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

Online ISSN 1857-9507
www.sf.ukim.edu.mk/sumarski_pregled.htm

ШУМАРСКИ ПРЕГЛЕД
FOREST REVIEW

МЕЃУНАРОДНО НАУЧНО СПИСАНИЕ
INTERNATIONAL SCIENTIFIC JOURNAL

80 ГОДИНИ ОД РАЃАЊЕТО НА РАДОСЛАВ РИЗОВСКИ
80 YEARS OF RADOSLAV RIZOVSKI'S BIRTH

Шум. преглед (Šum. pregled)
For. review

Год. 46
Vol. 46

Стр. 1-95
Pag. 1-95

Скопје, 2015
Skopje, 2015

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

Online ISSN 1857-9507
www.sf.ukim.edu.mk/sumarski_pregled.htm

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

ШУМАРСКИ ПРЕГЛЕД

FOREST REVIEW

МЕЃУНАРОДНО НАУЧНО СПИСАНИЕ
INTERNATIONAL SCIENTIFIC JOURNAL

Шум. преглед (Šum. pregled)	Год. 46	Стр. 1-95	Скопје, 2015
For. review	Vol. 46	Pag. 1-95	Skopje, 2015

ШУМАРСКИ ПРЕГЛЕД
Меѓународно научно списание
Год. 46 / Стр. 1-95
Скопје, 2015

Online ISSN 1857-9507
УДК 630
УДК 635.9
УДК 674

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

Главен и одговорен уредник
Д-р Бојан Симовски

Технички уредник
М-р Дејан Манџуковски

Корица и насловна фотографија
Д-р Бојан Симовски, *Ramonda nathaliae*

Излегува еднаш годишно

Интернет-страница
www.sf.ukim.edu.mk/sumarski_pregled.htm

Адреса на издавачот
УКИМ-Шумарски факултет во Скопје
Редакција на Шумарски преглед
Ул. „16 Македонска бригада“ бр. 1
(П. фах 235)
1 000 Скопје
Република Македонија
Е-пошта: sumpregled@sf.ukim.edu.mk
www.sf.ukim.edu.mk

FOREST REVIEW
International Scientific Journal
Vol. 46 / Pag. 1-95
Skopje, 2015

Online ISSN 1857-9507
UDC 630
UDC 635.9
UDC 674

Publisher
Ss. Cyril and Methodius University in Skopje
Faculty of Forestry in Skopje
Dean
Jane Acevski PhD

Editor-in-chief
Bojan Simovski PhD

Technical editor
Dejan Mandžukovski MSc

Cover page and photography
Bojan Simovski PhD, *Ramonda nathaliae*

Published once a year

Web page (on-line)
www.sf.ukim.edu.mk/sumarski_pregled.htm

Publisher's address
UKiM Faculty of Forestry in Skopje
Editorial Board of the Forest Review
Ul. 16 Makedonska brigada br. 1
(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. 46 / Стр. 1-95
Скопје, 2015

Online ISSN 1857-9507
УДК 630
УДК 635.9
УДК 674

Интернет-страница
www.sf.ukim.edu.mk/sumarski_pregled.htm

Адреса на издавачот
УКИМ-Шумарски факултет во Скопје
Редакција на Шумарски преглед
Ул. „16 Македонска бригада“ бр. 1
(П. фах 235)
1 000 Скопје
Република Македонија
Е-пошта: sumpregled@sf.ukim.edu.mk
www.sf.ukim.edu.mk

FOREST REVIEW
International Scientific Journal
Vol. 46 / Pag. 1-95
Skopje, 2015

Online ISSN 1857-9507
UDC 630
UDC 635.9
UDC 674

Web page (on-line)
www.sf.ukim.edu.mk/sumarski_pregled.htm

Publisher’s address
UKiM Faculty of Forestry in Skopje
Editorial Board of the Forest Review
Ul. 16 Makedonska brigada br. 1
(P.O. box 235)
MK-1000 Skopje
Republic of Macedonia
E-mail: sumpregled@sf.ukim.edu.mk
www.sf.ukim.edu.mk

For. review 46: 1-95. Skopje, 2015
Ss. Cyril and Methodius University in Skopje
Faculty of Forestry in Skopje

ISSN 1857-9507 on-line: www.sf.ukim.edu.mk/sumarski_pregled.htm

CONTENTS

For. review 46: 55-58. Skopje, 2015 ISSN 1857-9507 on-line: www.sf.ukim.edu.mk/sumarski_pregled.htm
UDC: 630*22:582.632.2(497.11-14)
Original scientific article

ANALYSIS OF FLORISTIC COMPOSITION OF MOUNTAIN BEECH FOREST ON LIMESTONE AND SERPENTINE IN SERBIA

NOVAKOVIĆ-VUKOVIĆ M., MILOŠEVIĆ R.
University of Belgrade, Faculty of Forestry, Belgrade, Serbia
Corresponding author e-mail address: marijana.novakovic@sfb.bg.ac.rs

ABSTRACT: The paper is floristic composition comparative research of mountain beech forests on serpentine in southwestern Serbia, and beech forests on limestone in eastern Serbia. The analysis showed that there are significant differences in the floristic composition. On the serpentine bedrock a low count of plant species was recorded, Jacquard's similarity index of studied stands had a very low value. Within phytocoenological relevés made on limestone bedrock, the most typical species of beech forests appear as isolated, while in the beech forests on serpentine, xerophyl species characteristic to the order *Erico - Pinetalia* and *Quercetalia pubescentis* were observed, in addition to "fagetal" species. In the spectrum of life forms on both the geological substrate hemicryptophytes dominated, and phanerophytes and nanophanerophytes of serpentinite had the significant presence, as a result of warmer climate in southwestern Serbia. In geofloristic spectrum, a group of submediterranean floral elements, which are connected with Balkan floral elements, is as twice as numerous in the mountain beech forest on serpentine than on limestone, which is another indicator of southwestern Serbia's exposure to submediterranean influence.
Keywords: beech, serpentine, limestone, southwest Serbia, eastern Serbia.

1 INTRODUCTION

Beech is the most ubiquitous tree species in Serbia with the widest altitudinal distribution, arising from a broad ecological amplitude in regard to climatic factors (light and temperature), and edaphic factors (geological substrate and soil types), and slightly lower amplitude compared to the humidity of habitat [8]. It occurs in most parts of Serbia, except in the Pannonian Plain, with the exception of Fruška Gora and Vršac Mountains [2]. On the territory of Serbia beech forests cover 660,400 ha (29.3% of the total covered area), out of which is 64.7% is in government property [1]. Considering that the beech communities are widespread in almost all mountain massifs in Serbia, their soils were formed on different rocks which vary in textural characteristics, chemical and mineral composition, as well as in resistance and products created in their degradation process [5]. Within beech forests, several basic types of substrate can be defined, considering the importance of the parent substrate for the genesis and soil properties [6]: carbonate rocks, acidic and neutral silicate rocks and mafic silicate rocks. Beech forests have very diverse botanical composition, considering their prevalence and effect of orographic-edaphic factors, so they include a large number of phytocoenoses. One of them is a mountain beech forest *(Asperulo odoratae-Fagetum moesiacae* B. Jovanović in 1973., Syn. *Fagetum moesiacae montanum* B. Jovanović 1953.; *Fagetum montanum asperuletosum* B. Jovanović 1973), which represents a powerful climate-regional belt of vegetation on the territory of Serbia, as well as the most abundant and economically important type of beech forest and Serbian woodland in general [11]. Aim of the paper was to determine the extent of the differences in the floristic composition between mountainous beech forests on serpentine and limestones, which would contribute to a better knowledge of beech forests on different geological substrates, since these forests are of great importance for Serbia.

2 MATERIAL AND METHOD

The study of mountain beech forests floristic composition (*Asperulo odoratae-Fagetum moesiacae* B. Jovanović 1973) was based on 24 phytocoenological relevés that were obtained from literature. 14 phytocoenological relevés were sampled in the mountain beech forest on serpentine bedrock on Crni vrh near Priboj [12], another 10 were sampled in the mountain beech forest on Mount Ozren - Sokobanja, on a limestone substrate [3]. Syntaxonomic names follow [16]. CA vegetation data analysis was performed using the statistical software CANOCO 4.5 [9]. Indexes of diversity and equivalence (Shannon -Wiener diversity index and Evenness) were calculated in the program JUICE 7 .0 [15]. Jaccard's similarity index of investigated stands was also calculated [10]. The spectrum of floral elements was made according to the systematization of phytogeographical elements [4], and spectrum of life forms [7].

3 RESULTS AND DISCUSSION

64 species were recorded in mountain beech forest on serpentine and 77 species in beech forest on limestone. The conclusion is that the beech forest on limestone is floristically richer than on the serpentine, although the analysis included a smaller number of phytocoenological relevés on limestone than in the serpentine [14] compared the vegetation of limestone and serpentine in Bosnia and came to the conclusion that the serpentine, unlike limestone, sees great uniformity in terms of growing vegetation and poorness in the number of species. It should be noted that the serpentine bedrock is very unfavorable for the development of the plant world, on which only plants that have managed to adapt to life on this inhospitable bedrock can survive. The same conclusion is reached by analyzing the floristic composition of beech forests on serpentine and limestones in Serbia. Floristic composition analysis of mountain beech forests on Pešter, on limestone and silicate bedrock, also showed greater floristic richness of this forest on limestone, but this phenomenon is explained by higher degradation and more open set of studied stands, which enables settlement to a large number of species [13].

ISSN 1857-9507 on-line: www.sf.ukim.edu.mk/sumarski_pregled.htm

Mountain beech forests on both serpentinite and limestone within studied stands occupy mainly same expositions - northern and northwestern. They are also located on similar inclinations - inclinations on serpentinite are in 5-40° range, while inclinations on limestone are in 0-30° range. Mountain beech forests on serpentinite are registered in 560-800 m elevation range, while stands on limestone are registered on elevations between 810-870 m. Based on all of the above-mentioned, it can be concluded that geological substrate is the primary factor that affects floristic composition in the studied stands of mountain beech forest on serpentinite and limestone. Jaccard's index of similarity of studied stands [10] is:

$$J = \frac{UV}{V + U - UV} = 0.24, \text{ where is}$$

UV- the number of common species,
U, V- the number of species in mountain beech forest on serpentinite and limestone, respectively.

Jacquard's similarity index shows that although this is the same community, floristic similarity among the studied stands is low.

Ordinate system (Fig. 1) shows that, although it is one plant community, phytocoenological relevés diverge depending of the geological basis. Within phytocoenological relevés made on limestone bedrock, in the negative part of the coordinate system, "fagetal" species appear as isolated: *Asperula odorata, Isopyrum thalictroides, Cardamine bulbifera, Anemone ranunculoides, Salvia glutinosa* and others. On the other hand, within the beech forests on serpentine, in addition to "fagetal" species, xerophyl species characteristicfor *EricoPinetalia* and *Quercetalia pubescentis* orders*: Fraxinus ornus, Campanula patula, Polygonatum odoratum,* appear on the graph.

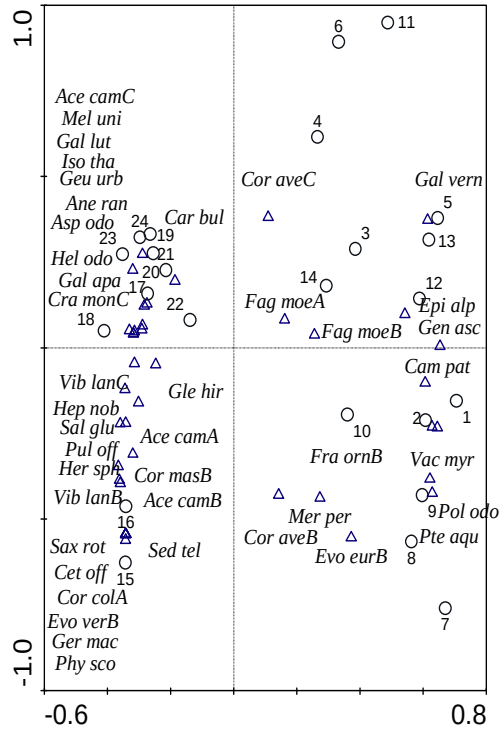

Figure 1: CA ordination biplot, fit range for the species 30-100%, 42 species (○-relevé representation, Δ-species representation; (1-14)- relevés on serpentine; (15-24)- relevés on limestone
Species abbreviations: *Ace cam-Acer campestre;Mel uni-Melica uniflora; Gal lut-Galeobdolon luteum; Iso tha-Isopyrum thalictroides;Geu urb-Geum urbanum; Cor ave-Corylus avellana; Gal vern-Galium vernum; Ane ran-Anemone ranunculoides; Asp odo-Asperula odorata; Car bul-Cardamine bulbifera; Hel odo-Helleborus odorus; Gal apa-Galium aparine; Cra mon-Crataegus monogyna; Fag moe-Fagus moesiaca; Epi alp-Epimedium alpinum; Gen asc-Gentiana asclepiadea; Vib lan-Viburnum lantana; Cam pat-Campanula patula; Gle hir-Glechoma hirsuta; Hep nob-Hepatica nobilis; Sal glu-Salvia glutinosa; Pul off-Pulmonaria officinalis; Her sph-Heracleum sphondilium; Cor mas-Cornus mas; Fra orn-Fraxinus ornus; Vac myr-Vaccinium myrtillus; Mer per-Mercurialis perennis; Pol odo-Polygonatum odoratum; Sax rot-Saxifraga rotundifolia; Sed tel-Sedum telephium; Pte aqu-Pteridium aquilinum; Evo eur-Evonymus europaeus; Cet off-Ceterach officinarum; Cor col-Corylus colurna; Evo ver-Evonymus verrucosa; Ger mac-Geranium machrorrhizum; Phy sco-Phyllitis scolopendrium* (the abbreviations following the species denotes A-tree layer,B –shrub layer, C-ground flora layer)

Shannon Wiener index (Table I) shows significant differences between the studied stands. This index has a much higher value in the mountain beech forest on limestone than on serpentinite, which is logical if we consider the number of recorded species, which is larger in the stands on limestone. On the other hand, Evenness index shows approximately equal value (Table I), provided that it's slightly higher in the mountain beech forest on limestone. Based on Evenness index it can be concluded that plant species do not have regular spatial distribution. As species that reduce the value of this index, we can mention the ones that are characterized by great number and coverage in a certain number of relevés: *Asperula odorata, Allium ursinum, Geranium machrorrhizum, Cardamine bulbifera etc.*

Table I: Indices of the diversity and evenness of mountain beech forest at the study sites

	Average Shannon-Wiener index	Average Evenness index
serpentinite	1.37	0.55
limestone	2.24	0.60

The life form spectrum (Fig. 2) reveals significant differences. Hemicryptophytes are dominant in mountain beech forest on limestone and serpentine, which is a common occurrence in temperate zone climatic conditions, with the fact that they are about 10% more numerous on limestone than on serpentine. On the other hand, phanerophytes have significant presence on serpentine, a lot larger than on limestone (37.5%: 27.3%). Considering that the analysis of the spectrum of life forms shows plant species relation to the climate of a region, we can conclude that this phenomenon is due to a warmer climate in southwestern Serbia. Geophytes also have strong presence both in the beech on the serpentinite and on limestone (20.41%: 19.47%), which was expected, considering very mesophilic nature of beech

forests. Other life forms have approximately equal presence on both the geological substrata.

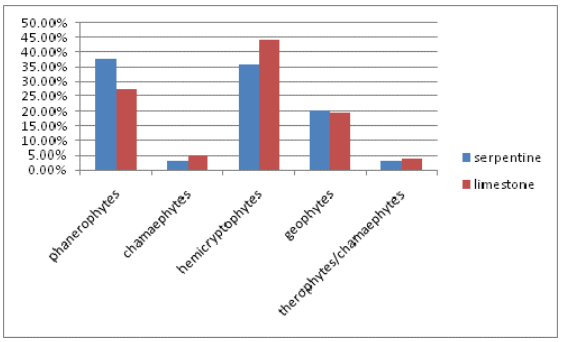

Figure 2: The spectrum of life forms for the community of mountain beech on limestone and serpentinite

Analysis of geofloristic spectrum (Fig. 3) also shows significant differences between the studied stands. In both cases, the most common as collective is Central European floral element. A group of species with wide ecological amplitude (Eurasian areal type) is the second most common on limestone. The biggest differences are reflected in the presence of a collective group of sub-Mediterranean floral elements, which are connected with Balkan floral elements. This group is as twice as numerous in the mountain forest of beech on serpentinite than on limestone, which is another proof that this community is more xerophyl on serpentine than on limestone. Larger presence of gropu of subatlantic floral elements on limestone than on the serpentine is indicator of more mesophilic conditions on limestone.

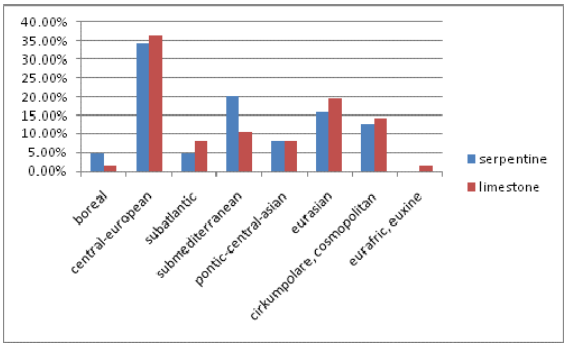

Figure 3: Spectrum of floral elements for the community of mountain beech on limestone and serpentinite

4 CONCLUSIONS

The paper is based on a comparison of the floristic composition of mountain beech forests *(Asperulo odoratae-Fagetum moesiacae* B. Jovanović 1973) on limestone and serpentinite, based on 14 phytosociological relevés made in the mountain beech forest on serpentine on Crni Vrh, close to Priboj, and 10 relevés made on limestone in Ozren-Sokobanja. The analysis showed significant differences. Jaccard's index of similarity on studied stands is 0.24, indicating a very low floristic similarity in studied stands. CA floristic data analysis showed relevés grouping into two groups, depending on the geological substrate. Within phytocoenological relevés made on limestone bedrock, typical species of beech forests appear as isolated: *Asperula odorata, Isopyrum th alictroides Cardamine bulbifera, Anemone ranunculoides, Salvia glutinosa* and others. On the other hand, within beech forests on serpentinite, in addition to "fagetal" type, xerophyl species characteristic to the order *Erico - Pinetalia* and *Quercetalia pubescentis: Fraxinus ornus, Campanula patula, Polygonatum odoratum* are also visualized on the graphics.

5 ACKNOWLEDGMENT

This work was carried out within the project "Sustainable management of the total resources of forests in the Republic of Serbia" -EVBR 37008, the Ministry of Education and Science of the Republic of Serbia.

6 REFERENCES

[1] S. Banković, Medarević, M., Pantić, D., N. Petrović, Nacionalna inventura šuma Republike Srbije-Šumski fond Republike Srbije, Ministarstvo poljoprivrede, šumarstva i vodoprivrede Republike Srbije-Uprava za šume, Beograd, (2009), pag. 244.

[2] R. Cvjetićanin, Fitocenoze bukve u Srbiji, Šumarstvo 1-2. UŠITS. Beograd, (2003) pag. 107-112.

[3] R. Cvjetićanin, M. Novaković, Fitocenološka pripadnost bukovih šuma u istraživanim sastojinama na Ozrenu-Sokobanja, Šumarstvo 3. UŠITS. Beograd, (2004) pag. 97-104.

[4] M. Gajić, Pregled vrsta flore SR Srbije sa biljnogeografskim oznakama, Glasnik Šumarskog fakulteta, Serija A „Šumarstvo“, br. 54, Beograd, (1980).

[5] V. Joksimović, M. Zdravković, Uticaj geološke podloge na bukove šume u Srbiji, u: Monografija Bukva u Srbiji, Udruženje šumarskih inženjera i tehničara Srbije, Beograd, (2005) pag. 83-93.

[6] M. Knežević, O. Košanin. Zemljišta u bukovim šumama Srbije, u: Monografija Bukva u Srbiji, Udruženje šumarskih inženjera i tehničara Srbije, Beograd, (2005) pag. 94-107.

[7] M. Kojić, R. Popović, B. Karadžić, Vaskularne biljke Srbije, Institut za istraživanja u poljoprivredi „Srbija“, Beograd, (1997).

[8] M. Krstić, R. Cvjetićanin, Bioekološke karakteristike mezijske bukve (*Fagus moesiaca* /Domin, Maly/Czeczott.), u: Monografija Bukva u Srbiji, Udruženje šumarskih inženjera i tehničara Srbije, Beograd, (2005) pag. 118-124.

[9] J. Lepš, P. Šmilauer, Multivariate analysis of ecological data, Faculty of biological sciences, University of south Bohemia, České Budějovice, (2002).

[10] A. E. Magurran, Measuring biological diversity. Oxford: Blackwell Publishing, (2004)

[11] V. Mišić, Red šuma bukve, Vegetacija Srbije II_1. Srpska akademija nauka i umetnosti, Beograd, (1997) pag. 159-270.

[12] M. Novaković, Šumska vegetacija Crnog vrha kod Priboja, magistarski rad-rukopis. Univerzitet u Beogradu- Šumarski fakultet, Beograd, (2008).

[13] LJ. Rakonjac, M. Ratknić, M. Matović, V. Lavadinović, Fitocenološke karakteristike planinske šume bukve na Pešterskoj visoravni Ass. *Fagetum*

ISSN 1857-9507 on-line: www.sf.ukim.edu.mk/sumarski_pregled.htm

moesiacae montanum B.Jov.1953, Šumarstvo 4. UŠITS. Beograd, (2005) pag. 93-110.
[14] H. Riter-Studnička, Biljni pokrov na serpentinama u Bosni, Godišnjak biološkog instituta u Sarajevu, (1963).
[15] L. Tichý, JUICE, software for vegetation classification. J. Veg. Sci., Uppsala 13, (2002) pag. 451-453.
[16] Z. Tomić, LJ. Rakonjac, Šumske fitocenoze Srbije, Institut za šumarstvo, Univerzitet Singidunum-Fakultet za primenjenu Ekologiju Futura, Beograd, (2013).

ШУМАРСКИ ПРЕГЛЕД
Меѓународно научно списание
Год. 46 / Стр. 1-95
Скопје, 2015

FOREST REVIEW
International Scientific Journal
Vol. 46 / Pag. 1-95
Skopje, 2015

Online ISSN 1857-9507
УДК 630
УДК 635.9
УДК 674

Online ISSN 1857-9507
UDC 630
UDC 635.9
UDC 674

Издавач
Универзитет „Св. Кирил и Методиј“ во Скопје
Шумарски факултет во Скопје
Декан
Д-р Јане Ацевски

Publisher
Ss. Cyril and Methodius University in Skopje
Faculty of Forestry in Skopje
Dean
Jane Acevski PhD

Главен и одговорен уредник
Д-р Бојан Симовски

Editor-in-chief
Bojan Simovski PhD

Технички уредник
М-р Дејан Манџуковски

Technical editor
Dejan Mandžukovski MSc

Корица и насловна фотографија
Д-р Бојан Симовски, *Ramonda nathaliae*

Cover page and photography
Bojan Simovski PhD, *Ramonda nathaliae*

Излегува еднаш годишно

Published once a year

Интернет-страница
www.sf.ukim.edu.mk/sumarski_pregled.htm

Web page (on-line)
www.sf.ukim.edu.mk/sumarski_pregled.htm

Адреса на издавачот
УКИМ-Шумарски факултет во Скопје
Редакција на Шумарски преглед
Ул. „16 Македонска бригада“ бр. 1
(П. фах 235)
1 000 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
Ul. 16 Makedonska brigada br. 1
(P.O. box 235)
MK-1000 Skopje
Republic of Macedonia
E-mail: sumpregled@sf.ukim.edu.mk
www.sf.ukim.edu.mk