ISSN 1064-2293, Eurasian Soil Science, 2015, Vol. 48, No. 9, pp. 897–910. © Pleiades Publishing, Ltd., 2015.
Original Russian Text © I.S. Urusevskaya, I.O. Alyabina, S.A. Shoba, 2015, published in Pochvovedenie, 2015, No. 9, pp. 1020–1035.

ON THE CENTENNIAL ANNIVERSARY OF THE BIRTH OF G.V. DOBROVOL'SKII

Soil-Geographical Zoning as a Direction of Science and as the Basis for Rational Land Use

I. S. Urusevskaya, I. O. Alyabina, and S. A. Shoba
Faculty of Soil Science, Moscow State University, Moscow, 119991 Russia
e-mail: iurusevskaya@yandex.ru, alio@yandex.ru
Received: March 19, 2015

Abstract—The history of soil-geographical zoning in Russia and the role of G.V. Dobrovol'skii in the development of this direction of soil science are elucidated. It is shown that the principles and methods of soil-geographical zoning have been refined since the 1960s. A new map of soil-ecological zoning of the Russian Federation on a scale of 1 : 2.5 M is presented, and the principles and methods of its compilation are discussed. The information content of this map, its taxonomic units, legend, and specific features of the design are described. The lithogeomorphic specificity of the separated soil okrugs and the climatic parameters of the air and soil regimes for the plain and mountainous provinces are briefly characterized. This map has contributed to the theory of soil-geographical zoning. It has a great practical meaning as the basis for the organization of rational land use with due account for the zonal and regional diversity of soil cover in Russia. It can also be used for the development of target-specific kinds of zoning. The role of this map in the cartographic block of the soil-geographical database of Russia is specified.

Keywords: geography of soils, soil cover, map of soil-ecological zoning of the Russian Federation
DOI: 10.1134/S1064229315090112

INTRODUCTION

Soil-geographical zoning is one of the important directions in soil geography. Along with its theoretical significance, this direction is of great practical meaning for sustainable use of land resources. The aim of soil-geographical zoning is to separate the territories with similar types of the soil cover patterns, similar combinations of the factors of soil formation, and similar economic uses of the soils. Soil-geographical zoning is based on the fundamental theoretical principles of pedology supplemented with modern notions on the certain hierarchical levels in the organization of the pedosphere, the history of pedogenesis, the soil cover as the crucial component of the biosphere, and the ecological role of soils in the life of human society. In agreement with the new concept of the soil cover of planet as a complex global natural system with its own structural hierarchy shaped in the course of the long history of soil development, soil-geographical zoning is based on a multilevel system of taxonomic units. This system directly reflects diverse and multifaceted relationships between the soil cover and the ecological (environmental) conditions of soil formation. Thus, in essence, soil-geographical zoning can be also perceived as soil-ecological zoning. G.V. Dobrovol'skii made a significant contribution to the development of soil zoning concepts.

HISTORY OF SOIL-GEOGRAPHICAL ZONING IN RUSSIA

The materials on physiographic, soil-geographical, agrochemical, soil-reclamation, and natural-agricultural zonings of Russia are very rich. As noted by Dobrovol'skii [7], elements of soil zoning are taken into account in the existing schemes of the natural, economic, and agricultural zonings of the country.

The foundations of soil-geographical zoning were shaped by Dokuchaev. He argued about the benefits of special soil studies for Russian agriculture and noted that "...detailed knowledge of soils is surely required for the division of Russia into natural and agricultural regions, which is of the utmost importance for the state" [17, p. 32]. Dokuchaev substantiated the need to distinguish soil regions reflecting intrazonal differences in the soil cover within soil zones. The subdivision of Russia into soil regions was considered by him a matter of the great theoretical and applied significance [18]. This idea supported Dokuchaev's concept of the zonal principles of agronomy.

The development of theoretical principles of soil zoning and the first zoning schemes for the European part of the Soviet Union are tightly connected with the names of Prasolov [28, 29] and Gerasimov [4, 5]. A comprehensive natural-historical zoning of the Soviet Union initiated by the Council on the Study of Productive Forces (CSPF) of the country and performed in 1939–1947 by the team of authors headed by academicians Strumilin and Prasolov [20]. This study was of great importance for the methodology of zoning and for the hierarchy of its units.

The works on the soil zoning of the Soviet Union were interrupted by World War II and resumed in the 1950s. In 1958, at the 1st Delegate Soil Science Congress of the Soviet Union, and in 1960, at the 7th International Soil Science Congress, a new scheme of the soil-geographical zoning of the Soviet Union developed by the Dokuchaev Soil Science Institute and the CSPF under the leadership of Letunov, Ivanova, Rozov, Fridland, and Shuvalov was presented [21, 22]. In 1962, a fundamental monograph *Soil-Geographical Zoning of the USSR (in Relation to the Agricultural Land Use)* was published. It was accompanied by a schematic map of soil-geographical zoning on a scale of 1 : 12.5 M [27]. For the first time, a comprehensive soil-geographical description of the entire Soviet Union was given in this monograph in agreement with the taxonomic system of the soil cover units of different levels. Soil-bioclimatic belts subdivided into soil-bioclimatic regions (oblasts) were considered the largest units. Within soil-bioclimatic oblasts, soil zones and subzones were separated on plain territories, and areas with different patterns of the vertical zonality (or mountainous soil provinces) were separated in the mountains. At the lower levels, further subdivision of the given units into soil provinces, soil okrugs, and soil districts (on the plains) and into the vertical soil zones, soil okrugs, and soil districts (in the mountains) was proposed. In the suggested scheme of soil-geographical zoning and in the monograph, the division of the territory to the level of plain and mountainous soil provinces was given. Lower categories were not separated (Table 1).

Along with this general soil-geographical zoning of the entire country, more detailed works on soil-geographical division of separate republics, regions, and oblasts were performed by scientific and educational institutes. In 1956, the Department of Soil Geography of the Faculty of Biology and Soil Science of Moscow State University headed by professor Vilenskii initiated the work on the soil-geographical zoning of the Soviet Union as a large interuniversity problem. This study involved eighteen universities and several agricultural and pedagogical institutes. In 1958, on the basis of the *State Soil Map of the Soviet Union* on a scale of 1 : 1 M and a number of regional works, a layout of the map of soil districts on a scale of 1 : 1.5 M was compiled for the European part of the Soviet Union by the Department of Soil Geography. In 1960, soil districts of the Asian part of the Soviet Union were mapped on a scale of 1 : 2.5 M.

In 1961, the Scientific Bureau on Soil Zoning for Agriculture at the Commission on Coordination of the Work of the Institutes of Higher Education was headed by the head of the Department of Soil Geography of Moscow State University G.V. Dobrovol'skii. Thus, the Department of Soil Geography became the methodological center of the works on soil-geographical zoning, and this direction of scientific studies became the main direction in the work of the department.

The initiative of Dobrovol'skii was supported by the Dokuchaev Soil Science Institute and the CSPF. In 1961–1967, the great work on harmonization of various schemes of soil-geographical zoning developed on different scales was performed. As a result, layouts of the maps of the soil-geographical zoning of the Soviet Union were compiled on the scales of 1 : 2.5 M and 1 : 5 M. For the first time, these maps demonstrated all the taxonomic units of the soil-geographical zoning from the soil-bioclimatic belts to the soil okrugs and soil districts. This work was adopted at the conferences of the institutes of higher education devoted to the problems of the natural and economic-geographical division of the Soviet Union for agricultural purposes in 1967 and 1971 [8, 39]. Later, this map and explanatory materials to it were used for the development of the agricultural [34], soil-agroreclamation [36], and natural-agricultural [30–32] divisions of the Soviet Union. The map of the natural-agricultural zoning of the Soviet Union (1 : 8 M) and the accompanying monograph [31, 32] were developed by researchers and specialists from the State Institute of Land Resources, the Department of Land Management of the Ministry of Agriculture of the Soviet Union, the Dokuchaev Soil Science Institute, and the Faculty of Soil Science of Moscow State University (Dobrovol'skii and Urusevskaya).

However, despite the active development of soil-geographical zoning schemes, the criteria for separation of soil okrugs and soil districts remained uncertain. A significant methodological contribution to this problem was made during the work on a detailed soil division of the Central economic region of the Soviet Union performed by the Department of Soil Geography of Moscow State University and on the soil-ecological division of the territory of Moldova performed by Ursu [37]. In 1972, a monograph *Geography of Soils and Soil Zoning of the Central Economic Region* under edition of Dobrovol'skii and Urusevskaya was published [3]. In this monograph, the major attention was paid to the theoretical grounds of the separation of soil okrugs and soil districts, the lowest taxonomic categories of soil-geographical zoning. Their soil covers were described in detail, and recommendations on the use of soil resources were made. It was stressed that the specific features of soil cover patterns should be used as the major criteria for the soil division of the territory: "the taxonomic system of soil zoning should follow the classification of soil cover patterns from its largest units—soil-bioclimatic belts—to its lowest (primary) units, i.e., soil districts" [3, p. 6].

In 1983, the *Map of the Soil-Geographical Zoning of the Soviet Union* developed by Dobrovol'skii, Urusevskaya, and Rozov on a scale of 1 : 8 M was published in a series of maps for the institutes of higher education [16]. This map successively developed the accumulated experience in soil-geographical zoning. It differed from the map of soil-geographical zoning published in 1962 [27] in a more detailed division of the territory. A new taxonomic category—soil-cli-

Table 1. The maps of the soil-geographical (soil-ecological) zoning of the Soviet Union and Russia

Map	Scale	Taxa of soil-geographical zoning and their number										Additional information in the legends
		belt	region	zone (subzone)	facies	province	okrug	district	moun-tainous province	moun-tainous okrug	moun-tainous subokrug	
Map of the soil-geographical zoning of the USSR [27]	1 : 12500000	4	13	25	None	74	None		37	None		None
Map of the soil-geographical zoning of the USSR [16]	1 : 8000000	4	11	21	36	60	365	None	34	None		Genetic types of the relief and parent materials in the soil okrugs; patterns of vertical soil zonality for mountainous provinces
Map of the soil-geographical zoning of the nonchernozemic zone of Russia [23]	1 : 1500000	None		6	None	16	86	391	2	None		Genetic types of the relief, parent materials, land use, and soil quality estimates for soil okrugs
Map of soil-ecological zoning (inset map to the Soil Map of Russia [26])	1 : 15000000	None		9	None	50	None		17	None		Genetic types of the relief, parent materials, land use, and soil quality estimates for soil okrugs; parameters of atmospheric and soil regimes for provinces
Map of the soil-ecological zoning of the East European Plain [24]	1 : 2500000	4	6	10	None	30	164	714	11	None		Parameters of atmospheric and soil regimes for provinces
Map of the soil-geographical zoning of Russia [14, 15]	1 : 15000000	4	9	15	28	51	241	None	28	None		Genetic types of the relief and parent materials for soil okrugs; patterns of the vertical soil zonality for mountainous provinces
Map of the soil-ecological zoning of the Russian Federation [25]	1 : 2500000	4	9	16	None	67	293	1379	31	121	41	Genetic types of the relief, parent materials, land use, and soil quality estimates for soil okrugs; parameters of atmospheric and soil regimes for provinces; patterns of the vertical zonality for mountainous provinces

matic facies—was introduced into this map; plain soil provinces were separated into soil okrugs, and the latter were typified with respect to their characteristic soil cover patterns, topographic features, and parent materials (Table 1). Soil-climatic facies were separated according to data on the accumulated daily temperatures above 10°C at the depth of 20 cm and the duration of the period with temperatures above 0°C at the same depth. The geographical distribution of soils in the Soviet Union and the major soil cover patterns were described on the basis of this map in a fundamental textbook *Geography of Soils* by Dobrovol'skii and Urusevskaya [9].

In the 1980s–1990s, the *Map of the Soil-Geographical Zoning of the Nonchernozemic Zone of the Russian Federation* (1 : 1.5 M scale) and the explanatory note to it [23], as well as the *Map of the Soil-Ecological Zoning of the East European Plain* (1 : 2.5 M scale) [24], were published. In the latter map, the legend was somewhat extended to include data on the ecology of soils; soil cover patterns of soil okrugs and soil districts were characterized [24].

In 1988, the *Map of the Soil-Ecological Zoning of the Russian Federation* compiled in the Dokuchaev Soil Science Institute by Rozov, Nosin, and Rudneva was published as a small-scale (1 : 15 M) inset map to the *Soil Map of the Russian Federation* [26]. In contrast to the map of 1962 [27], this new map did not show soil-bioclimatic belts and regions as the highest categories of the soil-geographical zoning. Mountainous soil provinces were distinguished within soil zones, i.e., the latter embraced both plain and mountainous territories.

A small-scale (1 : 15 M) *Map of the Soil-Geographical Zoning of Russia* developed by Dobrovol'skii, Urusevskaya, and Alyabina was included in the *National Atlas of Russia* (2007) and *National Soil Atlas of the Russian Federation* (2011) [14, 15].

The principles of soil zoning developed for Russia were also applied for the entire world. Thus, the *Map of Soil-Ecological Zoning* on a scale of 1 : 60 M was compiled by Dobrovol'skii, Stroganova, Rozov, and Trofimov and published in a fundamental two-volume atlas of world resources [42].

MAP OF SOIL-ECOLOGICAL ZONING OF THE RUSSIAN FEDERATION ON A SCALE OF 1 : 2.5 M

The *Map of the Soil-Ecological Zoning of the Russian Federation* (1 : 2.5 M) became the latest cartographic product developed at the Faculty of Soil Science under the leadership of G.V. Dobrovol'skii. It was published at the end of 2013 [25]. Dovorovol'skii and Urusevskaya were the editors of this map created by the team of authors (Urusevskaya, Alyabina, Vinyukova, Vostokova, Dorofeeva, Shoba, and Shchipikhina). This map was based on the *Soil Map of the Russian Federation* (1 : 2.5 M) edited by Fridland and published in 1988 and its corrected digital version of 2007 [26]. The original soil map shows the distribution of the particular units of soils, and the map of the soil-ecological zoning shows the distribution of the taxonomic units of the soil cover patterns. The taxonomic system of the soil-ecological zoning is based on the analysis of the soil cover patterns of all hierarchical levels and reflects the influence of different geographical factors on their geneses.

Taxonomic units of the soil-ecological zoning. A multilevel system of taxonomic units is realized on the map. It reflects the diversity of relationships between the soil cover patterns and the ecological (environmental) conditions and includes the following taxonomic categories: (1) geographical belts and (2) soil-bioclimatic oblasts (regions); plain territories are further subdivided into (3) soil zones and subzones, (4) soil provinces, (5) soil okrugs, and (6) soil districts; and mountainous territories are subdivided into (3) mountainous soil provinces, (4) mountainous soil okrugs, and (5) mountainous soil subokrugs. Intermontane depressions are separated at the level of mountainous soil okrugs and are further subdivided into mountainous soil districts.

The separation of the highest categories, including soil provinces, is dictated by the soil cover features related to the bioclimatic factor. The differentiation of soils related to the bioclimatic factor is clearly manifested in the regularities of soil geography, such as the horizontal and vertical zonality, the facial specificity of soils, and the provincial specificity of soils. At the lower levels on plain territories (in soil okrugs and soil districts), local lithological and geomorphic conditions are important in terms of the soil cover differentiation. Lithological and geomorphic conditions specify certain soil cover patterns at the levels of soil okrugs and soil districts. The geological history of the territory and the related orographic conditions are reflected in the subdivision of the soil cover into plain and mountainous territories.

The key element of the soil-ecological zoning is represented by soil zones on the plains and by mountainous soil provinces in the mountains. From this central level, the system can be built up by grouping soil cover patterns into bioclimatic regions. To develop it at the lower levels, soil cover patterns of the lower taxonomic categories have to be separated.

Geographical belts include plain soil zones and mountainous soil provinces characterized by similar solar radiation and temperature conditions.

Soil-bioclimatic oblasts (regions) are distinguished within the belts as the areas with similar conditions of climatic moistening and continentality.

Soil zone (or subzone) is defined as the area of the zonal soil type (subtype) and accompanying intrazonal soils.

Soil province is a part of soil zone with a predominance of the given soil species or facial subtypes of zonal soils; their separation is related to the differences in the degree of moistening and continentality of the climate (within latitudinal sections of soil zones), or to the differences in temperature conditions (within meridional sections of soil zones).

Soil okrug is a part of soil province characterized by alternation of several types of soil cover patterns (at the mesolevel) controlled by the lithogeomorphic and geological conditions. Soil okrugs are confined to the large tectonic morphostructures of the relief and are characterized by similar history of the soil cover development. This is reflected in the similarity of the soil cover patterns and in the specificity of the economic use of land resources. This problem is discussed in detail in the works by Dobrovol'skii and Urusevskaya [10–13, 38]. The separation of soil okrugs in the system of soil-ecological zoning is very important, as it shows the influence of the geological history of given territories on the genesis and geography of the particular soil cover patterns.

Soil district—the lowest taxonomic unit of the soil-ecological zoning—is a part of soil okrug with the same combination of soil cover patterns (at the mesolevel) predetermined by the morphosculpture of the relief and/or by the specific lithological features of the parent materials. The conditions of soil formation within the soil districts are relatively homogeneous, which specifies the possibility of the same economic use of land resources. Soil districts are considered the major units of a detailed soil zoning.

The taxonomic categories applied to mountainous territories are less developed and subjected to discussion. The heterogeneity of soil cover patterns in the mountains depends on the position of a given mountain system in the given geographic belt and soil-bioclimatic region. At the same time, it is controlled by the particular landscape characteristics of the territory determined by the height of mountain ridges, their barrier function, and the uneven distribution of heat and moisture supplies on the slopes of different aspects and shapes. Taken together, these factors specify the great diversity of the altitudinal sequences of zonal soils. These sequences are described as the vertical soil zonality. The types of the vertical soil zonality are specified as full generalized sequences of zonal soil types within the given mountain regions. As a rule, these sequences in the given area are incomplete and include not only zonal soil types but also intrazonal soil types. Such sequences are considered subtypes of the vertical soil zonality.

Mountainous soil province is a part of the mountain region within the given soil-bioclimatic oblast with a specific set of the types of the vertical soil zonality controlled by the solar radiation and temperature factors and by the climatic continentality, and depending on the orographic conditions.

Mountainous soil okrug is a part of the mountainous soil province with a predominance of the given type of the vertical soil zonality or some regular combination of several types of the vertical soil zonality.

Mountainous soil subokrug is a part of the mountainous soil okrug with the given subtype of the vertical soil zonality. It should be noted that the subdivision of mountainous soil provinces into okrugs and subokrugs is introduced into the considered map of the soil-ecological zoning of Russia for the first time. Earlier published small-scale maps of soil zoning subdivided mountain territories only at the level of mountainous soil provinces (Table 1).

Information contents and legend of the map. A characteristic feature of the *Map of the Soil-Ecological Zoning of the Russian Federation* is that this map has been developed on the basis a digitized version of the *Soil Map of the Russian Federation* [26] (corrected in 2007), which made it possible to perform various calculations using the MapInfo (version 10.5) software and a number of other digitized maps. Some results of these calculations were directly introduced into the map and made it more informative.

Thus, we calculated the composition of the soil cover for the lowest taxonomic categories (soil districts and soil okrugs) of the map of soil zoning (on the basis of information in the original soil map). These data were depicted in the form of a fraction, in which the nominator listed the predominant soils (for each district), and the denominator gave information on the predominant textures of soils and parent materials. Aggregated information on the soil covers of delineated okrugs was used to calculate the mean weighted soil quality (bonitet) indices for plain okrugs. The criteria used to calculate soil quality indices included those soil characteristics that are known to correlate with the biological productivity: the humus content (%), the thickness of the humus horizon (cm), the pools of humus (t/ha), the properties of the soil adsorption complex, and the content of physical clay (<0.01 mm, %) particles. These properties were ranked in relative points via their comparison with the properties of a leached medium-deep chernozem of the central Russian forest-steppe province taken as a reference soil with the quality index of 100 points. In the calculation of soil quality indices for separate soils, additional correction coefficients for the soil texture, the degree of erosion, the degree of cultivation, hydromorphism, podzolization, stoniness, gravel content, salinization, and solonetzic properties were introduced [2].

Land use information on administrative districts from the Federal Land Cadaster Survey (information on January 1, 2006 was used) was recalculated for plain soil okrugs; some corrections were introduced to the results of this recalculation on the basis of expert evaluation. This information is displayed on the map in the form of circular diagrams showing the percentages of arable lands, hayfields, rangelands (for northern territories, agricultural lands in general), forests, and other land categories within the soil okrugs. In the centers of these diagrams, the mean weighted soil quality estimates are given.

For the mountains, the patterns of the vertical soil zonality were systematized [39]. The map contains information on the vertical sequences of predominant soils for each mountainous soil okrug and subokrug.

Table 2. Lithogeomorphic features of soil okrugs

Plain territories
Marine plains
flat loamy
flat sandy and loamy
undulating sandy and loamy sandy, including eolian landforms
aerial volcanic sandy and loamy sandy
Alluvial and ancient alluvial plains
undulating loamy and clayey, predominantly loesslike
undulating sandy and clayey
flat sandy and loamy sandy
Delta plains
flat layered sandy–clayey
Outwash plains
flat sandy and loamy
flat and hilly sandy and loamy sandy
undulating sandy and loamy sandy embedded by loams and clays
hilly aerial volcanic sandy and loamy sandy
Lacustrine–alluvial plains
flat and undulating loamy
flat loamy with hilly–ridged footslopes
flat and ridged loesslike loamy
flat and undulating sandy and loamy
flat sandy and loamy sandy
Glaciofluvial–lacustrine plains
flat sandy–clayey
undulating sandy and loamy sandy with local embedding by loams and clays
Moraine plains
hilly with alternation of gravelly moraine loams and sands (terminal moraine plains)
hilly and undulating loamy
undulating loamy and two-layered plains with embedding by hard calcareous rocks
undulating sandy and loamy sandy plains with embedding by loams and clays
hilly sandy and loamy sandy
Moraine plains with covering loams
hilly and undulating with covering loams
undulating with calcareous covering loams
Glacial–marine plains
ridges and hilly loamy and sandy-loamy
Glacial plains with embedding by hard rocks
ridged and strongly undulating moraine plains with covering loams
hilly loamy with solifluction features
ridged and hilly sandy and loamy sandy
Erosional plains
undulating and ridged loesslike loamy
ridged with colluvial loams
hilly and ridged with loesslike colluvial loams
undulating with colluvial sands and loams

Table 2. (Contd.)

Plain territories
Erosional plateaus
ridged with gravelly loams and loesslike loams
Erosional plains with embedding by hard rocks
ridged and strongly undulating with colluvial loams
Abrasion–erosional plains
ridged with colluvial loams
Erosional–denudation plains
ridged and hilly with gravelly colluvial loams
hilly and ridged with volcanic sands and loamy sands
Erosional–denudation plains with residual mounts
ridged and hilly with colluvial gravelly loams
Piedmont plains
inclined undulating and ridged plains of the alluvial–colluvial genesis covered by loams and clays
ridged and hilly–ridged with loams and clays
Intermontane depressions
alluvial–colluvial sandy and loamy
Mountainous territories
Intermontane depressions
glacial and glaciofluvial aggradational
alluvial, lacustrine–alluvial, and colluvial aggradational
Flat-topped mountains
low
high
Low mountains
Middle mountains
High mountains

The soils (letter symbols of soil types) are listed in a sequence from the tops of the mountains to the foothills, and their approximate percent is indicated in four grades. Symbols of soils covering more than 20% of the territory are shown with double underlining; symbols of soils covering 10–20% of the territory are shown with single underlining; symbols of soils occupying 1–10% of the territory are shown without underlining; and symbols of soils occupying less than 1% of the territory are shown in brackets. For the intermontane depressions, symbols of soils occupying (in total) more than 90% of the territory are shown in a decreasing order.

The legend to the map of soil-ecological zoning consists of five major sections. The first section lists all the taxonomic units of the division of plain and mountainous territories (except for soil districts). The names of plain okrugs include information on the predominant soils and soil combinations occupying more than 60% of the territory, as well as information on the soil textures and the character of parent materials. For the mountainous soil okrugs, the types of the vertical soil zonality (generalized vertical soil sequences) are indicated in this section.

The second section of the legend characterizes the lithological and geomorphic features of the separated plain and mountainous soil okrugs (Table 2). It contains the list of the morphogenetic types of the relief shown on the map for the territories differing in the history of their geological development. Plain territories are further differentiated on the basis of data on the textures of parent materials.

The third section of the legend includes the list of the soils shown on the map, and the fourth section provides information on the textures of soils and parent materials shown by letter symbols in the formulae characterizing the composition of soils in the soil districts.

The fifth section is devoted to parameters of the atmospheric and soil regimes for plain and mountainous soil provinces. Along with traditionally used materials from the reference books on the climate of the former Soviet Union and the monograph by D.I. Shashko, new digitized maps of the parameters of air climate were applied for this purpose. These maps contain information on the accumulated daily air temperatures above 10°C, the duration of the period with daily air temperatures above 10°C, the duration of the frostless period, and the annual precipitation [1, 40]; in addition, the depth of penetration of the temperatures above 10°C into the soil, the accumulated daily soil temperatures above 10°C at the depth of 20 cm, the duration of the period with soil temperatures above 10°C at the depth of 20 cm, the accumulated daily soil temperatures below 0°C at the same depth, and the depth of penetration of the temperatures below 0°C into the soil (the depth of soil freezing) are indicated [33]. All these data were recalculated per delineations of the soil-ecological zoning shown on the map and subjected to expert evaluation. Tables 3 and 4 contain mean weighted parameters of the atmospheric and soil cli-

Table 3. Parameters of the atmospheric and soil regimes for plain territories

Soil provinces	Parameters of atmospheric regimes							Parameters of soil regimes					
	mean July t, °C	sum of $t > 10$°C	duration of the periods, days: with $t > 10$°C	duration of the periods, days: frostless	mean January t, °C	annual precipitation, mm	annual moistening factor (Vysotskii–Ivanov)	sum of $t > 10$°C at the depth of 20 cm, degree-days	depth of penetration of $t > 10$°C into the soil, cm	duration of the period with $t > 10$°C at the depth of 20 cm, months	sum of $t < 0$°C at the depth of 20 cm	depth of penetration of $t < 0$°C into the soil, cm	predominant type of the water regime
A_1, Northern isles of the Novaya Zemlya	0.5	0	0	unst	–30.0	175	>1.33	0	0	0	–4930	perm.	fr-aff.
A_2, Southern isles of the Novaya Zemlya and north of the Anzhu Islands	1.0	0	0	unst	–30.0	175	>1.33	0	0	0	–4330	perm.	fr-aff.
A_3, Taimyr	2.0	0	0	unst	–30.0	225	>1.33	0	0	0	–4820	perm.	fr-aff.
B_1, North European	5.8	0	0	<45	–15.7	330	>1.33	<100	29	<1	–960	perm.	fr-aff.
B_2, West Siberian arctic tundra	5.2	0	0	<45	–24.6	250	>1.33	<100	<20	<1	–2510	perm.	fr-aff.
B_3, Central and East Siberian arctic tundra	5.0	0	0	46	–30.8	215	1.0–1.33	0	0	0	–3500	perm.	fr-aff.
B_4, Arctic coastal–Chukotka–Wrangel Island	3.5	0	0	50	–29.0	195	>1.33	0	0	0	–2560	perm.	fr-aff.
C_1, Kola	10.0	370	37	79	–10.0	450	>1.33	610	67	1.6	–320	129	perc.
C_2, Kanin–Pechora	8.8	380	18	67	–16.0	410	>1.33	430	45	1.1	–670	218	fr-aff.
C_3, West Siberian tundra	10.2	330	37	64	–24.9	350	>1.33	470	47	1.2	–990	254	fr-aff.
C_4, Central Siberian tundra	11.5	<200	25	60	–32.1	285	>1.33	<400	<20	<1	–2890	perm.	fr-aff.
C_5, East Siberian tundra	9.1	<200	25	52	–31.5	180	1.0–1.33	<400	<20	<1	–2690	perm.	fr-aff.
C_6, Chukotka–Anadyr	9.7	390	35	65	–24.8	405	>1.33	<400	<20	<1	–2160	perm.	fr-aff.
C_7, Anadyr–Penzhina	13.3	620	49	66	–24.1	390	>1.33	540	37	1.4	–1710	perm.	fr-aff.
D_1, Kola–Karelian	14.0	930	72	86	–12.0	475	>1.33	1000	127	2.5	–280	109	perc.
D_2, Onega–Timan	14.3	1050	78	85	–14.0	480	>1.33	1060	146	2.5	–210	94	perc.
D_3, Timan–Pechora	14.5	960	74	77	–16.0	505	>1.33	980	140	2.3	–300	123	perc.
D_4, West Siberian northern taiga	15.8	1020	79	88	–24.0	480	>1.33	980	119	2.3	–480	168	fr-aff.
E_1, Karelian	15.0	1440	106	110	–10.0	580	>1.33	1600	228	3.6	–120	58	perc.

Table 3. (Contd.)

Soil provinces	Parameters of atmospheric regimes							Parameters of soil regimes					
	mean July t, °C	sum of $t > 10$°C	duration of the periods, days		mean January t, °C	annual precipitation, mm	annual moistening factor (Vysotskii–Ivanov)	sum of $t > 10$°C at the depth of 20 cm, degree-days	depth of penetration of $t > 10$°C into the soil, cm	duration of the period with $t > 10$°C at the depth of 20 cm, months	sum of $t < 0$°C at the depth of 20 cm	depth of penetration of $t < 0$°C into the soil, cm	predominant type of the water regime
			with $t > 10$°C	frostless									
E_2, Onega–Dvina	16.0	1440	101	100	–14.0	540	>1.33	1480	218	3.4	–110	56	perc.
E_3, Kama–Vychegda	16.5	1460	104	93	–17.0	570	>1.33	1460	219	3.5	–160	66	perc.
E_4, West Siberian middle taiga	17.1	1410	102	97	–21.2	495	1.0–1.33	1390	171	3.2	–280	107	perc.
F_1, Kaliningrad	17.0	2200	150	172	–6.0	660	>1.33	2580	>320	5.5	–25	28	perc.
F_2, Baltic	17.0	1790	126	132	–8.0	600	>1.33	1940	>320	4.5	–35	33	perc.
F_3, Central Russian southern taiga	17.5	1880	124	126	–13.0	555	1.0–1.33	2010	>320	4.4	–70	41	perc.
F_4, Vyatka–Kama	17.5	1730	116	109	–17.5	525	1.0–1.33	1830	234	4.0	–160	56	perc.
F_5, West Siberian southern taiga	17.5	1630	111	100	–19.5	460	1.0–1.33	1680	188	3.5	–270	103	perc.
F_6, Angara	17.8	1400	93	85	–24.1	375	0.77–1.0	1420	125	3.4	–760	194	perc.
G_1, Northern Lena	13.9	760	56	64	–38.5	280	0.77–1.0	470	31	1.3	–1710	perm.	fr-aff.
G_2, Indigirka–Kolyma	13.6	700	49	59	–37.4	190	0.77–1.0	<400	<20	<1	–2450	perm.	fr-aff.
H_1, Central Siberian middle taiga	17.1	1190	81	72	–28.6	375	1.0–1.33	1160	97	2.6	–900	247	fr-aff.
H_2, Central Yakutian	17.5	1260	84	77	–38.5	265	0.55–1.0	1080	64	2.5	–1570	perm.	fr-aff.
I_1, West Kamchatka	12.7	520	57	86	–15.5	585	>1.33	1060	93	2.7	–340	86	perc.
I_2, Central Kamchatka	15.5	510	57	70	–19.2	485	0.77–1.0	1050	83	2.7	–230	86	perc.
I_3, East Kamchatka	13.0	660	57	77	–12.2	615	>1.33	1010	82	2.5	–420	99	perc.
J_1, Magadan	12.1	780	66	83	–23.6	430	>1.33	700	55	1.7	–1650	300	perc.
J_2, Amur–Sakhalin	16.4	1370	99	109	–22.4	560	1.33	1660	164	3.6	–610	176	perc.
J_3, Upper Zeya	18.3	1490	101	81	–27.9	570	1.0–1.33	1600	139	3.6	–950	289	perc.
K_1, Central Russian broadleaved forest	18.0	2200	135	137	–10.0	500	1.0	2250	>320	4.5	–160	59	per. perc.

Table 3. (Contd.)

Soil provinces	Parameters of atmospheric regimes							Parameters of soil regimes					
	mean July t, °C	sum of $t > 10$°C	duration of the periods, days		mean January t, °C	annual precipitation, mm	annual moistening factor (Vysotskii–Ivanov)	sum of $t > 10$°C at the depth of 20 cm, degree-days	depth of penetration of $t > 10$°C into	duration of the period with $t > 10$°C at the depth of 20 cm, months	sum of $t < 0$°C at the depth of 20 cm	depth of penetration of $t < 0$°C into the soil, cm	predominant type of the water regime
			with $t > 10$°C	frostless									
K_2, Kama	17.9	1930	122	117	–14.5	490	1.0–1.20	1950	240	4.2	–210	79	per. perc.
K_3, West Siberian deciduous forest	17.7	1830	119	110	–18.3	415	1.0	1800	200	3.8	–370	119	perc.
K_4, Cis-Altai	17.9	1630	110	102	–19.2	455	0.77–1.0	1630	171	3.5	–310	104	perc.
K_5, Central Siberial deciduous forest	18.0	1500	105	97	–20.6	410	0.77–1.0	1400	115	3.5	–660	136	perc.
L_1, Central Russian forest-steppe	19.3	2350	145	143	–10.4	480	0.77–1.0	2480	>320	4.7	–190	59	per. perc.
L_2, Trans-Volga forest-steppe	18.2	2240	135	127	–14.0	435	0.60–1.0	2310	301	4.5	–230	86	per. perc.
L_3, West Siberian forest-steppe	18.0	1930	126	112	–18.0	355	0.70–1.0	1830	195	4.3	–500	132	per. perc.
L_4, Cis-Altai forest-steppe	17.7	1920	123	115	–17.3	440	0.77–1.0	1950	197	4.4	–520	137	per. perc.
L_5, Cis-Sayany	18.3	1550	104	92	–19.2	425	0.77–1.0	1620	148	3.6	–590	154	per. perc.
L_5, Irkutsk--Cheremkhovo	17.7	1400	94	81	–23.5	360	0.55–0.77	1530	133	3.4	–840	198	per. perc.
M_1, Cis-Caucasian	22.8	3300	185	184	–3.9	560	0.55–0.70	3740	>320	6.5	–30	17	nonperc.
M_2, Southern Russian	20.5	2820	162	160	–9.0	420	0.44–0.77	3050	>320	5.6	–190	64	nonperc.

Table 3. (Contd.)

Soil provinces	Parameters of atmospheric regimes							Parameters of soil regimes					
	mean July t, °C	sum of $t > 10°C$	duration of the periods, days		mean January t, °C	annual precipitation, mm	annual moistening factor (Vysotskii–Ivanov)	sum of $t > 10°C$ at the depth of 20 cm, degree-days	depth of penetration of $t > 10°C$ into the soil, cm	duration of the period with $t > 10°C$ at the depth of 20 cm, months	sum of $t < 0°C$ at the depth of 20 cm	depth of penetration of $t < 0°C$ into the soil, cm	predominant type of the water regime
			with $t > 10°C$	frostless									
M_3, Trans-Volga steppe	21.0	2600	149	141	–14.0	375	0.44–0.77	2660	>320	4.5	–270	99	nonperc.
M_4, Trans-Ural	20.7	2150	134	113	–17.5	350	0.44–0.77	2230	254	4.6	–460	122	nonperc.
M_5, West Siberian steppe	18.8	2080	127	114	–19.4	315	0.44–0.77	1980	209	4.5	–710	152	nonperc.
M_6, Cis-Altai steppe	19.4	2130	129	124	–18.1	370	0.44–0.77	2240	226	4.5	–740	167	nonperc.
M_7, Minusinsk	18.7	1440	105	93	–19.7	455	0.44–0.75	1960	157	4.3	–760	190	nonperc.
M_8, Trans-Baikal steppe	18.9	1630	98	87	–27.4	345	0.50–0.60	1780	119	3.8	–1650	315	seasonal fr.; perc.
N_1, East Cis-Caucasian	23.2	3340	184	187	–4.4	420	0.33–0.55	3970	>320	6.5	–45	24	nonperc. dry
N_2, Don	23.4	3130	172	172	–7.9	400	0.33–0.44	3630	>320	6.2	–170	62	nonperc. dry
N_3, Syrt–Trans-Volga	23.1	2860	157	149	–11.8	315	0.33–0.44	2940	>320	4.8	–210	100	nonperc. dry
N_4, Cis-Ural	21.3	2470	145	127	–17.0	305	0.33–0.44	2700	>320	5.1	–400	140	nonperc. dry
N_5, Cis-Altai dry steppe	20.1	2300	136	127	–18.4	270	0.33–0.44	2390	265	4.6	–750	187	nonperc. dry
N_6, Tyva	19.0	1340	92	68	–32.2	285	0.33–0.55	1780	115	3.7	–750	209	nonperc.
N_7, Southern Trans-Baikal	19.0	1710	108	94	–25.7	300	0.45–0.55	1880	130	3.8	–1530	320	seasonal fr.; perc.
O_1, Zeya–Bureya	20.4	1920	113	105	–27.8	505	0.80–1.20	1900	182	4.3	–860	243	perc.
O_2, Ussuri–Khanka	21.0	2120	122	136	–21.2	640	1.0–1.33	2300	>320	4.6	–660	138	perc.
P_1, Caspian	25.0	3390	180	181	–7.1	285	0.12–0.33	4010	>320	6.5	–160	56	nonperc.; strongly dry

Here and in Table 4, the following abbreviations are used: unst.—unstable, perm.—permafrost; fr-aff.—frost-affected, seasonal fr.—deep seasonal freezing; perc.—percolative, per. perc.—periodically percolative, nonperc.—nonpercolative (water regimes).

Table 4. Parameters of the atmospheric and soil regimes for mountainous territories

Mountainous soil provinces	Parameters of atmospheric regimes				Parameters of soil regimes				
	sum of daily $t > 10°C$, degree-days	duration of the periods, days: with $t > 10°C$	duration of the periods, days: frostless	annual precipitation, mm	sum of $t > 10°C$ at the depth of 20 cm, degree-days	depth of penetration of $t > 10°C$ into the soil, cm	duration of the period with $t > 10°C$ at the depth of 20 cm;	sum of $t < 0°C$ at the depth of 20 cm, degree-days	depth of penetration of $t < 0°C$ into the soil, cm
a1, Arctic islands	0	0	unst.	175–450	0	0	0	<–5000…–500	perm.
a2, Polar Urals	0–500	0–55	<45–67	325–750	0–400	0–20	0–1	–500…–100	120–200
a3, Byrranga	0	0–25	<45	225–375	0	0	0	–4500…–3000	perm.
a4, East Siberian	0–700	15–55	52–75	125–275	0	0	0	–3000…–1000	perm.
a5, Chukotka	0–700	0–65	<45–75	175–700	0	0	0	–3000…–1500	perm.
a6, Koryak–Taigonos	0–900	25–75	52–75	275–750	0–1200	0–60	0–3	–2500…–500	perm.
b1, Khibiny	700–900	45–65	67–82	450–550	400–1200	60–120	1–3	–1000…–100	40–140
b2, Northern Urals;	0–1300	0–95	<45–82	550–850	400–1600	20–200	1–4	–1000…–100	100–180
b3, Middle Urals	700–1700	75–125	52–112	450–850	800–2000	120–280	2–4	–1000–0	20–120
c1, Anabar–Putorana	0–1300	25–75	52–82	225–900	0–1200	0–120	0–3	–3500…–300	perm.
c2, Verkhoyansk	0–1300	25–95	52–97	125–1000	0–1200	0–80	0–3	–4000…–1000	perm.
c3, Kolyma	0–1100	15–75	52–75	125–1000	0–1200	0–60	0–3	–3500…–300	perm.
c4, Yenisei	900–1500	65–105	52–97	325–550	0–1600	0–160	0–4	–2000…–50	100–perm.
c5, Cis-Baikal	300–1500	45–105	52–97	275–1000	0–2400	0–280	0–5	–3000…–100	perm.
c6, Aldan	300–1500	45–105	52–75	225–1000	400–2000	20–200	1–4	–3000…–500	perm.
c7, East Sayan	1100–1700	45–105	52–97	325–1200	800–2400	40–280	2–5	–2000…–100	200–perm.
c8, Lena–Angara	1100–1500	55–95	52–97	275–550	400–2000	20–200	1–5	–2000…–300	200–perm.
c9, Trans-Baikal	700–2100	0–125	52–97	225–1200	400–2800	40–240	2–5	–2500…–500	perm.
d1, Kamchatka	0–900	25–65	52–127	375–2000	400–1600	20–120	1–4	–1500–0	20–200
d2, Okhotsk	0–1000	45–80	52–97	275–1200	0–1600	20–160	0–4	–2500…–500	perm.
d3, Sikhote-Alin–Sakhalin	700–2000	75–115	97–142	550–1200	800–2400	80–>320	2–5	–725– 0	20–160
d4, Bureya	600–2100	55–125	52–142	450–1200	800–2400	40–280	2–5	–2500…–100	160–perm.
e1, North Caucasian	0–>4000	<120–215	82–187	450–3200	800–4400	80–>320	2–8	–300–0	0–100
f1, Southern Urals	1500–2700	85–145	82–142	325–750	1200–2800	120–320	3–5	–500…–50	20–120
f2, Salair–Kuznetsk–Sayany	0–2100	45–130	52–112	375–1200	1200–2400	60–240	3–5	–1500–0	20– 270
f3, Altai	0–2300	45–130	52–112	275–2000	800–2400	60–240	2–5	–1500…–100	40–perm.
f4, Southern Sayany	0–1700	45–125	52–97	175–1000	1200–2000	60–200	3–5	–1500…–500	180–280
f5, Southern Altai	0–1300	45–85	52–75	175–2000	0–2400	0–200	0–4	–2000…–500	200–perm.
g1, Southern Sikhote-Alin	900–2500	0–155	97–187	550–1200	1600–3200	200–>320	3–6	–1000…–50	90–180
h1, East Caucasian	0–3700	<120–195	82–>200	450–2400	3200–>4400	320–>320	6–8	–100–0	0–40
i1, Western Trans-Caucasian	3100–>4000	<120–215	135–>200	1200–1700	3200–>4400	320–>320	6–>8	–50–0	0–10

mate for the distinguished plain and mountainous soil provinces.

Design of the map. Various illustrative means were applied in the design of the map. Background color as the most expressive means of cartographic images was used to show soil zones and subzones; plain soil provinces within them were depicted by color shades. Mountainous soil provinces were shown by oblique bands consisting of the main color and white spaces. The types of relief and parent materials within soil okrugs on the plains were shown by different kinds of hatching. The direction of the hatching clearly separates elevated plains (>200 m a.s.l.) from lowlands (<200 m a.s.l.). In the okrugs with a shallow embedding by hard bedrocks, special symbols are used to indicate the location of such areas. These symbols differentiate between the following groups of hard bedrocks: igneous and metamorphic acid and mafic rocks, slates, claystone, sandstone, chert, and limestone and other calcareous rocks. The nature of bedrock in the mountains is not shown on the map.

In general, the new *Map of the Soil-Ecological Zoning of the Russian Federation* published in 2013 and the legend to this map contain versatile information on the composition and patterns of soil covers in Russia and their regional specificity, as well as information on the character of vegetation, relief, parent materials, atmospheric and soil climatic parameters, and current land use (and, hence, the degree of anthropogenic load on the environment). This map systematizes information on the diversity of soil covers at different levels of their spatial arrangement in close relationships with the ecological (environmental) factors controlling the soil cover differentiation. The map clearly displays the complexity of the soil cover in Russia and provides an explanation to this complexity on the basis of fundamental regularities of the genesis and geography of soils. In this context, it represents a significant contribution to the development of the theoretical basis of pedology and the geography of soils.

CONCLUSIONS

Soil-geographical and soil-ecological zonings can be considered the scientific basis for the rational and ecologically balanced nature management, the development of agriculture and forestry, differentiated land use systems, soil reclamation and soil conservation actions, and long-term forecasts of the state of land resources in the country with due account for the zonal and regional diversities of soil covers. Soil-geographical zoning is used as the cartographic basis for the development of other kinds of applied zoning of the soil cover, such as the agricultural and natural-agricultural zonings, soil-reclamation zoning, etc. All of them are needed for the sound management of soil resources and soil conservation purposes.

The new *Map of the Soil-Ecological Zonings of the Russian Federation* [25] is included in the cartographic block of the Soil-Geographical Database of Russia [6, 41] and is available on the website of this information system (http://www.soil-db.ru/). The publication of the Unified State Register of Soil Resources of Russia (including its digital version on a CD) [19] can be considered a step forward in the development of the Soil-Geographical Database of Russia. This document has been approved by the Scientific Council of the Ministry of Agriculture of the Russian Federation. It contains the descriptions of particular soils and generalized descriptions of soil resources for the subjects of the Russian Federation, a computer-based model for the description of available soil data, and the materials of the soil-ecological zoning of Russia. In particular, the principles of the zoning and its taxonomic system are described in this document and are used for characterization of the soil cover of the country.

In general, the analysis of the current state of soil-ecological zoning in Russia attests to the active development of this branch of soil science. The outstanding contribution of G.V. Dobrovol'skii to this important work should be acknowledged with sincere gratitude.

ACKNOWLEDGMENTS

This study was supported by the Russian Foundation for Basic Research, project nos. 13-04-07011d and 15-04-03564a.

REFERENCES

1. *Agricultural Atlas of the Soviet Union* (Department of Geodesy and Cartography, Moscow, 1960) [in Russian].
2. L. B. Vostokova, Candidate's Dissertation in Biology (Moscow, 1972).
3. *Geography of Soils and Soil Zoning of the Central Economic Region of the Soviet Union*, Ed. by G. V. Dobrovolsky and I. S. Urusevskaya (Moscow State University, Moscow, 1972) [in Russian].
4. I. P. Gerasimov, "Soil-climatic facies of the plains of the Soviet Union and adjacent countries," Tr. Pochv. Inst. im V.V. Dokuchaeva, **8** (5), (1933).
5. I. P. Gerasimov, "Relief and surface deposits in the European part of the Soviet Union," in *Soils of the Soviet Union* (Academy of Sciences of the Soviet Union, Moscow, 1939), Vol. 1, pp. 27–92.
6. O. M. Golozubov, V. A. Rozhkov, I. O. Alyabina, A. V. Ivanov, V. M. Kolesnikova, and S. A. Shoba, "Technologies and standards in the information systems of the soil-geographic database of Russia," Eurasian Soil Sci. **48** (1), 1–10 (2015). doi: 10.7868/S0032180X15010062
7. G. V. Dobrovolsky, "Brief description of the history and modern status of the problem of agrosoil zoning," in *From Historical Experience of Agriculture in the Soviet Union* (Nauka, Moscow, 1969), pp. 190–206.
8. G. V. Dobrovolsky, P. A. Letunov, and N. N. Rozov, "Detailed soil-geographic zoning of the Soviet Union," in *Natural and Agricultural Zoning of the Soviet Union* (Moscow State University, Moscow, 1974), pp. 37–48.
9. G. V. Dobrovolsky and I. S. Urusevskaya, *Geography of Soils* (Moscow State University, Moscow, 2006) [in Russian].

10. G. V. Dobrovolsky and I. S. Urusevskaya, "Geomorphologic principles of the separation of plain soil okrugs," in *Geomorphologic Mapping on Survey Scales* (Moscow State University, Moscow, 1975), pp. 253–258.
11. G. V. Dobrovolsky and I. S. Urusevskaya, "Soil-geographical zoning," in *Soil-Geological Conditions of the Nonchernozemic Region* (Moscow State University, Moscow, 1984), pp. 387–464.
12. G. V. Dobrovolsky and I. S. Urusevskaya, "Soil-geographical zoning as the scientific basis for rational use and protection of land resources," Biol. Nauki, No. 4, 93–106 (1988).
13. G. V. Dobrovolsky and I. S. Urusevskaya, "Natural-economic conditions and soil zoning of the nonchernozemic area of Russia," in *Problems of Rational Use of Soils of the Nonchernozemic Zone* (Moscow State University, Moscow, 1978), pp. 4–41.
14. G. V. Dobrovolsky, I. S. Urusevskaya, and I. O. Alyabina, "Map of soil-geographical zoning, Scale 1 : 15000000," in *National Soil Atlas of the Russian Federation*, Ed. by S. A. Shoba (Astrel', Moscow, 2011), pp. 198–201.
15. G. V. Dobrovolsky, I. S. Urusevskaya, and I. O. Alyabina, "Map of soil-geographical zoning, scale 1 : 15000000," in *National Atlas of Russia*, Vol. 2: *Nature and Ecology* (Roskartografiya, Moscow, 2007), pp. 304–307.
16. G. V. Dobrovolsky, I. S. Urusevskaya, and N. N. Rozov, *Map of Soil-Geographical Zoning of the Soviet Union, Scale 1 : 8000000* (Department of Geodesy and Cartography, Moscow, 1983) [in Russian].
17. V. V. Dokuchaev, *On the Organization of the Departments of Soil Science and the of Microorganisms (in particular, Bacteriology) at Russian Universities* (Tipografiya E. Evdokimova, St. Petersburg, 1895) [in Russian].
18. V. V. Dokuchaev, *Research Works*, 1951, Vol. 6.
19. *Unified Register of Soil Resources. Version 1.0*, Ed. by A. L. Ivanov and S. A. Shoba (Dokuchaev Soil Science Institute, Moscow, 2014) [in Russian].
20. *Natural and Historical Zoning of the Soviet Union* (Academy of Sciences of the Soviet Union, Moscow, 1947) [in Russian].
21. E. N. Ivanova, P. A. Letunov, N. N. Rozov, V. M. Fridland, and S. A. Shuvalov, "A new scheme of soil-geographical zoning of the Soviet Union," in *The Reports of Soviet Soil Scientists to the VII International Soil Science Congress in the United States* (Academy of Sciences of the Soviet Union, Moscow, 1960), pp. 307–311.
22. E. N. Ivanova, P. A. Letunov, N. N. Rozov, V. M. Fridland, and S. A. Shuvalov, "Soil-geographical zoning of the Soviet Union," Pochvovedenie, No. 10, 1–12 (1958).
23. *Map of Soil-Geographical Zoning of the Nonchernozemic Zone of the Russian Federation, Scale 1 : 1500000*, Ed. by G. V. Dobrovolsky (Department of Geodesy and Cartography, Moscow, 1984) [in Russian].
24. *Map of Soil-Ecological Zoning of the East European Plain, Scale 1 : 2500000*, Ed. by G. V. Dobrovolsky and I. S. Urusevskaya (EKOR, Moscow, 1997) [in Russian].
25. *Map of Soil-Ecological Zoning of the Russian Federation, Scale 1 : 2500000*, Ed. by G. V. Dobrovolsky and I. S. Urusevskaya (Talka Plus, Moscow, 2013) [in Russian].
26. *Soil Map of the Russian Federation, Scale 1 : 2500000*, Ed. by V. M. Fridland (Department of Geodesy and Cartography, Moscow, 1988) [in Russian].
27. *Soil-Geographical Zoning of the Soviet Union (Related to Agricultural Use)* (Academy of Sciences of the Soviet Union, Moscow, 1962) [in Russian].
28. L. I. Prasolov, *Soil Regions of European Russia* (Petrograd, 1922) [in Russian].
29. L. I. Prasolov, "Genetic types of soils and soil areas in the European part of the Soviet Union," in *Soils of the Soviet Union* (Academy of Sciences of the Soviet Union, Moscow, 1939, Vol. 1, 9–26 [in Russian].
30. *Natural and Agricultural Zoning of Land Resources of the Soviet Union* (Kolos, Moscow, 1975) [in Russian].
31. *Natural and Agricultural Zoning of Land Resources of the Soviet Union: A Map on a Scale 1 : 8000000* (Department of Geodesy and Cartography, Moscow, 1984) [in Russian].
32. *Natural and Agricultural Zoning and Use of Land Resources in the Soviet Union*, Ed. by A. N. Kashtanov (Kolos, Moscow, 1983) [in Russian].
33. O. V. Reshotkin, I. O. Alyabina, O. I. Khudyakov, and D. A. Gilichinskii, "Sums of temperatures above 10°C in soil at the depth of 20 cm, scale 1 : 60000000; Duration of the period with temperatures above 10°C in soil at the depth of 20 cm, scale 1 : 60000000; Sums of temperatures below 0°C in soil at the depth of 20 cm, scale 1 : 60000000; Depth of penetration of temperatures above 10°C into the soil, scale 1 : 60000000; Depth of penetration of temperature 0°C into the soil, scale 1 : 60000000," in *National Soil Atlas of the Russian Federation*, Ed. by S. A. Shoba (Astrel', Moscow, 2011), pp. 40–42.
34. N. N. Rozov, S. I. Dolgov, I. G. Vazhenin, G. V. Dobrovolsky, and P. A. Letunov, "Soil-geographical and land zoning of the Soviet Union," Vestn. S-kh. Nauki, No. 3, 55–72 (1966).
35. N. N. Rozov, P. A. Letunov, and G. V. Dobrovolsky, "General map of soil zoning of the Soviet Union," in *Natural and Agricultural Zoning of the Soviet Union* (Moscow State University, Moscow, 1969), pp. 96–99.
36. N. N. Rozov, E. N. Rudneva, A. G. Bondarev, D. S. Bulgakov, V. N. Dimo, N. G. Minashina, and S. A. Shul'ga, "Complex of soil-agromeliorative zoning of arable lands of the Soviet Union," Pochvovedenie, No. 1, 79–93 (1989).
37. A. F. Ursu, *Soil-Ecological Microzoning of Moldavia* (Shtiintsa, Chisinau, 1980) [in Russian].
38. I. S. Urusevskaya, "Use of geomorphological maps for soil-geographical zoning," in *Application of Geomorphologic Cartography in the National Economy* (Moscow State University, Moscow, 1987), pp. 99–105.
39. I. S. Urusevskaya, "Types of the vertical soil zonality and the soil-geographic zoning of mountain systems in Russia," Eurasian Soil Sci. **40** (11), 1145–1157 (2007).
40. *Physical-Geographical Atlas of the World* (Department of Geodesy and Cartography, Moscow, 1964) [in Russian].
41. S. A. Shoba, I. O. Alyabina, V. M. Kolesnikova, E. N. Molchanov, V. A. Rozhkov, V. S. Stolbovoi, I. S. Urusevskaya, B. V. Sheremet, and D. E. Konyushkov, *Soil Resources of Russia. Soil-Geographical Database* (GEOS, Moscow, 2010) [in Russian].
42. G. V. Dobrovolsky, N. N. Rozov, M. N. Stroganova, and S. Ya. Trofimov, "Soil-ecological regions," in *Resources and Environment. World Atlas*, Moscow, 1998), pp. 100–101.

Translated by D. Konyushkov