COMPILATION OF SOIL MAP FOR THE AMUR RIVER BASIN: THE MAIN PARAMETERS

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INTRODUCTION

The accepted conception of creation of GIS-support for ecological condition research in the Amur River basin decrees that geo-information space of the geosystem should consist of three main information blocks [1]. These are National Geographical information block, Social Economic information block, and Management information block. Unified digital coverage "Soils" for the basin is an immediate constituent of the first block. It is important to note that this coverage is to fulfill several important functions in the information system. First, it supplies information about the patterns of soil cover distribution in the basin. Second, it is a verified source for compilation of a soil map for the territory of the whole basin. Third, it is a component (along with relief, vegetation, and geology) for compilation of a landscape map of the basin. In turn, the map is natural basis for planning and management of the territory's steady development. The digital coverage "Soils" has been made on Arc/Info, ArcView platforms at the detailed scale of 1:2,500,000 of common projection, according to the main rules [2]. The database (attributive table) includes separate fields with information about dominant soils, associated soils, parent material, and relief.

MATERIALS AND METHODS

The digital coverage "Dominant Soils" for the Amur River basin is based on the soil maps of the Russian Soviet Federative Socialist Republic, the Mongolian People's Republic, and the People's Republic of China. The maps were compiled over the years by members of different soil science schools and at different scales: The Soil Map of the Russian Soviet Federative Socialist Republic, Scale 1:2.5 M [3]; The Soil Map of the Mongolian People's Republic, Scale 1:2.5 M. [4]; the digital coverage "Soils of the Northeastern China", compiled in collaboration with soil scientists from China and in accord with soil nomenclature, adopted in China. Additionally, a number of soil maps at smaller scales were used [5, 6, 7, 8]. When compiling the digital coverage "Dominant Soils", the principle of preserving the source map data in the fullest was upheld [9]. For the Russian and Mongolian parts of the Amur River basin the source map data on soil mapping polygons was coded and added to the database. As for the digital coverage "Soils of the Northeastern China", its data on soil mapping polygons underwent multistage generalization with regard to the specific character of the region. Then the data was coded and added to the database. When compiling the legend of the digital coverage "Dominant Soils", the compilers took into consideration the difference between

national soil classifications and nomenclatures of the source soil maps in Russia, Mongolia, and China.

The legend of the Soil Map of the RSFSR [3] includes soil names of two nomenclatures – the one used when the map was compiled [10] and the previous one [11]. The legend also has a number of newly adopted soil names which were either retained in later soil classifications in Russia [12, 13] or given at least partial correspondences. In order to avoid terminological difficulties we use soil names of the Soil Map of the RSFSR for "English Name" section of the digital coverage legend. The soil names for the Mongolian part of the Amur River basin generally coincide with the soil names of the Soil Map of the RSFSR. The legend of the Soil Map of the MPR also has a few outdated soil names that were omitted in later soil classifications [12, 13]. We found it necessary to fully retain the soil nomenclature of the source soil map in order to avoid terminological discrepancy.

The soil names for the Chinese part of the Amur River basin are diverse. Many soil names, adopted in China, correspond to Russian ones, and such soil names are preserved in our legend (e. g. Chernozems, Chestnuts, Grey forests, etc.). Some soils of the Chinese soil classification [14] do not correspond to Russian ones, but they have possible correlates among Russian soils. In the legend of the digital coverage "Dominant Soils" for the Amur River basin names of such soil are substituted by the ones, adopted for their Russian correlates. The Chinese soil names are given in parenthesis (e. g. Brownzems (Brown earths)). In a few cases the soil names, used in the legend of the source soil map, were unofficial traditional names. Such soil names were correlated to the soil names of the Chinese soil classification [14], and their possible (partial) correlates were found in the Russian soil classification. In the legend of the digital coverage "Dominant Soils" for the Amur River basin names of such soil are substituted by the ones, adopted for their correlates in Russia. The official and the traditional Chinese soil names are given in parenthesis (e. g. Chernozem-likes (Black earth or chetu).

Soils of mountainous regions of the Amur River basin that belong to the same soil classification taxon as soils of plains are not listed in "Soils of Mountainous Regions" section of the source map legends and the digital coverage legend. This section includes soils that are not found in piedmonts and plains of the Amur River basin.

The "English Name" section of our legend includes soil names, adopted for the Russian soil nomenclature in English [15, 16, 17].

The soil nomenclature of the legend of the digital coverage "Dominant Soils" for the Amur River basin is correlated to the soil nomenclature of the Revised legend of the FAO-UNESCO Soil Map of the World [18]. The correlation is based on literary data [19, 20, 21, 22, 23], electronic resource data [24], and "Dominant Soils of the World" CD data [25]. The soil nomenclature of the present legend is also correlated to the soil nomenclature of the World Reference Base for Soil Resources (WRB). The correlation is based on literary data [26] and electronic resource data [24].

RESULTS AND DISCUSSION

The legend of the digital coverage "Dominant Soils" for the Amur River basin reflects the soil nomenclatures, adopted in Russia, Mongolia, and China. Beside this, the soil nomenclature of the legend is correlated to the soil nomenclatures of FAO-UNESCO and the World Reference Base for Soil Resources (WRB).

Diverse soils of the Amur River basin are grouped in the legend in full accord with landscape and geographical zoning principle, upheld in the source soil maps in Russia [27], Mongolia, and China: soils of tundra, taiga and coniferous-broadleaved forests; soils of broad-leaved forests and wooded steppe; soils of steppe; soils of dry steppe. Hydromorphic, saline, alluvial, anthropogenic, and mountainous soils also make separate groups. Due to the paper length concerns only a part of the legend that includes zonal soil groups is given below (Table).

The complex and specific soil cover of the Amur River basin is due to the combination of contrasting natural conditions (climate, relief, vegetation, parent material) within the territory. According to soil and geographical zoning [28] the territory of the Amur River basin lies within two soil-bioclimatic belts: the boreal (temperate cold) belt and the subboreal (temperate warm) belt. Diverse soil cover of the Amur River basin reflects the specificity of the territory's bioclimatic conditions (Map 1, 2). When describing the fragments, we use soil names from "English name" section of the legend in order to fully preserve their informative value. In our opinion, these names reflect the complex character and diverse nature of the regional soil cover better than the more generalized soil names of FAO-UNESCO and WRB nomenclatures [20]. The target map scale and the character of geographical distribution of soils in the Amur River basin allowed us to preserve soil mapping polygons of the source soil maps [3, 4] at taxonomic levels of "soil type", "sybtype", "genus", and "kind". The soil names in "English Name" section reflect this low-level taxonomic division. The nomenclatures of FAO-UNESCO and WRB deal with units of higher taxonomic levels – reference soil groups and soil subunits, and these can't fully reflect diversity and specific distribution of soils in the region under study. If necessary, the legend allows easy correlation between the "English Name" section nomenclature and those of FAO-UNESCO and WRB.

The Western part of the Amur River basin (Map 1) is a part of Mongol-Manjur mountain-and-plain area of Euro-Asian subboreal steppe region [29]. This part of the basin includes bordering areas of Russia, China, and Mongolia. It is characterized by soil cover of highly complex structure and by specific soil formation conditions. Absolute heights of ridges are 1000-1200m, and those of intermontane plains bordering Lake Dalainor are 550-750m. The climate is maximum continental with highly contrasting amplitudes of temperature fluctuations. Scattered areas of grey forest soils are found in the South of Zabaikalie (Russia) within the transitional zone on taiga and steppe border. In China the transitional zone has a continuous area of dark-grey forest soils that covers the Northwestern offshoots of the Great Khingan Ridge. In Mongolia the forest-steppe zone with characteristic areas of grey forest soils is absent due to mountainous relief with mountains and basins alternating within small areas. In the Western part of the Amur River basin the steppe zone forms a continuous band

that covers the Western offshoots of the Great Khingan Ridge in China, the offshoots of the Borshchovochny, Kukulbeisky, and Argunsky Ridges in Zabaikalie (Russia), and the Eastern offshoots of the Hentei in Mongolia. Chernozems of Eastern Siberian group are dominant in the soil cover of the area. These are washed chernozems, either noncalcareous or meal-calcareous. The profile of these soils is often immature, shallow, and stony. The soils undergo long periods of deep freeze. Light, luvic, and typical chernozems are found in China, meal-calcareous and noncalcareous chernozems are found in the South of Zabaikalie (Russia), and meal-calcareous contactly-meadowish chernozems are found in Mongolia.

The Zeisko-Bureinskay Plain (Map 2) has areas of specific meadow-chernozem-like soils that form a separate soil type called "the Amur prairie meadow-chernozem-like soils". They are widely used in agriculture. Their analogues – chernozem-like soils – are found in the Chinese part of the Amur River basin. They border areas of meadow soils and form band-like areas on more elevated elements of relief. Their Chinese name is black earths, and their traditional Chinese name is chetu. These soils are widely used in agriculture.

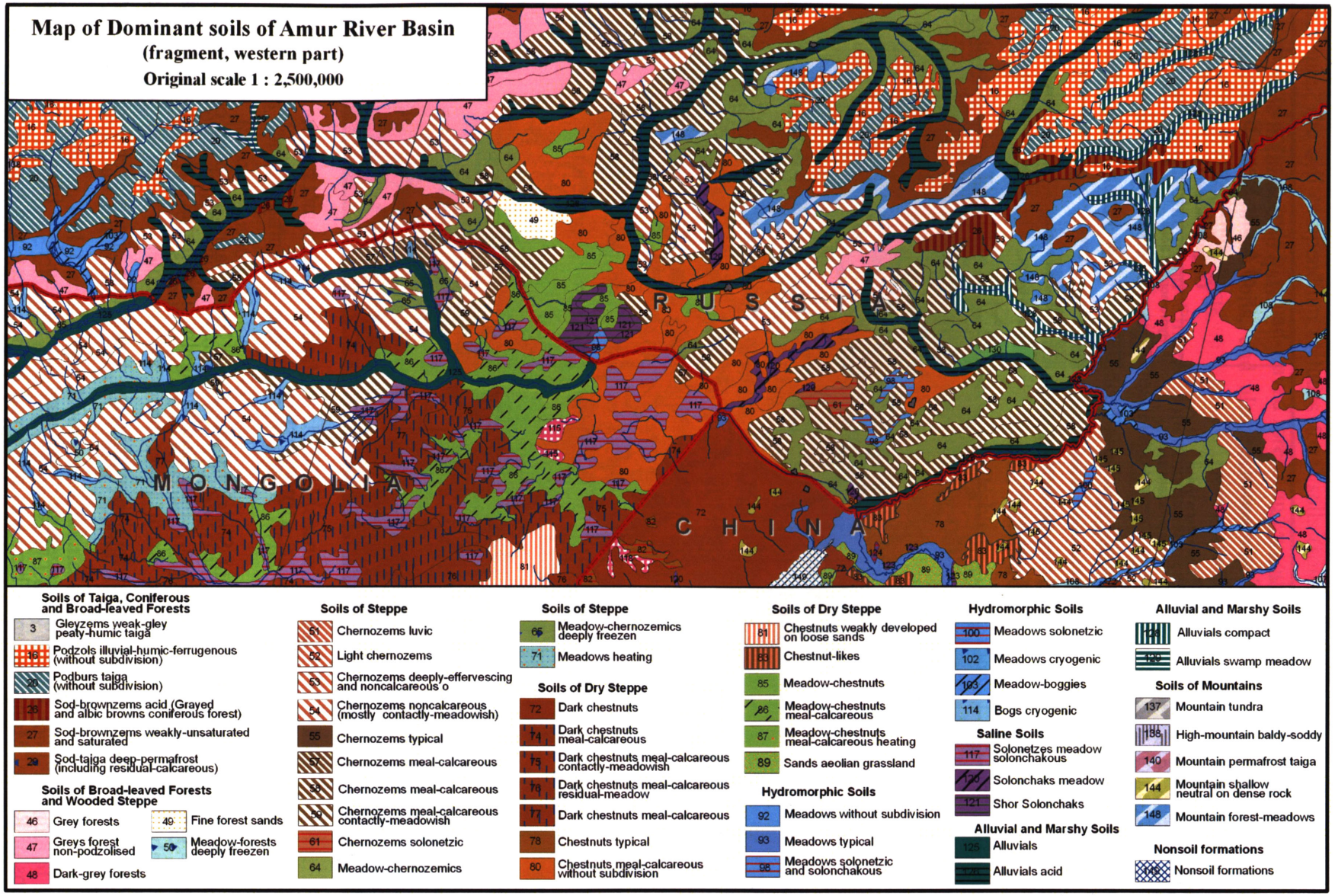
Legend of the Soil Map of the Amur River Basin (fragment)
Soil Compendium

Soil code	Soil Name		
	Name in English Russian Legend	**Name in the Revised legend of the Soil Map of the World FAO-UNESCO, 1990**	**Name in the World Reference Base for Soil Resources, 1998**
SOILS OF TUNDRA			
1	Podburs light tundra	Gelic Podzols (PZi)	Cryosols Haplic (CRha)
2	Podburs tundra (without subdivision)	Ferric Podzols (PZf)	
SOILS OF TAIGA AND SOILS OF CONIFEROUS AND BROAD-LEAVED FORESTS			
3	Gleyzems weak-gley peaty-humic taiga	Gelic Gleysols (GLi)	Cryosols Histic (CRhi)
4	Gleyzems peaty-muck taiga		
5	Taiga peaty-muck high-humic non-gleyic	Gelic Cambisols (CMi)	
6	Podzolics, mostly shallow podzolics	Dystric Podzoluvisols (PDd)	Albeluvisols Haplic (ABha)
7	Podzolic-gleys peat and peaty	Gleyic Podzoluvisols (PDg)	Albeluvisols Histic (ABhi)
9	Sod-pale-podzolics and podzolised brownzems	Eutric Podzoluvisols (PDe)	Albeluvisols Umbric (ABum)
10	Podzolised brownzems (Beijang bleached)		
11	Sod-pale-podzolics and podzolised brownzems deep-gleyic and gley	Gleyic Podzoluvisols(PDg)	Albeluvisols Gleyic (ABgl)
12	Podzolised brownzems meadow (Beijang bleached meadow)		
13	Podzolised brownzems gley (Beijang bleached gley)		
15	Podzols humic-illuvial	Haplic Podzols (PZh)	Podzols Carbic (PZcb)
16	Podzols illuvial-humic-ferrugenous (without subdivision)		Podzols Haplic (PZha)
17	Podzols dry-peaty		Podzols Histic (PZhi)
18	Podzols gley peaty and peat, mostly humic-illuvial	Gleyic Podzols (PZg)	Podzols Gleyic (PZgl)
20	Podburs taiga (without subdivision)	Cambic Podzols (PZb)	Podzols Entic (PZet)
21	Podburs dry-peaty		Podzols Histic (PZhi)

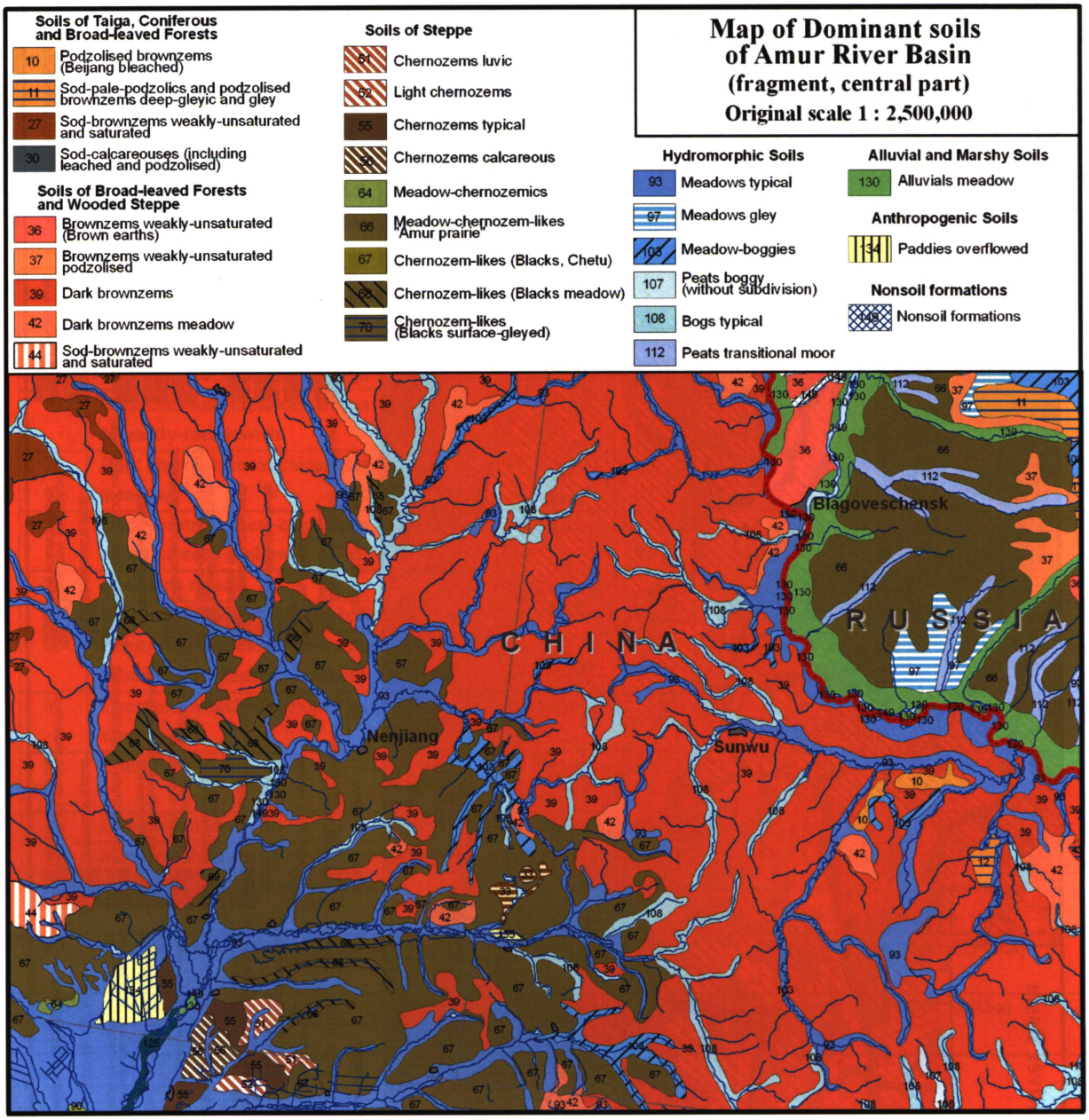
22	Podburs ochric		Podzols Rustic (PZrs)
23	Brownzems raw-humic illuvial-humic	Dystric Cambisols (CMd)	Cambisols Dystric (CMdy)
24	Brownzems raw-humic		
25	Brownzems raw-humic gley	Gleyic Cambisols (CMg)	Cambisols Gleyic (CMgl)
26	Sod-brownzems acid (Grayed and albic browns coniferous forest)	Dystric Cambisols (CMd)	Umbrisols Haplic (UMha)
27	Sod-brownzems weakly-unsaturated and saturated (Browns coniferous forest)	Eutric Cambisols (CMe)	Cambisols Eutric (CMeu)
28	Sod-brownzems gleyic and gley	Gleyic Cambisols (CMg)	Cambisols Gleyic (CMgl)
29	Sod-taiga deep-permafrost (including residual-calcareous)	Eutric-Gelic Cambisols (CMe-i)	Cambisols Eutric-Gelic (CMeu-ge)
30	Sod-calcareouses (including leached and podzolised)	Rendzic Leptosols (LPk)	Leptosols Rendzic (LPrz)
31	Volcanics ash typical	Haplic Andosols (ANh)	Andosols Haplic (ANha)
32	Dark volcanics ash	Umbric Andosols (ANu)	Andosols Umbric (ANum)
33	Volcanics ash on basi c rock	Mollic Andosols (ANm)	Andosols Mollic (ANmo)
SOILS OF BROAD-LEAVED FORESTS AND WOODED STEPPE			
34	Brownzems acid	Dystric Cambisols (CMd)	Cambisols Dystric (CMdy)
35	Brownzems acid podzolised		
36	Brownzems weakly-unsaturated (Brown earths)	Eutric Cambisols (CMe)	Cambisols Eutric (CMeu)
37	Brownzems weakly-unsaturated podzolised		
38	Brownzems gleyic and gley	Gleyic Cambisols (CMg)	Cambisols Gleyic (CMgl)
39	Dark brownzems	Eutric Cambisols (CMe)	Umbrisols Haplic (UMha)
40	Dark brownzems grayed	Dystric Cambisols (CMd)	
41	Dark brownzems albic		Umbrisols Albic (UMab)
42	Dark brownzems meadow	Haplic Cambisols (CMh)	Umbrisols Haplic (UMha)
43	Dark brownzems gley	Gleyic Cambisols (CMg)	Umbrisols Gleyic (UMgl)
44	Dark brownzem-likes	Haplic Cambisols (CMh)	Umbrisols Haplic (UMha)
46	Grey forests	Haplic Greyzems (GRh)	Luvisols Albic (LVab)
47	Greys forest non-podzolised		Phaeozems Luvic (PHlv)
48	Dark-grey forests		Phaeozems Greyi-Luvic (PHgz-lv)
49	Fine forest sands	Cambic Arenosols (ARb)	Arenosols Protic (ARpr)
50	Meadow-forests deeply freezen	Umric-Gelic Leptosols (LPu-i)	Umbrisols Gelic (UMge)
SOILS OF STEPPE			
51	Chernozems luvic	Luvic Chernozems (CHl)	Chernozems Luvic (CHlv)
52	Light chernozems	Luvic Phaeozems (PHl)	Phaeozems Luvic (PHlv)
53	Chernozems deeply-effervescing and noncalcareous on sandstones and sands)	Haplic Chernozems (CHh)	Chernozems Chernic (CHch)
54	Chernozems noncalcareous (mostly contactly-meadowish		
55	Chernozems typical		
56	Chernozems calcareous	Calcic Chernozems (CHk)	Chernozems Calcic (CHcc)
57	Chernozems meal-calcareous		
58	Chernozems meal-calcareous, including leached, typical, ordinary, southern (chernozems washed)		
59	Chernozems meal-calcareous contactly-meadowish	Haplic Chernozems (CHh)	Chernozems Haplic (CHha)
60	Chernozems meal-calcareous shallow		
61	Chernozems solonetzic	Luvic Chernozems (CHl)	Chernozems Luvic (CHlv)
62	Chernozems solonchakous	Luvic Chernozems (CHh)	

64	Meadow-chernozemics (Chernozems meadow)	Haplic Phaeozems (PHh)	Phaeozems Gleyic (PHgl)
65	Meadow-chernozemics deeply freezen	Gelic Phaeozems (PHi)	
66	Meadow-chernozem-likes "Amur prairie"	Gleyic Phaeozems (PHg)	
67	Chernozem-likes (Blacks, Chetu)	Haplic Phaeozems (PHh)	Phaeozems Haplic (PHha)
68	Chernozem-likes (Blacks meadow)	Gleyic Phaeozems (PHg)	Phaeozems Gleyic (PHgl)
69	Chernozem-likes (Blacks albic)	Albic Phaeozems (PHa)	Phaeozems Albic (PHab)
70	Chernozem-likes (Blacks surface-gleyed)	Stagnic Phaeozems (PHj)	Phaeozems Stagni-Epigleyic (PHst-pgl)
71	Meadows heating	Haplic Phaeozems (PHh)	Phaeozems Haplic (PHha)
SOILS OF DRY STEPPE			
72	Dark chestnuts	Haplic Kastanozems (KSh)	Kastanozems Haplic (KSha)
74	Dark chestnuts meal-calcareous	Calcic Kastanozems (KSk)	Kastanozems Calcic (KScc)
75	Dark chestnuts meal-calcareous contactly-meadowish		
76	Dark chestnuts meal-calcareous residual-meadow		
77	Dark chestnuts meal-calcareous and noncalcareous shallow	Haplic Kastanozems (KSh)	Kastanozems Haplic (KSha)
78	Chestnuts typical		
79	Chestnuts meal-calcareous shallow	Calcic Kastanozems (KSk)	Kastanozems Calcic (KScc)
80	Chestnuts meal-calcareous without subdivision (chestnuts leached)		
81	Chestnuts weakly developed on loose sands	Mollic Leptosols (LPm)	Leptosols Mollic (PLmo)
82	Chestnuts solonchakous	Luvic Kastanozems (KSl)	Kastanozems Sodic (KSso)
83	Chestnut-likes	Haplic Kastanozems (KSh)	Kastanozems Haplic (KSha)
85	Meadow-chestnuts (Chestnuts meadow)	Haplic Phaeozems (PHh)	Phaeozems Gleyic (PHgl)
86	Meadow-chestnuts meal-calcareous	Calcaric Phaeozems (PHc)	Phaeozems Calcaric-Gleyic (PHca-gl)
87	Meadow-chestnuts meal-calcareous heating		Phaeozems Calcaric (PHca)
89	Sands aeolian grassland	Haplic Arenosoils (ARh)	Arenosoils Haplic (ARha)
90	Sands aeolian meadow		

Map1


Map of Dominant soils of Amur River Basin
(fragment, western part)
Original scale 1 : 2,500,000
M O N G O L I A
R U S S I A
C H I N A
Soils of Taiga, Coniferous and Broad-leaved Forests
3 Gleyzems weak-gley peaty-humic taiga
Podzols illuvial-humic-ferrugenous (without subdivision)
Podburs taiga (without subdivision)
Sod-brownzems acid (Grayed and albic browns coniferous forest)
27 Sod-brownzems weakly-unsaturated and saturated
29 Sod-taiga deep-permafrost (including residual-calcareous)
Soils of Broad-leaved Forests and Wooded Steppe
46 Grey forests
47 Greys forest non-podzolised
48 Dark-grey forests
49 Fine forest sands
50 Meadow-forests deeply freezen
Soils of Steppe
51 Chernozems luvic
52 Light chernozems
53 Chernozems deeply-effervescing and noncalcareous o
54 Chernozems noncalcareous (mostly contactly-meadowish)
55 Chernozems typical
57 Chernozems meal-calcareous
58 Chernozems meal-calcareous
59 Chernozems meal-calcareous contactly-meadowish
61 Chernozems solonetzic
64 Meadow-chernozemics
Soils of Steppe
65 Meadow-chernozemics deeply freezen
71 Meadows heating
Soils of Dry Steppe
72 Dark chestnuts
74 Dark chestnuts meal-calcareous
75 Dark chestnuts meal-calcareous contactly-meadowish
76 Dark chestnuts meal-calcareous residual-meadow
77 Dark chestnuts meal-calcareous
78 Chestnuts typical
80 Chestnuts meal-calcareous without subdivision
Soils of Dry Steppe
81 Chestnuts weakly developed on loose sands
83 Chestnut-likes
85 Meadow-chestnuts
86 Meadow-chestnuts meal-calcareous
87 Meadow-chestnuts meal-calcareous heating
89 Sands aeolian grassland
Hydromorphic Soils
92 Meadows without subdivision
93 Meadows typical
98 Meadows solonetzic and solonchakous
Hydromorphic Soils
100 Meadows solonetzic
102 Meadows cryogenic
103 Meadow-boggies
114 Bogs cryogenic
Saline Soils
117 Solonetzes meadow solonchakous
120 Solonchaks meadow
121 Shor Solonchaks
Alluvial and Marshy Soils
125 Alluvials
Alluvials acid
Alluvial and Marshy Soils
Alluvials compact
Alluvials swamp meadow
Soils of Mountains
137 Mountain tundra
High-mountain baldy-soddy
140 Mountain permafrost taiga
144 Mountain shallow neutral on dense rock
148 Mountain forest-meadows
Nonsoil formations
Nonsoil formations

Map 2



CONCLUSION

The digital coverage "Dominant Soils" for the Amur River basin has been compiled. It covers bordering territories of Russia, China, and Mongolia. The digital coverage enables us to analyze the soil cover of the Amur River basin as a whole. It helps us to disclose geographical patterns of soil distribution within the basin and specific characteristics of different parts of the basin.

When compiling the digital coverage "Dominant Soils", the data from the source soil maps of Russia, Mongolia, and China was preserved in the fullest, and the soil cartographic material was unified. All the data was coded and added to the database.

The resultant soil compendium includes all the diverse soils of the Amur River basin (Scale 1:2.5 M). The soils are grouped in accord with landscape and geographical zoning

principle. The soil compendium includes zonal soils (soils of tundra, taiga and coniferous-broadleaved forests; soils of broad-leaved forests and wooded steppe; soils of steppe; soils of dry steppe), mountainous soils, and also such separate groups as hydromorphic, saline, alluvial, and anthropogenic soils.

Russian, Mongolian, and Chinese soil nomenclatures for the Amur River basin were correlated. Then the resultant soil nomenclature was correlated to the soil nomenclatures of FAO-UNESCO and the World Reference Base for Soil Resources.

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