

Received: October 5, 2016  
Accepted: November 1, 2016

ISSN 1857–9027  
e-ISSN 1857–9949  
UDC:631.4:528.93(497.7)  
DOI:10.20903/CSNMBS\_MASA.2016.37.2.34

*Review*

## SOIL MAPS OF THE REPUBLIC OF MACEDONIA

Gjorgji Filipovski

Macedonian Academy of Science and Arts, Skopje, Republic of Macedonia

The paper gives an overview of the history of preparation of 63 soil maps in printed and digital form, out of which 62 in a scale of 1 : 50 000 for a specific sections of the topographic maps, and one in a scale of 1 : 200 000 for the whole of the Republic of Macedonia. The Project for Preparation of Soil Map in a scale of 1 : 50.000 lasted almost seven decades (from 1947 to 2015). In the final phase of this process, within a FAO project, soil maps in hard copy and digital format were edited, together with corresponding study books for soil properties and soil forming factors for 10 regions of the country. A similar study book was written for the soils of the whole country. In addition, a common legend has been developed for all soil maps with 63 cartographic units. All classifications used during this long period of soil survey have been described and served as a basis for compiling of all legends. The areas of all cartographic units have been presented. The contents of all 11 soil studies have been described. Digitalization of all maps and the data base of soil characteristics were accomplished. For this purpose, an internet web-portal has been created ([www.maksoil.ukim.mk](http://www.maksoil.ukim.mk)). The results of the Project implementation were promoted and presented to the local scientific and professional public. The final works on the Project completion were financed by the FAO, UN Organization.

**Key words:** soil maps of the Republic of Macedonia; legend of the soil maps; areas of cartographic units; digitalization of project results

### INTRODUCTION

Soil survey and soil mapping in the Republic of Macedonia started soon after the liberation (after World War II), in 1947. This process started with the survey of soils of Strumica valley. The Soil Survey Study, including a soil map of this valley in a scale of 1:50 000, was published in 1951 (Gj. Filipovski [1]). These soil survey activities, in parallel to the preparation of **soil maps and soil studies** for our country, continued up to 2015. They lasted almost to seven decades. Only the author of this text took part in these researches over the entire period. All other contributors to the preparation of the soil maps (most of whom were collaborators of Prof. Gj. Filipovski) took part only during shorter or longer periods of time. Eight of these contributors, who are still active in this field, completed the soil map of the Republic of Macedonia including the soil survey in 2015. The other contributors to the soil mapping activities, regretfully, are not with us

any longer. We remember them with great love, respect and gratitude for their contribution.

With the finalization of the Project for preparation of soil maps of the Republic of Macedonia, 62 maps were published (in printed and digital form) over the topographic elements of the topographic maps in a scale of 1:50 000 and one for the entire territory of the Republic of Macedonia in a scale of 1 : 200 000. In addition, 11 soil studies have been published: 10 studies for particular regions and one for the whole territory of the country comprising 1028 pages in total.

The eight authors who participated in this task (including the retired soil scientists) are professors at the Faculty of Agricultural Sciences and Food, Institute of Agriculture and the Faculty of Forestry, all being parts of the Ss. Cyril and Methodius University in Skopje. The authors of these maps and studies (in alphabetical order) are as follows: Andreevski [3, 4], Vasilevski and Markoski [5], Markoski *et al.* [6], Mitkova *et al.* [7], Mi-

trikeski *et al.* [8, 9], Mukaetov [2], Petkovski [10] and Filipovski [11, 12].

Besides the study of one particular region, Filipovski [12] wrote the study for the whole of the Republic of Macedonia. The other authors wrote the soil studies for 9 separate regions.

### IMPORTANCE AND IMPLEMENTATION OF THE PUBLISHED SOIL MAPS AND STUDIES

The Project for preparation of soil maps and the studies have a fundamental and applicable character. They present our soils as an important natural and hard to renew resource, and as an important component of the natural ecosystems. Therefore, the results of these researches are being used in many basic sciences: botany (especially phytocoeology), ecology, zoology, geography, etc.

Soil maps are widely used in the construction industry (urban planning, infrastructure projects), spatial planning and creation of spatial plans, environmental projects, etc.

The results from soil survey and soil mapping are used by other soil related sciences: plant nutrition, soil microbiology, agrotechnics, hydrotechnics, etc.

Their use in agriculture is particularly wide, especially in agro-ecological zoning, cultivation of different crops, cultivation of perennial crops in viticulture and fruit growing, implementation of different agrotechnical and ameliorative measures (especially in irrigation and drainage), etc.

Their importance is also notable in forestry: cultivation and exploitation of forests, afforestation, implementation of anti-erosion measures, etc.

### MAIN CHARACTERISTICS OF THE PROJECT

The Project for preparation of soil maps and studies has several specific characteristics which make it different from other projects in the field of soil science. These are:

1. Particularly long project duration. It started in 1947 and, with interruptions, lasted until 2015 or for a total of 68 years. This can be explained with its specifics: soil mapping requires that 'every foot of land' is examined. Besides, sometimes problems occurred with project funding. That resulted in work interruptions, time gaps or slowing down of the pace of work. And lastly, the great changes and turbulent times that our country went through during this long period of time inevitably had an impact on the project completion.

2. Involvement of a particularly large number of researchers. As described above, it was necessary to engage a particularly large number of contributors to the soil mapping. The soil study that is published together with the Soil Map of Macedonia (Filipovski [12]) lists the names of all 24 researchers.

3. Participation of a large number of institutions in the creation of the project. Those were the institutions that employed these 24 researchers: MASA, Faculty of Agricultural Sciences and Food, Institute of Agriculture and Faculty of Forestry within the Ss. Cyril and Methodius University and the Tobacco Institute in Prilep, the Republic Institute for Water Management, the Rise Institute in Kočani, the Forestry Institute, the laboratories of some companies ('Agromehanizacija') and agricultural organizations. Some of these institutions do not exist any longer.

4. Expensive project. Due to the project research specifics, substantial financial resources had been used from different sources. The total amount is unknown. All the above mentioned institutions participated in the financing with budget funding. Beside them, financial support came from: the Directorate for Water Management, the Institute for Spatial Planning, agricultural complexes, water management companies, local councils and especially from the Federal and Republic Funds for Scientific Research. It should be particularly noted that without the expertise and the financial support provided by FAO (UN organization) in the amount of \$ 340,000, the Project could not have been completed. Also, some of these institutions that took part in the financing of the Project do not exist any longer.

5. The use of numerous different soil classifications for preparation of legends for the cartographic units of soil maps. During the long period of the Project implementation, several national soil classifications were used, which reflected the level of the soil science at the time. Those classifications were based on different principles and criteria. As a result of that, the created maps had different legends. This caused a serious problem. Focusing all my efforts and knowledge on this problem, in 2008 I managed to compile one common legend from all these different ones. That enabled the creation of all 63 soil maps in 2015. This was achieved in correlation with all cartographic units of numerous legends with the **taxonomic units** from the last version of our soil classification of 2006 (Filipovski [13]). This common legend was used in the creation of the soil maps published in 2015.

6. Digitalization of the soil maps and of the soil characteristics data base. During the first dec-

ades of soil mapping, digitalisation was not possible. Digitalisation was achieved with FAO assistance and with the implementation of the soil information system (SOTER) prepared by FAO [14].

## CONDITIONS FOR PROJECT COMPLETION

The final Project activities took place between 2013 and 2015 when 63 soil maps in their final form were completed together with 11 study books on soil properties.

This work was successfully completed as a result of several conditions being previously fulfilled, among others most notable being the following:

1. As a result of the soil mapping, there was a large number of field soil maps drawn by hand, some of which were even in a printed form. There were soil studies and reports for these maps.

2. MASA financed and completed several projects which enabled or facilitated the creation of the common legend and the creation of the 11 study books on soils. The completion of these projects was crowned with the publishing of several **monographs on the soils of Macedonia** (Filipovski [13, 15–23]). Some of these monographs are of vital importance for the completion of the Project, such as the monograph **Soil Classification of the Republic of Macedonia** published in 2006 (Filipovski [13]), and the monograph on the **Soils of the Republic of Macedonia** in six volumes (Filipovski [15–20]), which were used for the creation of the 11 study books on soils published in 2015. Two more monographs were used for the creation of these studies: **Soil degradation as a component of the environment in the Republic of Macedonia** (Filipovski [21]) and **The Characteristics of the Climate Vegetation Soil Zones (Regions) in the Republic of Macedonia** (Filipovski *et al.*, [22]).

3. It should be noted that after the publishing of the monograph on the **soils of Macedonia**, which presented all research results of the soils until its publishing, we had access to the most recent results from the doctoral and masters studies prepared by: Andreevski [24], Vasilevski [25], Markovski [26, 27], Mitkova [28], Mukaetov [29] and Jovanov [30]. These results were also used in creating of the 11 studies in 2015.

4. The final works in 2008 were of great importance for the Project completion. With the support of three of my collaborators (Petkovski, Mukaetov and Andreevski), at the Institute of Agriculture, all the existing 140 field soil maps in a scale of 1 : 50 000 were gathered and stored, together with their legends and soil studies. A large

number of these maps were in handwritten form. These data were kept in a number of institutions, funds or by the authors themselves. The collecting of this material was a hard and long process. Besides, the cartographic units indicated in the map legends were based on different classifications which used different criteria. After a long and hard work all these 140 legends with their cartographic units were correlated with the taxonomic units of the **Soil Classification** from 2006 (Filipovski [13]) with an aim to achieve a common legend. The whole completed work was presented in a handwritten text of 102 pages. The text contained a list of all collected soil studies for the 140 soil maps. Without this work the Project for the soil maps of the Republic of Macedonia could not have been completed.

5. During this period of seven decades, the soil mapping was also made possible with the classification of the Macedonian and the former Yugoslav soils, made by several authors. The classification criteria from these soil classifications were used as a base to define the cartographic units and legends. A separate chapter will be dedicated to the problems related to soil classifications.

6. After 1963, the work on the creation of the soil maps was made easier thanks to the published monograph on the soils of Yugoslavia (Filipovski *et al.* [31]). It resolved many questions related to soil classifications. In this monograph West European approaches in adoption of objective and measurable criteria for defining the taxonomic and cartography units were incorporated. This monograph motivated the process of creation of new versions of national soil classifications in former Yugoslavia, inspired by the international understandings and criteria of that time.

## SOIL CLASSIFICATIONS USED FOR COMPOSING LEGENDS FOR SOIL MAPPING DURING 1947 – 2015

In certain periods within these 70 years of soil surveying different classifications were used. In this respect, we can distinguish 5 periods:

1. The period between 1947 and 1959. During this period the scientific soil classification was not at a very high level. No international classification existed, and the soils in Yugoslavia had not been significantly researched to enable establishment of a good national soil classification. During this period Russian classifications were used (Rozov [32]) which were hard to implement in our conditions. Legends were compiled using descriptions of Yugoslav soil types in the books of Stebut

[33] and Gračanin [34]. The first national soil classification published by Gračanin [35], was inaccurate as it was done at the time when the soils of Yugoslavia were not adequately researched. Therefore, soil mapping during this period was quite difficult.

2. The period between 1959 and 1963. Till the beginning of this period the soils in the valleys of Macedonia were thoroughly researched for 12 years, and a substantial amount of scientific data was collected. This enabled the creation of the first version of the soil classification of the Republic of Macedonia (Filipovski [36]). It encompassed two categories of taxonomies (types and subtypes of the systematically researched soils in the valleys), and types for the mountainous soils, surveyed only with reconnaissance which is in fact an initial step in soil survey.

3. The period between 1963 and 1995. During this period the soil classification in the former Yugoslavia swayed considerably. An important contribution to this was the detailed soil monograph on the Yugoslav soils (Filipovski *et al.* [31]) published in 1963. It presented all the known research results of the Yugoslav soils till then. The same year, a group of authors wrote the first version of the national classification of the Yugoslav soils up to the level of type (Neigebauer *et al.* [37]). Later, again a group of authors compiled two new versions: in 1973 (Škorić *et al.* [38]) and in 1985 (Škorić *et al.* [39]). These two versions, as per the recommendation of the *Yugoslav Soil Research Society*, were used across all the republics of Yugoslavia for the purpose of creation of their soil maps. These classifications were based on measurable criteria and were detailed as they contained several categories of taxonomies (*orders, classes, types, subtypes, varieties, and soil forms*). It can be stated that with these classifications the soil mapping was made much easier as during field measurements they could define the taxon without any problems.

4. The period between 1995 and 2006. The monograph on our soils written during this period (Filipovski [15–20]) modifies and adjusts the last version of the Yugoslav soil classification (Škorić *et al.* 39) in accordance with the specifics of the soils in our country. It is used not only in the monograph but also in the research and soil mapping of the Macedonian soils during this period.

5. The period between 2006 and 2015. In 2006 the last version of the Macedonian Soil Classification was published (Filipovski [13]). It applies

contemporary criteria: 21 *diagnostic horizons*, 23 *diagnostic characteristics* and 27 *diagnostic soil materials*. All diagnostic horizons are quantitatively defined with specific parameters and therefore easily recognisable. They serve as a base for creation of our soil classification with precisely and measurably defined taxons out of the five categories (*big soil group, soil types, subtypes, varieties and forms*). That is why it was easily applicable. It is in essence a national classification based on the results of our well researched soils. This classification is also correlated with the international FAO classifications (Driessen *et al.* [40], Dudal [41]) and WRB (ISSS *et al.* [42], IUSS *et al.* [43]). As previously said, our classification was used for the soil mapping during this period. It also served for composing the common legend of all 63 soil maps that were published in 2015.

### COMMON LEGEND FOR ALL MAPS

The process of creation of a common legend for all 63 printed maps in 2015 was described previously. Cartographic units from the national soil classification (2006) are presented in Table 1, while the correlation of the national classification with the international classifications of WRB (ISSS *et al.* [42], IUSS *et al.* [43]) is presented in Table 2.

Table 1 below shows the common legend with all its cartographic units and areas covered with each unit.

The table shows that the common legend contains a total of 63 cartographic units. 17 of them contain only one soil type, and 46 are complexes, i.e. comprising several soil types.

The cartographic units are given by relief forms separately. There are 20 in mountainous relief forms, 28 in a hilly relief, 3 on sloppy terrains and 12 cartographic units in flat landforms. There are only few of the same cartographic units in several relief forms.

The Table 1 also represents the geography of our soils as it contains their surface areas in hectares. From the figures, it can be concluded that the surface areas of soils in the mountainous relief form represent 1.434.070 ha or 57,37%, in the hill land forms 698.159 ha or 27,93%, in hilly relief 160.394 ha or 6,42% and in flat relief forms 163.020 ha or 6,52% of the total surface area of our soils.

The cartographic units of the Table 1 are correlated with the international soil classification of WRB. This is represented in Table 2.

**Table 1.** Soils of the Republic of Macedonia (legend with cartographic units according to the soil classification of Gj. Filipovski)

| Cartographic soil units   | Hectares         |
|---|------------------|
| <b>I. Soils of mountainous relief</b>   |                  |
| Leptosol  | 38.502           |
| Leptosol on hard limestones and dolomites   | 1.128            |
| Complex of Regosol and Leptosol   | 70.898           |
| Complex of Mollic and Umbric Ranker   | 154.747          |
| Complex of Mollic and Umbric Ranker and Regosol                                   | 34.889           |
| Complex of Mollic and Umbric Ranker and Leptosol                                  | 1.124            |
| Complex of Mollic and Umbric Ranker, Regosol and Leptosol                         | 80.603           |
| Complex of Mollic and Umbric Ranker and Luvisol                                   | 930              |
| Rendzina on hard limestones and dolomites   | 146.229          |
| Complex of Rendzina on hard limestones and dolomites and Leptosol                 | 13.979           |
| Complex of Rendzina and Brown Soil on hard limestones and dolomites               | 35.050           |
| Red Soil (Terra Rossa)  | 260              |
| Complex of Red Soil (Terra Rossa) and Brown Soil on hard limestones and dolomites | 1.471            |
| Brown Soil on hard limestones and dolomites                                       | 82.879           |
| Brown Forest Soil   | 395.957          |
| Complex of Brown Forest Soil and Regosol  | 86.831           |
| Complex of Brown Forest Soil, Leptosol and Regosol                                | 127.721          |
| Complex of Brown Forest Soil and Mollic and Umbric Ranker                         | 54.437           |
| Complex of Brown Forest Soil, Mollic and Umbric Ranker and Leptosol               | 98.780           |
| Complex of Brown Forest Soil and Leptosol   | 7.555            |
| <b>TOTAL</b>  | <b>1.434.070</b> |
| <b>II. Soil of rolling relief and lake terraces</b>                               |                  |
| Regosol   | 102.310          |
| Complex of Regosol and Smolnitza  | 28.962           |
| Complex of Regosol and Colluvial Soil   | 584              |
| Pararendzina  | 47.616           |
| Complex of Pararendzina, Regosol and Leptosol                                     | 9.071            |
| Complex of Pararendzina, Regosol and Smolnitza                                    | 6.385            |
| Complex of Pararendzina and Leptosol  | 3.362            |
| Vertisol  | 60.537           |
| Complex of Smolnitza, Regosol and Leptosol  | 47.305           |
| Complex of Smolnitza and Pararendzina   | 32.833           |
| Complex of Smolnitza, Pararendzina and Regosol                                    | 9.906            |
| Complex of Smolnitza, Cinnamonic Forest Soil and Regosol                          | 40.181           |
| Complex of Luvisol and Regosol  | 7.130            |
| Complex of Chernozem and Pararendzina   | 2984             |
| Complex of Chernozem, Pararendzina and Smolnitza                                  | 9.906            |
| Complex of Pararendzina and Regosol   | 68.926           |
| Cinnamonic Forest Soil  | 96.030           |
| Complex of Cinnamonic Forest Soil and Regosol                                     | 45.860           |
| Complex of Cinnamonic Forest Soil, Pararendzina and Regosol                       | 14.538           |
| Complex of Cinnamonic Forest Soil, Pararendzina and Colluvial Soil                | 1.324            |
| Complex of Cinnamonic Forest Soil, Regosol, Pararendzina and Smolnitza            | 8.500            |
| Complex of Cinnamonic Forest Soil and Smolnitza                                   | 14.539           |
| Complex of Cinnamonic Forest Soil, Pararendzina and Smolnitza                     | 6.823            |
| Complex of Cinnamonic Forest Soil and Luvisol                                     | 2.188            |
| Complex of Cinnamonic Forest Soil, Luvisol and Regosol                            | 751              |
| Luvisol   | 13.942           |
| Rigosol   | 15.612           |
| Depasol   | 84               |
| <b>TOTAL</b>  | <b>698.189</b>   |
| <b>III. Soils of slopy relief</b>   |                  |
| Colluvial Soil  | 159.132          |
| Colluvial Rigosol   | 735              |
| Colluvial Hortisol  | 527              |

Table 1. (continuation)

|   | TOTAL | 160.394   |
|---|-------|-----------|
| <b>IV. Soils of flat relief</b>                               |       |           |
| Alluvial Soil   |       | 109.645   |
| Complex of Alluvial and Colluvial Soil                        |       | 2.540     |
| Complex of Alluvial Soil and Swampy Gley Soil                 |       | 1.197     |
| Complex of Alluvial Soil and Fluviative Meadow Soil           |       | 309       |
| Fluviative Meadow Soil  |       | 18.295    |
| Complex of Fluviative Meadow Soil and Hydromorphic Black Soil |       | 1.015     |
| Swampy Gley Soil  |       | 10.061    |
| Complex of Swampy Gley Soil and Histosol                      |       | 934       |
| Hydromorphic Black Soil                                       |       | 6.883     |
| Complex of Solonchak and Solonetz                             |       | 10.806    |
| Planosol  |       | 1.160     |
| Histosol  |       | 175       |
|   | TOTAL | 163.020   |
| Populated areas   |       | 44.172    |
|   | TOTAL | 2.499.845 |

**Table 2.** Soils of the Republic of Macedonia (legend with cartographic units according to the soil classification of WRB)

| Cartographic soil units  | Hectares |           |
|--|----------|-----------|
| <b>I. Soils of mountainous relief</b>  |          |           |
| Leptosol   | 38.502   |           |
| Leptosol calcareo  | 1.128    |           |
| Complex of Regosol and Leptosol  | 70.898   |           |
| Complex of Humic Eutric and Umbric Regosol (Umbrisol)                        | 154.747  |           |
| Complex of Humic Eutric and Umbric Regosol (Umbrisol) and Regosol            | 34.889   |           |
| Complex of Humic Eutric and Umbric Regosol (Umbrisol) and Leptosol           | 1.124    |           |
| Complex of Humic Eutric and Umbric Regosol (Umbrisol), Regosol and Leptosol  | 80.603   |           |
| Complex of Humic Eutric and Umbric Regosol (Umbrisol) and Albic Luvisol      | 930      |           |
| Rendzic Leptosol   | 146.229  |           |
| Complex of Rendzic Leptosol and Leptosol                                     | 13.979   |           |
| Complex of Rendzic Leptosol and Chromic Leptic Luvisol on hard limestones    | 35.050   |           |
| Rhodic Leptic Luvisol on hard limestones                                     | 260      |           |
| Complex of Rhodic Leptic and Chromic Leptic Luvisol on hard limestones       | 1.471    |           |
| Chromic Leptic Luvisol on hard limestones                                    | 82.879   |           |
| Cambisol   | 395.957  |           |
| Complex of Cambisol and Regosol  | 86.831   |           |
| Complex of Cambisol, Leptosol and Regosol                                    | 127.721  |           |
| Complex of Cambisol, Humic Eutric and Umbric Regosol (Umbrisol)              | 54.437   |           |
| Complex of Cambisol, Humic Eutric and Umbric Regosol (Umbrisol) and Leptosol | 98.780   |           |
| Complex of Cambisol and Leptosol   | 7.555    |           |
|  | TOTAL    | 1.434.070 |
| <b>II. Soil of rolling relief and lake terraces</b>                          |          |           |
| Regosol  | 102.310  |           |
| Complex of Regosol and Vertisol  | 28.962   |           |
| Complex of Regosol and Fluvisol  | 584      |           |
| Humic Calcaric Regosol   | 47.616   |           |
| Complex of Humic Calcaric Regosol, Regosol and Leptosol                      | 9.071    |           |
| Complex of Humic Calcaric Regosol, Regosol and Vertisol                      | 6.385    |           |
| Complex of Humic Calcaric Regosol and Leptosol                               | 3.362    |           |
| Vertisol   | 60.537   |           |
| Complex of Vertisol, Regosol and Leptosol                                    | 47.305   |           |
| Complex of Vertisol and Humic Calcaric Regosol                               | 32.833   |           |
| Complex of Vertisol, Humic Calcaric Regosol and Regosol                      | 9.906    |           |
| Complex of Vertisol, Chromic Luvisol on saprolite and Regosol                | 40.181   |           |

Table 2. (continuation)

|   |                  |
|---|------------------|
| Complex of Albic Luvisol and Regosol  | 7.130            |
| Complex of Chernozem and Humic Calcaric Regosol                                       | 2984             |
| Complex of Chernozem, Humic Calcaric Regosol and Vertisol                             | 9.906            |
| Complex of Humic Calcaric Regosol and Regosol   | 68.926           |
| Chromic Luvisol on saprolite  | 96.030           |
| Complex of Chromic Luvisol on saprolite and Regosol                                   | 45.860           |
| Complex of Chromic Luvisol on saprolite, Humic Calcaric Regosol and Regosol           | 14.538           |
| Complex of Chromic Luvisol on saprolite and Fluvisol                                  | 1.324            |
| Complex of Chromic Luvisol on saprolite, Regosol, Humic Calcaric Regosol and Vertisol | 8.500            |
| Complex of Chromic Luvisol on saprolite and Vertisol                                  | 14.539           |
| Complex of Chromic Luvisol on saprolite, Humic Calcaric Regosol and Vertisol          | 6.823            |
| Complex of Chromic Luvisol on saprolite and Albic Luvisol                             | 2.188            |
| Complex of Chromic Luvisol on saprolite, Albic Luvisol and Regosol                    | 751              |
| Albic Luvisol   | 13.942           |
| Aric Regosol  | 15.612           |
| Spolic Regosol  | 84               |
| <b>TOTAL</b>  | <b>698.189</b>   |
| <b>III. Soils of slopy relief</b>   |                  |
| Fluvisol (Colluvial soil)   | 159.132          |
| Aric Regosol  | 735              |
| Hortic Anthrosol  | 527              |
| <b>TOTAL</b>  | <b>160.394</b>   |
| <b>IV. Soils of flat relief</b>   |                  |
| Fluvisol  | 109.645          |
| Fluvisol (Alluvial and Colluvial soil)  | 2.540            |
| Complex of Fluvisol and Gleysol   | 1.197            |
| Complex of Fluvisol and Mollic Fluvisol   | 309              |
| Mollic Fluvisol   | 18,295           |
| Complex of Mollic Fluvisol and Mollic Vertic Gleysol                                  | 1.015            |
| Gleysol   | 10.061           |
| Complex of Gleysol and Histosol   | 934              |
| Mollic Vertic Gleysol   | 6.883            |
| Complex of Solonchak and Solonetz   | 10.806           |
| Planosol  | 1.160            |
| Histosol  | 175              |
| <b>TOTAL</b>  | <b>163.020</b>   |
| Populated areas   | 44.172           |
| <b>TOTAL</b>  | <b>2.499.845</b> |

## THE CONTENTS OF SOIL STUDY BOOKS

The 11 soil study books mentioned in the introduction of this paper, contains same chapters in the same order. It was an agreement between the authors of the study books. The first written study (Filipovski [11]) was used as a sample.

The results of the soil surveys for each of the 10 regions and for the whole of the Republic of Macedonia are presented in the following chapters:

1. Introduction, history and research goals
2. Literature review
3. Research results
  - 3.1. Factor influencing: *formation, evolution and characteristics* of the soils
    - 3.1.1. Geographic location and relief

- 3.1.2. Hydrographical characteristics and erosion (surface water, flooded areas and wetlands, ground water, irrigation water, erosion)

- 3.1.3. Parent material

- 3.1.4. Climate

- 3.1.5. Vegetation

- 3.1.6. Human influence

- 3.2. Soils of the valleys

- 3.3. Soils of the sloppy terrains

- 3.4. Soils of the undulated and hilly terrains and lake terraces

- 3.5. Soils of the mountain terrains

- 3.6. Geography (spatial distribution of the cartographic units).

In every chapter on the four relief forms, research results for each soil type are presented as follows:

- **Genesis and classification**
- **Morphological characteristics**
- **Mechanical structures**
- **Chemical characteristics**
- **Production characteristics**

A list of references is given at the end of each study.

The soil study for the whole territory of the Republic of Macedonia (Filipovski [12]) contains one additional chapter on the history of soil mapping during the period of 1947–2015.

#### THE HISTORY OF CREATION OF SOIL MAPS OF THE REPUBLIC OF MACEDONIA (1994–2015)

The history of soil survey and soil mapping of Macedonia before 1947 have been described in other works (Filipovski [12, 15]). Till the end of World War II there was not a single institution dealing with soil surveying. At the Agricultural Experimental and Control Unit in Skopje, established between the two world wars, there was not a soil scientist or soil science unit. A very limited research data related to soil properties exists from that period, mainly done by soil scientists from Belgrade. As far as the mapping is concerned, only one scheme-like soil map of the Skopje valley (Todorović [45]) has remained, however without any laboratory analysis.

During World War II the Agricultural Experimental and Control Unit in Skopje was renamed as Agriculture Research Institute, however, still without a soil scientist or a soil science unit. There were no soil researches performed during this period. It can be said that until 1947, soil survey of Macedonian soils did not exist in practice. This means that soils were unknown in terms of their properties and spatial distribution.

Three periods can be distinguished in the creation of the soil maps of Macedonia (Filipovski 12):

1. The period between the liberation and the proclamation of state independence (1944–1991).
2. The period from the proclamation of state independence to 2012 (1991–2012).
3. The period of finalization of the soil maps (2012–2015).

1. The period between the liberation and the proclamation of state independence (1944–1991). In December 1944, when Prof. Gj. Filipovski was appointed as Head of the Institute of Agriculture in Skopje, Macedonia got the first soil scientist. Still, during the first two years after the liberation, there were no conditions to begin with surveying and mapping of our soils. The Institute of Agriculture

had no equipment for field research of soils, there were neither means of transport nor financial means. The chemical laboratory within the Institute had supplies for regular functioning. The necessary conditions were met in 1947. It was then when Prof. Filipovski started with the surveying and mapping of the soils of Strumica valley. Research results were published in 1949 (Filipovski [1]). Those were the first data on our agricultural land to be published after the liberation.

This period preceding the proclamation of state independence can be recognised as the most productive in mapping of our soils. Only a small part of the soils of the country remained un-researched and unmapped. With regards to soil mapping, this period can be divided into two subperiods: the first between 1947 and 1963, and the second between 1963 and 1991.

In the first period (1947–1963) mainly the agriculture soils of our valleys were surveyed. For this purpose, adequate financial means were allocated from the government budget, as the rapid development of the country required the necessary research of soils. The results of these soil surveys were used for the needs of hydrotechnical ameliorations (irrigation and drainage). They were also necessary for improving the agricultural production (cultivation of perennial plantations of vineyards and orchards, in the implementation of different agrotechnical and ameliorative measures (especially in irrigation and drainage), etc.

These researches were abundantly funded especially by the Republic Institute for Water Management and the Directorate for Water Management. During this period, institutional, personnel and financial conditions were created for a very intensive and successful research and mapping of our soils. In 1947, within the Faculty of Agriculture and Forestry, the Department of Soil Science and Agrochemistry was established, which was initiated and headed by Prof. Gj. Filipovski for many years after. For the time, the Department was well equipped for educational and scientific work and it became a breeding ground for new soil scientists. At the same time, it worked intensively on the research and mapping of our soils.

During this subperiod, the other above mentioned institutions that took part in soil mapping, were gradually established.

During this subperiod, the research and soil mapping of the following valleys were undertaken (in alphabetical order): Belčišta, Berovo, Bitola-Gjavato, Valandovo, Veles, Gevgelija, Delčevo, Dojran, Izdeglavje, Kočani, Kirva Palanka, Kumanovo, Ljubanište, Ovče Pole, Ohrid, Pelagonija,



Polog, Radoviš, Resen, Skopje, Strumica, Struga and Tikveš. The following researchers took part in these researches and soil mappings (in alphabetical order): L. Vilarov, S. Vukašinović, K. Georgievski, M. Živković, Ms L. Manuševa, D. Popovski, R. Radojević, T. Tonovski, B. Kosevski and Gj. Filipovski. These researches were done with relatively dense network of soil profiles. On the basis of the researches until 1953, Prof. Gj. Filipovski had created the first soil map of Macedonia which encompassed only the soils of the valleys. This map, in a scale of 1:500 000, was published by 'Geokarta' [46] in Belgrade.

During the second subperiod (1963–1991) the research focussed mainly on the mountainous soils, however, with substantially sparse network of profiles. Till then the mountainous soils had not been researched. This mapping of soils was done within a long-term project of that time which was launched for creation of the Soil Map of Yugoslavia. This project was funded by the Federal and later by the Republic Fund for Scientific Research. In Macedonia, the project was realised at the Institute of Agriculture in Skopje. During this subperiod, besides the mountainous soils, the soils of some valleys that had not been researched and mapped yet were researched as well. Those were the valleys of: Debar, Kičevo, Ovče Pole, Štip, Mariovo and Polog, as well as Debarca, Župa, Malesija, Dolni Drimkol, Trojačka, Žegljansko and Otčično and part of Pelagonia valley. The following people took part in these researches and soil mappings: T. Avramovski, M. Andreevski, S. Geškovski, A. Gičev, N. Miševska, T. Mitkova, J. Mitrikeski, Z. Mišiku, D. Mukaetov, D. Petkovski, D. Popovski, K. Serbinovski, J. Spirovski, Gj. Tanev, B. Kosevski and Gj. Filipovski.

During this subperiod, for the purpose of spatial planning, Prof. Gj. Filipovski and Dr D. Popovski created soil maps and wrote a study on the Macedonian soils of the Ohrid-Prespa region, Municipality of Štip, Titov Veles region and the region of Eastern Macedonia.

2. The period from the independence to 2012 (1991–2012). Unfortunately, this two-decade period is not characterized with intensive soil mapping due to lack of funding. This period is characterized by the following: a) mapping of small parts of Macedonian soils that were not researched until then; b) completion of some works that enabled the final realization of the Project in the later period; and c) search for funding for Project completion.

During this period, first of all, the mapping of the territory of the Republic of Macedonia that was not researched was completed for the following

regions: Mariovo, Kičevo and Polog valley and the mountains of Galičica and Jablanica. For part of this territory the soil maps were missing, and for the other part the mapping was not with good quality. M. Andreevski, D. Mukaetov, D. Petkovski and D. Popovski took part in the mapping process.

During this period, the following tasks that enabled the completion of the Project in the later period took place: a) in 2008, with the assistance of three of Prof. Gj. Filipovski's collaborators, all completed soil maps until then in a scale of 1:50 000 were gathered, together with the soil studies for these maps; b) a common legend for all these maps which used many different legends was prepared, c) MASA published several monographs of Prof. Filipovski that were used in writing of the text – Study book of the soil map of Macedonia (Filipovski [12]). They were also used in the writing of the texts – study books of the soils of the ten regions of the country; d) of particular importance was the monograph on classification of soils from 2006 (Filipovski [13]) which served as a base for composing of the common legend for all maps.

This legend was composed in correlation with all previous cartographic units, with taxonomies of that classification. This classification is also correlated with international classifications; e) following the publishing of the monograph "Soils of the Republic of Macedonia" (for the period 1995–2004), several PhD and master studies were completed, as mentioned above. They were also used in drafting the soil studies and soil maps.

During this period, and in particular after 2008, when the necessary works on the Project completion were finalized, intensive efforts were made to find funding, which were unfortunately unsuccessful.

3. The period of final Project completion (2012–2015). During this period, the following final tasks were completed: a) application for and received funding and experts' assistance from FAO; b) for the purpose of Project completion, a team of 8 experts (previous contributors to the soil mapping) was established.

Following our written request, the FAO (an organization of the United Nations) expressed interest in funding of the final works for Project completion. They sent an expert who was acquainted with all available scientific data. Following his positive feedback, an agreement was signed between the FAO and the Ministry of Agriculture, Forestry and Water Management, since the FAO as an UN organization can sign agreements only with governments or governmental bodies. In parallel with the agreement, a programme for Project com-

pletion was drawn up. The FAO approved the necessary funding, expert support and a corresponding equipment for completion of the part of the Project related to digitalization of the soil maps and creation of the data base on soil characteristics.

Subsequently, a team of 8, still active soil experts, who took part in the process of mapping of our soils, was established with the purpose of completing the Project. Their names are mentioned in the introductory part. Two more lecturers from the Faculty of Natural Sciences (Institute of Geography) joined this team: Prof. I. Milevski and Prof. S. Gorin, who helped in the process of development of topographic data set and preparation of soil maps for printing. During this period, the team of these 8 soil scientists completed the following tasks:

1. Finalization of the process of soil mapping, with soil survey of few remaining parts. This means that they completed the soil maps for the following sections: Prizren 4, Bitola 3 and 4 and Gostivar 1, 2 and 3. This task has been completed by four members of the team of soil scientists (M. Andreevski, K. Vasilevski, M. Markoski and J. Mitrikeski).

2. All non-soil digital data necessary for completion of the digital soil maps were completed.

3. A set of 62 soil maps in printed and digital form in a scale of 1: 50 000 and one for the whole territory of the country in a scale of 1: 200 000, was completed

4. The digital geo-database on soil characteristics was designed and created.

5. Previously completed common legend with cartographic units for all soil maps was adopted.

6. All soil study books containing soil survey results of all 10 regions and one for the whole of the Republic of Macedonia, were finalised.

7. All soil maps with soil study books were published.

8. An internet Web Portal was created in order to enable the use of the soil maps and soil properties data to broader audience.

### DIGITALIZATION OF SOIL MAPS AND OF DATA BASE ON SOIL CHARACTERISTICS

Within the process of digitalisation of all soil survey results and soil maps, the Macedonian Soil Information System (MASIS) was created. MASIS is a soil information system that was established in accordance with the EU standards (EUCBN). It represents a modern digital geo-database where soil data as a whole (numerical and graphical) are integrated with the other natural variables. Data base

organized in such a way represents a good source of information for the final users, and at the same time the system allows further development and upgrades of stored data.

Besides integrating of soil data, their characteristics and their spatial distribution, MASIS's main role is, by implementing of models and various geostatistical procedures, to produce:

- Various thematic maps that facilitate the localization of the spatial distribution of certain soil characteristics.

- Initial maps on soil suitability for cultivation of particular crops.

- Maps on risks associated with soil degradation in order to identify regions subject to different risks, to quantify different risks, and to estimate their impact on the agricultural production and the environment.

- Maps on spatial distribution of: pH, CaCO<sub>3</sub>, organic matters, clay, dust and sand.

The vision of the MASIS system is to become an integrated electronic system, for efficient management of farms and agricultural production, with the aim of sustainable use of natural resources and environmental protection.

The soil maps that are integrated within MASIS are in a scale of 1 : 50 000 and represent the spatial distribution of the soils and borders among different soil mapping units and complexes. Beside this, the system contains soil characteristics data. In the frame of the interlinked data MASIS gives the spatial distribution of the soil types by hectares and percentages in a network of maps in a scale of 1 : 50 000, by municipalities and river basins. D. Mukaetov and M. Markovski were the major contributors to the process of digitalization.

### PROJECT PROMOTION

The Project results were presented to our professional and scientific community in the spring of 2015 at the Ministry of Agriculture, Forestry and Water Management, and in spring 2016 at MASA. The history of the research and the difficulties during Project completion, the research results and the results from the mapping of our soils, as well as the digitalisation of these results, were presented by Acad. Gj. Filipovski, Prof. Dr. J. Mitrikeski and Prof. Dr. D. Mukaetov.

### REFERENCES

- [1] Ѓ. Филиповски, *Почвиџе на Сџрумичко Поле*. Год. збор. на Зем.-шум. фак., на Универзитетот – Скопје II (1948/49), стр. 57–326.

- Gj. Filipovski, *The Soils of Strumica Valley: Yearly Articles of the Faculty of Agriculture and Forestry, Skopje II* (1948/49), pp. 57–362.
- [2] Д. Мукаетов, *Почвиите на пограничните офајтено со листовите Биџола 2 и 4, Лерин 2, Прилеп 1 и 3 и Кајмакчалан 1 на топографските карти во размер 1 : 50 000 (источно од Гринич)* (Толковник). Универзитет „Св. Кирил и Методиј“, Земјоделски институт – Скопје, 2015, стр. 69.
- D. Mukaetov, *Soils in the area covered by sections: Bitola 2 and 4, Lerin 2, Prilep 1 and 3 and Kajmakčalan 1 of the topographic maps in a scale 1 : 50 000 (east of Greenwich) (Interpreter)*. University Cyril and Methodius, Institute of Agriculture, Skopje (2015), p. 69.
- [3] М. Андреевски: *Почвиите на пограничните офајтено со листовите Призрен 4, Урошевац 2, 3 и 4 и Куманово 1 и 3 на топографските карти во размер 1 : 50 000 (источно од Гринич)* (Толковник). Универзитет „Св. Кирил и Методиј“, Земјоделски институт – Скопје, 2015, стр. 74.
- M. Andreevski: *Soils in the area covered by sections: Prizren 4, Uroševac 2, 3 and 4 and Kumanovo 1 and 3 of the topographic maps in a scale 1 : 50 000 (east of Greenwich) (Interpreter)*. University Cyril and Methodius, Institute of Agriculture, Skopje, (2015), p. 74.
- [4] М. Андреевски: *Почвиите на пограничните офајтено со листовите Охрид 1, 2, 3, 4, Корча 1 и 2, Биџола 1 и 3, Лерин 1, 4 на топографските карти во размер 1 : 50 000 (источно од Гринич)* (Толковник). Универзитет „Св. Кирил и Методиј“, Земјоделски институт – Скопје, 2015, стр. 86.
- M. Andreevski: *Soils in the area covered by sections: Ohrid 1, 2, 3, 4, Korča 1 and 2, Bitola 1 and 3, Lerin 1, 4 of the topographic maps in a scale 1 : 50 000 (east of Greenwich) (Interpreter)*. University Cyril and Methodius, Institute of Agriculture, Skopje, 2015, p. 86.
- [5] К. Василевски, М. Маркоски, *Почвиите на пограничните офајтено со листовите Гостивар 1, 2, 3, 3а и 4 и Скопје 1 и 3 на топографските карти во размер 1 : 50 000 (источно од Гринич)* (Толковник). Универзитет „Св. Кирил и Методиј“, Земјоделски институт – Скопје, 2015, стр. 58.
- K. Vasilevski, M. Markoski, *Soils in the area covered by sections: Gostivar 1, 2, 3, 3a and 4, and Skopje 1 and 3 of the topographic maps in a scale 1 : 50 000 (east of Greenwich) (Interpreter)*. University Cyril and Methodius, Institute of Agriculture, Skopje, 2015, p. 58.
- [6] М. Маркоски, Ј. Митrikesки, Т. Миткова, *Почвиите на пограничните офајтено со листовите Струмица 1, 2, 3, 4 и Демир Капија 2 и 4 на топографските карти во размер 1 : 50 000 (источно од Гринич)* (Толковник). Универзитет „Св. Кирил и Методиј“, Земјоделски институт – Скопје, 2015, стр. 62.
- M. Markoski, J. Mitrikeski, T. Mitkova, *Soils in the area covered by sections: Strumica 1, 2, 3, 4 and Demir Kapija 2 and 4 of the topographic Maps in a scale 1 : 50 000 (east of Greenwich) (Interpreter)*. University Cyril and Methodius, Institute of Agriculture, Skopje, 2015, p. 62.
- [7] Т. Миткова, Ј. Митrikesки, М. Маркоски, *Почвиите на пограничните офајтено со листовите Велес 2 и 4, Штип 1 и 3 на топографските карти во размер 1 : 50 000 (источно од Гринич)* (Толковник). Универзитет „Св. Кирил и Методиј“, Земјоделски институт – Скопје, 2015, стр. 90.
- T. Mitkova, J. Mitrikeski, M. Markoski, *Soils in the area covered by sections: Veles 2 and 4, Štip 1 and 3 of the topographic maps in a scale 1 : 50 000 (east of Greenwich) (Interpreter)*. University Cyril and Methodius, Institute of Agriculture, Skopje, 2015, p. 90.
- [8] Ј. Митrikesки, Т. Миткова, М. Маркоски, *Почвиите на пограничните офајтено со листовите Скопје 2 и 4 и Велес 1 и 3 на топографските карти во размер 1 : 50 000 (источно од Гринич)* (Толковник). Универзитет „Св. Кирил и Методиј“, Земјоделски институт – Скопје, 2015, стр. 68.
- J. Mitrikeski, T. Mitkova, M. Markoski, *Soils in the area covered by sections: Skopje 2 and 4 and Veles 1 and 3 of the topographic maps in a scale 1 : 50 000 (east of Greenwich) (Interpreter)*. University Cyril and Methodius, Institute of Agriculture, Skopje, 2015, p. 68.
- [9] Ј. Митrikesки, Т. Миткова, М. Маркоски, *Почвиите на пограничните офајтено со листовите Прилеп 2 и 4, Демир Капија 1 и 3 и Кајмакчалан 2 на топографските карти во размер 1 : 50 000 (источно од Гринич)* (Толковник). Универзитет „Св. Кирил и Методиј“, Земјоделски институт – Скопје, 2015, стр. 62.
- J. Mitrikeski, T. Mitkova, M. Markoski, *Soils in the area covered by sections: Prilep 2 and 4, Drmir Kapija 1 and 3 and Kajmakčalan 2 of the topographic maps in a scale 1 : 50 000 (east of Greenwich) (Interpreter)*. University Cyril and Methodius, Institute of Agriculture, Skopje, 2015, p. 62.
- [10] Д. Петковски, *Почвиите на пограничните офајтено со листовите Кустендил 3 и 4, Крива Паланка 1, 2, 3, 4 и дел од Куманово 2 и 4 на топографските карти во размер 1 : 50 000 (источно од Гринич)* (Толковник). Универзитет „Св. Кирил и Методиј“, Земјоделски институт – Скопје, 2015, стр. 90.
- D. Petkovski, *Soils in the area covered by sections: Kustendil 3 and 4, Kriva Palanka 1, 2, 3, 4 and part of Kumanovo 2 and 4 of the topographic maps in a scale 1 : 50 000 (east of Greenwich) (Interpreter)*. University Cyril and Methodius, Institute of Agriculture, Skopje, 2015, p. 90.

- terpreter). University Cyril and Methodius, Institute of Agriculture, Skopje, 2015, p. 90.
- [11] Ѓ. Филиповски, *Почвиџе на џобрачјеџо оџфаџено со лисџовиџе Шџиџи 2 и 4, Берово 1, 2, 3 и 4 и делоџ Разлог 3 на џоџоџрафскиџе карџиџи во размер 1 : 50 000 (исџиџочно оџ Гриниџ)* (Толковник). Универзитет „Св. Кирил и Методиџ“, Земјоделски институт – Скопје, 2015, стр. 119.
- Gj. Filipovski, *Soils in the area covered by sections: Strip 2 and 4, Berovo 1, 2, 3 and 4 and Razlog 3 the topographic maps in a scale 1 : 50 000 (east of Greenwich) (Interpreter)*. University Cyril and Methodius, Institute of Agriculture, Skopje, 2015, p. 119.
- [12] Ѓ. Филиповски, *Почвиџе на Реџублика Македониџа на џоџоџрафскиџа основа 1 : 200 000 (исџиџочно оџ Гриниџ)* (Толковник). – Скопје, 2015, стр. 250.
- Gj. Filipovski *Soils of the Republic of Macedonia on topographic maps 1 : 200 000 (east of Greenwich)*, Skopje, 2015, p. 250.
- [13] Ѓ. Филиповски, *Класификаџиџа на џочвиџе на Реџублика Македониџа*, МАНУ, Скопје, 2006, стр. 341.
- Gj. Filipovski, *Soil Classification of the Republic of Macedonia*, MASA, Skopje, 2006, p. 341.
- [14] UNEP, ISSS, ISRIC, FAO: *Global and National Soils and Terrain Digital Databases (SOTER)*. Procedures manual. World Soil Resources Reports 74, Rev. 1, FAO, Rome, 1995.
- [15] Ѓ. Филиповски, *Почвиџе на Реџублика Македониџа*, том I. *Пероџенейски факџори и класа на џочви со (A)-C и (A)-R џиџи на џрофилоџи*, МАНУ, Скопје, 1995, стр. 264.
- Gj. Filipovski, *Soils of the Republic of Macedonia*, Vol. I *Soil Forming Factors and the Soil Classes with (A)-C and (A)-R Profile Type*, MASA, Skopje, 1995, p. 264.
- [16] Ѓ. Филиповски, *Почвиџе на Реџублика Македониџа*, том II: *Класа на хумусно-аккумуляџивни џочви со A-C и A-R џиџи на џрофилоџи*, МАНУ, Скопје, 1996, стр. 313.
- Gj. Filipovski, *Soils of the Republic of Macedonia*, Vol. II: *Class of Humus Accumulative soils of A-C and A-r Profile Types*, MASA, Skopje, 1996, p. 264.
- [17] Ѓ. Филиповски, *Почвиџе на Реџублика Македониџа*, том III: *Класа камбични џочви со A-(B)-C и елувиџално-илувиџални џочви со A-E-B-C џиџи на џрофилоџи*, МАНУ, Скопје, 1997, стр. 519.
- Gj. Filipovski, *Soils of the Republic of Macedonia*, Vol. III: *Class of Cambic Soils A-(B)-C and Eluvial-Illuvial Soils of A-E-B-C Profile Type*, MASA, Skopje, 1997, p. 519.
- [18] Ѓ. Филиповски, *Почвиџе на Реџублика Македониџа*, том IV: *Хидроморфни џочви*, МАНУ, Скопје, 1999, стр. 548.
- Gj. Filipovski, *Soils of the Republic of Macedonia*, Vol. IV: *Hydromorphic Soils*, MASA, Skopje, 1999, p. 548.
- [19] Ѓ. Филиповски, *Почвиџе на Реџублика Македониџа*, том V: *Халоморфни џочви*, МАНУ, Скопје, 2001, стр. 439.
- Gj. Filipovski, *Soils of the Republic of Macedonia*, Vol. V: *Salt-affected Soils*, MASA, Skopje, 2001, p. 439.
- [20] Ѓ. Филиповски, *Почвиџе на Реџублика Македониџа*, том VI: *Анџроџоџени џочви (анџроџосоли)*, МАНУ, Скопје, 2004, стр. 253.
- Gj. Filipovski, *Soils of the Republic of Macedonia*, Vol. VI: *Anthropogenic Soils (Anthrosols)*, MASA, Skopje, 2004, p. 253.
- [21] Ѓ. Филиповски, *Деџраџациџа на џочвиџе како комџоненџиџа на живоџинаџиџа средина во Р. Македониџа*, МАНУ, Скопје, 2003, стр. 348.
- Gj. Filipovski, *Soil Degradation as a Component of the Environment in the Republic of Macedonia*, MASA, Skopje, 2003 p. 348.
- [22] Ѓ. Филиповски, Р. Ризовски, П. Ристовски, *Каракџерисџика на климаџско-веџеџаџиско-џочвениџе џобрачџа (зони, реџиони) во Р. Македониџа*, МАНУ, Скопје, 1996, стр. 177.
- Gj. Filipovski, R. Rizovski, P. Ristovski, *The characteristics of the Climate-Vegetation-Soil Zones (Regions) in the Republic of Macedonia*, MASA, Skopje, 1996, p. 177.
- [23] Ѓ. Филиповски, *Почвиџе на Реџублика Македониџа*, образувани џоџ расџиџиџелни заедници џроучувани оџ Кирил Миџевски, МАНУ, Скопје, 2007.
- Gj Filipovski, *Soils of the Republic of Macedonia formed under plant communities studied by Kiril Micevski*, MASA, Skopje, 2007.
- [24] М. Андреевски, *Услови за образување на лесивираниџе џочви во Реџублика Македониџа и нивниџе своџсџива* (докторска дисертациџа). Земјоделски факултет, Скопје, 2005.
- М. Andreevski, *Conditions for formation of albic luvisols in the Republic of Macedonia and its properties* (Dissertation), Faculty of Agricultural Sciences and Food, Skopje, 2005.
- [25] К. Василевски, *Почвиџе на џланинскиоџи масив Бисџира и нивнаџа корелациџа со одделниџе џасџини и џумски фџиџоџенози* (докторска дисертациџа). Шумарски факултет, Скопје, 1996.
- К. Vasilevski, *Soils of the mountainous massive Bistra and its correlation with distinct pasture and forest phytocenoses* (Dissertation), Faculty of Forest, Skopje, 1996.
- [26] М. Маркоски, *Физички и физичко-механиџки своџсџива на черноземниџе расџросџираниџи во Овче Поле* (магистерски труд), Факултет за земјоделски науки и храна, Скопје, 2008.

- M. Markoski, Physical and physico-mechanical properties of chernozems in Ovče Pole (Master Thesis), Faculty of Agricultural Sciences and Food, 2008.
- [27] M. Маркоски, *Генеза и својсџтва на њочвиџе образувани врз варовници и доломитџи во Република Македонија* (докторска дисертација). Факултет за земјоделски науки и храна, Скопје, 2013.
- M. Markoski *Genesis and properties of soils formed on limestones and dolomites in the Republic of Macedonia* (Dissertation), Faculty of Agricultural Sciences and Food, Skopje, 2013.
- [28] Т. Миткова, *Генеза и својсџтва на черноземџе во Р. Македонија* (докторска дисертација). Земјоделски факултет, Скопје, 1998.
- Т. Mitkova, *Genesis and properties of chernozems in R. of Macedonia* (Dissertation), Faculty of Agriculture, Skopje, 1998.
- [29] Д. Мукаетов, *Услови за образување, џенеза и својсџтва на хидроџенџе црници, расџросџранџеџи во Пелаџонија* (докторска дисертација). Земјоделски факултет, Скопје, 2004.
- D. Mukaetov *Conditions for formation, genesis and characteristics of the mollic vertic gleysoils spread out in Pelagonija*, (Dissertation), Faculty of Agriculture, 2004.
- [30] Д. Јованов, *Водно-физички и физичко-механички својсџтва на смолнициџе расџросџранџеџи во шџтџијскиоџ, џробџиџшџијскиоџ и свеџини-колскиоџ реџион* (магистерски труд). Факултет за земјоделски науки и храна, Скопје, 2010.
- D. Jovanov, *Water-physical physico-mechanical properties of vertisols spread in the area of Stip, Probistip and Sv. Nikole*, (Master Thesis), Faculty of Agricultural Sciences and Food, Skopje, 2010.
- [31] G. Filipovski, M. Ćirić, *Zemljišta Jugoslavije*. Posebna publikacija, JDPZ, N° 9, Beograd, 1963, str. 498.
- G. Filipovski, M. Ćirić, *Soils of Yugoslavia*. Special edition, JSSS, No 9, Belgrade, 1963, p. 498.
- [32] Н. Розов, *Принципи класификаџи почв*. Доклады VI. Международному конгрессу почвоведов. Пятая комиссия. Классификация почв. АН СССР, Москва, 1956.
- [33] А. Стебут, *Наука о џознаваџу земџиџџа* (Педологија). Издање Министарства пољопривреде и вода, Београд, 1927.
- A. Stebut, *Soil Science (Pedology)*. Edition of the Ministry of Agriculture and Water, Belgrade, 1927.
- [34] М. Граџанин, *Pedologija*, III dio. *Sistematika tala*. Školska knjiga, Zagreb, 1951.
- M. Gračanin, *Pedology Vol. III. Systematic of Soils*. Školska knjiga, Zagreb, 1951.
- [35] М. Граџанин, *Prilog genetskoj klasifikaciji tala*. Radovi Jugoslavenske akademije znanosti i umjetnosti, Odjel za prirodne nauke, knj. III, Zagreb, 1950.
- M. Gračanin, *Contributions to Genetic Soil Classification*. Works of the Yugoslav Academy of Arts and Sciences, Department of Natural Sciences, Book III, Zagreb, 1950.
- [36] Ѓ. Филиповски, *Прилоџ кон џрашаџеџо за класификаџиџа на џочвиџе на Нароџна Република Македонија*. Год. збор. на Зем.-шум. факултет, Земјоделство, кн. XII, Скопје, 1959.
- Gj. Filipovski, *Contribution to the Issue of Soil Classification of the People's Republic of Macedonia*. Year book of Faculty of Agriculture and Forestry, Agriculture, Book XII, Skopje, 1959.
- [37] V. Neigebauer, M. Ćirić, G. Filipovski, A. Škorić, M. Živković, *Klasifikacija zemljišta Jugoslavije. Zemljište i biljka*, god. XII, No 1–3, Beograd, (1963), стр. 21–44.
- V. Neigebauer, M. Ćirić, G. Filipovski, A. Škorić, M. Živković, *Soil classification of Yugoslavia. Soil and Plant*, year XII, No 1–3, Belgrade (1963), pp. 21–44.
- [38] A. Škorić, G. Filipovski, M. Ćirić, *Klasifikacija tala Jugoslavije*. Zavod za pedologiju Poljoprivrednog i Šumarskog fakulteta u Zagrebu, Zagreb, 1973.
- A. Škorić, G. Filipovski, M. Ćirić, *Soil Classification of Yugoslavia*, Department of Soil Science of the Faculty of Agriculture and Forestry in Zagreb, Zagreb, 1973.
- [39] A. Škorić, G. Filipovski, M. Ćirić, *Klasifikacija zemljišta Jugoslavije*. Posebna izdanja, knj. LXXVIII, Odjeljenje prirodnih i matematičkih nauka, knj. 13. Akademija nauka i umjetnosti Bosne i Hercegovine, Sarajevo, 1985, стр. 72.
- A. Škorić, G. Filipovski, M. Ćirić, *Soil Classification of Yugoslavia*. Special editions, Book LXXVIII, Department of natural sciences and mathematics, Book 13. Academy of Sciences and Arts of Bosnia and Hercegovina, Sarajevo, 1985, p. 72
- [40] P. Driessen, J. Deckers, O. Spaargaren, *Lecture notes on the major soils of the World*. World Soil Resources Reports 94, FAO, Rome, 2001.
- [41] R. Dudal, *Definitions of Soil Units for the Soil Map of the World*, FAO, Rome, 1968.
- [42] ISSS, ISRIC, FAO, *World Reference Base for Soil Resources*. World Soil Resources reports 84, FAO, Rome, 1998.
- [43] IUSS, ISRIC, FAO, *World Reference Base for Soil Resources 2006*. A framework for international classification, correlation and communication. World Soil Resources reports 103, FAO, Rome, 2006.
- [44] Ѓ. Филиповски, *Поделба на Р Македонија во осум климаџско-веџеџаџиско-џочвени џограџа (зони, реџиони)*. Македонска земјоделска ревија, 43 (1–2), Скопје (1996).

Gj. Filipovski, *Division of R. Macedonia in eight climatic-vegetation-soil regions*. Macedonia Agriculture Review, **43** (1–2), Skopje, (1996).

[45] Д. Тодоровиќ, Педолошко проучавање у Скопској котлини. *Гласник Скопског научног друштва*, књ. X, Одељење природних наука, Скопље (1931).

D. Todorovic, Soil survey of Skopje valley. *Herald of Skopje's national society*, Book. X, Department of Natural Sciences, Skopje, (1931).

[46] Г. Филиповски, *Педолошка карта 1 : 500 000*. Народна Република Македонија. Геокарта, Београд, 1953.

## ПЕДОЛОШКИ КАРТИ НА РЕПУБЛИКА МАКЕДОНИЈА

Ѓорѓи Филиповски

Македонска академија на науките и уметностите, Скопје, Република Македонија

Во овој преглед е опишан историјатот на изработката на 63 педолошки карти во печатена и дигитална форма, од кои 62 во размер 1 : 50 000 за одделните листови на топографските карти и една во размер 1 : 200 000 за целата Република. Проектот траеше близу 7 децении (од 1947 до 2015). За 10 подрачја заедно со педолошките карти се напишани и студии за почвите. Исто така, таква студија е напишана и за почвите на целата Република. За сите педолошки карти е составена заедничка легенда со 63 картографски единици. Опишани се сите користени класификации во тој долг период. Тие беа основа за составување на многуте легенди. Дадени се и површините на сите картографски единици. Опишана е и содржината на сите 11 студии за почвите. Извршена е дигитализација на сите карти и на базата на податоци за почвените својства. За таа цел на интернет е поставена web-страница ([www.maksoil.ukim.mk](http://www.maksoil.ukim.mk)). Резултатите од реализацијата на проектот се промовирани и претставени пред нашата научна и стручна јавност. Завршните работи за реализацијата на проектот се финансирани од FAO – организација на Обединетите нации.

**Клучни зборови:** педолошки карти на Р. Македонија; легенда на педолошки карти; површини на картографски единици; дигитализација на резултати од проект