodology). A lot of international experts and consultants have been engaged in the project implementation and they were (and still are) contributing to the development of the sector in Montenegro. Forestry forum is an event which has taken place twice (2010 and 2012) in Montenegro, and it represents a place for exchange of ideas and knowledge, and for presentation of achievements and activities over the previous year. IPA funds are also present in Montenegro, and they are used, in particular, for the development of the new Forest Information System in Montenegro, but also for the incorporation of NATURA 2000 into standard FMP documents and into practice.

4 NATIONAL FOREST INVENTORY AS A PROJECT PROVIDING SUSTAINABILITY AND FUTURE PROSPECTS

The first National Forest Inventory of the forests of Montenegro was undertaken in order to create realistic grounds for quality strategic planning in forestry. In methodological terms, this Inventory is compliant with the standards used by countries with long forestry tradition. The results of the first National Forest Inventory show substantial differences with these elements compared to previous (available) figures on forests resources of Montenegro. Forests cover 59.9% and forest land covers 9.8% (69.7% altogether) of the territory of Montenegro. Standing volume amounts to around 118 mil m^3 with current volume increment of 2.8

million m^3. The reliability and comprehensiveness of these and other results of the National Forest Inventory create realistic grounds for macro-economic planning, provide for correspondence with associations performing monitoring of forest ecosystems at regional and global levels, and place Montenegro amongst countries that have established their Forest Policy on reliable and methodologically appropriate grounds. This data will provide an establishment of the new dimension of the quality of the Forest Policy, considering the Forest Administration ct that Montenegro is among top forest covered European countries. The data will provide a base for clear definition of the contribution of Montenegrin forests to climate changes mitigation, and will provide high standards of international reporting. Also, the determination of the forest potential of Montenegro for the definition of the biomass energy, with a cooperation of the Ministry of Economy is ongoing.

5 CRITERIA FOR SUSTAINABLE FOREST MANAGEMENT

Sustainable forest management is one of major contributions which forestry as a sector can give towards the accomplishment of the defined goals of sustainable development of any country.

The UNCED, held in Rio de Janeiro in 1992, set the basic principles for sustainable forest management in terms of contribution to sustainable development. “Forest Principles” and Chapter 11 of Agenda 21, adopted at the Conference, included the commitment “to implement sustainable management and utilisation of forests in compliance with national development policies and priorities, as well as in compliance with environmentally defined national guidelines which take into consideration, as needed and if applicable, relevant internationally agreed methodologies and criteria” (Principle 8 d).

We can conclude that this Conference, i.e. the documents adopted at the Conference, vitally influenced the launch of numerous international and national initiatives for the development of criteria and indicators of sustainable forest management. International Tropical Timber Organisation (ITTO) was among the first to develop the criteria and indicators for sustainable management of natural tropical forests. Subsequently, the Centre for International Forestry Research (CIFOR), United Nations Environment Programme (UNEP), and World Conservation Union (IUCN) were significantly involved in providing technical support to the development and implementation of criteria and indicators for sustainable forest management. We particularly emphasise the importance of Ministerial Conferences on the Protection of Forests in Europe (MCPFEs), i.e. the resolutions adopted at such Conferences, which commit Montenegro both morally and politically, for the development of criteria and indicators of sustainable forest management in Europe in compliance with the mentioned UNCED principles. In this context, the most important document is the Lisbon Resolution L2 (1998), entitled “Pan-European Criteria, Indicators, and Operational Level Guidelines for Sustainable Forest Management, which presents commitments and frameworks for the development of national criteria and indicators.

It was the first case in our legislation, in compliance with the Pan-European guidelines, that the Law on Forests (Official Gazette of Montenegro 74/10) referred to the implementation of criteria and indicators of sustainable forest management. The Article 6 of the Law defines that “Forests and forest land, as ecosystem, shall be administered and managed in a sustainable and multifunctional manner in accordance with the criteria and indicators defined by the Ministry”. This results in the commitment to develop and adopt the criteria and indicators as general standards of sustainable forest management in Montenegro.

Criteria and indicators of sustainable forest management in accordance with the Law on Forests (Article 6 paragraph 5) for the needs of management, monitoring and evaluation of sustainability are adopted by the Ministry of Agriculture and Rural Development (Ministry of agriculture and rural development). These criteria and indicators determine, *inter alia*, the extent of silvicultural works (compared to the volume of cutting) which forest owners and beneficiaries are obliged to do (Article 50 paragraph 3).

The Criteria provide general guidelines, norms and manners of action, work and conduct (in forestry profession, of forest owners and beneficiaries and third persons as beneficiaries of forest functions) in the forest and toward the forest, and relate to all aspects of sustainability of forest administration and management. Therefore, these criteria represent general standards of sustainable forest administration and management and can be further linked to specific (more detailed) technical standards for specific fields.

Indicators represent quantitative and qualitative parameters which show the progress i.e. changes in accomplishment of specific criteria.

Criteria, and especially indicators, serve as overall parameters for monitoring and evaluation of forest conditions as well as the quality and sustainability of forest management.

Verification sources are documents (analyses, insights, reports, minutes, etc.) which contain evaluations of certain indicators in terms of related criteria. In addition to these documents, the main verification source will be the Report on Sustainability of Forest Administration and Management which will be developed in compliance with the related annual monitoring programme adopted by MINISTRY OF AGRICULTURE AND RURAL DEVELOPMENT (Article 47 paragraph 1 of the Law on Forests).

Essentially, the criteria and indicators of sustainable forest administration and management in Montenegro represent the framework for the future Forest and Forestry Development Strategy. This Strategy should be developed before them, so that these criteria and indicators could serve as parameters for monitoring and evaluation of implementation of this Strategy. However, since the case here is opposite, the development of this Strategy - based on the previously defined and adopted criteria and indicators which include all the necessary aspects of sustainability of forest administration and management - will be much Forest Administration facilitated.

9 INSTEAD OF A CONCLUSION

Based on all relevant Forest Administration acts, it can be stated that the New Forest Law is prepared in line with international and national principles of sustainable development and standards of modern reforms of legal

ISSN: 0585-9069

framework of forest sector, such as sustainability, multifunctionality, comprehensive and ecosystem approach, participation of stakeholders and public, service orientation of the national Forest Administration, opportunity of entrusting and privatizing state administration operations, privatization of state forest exploitation / concessions, introducing incentive policies and support to private sector, introducing innovative income of the budget for protection and improvement of forests, etc. Due to this, the New Law is comprehensive, ambitious and offers opportunities for remaining in force for a long time.

In order to have better, i.e. more efficient forest management and at the same time dedicate ourselves to nature conservation, it will be necessary to set up the transparent system which will, first of all, comply with the administrative needs and staff potentials. Challenges such as massive state administration, overlapping of competencies, impact of politics and still non-market economy in this area, as well as negative public perception regarding the forest valorisation are problems that have to be overcome by specific system measures, as soon as possible.

At the end, it should be emphasized that continuation of the forestry reforms will significantly change the ultimate results/outcomes if they are not followed by wider reform of institutions and forest resources management. Formal institutional changes in the form of new laws or organizations are not sufficient because if there are no changes in manner people behave, it is difficult to talk about getting to crucial system changes. The attempt of transferring 'the best practices' in institutional reform is significant in the research phase, but do not always meet all of our expectations. It is the Forest Administration ct they will give certain assistance understanding how and when institutions should implement reforms. But we should obligatory know that institutional arrangements that have proven successful in one country have both positive and negative effects for other countries. Good reforms take time, and it should be provided in order to implement this process without disturbances. Consequently, when speaking about changes to the system, we can say that there are no revolutions in forestry and it is unlikely that effective organizational changes will take place without previously identified and carefully considered bottle necks and appropriate schedule of system measures which must be implemented in correlation. The fact is that, despite the scope of reforms, there is no uniform "model" or methodology for reforms guaranteeing success. The solution will largely depend on the number of specific Forest Administration actors within the state that involve historical context of forest utilization but also public perception defined through traditions/customs and culture.

We should not forget that Montenegro declared itself officially as an Ecological State back in 1991 (*Article 1 of the Constitution prescribes that*, inter alia, *Montenegro is ecological state, which relies on its official Declaration of Ecological State back in 1991 (Declaration of Ecological State of Montenegro*), and it is obvious that the forest ecosystems are playing important role in the society, which is becoming more and more opened toward nature.

10 REFERENCES AND OTHER SOURCES

[1] Anđelić, M. et al. 2012. The development of the forest sector and forest policy in Montenegro in recent period. 14th International Symposium On Legal Aspects of European Forest Sustainable Development; Belarus Minsk,

[2] Anđelić, M. et al.2012. Status of forest resources of Montenegro, Congress-Role of research in sustainable development of agriculture and rural areas - Agriculture and Forestry p 23 Podgorica, Montenegro,

[3] Anđelić, M. et al.2012. Funding studies of forests and forestry Montenegro, Ministry of Agriculture and rural development, Podgorica,

[4] Anđelić, M. 2011. Forestry and Hunting Legislation in Montenegro, Ministry of Agriculture and rural development, Podgorica,

[5] Anđelić, M. et al.2012. Criteria and indicators for sustainable forest management in Montenegro, Ministry of Agriculture and rural development, Podgorica,

[6] Dees, M., anđelić, M. 2011. Metodology of the national Forest inventory of Montenegro, Podgorica,

[7] Ferlin, F. 2004. Comparison of the Central European state's forestry organisation models and numbers of forestry officers and servants with the situation in Slovenia), Study report, Slovenia Forestry Institute, Ljubljana, 79 p. (in Slovene), available at: http://www.gozdis.si/departments/silviculture/silviculture_dept.htm.

[8] Ferlin, F. 2008. Mission report to Montenegro, SNV Montenegro, Ljubljana, August 2008, 19 pp., Annex: Proposals and recommendation to development of new Forest law, 61 pp.

[9] Gerely, F. 2009. Personal communication, Podgorica, May 2009.

[10] Golob, A. 2008. Support New Forest Law Drafting and Contribution to Private Forest Information Concept Development, Brief report on the mission – Forest Law in Montenegro, SNV Montenegro, December 2008, 7 pp. with Annex 4, 14 pp.

[11] Stritih, J. 2008a. Legal and Institutional Framework in Montenegro. Forestry Development in Montenegro (FODEMO) Project – Phase II, Lux-Development, June 2008, 28 pp., Annex 2, 29 pp.

[12] Stritih, J. 2008b. Inputs for development of new Forest law in Montenegro – silviculture, forest utilisation and state forest management parts. Forestry Development in Montenegro (FODEMO) Project – Phase II, Lux-Development, December 2008, 7 pp.

For. review 43: 7 - 11. Skopje, 2012

ISSN: 0585-9069
UDC: 630*37(497.11)
Original scientific paper
Paper submission: May, 2012

OPERATING EFFICIENCY OF TIMBERJACK 1210B IN TRANSPORTING SOFT DECIDUOUS ROUNDWOOD

[1]DANILOVIĆ M., [2]ĐORĐEVIĆ Z., [3]NESTOROVSKI Lj.
[1]University of Belgrade Faculty of Forestry, Belgrade, Serbia
[2]PE Vojvodinašume, Petrovaradin, Serbia
[3]Ss. Cyril and Methodius University in Skopje, Faculty of Forestry in Skopje, Skopje, Macedonia
Correspondig author e-mail address: milorad.danilovic@sfb.bg.ac.rs

ABSTRACT: This article presents the results of a research concerning the operating efficiency of John Timberjack 1210 B forwarder in transporting soft deciduous roundwood following a clear cut conducted by John Deere 1470D ECO III. The evaluation of operating efficiency was based on 70 transport cycles. The wood was transported over the felling site, on the trail and finally by a truck road. This article also presents an analysis of the impact of ruts on the operating efficiency of the forwarder. Rut depth ranged between 17 and 40 cm.On the basis of the results of conducted data recordings, the operating efficiency was evaluated depending on the used harvesting technology.The forwarder achieved greater efficiency in comparison to the efficiency achieved when harvesting was conducted by chainsaws. Average time needed for loading the assortments in the felling site where the harvest was conducted by the John Deere 1470D ECO III harvester is shorter than the time needed for loading the assortments in the felling site where the chainsaws were used. Also, the passage time during loading and the moving time between loading and unloading stations are significantly shorter. Greater efficiency is the result of assortment grouping when the harvester is used and reduced overlapping of assortments. These results are very important for evaluating the usage of modern technologies for forestry utilization in lowland regions of Serbia.
Keywords: forwarder Timberjack 1210 B, harvester John Deere 1470D ECO III, first phase of transport, poplar, efficiency

1 INTRODUCTION

The choice of instruments of labour in the first phase of wood transport is very important from the economic, ecological and ergonomic points of view. Factors affecting the production effects of the instruments of labour in wood transport are numerous, and their importance varies depending on the operating conditions. The operating conditions of the first phase of transport in Serbian forestry significantly differ in lowland and highland areas. The operating conditions of the first phase of transport in lowland areas are characterized by a low carrying capacity of the terrain, as opposed to the hilly and mountainous areas, where the dominant factor is the slope of the terrain and its dissected relief. Instruments of labour imposed as a logical solution in lowland areas are forwarders and tractor equipages. On the other hand, the instruments of labour used in hilly and mountainous areas, depending on the forest purpose and harvestable volume and slope, are animal-drawn carts, agricultural tractors adapted for use in forest operations, as well as forwarders specialized for such operating conditions.

The effects of the instruments of labour in the first phase of wood transport are most affected by the average transport distance and the average volume of a piece, and these are the basic inputs into the norms of work in the first phase of wood transport.

The largest quantity of assortments poplar is concentrated in the forelands of major rivers passing through the province of Vojvodina. Clear cutting is applied in poplar plantations at the end of nearly twenty-year-long production cycles.

Clear cutting is highly suitable from a technological point of view, given the possibility of larger technological freedom. Under these conditions a large amount of assortments, usually over 300 m^3/ha, is concentrated on a small area. Felling and crosscutting are mostly performed using the chain saw in the 1M + 1R organizational form of work. In addition to felling and crosscutting of assortments with the chain saw, the John Deere 1470D Eco III Harvester has been in use in the FE "Sremska Mitrovica" since 2008. After felling and crosscutting of assortments using the chain saw, evenly spaced assortments remain in the felling site. Transport of these assortments is carried out by tractor equipages or forwarders, depending on the operating conditions, type of felling and transport distance. After felling and crosscutting of assortments with a harvester, overlapping of assortments is fairly reduced. This creates an opportunity for a more efficient use of the instruments of labour used in the first phase of transportation, i.e. the assortments produced remain in small piles positioned along the row that is being cut, which provides easier forwarder manipulation and reduced passing time during loading, quicker loading and faster movement of the instrument vehicles over the felling site. This was one of the reasons to investigate the production effects of forwarders in these operating conditions.

Accordingly, the goal of this paper is to investigate the effects of production of the Timberjack 1210 B forwarder following a clear-cutting with the John Deere 1470D Eco III harvester.

The production effects of a forwarder are affected by a number of factors, including: the intensity of felling, field conditions, operator skills (Lageson 1997, Karha 2003, Poršinsky 2005) and the silvicultural treatment (Eliasson, 2000, Glode and Sikstrrom, 2001, *et al.).*

2 METHOD AND RESEARCH OBJECT

This study was performed in the areas of FE "Sremska Mitrovica" , FA “Klenak” and FMU "Senajske bare-Krstac", compartment 26 (Fig. 1 and 2).

For. review 43: 7 - 11. Skopje, 2012
Ss. Cyril and Methodius University in Skopje
Faculty of Forestry in Skopje
ISSN: 0585-9069

Figure 1: Loading of assortments

Figure 2: Ruts

The recording was performed in November and December of 2009. A total of about 70 transport cycles were recorded.

The transport of wood was carried out in winter conditions. During the recording period, the weather was changeable with rainy and snowy intervals. A 5-10 cm high snow cover was formed. The average air temperature during the recording period was between 2 and 17 º C.

The soil types were III / 1 and IV/15. Ruts with a depth of 17 to 40 cm were formed during wood transport, depending on the recording period (Fig. 2). Rut depth was measured for each transport cycle at three different measurement points.

The recording was performed using photochronometry, i.e. work time study was applied. The time flow method was employed to measure the duration of the operations using a chronometer with an accuracy of up to one second.

In the course of forwarder application the following operations were recorded: *manipulation at the temporary landing, drive to uplift the load, manipulation in the felling site, loading of wood assortments, passing during loading, and return from the felling site to the unloading station*. All downtime periods during operation were recorded. The assortment landing was located on a truck road.

The number of transport cycles needed for the analysis was calculated using variation statistics. The Statistics 6.0 statistical program was used to statistically process the data, i.e. this paper employs conventional statistical and mathematical methods (regression, correlation, descriptive statistics, etc.).

3 RESEARCH RESULTS

The total volume of timber transported during the recording period was 899 m^3, i.e. the average volume of a transport cycle was 13.0 m^3. Timber transport by the Timberjack 1210 B forwarder in the studied conditions was carried out on roads that belonged to very different categories. Following transport over the felling site, the assortments were transported by a dirt road and finally by a hard (macadam) road. The unloading of assortments was performed in two piles for sorting purposes.

The average transport distance by dirt road was 492m, and the average speed at which the forwarder moved amounted to 63.5 $m \cdot min^{-1}$. The average transport distanc e over the felling site was 163m at the average speed of 42.9 $m \cdot min^{-1}$.

The duration of loading and unloading is directly dependent on the average volume of a piece and load volume $t_{ui} = f(m)$.

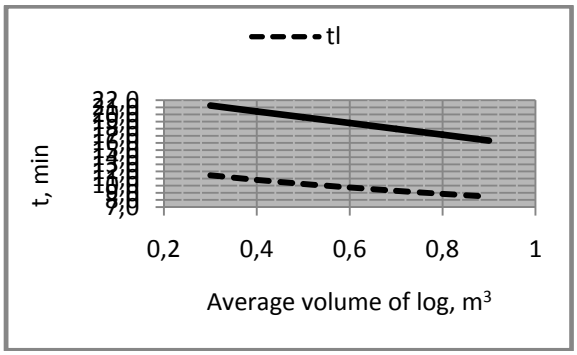


Figure 3: Correlation between loading and unloading time and the average volume of a piece

The loading time decreases with an increase in the average volume of a piece (R-0.167, p-0.164) (Fig. 3).

The correlation between the loading time and the average volume of a piece is presented by the formula $t_l = \frac{1}{0{,}072+0{,}051 \cdot m}$, and the sum of loading and unloading time by the function $t_{lu} = 23{,}7 - 8{,}17 \cdot m$.

The time of movement of a transportation means depends on the terrain characteristics, the speed of that transportation means and the transport distance $t_s = f(V,S)$.

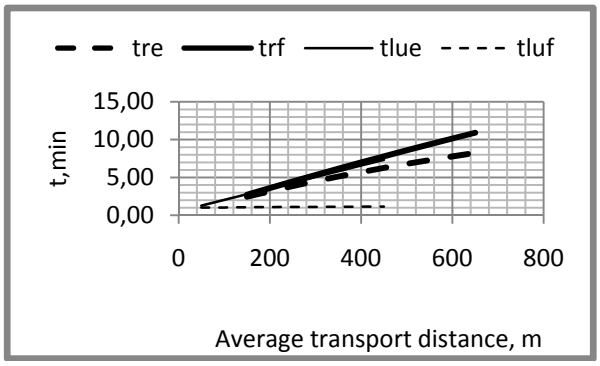


Figure 4: Correlation between forwarder movement time and average transport distance

The average movement time of a loaded transport vehicle on all categories of roads is shorter than the time achieved by an empty transport vehicle. The difference is most pronounced in the movement over the felling site (Fig. 4).

The correlation between the average time spent on the movement of an empty forwarder over the felling site and the average transport distance is represented by the linear regression equation $t_{lue} = 0,527 + 0,0151 \cdot S$, (R-0.882, p-0.000), and the full rounds, i.e. the same correlation for a loaded forwarder by the regression equation, $t_{luf} = 1,025 + 0,022 \cdot S$, (R-0.913, p-0. 000).

The correlation between the average time spent on the movement an empty forwarder on a dirt road and the average transport distance is represented by the equation $t_{re} = \frac{1}{0,035 + \frac{56,1}{S}}$, (R-0.723, p-0.000), and the full rounds, i.e. the same correlation for a loaded forwarder by the regression equation, $t_{rf} = \frac{1}{0,0093 + \frac{53,5}{S}}$, (R - 0.770, p-0. 000).

The participation of downtime in the total forwarder work time amounted to 1.5 min / round. The low percentage of downtime at work is the result of several factors, including: the skills of a forwarder driver, good organization of the field work, proper functioning of machinery, field conditions, etc. (Danilovic, 2010). The basic norms of work under the studied conditions were calculated on the basis of the performed recordings.

The basic norms are the following:

- Average speed on a dirt road (V_z) 63.5 $m \cdot min^{-1}$
- Average speed on a hard truck road (V_k) 83.3 $m \cdot min^{-1}$
- Average speed in the felling site (V_s) 42.9 $m \cdot min^{-1}$
- Manipulation time (t_m) 3.9 $min \cdot turi^{-1}$
- Loading time (t_u) 0.88 $min \cdot m^3$
- Unloading time (t_i) 72 $min \cdot m^3$
- Downtime(t_z) 1.5 $min \cdot turi^{-1}$
- Average volume of a round (Q) 13.0 $m^3 \cdot turi^{-1}$

The share of additional time that was used to calculate the work norms in this study was 18%.

In this study, the distance over the felling site was taken as the calculated transport distance. The coefficients for converting the distance on a dirt road and hard truck road into the distance over the felling site were k_z- 0.68 and k_k-0.52, respectively, and the calculated transport distance under the conditions that were the object of this research was 547.5 m.

The daily costs of operation of the Timberjack 1210 B forwarder were calculated using standard calculations, and they amounted to € 370.1·day^{-1}.

The purchase price of a forwarder is 285,000 EUR, and the amortization period is 5 years at the annual usage of 1,600 operating hours and the fuel price of 1.31 EUR·L^{-1}.

The average output achieved by the Timberjack 1210 B forwarder was 92.8 $m^3 \cdot day^{-1}$. The unit costs, which amounted to 3.99 euros • m^{-3}, were calculated on the basis of direct labor costs and actual performance.

These costs were directly correlated with the average transport distance and the average volume of a piece. Figure 5 shows the unit costs in correlation with the transport distance and the volume of a piece.

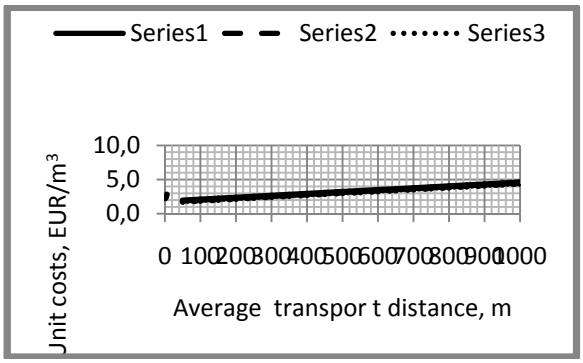


Figure 5: Correlation between unit costs, transport distance and the volume of a piece

Rut depth was measured at four points, i.e. two on the IV/15 soil type and another two on the III/1 soil type. On the III/1soil type, rut depth was measured at distances of 120 m and 300 m from the landing, while on the IV/15 soil type it was measured at distances of 220 m 435 m from the landing. The measurement was conducted in November, at the air temperatures ranging from 6 to17 º C and in December, at the air temperatures ranging from 2 to 6 º C. In addition, out of the six days in December three were characterized by a relatively light rainfall. Rut depth was measured in the same place after each forwarder pass. With the growing number of repetitions the number of cycles and rut depth increased. Maximum rut depth was 40 cm at both measurement points. This depth was measured on the III/ 1 soil type in rainy weather, after 49 cycles along the same rut, while on the IV/15 soil type the measured depth amounted to 38 cm and 35 cm, at the first and second measurement points, respectively. This interval was followed by a chilly period with a decrease in temperature. Movement of the forwarder changed, and new measurements were performed at the same distances from the landing. After 14 transport cycles, the maximum rut depth was about 34 cm on the III/1 soil type, and about 30 cm on the IV/15 soil type.

 ISSN: 0585-9069

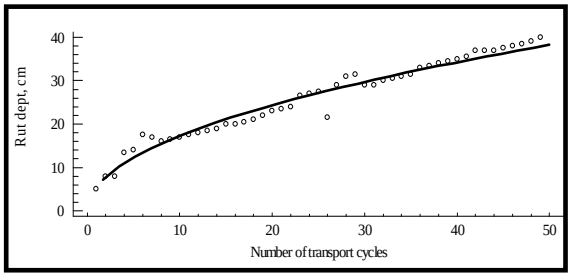


Figure 6: Correlation between rut depth and the number of transport cycles

Along with the growing number of repetitions or cycles, rut depth also increased. The correlation between the number of transport cycles and rut depth is represented by the function $D_r = 5,55 \cdot N^{0,493}$, (R-0. 981, p-0. 000) (Fig. 6).

4 DISCUSSION

The results of this study indicate that the Timberjack 1210 B forwarder achieves great outputs under the investigated conditions, and that its effects are greater than the effects achieved by this or similar forwarders realized when performing felling with the chain saw. The reason for this could be the fact that the overlapping of assortments in felling and crosscutting with the harvester was reduced, which enabled shorter duration of forwarder loading. In addition, there are fewer obstacles in the felling site, causing a lower coefficient of bypassing an obstacle, i.e. shorter transport distances. The speed of movement of empty and full forwarders over the felling site is higher than the maximum speed achieved by the same vehicles in the felling sites where felling and crosscutting were performed using the classical procedure, especially when long cordwood is not produced. In that case, the branches are scattered across the felling site which hinders forwarder movement. However, under the conditions that characterized this research, the branches were grouped in the middle of a row and they did not represent a major obstacle for the forwarder. At higher humidity these branches have a positive effect on the work of a forwarder, because they prevent the formation of large ruts. The efficiency of this instrument of labour was reflected in the high outputs that resulted from a small share of downtime, good manipulation skills, etc. Similar conclusions were obtained in previous studies of the Timberjack 1210 B and John Deere 1710D forwarders (Jezdić et al, 1995, Jezdić et al., 1999, Poršinsky 2005). Most of the paper authors point out that the key factors affecting the production effects are the transport distance, the average volume of a piece and field operating conditions. In lowland areas the chosen instruments of labour in the first phase of roundwood transport can be tractor equipages or forwarders. From the economic point of view, tractor equipages are preferable at larger transport distances. The limit distance of the cost-effective application of a forwarder instead of a tractor equipage varies widely, due to its dependence on several factors. This limit distance is significantly shorter under favourable operating conditions, than under unfavourable ones, characterized by a small carrying capacity of the terrain, large amount of shrubby vegetation, etc. (Danilovic 2010).

According to previous research the limit distance to which it is economically viable to use a forwarder is about up to 1 km, or often much less. In Serbia, the openness of forests with a network of roads is insufficient in lowland areas, which directly affects the applicability of forwarders. Hence, the presence of tractor equipages is higher. The situation is somewhat different in the FE "Sremska Mitrovica", where the average transport distance is shorter than 500 m, which imposes the application of forwarders as a logical solution. Under these conditions, it is necessary to pay special attention to the size of the chosen forwarders. It is economical to apply small forwarders for thinning, preferably without a thrust washer, and in major cuttings medium and heavy forwarders should be used (Danilovic 2010). At very difficult terrains, with low carrying capacity, it is necessary to mount half-tracks. For example, half-tracks are often used year round in Finland, regardless of field conditions (Suvinen, 2006). The advantage of half-track application is reflected in the reduction of pressure on the surface, due to the larger contact area between the tires and the ground.

Due to the low density of forest roads in the lowland areas of Serbia tractor equipage will continue to be a very important instrument of labour in roundwood transport.

The annual forwarder output under the conditions that are typical for this study is approximately 20,000 m^3, which means that the transport of technical roundwood from regular harvesting of poplar plantations that is carried out by harvesters can be performed by two forwarders. Good organization of work is necessary if that is to be achieved.

There was little difference regarding certain correlations between the effects of forwarders observed in this study and those obtained by other authors (Ghaffarian *et al.* 2007, 1999, etc. Jezdić, Danilovic, 2010), except to the extent dictated by terrain conditions.

The average speed of a forwarder in the felling site and on a soft summer road obtained in this study is slightly higher than the speed obtained in the research of transport of soft broadleaf roundwood using the Timberjack 1210 B Forwarder under similar operating conditions (Jezdić et al., 1999). Also, loading and unloading time expressed per piece is shorter than the time obtained for the Timberjack 1210 B forwarder.

5 CONCLUSIONS

The following conclusions can be reached on the basis of the analysis performed:

- Vehicle loading and unloading times are directly correlated with the average volume of a piece and the volume of load, and this correlation is linear;
- The correlation between the average time spent on empty and full forwarder movement over the felling site and the average transport distance is linear;
- The movement of forwarders over the felling site where felling was performed with a harvester is much easier compared to their movement over the felling site, where felling was performed using the chain saw, primarily due to the reduced overlapping of stems during felling;
- Full utilization of a forwarder capacity, which can be achieved by good organization of work, and hiring drivers trained for operation and maintenance of these vehicles, will increase production effects;

- The construction of forest roads will reduce the average transport distance and create conditions for an economic use of forwarders;
- In areas unprotected from floods, with pronounced depression and low carrying capacity, the forwarder is the best choice from the technical, economic and environmental points of view, and
- The correlation between the number of transport cycles and rut depth is represented by the power function model.

6 REFERENCES

[1] M. Danilović, I. Tomašević, Efekti pri privlačenju tehničkog oblog drveta mekih lišćara forvarderom VKS 904, Šumarstvo, Vol 1, (2000).
[2] M. Danilović, Transport šumskih sortimenata u ravničarskom području, Traktori i pogonske mašine Vol. 12. No. 3, (2007), str. 68-74.
[3] M. Danilović, Transport oblovine mekih lišćara forvarderom John Deere 1410 D u ravničarskim područjima, Poljoprivredna tehnika Vol 1, (2010), 99 – 111.
[4] M. R. Ghaffarian, K. Stampfer, J. Sessions, Forwarding productivity in Southern Austria, Croatian Journal of Forest engineering Vol 2, (2007), 169-175.
[5] P. Đoković, D. Jezdić, Prilog izboru transportnog sredstva za prvu fazu transporta sortimenata mekih lišćara, Toipola, (1980), 127-128.
[6] D. Jezdić, Mehanizovano iznošenje tehničke oblovine i celuloznog drveta u ravničarskim šumama, (1979), Beograd.
[7] D. Jezdić, G. Janjatović, Ž. Rukavina, Primena forvardera u transportu drvnih sortimenata, Šumarstvo Vol 1-2, (1995), 47-60.
[8] D. Jezdić, G. Janjatović, S. Mrđenović, Ispitivanje forvardera Timberjack 1210 B 6×6 u transportu drnih sortimenata, Topola, (1999), 163-164.
[9] S. Martin dos Santos, C. Machado, H. Leite, Technoeconomical analysis of the eucalyptus sxtraction with forwarder in flat terrain, revista arvore, Vicosa 19 (2), (1995), 213-363.
[10] S. Nikolić D., Jezdić, Tehničke norme i normativi u šumarstvu, (1993) pag., 240.
[11] S. Nikolić, D. Jezdić, Izbor transportnog sredstva za prevoz šumskih sortimenata u uslovima SAP Vojvodine, Topola, (1983), 137-138.
[12] T. Nordfjell, D. Athanassiadis B., Talbot, Fuel consumption in forwarders, International joutnal of forest engineering, 14(2), (2003), 11-20.
[13] T. Poršinsky, Djelotvornost i ekološka pogodnost forvardera Timberjack 1710 pri izvoženju oblovine iz nizinskih šuma Hrvatske, Doktorska disertacija, (2005), Šumarski fakultet Zagreb.
[14] S. Sever, Proizvodnost i performanse forvardera na radovima privlačenja drva, Mehanizacija šumarstva 5-6, (1988), Zagreb.
[15] A. Suvinen, M. Saarilahti, Measuring the mobility parametars of forwarders using GPS and CAN Bus Techniques, Journal of Terramechanics, 43(2), (2006),237-252.
[16] UK Forestry Commision, Terrain classification, Tecnihal Note 16/95, (1995).

For. review 43: 1 - 76. Skopje, 2012
Ss. Cyril and Methodius University in Skopje
Faculty of Forestry in Skopje

ISSN: 0585-9069

For. review 43: 12 - 14. Skopje, 2012

ISSN: 0585-9069
UDC: 662.632:674.031.632.2
Original scientific paper
Paper submission: May, 2012

ANALYSIS OF THE ASH QUANTITY DURING BEECH WOOD COMBUSTION

[1]NESTOROVSKI Lj., [2]NACEVSKI M., [1]TRAJKOV P., [1]TRAJANOV Z., [3]DANILOVIC M.
[1]Ss. Cyril and Methodius University in Skopje, Faculty of Forestry in Skopje, Skopje, Macedonia
[2]Ss. Cyril and Methodius University in Skopje, Faculty of Design and Technology of Furniture and Interior in Skopje, Skopje, Macedonia
[3]University of Belgrade Faculty of Forestry, Belgrade, Serbia
Correspondig author e-mail address: nestorovski@sf.ukim.edu.mk

ABSTRACT: The subject of investigation in this paper is the ash residue during combustion of the beech wood that is one of the most common forest species in Republic of Macedonia, and one of the most usable as fire wood in the households. The purpose of this investigation was to establish the amount of ash, as one of the biggest problems during energy production with forest biomass. The material for this investigation is collected from two different regions of the State, in order to eliminate or to emphasise the influence of the stand conditions. The results from the investigation show that during the beech wood combustion the wood is producing less ash than wood with bark, and the bark is producing highest amounts of ash.
Keywords: biomass, ash, residue, alternative energy

1 INTRODUCTION

The availability of energy is becoming a major issue, and the demand for energy is growing every day. Concerning that fact, as well as the fact that the reserves of fossil fuels, such as oil coal and natural gas are limited, the world is turning towards discovering and using alternative, environmentally friendly, and renewable energy resources.

One of these resources is biomass from forests. Wood has been used as energy source since the early days. While in Western Europe the use of firewood decreased in favour of fossil fuels, large parts of the human population in South-Eastern Europe (SEE) still depend on wood as energy source. In the wake of Kyoto Protocol the use of renewable resources for energy production has become a major issue in climate change mitigation (IPCC, 2007). Forest biomass plays a major role in the EU energy action plan (2020), as well as in most national policies in Europe. This interest in increased utilization of forest biomass resources raised questions on the potentials and limitations of forest ecosystems to produce biomass in a sustainable way. The importance of forests as a major source of global biodiversity has become well known during the recent decade. Not only as a source for utilization of wood and other non-wood products, but4 also for providing a multitude of other ecosystem services and functions.

2 OBJECTIVE OF THE INVESTIGATION

Forests contribute a substantial share of the energetic balance in Republic of Macedonia, where a significant share of the population is heating with firewood or other biomass source (75% of the heating energy is coming from firewood). The analysis of the World Bank predicts that the Balkan region is, or will be very soon, in a position where the energy availability will be restricted due to the lack of investments in the energy sector (World Bank Report, 2004) [6].

The objective of this paper is to estimate the potential residue in the form of ash, during wood combustion for energy purposes, as one of the major obstacles, and main deposition problem, and contribute to a more rational discussion about prospects and problems of forest biomass as a source of energy.

Republic of Macedonia is the south-eastern European developing country with low level of energy resources and lack of capacities for energy production. It has no natural gas and fossil fuel resources, and has limited lignite reserves. Its total annual energy production is around 122.000 TJ, and the total annual energy consumption is around 218.000 TJ. 56% of the needs are covered from domestic sources, and 44% of the needs are satisfied importing expensive energies. The main energy production is from coal (around 70.000 TJ), than from oil (around 40.000 TJ) and Forestry biomass (around 7.000 TJ).

About 85% of the electricity production is concentrated in two lignite fired thermal power plants (TPP), and the rest is covered by the hydro power plants. The system's electricity generating capacity is around 7.500 GW/year [7].

The goal of this investigation is to estimate the quantity of ash residue during wood combustion of Beech (Fagus moesiaca), from different parts of the wood, to establish if there is a difference in ash deposit between wood and bark, and emphasize the problem with its deposition or possible usage for other purposes.

3 APPROACH

Forests in Republic of Macedonia are mostly coppice, with low quality and very diverse in species. The first task was to establish two different stands of beech (Fagus moesiaca) in the Country, in order to eliminate eventual stand and ecological condition influence on the results. Samples were collected from different parts of the trees (1,3m, 5,3m, branches, bark and small branches) in order to investigate eventual differences in the ash production.

Collected samples were then brought in the laboratory, where the ash deposit in absolute dry condition was established for pure wood, mixed wood and bark and pure bark, and statistically processed.

4 RESULTS

4.1 Ash residue from Mavrovo stand

There were 34 samples taken from the beech from Mavrovo stand. On 12 of them, the ash residue was analyzed on pure wood (wood without bark), on 14 of them the ash deposit was analyzed on wood with bark (approximately as their percentile share in the wood

ISSN: 0585-9069

volume), and on 8 of them the ash residue was analyzed on pure bark. Results of the analysis show that the most ash residue is produced during the combustion of bark, and the less ash residue is produced during pure wood combustion (Figure 1).

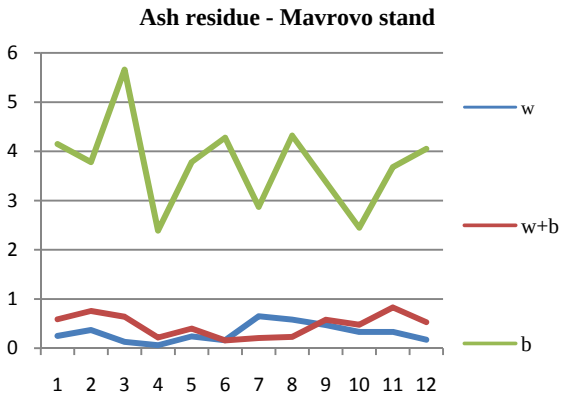


Figure 1: Ash residue from Mavrovo stand

The ash residue from pure wood from Mavrovo stand was in the outskirts between 0,06% and 0,65% of the burned volume, averaging 0,31166±0,05251, with standard deviation of 0,181901±0,03713 and variation of 0,033088±0,006754.

The ash residue from wood and bark from Mavrovo stand was in the outskirts between 0,16% and 0,76%, averaging 0,452857 ±0,056641, with standard deviation of 0,21193±0,040051, and variation of 0,044914±0,008488.

The ash residue from bark from Mavrovo stand was in the outskirts between 2,39% and 5,66%, averaging 3,90375±0,34976, with standard deviation of 0,98927±0,247318 and variation of 0,978655±0,244664.

4.2 Ash residue from Ohrid stand

There were 21 samples taken from the beech from Ohrid stand. On 8 of them, the ash residue was analyzed on pure wood (wood without bark), on 8 of them the ash deposit was analyzed on wood with bark (approximately as their percentile share in the wood volume), and on 5 of them the ash residue was analyzed on pure bark. Results of the analysis show that the most ash residue is produced during the combustion of bark, and the less ash residue is produced during pure wood combustion (Figure 2).

The ash residue from pure wood from Ohrid stand was in the outskirts between 0,04% and 0,14% of the burned volume, averaging 0,0,1025±0,010815, with standard deviation of 0,030589±0,007647 and variation of 0,000936±0,000234.

The ash residue from wood and bark from Ohrid stand was in the outskirts between 0,11% and 0,26%, averaging 0,1975±0,034161, with standard deviation of 0,096622±0,024155, and variation of 0,044914±0,008488.

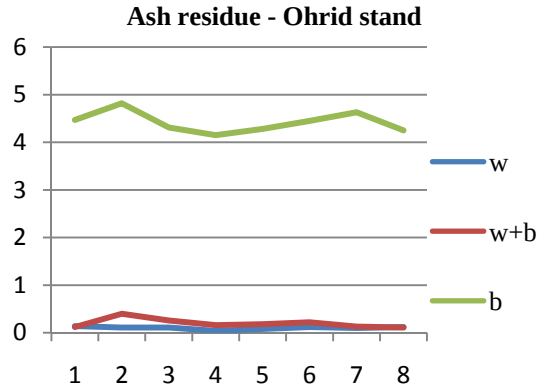


Figure 2: Ash residue from Ohrid stand

The ash residue from bark from Ohrid stand was in the outskirts between 4,15% and 4,82%, averaging 4,406±0,115352, with standard deviation of 0,257934±0,081566 and variation of 0,06653±0,021039.

The results also show that there is no significant statistical difference in ash deposition during combustion of pure wood and wood with bark in both stands and between the stands, but that there is statistically significant difference during bark combustion.

4.3 Ash residue for the beech as species

Since there were no statistically significant differences in ash deposition during combustion of beech wood between the two stands, we will present the average ash deposition for the beech as species (Figure 3).

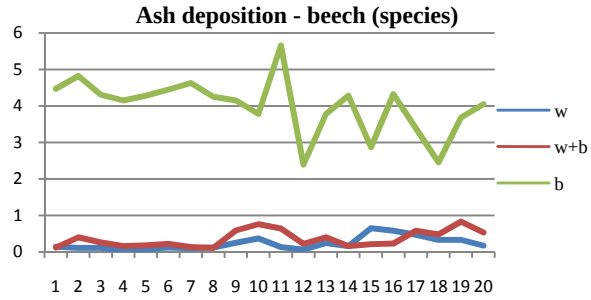


Figure 3: Ash deposition for the beech as species

The average ash residue of pure wood from both stands was in the outskirts between 0,04% and 0,65% of the burned volume, averaging 0,228±0,03909, with standard deviation of 0,1748±0,02764 and variation of 0,030055±0,004831.

The ash residue from wood and bark from both stands was in the outskirts between 0,11% and 0,76%, averaging 0,360 ±0,05461, with standard deviation of 0,2162±0,03259, and variation of 0,0467±0,0070.

The ash residue from bark from both stands was in the outskirts between 2,39% and 5,66%, averaging 4,0969±0,2249, with standard deviation of 0,8110±0,1591 and variation of 0,6577±0,1290.

As it is presented in the Figure 3, there is no significant statistical difference while burning wood or wood with bark (T=2,41413), but there is statistically

significant difference while burning only bark (T=14,886).

5 CONCLUSION

According to the results from this investigation the following conclusions can be drawn:

- There are no statistically significant differences in ash deposition during combustion of beech wood from different stands, so we can conclude that the stand conditions don't influence the amount of ash deposition;
- There are no statistically significant differences in ash deposition while burning wood with or without bark in normal natural ratio.
- There is statistically significant difference while burning only bark, and this condition gave more ash than burning wood.

6 REFERENCES

[1] Laponche, B., Jamet, B, Colombier, M., Attali, S.: Energy efficiency for a sustainable world, ICE editions, Paris,1997.
[2] van der Hem,A.B., Hoogsteen, R., Wetzels, F.J.B.: Energy and environment in Macedonian industry, PSO programme, Skopje, 2000.
[3] Lj. Nestorovski, Comparative Analysis of the energetic potential of forests as an renewable resources and the possibilities for its utilization in Republic of Macedonia, Skopje 2004
[4] F. Chiani, C. Corradi, L. Perugini, V.Rappuoli, R. Valentini, E.Angelova, Lj. Nestorvoski,: Biomass Availability in the Territory of Republic of Macedonia, 2010;
[5] Nacevski M.,Vasilevski K.: Influence of the age of annual tree ring on the amount of ash from the Black pine (*P. nigra*) wood from artificial stands, Skopje 1993;
[6] Nacevski M., Nestorovski Lj., Iliev B., Trajanov Z.: Quality analysis of the wood from domestic and foreign tree species, Skopje 2002.
[7] FYR Macedonia energy policy paper, World Bank, July 23, 2004
[8] Energy Balance 2009, Ministry of economy, 2009
[9] Second National Communication of R Macedonia under UNFCCC, 2008

For. review 43: 1 - 76. Skopje, 2012
Ss. Cyril and Methodius University in Skopje
Faculty of Forestry in Skopje

ISSN: 0585-9069

For. review 43: 15 - 18. Skopje, 2012

ISSN: 0585-9069
UDC: 630*232(498)
Original scientific paper
Paper submission: May, 2012

INDIVIDUAL AREA AND SPATIAL DISTRIBUTION OF SAPLINGS

PALAGHIANU C.
Ştefan cel Mare University of Suceava, Forestry Faculty, Suceava, Romania
Correspondig author e-mail address: cpalaghianu@usv.ro

ABSTRACT: Forest regeneration is a spatial multifaceted process with numerous unknown variables. The individual area or the area potentially available (APA) to an individual plant embodies an idea widely used in population ecology but it has fewer applications in forest research. It was used a Voronoi/ Thiessen tessellation in order to determine the individual area of each sapling. The study was conducted in a naturally regenerated area; using data collected from over seven thousands saplings positioned in a network of permanent rectangular sampling plots. The Voronoi/ Thiessen polygons were used to characterize spatial pattern of sapling distribution as well as the competition relations between the individuals. It is obvious that, at least from the mathematically point of view, the Voronoi tessellation represents one of the best solutions to determine neighbouring competitors of a tree. There were studied the correlations between APA values and the main biometrical attributes, height growth and competition indices. Furthermore, it is shown that APA coefficient of variation is a straight-forward indicator with positive results as an indicator of spatial pattern. The statistical significance of this indicator was evaluated by comparing the results with the values of a 95% confidence envelope generated by Monte-Carlo simulations. Two practical software tools were produced using Visual Basic (VORONOI and ARIA VORONOI) in order to simplify the analyses.
Keywords: individual area, area potentially available, Voronoi/ Thiessen polygons, spatial pattern, spatial distribution

1 INTRODUCTION

Researches used many times mathematical and especially geometrical techniques in their effort to explain individual competition.

The area potentially available (APA) concept represents an uncommon, but rather promising approach, introduced in plant ecology by Brown [2]. The same concept was independently developed by Mead [7], but early investigations in the field of plants growing space were conducted also by Konig, mentioned in his book „Die Forst-Mathematik" [6].

From the biological point of view, APA generally defines the area used by an individual to access vital resources, the available area for a plant to satisfy its needs in water, nutrients and light. So APA is very appealing to researchers interested in growth modelling, in their effort to solve an everlasting problem: *"Do trees grow faster because they are larger? Or they are larger because they have been growing faster?"* [17][4].

Considering the difficulty of the analysis there are few researches using this approach [8][9]. Smith [15] considers that this approach is ignored or even avoided due to misapprehend of APA geometrical foundation and computing difficulties. The late period is well-known for its computer development and also numerous and various algorithms were produced. So, the APA re-enters in researcher's attention as a promising investigation tool.

The APA was used to solve not only competition issues but also mortality and dynamics of seedlings [12] or spatial pattern [8]. Regarding spatial pattern, Garcia [4] considers the interaction between neighbouring growing areas as a result of autocorrelation. Two neighbours who are closer than average, will both have APA undersized values and vice versa. Winsauer and Mattson [18] have mentioned some advantages to make use of APA in forest researches – potentially available areas are not intersecting each other, there are sensitive to population dynamics and they are correlated with growth rates. This final remark represents the key aspect of APA utilisation as a competition evaluation tool because if an individual has a large APA, the competition pressure will affect it less. There is, of course, a drawback – the APA is based exclusively on the position of the individual and not on its biometrical attributes. That's why it is called "potentially".

The objective of this study is to elucidate what kind of information APA can offer regarding sapling populations. Can APA characterize the relationships between saplings? A subsidiary objective is producing software tools for Voronoi analysis.

2 METHODOLOGY

2.1 What is APA?

The area potentially available of a tree has experienced different forms of interpretation and use, analogous to Brown concept. For example, Staebler [16] Bella [1] and Moore [9] used in their researches a similar concept named "influence zone". Polygon areas were used as descriptive tool of spatial plant arrangement or as predictive tool of plant performance.

The most correct interpretation remains although the one based on the mathematical concept of space partitioning using Voronoi or Thiessen tessellation. So it is generally admitted that APA of an individual is equivalent to area of the Voronoi/ Thiessen polygon which is associated to that individual.

In the bi-dimensional space, a Voronoi polygon of an element includes all the points closer to that specific element than to any other element (Figure 1).

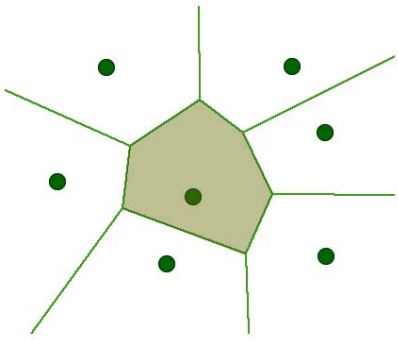


Figure 1: Voronoi / Thiessen polygon

The edges of a polygon contain the points located at

ISSN: 0585-9069

equal distance from two elements. The vertices of such a polygon are equally located from minimum three generating elements. Considering these properties, two elements are considered to be neighbours if their associated Voronoi polygons share an edge.

It is quite difficult to obtain a Voronoi partitioning for a large set of points, that's why this process is frequently done using specific algorithms and a computer. Algorithms were poorly optimized and the computers were very slow few decades ago, so the process was not pleasant and quick. The last years arrived with great improvements regarding the algorithms and the computer instruments, giving a new chance to Voronoi based applications.

2.2 Developing the software tools

In order to study the area potentially available to saplings I have developed specific software tools, using Microsoft Visual Basic. For the first tool, called VORONOI (Figure 2), I have used an algorithm presented by Ohyama [11] with O(n2) complexity. VORONOI is stand-alone software which is drawing the Voronoi diagrams using as input data the saplings coordinate placed in a spreadsheet. The user can obtain information regarding sapling neighbours by diagrams analyses. The Voronoi tessellation represents a natural method to select neighbouring trees, a difficult issue in assessing competition indices. The diagrams also offer information about spatial pattern of saplings – it's easier to determine if a pattern is aggregate or uniform.

The second software tool, named ARIA VORONOI, computes the area of each Voronoi polygon. These areas, equivalent to APA values, might be used as competition or aggregation index. Small values of APA might indicate competition pressure and great values of APA coefficient of variation might indicate aggregation of saplings for the analysed plot.

This software was also developed in Microsoft Visual Basic. The input data represents the saplings Cartesian coordinates, extracted from a spreadsheet. The programme computes area of Voronoi polygons and several statistic indicators - the average, standard deviation and coefficient of variation of APA values. It is generated a grid and each cell of the grid is analysed to asses which the generator point (sapling) is. The user can choose a grid size step in order to increase accuracy of determining APA values.

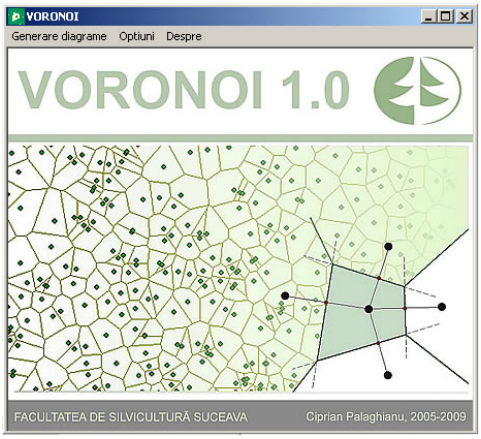


Figure 2: Voronoi software interface

It was taken into account the edge effect, so the saplings with incomplete APA were eliminated from the analyses.

User can specify a value for the buffer zone – in this way the APA is calculated only for the saplings located in the core area, even if the APA extends outside the core area. If the buffer zone is too small, in some exceptional cases, there might be saplings located in the core area with incomplete APA (Figure 3). The algorithm computes also the convex hull and all the points (saplings) located on the convex hull are eliminated. The recommended size of the buffer zone is the average distance between neighbours corrected with the coefficient of variation (20 cm in this study).

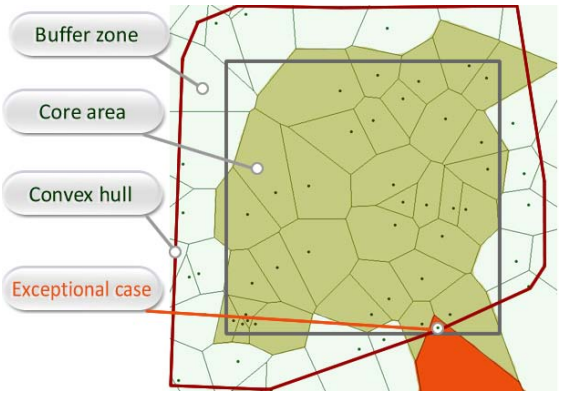


Figure 3: Correcting the edge effect

2.3 Material and analyses

The study area is located in Flămânzi Forest District, parcel 50A, near Cotu, a small settlement situated in Botoşani County, Romania. The topography is almost flat, with a slope average of 2-3% and the altitude is around 140 meters. The area of the stand studied is 21.5 hectares and the species composition consists of 30% sessile oak, 20% oak, 30% common hornbeam, 10% small-leaved linden and 10% common ash. The area is regenerated naturally and the regeneration gaps were created in 2001-2002 and were enlarged in 2007. Within this stand a 2.5 hectare homogenous area covered in saplings was selected for further investigation.

I installed a network of ten permanent rectangular sampling plots (7 x 7 m) where I measured the characteristics of all saplings and seedlings (Figure 4).

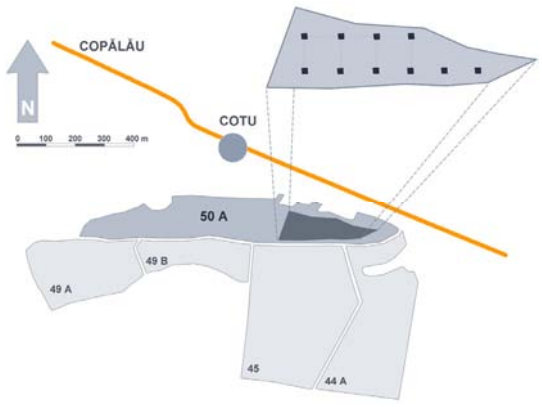


Figure 4: Location of the study

I used a GPS receiver in order to record the coordinates of the centre of each plot and I labelled every sapling and seedling inside the plot. The features of 7253 individuals were determined. The attributes assessed are: species, location of the individuals (x, y Cartesian coordinates), diameter, total height, crown insertion height, two crown diameters along the directions of axes and the latest annual height growth.

The analyses were based on areas of generated Voronoi polygons. There were studied the correlations between APA values and the main structural attributes (dimensional attributes, density), height growth and competition indices – Hegyi [5] and Schutz [14].

APA it was also used as a potentially spatial pattern indicator. There are several studies [4][8] that point out there is a relation between APA values or APA coefficient of variation and the spatial pattern of a population of mature trees. This fact might be relevant to sapling populations, too. In this case it was analysed the APA coefficient of variation for each plot in relation with Morisita [10] and Clark-Evans [3] spatial pattern indicators. APA coefficient of variation might be an indicator of spatial distribution. In order to find a relationship between aggregation and APA coefficient of variation values I have used a statistical test to establish if there is a significant deviation from Poisson spatial distribution (from the complete spatial randomness - CSR hypothesis). I have generated 19 Monte-Carlo simulations for each plot, using SpPack software [13] to simulate a CSR distribution for the same area and the same number of saplings. The extreme values of APA coefficient of variation produced the 95% confidence envelope of CSR hypothesis. Higher values of APA coefficient of variations would indicate significant deviations from CSR towards aggregation.

3 RESULTS

At first I have studied the relation between APA and the main biometrical attributes. There were identified very significant correlations with low intensity of APA with sapling diameter (r = 0.23***) and crown diameter (r = 0.21***). This is an expected result because several researchers [9], [15], [18] mentioned correlations of mature trees APA with the diameter or basal area.

Obviously there is a strong negative correlation between APA and sapling density (r = - 0.99 ***) and even between APA coefficient of variation and density (r = - 0.72 *). The uniformity tendency is more evident at a higher density.

Several studies [9], [18] indicate that APA might be correlated with growth and competition. Competition is one of the processes that shape the saplings spatial distribution. Consequently there were analysed the correlations between APA and competition indices – Schutz index and Hegyi index computed in respect to diameter, height, crown volume and crown external surface. The strongest correlation is between APA and the Hegyi index calculated in respect to diameter (r = - 0.32 ***) and height (r = - 0.27 ***).

In order to evaluate the performance of growth it was analysed the correlation between APA and sapling height growth. Surprisingly, there is no correlation between these parameters (r = 0.08 *). Other studies indicated significant correlations between mature trees growth (diameter growth) and APA but sapling populations seem to be more dynamic than mature trees. This initial developing stage is very unstable regarding spatial distribution of the individuals so APA is a factor with a smaller impact on height growth.

Some authors [8] point out there is a relation between APA values or APA coefficient of variation and the spatial pattern of a population of mature trees. This seems to be relevant to sapling populations, because of the APA correlations with spatial pattern indicators – Morisita (r = 0.70 *) and Clark-Evans (r = -0.84 **). The APA coefficient of variation is also correlated with spatial pattern indicators Morisita (r = 0.88 **) and Clark-Evans (r = -0.58). Aggregated patterns lead to higher values of APA coefficient of variation (Figure 5 a, b).

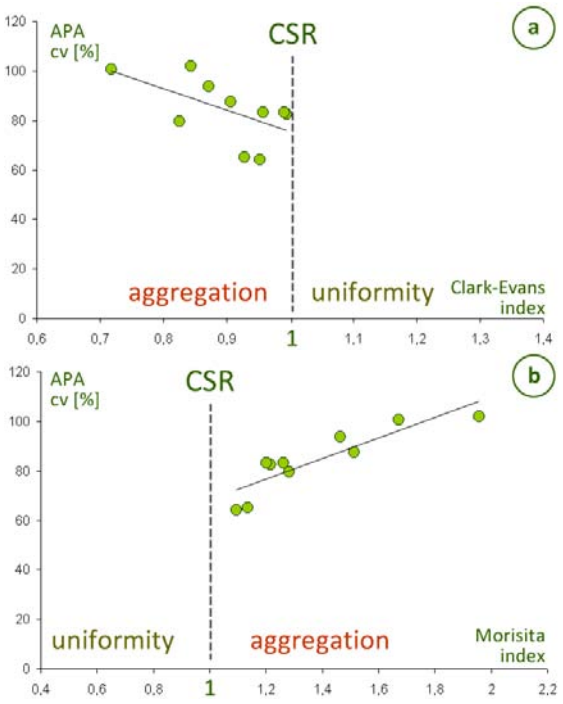


Figure 5: APA coefficient of variation related to Clark-Evans (a) and Morisita (b) index

This detail shows that APA coefficient of variation might be used as an indicator of spatial distribution. The Monte-Carlo simulations indicate significant deviations from CSR towards aggregation - the values of APA coefficient of variation overcome the 95% confidence envelope for all the plots (Figure 6).

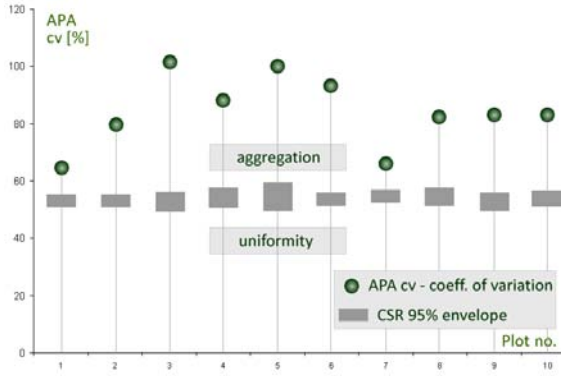


Figure 6: APA coefficient of variation values showing aggregation of saplings in all the ten plots

ISSN: 0585-9069

4 CONCLUSIONS

The results indicated that saplings APA have poor relationships with biometrical attributes, at least in saplings populations. The reason might be the fact that APA takes into account only sapling position and no other biometrical feature. There is a solution - the generation of Voronoi weighted diagram in respect to some biometric parameter (Figure 7). VORONOI software has the capability to generate such diagrams. Still, there is one problem because it's very difficult to compute the area of the resulted cells.

APA can be described as a low performance indicator of competition in saplings population because there is no relation to height growth and there are low intensity correlations with competition indices. There might be a possibility to use APA in competition analyses in combination with other attributes, but not as a stand-alone indicator. However, one important aspect in assessing competition is that the non-weighted diagrams are the best mathematical solution to establish the neighbours of a sapling or tree. So APA might be used as a criterion for selecting neighbours.

A remarkable result is that APA coefficient of variation represents a straight-forward indicator with positive results as an indicator of spatial pattern. The significance of this indicator might be evaluated by comparing the results with the values of a confidence envelope as it was shown in the paper.

As a final conclusion, APA is a complex and useful tool for characterizing population structure regarding spatial distribution, but seems more suited to mature trees than sapling populations. I hope the development of software tools VORONOI and ARIA VORONOI will simplify and support further studies.

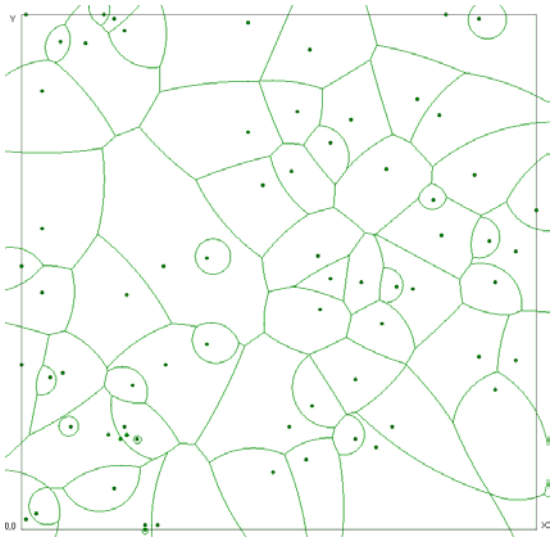


Figure 7: Weighted Voronoi diagram in respect to height generated by VORONOI software

5 ACKNOWLEDGEMENTS

This work has been mainly supported by the European Commission under the theme "Environment" of the 7th Framework Programme for Research and Technological Development (FP7), Grant agreement no. 226544 (MOTIVE project).

The views expressed herein are exclusively those of the author and do not necessarily reflect those of the European Commission or any other institution or organisation.

6 REFERENCES

[1] Bella, I.E., A new competition model for individual trees, Forest Science (1971), 17: 364–372.
[2] Brown, G.S., Point density in stems per acre, New Zealand Forestry Service Research Notes (1965), 38: 1-11.
[3] Clark, P. J., Evans, F. C., Distance to nearest neighbour as a measure of spatial relationships in populations. Journal of Ecology (1954), 35: 445-453.
[4] Garcia, O., Plant individual-based modelling: More than meets the eye, World Conference on Natural Resource Modeling Warsaw (2008), http:// forestgrowth.unbc.ca/warsaw.pdf.
[5] Hegyi, F., A simulation for managing jack-pine stands, Growth Models for Tree and Stand Simulation. Royal College of Forestry, Stockholm (1974), Sweden, 74–90.
[6] Konig, G., Die Forst-Mathematik in den Grenzen wirtschaftlicher Anwendung nebst Hülfstafeln für die Forstschätzung und den täglichen Forstdienst, 4th Ed – 1854 [1835], pg. 830.
[7] Mead, R., A relationship between individual plant-spacing and yield. Annals of Botany (1966) 30: 301-309.
[8] Mercier, F., Baujard, O., Voronoi diagrams to model forest dynamics in French Guiana, GeoComputation '97 & SIRC '97 Proceedings, University Otago, New Zealand (1997), 161-171.
[9] Moore, J.A., Budelsky. C.A., Schlesinger, R.C., A new index representing individual tree competitive status, Canadian Journal of Forest Research (1973) 3: 495-500.
[10] Morisita, M., Iδ index, a measure of dispersal of individuals. Researches on Population Ecology (1962) 4: 1-7.
[11] Ohyama, T., Voronoi diagram (2008), http:// www.nirarebakun.com/eng.html;
[12] Owens, M.K., Norton, B.E., The impact of 'available area' on Artemisia tridentata seedling dynamics. Vegetatio (1989) 82: 155-162.
[13] Perry, G.L.W., SpPack: spatial point pattern analysis in Excel using Visual Basic for Applications (VBA), Environmental Modelling & Software (2004) 19: 559–569.
[14] Schutz, J.P., Zum Problem der Konkurrenz in Mischbeständen. Schweiz. Z. Forstwes (1989) 140: 1069–1083.
[15] Smith, W.R., Area potentially available to a tree: a research tool, The 19th Southern Forest Tree Improvement Conference (1987), Texas, pg. 29.
[16] Staebler, G.R., Growth and spacing in an even-aged stand of Douglas fir, Master's thesis, University of Michigan (1951), pg. 46.
[17] Wichmann, L., Modelling the efects of competition between individual trees in forest stands, PhD Thesis, The Royal Veterinary and Agricultural University, Copenhagen (2002), pg. 112.
[18] Winsauer, S.A., Mattson, J.A., Calculating Competition In Thinned Northern Hardwoods, Res. Paper NC-306, St. Paul, USDA (1992), pg. 10.

For. review 43: 19 - 23. Skopje, 2012

ISSN: 0585-9069
UDC: 630*114(540)
Original scientific paper
Paper submission: May, 2012

EXPLORING THE SPATIO-TEMPORAL DYNAMICS OF FOREST LAND USE/LAND COVER CHANGES IN AHIRAN SUB WATERSHED OF CENTRAL INDIA

SINGH K. A., SINGH S. S.
Department of Forestry, Wildlife & Environmental Sciences, Guru Ghasidas University, Bilaspur, Chhattisgarh, India
Correspondig author e-mail address: aks.ggu@gmail.com

ABSTRACT: This study analyzed spatio - temporal changes in forest land use/land cover of Ahiran sub watershed (a part of Hasdeo watershed) situated in Chhattisgarh of Central India. In the present study, Landsat Thematic Maper False Colour Composite images of the year 1999, 2006 and 2009 were interpreted for detecting the changes on forest land use/land cover. The dynamics of changes within forest land use/ land cover categories has been assessed by creating the database of the maps and subsequent analysis under GIS domain. The ground realities of changes and impact of those changes have been verified and ascertained respectively through field observations. The study revealed a total change of dense forest decrease 8.77% and non forest increase 20.9% during the year 1999 - 2009. The changes have mainly taken place in the form of its depletion/degradation of forest land cover and expansion of settlements. It is significant to note that most of the changes (70% out of total change) have occurred in the specified mining areas and among all the types of changes, forest degradation is the highest one. The impact of changes has been severe for the existing agro-ecosystem, as the productivity of agricultural crops has gone down considerably with the passage of time.
Keywords: Ahiran sub watershed, Spatio-temporal changes, Forest land use/land cover, RS & GIS.

1 INTRODUCTION

Forest land use/land cover change is a key driver of global change [1-3]. To meet the demands of large population means the need for more food production, more requirement of energy, more water requirement, better civic amenities for a reasonable quality of urban life, more infrastructure development to sustain increasing pressure and increased per capita expenditure for maintaining quality of life. This requires prudent use of land use/ land cover in the area. Land use refers to man's activities and various uses, which are carried on land (such as agriculture, settlements, industry etc). Land cover refers to the material present e.g. vegetation, water bodies, rocks/soils and other resulting from land transformations. Although land use is generally inferred based on the cover, yet both the terms land use and land cover being closely related are interchangeable [4-7].

The growing population and increasing socio-economic necessities creates a pressure on forest land use/ land cover (FLULC). This pressure results in unplanned and uncontrolled changes in land use/ land cover [8-12]. The FLULC alterations are generally caused by mismanagement of agricultural, urban, range and forest lands which lead to severe environmental problems such as landslides, floods etc [13].

Remote sensing and Geographical Information Systems (GIS) is one of the powerful tool to derive accurate and timely information on the spatial distribution of forest land use/land cover changes (FLULCC) over large areas past and present studies conducted by organizations and institutions around the world, mostly, has concentrated on the application of FLULC changes. GIS provides a flexible environment for collecting, storing, displaying and analyzing digital data necessary for change detection [14-18]. Satellite imagery is used for recognition of synoptic data of earth's surface [19-21]. Landsat Multispectral Scanner (MSS), Thematic Mapper (TM) and Enhanced Thematic Mapper Plus (ETM+) data have been broadly employed in studies towards the determination of land cover since 1972, the starting year of Landsat program, mainly in forest and agricultural areas [13]. The rich archive and spectral resolution of satellite images are the most important reasons for their use.

The aim of change detection process is to recognize LULC on digital images that change features of interest between two or more dates [22, 23]. There are many techniques developed in literature using post classification comparison, conventional image differentiation, using image ratio, image regression, and manual on-screen digitization of change principal components analysis and multi date image classification [24]. A variety of studies have addressed that post-classification comparison was found to be the most accurate procedure and presented the advantage of indicating the nature of the changes [25-26]. In this study, change detection comparison (pixel by pixel) technique was applied to the Forest land use\land cover maps derived from satellite imagery.

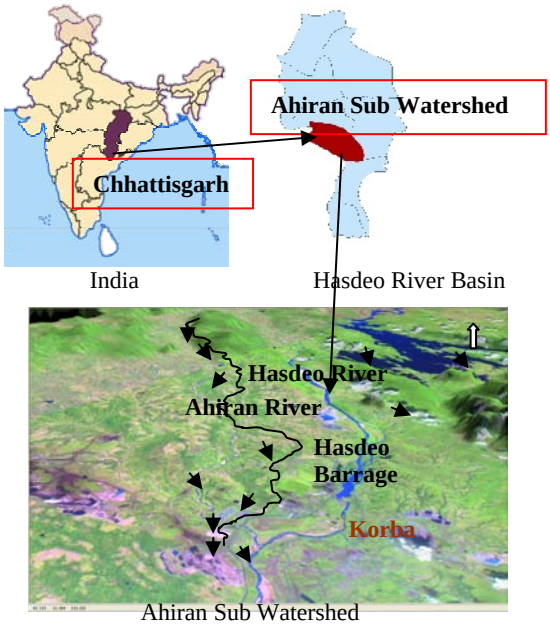


Figure 1: Location map of Ahiran Sub Watershed in Hasdeo River Basin

ISSN: 0585-9069

The climate of the study site is monsoonic. The rainy season occurs during mid-June to September and about 80% of the total annual rainfall occurs during this period [29]. The period between December and February is characterized by cold and dry weather conditions. The summer season i.e., March to mid-June is the warm period. The annual rainfall ranges from 890 to 1240 mm per year. The mean minimum and maximum temperature ranges from 7.8°C (January) to 24.5°C during December-January and average relative humidity is maximum during August (93%) and minimum (25.5%) during April.

2 METHODOLOGY

2.1 Image Processing

LandSat TM and ETM images of scene 142/45 of year 1999, 2006 and 2009 and thematic maps were used for the study. Erdas Imagine version 10.0 and ArcGIS version 9.5 were used for the processing of the images. The raw satellite images were converted from Tag Image file format (Tiff) to img format using Erdas in order to be compatible with other Erdas Imagine files. The layers were stacked and sub-set to delineate the catchment area for classification. This was followed by georeferencing using the TM projection with reference units in square kilometer to allow compatible positioning of other themes such as forest, roads, settlement and drainage. Landsat images for assessment of the impact of Forest Land Use and Land Cover Changes on the Ahiran sub watershed which were already digitized in that format.

The band combination of red, blue and green was used to display the raw images in standard colour composites. The spectral band combination for displaying images often varies with different applications [30]. This was necessary for the visual interpretation of the images. A band combination of red, blue and green (RGB) is often used to display images in standard colour composites for forest land use/land cover and vegetation mapping [30]. In this study, the LandSat TM and ETM images were displayed in a band combination of 1, 2 and 3 (red, blue and green) which is standard for visual interpretation of vegetation mapping in the tropics.

2.2 Forest Land Cover Classification

The unsupervised classification method was used to classify the images into the various land cover categories. The unsupervised classification is a method of clustering. It is self-organizing in that the image data are first classified by being aggregated into natural spectral groupings or clusters present in the scene. It enables the specification of parameters that the computer uses to determine statistical patterns in the data. The procedure begins with a specified number of cluster means, and then it processes the image data repetitively, assigning each of the pixels to one of the class means. After each iteration the initial cluster shifts to represent the new statistical means of the clusters in the data. This happens until there is no significant change of cluster means. Then the land cover identities of these spectral groupings were determined by comparing the classified image to the ground reference data.

The statistics of the various classes were generated using the Erdas Imagine. Finally maps were composed, using ArcGIS (Version 9.5) and the maps were validated in the field to assess its accuracy. This was conducted through field visit to define how closely the classification agrees with the actual field situation. It involved the selection of samples of identified locations on the map, which were then checked in the field. In carrying field validation, GPS coordinates of 25 locations together with their respective cover classes were picked. The coordinates were geocoded in the classified maps and then the classified map was compared with the actual field situation.

2.3 Change Detection of FLULC

The most commonly used forest land use/land cover change detection methods includes : image overlay, classification comparisons of forest land use/ land cover statistics, change vector analysis and image rationing [19]. The method used in this study was the classification and comparison of forest land use/land cover statistics. This method was adopted because the study needs to find out the quantitative changes in the sub watershed areas of the various forest land use/land cover categories. Using the post-classification procedure, the area statistic for each of the land cover classes was derived from the classifications of the images for each date (1999, 2006 and 2009) separately, using Erdas Imagine software. The areas covered by each forest land use/land cover type for the various periods were compared. Then the directions of the changes (positive or negative) in each land cover type 1999 and 2006, 2006 and 2009, and 1999 and 2009 were determined [21].

3 RESULTS AND DISCUSSION

3.1 Results of land cover classification

A total of five forest land use/land cover categories were identified and classified in the study. These were Dense forest (DF), Non forest (NF), Open forest (OF), Scrubland (SBL) and Waterbodies (WBD) area as shown in Figure 2.

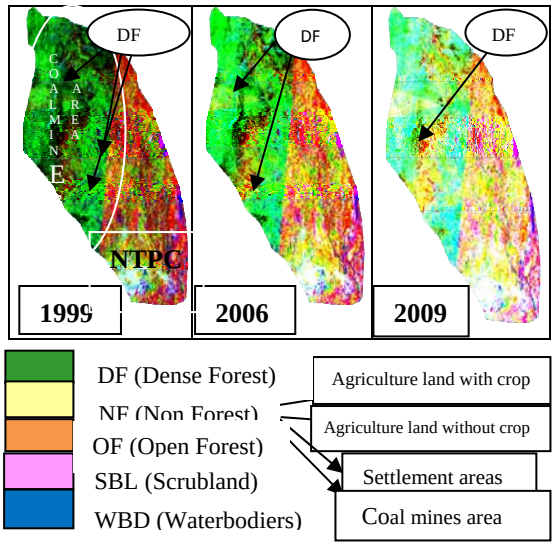


Figure 2: Spatio- temporal changes shows in Ahiran sub watershed in year 1999, 2006 and 2009

3.2 Extent of forest land use/ land cover (FLULC) categories

Table I shows that the most extensive forest land use/ land cover category of the Ahiran sub watershed as

at 1999 was dense forest which covered about 11295.51 hectares (56.57%). The second most extensive forest land use/ land cover category was non forest, which covered 7131.91 hectares (35.59%). Open forest covered about 823.59 hectares (4.11%). This is followed by water bodies, which covered about 352.58 hectares (1.72%) and open area/town which covered 16.55 hectares (0.82%).

Table I: Forest land use/ land cover classes of the Ahiran sub watershed as in 1999, 2006 and 2009

FLULC	1999		2006		2009	
	Area (Km^2)	(%)	Area (kms2)	(%)	Area (kms 2)	(%)
DF	205.613	22.71	177.542	19.61	126.213	13.94
NF	310.379	34.29	363.020	40.10	499.512	55.19
OF	105.768	11.69	114.154	12.62	134.992	14.91
SBL	1.004	0.11	1.891	0.20	8.413	0.92
WBD	282.466	31.20	248.603	27.47	136.100	15.0

Table I summarizes the forest land use/land cover classes of the Ahiran sub watershed. Moreover, as shown in Table I, the order of magnitude of the spatial extent of the forest land use/land cover categories in 2009 is different from that in 1999 and 2006.

3.3 Forest Land Use/Land Cover Changes (FLULCC)

Table II: Land cover changes of the Ahiran sub watershed for the periods between (1999 and 2006, 2006 and 2009 and 1999 and 2009).

FLULCC	1999-2006		2006-2009		1999-2009	
	Area (Km2)	(%)	Area (Km2)	(%)	Area (Km2)	(%)
DF	-28.071	-3.1	-51.329	-5.67	-79.4	-8.77
NF	+52.641	+5.81	+136.492	+15.09	+189.133	+20.9
OF	+8.386	+0.93	+20.838	+2.29	+29.224	+3.22
SBL	+0.887	+0.09	+6.522	+0.72	+7.409	+0.81
WBD	-33.863	-3.73	-112.503	-12.43	-146.366	-16.16

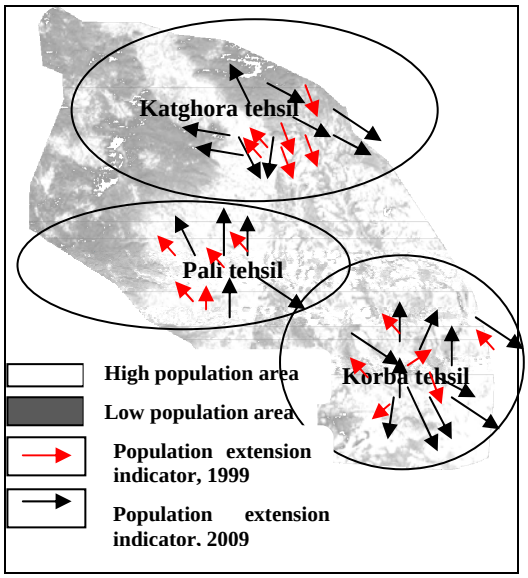
Table II shows the changes in the various forest land use and land cover categories (in km2 and %) during the periods between 1999 and 2006, 2006 and 2009, and 1999 and 2009.

In 1999-2006 the most extensive FLULCC to DF area which lost 28.071 sq kms (3.1%). It was followed by WBD with 33.863 sq kms (3.73%). Meanwhile, NF area gains 52.641 sq kms (5.81%), OF 8.386 sq kms (0.93%) and SBL 0.887 sq kms (0.09%). The landsat image study for 2006-2009, the assessment of the impact of FLULCC on the Ahiran sub watershed indicates that DF and WBD was lost from 51.329 sq kms (5.67%) and 112.503 sq kms (12.43%) area whereas, NF, OF and SBL was gained as 136.492 sq kms (15.09%), 20.838 sq kms (2.29%) and 6.522 sq kms (0.72%) area.

Finally, the order of magnitude of the FLULCC of the Ahiran sub watershed in 1999-2009 (10 years), interprets that DF and WBD area lost in high intensity of 79.4 sq kms (8.77%) and 146.366 sq kms (16.16%) whereas, NF, OF and SBL were area gained with 189.133 sq kms (20.9%), 29.224 sq kms (3.22%) and 7.409 sq kms (0.81%) respectively.

3.4 Causes of the land cover changes

The major cause identified in the study of the sub watershed is the population growth. Population growth is widely recognized as a key force behind environmental change, especially in developing countries [8]. The total population of the Ahiran sub watershed is distributed in three tehsils viz. Katghora, Pali and Korba tehsils. In Figure 3 white colour shows the high population area and black colour as low population area. The Korba tehsil has clear indication of high population area in compare to Katghora and Pali tehsil.



(Source: CoI, 2001)

Figure 3: Population status of Ahiran sub watershed in year 2009

The population extension indicator indicates that in Katghora tehsil of the sub watershed has maximum variation of population extension between years 1999-2009 in compare to other two tehsils. The main reason of population extension in this tehsil has been recorded as rich coal mines and forest availability in the forest area. The total population of Ahiran sub watershed was recorded 413262 (CoI, 2001). In which the population of Kotghora tehsil, Pali tehsil and Korba tehsil in Ahiran sub watershed were 251645, 55649 and 105968 respectively. But in recent years the population extension indicator already shows that the population is increasing mostly from traditional settlement area to forest area due to extensive population pressure and coal mines extension (upto 70%) in forest areas. Moreover, uncontrollable farming activities as well as timber logging in the catchment also contributed to the decline

ISSN: 0585-9069

in the forest cover. This is as a result of inadequate education. The study identified that the people in the sub watershed have not been educated enough concerning the physical interactions between land use and agriculture farming. The impact of changes has been severe for the existing agro-ecosystem, as the productivity of agricultural crops has gone down considerably with the passage of time.

4 CONCLUSION

The analysis of LandSat TM images of 1999, 2006 and 2009 revealed that forest land use and land cover of the Ahiran sub watershed has changed over the years. Five broad classes of land use and land cover classes were identified and mapped from the 1999, 2006 and 2009 satellite images. These were forest, open forest, water body, open area/town and grassland. The results showed that between the years 1999 and 2009, dense forest and water bodies decreased by 8.77% and 16.16% respectively, whereas non forest, open forest and scrubland increased substantially by about 20.9%, 3.22% and 0.81%. Changes in forest land use and land cover of the Ahiran sub watershed were found to be related to population growth, logging for timber and lack of proper education.

The trend of forest land use and land cover changes detected in this study has shown general conversion of the forestland to wasteland and settlements [31, 32]. These conversions have potential consequences on the catchment characteristics, forest structure and hydrology. Since forest land cover is a function of rainfall regime, soil conditions and geomorphology [33] the conversion of the forest to grasslands and settlements would definitely lead to changes in the soil conditions and the geomorphology of the catchment [12, 34].

The conversion of forest to non forest and scrubland disrupts the forest cycle of the sub watershed by altering the balance between biodiversity, rainfall, evaporation, higher and lower plant ratio and population ratio [35, 36]. With a lower leaf area, the grass does not intercept Landsat Images for assessment of the Impact of FLULCC on the sub watershed. The shift from forest to wasteland and settlement may produce dramatic changes in the catchment peak flows as well and make the land more vulnerable to erosion leading to natural resource destruction [37]. Specific practices relating to farming and urbanization such as construction, soil compaction during logging can reduce the infiltration capacity of the soil and in turn the flow of water through the soil profile [38-39]. Moreover, the increase in farming activities in the catchment coupled with water capacity could also increase erosion and sedimentation. Therefore, these forest land use and land cover changes detected could be related to the forest land and agriculture changes in the sub watershed.

5 REFERENCES

[1] R. A. Houghton, Land-use changes and the carbon cycle. Global Change Biology. 1, (1995), 275-287.

[2] A. B. Miller, E.S. Bryant, and R.W. Birnie, An analysis of land cover changes in the Northern Forest of New England using multitemporal LANDSAT MSS data. Int. J. Remote Sensing, 1998, Vol. 19, no. 2, (1998), 215-265.

[3] Daniel A. Mangestu and Ayobami A. Salami, Application of Remote Sensing and GIS in land use/ land cover mapping and change detection in a part of south western Nigeria (2007).

[4] S. E. K. Duadze, Land-use and land-cover study of the Savannah ecosystem in the Upper West region (Ghana) using Remote Sensing. ZEF Bonn, University of Bonn, Germany (2004).

[5] R. DeFries and A. S. Belward, Global and regional land cover characterization from satellite data; an introduction to the Special Issue. Int. J. Remote Sensing (2000), Vol.21 (6&7): 1083-1092.

[6] B. S. Chaudhary, G. P. Saroha and Manoj Yadav, Human induced land use/ land cover changes in Northern part of Gurgaon district, Haryana, India: Natural resources concept. J. Hum. Ecol. (2008), 23(3): 243-252.

[7] NPs/NBS Vegetation Mapping, USGS-Vegetation Mapping Program. http: // biology . usgs.gov/nps/aa/sect1.html (2002).

[8] G. W. Cheng, Forest change: hydrological effects in the upper Yangtze river valley. Ambio (1999), 28, 457–459.

[9] E. H. Helmer, S. Brown and W. B. Cohen, Mapping montane tropical forest succession stage and land use with multi-date LANDSAT imagery. Int. J. Remote Sensing (2000), Vol. 21, no. 11, 2163-2183.

[10] K. C. Seto, C.E. Woodcock, C. Song, X. Huang, J. Lu, R. K. Kaufmann, Monitoring land use change in the Pearl River Delta using Landsat TM. Int. J. of Remote Sensing (2002), 23, (10), 1985-2004.

[11] R. S. Dwivedi, K. Sreenivas and K.V. Ramana, Land-use/land-cover change analysis in part of Ethiopia using Landsat Thematic Mapper data. Int. J. Remote Sensing (2005), 26, pp. 1285-1287.

[12] T. Fung, Land use and land cover change detection with Landsat MSS and SPOT HRV data in Hong Kong. Geocarto International (1992), 3, pp. 33-40.

[13] J. B. Campbell, Introduction to Remote Sensing, Fourth edition, The Guilford Press, New York, USA, 2007.

[14] F. Guerra, H. Puig and R. Chaune, The forest-savannah dynamics from multi-data LANDSAT-TM data in Sierra Parima, Venezuela. Int. J. Remote Sensing (1998), Vol.19, no.11, 2061-2075.

[15] T. Yomralıoğlu, Coğrafi Bilgi Sistemleri Temel Kavramlar ve Uygulamalar, Seçil Ofset, Istanbul, Turkey (2000).

[16] Q. Wu, H. Q. Li, R. S. Wang, J. Paulussen, H. He, M. Wang, B. H. Wang, Z. Wang, Monitoring and predicting land use change in Beijing using remote sensing and GIS. Landscape and Urban Planning (2006), *78*, 322–333.

[17] M. N. Demers, Fundamentals of Geographic Information Systems, John Wiley & Sons, Inc., New York, USA (2005).

[18] FAO, Agrostat.http/www.FAO.org (1999).

[19] T. M. Lilesand and R. W. Keifer, Remote sensing and Image Interpretation. John Wiley and sons (1994), Pp750.

[20] K. A. Ulbricht, W. D. Heckendorf, Satellite images for recognition of landscape and land use changes. ISPRS Journal of Photogrammetry & Remote Sensing (1998), 53, 235-243.

[21] D. A. Stow, Reducing the effects of misregistration on pixel-level change detection. Int. J. Remote Sensing (1999), Vol. 20, no. 12, 2477-2483.

[22] W. Muttitanon, N. K. Tripathi, Land use/land cover changes in the coastal zone of Ban Don Bay, Thailand using Landsat 5 TM data. Int. J. Remote Sensing (2005), 26 (11), 2311-2323.
[23] S. Ringrose, C. Vanderpost and W. Maheson, Use of image processing and GIS technique to determine the extent and possible causes of land management / fenceline induced degradation problems in the Okavango area, northern Botswana. Int. J. Remote Sensing (1997), Vol. 18, no. 11, 2337-2364.
[24] D. Lu, P. Mausel, M. Batistella and E. Moran, Land-cover binary change detection methods for use in the moist tropical region of the Amazon: a comparative study. Int. J. Remote Sensing (2005), 26 (1) 101–114.
[25] J.F. Mas, Monitoring land-cover changes: A comparison of change detection techniques. Int. J. Remote Sensing (1999), 20 (1), 139-152.
[26] F. Yuan, K. E. Sawaya, B. C. Loeffelholz, Bauer, M.E. Land cover classification and change analysis of the Twin Cities (Minnesota) metropolitan areas by multitemporal Landsat remote sensing. Remote Sensing of Environment (2005), 98, 317-328.
[27] S. Das Gupta, Studies on vegetal and microbiological processes in coal mining affected areas. Ph.D. Thesis. North Eastern Hill University, Shillong. India (1999).
[28] A. Dkhar, Impact of coal mining on micro-landforms in Jaintia Hills district, Meghalya. M. Phil. Dissertation. North Eastern Hill University, Shillong. India (2002).
[29] S. S. Singh, Ajay K. Singh and Vandana, Forest land cover variation and catchment status in the Bamni sub watershed of Hasdeo river basin in Central India. J. Biodiversity and Ecological Sciences (2011). No.1, Vol.1, Issue 1. Pp 95-101.
[30] C. M. Trotter, Characterising the topographic effect at red wavelengths using juvenile conifer canopies. Int. J. Remote Sensing (1998), vol.19, no.11, 2215-2221.
[31] Ajay K. Singh and S. S. Singh, Upper Hasdeo Sub Watershed Status in Hasdeo River Basin at Chhattisgarh, India. In proc. FIG Congress 2010 “Facing the Challenges – Building the Capacity” Sydney, Australia, 11-16 April (2010). pp 1-6.
[32] C. N. Mundia and M. Aniya, Analysis of land use/cover changes and urban expansion of Nairobi city using remote sensing and GIS. Int. J. Remote Sensing (2005), 26, pp. 2831-2849.
[33] M. H. Costa, A. Botta and J. A. Cardille, Effects of Large-Scale Changes in Land Cover and Climate Variability in the Discharge of the Tocantins River, American Geophysical Union, Fall Meeting (2002), abstract B22C-0765.
[34] M. K. Steininger, C. J. Tucker, P. Ersts, T. J. Killeen, A. Villegas and S. B. Hecht, Clearance and fragmentation of tropical deciduous forest in the Tierras Bajas, Santa Cruz, Bolivia. Conserv. Biol.(2001) 15: 856– 866.
[35] L. Tole, An estimate of forest cover extent and change in Jamaica using Landsat MSS data. Int J Rem Sens. (2002), 23(1): 91-106.
[36] T. N. Carlson, S. G. A. Azofeifa, Satellite Remote Sensing of land Use changes in and around San Jose´, Costa Rica. Remote Sensing of Environment (1999), 70, 247–256.
[37] J. P. Guerschman, J. M. Paruelo, C. D. Bela, M. C. Giallorenzi and F. Pacin, Land cover classification in the Argentine Pampas using multi-temporal Landsat TM data. Int. J. Remote Sensing (2003), 24, 3381–3402.
[38] C. Nunes, and J. I. Auge, Land-Use and Land-Cover Implementation Strategy (Stockholm: IGBP) (1999).
[39] J. Rogana, D. Chen, Remote sensing technology for mapping and monitoring land-cover and landuse change. Progress in Planning (2004), 61, 301–325.

For. review 43: 1 - 76. Skopje, 2012
Ss. Cyril and Methodius University in Skopje
Faculty of Forestry in Skopje

ISSN: 0585-9069

For. review 43: 24 - 32. Skopje, 2012

ISSN: 0585-9069
UDC: 581.9(497.7)
Original scientific paper
Paper submission: May, 2012

CHOROLOGY AND HABITATS OF SOME PLANTS IN THE REPUBLIC OF MACEDONIA

[1]TEOFILOVSKI A., [1]MANDZUKOVSKI D., [2]SIMOVSKI B., [2]ACEVSKI J.
[1]*Public enterprise for managing forests Makedonski sumi, Skopje, Macedonia*
[2]*Ss. Cyril and Methodius University in Skopje, Faculty of Forestry in Skopje, Skopje, Macedonia*
Correspondig author e-mail address: acoteofilovski@hotmail.com

ABSTRACT: In this article are disclosed chorologycal and habitat data for 17 taxa in the flora of the Republic of Macedonia. *Chamaecytisus absinthioides* subsp. *absinthioides*, *C. absinthioides* subsp. *absinthioides* var. *multiflorus* and *Solidago virgaurea* subsp. *minuta* are recorded for the first time in the flora of the Republic of Macedonia, while new finding sites are added for: *Juniperus sabina*, *Dianthus diffusus*, *D. formanekii*, *D. leucophoeniceus*, *Cotoneaster mariana*, *Genista subcapitata* var. *holosericea*, *G. subcapitata* var. *mariovoensis*, *Vicia pisiformis*, *Alkanna graeca*, *Hyssopus officinalis*, *Morina persica*, and *Knautia longifolia*. The presence of *Juniperus sabina* and *Dianthus haematocalyx* subsp. *pindicola* on the Nidže mountain is confirmed and also for the first time concrete data for their finding sites and habitats on this mountain are given. The lowest finding site in the Republic of Macedonia of *Abies borisii-regis* is recorded.
Keywords: chorology, habitat, flora, dendroflora, taxa, new finding sites

1 INTRODUCTION

The Republic of Macedonia is situated in southwestern part of Balkan Peninsula. Its rich flora, developed as a result of its diverse climate and geological composition, was the main reason for extensive botanical researches carried out since the first half of the 19th century.

Our field floristic and vegetation explorations of vascular flora, during the last two decades, encompassed different regions of the Republic of Macedonia, predominately mountain in its western, southern and eastern part (Mt Shar Planina, Mt Suva Gora, Mt Bistra, Mt Nidze, Mt Kozuf, Mt Plackovica, Mt Osogovo etc.). Plants of different systematic groups were collected and observed whereby taxa which previously was not known as well as new finding sites for certain rare taxa were discovered. Such discoveries show that Macedonian flora is still insufficient known and require further investigations.

Chamaecytisus absinthioides subsp. *absinthioides*, *C. absinthioides* subsp. *absinthioides* var. *multiflorus* and *Solidago virgaurea* subsp. *minuta* are discovered for the first time in Macedonia. New finding sites are discovered for: *Juniperus sabina*, *Dianthus leucophoeniceus*, *D. formanekii*, *D. diffusus*, *Cotoneaster mariana*, *Genista subcapitata* var. *holosericea*, *G. subcapitata* var. *mariovoensis*, *Vicia pisiformis*, *Alkanna graeca* subsp. *graeca*, *Hyssopus officinalis*, *Morina persica*, and *Knautia longifolia*. *Juniperus sabina* and *Dianthus haematocalyx* subsp. *pindicola* are rediscovered on Mt Nidže and for the first time concrete finding sites and habitats are presented. Also were discovered the lowest finding site of *Abies borisii-regis* in the Republic of Macedonia.

For each taxon are provided literature distribution data in Macedonia which alongside with newly discovered finding sites are presented on distribution map. Some taxonomic issues regarding *Dianthus leucophoeniceus*, *D. haematocalyx* subsp. *pindicola*, *D. diffusus*, *Genista subcapitata* and *Solidago virgaurea* subsp. *minuta* are shortly discussed. Approximate general range of distribution for each taxon is cited.

2 MATERIALS AND METHODS

During the field research herbarium specimens and also habitat data were collected for each taxa. Herbarium specimens are deposited in the private herbarium of colectors. In some cases herbarium material was not collected and finding sites are designated based only on observation or photos which is indicated in the text. The specimens was determined according The Flora of the Republic of Macedonia (Micevski, 1995-2010), Flora Europaea (Tutin et al. eds., 1964-1980), Prodromus florae peninsulae Balcanicae (Hayek, 1927-1933), Mountain flora of Greece (Strid & Tan, eds., 1987, 1991), Flora Helenica (Strid & Tan, eds., 1997, 2002) and also some other floras and monographic works.

3 RESULTS

3.1 *Abies borisii-regis* Mattf.

Mt Kožuf - Konska Reka gorge, 310-360 m, 8.2011, observation D. Mandzukovski.

In the Konska Reka gorge were found two individuals about 5 m tall, one on 310 m altitude and other one on 360 m. Both localities represent a small thermo-mezophilous refugium in area of thermo-xerophilous community *Phyllireo - Carpinetum orientalis arbutosum andrachnis* Em at all. prov. Alongside with both these individuals of *A. borisii - regis* grow *Fagus silvatica* subsp. *moesiaca*, *Taxus baccata*, and *Platanus orientalis*. This is the lowest finding site so far known in Macedonia. Previously known lowest finding site was also on Mt Kožuf - near Petrovo Selo, in the area of ass. *Orno-Quercetum petraeae* on altitude between 490 and 520 m (Gudevski & Rizovski, 1968).

Balkan endemic species widespread in mountains of Macedonia, Greece and Bulgaria. (Fig. 5)

3.2 *Juniperus sabina* L.

Mt Nidže - Dolgiot Rid, stony places, on dolomitic marble, 1790 m, 23.7.2010, observation and photos D. Mandzukovski & A. Teofilovski.

ISSN: 0585-9069

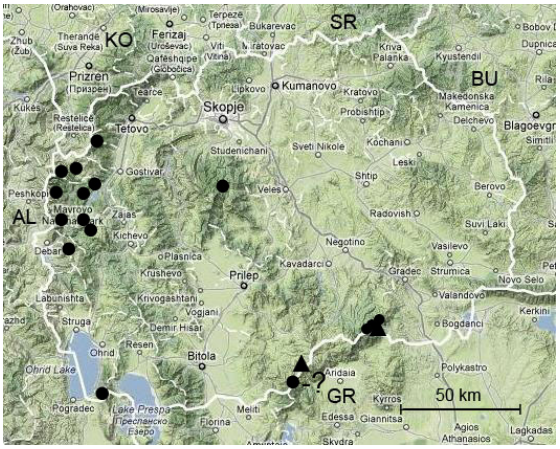


Figure 1: Distribution of *Juniperus sabina* in Macedonia (▲*new finding sites*, ● literature data)

Mt. Kožuf - Mala Rupa, steep rocky places, limestone supstrate, 1770 m, 27.7.2011, observation and photos D. Mandzukovski.

According Em (1965) occures on Mt Bistra, Mt Stogovo, Mt Korab and Mt Rudoka with isolated finding sites on Mt Jakupica, Mt Galičica (Mala Galičica - Poljce) and Mt Kožuf. Micevski (1985) quoted this species as very frequent on Mt Bistra, Mt Korab, Mt Krčin (Dešat), Mt Galičica, Mt Koža, Mavrovska Reka, Radika and Adžina Reka, Acevski (2000) for Mt Galičica (Stara Galičica) and also Mandzukovski (2009) for Mt Kožuf - Čiči Kaja and Ešek Burun. Velenovský (1922) quoted this species for Mt Nidže without concrete locality so it is unclear whether he found this species on Macedonian or on Greek territory of this mountain. The new finding site Dolgiot Rid is first and concrete confirmation of this general record for Mt Nidže.

Areal of this species includes mountains of C & S Europe and W & C Asia, from Spain to E Siberia. (Fig. 1)

3.3 *Dianthus leucophoeniceus* Dörfl. & Hayek

Resen - 0,4 km west from the pass Bukovo, dry grassy place, siliceous substrate, 1230 m, 23.6.2010, leg. A. Teofilovski.

Tetovo - 2,5 km NE from Orashje village, grassy place, serpentine supstrate, 450 m, 6.6.2009, leg. A. Teofilovski.

Previously recorded for: Skopje - Osinčani (Rohlena, 1935); Veles (Bornmüller, 1933); Skopje - Mt Žeden, Žeden gorge, Raduša, Katlanovska Banja; Taor gorge; Mavrovo - Mavrovi Anovi, Vrben; Mt Korab - Žužnje; Mt Stogovo - Gari (Micevski, 1993); Mt Suva Gora - Stanika, Gaber, Lokva, Novo Selo (Teofilovski, 2011).

Petals length of collected specimens fits to subsp. *brachypetalum* Acht. et Lindtner but it is a doubtful taxon.

Balkan endemic species occurs in: Kosovo, Albania, Macedonia, and Greece - N Pindus. (Fig. 2 and 3)

Figure 2: *Dianthus leucophoeniceus* (Bukovo)

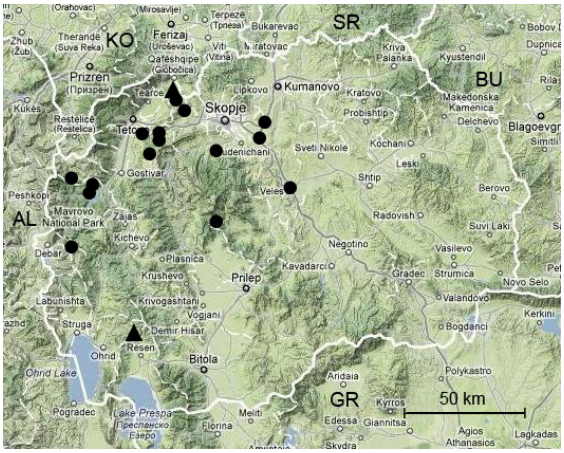


Figure 3: Distribution of *Dianthus leucophoeniceus* in Macedonia (▲*new finding sites*, ● literature data)

3.4 *Dianthus haematocalyx* Boiss. & Heldr. subsp. *pindicola* (Vierh.) Hayek

Mt Nidže - area from the right side of Suvi Dol to the top of Belo Grotlo, rocky places, limestone supstrate, 1780-2120 m, 24.7.2010, leg. A. Teofilovski & D. Mandzukovski, 7.7.2011, leg. D. Mandzukovski.

This taxon was already recorded for Mt Nidze (Todorovski, 1970) but without concrete finding site. Despite this record, Micevski (1993) in the "Flora of Republic of Macedonia" do not mention this subspecies at all. Records of some autors for subsp. *sibthorpii* (Vierh.) Hay. in S Macedonia (see Micevski, 1993) may referes to subsp. *pindicola*.

Figure 4: *Dianthus haematocalyx* subsp. *pindicola* (Mt Nidže)

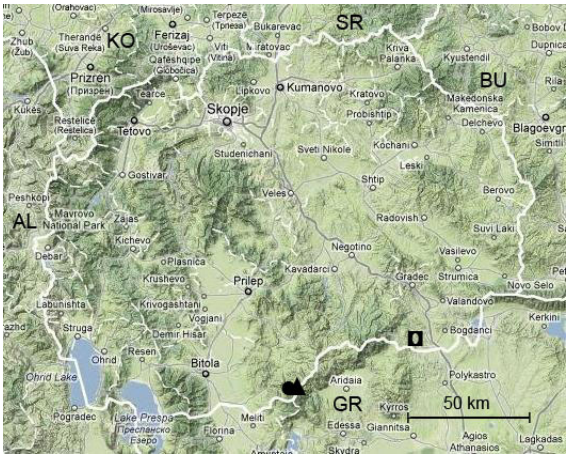


Figure 5: Distribution of *Dianthus haematocalyx* subsp. *pindicola* in Macedonia (▲*new finding sites*, ● literature data) and the lowest finding site in Macedonia of *Abies borisii-regis* (◘)

All collected and observing plants on Mt Nidže have glaucous stem and leafs which do not fit with the description in protolog (Vierhapper jun., 1897) and some older floras (Hayek, 1927; Tutin, 1964). However Strid (1986, 1997) and Constantinidis (1999) do not consider this feature when delimit subsp. *pindicola*, which probably implies its taxonomical irrelevance regarding this subspecies. Plants from Mt Smolikas (NW Greece) which belong to this subspecies, according several photos in Greek Mountain Flora (2006-), are also glaucous. Some specimens from Nidže have almost linear leafs, thus approaching to subsp. *chaematocalyx*.

Balkan endemic taxon occurs in: S Macedonia - Nidze, S Albania, and NW Greece. (Fig. 4 and 5)

3.5 *Dianthus formanekii* Borbás ex Formanek

Bitola - Bel Kamen peak, grassy place, siliceus supstrate, 1350 m, 17.6.2009, leg. A. Teofilovski.

Bitola - 2,6 km NW from Gorno Srpci village, grassy places, siliceus supstrate, 1060 m, 17.6.2009, leg. A. Teofilovski.

Previously recorded for: Kavadarci - Vataša; Prilep - Treskavec, Rasim-Bej (Micevski, 1993), Kanatlarci (Bornmüller, 1925), "Kokaleny" (Velenovský, 1922); Bitola - Mojno, Črničani, Armatuš (Vandas, 1909), Lopatica (Micevski, 1993).

This species is endemic to S Macedonia and NW Greece. All previously known finding sites in both countries were on relative low altitude, between 500 and 800 m. (Fig. 5 and 6)

Figure 6: *Dianthus formanekii* (Bitola - Bel Kamen)

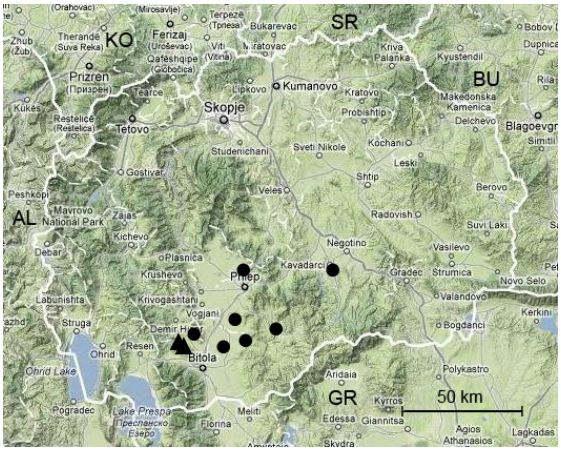


Figure 7: Distribution of *Dianthus formanekii* in Macedonia (▲*new finding sites*, ● literature data)

3.6 *Dianthus diffusus* Sipth. et Sm.

Mt Nidže - right site of Suvi Dol, in *Pinus sylvestris* forest, limestone supstrate, 1820 m, 19.7.2010, leg. D. Mandzukovski & A. Teofilovski.

A rare species in Macedonia, previously recorded only for: Mt Skopska Crna Gora; Straža - between Gostivar and Kičevo; Mavrovo - Koža, Vrben (Micevski, 1993).

The range of this species includes S & SE parts of Balkan Peninsula and some Aegean islands. It is closely related to another Balkan endemic *D. pubescens* Sipth. et Sm., which acording some autors represent a synonim of *D. difusus* (Strid, 1997). Our comparative examinations on one colection of *D. pubescens* from Mt Jakupica - near Kadina Reka (15.8.2010, leg. A. Teofilovski,

 ISSN: 0585-9069

unpublished) and the specimen of *D. difusus* from Mt Nidže support their separate specific status. (Fig. 8)

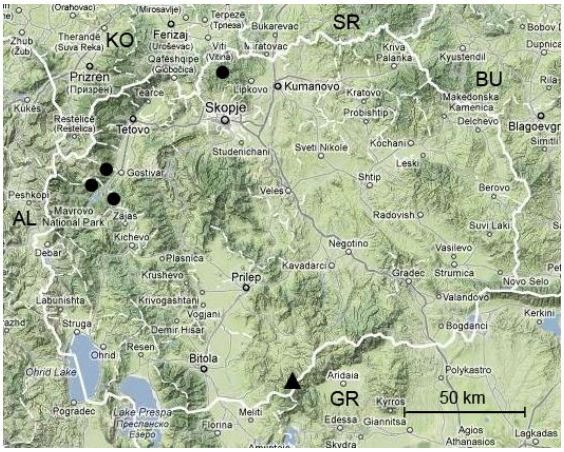


Figure 8: Distribution of *Dianthus diffusus* in Macedonia (▲*new finding sites*, ● literature data)

3.7 *Cotoneaster mariana* And. A. et And. V.

Mt Bistra – atop Volkovija village, clearing in fir forest, 23.8.2010, leg. J. Acevski & B. Simovski.

Mariovo - near road between Gradešnica and Staravina villages (only one individual discovered), dry pasture on siliceus supstrate, 890 m, 23.7.2010, observation and photo D. Mandzukovski & A. Teofilovski, 7.7.2011 leg. D. Mandzukovski & J. Acevski.

Long time overlooked species relatively recently described from Mt Galičica where its distribution is common on elevation belt between 1400 and 1800 m, on limestone thermophilous habitats (Andonoski & Andonovski, 1996). There is also some another records for Mt Galičica (Acevski, 2000; Matevski & al., 2011). Ours investigations show also relatively common presents of *C. mariana* on this mountain (several collections and photos from different parts on elevation beetwen 1250 and 1500 m, leg. and photogr. A. Teofilovski & D. Mandzukovski, Jun-July, 2010, unpublished).

Another known finding sites in Macedonia are: Mariovo - Manastir village (Andonoski, 1997), Mt Gradištanska Planina - between Malino and Alakince villages (Mandzukovski, 2001; Mandzukovski & Acevski, 2007), Poreče - a relatively large finding site near Krapa village (Mandzukovski, 2009).

Morphologically well defined species so far known only for Macedonia, but probably occurs also in some other S Balkan country, at least Albania. (Fig. 9 and 10)

Figure 9: *Cotoneaster mariana* (v. Gradešnica)

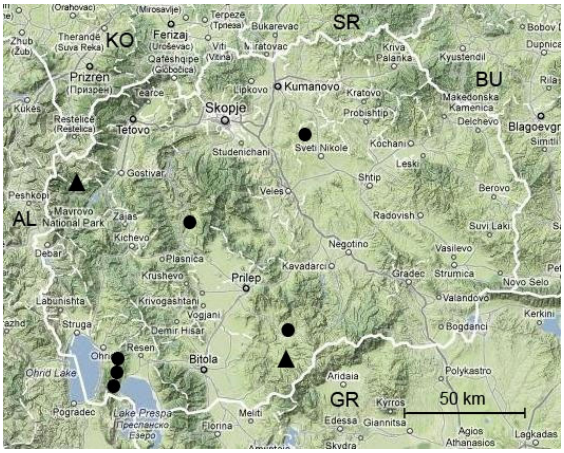


Figure 10: Distribution of *Cotoneaster mariana* in Macedonia (▲*new finding sites*, ● literature data)

3.8 *Chamaecytisus absinthioides* (Janka) Kuzm. subsp. *absinthioides*

Mt Suva Gora - area between Merovo village, Novo Selo village and locality Jablanica, road sites, forest clearings, and oak forests, 600-1000 m, 14.6.1998, 5.9.1998, 16.6.2011, leg. A. Teofilovski.

Mt Osogovo - c. 1km NW from Sasa village, sunny places on siliceus supstrate, 950 - 1200 m, 28.5.2012, leg. D. Mandzukovski

Mt Osogovo - southern slopes , widespread in atop of Novo Selo, Nebojani Kostin Dol villages, sunny places on siliceus supstrate, 800 - 1400 m, 03.12.2012, leg. D. Mandzukovski

Specimens from Mt Osogovo are closest to var. *absinthioides*, while specimens from Mt Suva Gora represent var. *multiflorus* Kuzm. Subsp. *absinthioides*, respectively var. *multiflorus*, is new for Macedonia.

C. absinthioides s.l. is known for several finding sites in Macedonia, mostly in its west part [several autors, sub *C. absinthioides* s.l. or its lower taxa (see Teofilovski, 2011)]. *C. absinthioides* s.l. [(probably belonging to subsp. *rodopaeus* (Wagn.) Kuzm.] recently was discovered also on Mt Šar Planina - 2,5 km W from

Rakovec village, 1290 m, (25.5.2011, leg. A. Teofilovski, unpublished).

Differences between *C. absinthioides* and W Anatolian species *C. eriocarpus* (Boiss.) Rothm. are not quite clear. Here we accept approach of Kuzmanov (1976) who regard *C. absinthioides* as separate species with range in: SE Jugoslavia (former), SW Bulgaria and N Greece. (Fig. 11 and 12).

Figure 11: *Chamaecytisus absinthioides* subsp. *absinthioides* var. *multiflorus* (Mt Suva Gora)

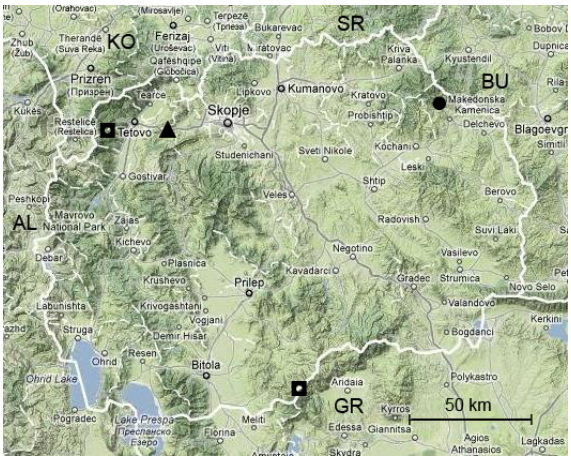


Figure 12: Distribution of *Chamaecytisus absinthioides* subsp. *absinthioides* (●), *C. absinthioides* subsp. *absinthioides* var. *multiflorus* (▲), and *Solidago virgaurea* subsp. *minuta* (◘) in Macedonia

3.9 *Genista subcapitata* Pančić
[Syn.**:** *G. involucrata* auct. non Spach]

Mt Plačkovica - Varnica, rocky places, limestone supstrate, 1100-1300 m, 7.2009, leg. D. Mandzukovski, 12.8.2009, leg. D. Mandzukovski & A. Teofilovski.

Mt Skopska Crna Gora - Crn Kamen, 1611 m, 7.7.2012, leg. Z. Nikolov.

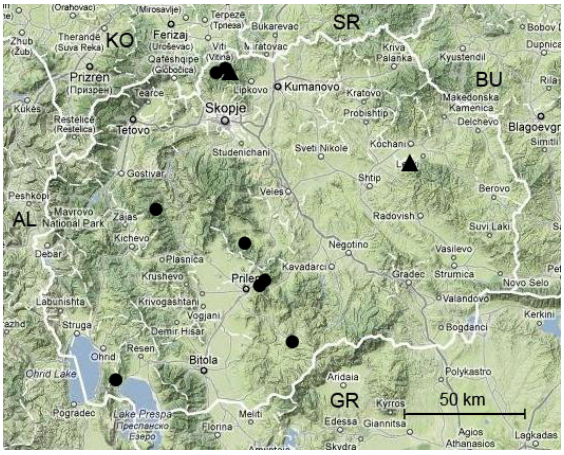


Figure 13: Distribution of *Genista subcapitata* in Macedonia (▲*new finding sites*, ● literature data)

Mostly of collected specimens from Mt Plačkovica belong to var. *mariovoensis* Micevski & Matevski while few specimens belong to var. *holosericea* Micevski & Matevski. The specimens from Mt Skopska Crna gora probably represent typical *G. subcapitata*.

Balkan endemic species occurs also in: E & SE Serbia, W, S & SW Bulgaria, N Greece, and Albania. In Macedonia previously recorded for: Mt Skopska Crna Gora - Pržalj, Crn Kamen, Ostruga, Pešter (Grupče, 1958, sub *G. involucrata*), Babuna (Bornmüller, 1927, sub *G. involucrata*), Mt Dobra Voda (sub var. *grandiflora* Micevski & Matevski), Prilep - Kozjak and Pletvar (sub var. *holosericea*), Mariovo - Bešište village (sub var. *mariovoensis* Micevski & Matevski, 1998, Micevski, 2001), Galičica (Šmarda, 1968). According revision made by Micevski (2001) specimens from Mt Skopska Crna Gora recorded from Grupče (1958) as *G. subcapitata* (sub *G. involucrata*) actually belong to *G. albida* Willd. var. *pestalozzae* Boiss. However, our examinations of one colection from this mountain (leg. Z. Nikolov) confirm the presence of *G. subcapitata* although a few specimens have some branches bearing 1 (-2) axillary arranged flower below the capitula and thus somewhat approaching to *G. albida*. Existing of *G. albida* in Balkan Peninsula is questionable. (Fig. 13)

3.10 *Vicia pisiformis* L.

Mt. Suva Gora - Podgorica (in the vicinity of Miletino village), near forest road in the oak forest belt, siliceus supstrate, 590 m, 15.6.2011, leg. A. Teofilovski.

Euro-caucasian species, very rare in Macedonia. So far was known only from: Mt Baba - over Velušina and Ostrec (Todorovski, 1970); Mt Šar Planina - Belovište (Teofilovski, 2011). (Fig. 14 and 15)

ISSN: 0585-9069

Figure 14: *Vicia pisiformis* (Mt Suva Gora)

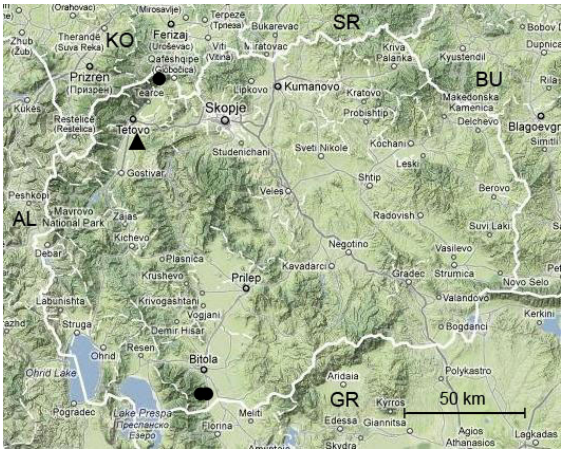


Figure 15: Distribution of *Vicia pisiformis* in Macedonia (▲*new finding sites*, ● literature data)

3.11 *Alkanna graeca* Boiss. & Spruner subsp. *graeca*

Mt Suva Gora - 1,2 km NW from Tenovo village, pastures on siliceus supstrate, 19.4.2012, leg. A. Teofilovski.

Figure 16: *Alkanna graeca* (Mt Suva Gora)

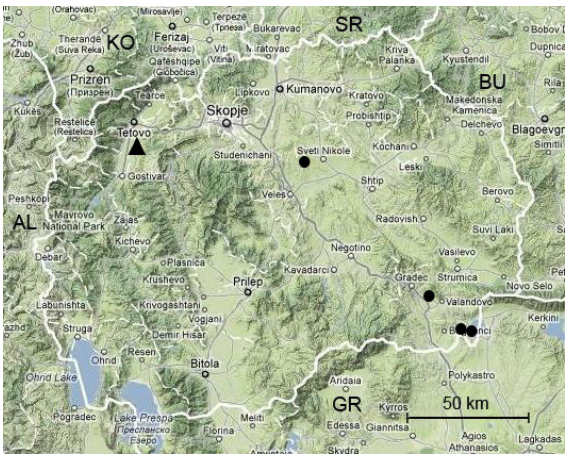


Figure 17: Distribution of *Alkanna graeca* in Macedonia (▲*new finding sites*, ● literature data)

Previously recorded from: Dojran - Mt Dub (Cirimotić, 1958), Dojran - between Star and Nov Dojran, Valandovo - Kalkovo village, Veles - Ivankovci village (Matevski, 2010).

A. graeca is an endemic to S Balkan. Subsp. *graeca*, is an endemic to Macedonia, Greece, and Albania while Bulgarian populations (S Pirin and Thracian lowlands - Hermenin) are distinguished in separate subsp. *slavjankae* Kož. (Kožuharov, 1989). Velenovský (1922) quoted montain ecotype subsp. *baeotica* (DC.) Nyman (sub *A. baeotica* DC.) for Mt Nidže but it is unclear whether he found this species on Macedonian or on Greek territory of this mountain. (Fig. 16 and 17)

3.12 *Hyssopus officinalis* L. subsp. *aristatus* (Godr.) Nyman
[Syn.: *H. officinalis* subsp. *pilifer* (Griseb.) Murb.; *H. officinalis* var. *pilifer* Griseb.)]

Kičevo - 0,4 km W of Prostranje village, stony places, limestone supstrate, 1050 m, 23.9.2010, leg. A. Teofilovski & D. Mandzukovski.

Figure 18: *Hyssopus officinalis* subsp. *aristatus* (v. Prostranje)

Kičevo - near road between Velmevci and Železnec villages, stony and rocky places, limestone supstrate, 760 - 820 m, 9.2010, leg. A. Teofilovski & D. Mandzukovski

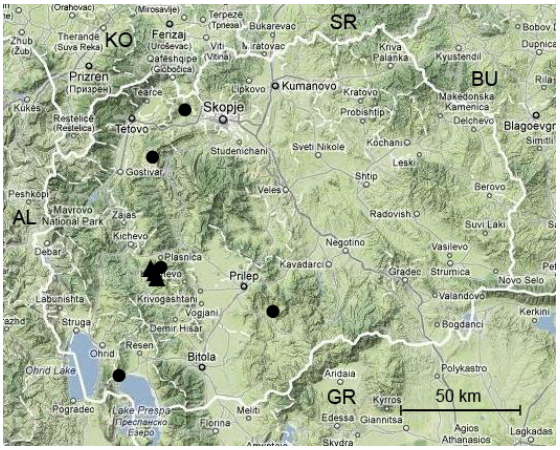


Figure 19: Distribution of *Hyssopus officinalis* subsp. *aristatus* in Macedonia (▲*new finding sites*, ● literature data)

Previously recorded for: Suvo Pole (Vandas, 1909, sub *H. officinalis* var. *pilifer*), W from river Vardar (Em, 1967, sub *H. officinalis* subsp. *pilifer*), Mt Žeden, Mt Suva Gora - Treska gorge, and Drenska Planina - Crna Reka gorge (Drenkovski, 1971, sub *H. officinalis* subsp. *pilifer*). Matvejeva (1965, sub *H. officinalis* var. *angustifolia* (M. B.) Briq.) quoted *H. officinalis* subsp. *officinalis* for Mt Žeden - Rašče villlage.

Subsp. *aristatus* is probably an Mediterranean taxa extending eastwards to Balkan Peninsula. (Fig. 18 and 19)

3.13 *Knautia longifolia* (W. et K.) Koch

Mt Šar Planina - Plat, grassy place, limestone supstrate, 2050 m, 18.7.2012, leg. A. Teofilovski & D. Mandzukovski.

Mt Šar Planina - 1,3 km NW from Brezno village, deserted meadow, siliceous supstrate, 1400 m, 1.7.2005, leg. A. Teofilovski.

Mt Nidže - Belo Grotlo, open stony places and *Pinus sylvestris* forest, limestone supstrate, 1790-1820 m, 5.8.2010, 12.8.2010, leg. A. Teofilovski & D. Mandzukovski.

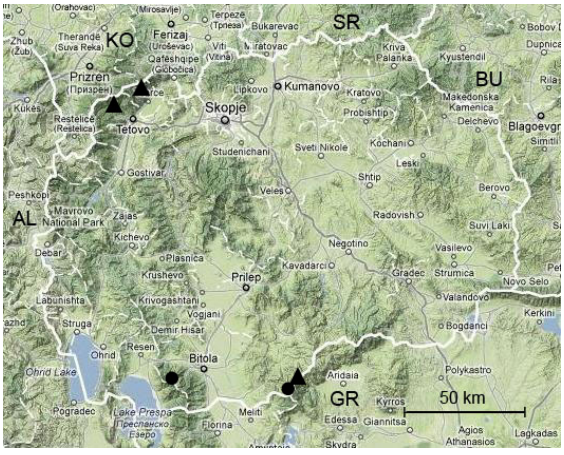


Figure 20: Distribution of *Knautia longifolia* in Macedonia (▲*new finding sites*, ● - literature data)

Probably a rare species in Macedonian mountain, previously recorded only for Mt Nidze (Micevski, 1978) and Mt Pelister (Horvat, 1938). Todorovski (1967) cited this species as a synonym of *K. midzorensis* Form. for Mt Nidze - Kajmakcalan and Mt Baba with Pelister, but later (1970) he cited only *K. midzorensis* for the same localities, without synonyms.

The range of *K. longifolia* includes: E Alps, E Carpathians and Balkan Peninsula. (Fig. 20)

3.14 *Morina persica* L.

Mt Plackovica - Varnica, stony places, limestone supstrate, 1100-1300 m, 12.8.2010, observation and photos D. Mandzukovski & A. Teofilovski.

Mt Plackovica - above Zrnovci village, dry places, 600-800 m,7.2009, observation D. Mandzukovski.

This species occurs in Macedonia mainly in its central part (many localities recorded by: Vandas, 1909; Jurišić, 1923; Bornmüller, 1926; Černjavski & all., 1937, sub *M. persica* subsp *turcica* Hal.; Matevski & al., 2008 etc.) and also in SW Macedonia - Mt Galicica (Weber, 1951, sub *M. persica* subsp. *turcica*; Micevski, 1971), S Macedonia - Demir Kapija (Bornmüller, 1926; Soška, 1939), Bošava (Soška, 1939) and NE Macedonia - Gradište near Kratovo (Ćušterovska, 2008).

The east eurimediterranean chorotype with general distribution in S Europe, C Asia, Turkey, W Syria, Lebanon, Iran, Afghanistan, W Himalayas, and Pakistan. (Fig. 21)

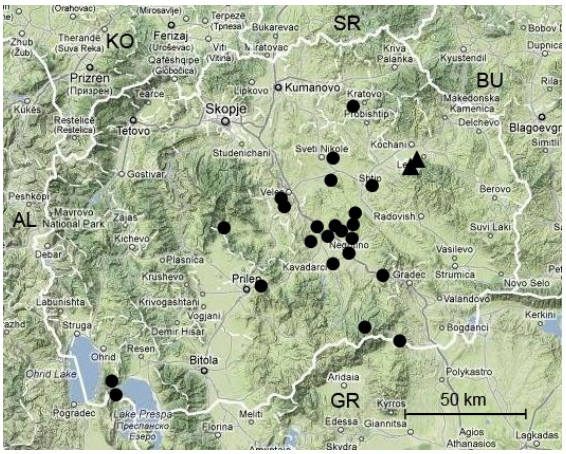


Figure 21: Distribution of *Morina persica* in Macedonia (▲*new finding sites*, ● literature data)

3.15 *Solidago virgaurea* L. subsp. *minuta* (L.) Arcang. [Syn.: *S. virgaurea* subsp. *alpestris* (W.K.) Gaud.]

Mt Šar Planina - E slopes of Ceripašina, stony places, limestone supstrate, 2120 m, 19.7.1988, leg. A. Teofilovski.

Mt Nidže - Bela Reka basin, stony places, limestone supstrate, 2000 m, 12.8.2010, leg. A. Teofilovski & D. Mandzukovski.

Mt Nidže - right site of Suvi Dol, *Pinus sylvestris* forest, limestone supstrate, 1780-1820 m, 25.7.2010, leg. D. Mandzukovski.

The subspecies is new for Macedonia. It represent an arctic-alpine ecotype connected with many intermediate forms to subsp. *virgaurea*. The latest is common taxon in the upper forest band in Macedonia, with general distribution in Europae, W Asia and N Africa.

Hayek (1928-1931) included to this subspecies Balkan endemic taxon *S. virgaurea* L. var. *vestita* Hal. (sub *S. virgaurea* L. ssp *alpestris* (W.K.) Gaud. var.

ISSN: 0585-9069

vestita Hal., comb. illeg.). According examination of one colection from Mariovo - Zovič (27.7.2010, leg. A. Teofilovski & D. Mandzukovski, unpublished) such combination has not justification. (Fig. 12)

4 ACKNOWLEDGEMENTS

We would like to thank Robert Brus (Ljubljana) for reviewing the manuscript and his usefull remarks, Zoran Nikolov (Skopje) who has lent us the specimens of *Genista subcapitata* and Kit Tan (Copenhagen) for useful discuss about *Dianthus haematocalyx* subsp. *pindicola*.

5 REFERENCES

[1] Acevski, J., Dendrofloristic characteristics of the mountain massif Galičica. Doctoral thesis- Skopje, (2000). (In Macedonian)

[2] Andonoski, A. i Andonovski, V., Cotoneaster mariana And. A & And V., new species discovered at Galičica mountain, Macedonia – Proceedings from Balkan conference ,,National parks and their role in biodiversity protection on Balkan, Ohrid , (1996), 99-104. (In Macedonian)

[3] Andonoski, A., New finding place of Cotoneaster mariana And. A et And. V. at Mariovo - R. Of Macedonia – Book of articles of International scientific symposium ,,50 years – Faculty of forestry" - Skopje, (1997). (In Macedonian)

[4] Bornmüller, J., Beiträge zur flora Macedoniens. Engl. Bot. Jahrb., 1. 59, (1925), 286-504.

[5] Bornmüller, J., Beiträge zur flora Macedoniens. Engl. Bot. Jahrb., 2. 60, (1926), 51-125.

[6] Bornmüller, J.,Bearbeitung der von H. Burgeff und Th. Herzog in den Kriegsjahren 1916-1918 in Mazedonien gesammelten Pflanzen. Allgem. Botan. Zeitsch., 32: . (1926): 16-37

[7] Bornmüller, J. (1927): Bearbeitung der von H. Burgeff und Th. Herzog in den Kriegsjahren 1916-1918 in Mazedonien gesammelten Pflanzen. Allgem. Botan. Zeitsch., 2. 23: 25-38

[8] Cirimotić, J., Prilog poznavanju flore planine Duba kod Dojranskog Jezera. God. Šum. Inst. Skopje, 3, (1958), 175-210.

[9] Constantinidis, T., *Dianthus haematocalyx* subsp. *phitosianus* (*Caryophyllaceae*), a New serpentine endemic from Greece. Phyton (Horn, Austria), 29-2, (1999), 277-291.

[10] Ćušterovska, R., Phytocenological studies of the vegetation on highland pastures around the Kratovo (manuscript), Master thesis, Ss. Cyril and Methodius University in Skopje, (2008). (In Macedonian)

[11] Černjavski, P., Rudski, I., Soška, T., Kratak pregled vegetacije juzne Srbije, Spomenica 25-god. Osl.. juz. Srb., Skopje, (1937), 135-159.

[12] Drenkovski, R.,: Neue Beitrage zur Horologie einiger sippen der Flora Mazedoniens. Fragmenta Balcanica, 8, 15 (193), (1971), 129-133.

[13] Em, H., Novi naogališta na smrdlikata ili somina (Juniperus sabina L.) vo Makedonija, GZZŠF Skopje, 18, (1965), 45-47.

[14] Em, H., Survey of Macedoninan dendroflora- - Skopje (1967). (In Macedonian)

[15] Greek Mountain Flora (http://www. greekmountainflora.info/, accessed 30.3.2012) (2006-).

[16] Grupče, Lj., Vrz rastitelnosta na Skopska Crna Gora. Filozof. fak. Prirod. matem. odd., Posebni izd., 9, (1958) 1-80

[17] Gudeski, A., Rizovski, R., Der niedrigste fundort der tanne in SR Mazedonien, Journal of forestry-organ of the alliance of foresters of the SR of Macedonia XVI, Faculty of forestry"-Skopje (1968), 44-47 (In Macedonian)

[18] Hayek, A., Prodromus florae peninsulae Balcanicae. I-III. Dahlem bei Berlin (1924-1933).

[19] Horvat, I., Istraživanja vegetacije planina Vardarske banovine. Ljet.Jug.Akad., Zagreb, 47, 1 (1935), 42-160.

[20] Jurišić, Ž., Prilog flori Južne Srbije. Spomenik SKA, 60, (1923), 1-45.

[21] Kožuharov, S., Alkanna Tausch, - In Jordanov, D., (ed.). - Флора на НР България, София, 9, (1989), 74-119.

[22] Kuzmanov, B. (1976): *Chamaecytisus* Link. - In Йordanov, D., (ed.). Flora na NR Вългaрия, Sofия, 6: 74-119

[23] Kuzmanov, B. (1976): *Chamaecytisus* Link. - In Йordanov, D., (ed.). Flora na NR Вългaрия, Sofия, 6: 36-61

[24] Mandzukovski, D., Novo naogalište na steblestata mušmulica Cotoneaster mariana And.A & And V. pokraj Ovče Pole-Makedonija, Naši šumi, 9, Skopje (2001), 8-9.

[25] Mandzukovski, D., Acevski J., Endemic and rare species on the Gradištanska mountain , Proceedings from International simposium - 60 years Faculty of foretsry, 35 years Wood Technology, Ohrid (2007), 114-119. (In Macedonian)

[26] Mandzukovski, D., Contribution to the knowledge of the dendroflora of the R. of Macedonia (I), Forestry review, year. 42, Faculty of foretsry -Skopje, (2009), 147-154. (In Macedonian)

[27] Matevski, V., The Fora of Dobra Voda mountain. PMF, Univ. Sv. Kiril i Metodij, Skopje (1995), pag. 46. (In Macedonian)

[28] Matevski, V., The Flora of the Republic of Macedonia. MANU, Skopje, 2 (1), (2010), 1-187. (In Macedonian)

[29] Matevski, V., Čarni, A., Avramoski, O., Juvan, N., Kostadinovski, M., Košir, P., Andrej Paušič, A., Šilič, U., Forest Vegetation of Galičica Mountain Range in Macedonia, Založba ZRC, 2011, pag. 200.

[30] Matevski, V., Čarni, A., Kostadinovski, K., Košir, P., Šilc, U. & Zelnik, I., Flora and vegetation of the Macedonian steppe. ZRC SAZU, Ljubljana, (2008), pag. 171.

[31] Matvejeva, J., Supplement to knowledge of flora at Žeden mountain. - ACTA Mus. Maced. Sc. Natur., Skopje 10 (2), (1965), pag. 52. (In Serbo-Croatian)

[32] Micevski, K.,, Steppenvegetation" in Mazedonien, Annuaire de la faculte des sciences de la universite de Skopje , 23, (1971), 131-150. (In Macedonian)

[33] Micevski, K., The Flora of SR Makedonija. MANU, Skopje, 1 (1), (1985), 1-152. (In Macedonian)

[34] Micevski, K., The Flora of the Republic of Macedonia. MANU, Skopje, 1 (2), (1993), 153-391. (In Macedonian)

[35] Micevski, K., The Flora of the Republic of Macedonia. MANU, Skopje, 1 (5), (2001), : 1121-1430. (In Macedonian)

[36] Micevski, K., Retki i nepoznati vidovi za florata na Makedonija. God. zb. - Biol., Skopje, 31, (1978), 151-165.
[37] Micevski, K., Matevski V., *Genista subcapitata* Panč. In der flora der Republik Makedonien, Contributions, Section of biological and medical sciences, MASA, Skopje, XIX, 1-2 (1998), 17-22. (In Macedonian)
[38] Rohlena, J., Zehnter Beitrag zur Flora von Montenegro (und Mazedonien). Vestnik Král. Spol. Nauk., Praha, 2, (1935), 1-19.
[39] Šmarda, J., Výsledky biogeografických cest do Jugoslávie v letech 1964-1967., Ceskoslovenská akademie věd Geografický ústav. Brno (1968).
[40] Soška, T., Beitrag zur Schluchtenfloren von Südserbien III, BSS Sk, 20 (7), (1939), 167-191.
[41] Strid, A., *Dianthus* L. - In Strid, A., (ed.). Mountain Flora of Greece. Copenhagen & Edinburgh, 1, (1987), 176-200.
[42] Strid, A., *Dianthus* L. - In Strid, A. & Tan, K. (eds.)., Flora Hellenica. Koenigsten. 1, (1997), 343-372.
[43] Teofilovski, A., Contributions to the flora of the Republic of Macedonia, Skopje, 2011, pag. 142. (In Macedonian)
[44] Todorovski, A., Melliferous flora of the district of Bitola, Prilozi, Bitola, 6-8, (1967), 3-26. (In Macedonian)
[45] Todorovski, A., The decorative flora of the area of the district of Bitola, Prilep, Kruševo and Demir Hisar. Prilozi, Bitola, 14, (1970), 1-36. (In Macedonian)
[46] Tutin, T.G., *Dianthus* L. - In Tutin, T.G. & al. (eds.), Flora Europaea, Cambridge, 1, (1964), 188-204.
[47] Vandas, C., Reliquae Formanekianae. Brunae, (1909).
[48] Velenovský, J. Reliquiae Mrkvičkanae. Pragae. (1922).
[49] Vierhapper, F. jun., Ueber einen neuen *Dianthus* aus dem Balkan., Verhand. der zoo.-bot. Ges. Wien. 48-1, (1897), 31-35.
[50] Weber, F., Botanická vycházka do pohori Galičica. Zbornik Klubu prirodovedeckeho v Brne, 29, (1951), 1-11.

For. review 43: 1 - 76. Skopje, 2012
Ss. Cyril and Methodius University in Skopje
Faculty of Forestry in Skopje

ISSN: 0585-9069

For. review 43: 33 - 36. Skopje, 2012

ISSN: 0585-9069
UDC: 630*38:519.87(497.7)
Original scientific paper
Paper submission: May, 2012

INFLUENCE OF SOME FACTORS ON THE DENSITY OF FOREST ROADS IN THE SKIDDING WITH ANIMALS

TRAJANOV Z., NESTOROVSKI Lj., TRAJKOV P.
Ss. Cyril and Methodius University in Skopje, Faculty of Forestry in Skopje, Skopje, Macedonia
Correspondig author e-mail address: ztrajanov@sf.ukim.edu.mk

ABSTRACT: In the paper are presented the results from the investigation of the optimal density of forest roads. We know from practice that there isn't universal solution to open forests and determine the optimal density of forest roads. In this research paper will analyze the density of forest roads in the skidding with animals (horse). Animals skidding as traditional still which occupies an important place in practice in Macedonian forestry. Several factors affect the solution for optimal density of forest roads because it is necessary to analyze the impact of these factors on the final solution. The obtained solutions represent a basis for solving the forest transportation practice.
Keywords: forest, roads, optimal density, animals, skidding

1 INTRODUCTION

In Republic of Macedonia skidding with horses is very widespread and has a long tradition. In practice, a part of the log skidding nowadays is done by horses (drags), and a great percentage of the firewood skidding is done by horses (pack-saddled). Recently, there has been an abandonment of this kind of skidding, but it will continue to exist in the future.

In practice, the transport of wood assortments is the most expensive phase of the direct process of production. Therefore, a need to find a solution for calculating the minimal expenses for transport is imposed, in a situation when all the planned activities of forest management would be successfully fulfilled.

There is a direct dependence between the minimal expenses of skidding and the optimal solution of the forest road network which can be expressed by: density of road network, spatial arrangement, and quality of roads. With that, the network of forest roads should evenly open the whole area, where the evenness doesn't refer to the distance between roads, but it refers to economic needs, economic significance and environmental importance of specific parts of the forest.
Field researches have been carried out on the mountain Plackovica, in the area Leva Reka. The relief of the terrain is medium developed, crissed-crossed by many smaller or bigger watercourses. The gradient of the terrain varies, on average it is 41%. The geological base is silicate and above it there is dark brown forest soil – Districhen kambisol. Rarely, the rocks come out on the surface and usually they are isolated smaller amounts. The climate is continental, i.e. mountainous. In conditions like these, the community of beech tree forest is developed, ass. Fagetum montanum, where the dominant wood type is the beech tree.

Beside the beech trees, in the earthbound part, grass plants and bushes can be isolated too. From a theoretical viewpoint, in the calculations a period of 100 years is being analyzed. This period coincides with the felling cycle of reproductive woodcutting. In that way, with the help of the felling cycle, one can define the volume of wood which will be used in a certain area for a specific time, time during which all the roads will be built in order to finish the woodcutting in every part of the area, as well as prompt and correct fulfillment of the protection and cultivation tasks in the forest. In these researches a situation has been analyzed, in which the truck roads are storey-placed in the area, one above the other. Therefore, the skidding is done by using four operations, such as: skidding of technical wood in increase, skidding of technical wood in fall, skidding of firewood in increase, and skidding of firewood in fall. Skidding with horses is done by a common technology of working.

2 METHOD OF WORKING

The methodology described in Z. Trajanov's doctoral thesis [3] has been used in the production of this scientific paper. Therefore, one should begin with the following mathematical principles.

The optimal density of road network is calculated by differential calculations, i.e. the first deduction from the total costs for transport.

The equation (1) is used for calculating the optimal density of road network for wood transport.

$$\frac{DTsum}{DGkp} = 0 \tag{1}$$

Total costs for horse skidding - *Tsuma*, are calculated with the equation (2).

$$Tsuma = Ta + Tkp + Tav \tag{2}$$

Tkp – costs for truck roads
Tav – costs for animal drags
Ta – costs for horse skidding

This formula is the basis for calculating the optimal density of road network. Similar methodology has also been used in other researches from this area, in the Republic of Macedonia, researches of R. Akimovski (2). The reason why this methodology is being used, as well as the introduction of changes, is because of the new mathematical software which can solve complicated problems. Therefore, in contrast to the past situations when many parameters have been neglected in order to get simpler formulae for calculation, the new software solutions do not put limits to the number of unknown parameters and the combining of various mathematical operations. The new software also provides us with flexibility, i.e. easy calculations for each situation separately, all in order to get more accurate results. This paper will analyze the solutions obtained for a specific situation in the practice of skidding of wood assortments with horses, in the mountain Plackovica in Republic of Macedonia.

For. review 43: 33 - 36. Skopje, 2012
Ss. Cyril and Methodius University in Skopje
Faculty of Forestry in Skopje

ISSN: 0585-9069

3 RESULTS FROM THE RESEARCH

This mathematical model for estimating the optimal density of road network as a basis for calculations takes the economic parameters, i.e. estimation of the minimal costs for a specific situation. The other functions of the road network are adjusted according to the result obtained. It means that the result obtained will go through as many transformations as needed, imposed by the other non-economic characteristics of the forest viewed by sociological, tourist, recreational, economic and environmental aspect.

The zones of optimal costs are best shown by a three-dimensional presentation. The costs of horse skidding in relation to the extent of using the volume of wood in the course of the period analyzed and the dependence from the density of road network is shown in diagram 1.

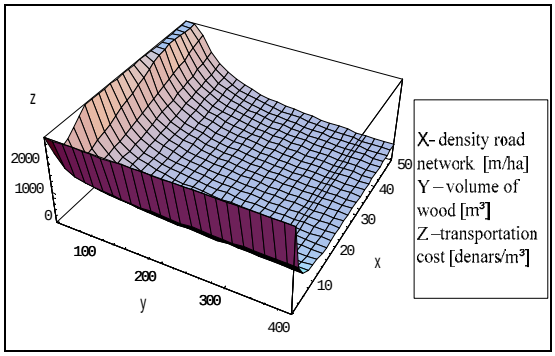


Diagram 1: Relation of the total costs of horse skidding to the volume of wood and the density of road network (1 euro = 61,5 denars)

From the diagram one can see that the costs are the biggest when using small volume of wood and in situations when there is little density of the road network. With increasing of the road density, as well as of the volume of wood, at the beginning the costs decrease intensively so that later they will start to decrease moderately.

3.1 Influence of the quantity and the quality of the forest which is being managed

The potential of the forest, such as the volume of woodcutting in quantity and quality, have influence on the optimal density of the road network.

On the basis of the methodology presented, one can establish a connection between the density of the road network and the volume of wood which is used in forest management in the course of the analyzed period of 100 years. At that, the optimal density is analyzed in four situations with different portions of the firewood (0.3, 0.6, 0.9, and 1.0) in relation to the total volume of wood which is used in the course of the analyzed period. Data about the optimal density of the road network in relation to the volume of wood is given in table I.

Table I: Optimal density of the road network in relation to the quantity of the volume of wood and the portions of firewood

Q[m³/ha]	50	150	250	350	450	500
coefficient	*Gkp [m/ha]*					
firewood (0,3)	9,8	19,5	26,6	30,3	34,2	36,0
firewood (0,6)	8,4	17,1	22,7	27,0	30,6	32,3
firewood (0,9)	6,8	14,2	19,3	23,1	26,4	27,8
firewood (1,0)	6,3	13,1	17,9	21,7	24,7	26,1

The results obtained for the optimal density of the truck road network in relation to the volume of wood, as well as to the portions of firewood, are graphically shown in diagram No.2.

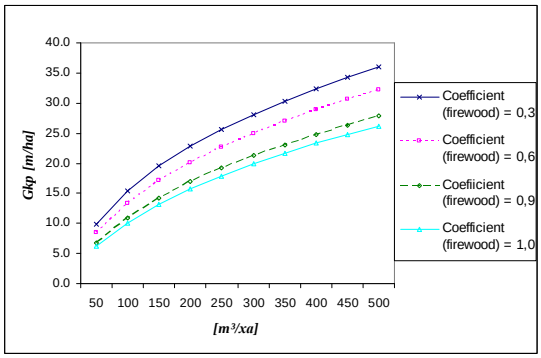


Diagram 2: Optimal density of the truck road network in relation to the quantity of the volume of wood and the portions of firewood

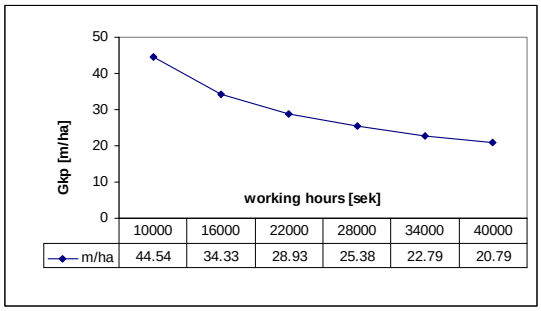
From the chart and the diagram, one can see that with the increase of the used volume of wood, there is also an increase of the optimal density of the road network. Moreover, if the portions of firewood are bigger, the density of the road network decreases even more.

If, under the same circumstances, only one parameter is being analyzed, one will see how it can influence the solution. In that way, when using on average 300 m^3/ha a year for the analyzed period of 100 years, and under the same circumstances of working, the following analyses can be received.

3.2 Influence of the technology of working, viewed by the length of working hours and efficient use of those working hours

The organization of the working process i.e. the choice of technology of work, as well as the efficient use of working hours, have an influence on the costs of transport. Therefore, there is an influence of the technology of working on the density of the road network.

The influence of the length of working hours for skidding of wood assortments in relation to the optimal density of the road network is graphically shown in diagram 3.

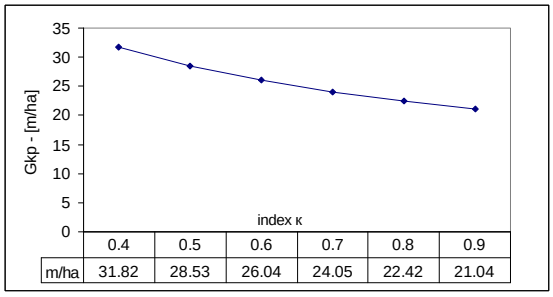


	10000	16000	22000	28000	34000	40000
m/ha	44.54	34.33	28.93	25.38	22.79	20.79

Diagram 3: Influence of the working hours during the day on the optimal density of the road network

The extension of working hours decreases the costs for skidding, i.e. it influences the decrease of the optimal density of road network. Therefore, in practice, all the factors which can shorten the normal working hours during the day should be avoided. In the practice, in Republic of Macedonia, a considerably negative model is the model of daily transport of the workers to their place of work. With such organizational arrangement, great losses have been made because of the lower productivity in working.

Despite the length of working hours, an important parameter is also the efficient use of those working hours, i.e. – a coefficient of efficient use of the working hours (index – k).



	0.4	0.5	0.6	0.7	0.8	0.9
m/ha	31.82	28.53	26.04	24.05	22.42	21.04

Diagram 4: Influence of index k – coefficient of efficient use of working hours – on the optimal density of road network

The influence of index k – coefficient of efficient use of working hours – on the optimal density of the road network, for the analyzed models, is shown in diagram 4. From the graphic presentation one can see that the optimal density decreases with the increase of the efficient use of working hours, i.e. by avoiding the stagnations in the working process.

3.3 Influence of the spatial arrangement of roads and the choice of the direction for skidding (factor x)

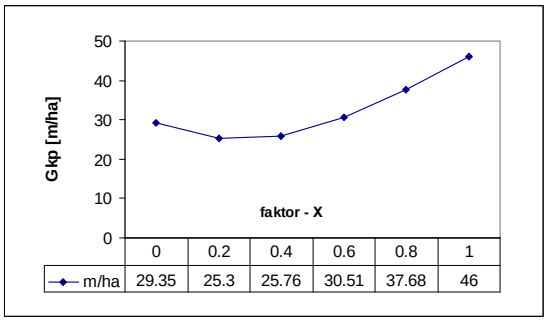
The choice of the type of skidding, in increase and in fall, is also a factor which can make a certain technology of working better or worse. By making the right choice whether certain assortments will be skidded in increase or in fall, the time for skidding can be shortened and with that the costs for skidding will be reduced as well.

The coefficient *xa* is a part (fraction) from the distance between truck roads *Rkp*, which should optimally be skidded in increase at the horse skidding.

According to the model covered by Z. Trajanov [3], with the help of analyzing the optimal time for skidding of all the assortments in a certain coppice, a theoretical model for determining the value of factor *xa* has been obtained.

With the help of differential estimating, i.e. by calculating the first deduction of *xa* by using the above mentioned technology, the value of *xa* can be established as 0.24. It means that the skidding would be made most optimally if 24% of the volume of wood which gravitates to the higher road, i.e. increase should be skidded in increase, and the rest should be skidded in fall. From this relation one can come to a quite logical conclusion that the horse while skidding in increase will not achieve good performance.

The data of the dependence of coefficient *x* or the area which would be skidded in increase in relation to the optimal road network is shown in diagram 5.



	0	0.2	0.4	0.6	0.8	1
m/ha	29.35	25.3	25.76	30.51	37.68	46

Diagram 5: Influence of coefficient *x* – the area which is skidded- on the optimal density of road network

The trend of optimal density decreases with the increase of coefficient *x* to a certain value, i.e. it reaches a minimum of the index at 0.24, after which there is a trend of increasing of the density of road network.

3.4 Influence of the non-economic aspects for opening the forest

Unlike the factors which are related to forest management and which can be calculated, in practice, the solution of the optimal density of the road network depends on many other factors which are not related to the forest management and which can not be expressed by a value. Thus, in practice, it is often necessary to build roads which will connect certain settlements, tourist facilities, recreational facilities, economic facilities, hunting facilities and so on. Also, it is of no less importance the significance of forest roads in relation to protection in general, primarily to protection from forest fire. Therefore, in practice, one should find a solution where the road would be multi-functional, and by doing so, one would get a good solution viewed from many different aspects, such as: functional, financial, economic and environmental aspect. In the end the projection of the road network should meet all the requirements of the forest.

4 CONCLUSIONS

- There is no universal solution to the problem of optimal density of the road network. A reason for that are the numerous parameters with a changeable character, which also have an influence on the optimization of the costs for transport.

 ISSN: 0585-9069

- As a basis for estimating the optimal density of road network, one takes the economic effect from working. Despite this basis, the solution would go through further corrections so that all the planned non-economic activities in the forest could be fulfilled.
- With the increase of the volume of wood which would be used in the analyzed period, the density of the road network increases as well.
- With the increase of the portions of firewood in the volume of wood which would be used in the course of the analyzed period, there is a decrease of the optimal density of the road network.
- With the extension of working hours during the work day, the optimal density of the road network is decreased.
- With the increase of the efficient use of working hours during the day, the optimal density of the road network is decreased.
- An ideal fraction of the distance between truck roads which should be skidded in increase is 0.24, whereas in fall a fraction of 0.76 should be skidded. The closer we are to the ideal fraction, the more the optimal density of road network decreases and then one can make the smallest costs in the process of transport.
- In practice, one must find a projection of the road network which would express a compromise of all the requirements of the forest.

5 REFERENCES

[1] Radovan Akimovski, Strasho Todorovski, Stanojko Angelov, “Research in skidding of beech tree logs with tractors in Macedonia“, Annual collection at the Faculty of Agriculture and Forestry – Skopje, 1968, Skopje.
[2] Radovan Akimovski, “Research into the problem of opening the forests in Macedonia“, annual collection at the Faculty of Agriculture and Forestry, 1966, Skopje.
[3] Trajanov Zdravko, “Models of optimal solutions of forest transport depending on the type of woodcutting at forest management”, doctoral thesis, University of Ss. Cyril and Methodius, 2008, Skopje.
[4] Trajanov Zdravko, Ljupcho Nestorovski “Dependence of the optimal density of the road network on the used volume of wood at skidding with horses”, Forestry Review, 2009, Skopje.

For. review 43: 37 - 41. Skopje, 2012

ISSN: 0585-9069
UDC: 630*27(497.11)
Original scientific paper
Paper submission: May, 2012

THE CONCEPT OF LANDSCAPING THE PARK ZONE OF THE ARBORETUM OF THE FACULTY OF FORESTRY IN BELGRADE

VUKIN M., ZIVANOVIC M.
University of Belgrade Faculty of Forestry, Belgrade, Serbia
Correspondig author e-mail address: marina.vukin@sfb.bg.ac.rs

ABSTRACT: The Arboretum of the Faculty of Forestry in Belgrade is a natural monument with representative floristic characteristics, which covers an area of 6.69 ha. It is a unique spatial-environmental unit within the city green space system with outstanding landscape features emphasized by its views towards the central area of the city of Belgrade and other sites of interests. This paper presents a landscape design plan for the extended zone of the Arboretum, which should make a separate compositional and functional unit of this protected natural area. It will be 0.40 ha in size. The concept of landscaping involves construction and establishment of the following garden-landscape elements and other facilities: an entry area with a system of pathways, a multi-purpose plateau, a sensory garden, pavilions, water area, lawns, perennial gardens, tree groups and alleys.
Keywords: arboretum, park zone, design

1 INTRODUCTION

The Regional Spatial Plan for the City of Belgrade Administrative Area (2011) puts a special emphasis on the necessity to create new landscape site design plans for certain spatial-environmental units and other areas of the urban city structures [9]. As a special-purpose area and a spatial-environmental unit located in the vicinity of the city center, Arboretum of the Faculty of Forestry in Belgrade has a multi-functional significance in the city system of green spaces.

The Arboretum of the Faculty of Forestry is a protected natural area in the category of natural monuments and anthropogenic urban ecosystems with an array of functions: educative, scientific, decorative, ecological, cultural, tourist and many others [5,6]. Since the area is in the process of reconstruction, some parts of the central zone of the Arboretum as well as the extended zone do not still serve their primary purpose. One of the most important tasks of the reconstruction and recultivation of the extended zone is to landscape the park zone.

Considering the above mentioned the following research task ensued:

- to define the present state of the area planned for the park zone;
- to present the concept of landscaping the park zone with new facilities, using model presentations.

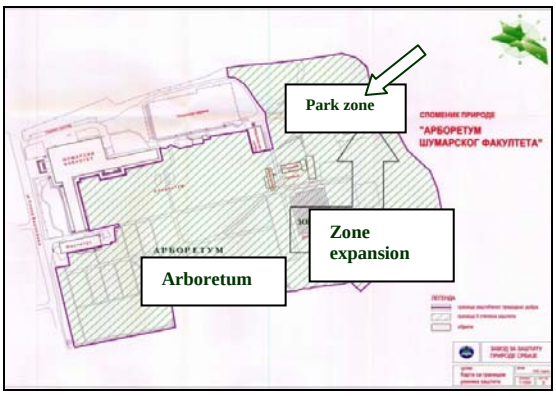
2 MATERIAL AND METHODS

This paper is based on the material obtained from the plans and technical documentation of the Faculty of Forestry yard and arboretum, which together cover an area of 9.70 ha. The arboretum itself covers an area of 6.69 ha. According to the *Master plan for the Natural monument `Faculty of Forestry Arboretum`* for the period from 2011 to 2020, a park zone is planned to be build within the zone of extension of this spatial entity [11]. The future park zone, which is the subject of this paper, will cover an area of 0.40 ha. Methodology of work is based on graphic presentation of the concept of landscaping the zone. Software packages AutoCAD 2013 and digital modelling - 3D presentations were used for this purpose [1,3,7]. The work was carried out in three stages: preliminary stage (inspection of surveying basics – Cadastral and Topographic plans of the faculty yard, field surveying), recording the current state and landscape design plan development.

3 RESULTS AND DISCUSSION

3.1 Basic data on the current state

Map 1 shows the current state of the Arboretum. The area of the future park zone, which makes the northeast part of the extension zone, is marked. This spatial presentation of the Arboretum reveals its outstanding landscape characteristics determined by its location in the vicinity of the city center and by the essential values that are reflected in the authenticity, representativeness and landscape attractiveness of this place. [5].



Map 1: Map of the Arboretum with its protection regime borders
(source study: *Protection of the Arboretum of the Faculty of Forestry in Belgrade*, Institute for Nature Conservation, 2010) [8]

The existing vegetation was recorded (*Map 2*) and a manual of dendroflora evaluation was done (*Table I*). Each existing specimen had its area determined, estimation elements measured, health state and vitality evaluated and functional-aesthetic values determined. Among the registered broadleaved species, Turkey oak *Quercus cerris* L. and Flowering ash *Fraxinus ornus* L., are dominant and they will be preserved. On the other hand, 19 specimens of different autochthonous broadleaved species are planned to be felled due to their bad health state and low quality. Silvicultural-sanitation measures (such as removal of diseased, damaged and

ISSN: 0585-9069

dead trees, crown pruning and shaping, application of control measures etc.) should be carried out on the retained trees. The soil of the whole protected natural area is characterized as *lessive brown soil* [6]. The soil cover of the whole studied area (0.40 ha), which includes the park zone accessible to wheeled vehicles and adjacent to tennis courts is of poor quality and anthropogenically altered.

Map 2: The existing vegetation site plan

Table I: Manual of dendroflora evaluation

Species	D_t (cm) / h (m)	Crown width (m)	Health state	Decorative value	General assessment	Note (to be
Robinia pseudoacacia L.	60,0 / 19,5	6,0	4	2	3	-
Acer pseudoplatanus L.	34,0 / 19,0	5,0	4	2	3	-
Acer pseudoplatanus L.	32,0 / 15,0	6,0	5	4	4	+
Acer pseudoplatanus L.	43,0 / 19,0	6,0	5	4	4	+
Acer pseudoplatanus L.	36,0 / 19,0	6,0	5	4	4	+
Juglans regia L.	25,0 / 10,0	8,0	4	3	3	+
Juglans regia L.	25,0 / 11,0	8,0	4	3	3	+
Populus nigra L.	35,0 / 19,0	5,0	4	4	4	+
Juglans regia L.	24,0 / 11,0	5,0	4	3	3	+
Juglans regia L.	25,0 / 9,0	7,0	4	2	2	+
Juglans regia L.	30,0 / 15,0	8,0	4	3	3	+
Populus nigra L.	32,0 / 19,0	5,0	4	4	4	+
Populus nigra L.	28,0 / 18,0	5,0	4	3	3	+
Populus nigra L.	37,0 / 19,0	6,0	4	3	4	+
Betula pendula Roth.	27,0 / 18,0	5,0	5	5	5	+
Betula pendula Roth.	22,0 / 16,0	5,0	3	3	3	+
Betula pendula Roth.	24,0 / 15,0	5,0	3	2	3	+
Betula pendula Roth.	18,0 / 12,0	4,0	3	3	3	+
Betula pendula Roth.	32,0 / 15,0	6,0	3	3	3	+
Prunus cerrasifera Ehrh.	5,0 / 5,0	2,0	5	3	3	-
Acer negundo L.	22,0 / 12,0	10,0	5	1	3	-
Juglans regia L.	13,0 / 11,0	6,0	5	5	5	+
Ulmus campestris L.	17,0 / 12,0	5,0	4	5	5	+
Fraxinus ornus L.	12,0 / 10,0	1,5	2	1	2	-
Fraxinus ornus L.	4,0 / 4,0	1,5	2	2	2	-
Quercus cerris L.	17,0 / 15,0	5,0	5	5	5	+
Quercus cerris L.	5,0 / 7,0	2,0	2	2	2	-
Quercus cerris L.	11,0 / 11,0	3,0	2	2	2	-
Quercus cerris L.	14,0 / 12,0	3,0	2	2	2	-
Quercus cerris L.	42,0 / 21,0	10,0	5	5	5	+
Quercus cerris L.	6,0 / 5,0	2,0	2	2	2	-
Quercus cerris L.	11,0 / 11,0	3,0	2	2	2	-
Robinia pseudoacacia L.	23,0 / 18,0	5,0	2	1	2	-
Fraxinus ornus L.	16,0 / 13,0	3,0	2	2	2	-
Fraxinus ornus L.	14,0 / 9,0	3,0	5	4	4	+
Fraxinus ornus L.	9,0 / 10,0	3,0	5	4	4	+
Fraxinus ornus L.	10,0 / 12,0	3,0	5	4	4	+
Quercus cerris L.	24,0 / 21,0	6,0	5	5	5	+
Quercus cerris L.	5,5 / 9,0	2,0	2	2	2	-
Quercus cerris L.	42,0 / 23,0	10,0	5	5	5	+
Fagus moesiaca (Maly) Czeczott.	17,0 / 13,0	4,0	2	2	2	-
Fagus moesiaca (Maly) Czeczott.	19,0 / 13,0	3,0	2	2	2	-
Juglans regia L.	70,0 / 26,0	20,0	5	5	5	+
Juglans regia L.	70,0 / 25,0	20,0	5	5	5	+
Acer pseudoplatanus L.	15,0 / 10,0	1,5	2	2	2	-
Acer negundo L.	18,0 / 12,0	1,5	2	2	2	-
Ailanthus altissima (Mill.) Sw.	22,0 / 16,0	6,0	2	1	2	-
Ailanthus altissima (Mill.) Sw.	25,0 / 16,0	7,0	2	1	2	-
Juglans regia L.	18,0 / 10,0	9,0	2	2	2	-

3.2 The concept of landscaping the park zone

The proposed park zone is a value of great functional and structural significance within the Arboretum. The value of this park zone is increased by the fact that it allows a view of the newly built Ada bridge over the river Sava and other sites of interest in the center of the city.

Map 3 presents the site-grading plan, with the spatial arrangement of the basic elements of the designed park zone. This park zone as a macro-unit contains the following elements:

- entry area with a system of pathways;
- a multi-purpose plateau;
- sensory garden;
- pavilions;
- water area;
- lawns;
- perennial gardens;
- groups of trees;
- alleys.

Map 3: Site-grading plan of the park zone

The design of the park composition with its garden and architectural elements and with other infrastructure elements is presented in *Map* 4.

Map 4: Design plan of the park zone

A 3D modelling design with the layout of vegetation and plant collections is presented in *Figure 1.*

Figure 1: Concept plan of park zone landscaping (3D presentation)

The entry area (1) starts in the north-west part of the park zone, and the system of pathways (2) enables a good interconnectedness of all elements of the designed object and good movement dynamics, directing the visitors towards the focal points and other parts of the Arboretum. The total area of pathways and roads within the entry area and the park zone itself amounts to 1 278.70 m^2. Pathways account for 374.00 m^2, and roads for 904.70 m^2. The system of communication lines designed in such a way makes an impression of spatial unity and harmony, with a strong balance between the contents of the space and the logical sequence of garden-architectural and other components of the contents. Vegetation is modelled in the style of parterres and emphasizes the movement direction. The multi-purpose plateau (3), 82.41 m^2 in size, is designed as a circular area, with semi-circular stone benches and a rectangular wooden pergola (*Figure 2*). This area, characterized by outstanding views of the Ada bridge and other parts of the central and wider area of the city is designed for visitor receptions and educational activities. The sensory garden (4), 90.00 m^2 in size, is designed to meet the needs of horticultural therapy and education of people with special needs, (*Figure 3*), with the purpose of stimulating different sensations and abilities. It is designed in four circular plateaus. The proposed plant species are planted in semi-circular concrete plant boxes, 70 cm in height. Each plant box contains species that encourage specific senses – smell, sight, touch or taste. Pavilions (5) make 2 separate units, where visitors can spend some time and enjoy the views of the city sites of interest (*Figure 4*). Water area (6) covers 46.20 m^2 and makes a microambient along the south-east border of the park zone with vegetation typical of aquatic ecosystems (*Figure 5*). Most of it receives enough sunlight, but a smaller part is in the shade of the existing dendroflora.

Figure 2: Multi-purpose plateau

Figure 3: Sensory garden

Figure 4: A part of the pavilion by the sensory garden

Figure 5: Water area

3.3 Landscaping the spare areas

Since this paper presents a design solution with the definition of the basic elements, it will provide general guidelines for landscaping and designing the spare areas.

For. review 43: 37 - 41. Skopje, 2012
Ss. Cyril and Methodius University in Skopje
Faculty of Forestry in Skopje
ISSN: 0585-9069

(*Table II*). The total area of the green spaces, which comprise lawns, areas covered with deciduous and evergreen shrubs, perennials, and prostrate conifers amounts to 2,588.89 m^2. Landscaping the spare areas consists of establishing lawns, perennial gardens, groups of trees and alleys (*Map 5*). The total area of lawns is 2,548.89 m^2 (*Map 6*). Lawn T_1 accounts for 960.00 m^2 of the area, lawn T_2 for 1,093.89 m^2, lawn T_3 for 195.00 m^2 and lawn T_4 for 300.00 m^2.

Table II: Growing stock specification

ordinal number	Species	pieces
I Broadleaved trees		
1.	*Fraxinus excelsior "Globosa"*	21
2.	*Ginkgo biloba* L.	3
3.	*Liriodendron tulipifera*	4
4.	*Magnolia x soulangeana* Soul.-Bod.	4
5.	*Albizia julibrissin* Durazz.	10
6.	*Liquidanbar styraciflua* L.	6
7.	*Fagus sylvatica "Atropurpurea"*	9
8.	*Acer platanoides "Crimson King"*	16
	TOTAL:	**73**
II Coniferous trees		
9.	*Chamaecyparis lawsoniana "Ellwoodii"*	4
10.	*Cedrus atlantica "Glauca"*	3
	TOTAL:	**7**
III Prostrate Conifers		
11.	*Juniperus horizontalis "Wiltonii"*	16
	TOTAL:	**16**
IV Evergreen shrubs		
12.	*Prunus laurocerasus* L.	24
	TOTAL:	**24**
V Deciduous shrubs		
13.	*Weigela florida* (Bunge) A.DC.)	10
14.	*Deutzia gracilis* Sieb. et Zucc.	7
15.	*Spiraea bumalda*	5
	TOTAL:	**22**
VI Perennials		
a.	*Santolina rosmarinifolia*	72
b.	*Lavandula officinalis*	50
c.	*Coreopsis grandiflora*	45
d.	*Thymus sp.*	25
	TOTAL:	**192**
VII Decorative grasses		
e.	*Imperata cylindrica*	55
f.	*Festuca glauca*	70
g.	*Carex sp.*	61
h.	*Cortaderia selloana*	2
	TOTAL:	**188**
VIII Plants in the sensory garden		
	Taste and Smell/1	
	Ocimum basilicum	10
	Allium schoenoprasum	16
	Petroselinum sp.	15
	Melissa officinalis	16
	Origanum vulgare	16
	Anethum gravedens	16
	Smell	
	Lavandila officinalis	21
	Santolina chamaecyparissus	13
	Rosmarinus officinalis	10
	Helychrisum arenarium	5
	Touch	
	Stachys lanata	10
	Salvia officinalis	10
	Festuca glauca	10
	Sedum spectabila	16
	Sedum acre	16
	Taste and Smell/2	
	Coriandrum sativum	16
	Mentha sp.	24
	Thymus citrodorus	20
	Apium graveolens	26
	TOTAL:	**286**
IX Climbers		
p_1	*Lonicera caprifolia*	100
p_2	*Parthenocissus tricuspidata*	86
p_3	*Wisteria sinensis*	6
	TOTAL:	**192**

Map 5: Planting plan with growing stock specifications

The lawns are exposed to direct sunlight and they are intended to be established by sawing grass seed, in the quantity of 2.5-4 kg/100 m^2. The grass mixture has the following composition:

Festuca rubra var. *commutata* 40%
Poa pratensis 20%
Lolium perennials 25%
Trifolium repens 15%

Map 5 and 6 presents the design of 5 areas covered with perennials (a, b, c, d). Several tree groups and alleys are also planned to be established. A detailed analysis envisages planting of decorative broadleaved cultivars, that will be dominant in the future dendrofund and a smaller number of conifers of different modes of growth, structure and colour. Broadleaved seedlings should be 6-8 years old (*Figure 6*) and coniferous seedlings should be 4-6 years of age. The seedlings of prostrate conifers aged 2-4 years, evergreen shrubs aged 2-4 years and deciduous shrubs aged 2-4 should be used.

The alleys are composed of attractive species of diverse forms. They are not straight, but follow the pathways within the park zone along the lawns. All species should be of great functional-esthetical and ecological value, adapted to urban living conditions [2,4].

Map 6: Lawn area plan

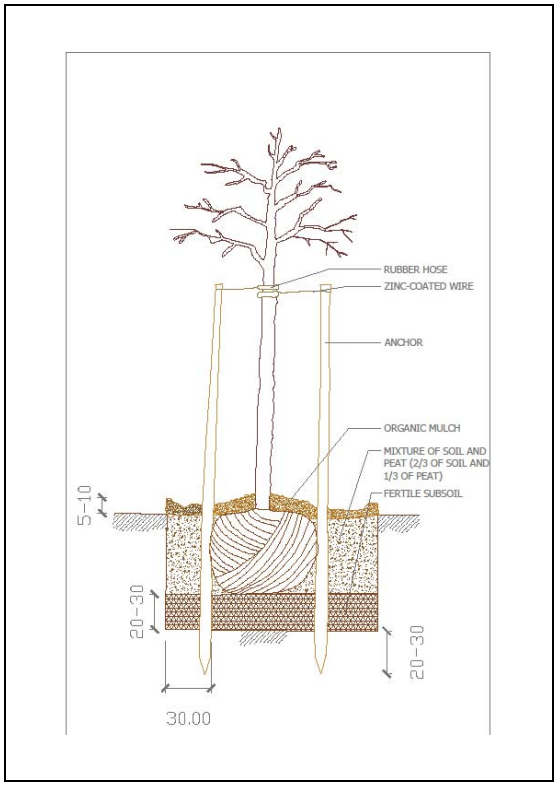


Figure 6: Planting a standard broadleaved balled and burlapped seedling

4 CONCLUSIONS

The concept of landscaping the park zone of the Faculty of Forestry Arboretum in Belgrade involves planning the layout of landscape-architectural elements and enhancing the functionality and esthetics of the space in this spatial-environmental unit which is of great importance in the system of city green spaces and protected areas. Area park zone is 0.40 ha. In line with the need to present and promote this multi-functional space, the following components have been defined by using graphic presentations and 3D modelling: an entry area, a system of pathways (1,278.70 m^2); a multi-purpose plateau (82.41 m^2); a sensory garden (90.00 m^2); water area (46.20 m^2); lawns (2,548.89 m^2); pavilions; perennial gardens; groups of trees and alleys. Along with the registration and evaluation of the existing vegetation (components that will be largely preserved), landscaping and designing of the spare areas also involve establishment of lawns, perennial gardens, alleys and groups of trees. Composition design of the park zone of the Arboretum is an overall graphic-modelling presentation of landscaping this functional unit. An elaborate analysis of the defined units will be the next stage of the spatial design of this structure. Besides other elements of this spatial entity, the designed green spaces and the planned park and architectural furniture contribute to the harmonization of the whole area as an protected environmental entity.

5 REFERENCES

[1] Cantrell, B., Michaels, W. (2010): Digital Drawing for Landscape Architecture: Contemporary Techniques and Tools for Digital Representation in Site Design. John Wiley and Sons Ltd, United Kingdom.

[2] Cvjeticanin, R., Perovic, M. (2010): Prakitikum iz dendrologije za osnovne akademske studije na Šumarskom fakultetu za studijske programe Šumarstvo i Ekološki inženjering u zaštiti zemljišnih i vodnih resusrsa. Univerzitet u Beogradu Šumarski fakultet. Beograd.

[3] Finkelstein, E. (2006) AutoCAD 2007 and AutoCAD LT 2007 Bible. Indianapolis: Wiley Publishing.

[4] Vukicevic, E. (1982): Dekorativna denrdrologija. Udžbenik. Beograd.

[5] Vukin, M., Stavretovic, N., Ostojic, D. (2010): Significance of the Arboretum of the Faculty of Forestry in Belgrade in public Participation in Environmental protection. Procedeeings. *XVIII Scientific and Professional Meeting 'Ecological Truth' Eco-Ist'10*. University of Belgrade – Technical Faculty in Bor. Banja Junakovic, Apatin, Serbia, June 01-04.

[6] Vukin, M. (2010): Arboretum Šumarskog fakulteta u Beogradu. Univerzitet u Beogradu Šumarski fakultet. Beograd. (pp. 1-113)

[7] Tanasic, R., Bajkin, A. (2007): Grafički programi u pejzažnoj arhitekturi. Savremena poljoprivredna tehnika. Vol. 33, br. 3-4. Novi Sad.

[8] (2010): *Studija zaštite Arboretuma Šumarskog fakulteta u Beogradu*. Zavod za zaštitu prirode Srbije. Beograd. Rukovodilac studije dr Dragana Ostojić.

[9] (2011): *Regionalni prostorni plan administrativnog područja grada Beograda. http: //www.beograd.rs*

[10] (2011): *Plan upravljanja Spomenika prirode „Arboretuma Šumarskog fakulteta" za period 2011-2020. godine*

For. review 43: 1 - 76. Skopje, 2012
Ss. Cyril and Methodius University in Skopje
Faculty of Forestry in Skopje

ISSN: 0585-9069

For. review 43: 42 - 45. Skopje, 2012

ISSN: 0585-9069
UDC: 631.413.4(497.7)
Preliminary communication
Paper submission: May, 2012

CONTENT OF EXCHANGEABLE CATIONS IN ALBIC LUVISOLS IN REPUBLIC OF MACEDONIA UNDER DIFFERENT VEGETATIVE COVER

ANDREEVSKI M., MUKAETOV D.
Ss. Cyril and Methodius University in Skopje, Institute of Agriculture, Skopje, Macedonia
Correspondig author e-mail address: m.andreevski@zeminst.edu.mk

ABSTRACT: Main goal of the examinations presented in this paper is to conduct in depth analysis of adsorption complex of albic luvisols in Republic of Macedonia, with a special emphasis on the content of exchangeable cations. On several location of the country, 23 soil profile of albic luvisols were excavated; 15 soil profiles under forest vegetation, 4 under grass vegetation and 4 under cultivated crops.
The results derived during the investigations showed that CEC has its highest values in the surface horizon of albic luvisols under forest vegetation (high percentage of organic matter), lower values of CEC are determined in soil profiles under grass vegetation, while the lowest values of this parameter were obtained in cultivated albic luvisols (intensive decomposition of organic matter due to cultivation).
Albic luvisols uder forest vegetation have lower values of sum of exchangeable basic cations, higer sum of acid cations ($H^+ + Al^{+++}$) and lower values of base saturation percentage (V%). In all examinated soil profiles of albic luvisols predominant cation is calcium, magnesium have smaller quantities wile the quantities of potassium and sodium are neglegible.
Keywords: albic luvisol, cation exchange capacity, exchangeable basic cationect

1 INTRODUCTION

The content of exchangeable ions is significant indicator for the soil formation conditions. Many processes and characteristics of soil depend of cation exchange capacity (CEC) and it's content.

Data regarding the content of the exchangeable ions of albic luvisols in R. of Macedonia can be finding in the previous work of [5, 8, 10, 11, and 12]. After revision of previous work, we couldn't find data regarding the content of adsorbed ions of albic luvisols developed under different vegetative cover in R. of Macedonia. Due to that have conducted a detailed research of the content of exchangeable ions under forests and grass vegetative cover and cultivated albic luvisol and to contribute towards better exploration of this soil type. The aim of this research is to investigate the impact of forest, grassland and cultural vegetation on the content of exchangeable cations in albic luvisols in Republic of Macedonia.

2 MATERIAL AND METHODS

On different locations of the country, 23 soil profiles of albic luvisols were excavated and morphologically described on the field. More than half of soil profiles (15) were under forest vegetation, 4 soil profiles were under grass and the other 4 on arable land.

Field examinations have been performed according to accepted methods in Former Yugoslavia [13].
The laboratory analyses have been done according to the standard adopted methods in Former Yugoslavia and Republic of Macedonia, as follows:
Mechanical composition of soil has been determined by pipette method [9]; the dispersion of the particles has been done with 0,4N Na-pyrophosphate. The separation of the mechanical elements in fractions has been done by the international classification [6].

- pH (reaction) of the soil solution has been determined with glass electrode in water suspension and in NKCI suspension [6].
- The total N has been determinate by Kjeldahl micromethod [1].
- Easy available forms of P_2O_5 and K_2O were determinate by Al method [4]
- The content of humus has been determinate at the base of total carbon by the method of Tjurin modified by Simakov [7]
- Extraction with barium chloride three-ethanolamine in glass colons (Melich method) was used for quantification of acid exchangeable cations ($H^+ + Al^{+++}$). The extract is titrated with 0,04 N HCl in a presence of mixed indicator [1]
- Extraction with BaCl2 (Hendershot and Duquette method [16]) was used for quantification of the exchangeable cations (Ca^{++}, Mg^{++}, K^+, Na^+). Readouts were accomplished on AAS, “Varian”.

Cation exchange capacity (T), sum of basic exchangeable cations, and base saturation percentage (BSP) as well as the percentage of particular ions saturation were calculated.

3 RESULTS AND DISCUSSION

In order to give a correct interpretation of the results for CEC and the content of exchangeable cations of albic luvisols formed under different vegetative cover, a detailed overview of the mechanical composition and some chemical properties will be given. Average results of 15 soil profiles under forest vegetation, 4 soil profiles under grass and 4 soil profiles on arable land are presented in Table 1 and 2.

Cation exchange capacity is directly correlated with total amount of clay minerals, SOM and reaction of extracting solution used for its quantification [14].
CEC data of the examined albic luvisoil profiles are presented in Table 3. Out of the presented data, differences in CEC between particular horizons can be observed. These differences are mainly due to the higher SOM accumulation in topsoil, leaching (translocation) of clay minerals from topsoil and eluvial (E horizon) into the argiluvic (Bt horizon), layer structure of the sediments, cultivation and the inherit quantum of clay minerals from the previous stadium of soil evolution.

For. review 43: 42 - 45. Skopje, 2012
Ss. Cyril and Methodius University in Skopje
Faculty of Forestry in Skopje
ISSN: 0585-9069

Table I: Mechanical composition of albic luvisol

Hor.	Skeleton > 2mm	Coarse sand 0,2-2mm	Fine sand 0,02-0,2mm	Silt 0,002-0,02mm	Clay <0,002 mm
			Grass vegetation		
A	7.79	11.50	52.53	22.48	13.50
E	12.29	11.78	51.28	23.45	13.50
Bt	6.11	8.41	40.50	20.10	30.99
BtC	9.51	15.30	29.90	30.10	24.70
C	8.17	7.55	43.00	16.20	33.25
			Arable land		
Ap	8.60	8.70	38.70	27.10	25.50
Bt	2.57	5.25	27.26	21.13	46.36
BtC	4.50	3.40	22.43	22.90	51.27
C	1.65	6.67	30.97	14.90	47.47
			Forest vegetation		
A	8.90	11.26	47.94	25.01	15.79
E	15.63	11.74	44.11	27.26	16.89
Bt	8.09	8.35	36.99	23.42	31.24
BtC	5.11	8.62	40.42	20.32	30.64
C	6.87	11.31	39.44	20.09	29.16

Table II: Chemical properties of albic luvisol

Hor.	SOM %	C/N	pH		Total	Easy av. mg/100g	
			H_2O	NKCl	N%	P_2O_5	K_2O
				Grass vegetation			
A	4,52	10,14	5,93	4,95	0,26	2,05	23,85
E	2,10	9,42	5,79	4,66	0,13	<1	14,25
Bt	0,98	8,14	5,89	4,55	0,08	<1	14,63
BtC	0,77	4,47	6,95	5,65	0,10	<1	10,30
C	0,54	9,69	6,20	4,65	0,04	<1	15,75
				Arable land			
Ap	2,65	7,52	5,81	4,78	0,20	11,75	32,40
Bt	0,92	6,21	6,01	4,92	0,09	3,44	28,56
BtC	0,80	6,29	5,95	4,90	0,08	<1	22,60
C	0,48	5,05	6,80	5,73	0,06	<1	22,60
				Forest vegetation			
A	7,10	13,45	5,56	4,61	0,30	6,37	28,67
E	2,07	10,71	5,23	4,00	0,11	<1	12,89
Bt	0,90	8,38	5,45	4,07	0,07	<1	16,20
BtC	0,64	7,44	5,53	4,08	0,05	<1	18,42
C	0,43	6,29	5,93	4,61	0,05	<1	18,20

Cation exchange capacity has its highest values in topsoil of the soil profiles formed above the forest vegetation (21,17 cmol (+) kg^{-1} soil) due to high SOM percentage, and in soil profiles formed under grass vegetation (18,10 cmol (+) kg^{-1} soil), while its lowest values were found in soil profiles on cultivated sites (14,65 cmol (+) kg^{-1} soil) which is result of intensive mineralization of SOM. The decreasing of CEC in eluvial horizon is much more intensive in soils under forest vegetation (11,98 cmol (+) kg^{-1}soil) than in albic luvisols under grass vegetation. (13,04 cmol (+) kg^{-1} soil). This is result of rapid decreasing of SOM quantity in the eluvial horizon of albic luvisols under forest vegetation. There are slight differences in CEC values between horizons Bt, BtC and C which are mainly result of the character of clay minerals and its content.

It should be noticed that CEC in argiluvic (Bt) horizon of soils under forest and grass vegetation is lower in comparison with surface horizon, while in soil profiles on cultivated sites CEC in topsoil is lover than in Bt horizon. Despite the high content of clay in Bt horizon of albic luvisols under forest and grass vegetation, its CEC has lower values than in topsoil, which is due to the high SOM in surface horizon A. Cultivated soils have lower content of organic matter hor. Ap, so the influence of humus on CEC is low.

Table III: Exchangeable cations content in albic luvisol

Hor.	Exchangeable cations in cmol (+)kg^{-1} soil					
	Ca^{2+}	Mg^{2+}	K^+	Na^+	S	H^++Al^{3+}
			Grass vegetation			
A	8,40	2,23	0,44	0,27	11,33	6,78
E	5,83	1,65	0,20	0,14	7,81	5,23
Bt	6,73	2,17	0,17	0,27	9,40	6,04
BtC	8,92	2,38	0,17	0,21	11,67	3,10
C	7,04	1,69	0,15	0,35	9,21	5,30
			Arable land			
Ap	6,54	1,48	0,49	0,17	8,68	5,98
Bt	7,05	2,15	0,32	0,25	9,77	6,20
BtC	9,65	2,69	0,23	0,21	12,78	8,77
C	8,82	2,20	0,17	0,24	11,42	4,63
			Forest vegetation			
A	7,15	2,36	0,47	0,22	10,19	10,98
E	3,47	1,43	0,16	0,17	5,23	6,75
Bt	5,05	2,35	0,18	0,24	7,81	8,40
BtC	5,04	1,98	0,15	0,18	7,35	7,24
C	4,96	1,65	0,17	0,20	6,97	7,01

The sum of basic cations mainly depends on CEC and percentage of base saturation (BSP). Cultivated albic luvisol and those under grass vegetation have higher average values of sum of basic cations in comparison with albic luvisols under forest vegetation which is a result of so called biological accumulation of basic ions. Opposite to this, the exchangeable acid cations (H^+ + Al^{+++}) shows higher values in soils under forest vegetation in comparison with cultivated albic luvisols and those under grass vegetation. The process of acidification is more intensive in soil profiles under forest vegetation, therefore sum of basic cations is low, while acid cattions have high values

Base saturation percentage (BSP) has lower values in albic luvisols under forest vegetation than cultivated and soils under grass vegetation. Albic luvisols under forest vegetation are formed on higher altitudes with higher annual precipitations. This situation coupled with the modest content of basic cations in forest litter leads to poor content of basic cations and more intensive process of acidification in this soil profiles in comparison to the soil profiles under cultivation and grass vegetation.

In cultivated albic luvisols, basic materials are incorporated with application of fertilizers. This is another reason for base saturation of these soils.

The quantity of particular adsorbed ions in albic luvisols is significantly related to the parent material

mineralogical content, or more precisely what type of decaying products are predominant in parent material: basic, acid of carbonate rocks products.

Table IV: Percentage of exchangeable cations in albic luvisol

Hor.	Exchangeable cations in % of T					T	V%
	Ca^{2+}	Mg^{2+}	K^{+}	Na^{+}	$H^{+}+Al^{3+}$		
Grass vegetation							
A	46,30	12,29	2,47	1,52	37,43	18,10	62,56
E	44,28	12,39	1,63	1,17	40,55	13,04	59,44
Bt	43,17	13,91	1,09	1,89	39,67	15,44	60,33
BtC	60,38	16,11	1,13	1,42	20,98	14,77	79,02
C	51,45	11,85	1,05	2,58	33,08	14,51	66,92
Arable land							
Ap	42,76	9,69	3,23	1,17	43,16	14,65	56,84
Bt	44,51	13,79	2,09	1,83	37,78	15,97	62,22
BtC	43,61	12,24	1,16	0,97	42,02	21,54	57,98
C	62,47	14,98	1,17	2,16	19,22	16,05	80,78
Forest vegetation							
A	35,79	11,76	2,36	1,13	48,96	21,17	51,04
E	28,88	11,98	1,25	1,42	56,41	11,98	43,59
Bt	32,17	14,76	1,12	1,51	50,44	16,21	49,56
BtC	37,80	14,18	1,08	1,22	45,73	14,59	54,27
C	38,76	12,23	1,24	1,39	46,38	13,98	53,63

Bistratification of the soil profile and the pedogentic process also have an important influence on the content of adsorbed ions. With the processes of debasification and acidification the adsorbed basic ions from hor. A and E are leached and translocated into hor. Bt, BtC and C. For the soil under natural vegetation so called biological accumulation have an important rolle on accumulation of basic ions in hor. A. In cultivated albic luvisols the content of adsorbed ions is significantly changes due to the mixing of genetic horizons which have different content of adsorbed cations. Total content of adsorbed ions expressed in cmol (+) kg^{-1} soil will depend on the quantity of SOM, clay minerals content and the caracter of clay minerals [15].

Generally speaking in all examined profiles of albic luviosls dominant cation is Ca, and Mg, while potassium and sodium are presented with minimum quantities. Some slight differences of this parametar were determined between cultivated albic luvisols and soils under forest and grass grass vegetatin (table 3).

In all horizons the content of exchangeable Ca (% of T) is lower in the exeminated albic luvisols under forest vegetation in comparison to the cultivated and albic luvisols under grass vegetation, whille the content of acid cations is higher in soils under forest vegetation. Culivated albic luvisols and those under grass vegetation contains higher quantities of exchangeable Ca and lower content of acid cations, mainly due to the weaker process of acidification on lower altitudes and higher biological acummulation of Ca originated from grass vegetation and remains from cultuvated crops. According Jarceva [2,3] cultivation and the input of fertilizers have influence on decrease of exchangeable acidity.

The higest content of exchangeable K^{+} was detected in cultivated albic luvisols and is result of input of organic and mineral fertilizes.

4 CONCLUSION

Cation exchange capacity in argiluvic hor. Bt in soil profiles under forest and grass vegetation cover is lower in comparison to surface horizon. In cultivated soil profiles an opposite situation was detected, CEC is lower in topsoil and increase in Bt horizon.

The sum of basic cations have higher values in cultivated soils and soils under grass vegetation in comparison to albic luvisols under forest, while the exchangeable acid cations have higher values in soil under forest in comparison to the cultivated soils and soils under grass vegetation.

The examined albic luvisosl profiles under forest vegetation have lower base saturation percentage in comparison to the cultivated and soil under grass vegetation.

In all examined profiles of albic luvisols the dominant exchangeable cation is Ca, the next cation with slightly lower content is Mg, while the content of potassium and sodium in CEC is negligible.

5 REFERENCES

[1] Bogdanović M. red. et al., Hemiske metode ispitivanja zemljišta. JDPZ. Beograd, (1966), pag.270.

[2] Ivović P., Mijović R., Zemljišta novih obradivih površina Kosova i Metohije. Viša poljoprivredna škola, Priština, (1969), pag. 42-106.

[3] Ivović P., Mijović R., Promene izmenljive kiselosti na novim obradivim površinama Kosova i Metohije. Agrohemija, No 3-4, Beograd,(1969a), pag. 107-110.

[4] Manojlovic S., Rajkovic Z., Glincic M., Sestic S., Prirucnik za sistematsku kontrolu plodnosti zemljista i upotrebu djubriva (1969), Pag. 114

[5] Mitkova T., Sostav na razmenlivite (atsorbirani) joni na cimetnite šumski počvi vo kumanovskiot i prilepskiot reon. Magisterski trud. Zemjodelski fakultet, Skopje (rakopis) ,(1992), pag. 80

[6] Mitrikeski J., Mitkova T., Praktikum po pedologija. Univerzitet "Sv. Kiril i Metodij"- Skopje, Zemjodelski fakultet. Skopje, (2001), pag. 1-165

[7] Orlov S. D., Grišina A. L., Praktikum po himii gumusa. Izdatelstvo Moskovskogo univerziteta, (1981), pag. 271.

[8] Popovski D., Ispitivanja adsorptivnog kompleksa crvenica NR Makedonije. Arhiv za poljoprivredne nauke, god. XIV, sv. 46, Beograd, (1961), pag.1-14.

[9] Resulović H. red. et al., Metode istraživanja fizičkih svojstava zemljišta. JDPZ. Beograd, (1971), pag. 207

[10] Spirovski J., Počvite pod šuma od ploskač (Quercus conferta) vo poširokata oblast na Demir Kapija. Godišen zbornik na Zemjodelsko-Šumarskiot fakultet, kn. XIX, Skopje, (1966), pag. 589-609

[11] Spirovski J., Počvite pod bukova šuma vo potegot Demirkapisko-Konjska Reka, Gevgelisko. Šumarski pregled br. 1-3, god. XIX, Skopje (1971), pag. 9-21.

[12]Spirovski J., Rizovski R. Počvite pod nekoi ploskačevi šumi vo Dolnoto Povardarie. Godišen zbornik na Zemjodelsko-Šumarskiot fakultet, kn. XXIX, Skopje, (1975), pag. 21-35.

[13]Filipovski G. edit. et al., Metodika terenskog ispitivanja zemljišta i izrada pedoloških karata. JDPZ. Beograd, (1967), pag. 192.

[14] Filipovski Đ., Pedologija. Treto izdanie. Univerzitet "Kiril i Metodij", Skopje, (1984), pag.599

ISSN: 0585-9069

[15]Filipovski Đ., Počvite na Republika Makedonija, tom III, MANU, Skopje, (1997), pag.519
[16]Carter M. R. edit., Soil sampling and Methods of Analysis, Canadian Society of Soil Science, (1993), pag.823.

For. review 43: 46 - 50. Skopje, 2012

ISSN: 0585-9069
UDC: 630*22(497.7)
Preliminary communication
Paper submission: May, 2012

INTRODUCING FAST GROWING TREE SPECIES FOR AGRO-FORESTRY PRACTICES ON AGRICULTURAL LAND IN MACEDONIA

TODOROV V., STAVREVSKA – PANAJOTOVA A., PETROVSKI S., KAMPEN P.
SNV Netherlands development organisation, Office in Skopje, Macedonia
Correspondig author e-mail address: voislav.todorov@cnvp-eu.org

ABSTRACT: Biomass produced from wood is increasingly used for energy. Currently in Macedonia mainly firewood (wood logs/traditional system) is used for heating. Modern production of wood chips and/or pellets is in limited use. This market is increasing rapidly in the region and EU. Fast growing species offer a good possibility for production of biomass for energy in the region. In Macedonia many agricultural lands are not or marginally used. Some of these lands are not very suitable for agricultural farming, but can be used for fast growing species and biomass production. In 2010 the fast growing species *Salix alba* var. *express* was introduced at total of 10 different sites as tree belts in Macedonia. Besides the production of biomass tree belts also fulfil other functions as wind protection, reducing water inundation in wet areas, improvement of micro climate conditions, erosion control of river banks, soil conservation, as well biodiversity or landscaping, serve as flowering plants for honey production. Planting was done in March before the growing season started, with 10.000 stumps/ha and soil preparation with ploughing up to 25-30 cm deep. Species showed a very good growth in the first season with height of 1,5 to over 2 meter, with estimated growth of 3.8 m^3 of biomass. In the second year growth resulted in heights up to 4 m and estimated over 70 m3/ha. Farmers showed good interest indicating that fast growing species can be integrated trough agro-forestry practices in their farming systems.
Keywords: biomass, fast growing species, agro-forestry, energy.

1 BACKGROUND

Today forestry and forests are gaining increased attention in the world. Importance of environmental issues and importance of forest ecosystems in mitigating climate changes is one of the top priorities today in the world. Forest resources also have significant impact on the quality and improvement of live in rural communities. Forests contributes up to 70% of earth carbon (C) fixation and are a major sink for CO_2 on a global scale.

Afforestation, defined as the establishment of forests on lands that have not been recently forested, can have multiple environmental and social benefits, such as: wildlife habitat protection, recreational potential, visual and aesthetics benefit, improvement of soil, water and air quality. Tree planting and establishment of fast growing plantations can contribute to mitigation of climate change today stocking CO_2 in the wood.

Fast growing plantations are usually established for production of wood biomass and used for production of energy.

Bio-energy can to some extent replace fossil fuels and has the advantage of being almost CO_2 neutral (the emitted carbon is absorbed in the biomass when sustainable managed). That is the reason why fast growing plantations for production of woody biomass/ bio-energy have received high attention currently.

In Europe several fast growing species are introduced and used for production of woody biomass.

Macedonia is one of the countries that have good potential for development of fast growing plantations due to its geographic position and availability of land resources.

This paper presents the farmer based experimental establishment of fast growing plantations with *Salix* species in Macedonia with purpose to test and show the results of introduction of Hungarian variety *Salix alba* var. *express* and its economic and environmental viability for biomass production.

Taking in consideration the commitment of R. Macedonia to use 20% renewable energy till 2020 and the strategy for Rural Development, establishment of fast growing plantations on agricultural land offers a reasonable potential.

With this pilot project, the Agro-forestry concept was practiced as well in Macedonia. Agro-forestry is an integrated approach of using the interactive benefits from combining trees and shrubs with crops and/or livestock. It combines agricultural and forestry practices to create more diverse, productive, profitable, healthy and sustainable land-use systems. Research over the past 20 years in the world has confirmed that agro-forestry can be more biologically productive, more profitable, and be more sustainable than certain forestry or agricultural monocultures.

2 METHODOLOGY

For the purpose of this project a farmer based research is applied to be able to obtain direct field experience from farmers giving practical results that can provide guidance to the practical application of fast growing species in agro-forestry systems in Macedonia. Empirical data from the farmer based field practices are used to present and justify the findings in this paper.

The plantation of *Salix alba* var. *express* species aims to investigate and obtain data about the rate of success and growing rate of *Salix alba* var. *express* in Macedonia under real farmer field conditions.

The species is autochthon in Macedonia, but however for this improved variety, imported from Hungary, there was no data previously in Macedonia about conditions and sites where it can be successfully cultivated. The results gained from the planting sites and monitoring done in the previous 2 years are data that will be used in this paper, in order to present the real situation and development of the species in selected fields in Macedonia.

Site selection process was done in consultation with farmers, explaining the agro-forestry concept and opportunities of fast growing plantations for biomass production. For the selection, internal network of National Association of Private Forest Owners in Macedonia was used. Farmers were selected by their

 ISSN: 0585-9069

willingness to participate in the project; farmers not necessary being members of the forest owners association. Selection of specific plots was done in consultation with participating farmers, according to their needs and vision on utilizing part of their agricultural land. Sites were selected to represent different site conditions, in first place difference in access to underground water. Farmers indicated small plots of their agricultural land that was not in use or marginal land covered with shrubs and trees with purpose to protect the fields form erosion and wind. No specification were given on size and siutation, as the research aims to follow real farmer interest and options for agro-forestry within their farrming systems.

A varieties of sites were selected: land plot placed by the river bank where farmer wanted to protect the land from erosion; piece of land in the corner of a land plot with no possibility for cultivation; land plots where high level of water under the ground was limiting cultivation; piece of land where trees were planted as a tree/hedge-row fence with the neighbor. Sites were selected taking also in consideration different soil and climate conditions needed for the project results.

3 BIOMASS PRODUCTION IN MACEDONIA

Biomass production and use of wood for energy production in Macedonia is mainly concentrated on utilization of forests and use of firewood in individual households. Part of the wood is coming from the trees that are growing on agriculture land. Annually in Macedonia from state and private forest are harvested around 700.000-800.000 m^3 of wood for heating. Also some amount of not registered wood is harvested, approximately 25 – 30 % as stated in REC working paper [2]. Different concepts of production and utilization of wood biomass have been developed in the World and Europe. Among these different concepts is as well the previously mentioned agro-forestry concept, widely used in developed countries.

In Hungary, based on the production rates experienced with *Salix alba* var. *express*, a biomass production of 23 ton/ha in the first year was achieved. This would lead to at least 65 ton/ha on a three year cycle. It is important to note that Hungarian experiences with fast growing plantations are based on climate and site conditions specific for Hungary.

Although practiced in reality, but not as a deliberate management system, it is a challenge to have acceptance for the agro-forestry concept as it is new in Macedonia and to plant the fast growing species on agriculture land. In 2010 *Salix alba* var. *express* was introduced on some farmer based pilot schemes at limited scale, to investigate the results of growth and analyze their potential and agro-forestry practice potential. A total of 9 different experimental sites were planted in Macedonia with different soil and climate conditions.

4 BIOMASS CULTIVATION DATA

4.1 Sites

The selected experimental plots are placed in the villages of Amzibegovo, Mustafino and Meckuevci, located close to Sveti Nikole (East Macedonia) and in Taor near to Skopje (North Macedonia).

Experimental sites in the village of Amzibegovo have been spread on four locations:

- Site 1 is on moist sandy clay soil, located along the river, flooded in the period of high waters.
- Site 2 is on stony clay soil, 10 m higher than the level of the river alongside. On this plot there is a good irrigation system that can be used to irrigate the plantation.
- Site 3 is on moist clay soil located along the river, with high level of underground water.
- Site 4 is on moist clay soil located along the river, owned by 1 farmer. It has high level of underground water. This parcel has big risk for spreading of reed, and it was recommended to the owner to take control over reed spreading in vegetation period.

In the village of Mustafino all three sites have been grouped as one location due to very similar growing conditions. The sites are on moist clay soils along the river bank with medium level of underground water.

Village of Meckuevci has only one planting site, planted with *Salix*, on stony clay soil few meters above the water level of the stream. This plot was with low level of underground water, dry during the year except in rain season.

In the village of Taor there are three different sites, planted with *Salix* on moist clay soil, with high level of underground water.

4.2 Planting

Planting (striking) of cuttings/stumps is done by hand or using specially made planting tools for creating planting hole. It can however also be done by machine in large scale plantings. The stumps need to be pushed vertical and tightly completely under the soil (1-2 cm) to protect them from evaporation.

Planting was done with density of 10.000 stumps/ha. Tree stumps/cuttings were 20-30 cm of length and diameter of 1.5-2.5 cm.

Fugure 1: Cuttings/ Stumps

On some sites soil preparation was done mechanical by ploughing the soil up to 25-30 cm deep. On the plot in Meckuevci planting was done directly by making holes with planting tool and than sticking the cuttings in to the holes.

Cuttings were made at the end of the winter, February, immediately prior to planting. Planting was done in March, before the growing season starts. Since this variety is not yet available in Macedonia stumps were imported from Hungary, product of *Sylvanus Csoport Kft*. The costs come to around 0.2 euro/stump. With an average of 10.000 pc/ha costs are 2.000 euro/ha for supplying planting material.

Figure 2: Planting site village Amzibegovo

Planting schemes used were on average of 10.000 pcs/ha in the pilot, this can vary also depending on harvest method. If mechanical harvesting is done via harvester or trailed chipper, spacing in plantations and rotation periods should fit for the machinery. In the small scale pilots, where willow is planted closer, manual harvesting is foreseen. The following planting schemes were used:

Table I: Planting scheme

	Single row technology		
Spacing in row/between rows (in m)	1 x 2	1 x 1	0.7 x 1
Amount of cuttings (pc)	10.000	10.000	10.000
Rotation (yrs)	2-3 years	2-3 years	2-3 years

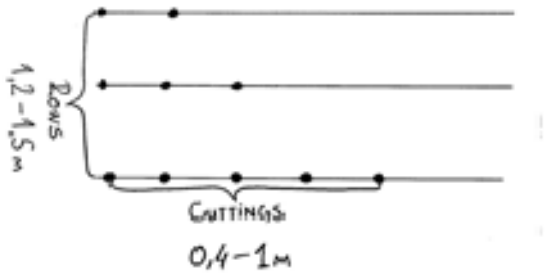


Figure 3: Planting scheme

4.3 Tending

After planting manual weed control is recommended 1-2 times to avoid overgrowing by weeds. Chemical weed control is recommended by producer of the *Salix*, but was not practiced in the experimental plots in order to follow natural growth of the species and be close to actual farmer conditions (low input farming). In case of a dry spring irrigation might be needed, but was not applied in the experimental plots from the same reason. However a favorable spring was experienced in the first year of growth. In the Second year mechanical cleaning of invasive grasses is needed in the plantations.

Harvesting of wood is usually practiced in rotations of 2-3 years. The lifespan of energy willow is usually 25-30 years.

After harvest the remaining stumps is recommended to be sprayed with *Vegesol eReS*, 4-5 l/ha as a basic treatment to increase protection of the stumps from fungal and bacterial infection and increase the life cycle and yield of the plantation. Pest control under normal field conditions is not needed. Nutrients supply is sufficient from the remaining's (mulching) after the harvest. In experimental plots in Macedonia only mechanical weeding was applied on one parcel in Taor by the farmer. It was left on purpose to be decided by the farmer to allow real field situation to follow the growth in natural conditions and with minimal interventions by farmers.

5 BIOMASS PRODUCTION DATA

This was an experimental pilot in Macedonia and the real field data are only available from monitoring done in years 2010-2011. Results of growth and monitoring from the years of 2010 and 2011 will be presented in this paper.

Monitoring on the experimental plots was conducted several times in the two year period. On monitored sites few parameters were measured: success rate, top height, reached number of sprouts per cutting and stump diameter.

First monitoring was conducted one month after planting in March 2010. On the first monitoring almost all sites showed a survival rate of over 90% of the plants. Planting was successful and disaster rate was mainly caused by biotic factors, in first place climate and also on some spots weed invasion.

All sites showed good growth, reaching a height of around 10 cm with 3-5 sprouts with diameter of 0.2 – 0.3 cm in the first month.

The second monitoring done in June 2010, before the dry season started, showed also good results in the survival rate ranging from 60-100%. Only site in Meckuevci had a survival rate of 15% due to very hard site conditions, strong and dry winds and draught. Height reached in this stage was ranging from 40 – 200 cm, with 2-5 sprouts and diameter ranging from 0.5-1.5 cm.

In the first year last monitoring was done at the end of the growing season in October. Success rate ranged from 70 – 100 %. Meckuevci planting site had rate of success 0%, due to biotic and abiotic factors like animal grazing, draught and to high insolation.

In 2011 two monitoring missions were conducted, one in the beginning of June and other one at beginning of October.

Results obtained in these two monitoring missions showed results that were significantly different from the previous season.

Most of the experimental plots were totally destroyed by human factor. Only success was evident in site 1 in Amzibegovo and site in village of Taor. Success rate on site 1 was 70% with top height of 450 cm with sprouts diameter of 5-6 cm and number of sprouts was ranging from 2-4. On the site in Taor success rate was ranging from 70-95% top height was up to 400 cm, with sprouts diameter ranging from 5-7 cm.

After these two monitoring seasons it was evident that the best sites were those having a high water table with moist clay soils. The care of the farmers and protection of the experimental plots was as well crucial for the obtained results. With very limited tending and no additional costs for irrigation, fungal, bacterial or pest

 ISSN: 0585-9069

control and nutrients supply, these few sites showed very good results on the field.

Figure 4: Beginning and end of season 2010-2011

Based on the trials taken from the experimental plots and measurements and calculations the average weight and tones of biomass produced on hectare were estimated.

In October 2011 at both sites the potential of growth showed very good results. At one site two trial pieces of energy willow were harvested. The total weight of piece of cut *Salix* was 4 kg. After natural drying in January 2012 the weight of the same wood decreased to 2,6 kg due to drying process. The moisture was measured in the ranges of 5,5% to 64%, depending on the size of the wood piece.

Analyzing the results from the measurements, after two years of growth, potential was estimated on 52 t/ha in the moment of harvesting. Having in mind measurements, the potential of growth transferred in semi dry wood (2-6 months of aerial drying) is estimated on 33,8 t/ha.

The weight of *Salix*, semi dried is 460 kg/m^3. Transfering 33,8 t/ha is equal to potential of 73,48 m^3 wood/ha in a two year period [5]. That is very high growth potential that hardly any species in Macedonia can reach close to.

Knowing that heat potential of *Salix* is approximatly 50% of hard wood, the real potential from the perspective of heating with wood that ussualy is used on the market is arround 36 m^3 of wood.

6 CONCLUSIONS AND RECOMMENDATIONS

Planting fast growing species on agriculture land has multiple effects for the farmers and their land. In practices around the world there are variety of combinations of forestry and agriculture. In some areas forest are combined with pastures providing fodder (acorn) for the cattle and wood for the farmer. There are areas where forests are combined with agriculture crops improving microclimate conditions and at the same time providing heating wood.

Some of the species planted have the possibility to influence the water regime, such as *Salix* sp. In the areas where the level of water is high one of the proposed solutions may be planting of fast growing species.

Based on the experiences and results gained from the experimental planting of *Salix alba* var. *express*, there is opportunity for the land owners to improve the income for their households. Planting fast growing species provides opportunity to land owners to supply themselves with biomass for their households. According to official statistic data, around 90% of wood for heating is spent in the households in Macedonia for house heating. (State Statistical Office, Energy report 6.1.11.92, 2011). Regarding growth potential, energy willow showed very good potential on good sites.

The ussual annual increment of native forest species in Macedonia is in ranges of 1 to 5 m^3/ha annualy. The average annual increment of *Salix* is 36 m^3/ha on the best sites and with proper treatment and protection. The results from the growth potential highly recommends planting of energy willow on the sites that are suitable and where is a real farmer interest.

Absorption of CO_2 of fast growing willow plantations is also an asset; it also enriches soil with mineral and microelements, nutrients of natural origin. According to some experiences in Europe 1 ha of energy willow plantation absorbs more than 200 tons of CO_2 from air during 3 years [2].

Planting fast growing species offer a variety of options for agro-forestry providing products and services according to the needs and possibilities of farmers. It may be implemented on the corners of the land that is not maintained or as a windbreak belts contributing to very different aspects such as wind protection and reduced evaporation, erosion control on the river banks, improvement of biodiversity and aesthetic/landscape improvement. Fast growing plantations as well contribute to creation of natural microclimate in the places of people residence or functioning as green belt or corridor for wild life and fauna.

The pilots showed that such multiple opportunities exist and farmers were interested to participate. However it is crucial for success that the farmers have genuine interest and provided the needed protection and silvicultural treatment.

In the case of this experiment and conditions for Macedonia it is evident that *Salix alba* var. *express* growing can be successfully done only if soil preparation is done on time, proper treatment against weed and pest control is applied before planting, and proper protection provided for grazing or human induced damages. Beside the management factors the first and the ultimate site condition for successful growth is access of water and humidity of soils. This *Salix* variety needs a humid soil condition to be able to reach such high growth rates.

The use of fast growing species in farmer based agro-forestry practices are related to the measures of EU Rural Development policy: agro-forestry, afforestation on agriculture land and diversification of economy.

The result from the experimental sites can be used to present, increase awareness and promote support for activities related to plant fast growing species on small scale farming and to include as eligible measure for the National Rural Development program.

Through the activities on the field, and planting of willow, farmers gained knowledge and experience on possibilities to implement agro-forestry measures and positive effects that these measures can have on development of their farms and providing opportunities for diversified income generation.

Figure 5: Village Amzibegovo, site monitoring October 2010

Figure 6: Village Amzibegovo, monitoring June 2011

7 ACKNOWLEDGEMENTS

The establishment of short rotation plantations of *Salix alba* var. *express* was done as experimental farmer based research under the ongoing Balkan forestry program of SNV - Netherlands development organization in cooperation with National Association of Private Forest Owners in Macedonia – NAPFO, and within the framework of the Sida-SNV Forestry Development Project, Kosovo & Regional 2009-2013.

8 REFERENCES

[1] Piloting on Agro-forestry and Renewable energy possibilities, SNV report, Skopje, 2011
[2] REC working paper “Illegal logging in South east Europe” by Miriam Markus Johansson, Bruno Mesquita, Aniko Nemeth, Mihail Dimovski, Cecile Monier and Peter Kiss-Parciu, Szentendre, Hungary 2010, page 90.
[3] SNV Skopje, monitoring year 2010/2011
[4] State Statistical Office, Energy report 6.1.11.92, 2011
[5] Šumarski priručnik II, Institut za šumarska istraživanja, Poljoprivredni nakladni zavod, Zagreb 1946)
[6] http://www.envsec.org/publications/illegal_logging_in_south_eastern_europe_regional_report_en_oct_2010.pdf
[7] http://www.salixenergy.com/en/index.php?option=com_content&view=article&id=55&Itemid=62

For. review 43: 1 - 76. Skopje, 2012
Ss. Cyril and Methodius University in Skopje
Faculty of Forestry in Skopje

ISSN: 0585-9069

For. review 43: 51- 56. Skopje, 2012

ISSN: 0585-9069
UDC: 635.92.05:712.252(497.7)
Professional paper
Paper submission: May, 2012

SOME SHADE TOLERANT PLANTS USED IN LANDSCAPE DESIGN IN MACEDONIA

BRNDEVSKA V., [1]RIZOVSKA ATANASOVSKA J.
[1]*Ss. Cyril and Methodius University in Skopje, Faculty of Forestry in Skopje, Skopje, Macedonia*
Correspondig author e-mail address: vikibrn@gmail.com

ABSTRACT: The choice of plant species in landscape design is a complex work that depends on many factors. One of them is the plants' need for light. According to this, there are: heliophytes (sun-loving), shade tolerant and semi-shade tolerant plants. The number of shade tolerant plant species is the smallest. However, there are enough in order to shape a complex, functional and aesthetic landscape, and the need for them is a challenge for creating many varieties and cultivars on a daily basis. Some of the shade tolerant plants are present in our green environments for a very long time, but there are some that are relatively new or have existed in Macedonia, but their usage was small. They are characterized by specific morphological characteristics, which give them a specific role and a special place in the design of green areas.
Keywords: landscape design, shade tolerant plants, varieties, cultivars, specific morphological characteristics

1 INTRODUCTION

One of the factors that should be taken into account when designing green areas is the use of plants according to their need of light. According to this, they are divided in: heliophytes (sun-loving), shade tolerant and semi-shade tolerant plants. The number of shade tolerant plants in relation to the other is smaller and thus the choice of plants when designing green areas that are in shade throughout the whole day or much of the day is limited. However, there are enough to form a complex, functional and aesthetic landscape.

There are shade tolerant plants present in green areas with us for a very long time, but there are some that are relatively new or have existed here, but their usage was small. Among the shade tolerant species encountered in designing green areas in Macedonia are a growing number of perenials, some annual and biannual plants, shrubs and trees. Here we can list the taxons from the genus *Taxus* L., *Hosta* Tratt., *Hydrangea* L., *Skimmia* Thunb., *Aucuba* Thunb., *Erica* L., *Calluna* Salisb., *Hedera* L. etc. These plants develop best in shady conditions and then their decoration is the most extensive. Each taxon is characterized by its specific morphological characteristics, which give them a specific role and a special place in the design of green areas.

2 MATERIAL AND METHODS

The material of work are the shade tolerant plant species that are characterized with specific morphological characteristics, have decorative value and which recently can be used in the design of green areas in Macedonia. Most of them has not been present in our region before, some were but with small usage. The emphasis is on species that are best developed in shade, where their decoration is most extensive.

The method of work means finding and determining the shade tolerant plant species that are recently used in the design of green areas in Macedonia. The research was conducted in the city of Skopje, mostly on green areas available for public use and in the larger garden centers in the city ('Eco Growth', 'Foya-Co', 'Horti Expert' and 'Green Planet') which perform procurement of plant material from both domestic and foreign origin and have a large variety of plants. Garden centers, as part of the research locations are chosen because of the specificity of the work and determination of plant species which means closer contact with plants, that's not possible to be done in private gardens.

Still, during the research, individual specific green areas were visited and explored, that required special permission for entrance by the owners (residential complex 'St. John', some private properties and balcony gardens).

The researches were performed in fall and spring, moreover, in the period from October to November and April to June 2010 and 2011. This period was chosen for research because the selection of seedlings in garden centers in the active planting season is largest. First the plants were determined after locating certain green areas. The basic information regarding taxons located in garden centers were obtained from the declarations attached with the plant material, but in order to obtain detailed and quality data, the plant material was determined by cabinet processing. Afterwards, their basic morphological characteristics, low temperature resistance and durability and the conditions necessary for successful development were processed. All this is presented in tables with results of concrete conclusions.

The research helped determine the effects of their usage in the landscape design of green areas in our country. Relevant data are presented with appropriate photos.

3 DISCUSSION AND RESULTS

The research regarding the shade tolerant plants used in landscape design in our country showed that the most used species are representatives of genus *Taxus* L., *Hosta* Tratt., *Hydrangea* L., *Skimmia* Thunb., *Aucuba* Thunb., *Erica* L., *Calluna* Salisb. and *Hedera* L..

3.1 Genus: *Taxus* L. – Yew (fam. Taxaceae)

The plants from the genus *Taxus* are coniferous evergreen shrubs or small trees. They have soft and flat pins. They are characterized with semi-smooth texture. Yew is a bicameral type and female specimens produce berries with red meaty covering. They ripe in fall and fall off in December and greatly increase the decorative value of the plant. They can withstand temperatures up to -30°C. Best developed in sandy, weakly acidic and well-drained soils. They have relatively slow growth.

Taxus baccata L. is a species found in the past on our green areas, and the following taxons are being used in recent times: *Taxus baccata 'Fastigiata'*, *Taxus baccata 'Fastigiata Aurea'*, *Taxus baccata 'Repandens'*, *Taxus*

ISSN: 0585-9069

baccata 'Repandens Aurea' and *Taxus x media 'Hicksii'* which is a hybrid between *Taxus baccata* L. and *Taxus cuspidata* Siebold & Zucc.

Depending on the basic characteristics, each type is differently used in the design of green areas. Some are used as solitary trees, as part of a group of trees, can form hedges or be planted in alpinum or in pots.

They often represent the focal point due to the shape or color, and the spreading plants are usually used as living ground covers. *Taxus baccata* L. is found as topiary tree, and is also used to form hedges due to its bigger growth and the ability to shape it. It is the only representative that can be found in public green areas, while the remaining taxons are found only in private gardens. Cultivars in yellow, unlike the rest of the plants are not so present in our country.

Figure 1 shows group of trees and Figure 2 topiary tree of *Taxus baccata* L. with pyramidal shape.

Figure 1: Group of trees from *Taxus baccata* L. – complex 'St. John', settlement Zlokukani, Skopje

Figure 2: Topiary tree of *Taxus baccata* L. – 'Horti expert', settlement Karposh 2, Skopje

Table I shows the representatives of the genus *Taxus*, their shape and color as basic morphological characteristics and the maximum size they can reach.

Table II shows the most commonly encountered representatives of the genus *Taxus* and their usage in landscape design. These plants, though extremely decorative, due to the expensive cost can only be found in more exclusive yards. This is the reason that there are rare cases of formation of hedges and topiary trees of *Taxus baccata* L..

3.2 Genus: *Hosta* Tratt. – Funkiay, Plantain Lily (fam. Liliaceae)

Hosta spp. is a leafy decorative perenial originating from East Asia. There are about 50-70 species and more than 4,000 hybrids, cultivars and varieties, whose number is constantly growing. They differ in shape, color and size of the leaf. These plants are grown mostly for its decorative leafs.

Their size can be from a few cm to 6m. Dwarf representatives can grow to 10cm, the miniature to 10-15cm, the low high to 15-25cm, the medium high to 25-45cm, the high 45-70cm, and the highest over 70cm. The form of the leaf can be long, circular, elliptical-circular, heart-shaped etc, and the color can be green (all shades), yellow, gray, blue, brown, or colorful leaves combined with the aforementioned colors. They bloom in summer, and the flower is striking and short lasting.

They can withstand shadow and semi-shadow, although some varieties can live on the sun if the soil is sufficiently moist. However, they are best developed in shadow, in quality moist soil, enriched with organic materials whose pH value is between 6.5 and 7.3. They can sustain temperature up to -34°C.

The following representatives of the genus *Hosta* can be found in our country: *Hosta 'Big Daddy', Hosta decorata, Hosta 'Gold Standard', Hosta montana 'Aureomarginata'* and *Hosta 'Blue Angel'* (Fig. 3) and they are usually part of private yards. They are successfully combined with other types of perennial plants. They're used as living ground covers, especially when planted in a group and as a focal point that attracts attention because decorativeness sheet. They can live by water surfaces, and are grown in pots for decoration of small yards, balconies and terraces.

Hosta decorata

Hosta 'Gold Standard'

Hosta montana'Aureomarginata'

Figure 3: Some representatives of the genus *Hosta* recently used for landscape design in our country

3.3 Genus: *Hydrangea* L. – Hydrangea, Hortensia (fam. Saxifragaceae)

The genus *Hydrangea* L. contains 70-75 species of flower plants that originate from southern and eastern Asia and North and South America. The name Hortensia can be found as a synonym for this plant. There are over 600 named varieties and cultivars. Most of them are flower shrubs that grow to 1-3m, and rarely reach the size of a small tree. Decorativeness is a result of the flower which is large and ball-shaped, 10-20cm in diameter. The color, which varies from the pH value of the soil, can be white, blue, pink, purple and red in various shades.

Acidic soils produce blue flowers, neutral pale brown and alkaline pink or purple.

When designing green areas, they are used as decorative flower shrubs and are often the focal point in the period of flowering. We use them as plants used for decoration of balconies and terraces planted in pots, and they can also be found in yards, planted separately or in groups.

The most often used are *Hydrangea macrophylla* Thunb. and *Hydrangea arborescens 'Annabelle'* (Fig. 4). *Hydrangea macrophylla* Thunb. is the most popular type. It can be found in our regions from a very long time ago, but today are used large number of new cultivars different by color of flower (*Altona, Amethyst, Ayesha, Enless Summer, Penny Mac, Dooley, Forever Pink, Harlequin, Ravel, Nikko Blue* etc). They can withstand temperature of -30°C to -20°C. *Hydrangea arborescens 'Annabelle'* is characterized with higher growth, withstands temperatures up to -40°C and richly blooms even after the coldest winters.

Figure 4: Group of plants from *Hydrangea arborescens 'Annabelle'* – private yard, settlement Center, Skopje

3.4 Genus: *Skimmia* Thunb. – Skimmia (fam. Rutaceae)

Skimmia is an evergreen, densely branched shrub that grows up to 1.5 m in height. It's characterized with ball like shape.

The leaves are elliptical egg-shaped, leathery and thick. It is specific by it's with red and white flowers, gathered in grape-like flowers that stand up. *Skimmia japonica* Thunb. has round fruit with red to black color which remains on the branches throughout the winter. In our country, we are familiar with the cultivar *Skimmia japonica 'Rubella'* (Fig. 5). It can be found in rich and moist, well-drained soil, in shadow and semi-shadow. Withstands polluted air temperatures up to -20°C.

Figure 5: *Skimmia japonica 'Rubella'*

Because of the flower that remains in winter, it's highly valued decorative type and is often a focal point, especially in winter when many plants lose their main decorative features. It's used planted in pots for decoration of small yards, balconies and terraces, as a bush planted separately or in a group in private yards, and is also used to form low symbolic hedges.

3.5 Genus: *Aucuba* Thunb. – Aucuba, Gold Dust Plant (fam. Cornaceae)

Aucuba japonica 'Crotonifolia' (Fig. 6) is an evergreen shrub. Grows slowly up to 3m in height, although most specimens reach only 1,8m. As decorative specie, it is valued by the density and color of the leafs. The leaf is leathery, oval-elliptical, long 8-20cm, with rare and rough edge jags. It has bright green color with golden-yellow spots. It form a red ball-like fruit to 1.5cm, which matures in November and falls in March, and during this period increases the decorative value of the plant.

It lives in wet well permeable soil. It withstands temperatures up to -20°C. It can successfully grow in any areas, but its decorative features are most prominent in shade. In designing green areas, it's used as a focal point for the formation of hedgerows, low or medium high, which can but don't have to be formed by cutting. It's also used as a plant for decoration in pots. Here we can rarely find it on public spaces, but often in private yards and green areas around public buildings.

Figure 6: *Aucuba japonica 'Crotonifolia'* as part of landscape design of green area in front of public building – 'Mida Auto', settlement Karpos 2, Skopje

3.6 Genus: *Erica* L. – Erica (fam. Ericaceae)

Erica sp. L. is a perennial evergreen flower plant which originates from the mountain areas of central and southern Europe. In designing green areas, we come across the types *Erica carnea* L., *Erica x darleyensis* and *Erica gracilis* L. (Fig. 7) and many cultivars, which differ by the color of the flower. They can reach up to 20cm height. They bloom in various shades of pink, purple and white. They are especially valued because they bloom in winter. They can live in acidic soils, necessary for their flowering. They can withstand temperature up to -30°C, and are best developed in shade.

When designing green areas, they are used as flower plants in flower-beds during winters, but as living ground covers around conifer solitary trees. They can also be found in alpinum and rock gardens as well as decoration of greening slopes and pots. Here, they are mostly planted in private yards, it can be noticed that their use has been reduced due to their rapid extinction or loss of

 ISSN: 0585-9069

decorative features as a result of inappropriate soil conditions they grow in.

Erica carnea

Erica x darleyensis

Figure 7: Some representatives from genus *Erica* L. used in green areas designing in recent time in Macedonia

3.7 Genus: *Calluna* Salisb. – Heather (fam. Ericaceae)

Calluna vulgaris Salisb. is the only specie from the genus *Calluna*. It is a low evergreen shrub that grows 20-50cm or rarely up to 1m in height. Its natural habitat is in Europe and Small Asia, and the numerous cultivars differ in color of the flower, leafy mass and height. They can live in acidic soils, in shadow and semi-shadow. They can withstand temperature up to -30°C.

The cultivars have flowers in many shades of white, pink, purple and red. Here, they start to bloom in autumn. The flower is preserved during winter even though it becomes brown. Some have specific texture and leaf color which is found in various shades of green, silver-blue, gold and red. When designing green areas, they are used as living ground covers and flower plants in all types of floral formation. Here, you can come across the following cultivars: *Calluna vulgaris 'Dark Beauty'*, *Calluna vulgaris 'Marleen'* (Fig. 8) etc.

Calluna 'Dark Beauty'

Calluna 'Marleen'

Figure 8: Cultivars from *Calluna vulgaris* used in green areas designing in recent time in Macedonia

3.8 Genus: *Hedera* L. – Ivy (fam. Araliaceae)

Genus *Hedera* L. has 15 species and numerous cultivars and hybrids. It can reach a length of up to 30m. It's planted on surface with small roots. There are varieties with different leafs in shape, size and color. Some are characterized by dark blue berries that are ripen in late fall and remain throughout the winter period. Most can live in any area but they perfectly develop in shadow, they can grow in any soil, but best in wet and humus one. Here, you can come across the following: *Hedera helix* L., *Hedera algeriensis 'Gloire de Marengo'*, *Hedera helix 'Arborescens'*, *Hedera helix 'Goldheart'*, *Hedera hibernica* Bean., *Hedera colchica 'Dentata Variegata'* and *Hedera helix 'Marginata Elegantissima'*. Some of them are present on these regions for a very long time, such as *Hedera helix* L. and *Hedera hibernica* Bean., while others are brand new or rarely used in the past.

When designing green areas, they are used as creepers that cover sodden buildings, as hedges on previously placed foundation, as living ground covers for greening slopes, in pots, separately or in the base of other plants. They successfully grow in combination with other creepers.

Figure 9 shows a hedge formed on a foundation by *Hedera helix* L., and Figure 10 shows *Hedera algeriensis 'Gloire de Marengo'* as part of balcony foliage in a public facility.

Figure 9: Hedge form *Hedera helix* L. – private yard, settlement Center, Skopje

Figure 10: *Hedera algeriensis 'Gloire de Marengo'* - balcony foliage in a public facility 'Tetraktis' in the complex of 'Mida Motors', settlement Karpos 2, Skopje

Table III shows resistance to low temperatures of the representatives of genus *Hedera* L.

Table IV shows the taxons that are part of this research, their life forms and main decorative features.

Table I: Basic characteristics of the plants from genus *Taxus* L.

Ordinal number	Plant species	Basic characteristics			
		Shape	Color	Maximal growth	
				Height	Spread
1	*Taxus baccata*	Irregular pyramidal	Dark green	20m	1m
2	*Taxus baccata 'Fastigiata'*	Columnar	Dark green	1,5-2,0m	0,5-0,6m
3	*Taxus baccata 'Fastigiata Aurea'*	Columnar	Yellow	1,5-2,0m	0,5-0,6m
4	*Taxus baccata 'Repandens'*	Horizontal-spreading	Dark green	0,3-0,5m	0,8-1,5m
5	*Taxus baccata 'Repandens Aurea'*	Horizontal-spreading	Yellow	0,3-0,5m	0,8-1,5m
6	*Taxus x media 'Hicksii'*	Columnar	Dark green	1,5m	0,8m

Table II: Use of representatives of the genus *Taxus* L. in landscape design

Ordinal number	Plant species	Use in landscape design					
		Solitary tree	Topiary tree	Group of trees	Hedges	In alpinum	In pots
1	*Taxus baccata*	√	√	√	√		
2	*Taxus baccata 'Fastigiata'*	√					√
3	*Taxus baccata 'Fastigiata Aurea'*	√					√
4	*Taxus baccata 'Repandens'*					√	√
5	*Taxus baccata 'Repandens Aurea'*					√	√
6	*Taxus x media 'Hicksii'*	√					√

Table III: Resistance to low temperatures of the representatives of genus *Hedera* L.

Ordinal number	Plant species	Resistance to low temperatures
1	*Hedera helix*	-30°C
2	*Hedera algeriensis 'Gloire de Marengo'*	-10°C
3	*Hedera helix 'Arborescens'*	-30°C
4	*Hedera helix 'Goldheart'*	-20°C
5	*Hedera hibernica*	-30°C
6	*Hedera colchica 'Dentata Variegata'*	-20°C
7	*Hedera helix 'Marginata Elegantissima'*	-20°C

Table IV: Taxons classification according to life forms and their decorative characteristics

Ordinal number	Plant species	Life form	Decorative characteristics
1	*Taxus sp.*	Evergreen shrubs or small trees	Shape and color
2	*Hosta sp.*	Perennials	Leafy decorative
3	*Hydrangea sp.*	Deciduous flowering shrub	Flowery decorative
4	*Skimmia japonica 'Rubella'*	Evergreen flowering shrub	Flowery and leafy decorative
5	*Aucuba japonica 'Crotonifolia'*	Evergreen shrub	Leafy decorative
6	*Erica sp.*	Evergreen flowering perennial	Flowery decorative
7	*Calluna vulgaris*	Evergreen flowering perennial	Flowery decorative
8	*Hedera sp.*	Evergreen climber	Leafy decorative

4 CONCLUSIONS

After the conducted research regarding the shade tolerant types of plants used in recent times in landscape design of green areas in Macedonia, the following conclusions have been reached:

- The following taxons from the genus *Taxus* L. can be found on our green areas: *Taxus baccata* L., *Taxus baccata 'Fastigiata'*, *Taxus baccata 'Fastigiata Aurea'*, *Taxus baccata 'Repandens'*, *Taxus baccata 'Repandens Aurea'* and *Taxus x media 'Hicksii'*. Only *Taxus baccata* L. is a type found in the past on our green environments, and the rest can be found in recent times;

- In landscape design in our country, the representatives of the genus *Taxus* L. are often used as solitary trees, as part of group of trees, they can form hedges or be planted in alpinum and in pots. They often represent the focal point due to the shape or color, and

ISSN: 0585-9069

the spreading ones are usuallly used as living ground covers. *Taxus baccata* L. is found as topiary tree, and is used to form hedges. Cultivars in yellow, unlike the rest of the others, are less present in our country;

- Representatives of the genus *Hosta* Tratt. used for landscape design in our country are: *Hosta 'Big Daddy'*, *Hosta decorata*, *Hosta 'Gold Standard'*, *Hosta montana 'Aureomarginata'* and *Hosta 'Blue Angel'*. They are usually part of private yards. They are successfully combined with other types of perennial plants. They are used as living ground covers, especially when planted in a group when they represent the focal point. They are grown in pots for decoration of small yards, balconies and terraces;

- Representatives of the genus *Hydrangea* L. used in our country are *Hydrangea macrophylla* Thunb. and *Hydrangea arborescens 'Annabelle'*. In designing, they are often a focal point in the period of blooming. Here, we use them as plant used for decoration of balconies and terraces planted in pots, and in the yards they can be found planted separately or in groups;

- *Skimmia japonica 'Rubella'* is often a focal point in the winter. It's used planted in pots to decorate small yards, balconies and terraces. Here we can find it in private gardens planted separately or in a group, used to form low symbolic hedges;

- *Aucuba japonica 'Crotonifolia'* is used in private gardens and green areas in front of public facilities. It's planted separately, in a group, and is used to form low and middle-low hedges that often present a focal point;

- They are used as flower plants in flower-beds during the winter, living ground covers around conifer solitary trees, in alpinum and rock gardens, for decoration of slopes and in pots;

- *Calluna vulgaris 'Dark Beauty'* and *Calluna vulgaris 'Marleen'* are the representatives from the genus *Calluna* that can be found in our country. They are used as living ground covers and flower plants in flower formations;

- The following representatives from the genus *Hedera* L. can be found on our green areas: *Hedera helix* L., *Hedera algeriensis 'Gloire de Marengo'*, *Hedera helix 'Arborescens'*, *Hedera helix 'Goldheart'*, *Hedera hibernica* Bean., *Hedera colchica 'Dentata Variegata'* and *Hedera helix 'Marginata Elegantissima'*. They are mostly used for covering sodden objects, to form hedges previously placed foundation, as living ground covers, for decoration of slopes and decoration with pots.

From all of the above stated, it can be concluded that although the number of shade tolerant plants in relation to others is smaller, there are still enough in order to be able to form a complex, functional and aesthetic landscape. Besides the researched plants, other types encountered in the design of green areas in Macedonia include large number of perennials, some annual and biannual plants, shrubs and trees.

5 REFERENCES

[1] А. Андоновски, Декоративна дендрологија, Скопје, (1992), pag 85, 185.
[2] M. Vidaković, Četinjače, Zagreb, (1982), pag 609, 612, 617.
[3] Н. Анастасијевић, Подизање неговање зелених површина, Универзитет у Београду, Шумарски факултет, Београд, (2007), pag 72, 366, 368.
[4] R. Markley, Živice, Stanek, Biblioteka Vrt, Zagreb, (2010), pag 37, 38.
[5] В. Андоновски, Пејзаж и дизајн во зелените површини, Авторизирани предавања, УКИМ, Шумарски факултет, Скопје, (2005), pag 8, 9, 12, 26, 95.
[6] С. Цеков, Дендрологија, Скопје, (1988), pag 51, 52, 360, 416.
[7] Č. Šilić, Atlas drveća i grmlja, Sarajevo, (1973), pag 31, 75, 76, 142.
[8] Č. Šilić, Ukrasno drveće i grmlje, Sarajevo, (1990), pag 104, 133, 145.
[9] Velika ilustrirana enciklopedija VRT, Mozaik knjiga, Zagreb, Encyclopedia of Gardening, The royal Horticultural Society, London, (2005), pag 93, 99, 133, 127, 186, 367.
Photography:
[10]Брндевска, В. (2010, 2011).

For. review 43: 57 - 61. Skopje, 2012

ISSN: 0585-9069
UDC: 630*22(497.2)
Professional paper
Paper submission: May, 2012

AESTHETIC EVALUATION OF FOREST LANDSCAPES WITHIN THE TRAINING AND EXPERIMENTAL FOREST RANGE (TEFR) YUNDOLA, R. BULGARIA

[1]GALEV E., [2]SANDEVA V., [2]DESPOT K.
[1] *University of Forestry, Sofia, Bulgaria,*
[2]*Goce Delcev University, Štip, Macedonia*
Correspondig author e-mail address: emil.galev@abv.bg

ABSTRACT: The research focuses on understanding the scenic beauty of the landscape in the context of environmental planning, management focused on the forest landscape.Our landscape preferences are thought to be influenced by many factors: age, gender, ethnicity, regionality, recreational activity; some researchers even maintain there is an evolutionary basis behind certain landscape preferences. But of these factors, our dominant culture and history have played major roles in shaping our preferences for landscapes that are natural in character. Aesthetic appreciation of forest parks in the survey is made of the objective characteristics of the existing topography and vegetation. Data are taken from the map or text materials containing information about the terrain. The dominance elements and variable factors of landscapes appear in varying degrees, depending upon the viewing distance. The research automates aesthetic evaluation of forest landscapes using GIS.
Keywords: visual impact, scenic beauty, aesthetic, landscape preferences

1 THEORETICAL PREREQUISITES FOR AESTHETIC EVALUATION OF LANDSCAPES

A number of research exist in which various methods for visual evaluation of the landscape are used. All these studies show that such an evaluation of landscape resources is a very important moment in determining the potential of recreational areas. Through spatial analysis, photographic, visual or psychological evaluation, individual territorial units should be classified to determine their emotional performance, despite the subjective element that can not be avoided.

The method of Seung-Bin (1984) is expressed in statistical analysis of evaluations of interviewed people who were shown pictures of 12 urban areas.

Survey methods are often used in evaluating the aesthetic qualities of landscapes. According to Rosenthal and Driver (1983) most of the respondents mainly appreciate the opportunity to enjoy beautiful scenery and is particularly marked overall demand for peace, solitude and rest in nature. According to Abello and Bernaldez (1986), all these surveys show that the aesthetic criteria of people depend on the nature, age, gender and their education and grades that they give the landscapes depend on their personal preferences for various forms of recreation. There are even those studies which have been specifically designed to prove weak authoritativeness and objectivity of the results of such inquiries. They apply the visual evaluation method of landscape using two groups of observers. The first group was previously aware of the existence of some clearly visible damage in the landscape and the other does not. The results show that dark observers did not notice the existing visible damage and provide better evaluation of these landscapes. Exactly this was conducted by Buhyoff (1982) experiment. "Gap" according to him is mainly due to the fact that the sites assessed are too large and it can no longer pay attention to all details and particulars, and the fact that the eye of a non-specialist is not trained to see everything.

According to Cooper, Murray (1992) a constructive method for visual evaluation of sites should include a description, analysis and classification of areas to create a structure within which to cover all landscape components. The biggest problem in the development of quantitative methods to evaluate the visual impact by Buhyoff, Riesenmann (1979) is to determine the coefficient of importance of individual landscape components in the overall evaluation. Unwin (1975) describes three stages in the evaluation of landscape: "measurement" of the landscape, formulation of landscape values through the survey of people's preferences, and finally an evaluation of the visual qualities of the landscape. Most sophisticated models in this regard he says are psychophysical which use first psychological impact, and after that objective quantitative and qualitative parameters of the landscape. The creation of such a model requires three sets of data: photos, survey data on people's preferences to landscape and landscape parameters.

The method of Shafer, Hamilton, Schmidt (1969) for determining psychophysical preference of people to the countryside is to predict how they will appreciate the natural landscape. Most important characteristics for the aesthetic appeal of landscape according to the authors are taken into account. Proportions are calculated between the quantitative values of landscape characteristics in practice. Changing these proportions within a specific landscape creates a feeling of depth and perspective. Based on a mathematical formula involving perimeters and areas of forests, open spaces and water areas the authors define three types of ground cover: plant, non-vegetable and water, and outline the following areas at a distance.

Wherrett (1997) automates this model using GIS and conduct surveys to identify people's preferences for visual images of landscapes. The results showed that weather conditions and different focal lengths, where photographs were taken on the ground are not significant, but seasonal characteristics of vegetation and architectural elements have a significant influence in shaping those preferences.

Chiusoli (1977) offers a valid method to estimate parametric values of landscape and visual appeal of the plant component of the landscape called "integrated analysis of the landscape". It is based on analyzing aerophotos and panoramic images of the study area. By comparing the data obtained the author determined percentage ratios between the different landscape components. These ratios vary widely, thus achieving a just estimate. According to the author it has not yet developed a unified methodology for "parametric" visual evaluation of plant components in the landscape, because

 ISSN: 0585-9069

in practice the evaluation of its appearance is associated with too many subjective criteria. Therefore he considers the most appropriate first to analyze the landscape using aerophotos and territory be divided into homogeneous zones according to the most common characteristics of plant cover, and then to determine their area ratio. Appearance of landscapes, revealing to be monitored by the ground that what they learn from any point outside or inside them is totally different, so panoramic photographs reflect the real picture is revealed to him. Therefore the author considers most appropriate both method of analysis to unite and after processing the data from aerophotos to create a series of panoramic images for areas with established aesthetic values. Pelt (1980) also recognizes that the perception of the landscape of the casual observer is implemented by the land and therefore pay particular attention to principles of felling and afforestation on different relief forms in order to avoid adverse visual effects resulting from the creation of unsustainable or geometric outlines of woodland. Forestry Commision (1994) examined much more detail this issue and defined some guiding principles of forest landscape design, designed to preserve the visual value of plantations and open spaces.

In Bulgaria most commonly used criteria for aesthetic evaluation of natural environment is developed by Bulev (1977). Evaluated as the unit area, he used a square side length, depending on the scale of the graphic material. For each of the square sections are determined grade evaluation, depending on the presence or absence in his range of different landscape elements (forests, rivers, rocks, agricultural areas, roads, power lines, etc.). The same criteria used Bezlova (1989) and adds them to apply locally for its development. She assesses areas as follows: dynamic of the relief, mosaic structure of plant cover, engineering network, availability of natural phenomena, natural sites and protected areas, and visual-spatial relationships. Then she sum of the ballroom evaluations as a percentage of the maximum value and then groupes territories.

In conclusion we can say that experiments, theories and summaries of the visual landscape evaluation has not yet reached the necessary universality of theoretical knowledge in order to establish a common scheme which will only be evaluated.

2 ANALYSIS OF THE MOST IMPORTANT NATURAL COMPONENTS WHICH DETERMINE AESTHETIC PROPERTIES OF LANDSCAPES WITHIN THE TERRITORIAL SCOPE OF THE TEFR YUNDOLA

In conclusion of the analysis can be concluded that forest landscapes in the Yundola region can take a significant number of visitors. They should therefore be classified according to the opportunities offered for recreation. Then it is necessary the natural potential to be evaluated but differentiated for individual recreational activities, and these activities can be codified and classified in different levels of aggregation. The most synthesized unit having territorial scope must be the “forest subdivision”, but in terms of recreational activities, must be the specific recreational activity.
In analyzing of the individual characteristics of relief and forest vegetation, first was reported their impact on recreational activities and established the practical feasibility of each of them as an evaluation indicator, depending on the impact that have on the main recreational activities. In this respect, are shaped some fundamental conclusions concerning the question of evaluation of recreational forest landscapes in general and of research subject in particular.

General conclusions:

1. When conducting landscape-recreation research is required to analyze taxological data of forest vegetation.
2. Analysis developing and design can be achieved only by additional field studies conducted during different seasons.

Specific findings:

1. In almost all parts of the Forestry range, the taxological data of forest stands evidence of their high productivity as well as of their very good outstanding artistic and aesthetic qualities and recreational function. Therefore:
a/ it can be expected that greater influence in recreational evaluation of the site will have a factor "relief" where the differences are very prominent;
b/ it is most appropriate to take into account only those taxological indicators that most influence the formation of the external appearance of the forest landscape, as well as fo its spatial structure.
2. The majority of forests in the area of the Forestry are accessible in all its parts. The development of mobile communications will make them more accessible and this will create prerequisites for economic development in general and for leisure in particular.
3. The main recreational activities practiced within the research area are: walking and stationary recreational in the nature environment, hiking, sunbathing, picking wild berries and mushrooms, villa holiday, outdoor games and winter sports.
4. In conclusion it should be said that forest landscapes in the vicinity of Yundola must first be classified according to their recreational opportunities and then to be evaluated all available resource potential that can be used for purposes of recreation, but differentiate for individual recreational activities. These activities themselves can be codified and classified in different levels of aggregation. The most synthesized unit in terms of territorial coverage should be “forest subdivision”, but in terms of recreational activities should be “specific recreational activity”.

3 EVALUATION MECHANISM

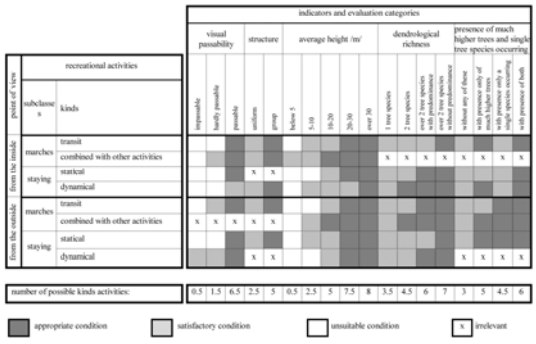
In this paper the aesthetic evaluation of landscapes is defined as a grouping of predefined territorial units in some grade categories according to their positive or negative aesthetic qualities defined by pre-selected indicators and criteria. The indicators and criteria are also systematic and have been elected in accordance with the conditions set by the main objective of the research or development project, for the purposes of that evaluation takes place. Aesthetic evaluation is based on the specifics of the landscape and is determined by visually dominant natural and anthropogenic components.

Table I: The most common criteria for a high aesthetic evaluation of forest vegetation

indexes	**gradation of categories and the most common criteria for an appreciation**
multilevelness and passability	**the passable stands** in the most general case, form a picturesque framework of open spaces and create greater psychological comfort as for the people watching them on side, and those who pass through them
structure	**the block spatial location** of trees definitely have a strong aesthetic impact on people especially during passing through forest plantations
average height	the forest stands with an average height **over 10 m** caused a strong emotional experience because it goes beyond the human scale
dendrologic richness of forest stands	the forest stands in the composition of which are involved **more than 2 tree species** create more expressive emotional and psychological effects arising from greater volume diversity in the space
presence of much higher trees and single tree species occurring in forest stands	**the much higher trees** as well as **the single tree species occurring** in forest stands presence a greater diversity in in the spatial structure and coloring of forest stands

It serves primarily to determine the visual qualities of open spaces, and in particular their advantages or disadvantages as places to stay static. Significant role in its forming play the relief, the forest vegetation and somewhat aquatic components of landscape, but in many cases could be setting some anthropogenic components. The factors which most contribute to the aesthetic impact of forest vegetation and broad criteria for aesthetic evaluation of forest stands are classified in Table I.

Table II: Componential assessment for aesthetic valuation of the forest stands



The Table II specifies the number of appropriate subgroups of most widely practiced recreational activities in certain values of taxological indicators. It is reported the fact that forest stands have a different visual impact when have been seen from side and when have been viewed as an immediate environment for recreation.

The indicator "*passability*" characterizes the possible of physical and visual intrusion into forest areas and depends on the structure of forest stands expressed by the location and by the different combinations of main component parts of the forest flora. Therefore it presents in both aspects of evaluation. The indicator "*construction*" determines primarily spatial structure of the forest stands, but has a major role in shaping their external appearance and diversity of the forest landscape. The *average height* is a very important indicator of psychological comfort of the recreational environment, which is determined by those in human genetic effects to the surrounding area determined by the so-called "human scale". The *dendrological richness*, and the *presence of much higher trees and single tree species occurring* in forest stands are a prerequisite for a greater vertical uneventness of forested areas and r foa greater variety in their coloring.

Factors contributing to the greatest extent for the aesthetic impact of open spaces are systematized in Table III. *Vertical and horizontal indentation* of the relief considered separately determine the possibility of visual perception of space. Joint expression of these two factors determines the *depth of the visible prospects*, as the maximum values of this indicator are obtained by high values of vertical relief indentation and low values of horizontal relief indentation, which creates prerequisites for the detection of more distant panoramic views. The *extent of interception of the horizon* is determined largely by terrain features, but after reading the above parameters remain only the characteristics of forest vegetation, which can be a framework of perspectives or can be a barrier preventing their detection. The *number of visible landscapes* depends primarily on diversity of forest vegetation surrounded open spaces and determines in the most a picturesque variety in the foreground of the landscape. The *ratio between perimeter and area* of landscapes contributes much to the diversity of plastic-volume relationships. For the uniqueness and attractiveness of the mountainous landscape of the utmost importance are also the *degree of indentation of the visible horizon* and the presence of natural phenomena.

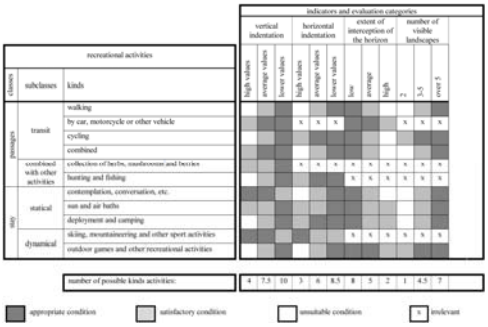
Table III: The most common criteria for a high aesthetic evaluation of the open spaces

indexes	**gradation of categories and the most common criteria for an appreciation**
vertical indentation of the relief	**strongly indented terrains** provide better opportunities to detect distant panoramic views, but **less indented terrains** are favorable to adopt landscape forgroun
horizontal indentation of the relief	**slightly** separated, in a horizontal attitude landscapes have a positive psychological impact because it allows the visual perception of vast spaces
extent of interception of the horizon	territory **low** on the horizon interception create better conditions for visual perception of landscape
number of visible landscapes	**higher values** of this parameter determine the variety of sights and scenery of the landscape
depth of the visible prospects	**maximum values** of this indicator are obtained by high vertical and low horizontal relief indentation and contribute to better visibility of landscapes
degree of indentation of the visible horizon	**high values** contribute to diversity, attractiveness and emotional-psychological impact of landscape
presence of obstacles	**low values** contribute to better visibility of landscapes
presence of natural phenomena	**presence** of interesting rock formations or other sculptural relief forms and phenomena influences strongly on visual perception and creates a unique and exotic landscape
ratio between perimeter and area of landscapes	**higher values** determine a great landscape diversity

To assess the visual impact of wooded areas is used species composition, but from an aspect called dendrological richness. Forest stands were divided into four groups depending on the number of tree species involved, whether they share in the total stock: forest stands consisting of one tree species; forest stands consisting of two tree species; forest standss consisting of three or more species with predominance of one of them; and finally consisting of three or more species without predominance. As a positive quality is reported the presence of much higher trees and single tree species occurring in the species composition. The passability, the construction and especially the average height of the forest stands are also taken into account in determining the visual evaluation.

ISSN: 0585-9069

Table IV: Componential assessment for aesthetic evaluation of the open spaces



Thus, forested areas are grouped into three groups according to the visual impact of plantations due to their external appearance (Table V):

The results of forest standss assessment, as well as the open spaces assessment are presented on maps (fig. 1 and fig. 2) accompanied by photographs. Grouping of landscapes is made mainly based on visual characteristics of the terrain and vegetation component. Based on the results of these study it have been made a number of conclusions necessary for the development of functional zoning of the area. The aesthetic qualities of the natural conditions are assessed in the following indices:

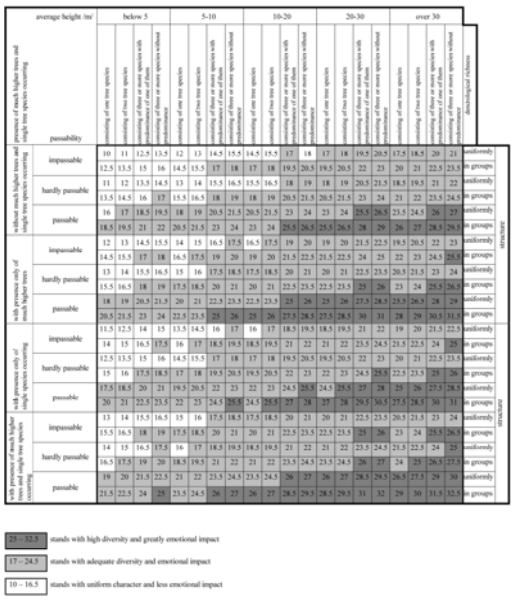
for the forest stands:

• average height;
• passability;
• construction;
• dendrological richness;
• presence of much higher trees and single tree species occurring;

for the open spaces:

• vertical and horizontal indentation of the relief;
• degree of the horizon shelterness;
• number of visible landscapes;
• passability, construction, dendrological richness, and presence of much higher trees and single tree species occurring in the surrounding tree forest stands.

Table V: Evaluation of forest stands to their visual impact



In conclusion we can say that the determination of aesthetic value of landscape is very complex process including the description, analysis and evaluation, expressed in the grouping of territorial units defined set of criteria associated primarily with sensory experiences.

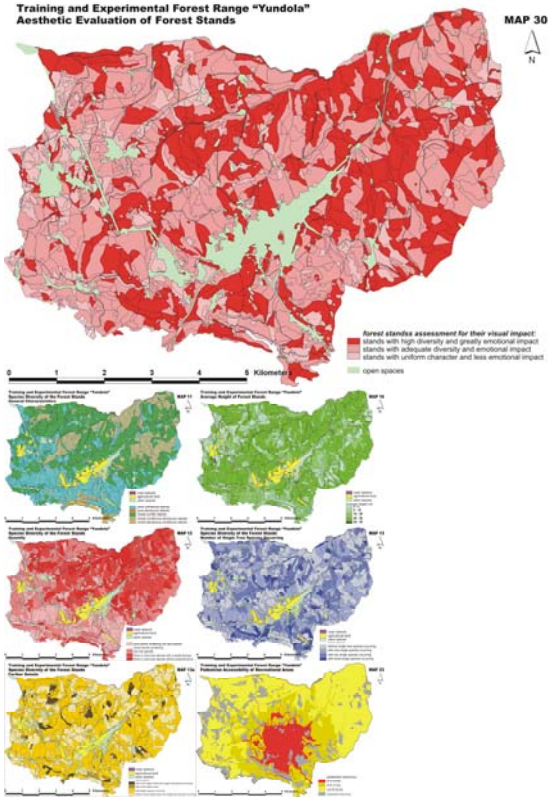


Figure 1: Aesthetic evaluation of forest stands

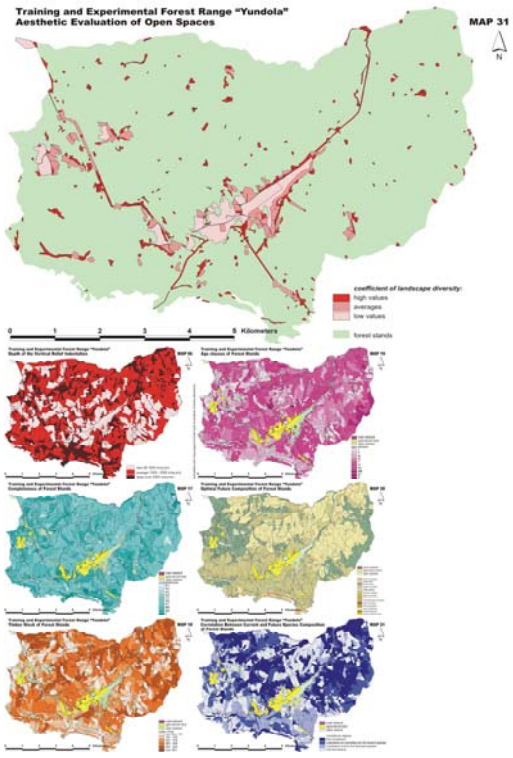


Figure 2: Aesthetic evaluation of open spaces

4 REFERENCES

[1] Appleton, J. 1975. The experience of landscape. London: John Wiley. 293 p.
[2] Buhyoff. G. J., Wellman, J. D. & Daniel, T. C. (1982). Predicting scenic quality for mountain pine beetle and western spruce budworm damaged forest vistas. Forest Science, 827-838.
[3] Cox, T.R. 1985. Americans and their forests: romanticism, progress, and science in the
[4] late nineteenth century. Journal of Forest History. 29: 156-168.
[5] Daniel. T. C., & Boster, R. S. (1976). Measuring landscape esthetics: The scenic beauty estimation method (U.S.D.A. Forest Service Research Paper 167). Ft. Collins, CO: Rocky Mountain Forest and Range Experiment Station.
[6] Kaplan, R.; Talbot, J.F. 1988. Ethnicity and preference for natural settings: a review and
[7] recent findings. Landscape and Urban Planning. 15: 107-117.
[8] Lyons, E. 1983. Demographic correlates of landscape preference. Environment and Behavior. 15(4): 487-511.
[9] Ribe, R.G. 1991. The scenic impact of key forest attributes and long-term management
[10] Alternatives for hardwood forests. In: McCormick, L.H.; Gottschalk, K.W., eds. Proceedings, 8th Central Hardwoods Forest Conference; 1991 March 4-6 University Park, PA. Gen. Tech. Rep. NE-148. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 35-54.
[11] Schroeder, H.W. 1987. Dimensions of variation in urban park preference: a psychophysical analysis. Journal of Environmental Psychology. 7: 123-141.
[12] Zube, E.H.; Pitt, D.G.; Evans, G.W. 1983. A lifespan developmental study of landscape assessment. Journal of Environmental Psychology. 3: 11 5-128.

For. review 43: 1 - 76. Skopje, 2012
Ss. Cyril and Methodius University in Skopje
Faculty of Forestry in Skopje

ISSN: 0585-9069

For. review 43: 62 - 64. Skopje, 2012
ISSN: 0585-9069
UDC: 630*22:528:[007:004.6(497.2)
Professional paper
Paper submission: May, 2012

CREATING A DATABASE FOR THE DENDRARIUM USING REMOTE SENSING AND GIS TECHNOLOGIES – EXAMPLES OF EXPERIMENTAL FOREST DEPARTMENT "PETROHAN", R. BULGARIA

[1]GALEV E., [2]SANDEVA V., [2]DESPOT K., [3]ACEVSKI J., [3]SIMOVSKI B.
[1] University of Forestry, Sofia, Bulgaria,
[2]Goce Delcev University, Štip, Macedonia
[3]Ss. Cyril and Methodius University in Skopje, Faculty of Forestry in Skopje, Skopje, Macedonia
Correspondig author e-mail address: emil.galev@abv.bg

ABSTRACT: Using Remote Sensing and GIS technologies as an aid for creating database for the dendrarium in the Training and Experimental Forest Range "Petrohan" is the focus of discussion in the paper. The cardinal study goal is illustrating a concrete instance of applying GIS technology in the landscape architecture survey. This paper describs the methodology of vegetation mapping using traditional method combined with remote sensing data. Creating graphical and attribute table databases is also useful in the education of students in the University of Forestry in Sofia. Making semester projects in academic discipline "Dendrology" the students have to learn and analyze the features of trees and shrubs. GIS software provids the capability to analyze large data sets containing features of coniferous and deciduous trees and shrubs in the dendrarium. In the other hand the purpose of the development of the vegetation mapping methodology is to provide an objective and cost-effective survey method utilizing satellite remote sensing for the vegetation mapping. Overall, these results confirm that satellite imagery data coupled with field observations and direct measurements can be used effectively for precise mapping of trees and shrubs.The result of the analysis shows that image objects extracted from satellite data provide a new opportunity to make detailed inventory maps of ornamental vegetation in parks. In such cases, it is imperative that such exploration technologies should be used, which are cost effective and provide greater accuracy. An integrated approach of remote sensing and GIS technologies can just suffice these requirements during exploratory efforts in difficult terrains.
Keywords: satellite image, mapping, vegetation, coniferous, deciduous

1 INTRODUCTION

Detailed mapping of tree and shrub species is often required in various landscape architecture design projects. This paper illustrates a concrete instance of the vegetation mapping using Google Earth Satellite Database, assuming the future use of satellite imagery data for the vegetation inventory information acquisition. A key requirement for the effective inventory of ornamental plants is the accuracy. Hand-mapping in the field is a technique commonly used in practice, but is inaccurate. In addition hand-mapping from field observation requires access to the site from the ground and visibility, a condition that does not exists always, especially on a very steep ground and in the presence of closely planted trees and bushes. Then measurement of distances is extremely time-intensive and often necessitates a large number of linear measurements. Because of these constraints, hand mapping is usually done on an as-needed basis, and comprehensive map that would support data base is done after taking dimensions of the terrain. There is need, therefore, to develop repeatable and reliable techniques for successive field and computer work, which allows mapping the vegetation objects, which can be accomplished using more conventional methods.

This study tested the suitability of the satellite imagery for improved mapping of plants in the parks. This work will be useful in future decisions about methods for detailed mapping of vegetation. (Rangelov 2003).

The objective of the investigation was to make a detailed dendrological inventory. The information it has provided might be useful insofar as directing future surveys or design projects. The graphical output serves as a basic plan to assess future activities in the park. The goals of this project were to map the spatial location of ornamental plants in the study area and to test the efficacy of satellite imagery for plant mapping.

Resolution of Google Earth data is about 1.00 m and provides enough information for distinguishing the majority of the trees. On the other hand, Google Earth imagery provides useful information such as diameters of the crowns. Therefore it is suitable for delineating trees in a quite precise manner. (Asenova 2009).

2 MATERIAL AND METHODS

In this study, a detailed mapping from actual satellite data was conducted for a specific park area. The dendrarium in the Training and Experimental Forest Range "Petrohan" near the village of Barzia was chosen for the study area. According to (Kuneva et al. 2009) this area is characterized by a rich species diversity of trees and shrubs and dense wood massifs. The ground in the area is characterized by displacement and slope configuration by (Destan 2007).

Technical objectives of the research are:

- to conduct the inventory in a way that all trees and shrubs occurring at the park are documented with their location and size in a scientifically credible manner;
- to develop methodology to accurately identify the location of ornamental park vegetation using satellite imagery, image-editing software and graphic software;
- to test methodology in a study area marked by difficult access of terrain and dense vegetation within the AutoCAD environment;
- to assess the accuracy of the mapping.

For this study, traditional methods by (Rangelov 2003) were used in the beginning of the field work for initially mapping of the terrain data, which was recorded in a sketch and then transferred to the digital format. According to (Asenova 2009) the multispectral satellite data with a spatial resolution of 1.00 m allows identification of quite a number of vegetation objects and amend their location and size at a drawing.

ISSN: 0585-9069

The sketch-map was created for use as a tentative set. Using a combination of field photos and field notes hand-mapped trees, shrubs and massifs were adjusted on the display of the image data. Using distinguished and adjusted trees as pickets were conducted direct measurements in the field and small trees and shrubs were fixed in the drawing.

The final product was derived from the Google Earth data after conducting the field work and after some amendments in the drawing. This product will allow the resource manager of the park to make up to date, well informed management decisions with a detailed vegetation map in a relevant and efficient timeframe.

A detailed drawing for the plants is created in three stages. The investigation started with drawing up a field sketching map produced for the park including areas managed as a dendrarium. The investigation used standard floristic inventory procedures to identify and document all 116 plant species observed. Location of the existing plants was judged by sight at first and was recorded as coniferous and deciduous trees or shrubs. The locations were marked in the geodetic survey as points (for the ornamental trees) or as polygons (for woodlands and shrubs). The geodetic survey was updated and made more precise prior to conducting the first stage of field work at the park. The primary purpose of the conducted field inventory is to create a field sketching map, and also verify the current presence of already-documented species, provide information on relative abundance, provide distribution information on endangered or threatened species or species of concern. Positions of the plants on the sketching map were fixed by traditional methods, i.e. approximately. The vegetation of the sketch-map has been scanned and processed in a digitized form. The trees were delineated over the drawing like points and the shrubs – like polygons.

The study starts with the image conversion in derivative formats for CAD software, which allow to insert it into AutoCAD where is possible to delineate image objects. The conversion was done using image processing software. The satellite photo was not put under geometrical rectification. This was equilibrated with just a little deformation of the image in order to coinciding with the geodetic cadastre. The satellite photo was used for this study as a technical aid. Its purpose is to provide pickets for the following stage of work – detailed field observations. At this stage, using an electronic ranger had been fixed positions of small trees and shrubs toward amended by satellite photo trees. Image insertion implemented in the AutoCAD was used to improve and to specify the field sketching map.

The image was converted to a derivative format for AutoCAD and used to rectification of the location and size of the distinguished tree crowns. Thus the draft of vegetation map was obtained and was finalized and supplemented by subsequent field surveys (field observations and direct measurements). The map compilation took into account massifs and single trees conducted in the area. The method permitted to delineate areas of conifers and deciduous woodlands on an extremely steep and difficult of access terrain, and to identify precise location and size of many individual tree crowns.

3 RESULTS AND DISCUSSION

Many image objects at this zoom level correspond to individual tree crowns, as well as other spatial objects including roofs of buildings, walks, retaining walls, etc. Some of the shrubs are smaller than the individual pixels. A research question is how to determine an optimal zoom level for identification of individual plants.

The purpose of the work was to obtain sound information on the locations and real sizes of the trees and shrubs in a digitized form. The initial objective was to travel all over the entire territory of the dendrarium, and to draw up a sketch of the existing vegetation over the geodetic survey.

Each graphical object in the hand made sketch needs to be amended, in accordance with the image (Figure 1). Some image objects in this study were relatively easy to be identified based on the spectral properties, and others are difficult to be determined only by the contextual information such as relative sizes, spatial relationships, texture, and so on. The Google Earth data used in this study was taken in spring, and vegetation–covered and non-vegetation areas were spectrally distinctive on the imagery. Among the conifer and deciduous trees, and grass areas showed relatively distinctive spectral properties on the photo so that their identification were easier after an arbitrarily variation of their color adjustment. On the contrary, instances of some vegetation classes were difficult to distinguish from other vegetation classes. For instance, some trees (both coniferous and deciduous) with loose crowns are very difficult to identify, but they cast clearly visible shadows on the ground so that property must be used for the determination rule. For distinguishing deciduous from coniferous trees, texture information of image objects appears to be useful. Sizes and shapes of image objects were also useful properties for distinguishing some trees such as high specimens with large crowns from others. Figure 2 shows a precise drawing illustrating conifer and deciduous trees as well as decorative shrubs within the dendrarium. Figure 3 shows developed GIS database concerning detailed graphical and attribute information for the dendrarium territory.

Figure 1: Amendment of the drawing

In comparison with traditional inventory methods the remote sensing data tend to produce better results representing vegetation cover. In the case of vegetation mapping using very high resolution satellite data, the results are useful in combination with traditional methods results, because the image provides additional information about the location and size of trees in the image objects delineated by the sketch. Anyhow some gaps in the drawing come into sight during the drawing amendment. To rectify these gaps, additional field work is needed, with an electronic telemeter.

Figure 2: Dendrological drawing of the object

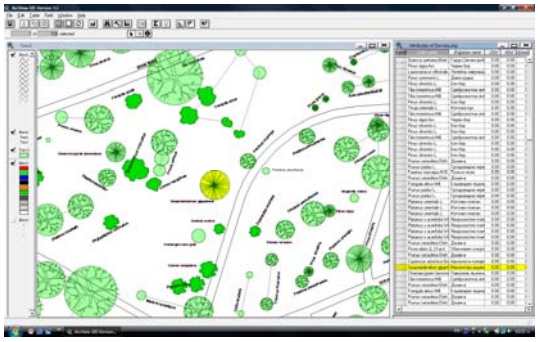


Figure 3: GIS database for the dendrarium

4 CONCLUSIONS

Traditional methods for large scale vegetation mapping require expensive time intensive field surveys. The use of remotely sensed, high resolution, multispectral data for mapping vegetation provides a detailed, accurate product in a time and cost effective manner. For this project, applying a hybrid approach was developed a plant inventory map using imagery data.

The result of the hybrid approach and using Google Earth data in this study suggests that Google Earth data would be a useful additional information source for the vegetation mapping for the landscape architecture design projects.

Very high-resolution satellite images are a useful information source for vegetation mapping, which is part of the design project data set.

Through this project, the spatial distribution of ornamental plants was mapped at a famous Bulgarian park in digital format.

The information collected through this effort will:

- increase the ability of landscape architects to analyze and map plants and non vegetative elements of the parks;
- serve as a baseline for long-term monitoring, assist with the characteristics of changes in parks over time and detect new elements there.

In addition, the data collected through this study will provide the basis for a plant inventory plan for the dendrarium in the Training and Experimental Forest Range "Petrohan" near the village of Barzia. This study shows that ornamental plants in the parks can successfully be mapped using satellite data and conventional methods. These techniques show promise as useful tools for vegetation inventory. This is especially applicable in the landscape architecture design projects because spatial extents and distribution of existing vegetation is very important and define the future plant composition of the parks.

5 REFERENCES

[1] Asenova M. 2009. GIS as an effective tool for forest management. Management & sustainable development, University of Forestry, Sofia, Vol. 22 (1): 94–101. (in Bulgarian).

[2] Destan S. 2007. Importance of Maturity Concept in Determination of Functional Rotation in Forestry. Review of the Faculty of Forestry, University of Istanbul. Series B, Vol. 1, № 1: 52–53.

[3] Kuneva Ts., Kabatliyska Z., Petrova R., Yancheva D. 2009. One year flowering meadows. "Avangard Prima", Sofia, 108 p. ISBN 978-954-323-326-7.

[4] Rangelov V. 2003. Spatial characteristics significantly affect the appearance of park areas. Proceedings of the "Jubilee Scientific Conference 50 Years University of Forestry – Sofia", April 2003, Sofia, Bulgaria: 272–276.

For. review 43: 1 - 76. Skopje, 2012
Ss. Cyril and Methodius University in Skopje
Faculty of Forestry in Skopje

ISSN: 0585-9069

For. review 43: 65 - 69. Skopje, 2012

ISSN: 0585-9069
UDC: 635.9.053:72.012.6(497.711)
Professional paper
Paper submission: May, 2012

THE USAGE OF CLIMBING PLANTS IN FAÇADE GREENING IN TODAY'S URBAN LIVING WITH EXAMPLES OF THE CENTRAL URBAN REGION OF SKOPJE, R. MACEDONIA

KANAREVA N., [1]RIZOVSKA ATANASOVSKA J.
[1]*Ss. Cyril and Methodius University in Skopje, Faculty of Forestry in Skopje, Skopje, Macedonia*
Correspondig author e-mail address: natasakanareva@yahoo.com

ABSTRACT: We consider the climber plants that are structural elements of the façade greening. The new trends in the urban greening, such as façade greening, green walls and green roofs that affects buildings and architectural objects, belong to the group of vertical greening. They are important because of their function, firstly an aesthetic one (by covering damaged walls), and the sanitary function, by improving microclimate (oscillation of the temperature and humidity of the air). There are also other effects they have in an urban environment, they give heat, wind, sound and rain protection.
Keywords: climber plants, façade greening, vertical greening, green walls

1 INTRODUCTION

Facade greening has a long history that could be seen from the old draws, where some climbing plants, like vine and ivy are shown. It begun in the time of Babel and its hanging gardens, where plants were hanging over multileveled terasses. Second point is the Romantic Era, period when castles were wrapped with plants. Ancient looking walls overgrown with ivy became then an ultimate fashion. The third point is at the beginning of the 20th century when they were revived again. Nowadays, we have modern green façades as a specific type of greening in the urban way of life.

In the modern cities where urbanization and traffic become bigger from day to day, there is a constant need for findding new methods and solutions for increasing green spaces. That means introducing plants among the architectural objects in the cities will raise the quality of life for the people. The new era started two or three decades ago, creating gardens on the roofs, modern façade greening and green walls. That was the initial point of usage the new trends in urban landscaping.

Considering that, some new trends in cities greening are: living walls, façade greening and green roofs. Designers, architects and engineers now have oportunities to put beautiful 'clothes' on buildings, no mater if the need is aestetical or functional. A good relation between green areas and nature suppose to improve the living of the citizens in an urban environment.

Facade greening is a pretty new concept for increasing greenery in the big city where there is not enough space for parks and gardens. Commonly used plants for facade greening are climbing plants. Vertical gardening or greening, using climbing plants, can insert the spirit of nature, offer a new view on architecture and make cities good places for living. The city greyness, damaged or monotony facades, can easily be changed with this type of greening concept, considering it as good decoration for buildings.

Today, with the contribution of this kind of greenings and the other types of open green spaces in the cities, many scientists in the world are facing to strong task in front of them to make our environment more clean, more beautiful and more healty place for living.

The term facade greening is very closely connected to the usage of climbing plants matters dealt with in this paper. There will be described the climbers and how they affects on buildings, their suitable growth support system and the types of the mechanisms they are using to crawl on the surface.

2 MATERIAL AND METHODS

In this paper is present affects off the climber species as essential parts of façade greening and their use in this type of greening in an urban surrounding, considering few examples from the central urban region of Skopje (the settlements: Centar, Avtokomanda, Karposh 1, Karposh 2, Karposh 3, Kapishtec). There are some architectural objects and public buildings and some other objects directly related to the green spaces, like fences, damaged walls or trees. The detected object and buildings are correctly descripted and the climber species are determined. Than are given the morphological characteristics and ecology of the climber species and also their usage according their specifics in facade greening. Here are presented some photos from the climbers and their growth support systems.

The literature connected to this issue had to be found while researching the climbing plants, their usage and effects they have on the environment. That means appropriate information about their morphological characteristics and principles for designing green facades would be properly given. Furthermore should be given some suggestions for their appropriate use, to propose species considering their functions (decorative and sanitary), effects and benefits that come out from their usage.

Climbing plants should be divided in two groups: flower decorative and leaf decorative ones. Also there are described the functions and the type of surface attachment mechanism from different climber species. At last, locations and the buildings with façade greening in Skopje were pointed out.

3 RESULTS AND DISCUSSIONS

Façade greening belongs in the group of vertical greening, together with green walls and green roofs. Before start talking about façade greening we should be introduced with this term and make difference with green walls.

There is a big difference between green walls and facade greenings. The concept of green wall is more complex then supporting system of façade greening. Creating a green wall means specially made panels attached on a wall, planted with different kinds of plants and there must be designed an irrigation system too. In

 ISSN: 0585-9069

that panels can grow different species of grasses and flowers while for façade greening usually are used only climbers. The concept for façade greening is creating a suitable climbers growth support system. After installing it on the wall, climbers can be planted in the ground or in a pot, and later they erect on the wall. Some of these plants can climb freely on the surface of the wall (self-clinging climbers, *Hedera helix L.*) and the others can climb up only with suitable growth support systems (*Wisteria sinensis Sims.*).

3.1 Aesthetic functions of green façades

A group of different species positioned right on a façade, could represent a beautiful picture, camouflaging a monotonous, damaged or ruined wall. Designing façade greening, some visual effects could be changed, vertical lines can be less tall and long walls will look shorter (if a climber is planted and growing up near to a window, taller building would look smaller, opposite of this, if the climber is clinging higher on a wall, the building would look taller).

Some climbers can give nice aromatic note to the surrounding, like *Clematis armandii, Lonicera americana, Lathyrus odoratus L.*, and their position should be nearby windows and doors.

Parthenocissus tricuspidata Planch. and *P. quinquefolia Planch.* have leaves that in autumn become red and give to walls remarkably looking. *Hedera helix L.* is suitable for north sided walls. Its dark green leaves can cover the whole surface of the wall even in winter. Some walls will look astonishing during summer if there are flower plants like *Campsis radicans Seem.* with red-orange flowers.

Climbing plants can wrap spiral around pillars, the others can form green spots on the walls or make tracks near to the doors. Suitable for these types of figures are: *Clematis × jackmanii Jackman & Sons*, with dark violet flowers, *Lonicera caprifolium L.*, with yellow flowers, *Wisteria sinensis Sims.*, with rich blue-violet flowers, etc. In climbers selection should make attention on a wall exposure. For south and south-west exposures, good choices are sun-loving plants like: *Parthenocissus quinquefolia Planch., Lonicera caprifolium L.* and *Periploca graeca L.* and for north exposures: *Hedera helix L.* and *Campsis radicans Seem.* Façade greening can be arranged with annual and perennial climbers. Perennials usually are used for long lasting period. For short period (fast camouflage or decoration) there are some kinds of annuals, such as *Ipomoea violacea L.* with white, rose and blue flowers, *Lathyrus odoratus L.* with smelling flowers, *Phaseolus coccinaeus L.* with small red flowers and *Tropaeolum L.* sp. with orange-red flowers.

3.2 Sanitary function of the green façades

Despite the aesthetic function, façade greening have sanitary function too. The usage of climbing plants does not make damages on walls because they are not directly attached on them; they are growing on special designed supporting system. But the benefits of greened facades are many:

1. They improve microclimate, binding the dust from the air and enriching it with oxygen;
2. They equate oscillations of temperature and humidity through evaporation;
3. Give wind protection and directs the wind reducing the losses of thermal energy;
4. Offer heating protection, helped by air bags between façade and climbing plants;
5. Give protection from rain and direct transportation of water to roots;
6. Give sound protection, the leafs of the plants have ability to absorb the sound;
7. They have ability of filtering and improving the air quality by absorbing hard metals;
8. They are living space for birds and insects.

3.3 Climbing plants commonly used for façade greening

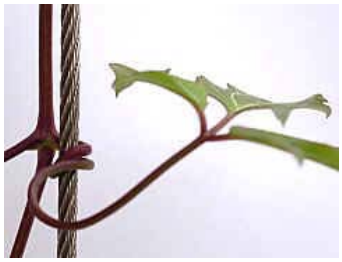
Climbing plants or lianas belong to more than 110 families of vascular plants. Climbers are fast growing, woody or legume species, their roots are in soil but the life form of stems have need for some support to creep on it. It is convenient to recognize two categories of adaptation for climbing plants, with active mechanisms, involving growth and tropisms of the plant to become attached, and with passive mechanisms, whereby they have existing structures that come in contact with the supporting structure. Each mechanism provides biomechanical and ecological advantages and disadvantages, depending on situation in which the vine or liana is growing.

- Active mechanisms
  - a) Attachment by tendrils (stem, stipule, leaf tip, flower axis)
  - b) Twining
  - c) Attachment using adventitious roots
- Passive mechanisms
  - d) Arrangement of branches or leaves in a supporting design
  - e) Spines and stiff emergences
  - f) Sprawling (scrambling or scandent growth habits)

a) Tendrils

b) Twining

c) Adventitious roots



d) With leaf

e) With spine

f) Sprawling

Figure 1: Active and passive mechanisam of attaching to surface

- Flower decorative climbers

Clematis sp. L. grows in semi-shaded to moderately sunny positions, on fresh, humus-rich soils with good drainage and shade on the root zone. Climbers with leaf-tendrils and foliage from May to October, defoliation of dried up leaves often go slow. Flowers, depending on cultivars, often with beautiful filigree seed heads.

Jasminum officinale L. grows on sunny to semi-shaded positions. Foliages appear in April and last till October. White flowers of this plant bloom all summer. It has moderate to vigorous growth habit, suitable for detail and accent planting.

Lonicera sp. Thunb. usually grows on sunny to semi-shaded positions, rather then full sun exposure. *Lonicera* belongs to twiners, their foliage appears in April and last till October. The colors of the flowers are different depending on species and they are white, crème, yellow to orange, pink and red. They have long-lasting blossoms; some species exude a heavy perfume.

Aquebia quinata Houtt, prefers sunny to shaded positions, protected from wind. This evergreen plant is a twiner and its initial growth is rather slow. Flowers are red-brown, clusters in early spring and perceived from close-up.

Wisteria sinensis (Sims.), grows on full sunny position, if possible. It is an extremely strong and vigorous twiner that can reach 20 m height. Leaves are mostly light green, foliage from May to November, in autumn rarely with yellow coloring. Flowers have rich deep blue or deep purple color and show up in midsummer.

Campsis radicans Seem., prefers warm, sunny to part-sunny position; shade on the root zone is beneficial. It is a frost resistant self-clinging climber with adhesive stem roots. Flowers are red or yellow-orange and blossoms appear from July until September.

Polygonum aubertii L. or Silver Lace vine prefer sunny to semi-shaded position. It is a strong twiner and one of the most vigorous climbers. Foliage last until November. White flowers flowering from July until Spetember.

Passiflora coerulea L., grows on sunny to semi-shaded position, not too windy. For constant flowering should be fertilized several times. Flowers are white with violet color and resist all summer. Foliages with dark green color are very decorative.

- Climbers with picturesque leaf color

Hedera sp. L. stands sunny to semi-shaded position. It is self-clinging climber with adventitious stem roots. This evergreen specie has dark green color of its leaves attractive even in winter.

Parthenocissus quinqefolia Planch is a moderate to good self-clinging vine, well-known for its beautiful leaf form and autumn color. It stands sunny to semi-shaded position. With its adventitious stems can cause building damages.

Parthenocissus tricuspidata Planch grows on sunny to semi-shaded positions. Leaves are light green from May to October and in autumn they change their color in red. It is self-clinging climber that covers extensive areas quickly. It is one of a favorites for façade greening.

Vitis coignetiae Pulliat. needs sunny to semi-shaded positions. Its foliage appear in May and last till October. If its leaves are exposed in sun during the autumn, they pass from green to intense yellow and red color. This climber has tendrils and vigorous growth.

All characteristics of the climbing plants are shown in Table I below.

3.4 Façade greening in the central urban region of Skopje

The terms: vertical gardens, green roofs, façade greening, green walls, are new trends in greening of the architectural objects in the cities. They are contributing in improvement of the life in an urban environment, considering the amount of vegetation there. So, the importance for increasing the open green spaces of any type, in dense settlements including is very big. Considering Skopje as a city with lots of traffic, various types of architectural objects and industrial capacities, it is obvious that this kind of greening fulfils numbers of functions and satisfy the need of green spaces in the dense urban environment. Although today not many buildings are greened that way, in future the number of them might be bigger.

It could be recognized green façades in some locations in Skopje, more rarely on public buildings, than on individual ones which number is certainly bigger. The one of the most remarkable ones is in the center of the city, the point end of Partizanski odredi Street, where green façade is made from *Hedera helix* L. and *Parthenoissus quinquefolia* Planch. It is very attractive especially in autumn when there is a contrast between dark green leaves of *Hedera helix* L. and red ones of *Parthenocissus quinquefolia* Planch. Other location with façade greening is present in the City Mall in the center of the city (Dame Gruev Street), where there is

For. review 43: 65 - 69. Skopje, 2012
Ss. Cyril and Methodius University in Skopje
Faculty of Forestry in Skopje
ISSN: 0585-9069

Parthenocissus qiunqefolia Planch over the walls and pillars. Its autumn red leaves stand as contrast of the white color of the building. There is also a wall nearby Faculty of Chemistry that is a part of Botanic garden (Aleksandar Makedonski Boulevard), where *Parthenocissus tricuspidata* Planch is present. The wall from one side of this building is whole covered by this specie which is very attractive in autumn because of the leaves when become red. It should be mentioned the wall of Hotel "Continental" (Aleksandar Makedonski Boulevard) with north exposure is covered with *Hedera helix* L., making contrast to the white color of the façade. One of the walls of Forestry Faculty in Skopje (Aleksandar Makedonski Boulevard) was covered with *Wisteria sinensis* (Sims). Over long period of time, the plant was removed and now there are only some fragments of it. Also there are two examples where plants are climbing on dry trees, the first one is near boulevard Krushevska Republika, *Hedera helix* L. and the second one in the Bonsai Garden in City Park in Skopje, *Parthenocissus tricuspidata* Planch.

These few species could be seen on many private houses too. Their frequent use is mainly because of their decorative effect in autumn (when the green color of the leaves like *Parthenocissus qiunqefolia* Planch and *Parthenocissus tricuspidata* Planch turn (passes) into red.

Some climber species mentioned in this work are used in the vertical greening in the gardens of the private houses, decorating architectural elements, balconies, terraces, fences or trees. But that is an issue for another paper, where more details and descriptions of them will be presented.

Urban green infrastructure can be a good compromise between empty walls of buildings and the rest of the surrounding. It is a great opportunity for a landscape architect to use his own knowledge, creation, technical education and vision designing some kind of new green space.

4 CONCLUSION

Today, when green spaces are often limited in the big cities, the concept of façade greening could be a good solution for bringing nature in the dense urban settlements. There can be given conclusions of this paper affect of climber plants and their usage in façade greening in an urban environment.

1. The benefits of greened façades are in: improving microclimate, increasing the amount of vegetation in urban settlements, saving energy for heating in winter and for cooling in summer, filtering the air, binding the dust, etc;
2. Climbing plants used for façade greening usually grow in the ground or they could be set in pots and climb to grow over facades;
3. While green roofs are mostly accessible to few people, the effects of greened façades are highly visual and could be enjoyed by a wide range of people;
4. Green façades have more aesthetic then other advantages. Using climbers on the wall can be created an attractive picture or hide damaged or bed looking façade;
5. Façade greening is enabled by specifically designed support structures that allow vertical vegetative coverage via the controlled growth of climbing and cascading species;
6. Façade greening is non expensive option to increase greenery in the city;
7. Climbing plants are very adaptable and can take different directions growing in horizontal or in vertical lines, they have low-weight mass and ability for fast covering the surface.

There are architectural objects in Skopje which façades are covered with climber plants but they are not in a big number. Although there are just a few, their contribution is significant for the greening of the urban environment and is considerable factor of the urban

Table I: Plant sensibility on temperature and light, type of surface attachment mechanism of climbers

Climbing plant	Sensibility of temperature		Sensibility of light			Mechanisms of attaching to surface					
	Sensitive of low t	insensitive of low t	Sunny position	Semi-shaded position	Shaded position	Adventitious roots	Twining	Tendrils	spines	branches	Sprawling
1	2	3	4	5	6	7	8	9	10	11	12
Clematis jackmanii Jackman & Sons	+		+							+	
Aquebia quinata Houtt.				+			+				
Campsis radicans Seem.		+	+			+					
Parthenocissus quinquefolia Planch.		+			+	+				+	
Parthenocissus tricuspidata Planch.	+				+	+					
Hedera helix L.		+			+	+					
Lonicera japonica Thunb.		+	+				+				
Polygonum aubertii L.	+		+	+			+				
Wisteria sinensis (Sims.) Sweet.		+	+				+				
Vitis coignetiae Pulliat.	+		+					+			
Jasminum officinale L.		+	+							+	
Passiflora caerulea L.	+		+					+			
Actinidia kolomikta Maxim.	+			+			+				

living, increasing the green areas where there is not enough space for large parks and gardens.

Despite sanitary function, this kind of greening improve the quality of urban living making better microclimate conditions in the cities and in the same time it has an aesthetic function too as décor on the buildings or other architectural objects.

5 REFERENCES

[1] Abbs, B. Climbing plants, (2008), pag. 6, 30-31
[2] Андоновски, В. Пејзаж и дизајн во зелените површини, (2005), pag. 54-55, 67
[3] Bridgewater, A. Dizajn I planiranje vrta, (2008), pag. 29
[4] Buchan, U. Planting for all seasons, (1999), pag. 81-89
[5] Squire, D. Penjacice –strucnjak za vrt, (2008), pag. 31-37
[6] Šilić, Č. Atlas drveća i grmlja, (1973), pag. 142
[7] Џеков, С. Дендрологија, (1988), pag. 479, 431

For. review 43: 1 - 76. Skopje, 2012
Ss. Cyril and Methodius University in Skopje
Faculty of Forestry in Skopje

ISSN: 0585-9069

For. review 43: 70 - 72. Skopje, 2012

ISSN: 0585-9069
UDC: 635.9(497.742)
Professional paper
Paper submission: May, 2012

SOME NEW FLOWER PLANTS USED IN DESIGNING OF GARDENS AND BALCONIES IN STRUMICA (R. MACEDONIA)

MICEVSKA A., [1]RIZOVSKA ATANASOVSKA J.
[1]*Ss. Cyril and Methodius University in Skopje, Faculty of Forestry in Skopje, Skopje, Macedonia*
Correspondig author e-mail address: micevska@hotmail.com

ABSTRACT: Besides other plants, the flower-decorative plants are taking the highest application when greening our gardens and balconies. Their usage is bigger considering their decorative characteristics, such as flowers, leaves or habitus. The most interesting are the flowers with variable colors and dimensions and most important the long duration of flourishing in summer. This work is dealing with annual, and perennial plants that are quite new for making gardens and balconies arrangements.
Keywords: flower plants, gardens, balconies, annual, perennials

1 INTRODUCTION

In order to decorate, design a place it is necessary to find appropriate plant that can be decorative in first place and can fulfill the needs for aesthetic and functional space. It is very important every plant to be put in right place considering there its position towards the sun (exposition) where it can show all the decorativeness of its characteristics, such as color, dimensions of the flowers and flourish.

The needs for designing a place where one can enjoy in its decorativeness make people to be more inventive and original in their ideas. But quality arranged green spaces such as gardens, balconies or others depends also on the condition and nature characteristics of the area where they happened to be designed.

From the ancient times of our civilization, flower-plants were considered as decoration and were privilege of the wealthy people of a time. But as the time pass, the flower plants happened to be important part of people's life, first as spice, and then in various rituals and customs. They enter in the life of the common people in every segment of their living satisfying their need for esthetics.

There are countries in Europe that are dealing with selection and hybridization of flowers and decorative plants. Every day there are new varieties, cultivars, forms of flower species that are easily spread out through many countries nowadays. Here the interest is pointed on ones that are used in designing gardens and balconies recently in our country, which means some new species, cultivars, varieties and forms.

2 MATERIAL AND METHOD

The research of the flower plants was spread out in Strumica, in the private gardens and balconies and in Garden-centers where information for their sell was taken. Then, mostly through terrain work were noted the gardens and balconies decoratedwith flower species. Then there had to be found for which ones the interest was the biggest. After that the determination was made.Collected information was selected, processed andthe results are shown in tables where different datais exposed. Also there were taken pictures of the species that are theme of this work.

3 RESULTS AND DISCUSSION

There are the flower plants that were most found in the gardens and balconies in Strumica (R. Macedonia).

Gazania rigens (L.) Gaertn. (fam. *Asteraceae*) - treasure flower or small gerbera is usually planted directly in the ground in the gardens or in pots in the balconies (Fig. 1). This plant can only reach 10-15 cm in height. Itsleaves are narrow, green from the upper side and gray on the other. The flowers are taking attention with their various colors that are very alike gerbera. This sun loving plant open wide its flowers during the day, but in the evening or when there is lack of light they are closed. Its flowers stand on the steams through the summer. It cannot stand low temperatures, so it belongs to the group of annual plants, but anyway it still can be considered as popular plant.

Figure 1: *Gazania rigens*

Impatiens hawkeri W. Bull (New Guinea group) (fam. *Balsaminaceae*) - This plant is decorative because of its flowers (Fig. 2), which can be in any color except in blue. There are plenty of flowers on the stems (that are with bigger dimensions), and together with the leaves, give complete decorative effect of the plant. The habitus is wide, up to 20 cm high. This plant doesn't want to be exposed too much on intensive sun light. It cannot stand low temperatures, so it belong in the group of annual plants.

For. review 43: 70 - 72. Skopje, 2012
Ss. Cyril and Methodius University in Skopje
Faculty of Forestry in Skopje
ISSN: 0585-9069

Figure 2: *Impatiens hawkeri* (New Guinea group)

Sutera cordata (Thunb.) Kuntze (fam. *Scrophulariaceae*) – bakopa is creepy plant that cannot stand low temperatures and ice. It has small white or purple flowers and leaves in shape of a hart (Fig. 3). This plant creeps low and it can be spread out 40-60 cm. The stems are full of small flowers that stand there through whole summer.

Figure 3: *Sutera cordata*

Argyranthemum frutescens (L.) Sch. Bip. (fam. *Asteraceae*) - summer chrysanthemum is perennial and is one of the most decorative plants used in designing gardens and balconies nowadays. Besides the flowers, decorative are the leaves too. The flowers are small and gathered in big number on a steam. They can be found in every color but blue. The habitus is wide, 10-15 cm (Fig. 4).

Figure 4: *Argyranthemum frutescens*

Lychnis × *haageana* Lemoine (fam. *Caryophyllaceae*) - red lava, got its name after intensive red or orange color of the flower which appear in summer (Fig. 5). The color of the flowers is more intensive if they have sunny position. The leaves are narrow and hairy. This plant can reach 30 cm in height. It loses its decorativeness in autumn when its leaves fall down, but in spring it starts up with its growing again.

Figure 5: *Lychnis* × *haageana*

Verbena L. - cultivars (fam. *Verbenaceae*) – Verbena has small flowers gathered together at the top of a steam. They can be in various colors and can flourish with lots of flowers in the whole summer period. The leaves are small and tinny (Fig. 6). The decorative effect will be bigger if it is set in hanging pots and on balconies, but as it spread out very quickly, the effect can be reached if it is set directly in ground too. It is sensitive on low temperatures, but if it's well protected it can survive to the next vegetative season.

Figure 6: *Verbena* cultivars

Platycodon grandiflorus (Jacq.) A. DC. (fam. *Campanulaceae*) – called Balloon flower, except for its decorativeness it is also used in medicine too. This perennial has green leaves that fall down in autumn, but in spring with the new vegetative season it start with its growth again. It can reach 15-20 cm in height and can be 20-30 cm wide. Its buds have form of a balloon (where its name comes) which later open in form of a star. The flower can be single or double, white, pink or blue colored (Fig. 7). It can equally grow on sunny or semi shaded positions, but it cannot stand too moist soil.

Figure 7: *Platycodon grandiflorus*

In Table I are presented the new flower species that were most found in the gardens and balconies nowadays.

Table I: Characteristics of the flower ornamental plants

No	Species	Flower	Vegetation period	Habitus	Composition forms
1	*Gazania rigens*	Single in various colors	Annual	Straight	Single, groups
2	*Impatiens* 'New Guinea'	Single in various colors	Annual	Straight	Single, groups
3	*Sutera cordata*	Single, white and purple	Perennial	Creeper	Single, groups
4	*Argyranthemum frutescens*	Single/double, in all color variable	Perennial	Straight	Single, groups
5	*Lychnis* × *haageana*	Single red and orange	Perennial	Straight	Single, groups
6	*Verbena* cultivars	Single in various colors	Annual	Creeper	Single, groups
7	*Platycodon grandiflorus*	Variable	Perennial	Straight	Single, groups

4 CONCLUSIONS

In this work are presented seven flower species that are most used as new ornamental plants in the gardens and balconies in Strumica (R. Macedonia) nowadays.

They are variable considering the color of their flowers which flourish intensively in summer.

According their vegetative period, three of them are annuals and four perennials.

By their habitus, two of the species are creepers and five are straight up.

Considering their use in the gardens and balconies in pots or directly in the ground, they can be set single or in groups.

They are quite easy for nourishing. The perennials have to be replaced in order to remain the flower effect, and the annuals in winter should be removed in warmer places for the next vegetative period when the temperatures would be good enough for them.

At last, according all of that it can be concluded that the use of these flower species should be more intensive in future because of their decorative characteristics. They don't need special conditions for their nourishing. They flourish intensively through the whole summer and can be used in various composition forms and combined with other species/plants.

5 REFERENCES

[1] Booth, N. K. (1989): *Basic Elements of Landscape Architectural Design*. Watson-Guptill Publications. USA.
[2] Brooks, J. (2001): *Garden Design*. Doring Kindersley Limited. London. UK.
[3] Hannebaum, L. G. (2002): *Landscape design*. Prentice Hall-Upper Saddle River, New Jersey. USA.
[4] Hessayon, D. G. (2006): *The Garden Expert*. London.
[5] Procter. N. (1988): *Perennials*. Salamander book ltd. London.
[6] Поповски, П. (1989): *Паркови со заштита на човековата околина*. Скопје.
[7] Ризовска Атанасовска, Ј. (2007): *Проектирање на зелени површини.* Авторизирани предавања. УКИМ, Шумарски факултет. Скопје.
[8] Ризовска Атанасовска, Ј. (2002): *Перени и едногодишни растенија* Авторизирани предавања. УКИМ, Шумарски факултет. Скопје.
[9] ***(2005): *Velika ilustrirana enciklopedija VRT*. Mozaik knjiga. Zagreb. (Encyclopedia of Gardening. The Royal Horticultural Society. London).

For. review 43: 1 - 76. Skopje, 2012
Ss. Cyril and Methodius University in Skopje
Faculty of Forestry in Skopje

ISSN: 0585-9069

For. review 43: 73 - 76. Skopje, 2012

ISSN: 0585-9069
UDC: 630*2
Professional paper
Paper submission: May, 2012

THE SENSE OF PLACE RESEARCH APPROACH TO FORESTS

RANTAŠA B.
Wageningen University / Ghent University
Correspondig author e-mail address: bojan@rantasa.net

ABSTRACT: Gieryn calls for a new approach to analysing place [5]. He encourages researchers to indulge them selves in a more visual approach, one that combines maps, photographs, landscapes, etc. and not being limited to mere significance testing of variables [5]. In the paper I take this challenge to explore what could this new approach to research on sense of place be. I make an analysis of the forest related literature that discusses the sense of place. Most scientists make attempts to predict sense of place, reducing it to e.g. attachments and satisfactions related to forests, in order to develop measurable, manageable concept for forest planners. Practitioners ask for people's feelings and try to interpret the geography and the spirit of the place in its complexity. I conclude the paper acknowledging that there is an abundance of approaches to the research on sense of forest place. However, using the words of Lefebvre we still do not have a perfect understanding of the cause and effect in place making [12]. I identify the unique lived experience of people at the centre of sense of place making and invite researchers to make an approach to an understanding of sense of place with the reason, senses and feelings.
Keywords: place, forest, sense of place, research, practice, approach

1 INTRODUCTION

In the scientific forest literature there have been calls for inclusion of sense of place in forest planning [29]. However this has not been done so readily [22]. The reason to this slow inclusion of sense of place in forest planning has been argued that it is due to the issue that most research results are qualitative, while forest planners want hard statistical data [22], [23]. Yet, if we are to build *forests for people* (1), managers should adapt their management practices to a more human understanding. On an event 'Towards the Sustainable Use of Europe's Forests – Forest Ecosystem and Landscape Research: Scientific Challenges and Opportunities, Farcy noted the need for forest planners to change their traditional practice of wood management, and to take into consideration more dimensions, the social and natural diversity in specific [3]. Sense of place could be that additional dimension and provide the link and understanding for reaching the objective of forests for people. As Williams and Steward say: 'That [sense of place], in essence is, the central objective of natural resource planning, and it may be the only genuinely integrative approach to managing ecosystem.' [29, p.23]'

The issue that poses many concerns in sense of place research and application is: How to analyse sense of place? Various calls have been made in this relation [5], [9], [22]. At first hand it seems that the issue is not whether a quantitative or qualitative analysis should be made. Stedman in his call for more quantitative research to forests still recognizes the importance of having qualitative research on sense of place [22]. One needs an in depth qualitative analysis before a quantitative analysis can be employed [1], [11]. Yet, researchers can be divided between quantitative analysis proponents and qualitative analysis proponents. But, there is one thing that researchers agree upon, and that is that sense of place is a complex matter [5], [9], [21], [22], thus my question here is how we should approach this complexity.

Gieryn [5] understood the complexity of analysing sense of place. Gieryn, makes a bold move and calls for a new approach to sense of place [5]. He encouraged researchers to indulge themselves in a more visual approach, one that combines maps, photographs, landscapes, etc. and not being limited to mere significance testing of variables [5].

'Maybe a place-sensitive sociology is not a set of empirical findings at all or even a distinctive kind of explanatory model, but rather a way to do sociology in a different key–a visual key. […] What I lacked were tools to analyse place in its given two and three dimensions. I am a victim, perhaps, of trained incompetence in a discipline that cultivates statistics and words as means to grasp the social. Sociologists could become more adept with maps, floor plans, photographic images, bricks and mortar, landscapes and cityscapes, so that interpreting a street or forest becomes as routine and as informative as computing a chi-square. That visualizing (I think) is the next step.' [5, p.483]

This call, in its essence, is a call for a qualitative approach. Yet, it is an approach that requires great openness from the researchers' side when approaching sense of place. I believe that this openness is key in grasping the complexity of sense of place. And this is the issue that I intend to elaborate, as the visual key would require combination of methods that otherwise may not be used. To take a quote from Patrick Keiller's film, an exploration of place: 'Robinson believed that if he look to the landscape hard enough it will reveal to him the molecular basis of historical events and in this way he hoped to see into the future' [19]. Though in a symbolic sense, this is that visual approach that Gieryn calls for [5]. But the issue is whether it is present in the forest related literature.

In this paper I take this challenge to explore what could this visual approach [5] in research on sense of place be. Therefore, 1. I look into the current research approaches in the analysis of sense of place of forests; 2. I look into the practices of analysing sense of place by practitioners; and lastly 3. I conclude this paper with a call to researchers of sense of place.

2 SENSE OF PLACE IN FORESTRY

2.1 The approach of scientists

The recognized complexity of sense of place has compelled researchers to analyse sense of place in a qualitative manner. However this approach has been regarded as wrongful in the context of forest planning [22], [23]. Stedman says that forest managers require measurable elements: 'One cannot "manage for sense of place" or integrate it into resource planning unless its

ISSN: 0585-9069

particulars are known, as well as the process by which it is created.' [22, p.827]. Therefore to satisfy traditional forest planning practice, sense of place is being measured and statistically treated [22], [23]. This approach and understanding originates from the history of scientific forestry (2). Scientific forestry was designed for control of the resource for central (state) planning seeing the forest in a utilitarian way, through the availability of wood, and stripped from any other social or natural values [20]. In this relation, scientific forestry '[…] has relied more heavily on conventional positivistic science and its hypothesis-testing approach.' [22, p.824]. The consequence of this is that statistical measuring of sense of place in order to be managed. However sense of place is a human dimension, and measuring variables on sense of place is as close as explaining the forest landscape through the average wood mass of the plot. Or to take a thought by Scott on the abstract measurements, it is like explaining books in kilograms [20]. Not impossible but at least questionable.

Due to this argument on traditional forestry, there is a tendency for quantitative research to be conducted in relation to sense of place of forests. Though not neglecting the importance of qualitative research in Stedman's call [22], researchers may be inclined to go directly to quantitative research, thus skipping a process of understanding the sense of place and any possible issues that may be hidden.

Looking at the forest related literature is evidenced that the quantitative approach has more and more presence [22]. The sense of place is been treated in variables that express: rootedness [15]; attachment to place [10], [28]; attachment, identity, and dependence [8], [9]; characteristics of the environment, human uses of the environment, constructed meanings, place attachment and satisfaction [22]; etc. We can not say that one quantitative approach is more dimensional than the other since the elements of sense of place remain to be discussed and treated differently by different researchers and or scientific disciplines [27]. In quantitative approach to sense of place attempts to portray the complexity of sense of place is being made and improved over time [9]. The question that I find more important to this is whether the selection of elements or dimensions of the sense of place are appropriate for that place. An information that should be sought through a qualitative exploration. However, hardly any literature combines both quantitative and qualitative approach to the research of sense of place.

The limitedness of employing only quantitative research is portrayed on a research on lake side owners, where the results exhibit variations (in e.g. lake importance) of unknown origin that compels the scientists to speculate on the origin of this variation [9]. Thus, the important aspect of understanding the complexity of issues that hide in the landscape is missing from this research. 'A general critique of all of these quantitative studies, and key to this effort, is the unsatisfactory relation between the literature they cite and the questions they examine empirically. Typically, the literature review sections of these studies adequately represent the complexity of place concepts, but the quantitative applications are often quite narrow, failing to incorporate the theoretical complexity into actual measures and hypothesized relationships. Measurement, even that which explores the potential multidimensionality of place concepts such as attachment, has been narrowly focused on the sense of place concept itself (e.g., describing higher or lower levels of place attachment) rather than examining factors that may produce attachment, or the effects of attachment on other variables.' [22, p.825]. And Stedman continues: 'Thus, I assert that important thematic areas of sense of place theory, […] have not been adequately tested in quantitative research approaches.' [22, p.825]. Stedman thus sets the question on 'How can we examine the multidimensionality of place in a manner consistent with theory?' [22, p.825]. But is it the theory that has been missing in quantitative research or is it the lack of information that would be gathered beforehand in an explorative, qualitative research? We researchers should not simply go about '[…] counting and measuring before we truly understand underlying meanings that would help identify what we should be counting or measuring' [11, p.463]. Since qualitative approach should provide the knowledge what to quantify, I would add that there is no quantitative approach that can replace a qualitative approach in the analysis of sense of place.

The other side of the coin – the qualitative research is not missing from forest related literature on sense of place. It has been noted that qualitative research has been dominating in the past as a way to understand the complexity of place [22]. The qualitative approach, unlikely the quantitative, does not treat but a few dimensions of the sense of place. Qualitative research focuses to illuminate or develop new insights. As in the case of quantitative, qualitative research is in process of finding the right approach. 'Momentum around place research is connected to the development of effective and illuminating qualitative research methods and increasing acceptance of these methods.' [30, p.858]. Yet, the interview, whether structured or open, remains as the sole method of gaining the information sought [1], [30].

As seen so far, the scientists' approach in researching sense of place has been very rigid, and in a sense is lacking that visual approach. But where would we be able to find use of 'maps, floor plans, photographic images, bricks and mortar, landscapes and cityscapes' [5, p.483]? Recent research suggests that incorporation of spatial aspects of sense of place should be done [7], [9] is along side Gieryn's call for a visual approach [5]. "In this way [by incorporating spatial aspects], a more comprehensive understanding of places might be attained than if one were to operationalise sense of place as it has been described in the literature." [9, p.326].

At this point it is worth mentioning the work of Studley in the region of Eastern Kham [23], [24]. In the seven years long study Studley made an anthropologic, quantitative research, though combined with qualitative research, on forest values [23]. Studley used several methods to quantify indigenous forest values: text analysis for forest value identification, multidimensional scaling for the cognitive mapping of forest values, geostatistics for forest value distribution, and boundary analysis for changes in forest values and their coincidence with cultural or biophysical phenomena [23]. In this process, Studley [23] extracted dimensions of the indigenous sense of place, embedded with the local meaning, believes, cults and senses [23], [24]. But to do this he underwent a careful and diligent process in identifying the values and developing customized methods to measure them in a way that is appropriate to the local understanding. It is perhaps this multilayer approach that we should embrace in combining qualitative and quantitative with spatial aspects.

But what about photographic images and landscapes? Are they to be treated merely as artistic forms in place related science? If we are to look at paintings, Malpas vividly explains this with the case of Hobart, a town in New Zeland: 'The significance of the work undoubtedly derives from the all encompassing view of early Hobart and its immediate surrounds that the painting presents to the viewer, as well as the record it provides of the town at this point in its history. It is through its presentation of this view that the work contributes to the sense of the town's history and identity.' [13, p.3]. As Merifield would say, place is a constellation of social elements at a point in time [16] which is comparable to a painting, as described by Malpas [13], or even a photographic image. Or on the other hand, without going in to the depths of the discussion of the dynamism of place, the image can be evidence to the dynamic character of place [14].

2.2 What about practitioners?

Unburden with the rigidity of the scientific method, practitioners have the opportunity to experiment end employ methodologies that may bring innovation to the approach in researching sense of place. Though there are not a lot of practitioners that employ sense of place in their planning, there are a few that they do. Their methods are qualitative and do combine visual aspects.

A development group from the USA, Regenesis Collaborative Development Group [17], [18] employs a mixture of exploring the geographical characteristics of a location with people's stories of that place. They interpret the geographic landscape and the spirit of the place in order to provide guidance for the landscape planning they make, which will fit to the place.

Though not related to forest planning practices, other, innovative approaches to analyse the sense of place by practitioners are coming up which may be used in forest planning as well. An example is of an urban planning consultancy from Scotland that was asked to develop new design of a school. In their practice they used stakeholders' consultation workshops and asked people how they feel about the school space [2]. A different approach is by an architect from the USA who puts his clients under hypnosis to draw out of them the sense of place they want and need [6].

The examples from practitioners shown above come down to a common feature, and that is that sense of place can be represented through the emotional reasoning of people and combined with visual – spatial aspects. However, the use of these approaches by scientists may be limited. Since science is dominated by rational thought – logic, emotions are suppressed. This suppression of emotions – the human dimension, can lead to non-working solutions [26] in the same manner as the sense of place is often left out from planning and leading to results that do not fit the place or even alter or destroy the place itself [4].

It is interesting to see that though some scientists consider that planners or better say practitioners need hard statistical data for the results of studies on sense of place to be incorporated for their management [22], [23], practitioners them selves employ many, different, innovative and quite unusual qualitative methods on exploring sense of place and using it in their plans. However, the greater question regarding the above examples is about the validity of these methods. As Lefebvre says: 'Even neocapitalism or 'organized' capitalism, even technocratic planners and programmers, cannot produce a space with a perfectly understanding of cause and effect, motive and implication.' [12, p.37]. And this concern is not limited only to practitioners, but also to scientists that research sense of place. This statement [12, p.37] should not discourage people to explore and use sense of place in their work. It should be taken as an awareness notice to be more critical in the efforts to research and employ sense of place.

3 CONCLUSION

The examples I have portrayed of scientists' and practitioners' approaches in researching sense of place express an abundance of approaches. Whether that they are quantitative or qualitative they may tackle but a few elements [8], [10], [15], [21], [28], or make attempts to approach comprehensively to the sense of place [1], [9], [30]. It seems that the visual approach in researching sense of place may better be found on the practitioner's side [2], [6], [17], [18]. While scientists are limited in combining methods, the work of Studley [23], [24] and his multilayered combination of qualitative and spatially determined quantitative approach should be noticed. As this multilayered approach with spatial aspects could be that visual approach. Though, with a down side of being of long duration.

Perhaps I could add an advertising point by Rory Sutherland: 'When you place a value on things like health, love, sex and other things, and learn to place a material value on what you've previously discounted for being merely intangible […] you realize you're much, much wealthier than you ever imagined.' [25]. In forest planning this valuing could come from the inclusion of sense of place. Knowing that all values are subjective [25], and to that matter is that even sense of place is subjective. It is our perception of an outsider that is the source of misconceptions [20], [25] to the analysing of a very human dimension – sense of place. Keeping in mind that analysing sense of place is complex and therefore is hardly likely that with certainty can predict how we can manage it [12, p.37] we should primarily embrace the basic aspect of understanding it and respecting it. Thus, we researchers should find ways to employ multilayered approaches that combine qualitative and quantitative analyses. We should use our reasoning, common and scientific, all our senses that we as humans have, but also our feelings, and engage our selves with the landscape in order to bypass that position of an outsider and grasp the sense of place in order to portray it to its detail. Turning sense of place research into an exploration that goes well beyond the scientific skills of applying precision methodology.

4 NOTES

(1) Forests for people – the theme of the International Year on Forests, 2011. The aim was to highlight the relationship between people and forests, and humankind's role in ensuring the forests well-being and development.
(2) The origin of scientific, or also referred to traditional forestry, is in 18 century in Germany, and very soon after in France. It appeared as an answer to the State's needs for control of the resource – the availability of wood. For more details see Scott (1989).

ISSN: 0585-9069

5 ACKNOWLEDGEMENTS

- I'd like to thank Bojan Simovski for his kindness and responsive guidance concerning the technicalities of the paper.
- I thank Gabriel Specht for taking time to read drafts of this paper and give me comments that improved the clarity of this paper.
- I express my appreciation to John Studley for the inspiring e-mail communication.

6 REFERENCES

[1] 1. O. Avramoski, Construction of Place-Based Identities Across Scales: Implications for Ecosystem Management, Ph.D. dissertation. Central European University, (2005), pag. 1-296.

[2] A. Cunningham, K. Kenyon, and M. Sims, Senses of Place: Building Excellence: The Toolkit and Outcomes. (2011), pag. 1-80.

[3] C. Farcy, Forest Planning in Europe: State of the Art, International Debate and Emerging Tools. In: Towards the Sustainable Use of Europe's Forests – Forest Ecosystem and Landscape Research: Scientific Challenges and Opportunities, F. Andersson, Y. Birot and R. Päivinen Ed. (2004), pag. 11-20.

[4] J. Friedmann, Place and Place-Making In Cities: A Global Perspective. Planning Theory and Practice, 11(2). (2010) pag. 149-165.

[5] T.F. Gieryn,. A Space for Place in Sociology. Annual Reviews Sociology, 26. (2000), pag. 463-496.

[6] R. Hester, Social Values in Open Space Design. Places, 6(1). (1989), pag. 68-77.

[7] M.C. Hidalgo, and B. Hernandez, Place Attachment: Conceptual and Empirical Questions. Journal of Environmental Psychology, 21. (2001), pag. 273-281.

[8] B.S. Jorgensen and R.C. Stedman, Sense of Place as an Attitude: Lakeshore Owners Attitudes Toward Their Properties, Journal of Environmental Psychology, 21. (2001), pag. 233-248.

[9] B.S. Jorgensen and R.C. Stedman, A Comparative Analysis of Predictors of Sense of Place Dimensions: Attachment to, dependence on, and identification with lakeshore properties, Journal of Environmental Management, 79. (2006), pag. 316-327.

[10] B.P. Kaltenborn, Effects of Sense of Place on Responses to Environmental Impacts. Applied Geography, 18(2). (1998), pag. 169-189.

[11] L.E. Kruger and M.A. Shannon,. Getting to Know Ourselves and Our Places Through Participation in Civic Social Assessment. Society & Natural Resources: An International Journal, 13(5). (2000), pag. 461-478.

[12] H. Lefebvre, The Production of Space, (1974), pag. 1-455.

[13] J. Malpas, Place and the Problem of Landscape, in The Place of Landscape: Concepts, Contexts, Studies, J. Malpas, Ed. (2011), pag. 3-26.

[14] D. Massey, Landscape/Space/Politics: An Essay. (2011), [online] Available: http://thefutureoflandscape.wordpress.com/landscape spacepolitics-an-essay/

[15] F.T. McAndrew, The Measurement of "Rootedness" and the Prediction of Attachment to Home-Towns in College Students. Journal of Environmental Psychology, 18. (1998), pag. 409–417.

[16] A. Merrifield, Place and Space: A Lefebvrian Reconciliation. Transactions of the Institute of British Geographers, New Series, 18(4). (1993), pag. 516-531.

[17] Regenesis Collaborative Development Group, Mahogany Ridge Grand Tetons Resort: A Story of Place, (2008), pag. 1-14.

[18] Regenesis Collaborative Development Group, The McAllen Story of Place, (2010), pag. 1-59.

[19] Robinson in Ruins, [film] Directed by Patrick Keiller, (2010).

[20] J.C. Scott, Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed, (1998), pag. 1-446.

[21] R.C. Stedman, Is It Really Just a Social Construction?: The Contribution of the Physical Environment to Sense of Place, Society & Natural Resources: An International Journal, 16(8). (2003), pag. 671-685.

[22] R.C. Stedman, Sense of Place and Forest Science: Toward a Program of Quantitative Research. Forest Science, 49(6). (2003), pag. 822–829.

[23] J.F. Studley, Sustainable knowledge systems and resource stewardship: In search of ethno-forestry paradigms for the indigenous peoples of eastern Kham. PhD disertation. Loughborough University , (2005), pag. 1-454.

[24] J.F. Studley, Territorial cults as a paradigm of place making, (2010), pag. 1-29.

[25] TED, Rory Sutherland: Life lessons from an ad man [video] (2009) Available: http://www.ted.com/talks/rory_sutherland_life_lessons_from_an_ad_man.html

[26] theRSAorg, The Social Animal, [video] (2011), Available: http://www.youtube.com/watch?v=FYCBGSdtfN8

[27] F. Vanclay, Place Matters, in Making Sense of Place, F. Vanclay, M. Higgins and A. Blackshaw, Ed. (2008), pag. 3-11.

[28] D.R. Williams and J.W. Roggenbuck, Measuring Place Attachment: Some Preliminary Results. In: NRPA Symposium on Leisure Research. San Antonio, Texas, USA 20-22 October 1989. (1989), pag. 1-7.

[29] D.R. Williams and S.I. Stewart, Sense of Place: An Elusive Concept That Is Finding a Home in Ecosystem Management, Journal of Forestry, 66(5). (1998), pag. 18-23.

[30] L. Yung, W.A. Freimund and J.M. Belsky, The Politics of Place: Understanding Meaning, Common Ground, and Political Difference on the Rocky Mountain Front. Forest Science, 49(6). (2003), pag. 855-866.

INSTRUCTIONS TO AUTHORS

Author(s)
University(ies) / Institute(s)
Address(es)

ABSTRACT: These notes provide important information on how to prepare and submit your paper. Read the notes carefully and follow them as precisely as possible. **Any inaccuracy will cause delay at the Technical Editors and in the publication of the Forest Review**. Your paper must be **written in English (UK)** and the layout should be exactly the same as this master document. **In order to prepare your layout, save this document with a new name and use it as a guide. Replace the text of this document with the text of your paper without changing the layout, font type and size, line spacing, page margins and structure of this template** (see section 3). **Do not insert page numbers or page headers/footers**. If you have any question, please do not hesitate to contact us (see section 7.3).
Keywords: select 3 to 6 keywords.

1 DEADLINES AND DELIVERY

Papers will be published in the Forest Review only if correctly submitted.

The electronic version of your paper must be submitted to the Technical Editors by e-mail according to the dates (see section 5, note 3), by one of the authors, together with **two suggested reviewers** (see section 11), and the **Copyright Transfer Agreement Form** duly filled-in and signed (this will be available and sent to the corresponding author before Review print).

Your original manuscript must be delivered in the following formats:

- **Microsoft Word** (97/2003, .docx), and **Adobe Acrobat PDF** by e-mail.

Please make sure that the paper you submit is the **final version** with all **numberings in the correct order. Do not submit the paper more than once.**

2 PREPARING THE MANUSCRIPT

2.1 Volume and length of the paper

Please consider that the complete paper in pdf format, including illustrations, may not exceed **10 A4 pages**. This is a very good proven capacity for final papers.

2.2 Organisation of the paper

The **title** of the paper should be informative and concise. It must be followed by the author(s) name(s) – listing the principal author first, organisation, complete address, telephone, fax and e-mail address.

No logos may appear in the title.

The **abstract** preceding the body of your paper should give a brief account of the most relevant aspects of your paper, in 200/250 words. Please avoid using symbols, graphics and text formatting (bold, italic, underline) in this part of the document.

Next, in order of importance, select three to six of the most relevant **keywords** and include them in your paper. The keywords should be separated with commas.

The **body** of the text must be in **two columns**. Number each heading using decimal numbering. Follow the layout specifications in section 3 below.

3 LAYOUT SPECIFICATIONS

The layout of your paper should have exactly the same format as this master document.

Before you start working on your paper, if you use Adobe Acrobat, select the printer option "Acrobat Distiller" (version 5.0) or Adobe pdf (version 6.0), in order to avoid accidental misplacement of layout elements afterwards when converting the Word file into PDF format.

3.1 Font type and size

Font type: **Times New Roman**. Font size: **9pt**. Line spacing: **single**. Text alignment: **justified left and right**. Captions should have the same font and size as the typeface used for the text. Make sure that illustrations are clear and easy to read. Please do not use any other font than Times New Roman.

3.2 Page size

Page size must be **A4** (210 mm x 297 mm).
Margins: top: 32 mm; bottom: 19 mm; left and right: 25 mm.

The **body of the text must be in two equal columns** of 73,6 mm each. All written parts and images must fit **inside** these margins (for further details see subsection 4.1 about figures, and subsection 4.2 about tables).

3.3 Typing the text

Begin at the top of the first page with the **title** of the paper in bold capital letters and centered.

Leave one blank line between the title and the name of the author(s).

List the surname preceded by the initial of the first name; when several authors prepare a paper, the name of the main one should appear first. On the following lines, give the name of the company or institute, wherever applicable, with the full address; the name of each organisation should be easy to depict. This paragraph must be centered and without any blank space.

Next, leave two blank lines and then type an **abstract** of no more than 250 words (keep the indent of this block on both sides, as shown on this document). At the end of the abstract give your 3/6 **keywords** on the last line.

Leave two blank lines between the abstract and the body of the text of your paper, which must be in two columns.

3.4 Headings

Leave one blank line before each section and one blank line before the heading of each sub-section. Headings and sub-headings should be numbered (e.g. 3, 3.1, 3.2). Separate the numbers from the text of the

heading with two spaces.

There should be no blank line after the title of the sub-sections but only an indentation to indicate the beginning of a paragraph. Section headings should be in capital letters. Sub-section headings should be in upper and lower case. Headings should be normal text – not underlined or in bold.

4 ADDITIONAL COMPONENTS

4.1 Illustrations

Illustrations (photographs, drawings, graphs, charts, etc.) should not exceed 50% of the whole paper and should be placed as near as possible their citation. Illustrations must not be taken from previously-printed materials.

Illustrations should have a resolution of **300 dpi** using simple colors (Standard+RGB) and be placed at **100% scale** (i.e. if an illustration covers the full column width, it should be of approx. 860 pixel).

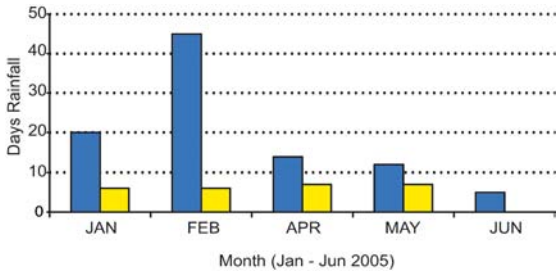
Illustrations should have the layout in line with the text (right click on the object – Format object – Layout – in line with the text, which should be the left-most option in the layout dialogue window).

All illustrations must be numbered progressively in bold decimals (e.g. **Figure 1**:) and have a reference in the text (e.g. Fig. 1). Captions should be as clear as possible, to allow comprehension of the illustration without reference to the text.

Graphs and charts must not be imported from Excel, but should be inserted as a picture (.jpg, .bmp or .gif). Please, use simple contrasting colors and effects instead of fill patterns. See Fig. 1 for good/bad example.

Illustrations must be clear also when printed in black and white.

Good example with contrasting colors:



Bad example with fill patterns:

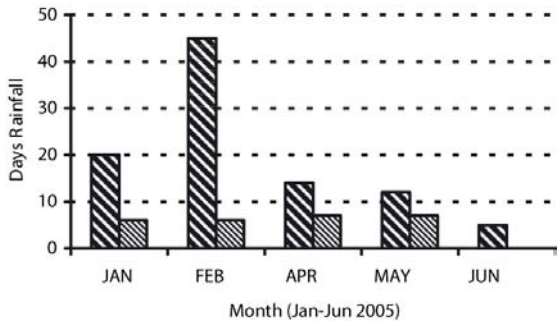


Figure 1: Clear line drawings are essential

4.2 Tables

Tabular presentation of data is an easy way to condense many items. Tables must be numbered in bold Roman numerals (e.g. **Table I**), and have a reference in the text. Captions should be as clear as possible, for an easy comprehension of the tables.

Table I: Overview of biomass resources available

Biomass Sources	Quantity	Moisture	Residue
Sewage Sludge	1.86	1.73	1.40
Septage	0.32	0.28	0.16
Fruit Pulp	3.78	3.89	4.02

4.3 References and notes

References and notes must not appear as footnotes in the pages, but should be listed together at the end of the text, in the dedicated sections.

When referring to them in the text, please type the corresponding reference number in brackets. Use round brackets for the notes (1) and square brackets for the references [1].

To make them easier to find, indent your notes and references from the second line, as in the examples (see sections 5 and 6).

4.4 Acknowledgements

Any acknowledgement should be added before the references and/or notes, in a dedicated section, as in the example (see section 8).

5 NOTES

(1) This section should have the progressive number before the title, exactly as for the previous ones.
(2) Do not add any unnecessary space between the listed numbers of your notes.
(3) Important dates of the Forest Review are:

Abstract submission	March 15th
Abstract acceptance	March 30th
Paper submission	May 15th
Paper acceptance	June 15th
Forest Review Print	October 15th

6 REFERENCES

[1] This section should have the progressive number before the title, exactly as for the previous ones.
[2] Do not add any unnecessary space between the listed numbers of your references.
[3] G. Campolmi, Proceedings of the 3rd World Biomass Conference – Biomass for Energy, Industry and Climate Protection, III Vol. (2005), pag. 981.
[4] D. Reed, Evaluation of Biomass Resources in the southern regions in Nigeria, (2007), pag. 124.
[5] O. Vecchi, Biofuel Production in central Italy, (2008), pag 45.

7 OTHER POINTS

7.1 Permissions

Authors are fully responsible for their manuscripts. They must take the necessary steps to obtain permission for using any material that might be protected by copyright.

7.2 Copyright

Please be aware that on delivery of your manuscript, you transfer the **copyright** to **University Ss. Cyril and Methodius in Skopje, Faculty of Forestry in Skopje**, publishers of the Forest Review.

7.3 Further information

We are available to assist you. Please, do not hesitate to contact us for any query; please address your e-mails to sumpregled@sf.ukim.edu.mk.

8 IMPORTANT SPECIFICATIONS FOR THE PDF

8.1 Printer

If you are using Adobe Acrobat, please select Acrobat Distiller (version 5.0) or Adobe Pdf (version 6.0) as printer option to convert your Word file into pdf format. Go to Printer Properties and click on "Acrobat pdf settings"; in Conversion Settings select "Press" quality.

If you are using **special fonts** make sure that the checkbox "Do not send fonts to distiller ("adobe pdf" for version 6.0)" is **not** selected.

8.2 Password / Security

Please **do not use any Password / Security when making the Pdf file.** As the header and page numbers will be added by us, we need to ensure that you pdf file is not password protected.

9 ACKNOWLEDGEMENTS

- We thank you for successfully following these instructions. This will make the Reviewers easier to read and avoid queues at the Technical Editors!
- The Authors are grateful to the students-members of DREN - NGO of students of Forestry at the Faculty of Forestry in Skopje for their helpful cooperation.
- …….

10 LOGO SPACE

If you wish, you may add your logos (e.g. Organisations, Project Partners, Supporters, Brands etc) at the end of the paper.

11 IMPORTANT NOTICE FOR THE SUBMISSION

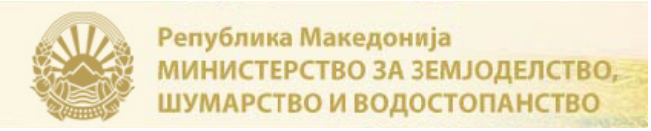
To ensure a convenient publication process, the authors are requested to follow these instructions. Submission of a paper implies that it reports unpublished work and that it is not under consideration for publication elsewhere. If previously published tables, illustrations or more than 200 words of text are to be included, then the copyright holder's written permission must be obtained. Copies of any such permission letters should be scanned and attached with the paper.

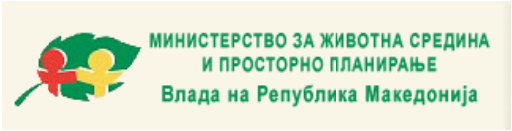
A **condition of submission** (with the abstract submission) is that the author nominates **two people** who are qualified to act **as reviewers** and who have not previously been involved with the paper in any way. Both of the nominated reviewers must be working in a different country to the first named author.

Before the publication, the paper will be reviewed by the members of the Editorial Board and a notification of acceptance will be send to the corresponding author. Editors may request that authors submit a revised version of their paper before it can be accepted for publication. The Editor's decision on all submissions is final.

Finally, the authors will receive **Copyright Transfer Agreement Form** which they need to fill-in and sign for the publication to be complete.

CONTRIBUTORS, SUPPORTERS and FRIENDS of the FOREST REVIEW





ШУМАРСКИ ПРЕГЛЕД
Меѓународно научно списание
Год. 43 / Стр. 1-76
Скопје, 2012

FOREST REVIEW
International Scientific Journal
Vol. 43 / Pag. 1-76
Skopje, 2012

ISSN 0585-9069
УДК 630
УДК 635.9
УДК 674

ISSN 0585-9069
UDC 630
UDC 635.9
UDC 674

Издавач
Универзитет „Св. Кирил и Методиј“ во Скопје
Шумарски факултет во Скопје
Декан
Д-р Александар Трендафилов

Publisher
Ss. Cyril and Methodius University in Skopje
Faculty of Forestry in Skopje
Dean
Aleksandar Trendafilov PhD

Главен и одговорен уредник
Д-р Љупчо Несторовски

Editor in chief
Ljupčo Nestorovski PhD

Уредувачки одбор
Д-р Марилена Иџојтиќ (Загреб, Хрватска)
Д-р Милосав Анѓелиќ (Подгорица, Црна Гора)
Д-р Милорад Даниловиќ (Белград, Србија)
Д-р Роберт Брус (Љубљана, Словенија)
Д-р Ирена Папазова Анакиева (Скопје, Македонија)
Д-р Чиприан Палагиану (Сучава, Романија)
М-р Бојан Симовски (Скопје, Македонија)

Editorial board
Marilena Idžojtić PhD (Zagreb, Croatia)
Milosav Anđelić PhD (Podgorica, Montenegro)
Milorad Danilović PhD (Belgrade, Serbia)
Robert Brus PhD (Ljubljana, Slovenia)
Irena Papazova Anakieva PhD (Skopje, Macedonia)
Ciprian Palaghianu PhD (Suceava, Romania)
Bojan Simovski MSc (Skopje, Macedonia)

Технички уредник
М-р Бојан Симовски
Д-р Чиприан Палагиану

Technical editor
Bojan Simovski MSc
Ciprian Palaghianu PhD

Корица и насловна фотографија
М-р Бојан Симовски, *Quercus cerris*

Cover page and photography
Bojan Simovski MSc, *Quercus cerris*

Тираж: 500

Copies: 500

Излегува еднаш годишно

Published once a year

Печати
Печатница Европа 92, Кочани

Printed by
Print House Evropa 92, Kočani

Адреса на издавачот
УКиМ Шумарски факултет во Скопје
Редакција на Шумарски преглед
Бул. Александар Македонски бб
(П. фах 235)
1000 Скопје
Република Македонија
Е-пошта: sumpregled@sf.ukim.edu.mk
www.sf.ukim.edu.mk

Publisher's address
UKiM Faculty of Forestry in Skopje
Editorial Board of the Forest Review
Bul. Aleksandar Makedonski bb
(P.O. box 235)
MK-1000 Skopje
Republic of Macedonia
E-mail: sumpregled@sf.ukim.edu.mk
www.sf.ukim.edu.mk