Using of the methods of landscape research in determining allowable recreational pressure

A E Astashin\textsuperscript{1,2}, N I Astashina\textsuperscript{1}, E A Vasilieva\textsuperscript{1} and E V Illicheva\textsuperscript{1}

\textsuperscript{1}Nizhny Novgorod state engineering and economic university, Oktyabrskaya St., 22a, Knyaginino, Nizhny Novgorod Region, 606340, Russia
\textsuperscript{2}Kozma Minin Nizhny Novgorod State Pedagogical University (Minin University), Ul’yanova, 1, Nizhny Novgorod, Nizhny Novgorod Region, 603950, Russia

E-mail: vea717@mail.ru

Abstract. The development of tourism, as one of the most dynamically developing sectors of the economy, entails an increase in the recreational pressure on the visited territories. The research of modern landscapes shows that their use for recreational purposes can lead not only to significant negative changes in individual components, but also to fundamental disturbances and degradation of landscapes in general. In this connection, the systematic monitoring of the recreational pressure, the search for its optimal values, which do not entail the degradation of the landscape, is of particular relevance. Research of the recreational capacity of landscapes was started as far back as the twentieth century. Over the past decades, the standards of recreational pressure for the most common types of landscapes have been defined. Based on the developed methods of assessing the degree of recreational landscape digression, measures to improve the landscape have been proposed. It has been established that the increase in the economic effect from the development of tourism and recreation is possible on the basis of landscape and recreational analysis, which takes into account the individual characteristics of the territory when determining the permissible recreational pressure. The article briefly describes the main groups of landscape research methods used in determining the permissible recreational pressure on the landscape. The most important parameter on which the researchers rely when they calculate the permissible recreational pressure on the landscape is the density of the recreational pressure. During research of the density of recreational pressure, some traditional methods of researching landscapes are applicable, for example, conducting reconnaissance routes. The analysis of approaches to the definition of permissible recreational pressure on the landscape is spent, a brief algorithm for conducting landscape research at the local level is given, and the example of creating the appropriate landscape maps is given. The article presents the results of landscape research, conducted on the territory of the Vorotynsky district of the Nizhny Novgorod region. The analysis shows that sustainable development of tourism and recreation can be based on the results of extensive research, including the establishment of landscape features of the territory and the determination of optimal types of recreational activities and the degree of its intensity for each natural-territorial complex.

1. Introduction
The Nizhny Novgorod Region enters in TOP-10 the most popular tourist destinations in Russia. In 5 years the region rose from the 11th place by the 8th, showing positive dynamics of growth of a tourist and excursion stream and development of infrastructure [1, 2].
Growth of number of tourist arrivals inevitably involves increase in recreational pressure of the visited territories. Excessive recreational influence leads to degradation of a landscape, loss of the characteristics determining its recreational value. Therefore, there is a danger that inflow of tourists to the region will begin to be reduced. The subjects operating tourist resources and interested in sustainable development of tourism in the region are faced by a task of inexhaustible use of resources.

The effective solution of this task is possible only on the basis of system – landscape – approach. In article the main groups of methods of the landscape researches which are used when determining permissible recreational pressure on a landscape are briefly characterized. However, application of landscape approach is complicated by the fact that the grid of landscape division into districts at the local level, as a rule, is absent. It does a problem of carrying out the landscape and recreational analysis of the territory which is difficult realized. The short algorithm of performance of landscape researches at the level of landscapes, natural boundaries and subnatural boundaries is given in article.

2. Materials and methods
Researches of landscapes recreational capacity were begun in the 20th century. For last decades norms of recreational pressures for the most widespread types of landscapes were determined. For the first time influence of recreational activity on a condition of oak groves of Moscow are described and ranged on extent of recreational degradation by R.A. Karpisonova [3]. Further work towards the research of the influence of recreational activities on the landscapes of various regions of the USSR and Russia was continued [6, 7, 8, 9, 8 and 9]. Certainly, each landscape is unique and is characterized by combination of conditions: morpholithogenous basis, hydrological regime, land cover and degree of anthropogenic transformation.

Researchers of various schools made efforts to determine the permissible recreational pressure based on the characteristics of one or another component of the landscape: vegetation, soil. Sometimes attempts to coordinate several parameters, for example, type of vegetable association and feature of a morpholithogenous basis were made [12, 13, 14, 15, 16, 17, 18, 17 and 18]. Some authors introduced correction factors (or identified tolerance classes) based on the characteristics of one or another component of the landscape [9]. It is absolutely fair to take into account not only the features of the landscape, but also the specifics of recreational activities (excursions, tourism, planned or amateur, mass daily recreation [10]). On the basis of the developed methods for assessing the degree of recreational landscape digression, measures were proposed to improve the landscape [20]. It should be noted that in matters of interaction between the holidaymakers and the landscape, not only the impact of holidaymakers on the landscape was considered, but also the recreational effect exerted by the landscape on holidaymakers [21].

It is obvious that there is no universal methodology for establishing admissible recreational pressure on landscapes of each specific territory; however, it is quite possible to perform the corresponding calculations, based on existing methods.

3. Results
The major parameter on which the researchers rely when calculating the permissible recreational pressure on the landscape is the density of recreational pressure - it is quantity of holidaymakers (vacationers) on a certain area in a certain period of time, most often – the people / hectare per hour.

It is necessary to consider that in morning and evening hours the quantity of holidaymakers, as a rule, is less, than in the middle of the day. Therefore, it is expedient to calculate the density of the recreational pressure throughout the day, and then to divide time of observations for intervals: from 7 to 11, from 11 to 15, from 15 to 19 hours – and calculate the average density in the interval, then the average, minimum and maximum density during the day and in an hour.

On the other hand, it is impossible to judge the density of the pressure on the basis of observations of a single day. Depending on the day of the week (weekdays or weekends) and also from weather conditions, maturing time in forests of mushrooms, berries, nuts, etc., the recreational pressure will vary.
All this needs must be taken into account in the process of analyzing the density of recreational pressure of landscapes.

The basis for determining the recreational pressure is a landscape map, made at the hierarchical level of landscapes, and for the most visited territories – at the level of the natural boundaries.

The map chart of landscapes of the landscapes of the Vorotynsky municipal district of the Nizhny Novgorod Region (map chart 1) [22] and also a map chart of natural boundaries of the territory of Vasilsursky village administration of Vorotynsky district (map chart 2) is given in this work as this territory is the most perspective for the organization of ecological tours and excursions [23].

Map 1. The landscapes of Vorotynsky district.
Map 2. Landscape conditions of Vasilursk and its environs.

It is expedient to coordinate and generalize landscape works to one specialist-geographer, and not to build the scheme of landscape zoning by results of mechanical Association of the schemes of zoning of the territory developed by branch experts (the geologist, the geomorphologist, the soil scientist, the botanist, etc.).

Development of the landscape zoning scheme at the level of landscapes, natural boundaries and subnatural boundaries requires mandatory field work in order to detail the boundaries of the allocations and the characteristics of their current state, and the preliminary boundaries are carried out at the primary cameral stage, at the same time planned key points of field research based on the analysis of thematic maps, remote sensing data, statistical data, literature analysis, etc.

At the field stage, the group of researchers works both at the planned key points and at additional points, determined directly on the ground based on the specifics of the territory and tasks. On the ground, the leading criteria of landscape zoning are specified and the boundaries of landscape allocations are drawn.

An effective way to organize field research we see the laying of the transect system, as a rule, planned based on the scientific needs and technical capabilities of the research team. The result of the work on the transects is the collection of information necessary to create a reference landscape profile (or profiles), reflecting the characteristics of the landscapes of the research area.

Observation points should cover all facial variety along the line of the reference profile in order to identify interfacial and interobjective relationships, patterns in the construction of facies series, the reliability of certain external features of natural territorial complexes (NTC) for their use in landscape mapping as indicative [24].

The team of researchers on the ground details the data on the composition and distribution of Quaternary and pre-Quaternary rocks, terrain features, intensity and direction of relief-forming processes, features of the hydrographic network, soil and vegetation cover, the nature and intensity of
anthropogenic impact. As a rule, work on the key point allows you to get data about the NTC at the level of a geographic object.

The results of complex research in the field are recorded in a prepared form and displayed on a topographic basis. At each point, a panoramic photo is made according to a single rule: shooting is carried out from North to South clockwise. The numbers of photos and points exposed with the help of GPS-receiver are entered in the form of description of geographical object.

The number of key points depends on the diversity of landscape conditions of the research area and its area. It should be noted that the complex description on the key point requires a lot of time – from half an hour to several hours. Therefore, the description of the tract, typical for the territory under consideration, it is advisable to perform 1-3 times, while the rest of the tract with identical characteristics are displayed on the map by the corresponding conventional sign or index without a detailed description (except for some minor individual features inherent in this tract, but not having a cardinal influence on its structure and functioning).

The analysis of the collected factual material, conclusions, route observations, various additional characteristics not provided by the blank form, sketches, etc. – are recorded in the field book.

After the end of the research, 2-3-day primary office treatment is carried out at the working site. [25].

In the course of research the density of recreational pressure, some traditional methods of landscape research are quite applicable. For example, to determine the objects, places, points of determination of the density of recreational pressure, it is necessary to conduct reconnaissance routes, in the process of which on the basis of visual-comparative method, the diversity of density and types of placement of recreants (longitudinal-linear, linear-fragmentary-area, area, etc.) is estimated, as well as objects, segments, sites for counting the number of vacationers are determined (planned).

Researches show that in the summer season places of concentration of recreants, as a rule, are water bodies, especially ecotonic zones of water bodies and forests, water bodies and shrubs, water bodies and meadow, meadow-steppe landscapes of both natural and anthropogenic Genesis.

With a relatively uniform distribution of tourists along the coastline of water bodies, it is advisable to use the method of route accounting. The essence of this method is to calculate the number of tourists on the basis of visual observation. At the same time, it is first necessary to determine the longitudinal and transverse intervals of pressure counting, since the density of recreants can be different. In the process of route accounting, first of all, the total number of recreants is calculated. At the same time, the way they are moved, as well as the type and duration of recreational activities, are very important.

Ways of moving on land: 1) on foot; 2) by bicycles; 3) on motorcycles; 4) in passenger cars; 5) by minibus; 6) on buses and trucks.

When assessing the recreational impact on land complexes should take into account the nature of recreational activity: 1) excursions; 2) picnics; 3) the collection of mushrooms and berries; 4) long-term stationary amateur rest; 5) rest on the basis of institutions of stationary recreation (houses and recreation centers, etc.); 6) rest with the use of motor vehicles (jeeping, rally raids, etc.).

Depending on the nature of recreational activity, the following types of recreation are distinguished with the predominant use of water areas: 1) swimming; 2) riding on rowing boats (boats, kayaks, etc.); 3) riding on motor boats (boats, jet skis, etc.); 5) riding on sailing ships.

The need for such a complex differentiation of accounting is due to the different direction and intensity of the impact of recreants on both terrestrial and amphibious landscapes.

If there are significant differences in the density of the placement of recreants along the coastline (in places of beaches, bivouac parking, etc.), it is necessary to use a differentiated count of the number of tourists. As a rule, the density of recreants in such places varies not only along the coastline, but also gradually changes both within the water area and as the distance from the shore of the reservoir.

As a rule, areas with different intensity of recreational pressure correspond to the level of facies and their groups, thus, the landscape approach to the assessment of recreational pressure is in demand at hierarchical levels, starting from the lowest.
The total number of holidaymakers, tourists on the beach (recreational pressure) represents the amount of holidaymakers, obtained in the result of their counting in sample plots. The same work is carried out within the water area.

In order to more accurate, fast and non-Intrusive work on the calculation of recreational pressure in places of high concentration of tourists, it is advisable to pre-conduct "transparent" marking of both the density of recreants and control transects to obtain quantitative characteristics.

A slightly different method of obtaining an idea of recreational pressure is used in recreational research of forest landscapes. A. I. Tarasov [26] proposes in this case to use the following indicators of recreational use of forest landscapes:

- Number of people per 1 hectare per day (attendance);
- One-time number of visitors per 1 hectare (density of tourists);
- The number of visitors per 1 hectare per hour on days of heavy pressure.

In the process of recreational research of great importance is the method of quantitative characteristics. It occupies a special place in the analysis of changes in landscapes that occur under the influence of recreational pressure of different intensity.

With the advent of recreants in the landscape begins to form a network of paths and roads. With increasing density of tourists inevitably grows and the density of road and path network, increases the number and size of "windows" trampling, "windows" burning, there is a violation and impoverishment of the natural tiered structure of forest, meadow, steppe and other types of phytocoenosis, compaction of soil. In connection with the increasing factor of concern there is a reduction in the diversity of the animal world. Quantitative characteristics of these effects are used in determining the stages of recreational digression. At the same time, such an indicator as the density of the network of paths, the total length of the network of paths per unit area, usually an area of 1 hectare, is of significant importance.

The area occupied by the network of paths is determined on the basis of the calculation of the total length of the network and then multiplied by the average width of the paths. In the presence of places of trampling and places after campfires their calculation per unit area is also made (1 hectare).

In order to obtain the most reliable ideas about the consequences of recreational impact on the landscape, the method of artificial modeling of recreational pressure is used. In this case, a different number of pseudo-recreants are concentrated on specially selected model sites. At the same time, all the consequences of recreational activities are recorded.

4. Discussion
Back in the twentieth century, domestic specialists developed a number of methods for determining the permissible recreational pressure for different landscape conditions, taking into account both the impact on the separate components of the landscape, most often on the vegetation cover, and their combinations. Many methods of assessing the recreational pressure on the landscape are summarized and analyzed in the monograph by V. P. Chizhova "Recreational landscapes: stability, regulation, management" [27] and the monograph by N. V. Bugrova and P. A. Feklistova [9]. The results, obtained in the course of landscape zoning and the assessment of permissible recreational pressure, allow not only to plan recreational activities in a local territory, but also to conduct a comparative assessment of the territories in the initial stage of choosing the most promising territories. To solve this problem, in addition to the method of landscape and recreational analysis, it is advisable to use the method of weight coefficients and analysis of hierarchies [28].

5. Conclusion
Thus, in the process of recreational research, it is possible to obtain information not only about the quality and value of recreational landscapes, but also about the quantitative characteristics of the intensity of permissible, actual and prospective recreational pressure, and on the basis of the obtained
data to develop a strategy for the organization of recreational use of the territory. This is possible on the basis of comparison of norms and parameters obtained in the process of recreational research of specific landscapes with scientifically based norms and parameters developed by experts in the field of recreational environmental management.

References
[1] Shancev V P 2016 The state and prospects of socio-economic development of the Nizhny Novgorod region Vestnik NGIEI 5 74–82
[2] Zyulyaev N A, Nizova L M and Sorokina E N 2018 Domestic tourism as a type of economic activity at the mesoeconomic level Vestnik NGIEI 6 73–83
[3] Karpsonova R A 1967 Dubrava forest park zone of the city of Moscow (Moscow: Nauka) p 103
[4] Zelenskij N N 1979 Experience in determining the main stages of recreational digression of the resort forests of the Precarpathian region Experimental biogeocenology and agrocenoses 50–2
[5] Polyakov A F 1983 Recreational forest use in the Mountain Crimea Recreational forest use in the USSR (Moscow: Nauka) 75–89
[6] Astrologova L E 1999 Vliyanie rekreacji na stroenie i strukturu cenopopulyacij chemiki v sosnyakach chemichnykh Problemy lesovyrashchivaniya na Evropejskom Sever (Arhangelsk: IzdatelstvoAGTU) p 96
[7] Byzova N M 2001 Rekreationnye resursy Arhangel’skoj oblasti Ekologicheskaya situaciya v Arhangel’skoj oblasti: problemy i perspektivy ozdorovleniya (Arhangelsk: Izdatelskii centr AGMA) chapter 2 pp 134–140
[8] Solncev G K 2003 Rekreationnoe pol’zovanie gornymi lesami Severnogo Kavkaza Leshoz inform 10 27–48
[9] Burova N V and Feklistov P A 2007 Antropogennaya transformaciya prigorodnyh lesov (Arhangelsk: Izdatelstvo Arhang. gos. tekhn. un-ta) p 264
[10] 1987 Vremennaya metodika opredeleniya rekreacionnyh nagruzok na prirodnýe kompleksy pri organizatsii turizma, ekskursii, massovogo povedenovogo otdyha, i vremennye normy etih nagruzok (Moscow.: Izdanie Goskomlesa SSSR) p 34
[11] Dyrenkov S A 1983 Izmenenie lesnyh biogeocenozov pod vliyaniem rekreacionnyh nagruzok i vozmozhnosti ih regulirovanija Rekreationnoe lesopol’zovanie v SSSR (Moscow: Nauka) pp 20–35
[12] Kotlyarov I I 1989 Ustojchivost’ k rekreationnym nagruzkam sosnovych lesov centralnoy chasti Severnogo Kavkaza Leshoz inform 2 60–66
[13] Rysin L P and Polyakova G A 1987 Vliyanie rekreationnogo lesopolzovaniya na rastitelnost’ (Moscow: Nauka) pp 4–26
[14] Golod D S and Krassovskij 1990 Vliyanie rekreacji na struktury etih lesnych biogeocenozov Sovremennoe sostoyanie i perspektivy rekreationnogo lesopolzovaniya (Leningrad: LenNIILH) chapter 2 pp 133–41
[15] Melanholin P N 1990 Vozmozhnost’ vosstanovleniya napochvennogo pokrova pri rekreationnoy nagruzke Sovremennoe sostoyanie i perspektivy rekreationnogo lesopolzovaniya (Leningrad) pp 44–5
[16] Lebedev A V 1999 Patologiya derev’ev eli pri razlichnoy rekreacionnoy nagruzke Izv. vuzov. Lesn. zhurn. 2–3 52–7
[17] Astrologova L E, Feklistov P A and Prygov E V 1999 Izmenenie sostoyaniya i struktury napochvennogo pokrova v sosnyakach chemichnykh pod vliyaniem rekreationných nagruzok Evropejskij Sever Rossii: proshloe, nastoyashchee, budushchee (Arhangelsk: Pravda Severa) pp 133–41
[18] Chizhova V P 1977 Rekreacionnye nagruzki v zonah otdyha (Moscow: Agropromizdat) p 49
[19] Melluma A ZH, Rungule R H and Emsis I V 1982 Otdyh na prirode kak prirodoohrannaya problema (Riga: Zinatne) p 168
[20] Kolbovskij Е YU 2004 Izuchaem landshafty Rossi (YAroslavl: Akademiya razvitiya) p 288
[21] Kazankin A P, Slepyh V V and Terre N I 1994 Ekologicheskaya, psihologicheskaya i rekreacionnaya yomkost' lesov v rajone Kavkazskih Mineralnyh Vod Ekologicheskie osnovy vedeniya kozhajstva v gornykh lesah (NIIgorleskekol) pp 89–91
[22] Astashin A Е 2009 Turistsko-rekreacionnaya kadastrovaya ocenka landshaftov regiona (na primere Vorotynskogo rajona Nizhegorodskoj oblasti) / dissertaciya na soiskanie uchyonoy stepeni kandidata geograficheskikh nauk (Moscow: Moskovskij gosudarstvennyj oblastnoj universitet) p 187
[23] Astashina N I and Astashin A Е 2018 Osobo ohranyaemye prirodnye territorii Vorotynskogo rajona Nizhegorodskoj oblasti: perspektivy rekreacionnogo ispolzovaniya (Nizhnij Novgorod: Povolzh'e) p 84
[24] Vidina A A 1962 Metodicheskie ukazaniya po polevym krupnomasshtabnym landshaftnym issledovaniyam (dlya celej sel'skhozoyajstvennogo proizvodstva v srednej polose Russkoj ravniny) ed N A Solncheva (Moscow: MGU im. M.V. Lomonosova) p 132
[25] Astashin A Е, Borisov Е I and Pashkin M N 2017 Iz opyta organizacii i provedeniya ekspedicionnyh landshaftnich issledovaniy v Nizhegorodskoj oblasti Geograficheskaya nauka skvoz' prizmu sovremennosti: Sbornik statej po materialam X Mezhuvozovskoj nauchno-prakticheskoj konferencii studentov "Geograficheskaya nauka v skhole i v vuze skvoz' prizmu sovremennosti" (Nizhnij Novgorod: Nizhegorodskij gosudarstvennyj pedagogicheskij universitet imeni Kozmy Minina) pp 7–10
[26] Tarasov A I Rekreacionnoe lesopolzovanie (Moscow: Agropromizdat) p 176
[27] Chizhova V P 2011 Rekreacionnye landshafty: ustoichivost', normirovanie, upravlenie (Smolensk: Ojkumena) p 176
[28] Astashin A Е and Astashin E A 2015 Vozmozhnosti i preimushchestva primeneniya metoda analiza ierarhij dlya provedeniya sranit'el'nnoj ocenki territorij po kriteriyu turistsko-rekreacionnoj cennosti Azimut nauchnyh issledovanij: ekonomika i upravlenie 3 7–12