Russian Approaches to the Forest Type Classification

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Abstract. The results of researches characterizing the geographical distribution of forest-ecological,
phytocenotic, and genetic classifications of forest types in the Russian Federation nowadays are
presented in the thesis. A comparative analysis was carried out for the following items: the inclusive
concept of a classification unit (a type of habitat conditions; a type of forest); features of
distinguishing the border of the classification units; classification features used to determine the type
of habitat conditions; features of the classification of phytocoenoses used to determine the forest
type; the degree to which the successional dynamics of forest stands are taken into consideration;
the degree to which the influence of anthropogenic factors are taken into consideration; the level of
implementation in forest management and forestry practice; regions of implementation. In the
process of development of forest typologies, the concept of a forest type changed from
understanding it as a forest area homogeneous by composition, structure, and appearance
(homogeneity in space) in natural classifications to the concepts of a forest type, in which priority is
given to homogeneity in origin (genesis), as well as developmental processes and dynamics
(homogeneity in time) in genetic and dynamic typologies. Currently, there is the following forest
type classification in the Russian Federation: forest-ecological, phytocoenotic, genetic, and
dynamic. When classifying forest areas within the forest-ecological direction provided by E.V.
Alekseev – P.S. Pogrebnjak, the priority is given to the characteristics of the habitat conditions.
Within the phytocoenotic direction provided by V.N. Sukachev, the priority is given to the
phytocenosis characteristics. Within the genetic approach provided by B.A. Ivashkevich – B.P.
Kolesnikov, a forest type is considered as a series of alternating phases – types of phytocoenosis
within the same type of habitat conditions. In this case, phytocoenotic classifications can be a part of
the genetic classifications for the climax forest phytocoenosis. And the dynamic approach provided
by I.S. Melekhov is very close to the genetic one and is a superstructure over the classical
phytocenotic forest typology provided by V.N. Sukachev. The current use of forest typological
classifications by forest inventory management enterprises in the Russian Federation was studied. A
map of the geographical distribution of forest typologies of the above-listed directions of forest
typology researches was created. Forest-ecological classifications are used mainly in the southern
regions of the European part of Russia and the North Caucasus. Forest typologies created based on
a genetic approach to the forest type classification are used in Western Siberia, in the south of the Far
East and Eastern Siberia, and in some regions of the Urals. Phytocoenotic classifications of forest
types are used in other regions of the Russian Federation.

1. Introduction
Modern rational forestry systems are based upon forest typologies. The most intensive development of
key forest typology study directions occurred in different countries of the Northern Hemisphere from
the end of the XIX, and almost until the end of the XX century. Results include forest type classifications that are actively used in forest management of the said countries. In the beginning of the XXI century scientific and practice-oriented interest of forest researchers shifted towards development of forest type classifications allowing harmonization of national forest inventory systems using criteria and indicators of sustainable forest management [1-4].

Second decade of the XXI century featured an increase in numbers of publications describing effects the local climate changes have upon the habitats and forest vegetation, including effects the changes have upon the use of the forests, and indicators used for multiple purposes, including forest type defining [5—11]. Keeping this in mind, improvement of forest topology patterns under conditions of current climate changes, and anthropogenic pressure remains among the key directions of forest typology research.

Scientists from the Russian Empire and USSR developed several original approach towards forest typology development, and their research results are still actual [6, 7, 12]. Despite a certain decrease in the number of publications on the topic in Russian Federation in the late XX-early XXI centuries, that was primarily due to social and economic factors, Russian scientists continue research and development in this area [13—20].

Necessity of research aimed at harmonization of Russian Federation’s national forest inventory systems at the level of sustainable forest management indicators criteria is determined by the fact that Russia is among the countries that joined Montreal and Pan-European processes [2, 21–22] aimed at harmonization of national forestry systems. Success of the initiative depends upon a number of factors including familiarity with forest classification types used at national and international levels by the specialists from different countries joining Montreal and Pan-European processes in the areas of creating forest inventory, and forest management. Free access to research results in this area is extremely important ecologists and people making decisions at the industrial, national and International levels.

The goal of the work was to perform comparative analysis for the main forest type classifiers used in Russian Federation

2. Key forest type classifications used in Russian Federation

Key approaches to classification of the woods, phases of forest typology development in Russian Empire and USSR, and specifics of the forest type classifications were covered in [6, 7, 12, 20]. Specialists distinguish the following periods and directions of forest typology studies in Russia – pre-Morozov period, A. Krüdener’s classification of forest types, forest ecology direction by E. Alekseev and P. Pogrbynjak, V. Sukachev’s phytocoenotic forest typology; geographico-genetic forest typology by B. Ivashkevich and B. Kolesnikov, and dynamic typology by I. Melekhov. Directions of forest typology research listed after A. Krüdener’s classification were developing simultaneously.

The following table contains results of analyzing key forest type classification currently used in Russian Federation. In some Russian regions local forest management authorities use proprietary classifications of forest types developed by researchers that were not listed above. However, these classifications usually belong to abovementioned classifications. It is also necessary to note regional forest type schemes and inventories that are widely used in forest management, research [23—28], and logging classifications [29, 30]. These schemes are prevailing based on the key principles of the main classifications, and use Morozov’s ideas [31, 32]. While developing forest typologies, authors clarified and extended the term of forest type, changing the concept of forest part that is homogenous in terms of composition, structure, and appearance into a forest type idea where homogeneity in terms
of origin (genesis), development processes and dynamics (temporal homogeneity) is prevailing over uniform composition and structure (spatial homogeneity).

In natural classifications, i.e. ecological-sylvicultural and phytocoenotic ones, forest type is considered in terms of forest biogeocoenosis components’ spatial uniformity of characteristics. In genetic classifications priority of spatial uniformity criteria for forest parts were replaced by uniformity criteria for the series of forest biogeocoenoses in time [6]. Each series of coenoses types relate to a specific forest type in genetic classification. Regional genetic classifications base upon the same common principles; however they always consider regional specifics with regards to climate, soils, and landscape, which creates regionally-specific schemes. These schemes fully implement Morozov’s geographical principle due to the requirement of including forest vegetation conditions codes in the names of the forest types [23, 20, and 33]. System of alphanumerical codes was developed, allowing to represent forest type affiliation with a certain zone, subzone, province, altitudinal belt, floristic complex of biogeocenoses, and edaphic and hydrological complex of forest growth conditions (classes, groups, types) [23, 20, 33]. Altogether that provides genetic classification forest type with a precise geographic and ecological “address”. That is the key fundamental difference of a genetic classification form natural typologies, as the latter have no clear boundaries for use [23]. In order to stress regional specifics of genetic classifications, they are usually referred to as geographo-genetic ones [6].

Forest type in genetic typologies is determined within the limits of certain forest growth conditions type, including relief genesis and landforms, illumination conditions, physical and chemical properties of parent rock material and soils, water regime, and specifics of plants’ watering and mineral nutrition. Within the framework of genetic approach, forest type is a stage of forest genesis process [34].

Stand types or phytocoenosis types represent the phases of forest type development, meaning that forest conenoses can replace each other within a single type of forest growth conditions. Appearance, composition and structure of the conenoses can substantially differ, while they will nevertheless belong to the same forest type [34, 35]. Forest type in genetic classifications is formed by a sequence of stand types [15, 16], or, in other words, “stand type is a form of forest type existence, while the latter is represented by genetic series of stand types replacing each other in time” [34]. Forest type can be described by a certain growth sequence of forest stand, composed by specific forest forming species.

### Table 1. Specifics of Key Directions in Forest Typologies Used in Russian Federation

| Parameters          | Ecological-sylvicultural (E. Alexeev – P. Pogrebnyak) | Phytocoenotic (V. Sukachev) | Genetic (B. Ivashkevich – B. Kolesnikov) | Dynamic (I. Melekhov) |
|---------------------|------------------------------------------------------|----------------------------|-------------------------------------------|------------------------|
| Forest type definition | Forest type is a combination of forest lots with similar soil, hydrological, and climactic conditions, and considering historical factor. Forest type is determined by the type of forest growth conditions. Interpretations of the latter factor may differ from the type of conditions per se to the combination of forest biogeocoenoses viewed. | Forest biogeocoenosis type, unlimited potential number of forest types | Series of interrelated forest phytocoenoses within the limits of specific site conditions, i.e. the series of forest biogeocoenoses replacing each other in time. Forest type definition is wider than in V. Sukachev’s classification, and there is no limit for the number of potential forest types. | Forest type definition is similar to the one by V. Sukachev, stages of forestation development added, including type of clearings and burnt. |
within the limits of forest growth conditions. The typology is used in the regions where the types of forest site condition well match the forest stand types, thus in order to determine forest type it is enough to just determine forest growth conditions using edaphic grid that allows using only 24 combinations of forest growth conditions.

| Forest type boundary | By the boundary of forest growth conditions for forested and deforested sites | By the boundary of site conditions for forested and deforested areas | By the boundary of forest phytocoenosis for forested sites only, considering the forest growth conditions |
|---------------------|--------------------------------------------------------------------------------|-----------------------------------------------------------------|-----------------------------------------------------------------|
| Parameters used for classification of forest growth conditions | Parent rock, soil type, composition, trophicity, and humidity | Direct impact factors (soil trophicity, moistening and aeration modes) are considered using indirect factors: indicators of living ground vegetation, position of landscape, and moistening regime | Altitude over sea level (altitude class) for highlands or regional complex of forest growth conditions for lowlands, moistening regime, landscape and soil specifics |
| Features of biocoenosis used to determine forest type | Stand composition within the limits of forest growth conditions, considering requirements of plant species for soil trophicity and humidity | Stand composition, living ground vegetation indicators, forest management and taxation parameters, growth class and reproduction | For forested sites method uses parameters from V. Sukachev’s classification, including key ones of stand productivity, and specifics of natural reproduction (species, numbers, and age). For deforested sites key features include presence and species of tree undergrowth, and dominant species ground vegetation |
|                     |                                                                                  |                                                                | Ground vegetation features are used for deforested sites. For phytocoenoses method uses parameters from V. Sukachev’s classification |

For the forest type a transition is possible from one type into another, and there are no limits for the potential number of forest types.
Considering seral dynamics

Initial theoretical attempts followed by efforts to consider seral dynamics in classification schemes

In theory (classification schemes have an ability to forecast stand replacement based upon reproduction data)

Both theoretically and in classification schemes, age and reproduction dynamics are presented as series of potential phytocoenoses types replacing each other under the same growth conditions. Method has specific patterns used in organizing forest management activities

Developed typology of clearings and burnt areas as a stage in reproductive dynamics, preceding actual formation of a forest type; type transition into another is considered in theory.

Considering impact of anthropogenic factors

At the level of theory for direct impacts. Indirect impacts are not considered

At the level of theory for direct impacts. Indirect impacts are not considered

Both theoretically and in classification schemes, by the logging type (with and without burning), that are used for forest management activities. Indirect impacts are not considered

Developed typology of clearings and burnt areas. Indirect impacts are not considered

Level of use in forest management activities, regions of use

High (Southern regions of Russia)

Very high (Western Russia, Eastern and Western Siberia)

High (some regions of Russian Far East, Urals, and Western Siberia, some regions in European Russia)

Jointly used with V. Sukachev’s classification

It is necessary to note that natural classifications consider stand type, forest type, and forest biocoenosis as synonyms, forest type is a broader term in genetic classification. Genetic approach to forest type classification does not discard natural typologies, but supplements and extends them [7, 36, and 37]. For example, genetic classification by Ivashkevich and Kolesnikov is based upon the results of classification proposed by Sukachev, supplemented with data on duration, direction, and pace for different change types.

One of the shortcuts for natural forest typologies is relatively low attention they pay to anthropogenic impact. That was corrected in a dynamic typology suggested by I. Melekhov, which was based upon the classification by V. Sukachev, but with extended interpretation of a forest type. Forest type in this classification similarly to the genetic typology by Ivashkevich and Kolesnikov is considered in space and time, as forest type is considered to represent a stage or several stages in forest development [7]. Dynamic typology considers exo- and endogenous changes that occur in the woods, ability for transition from one forest type into another or the link among the stages within a single forest type. Seral cases occurring at the clearings represent the restoration (demutation or de-mutation) schemes. Initial demutation stage corresponds with a clearing type determined based upon the number of forest growth conditions, which is at term evaluated based on conditions of forest growth, i.e. specifics of the plants present in the initial forest type before logging.

3. Geography of using forest typology classifiers in Russian Federation

Figure 1 presents a map that shows modern use of forest typology classification created on the base of data obtained from responses sent to the regional divisions of state forest inventory enterprise “Roslesinforg”, studying regional forest plans, and the review by Yu. Neshataev [38]. Details on
names, parameters, authors and organizations that developed classifications for certain regions of Russia and USSR are not listed here due to limited space. Classification by I. Melekhov was not considered separately, but as an extension and development of V. Sukachev’s phytocoenotic classification. We have also shown Ukraine (Ukr) and Belarus (Blrs) in Figure 1, as this allows us to more clearly represent the areas of creation in the USSR and the current distribution of ecological-sylvicultural and phytocoenotic classification of forest types.

Genetic typologies are used in thirteen regions of Russian Federation. Ecological-Sylvicultural typologies are used in fourteen regions. Two regions use classifications from phytocoenotic and forest ecology types, other regions that are not listed here, use phytocoenotic classification.

![Figure 1. Use of key forest type classifications in Russia, and former Soviet Union republic: Ukraine (Ukr) and Belarus (Blrs). Dynamic classification was considered to be an add-on for phytocoenotic classification, and thus it was not presented on the page.](image)

4. Conclusions
1. In course of developing forest typologies, the concept of forest type changes from the uniform fragment of forest with uniform appearance, composition and structure in natural classifications to the concepts of a forest type, in which priority is given to origin (genesis), as well as developmental processes and dynamics (homogeneity in time) in genetic and dynamic typologies.

2. All approaches to vegetation classification and now required to consider climatic and edaphic factors, and assess their role in differentiation of the plants, even if initially plant units (forest types and other syntaxons) were selected mainly using features of the plants. Nevertheless, Morozov’s geographic principle is fully implemented only in genetic forest typology due to the use of alphanumerical codes for reflecting forest type affiliation with a certain zone, subzone, province, altitudinal belt, floristic complex of biogeocenoses, and edaphic and hydrological complex of forest growth conditions (classes, groups, and types).
3. Key problem of modern typologies is related to taking into account seral dynamics of forest biogeocoenoses. Best solution of this problem is available in genetic topology, where key diagnostic features for determination of forest types include stable parameters of forest growth, and the concept of dynamic series of biogeocoenoses’ formation and development is introduced.

4. Issue of considering anthropogenic impacts is actual for all reviewed typologies and is actively discussed on theoretical level. Practical applications involve development of regional classifiers for clearings and burnt wood types in genetic and dynamic typologies. At the same time lack of consideration for anthropogenic impacts is considered to be the shortcoming of natural forest typologies.

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References

[1] A. Barbati, P. Corona, M. Marchetti “European forest types” — European Environment Agency. EEA Technical report No 9/2006. Copenhagen, Available at: https://www.eea.europa.eu/publications/technical_report_2006_9, 2007.

[2] A. Barbati, M. Marchetti, G. Chirici, P. Corona “European Forest Types and Forest Europe SFM indicators: Tools for monitoring progress on forest biodiversity conservation”, Forest Ecology and Management, vol. 321, pp. 145–157. DOI: 10.1016/j.foreco.2013.07.004, 2014.

[3] Brand D.G. Criteria and indicators for the conservation and sustainable management of Forest: progress to date and future directions. Biomass and Bioenergy, vol.13, no. 4/5, pp. 247-253, 1997.

[4] F. Castañeda “Criteria and indicators for sustainable forest management: international processes, current status and the way ahead”, Unasylva, vol. 51 (203), pp. 34-40, 2000.

[5] S.C. DeLong, H. Griesbauer, W. Mackenzie, V. Foor “Corroboration of biogeoclimatic ecosystem classification climate zonation by spatially modelled climate data”, BC Journal of Ecosystems and Management, vol. 10, no 3, 49–64, 2010.

[6] V. Fomin, N. Ivanova, A. Mikhailovich “Genetic forest typology as a scientific and methodological basis for environmental studies and forest management”. IOP Conf. Series: Earth and Environmental Science, vol. 609, 012044. DOI: 10.1088/1755-1315/609/1/012044, 2020.

[7] V. Fomin, A. Mikhailovich, S. Zalesov, A. Popov, G. Terekhov “Development of ideas within the framework of the genetic approach to the classification of forest types”, Baltic Forestry, vol. 27, no. 1 (466), pp. 1–14. DOI: 10.46490/BF466, 2021.

[8] W.H. MacKenzie, C.R. Mahony “An ecological approach to climate change-informed tree species selection for reforestation”, Forest Ecology and Management, vol. 481, 118705. DOI: 10.1016/j.foreco.2020.118705, 2021.

[9] D.I. Nazimova, V.G. Tsaregorodtsev, N.M. Andreyeva “Forest vegetation zones of Southern Siberia and current climate change”, Geography and Natural Resources, vol. 31, no. 2, pp. 124-131, 2010.

[10] H.W. Nelson, T.B. Williamson, C. Macaulay, C. Mahony “Assessing the potential for forest management practitioner participation in climate change adaptation”, Forest Ecology and Management, vol. 360, pp. 388–399. DOI: 10.1016/j.foreco.2015.09.038, 2016.
[11] P. Spathelf, E. Van Der Maaten, M. Van Der Maaten-Theunissen, M. Campioli, D. Dobrowolska “Climate change impacts in European forests: The expert views of local observers”, *Annals of Forest Science*, vol. 71, no. 2, pp. 131–137. DOI: 10.1007/s13595-013-0280-1, 2014.

[12] V.V. Fomin, S.V. Zalesov, A.S. Popov, A.P. Mikhailovich “Historical avenues of research in Russian forest typology: ecological, phytocoenotic, genetic, and dynamic classifications”, *Can. J. Forest Res.*, vol. 47, no. 7, pp. 849–860. DOI: 10.1139/cjfr-2017-0011, 2017.

[13] A.V. Gornov Classification of forests using a field guide of forest types of the European Russia (evidence from Karelia and the Karelian isthmus), *Forest Science Issues*, vol. 1, no 1. С. 1–53. DOI: 10.31509/2658-607x-2018-1-1-53, 2018, (in Russian).

[14] O. V. Morozova, L. B. Zaununova, L. G. Isaeva, V. A. Kostina “Classification of boreal forests of the north of European Russia. I. Oligotrophic coniferous forests”, *Vegetation of Russia*, no. 13, pp. 61-81. DOI: 10.31111/vegrus/2008.13.61, 2008, (in Russian).

[15] S. N. Sannikov “Divergence, convergence and inheritance of the structure of forest biogeocenoses. Genetic typology, dynamics and geography of Russian forests”, Yeakaterinburg: Publishing House of the Ural Branch of the Russian Academy of Sciences, pp. 56–61 2009, (in Russian).

[16] S. N. Sannikov “Ecological and genetic classification of forest types on the basis of dynamic series of biogeocenosis development”, *Siberian Forest Journal*, no. 1, pp. 3–15.] DOI: 10.15372/SJFS20190101, 2019, (in Russian).

[17] V.N. Sedykh “Landscape-typological basis for conducting forest management on the territory of Siberia”, *Forest Taxation and Forest Management*, vol 34 (1), pp. 70–77, 2005 (in Russian).

[18] S. K. Farber, N. S. Kuzmik “Forest typology: theory and prospects of use in the forests of Siberia”, *Coniferous Boreal Zones*, vol. 31 (1-2), pp. 143–148, 2013, (in Russian).

[19] S.K. Farber, V.V. Koshkarova, N.S. Kuzmik “Mapping of Holocene forest formations using basic climate indicators-heat and moisture”, *Siberian Journal of Forest Science*, no. 6, pp. 26-40.] DOI: 10.15372/SJFS20170602, 2017, (in Russian).

[20] L.P. Rysin, L.I. Savel’eva “Spruce forests of Russia”, Moscow: Nauka Publ., 336 p., 2002, (in Russian).

[21] “The Pan-European Forest Process. Criteria and Indicators for Sustainable Forest Management” [Online] 1993 [Accessed 04June 2021] Available at: http://www.fao.org/docrep/004/AC135E/ac135e09.htm.

[22] “The Montréal Process. Criteria and Indicators for the Conservation and Sustainable Management of Temperate and Boreal Forests” [Online] 2015 [Accessed 04 June 2021] Available at: http://www.montrealprocess.org/documents/publications/techreports/MontrealProcessSeptember2015.pdf.

[23] B.P. Kolesnikov, R.S. Zubareva, E.P. Smolonogov Forest vegetation conditions and forest types of the Sverdlovsk region. Sverdlovsk: Academy of science of the USSR Publ., 176 p., 1973, (in Russian).

[24] E.I. Kuzmenko, E.P. Smolonogov “Forest ecosystems of the middle and southern taiga of the West Siberian plain (structure and spatial-temporal dynamics)”, Novosibirsk: Publishing House of SB RAS, 218 p., 2000, (in Russian).

[25] A.Ya. Orlov, S.P. Purses, V.V. Osipov, A.A.Sokolov “Types of forest biogeocenoses of the southern taiga”, Moscow: Nauka Publ., 232 p., 1974, (in Russian).

[26] L.P. Rysin, L.I. Savel’eva “Spruce forests of Russia”, Moscow: Nauka Publ., 336 p., 2002, (in Russian).

[27] L.P. Rysin, L.I. Savel’eva “Cadastre of forest types and types of forest biogeocenoses”, Moscow: Comradeship of Scientific Publications KMK, 144 p., 2007, (in Russian).
[28] L.P. Rysin, L.I. Savelyeva “Pine forests of Russia”, Moscow: Comradeship of Scientific Publications, 289 p., 2008, (in Russian).

[29] A.M. Kryshen Plant communities of cuttings: structure, dynamics and classification (on the example of Karelia). Dissertation for the degree of Doctor of Biological Sciences. Petrozavodsk, 42 p., 2005, (in Russian).

[30] I.S. Melekhov Basics of felling typology. Foundations of felling typology and its significance in forestry. Arkhangelsk, pp. 5–34, 1959, (in Russian).

[31] G.F. Morozov “The doctrine of forest types”, Leningrad: State Publishing House, 367 p., 1925, (in Russian).

[32] G.F. Morozov “The doctrine of the types of plantings”, Moscow-Leningrad.: Selkolkhozgiz Publ, 421 p., 1931, (in Russian).

[33] E.P. Smolonogov “Ecological and geographical differentiation and dynamics of cedar forests of the Urals and the West Siberian plain (ecological and forestry bases of optimization of the economy)”, Sverdlovsk: Ural Branch of the USSR Academy of Sciences Publ., 288 p., 1990 (in Russian).

[34] B. P. Kolesnikov “The genetic stage in forest typology and its tasks”, Russian Journal of Forest Sciences, no. 2, pp. 3–20, 1974, (in Russian).

[35] E.P. Smolonogov “Main principles of the genetic approach to the typological classification of forests”, Russian Journal of Ecology, vol. 29, no 4, pp. 220–225, 1998, (in Russian).

[36] B.A. Ivashkevich “Types of forests of Primorye and their economic significance”, Productive Forces of the Far East: The Plant World, vol. 3, p. 3-20, 1927, (in Russian).

[37] B. P. Kolesnikov “Genetic classification of forest types and its tasks in the Urals”, Proceedings of the Institute of Biology of the Ural Branch of the USSR Academy of Sciences, vol. 27, C. 47–59, 1961, (in Russian).

[38] B. Yu. Neshataev “Forest typology in Russia: history and modern problems. Forest typology: modern methods of forest types allocation, classification and zoning of forest vegetation”, materials of the International Scientific Seminar, (Minsk-Naroch, October 20–21, 2016). National Academy of Sciences of Belarus, V. F. Kuprevich Institute of Experimental Botany of the National Academy of Sciences of Belarus. Minsk: Kolorgrad, pp. 13–27, 2016 (in Russian).