Scientific approach to the history of Voronezh forest destruction

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Abstract. The article is devoted to the history of the use and destruction of forests in the Voronezh region. The main task of the study is to establish when the active anthropogenic impact on Voronezh forests began, and from what moment can we talk about their extermination for human needs. The article used the historical, comparative, analytical methods. To achieve the results, we used the data obtained by Voronezh historians and archaeologists, and materials of research in the field of forestry. The combination of these two areas of knowledge is a new method of research. It enables to establish that the first human settlements on the territory of the Voronezh region in the Upper Paleolithic (40-35 thousand years ago) did not leave traces of wooden products or constructions. The authors concluded that the Mesolithic man already actively used wood not only for heating and cooking, but also for building dwellings and for making tools. They hardly exerted a noticeable influence on the formation and evolution of tree stands by the virtue of their small number. The impact of people of the Neolithic and Early Aeneolithic could already be felt, but only in the immediate vicinity of the settlement itself. Arrival of Bronze Age cultures has greatly increased deforestation in the Middle Don region in the 3-2 millennium BC. Especially this process has accelerated with the advent of iron tools. Consequently, in our opinion, the middle of the 2nd millennium BC should be considered the starting point of the history of the Voronezh forest extermination, when slash-and-burn agriculture came to the forest-steppe.

1. Introduction
Forest is a renewable resource. Their productivity and biomass should remain fairly constant with the relative stability of the climate in the interglacial periods of forest area. However, the forest area of the planet has declined by more than one and a half times - from 50% to 27% of the land over the past two millennia [1], and in the European part of Russia - by more than doubled from 60 to 28% [2]. The main reason for such a rapid, in geological terms, the reduction of forest resources, of course, is the anthropogenic impact in the form of depleting forest use and withdrawal of forest areas for agricultural or residential use [1]. The constant, long-term and intense impact of man on forests over many centuries has led to a reduction in their area. In addition, it could not help but have a selective effect on the most exploited species. Such a selection had undoubtedly negative consequences, since all selective logging in domestic forests century had a mine character up to the twentieth. That is, in the
first place, the most productive trees dominating in plantation have been selected. Unfortunately, this problem was not considered by the international scientific community. As for Russian researchers, they attributed the beginning of the forests destruction to Voronezh activities of Peter I in the late 17th - early 18th century. The scientific novelty of this article is that the authors strive to trace the process of forest destruction in the Voronezh region from its very beginning, that is, from the settlement of these places by humans.

The purpose of this study is to search for the historical causes of the current depressive state of most forest-forming species in domestic forests, the constant increase of their pathological features [3]. For this, one should have an idea about the volumes and dynamics of human forest use over the entire history of their use. In this article we want to find out when the environmentally significant human impact on our forests began. Let's try to understand this by the example of Voronezh forests. In this article we want to find out when the environmentally significant human impact on our forests began on the example of the Voronezh forests and to prove that it began already in antiquity, namely 2 millennia BC, when slash-and-burn agriculture came to the Voronezh forest-steppe.

2. Materials and methods
Forestry specialists always asked human impacts on forest ecosystems [4], forest soils, including the Voronezh area [5]. Most historians and experts in the field of forestry believe that the main deforestation of the European part of Russia, and the Voronezh region in particular, began from the Petrine times (late 17th century), during the period of active construction of the Azov and Baltic fleets. So say M M Veresin [6], V V Uspensky [7], P A Popov [8]. Some researchers even transfer this period to the middle of the 19th century - a period of rapid capitalization of Russia, the development of the railway network and the beginning of large-scale timber exports [9]. In this article, we draw attention to the fact that before that, people lived on the territory of modern Russia for several thousand years and, as it is known from history, forest was the basis of their livelihood [9]. This is evidenced by the archaeological data throughout the territory of Russia [10].

It is reasonable to assume that “per capita” wood consumption in Russia was not more, but it was commensurate with modern one in the period before the development of industry and the widespread use of iron, concrete, coal, oil and other non-woody attributes of civilization. There is no direct documentary evidence about the volume parameters of forest consumption of ancient and even medieval man. In this study we decided to use indirect data, such as population density dynamics, nature of its life, soil changes, geobotanical studies, etc. In our opinion, it is enough to designate not only the main historical milestones in the process of forest use and forest destruction, but also to determine, in its volumes in the first approximation (at least within the limits of the order).

Based on this, we set out to clarify the period of the beginning of a significant human influence on forest biocenoses using the example of the Voronezh Region. Thus, the subject of the study is the forests located in the Voronezh region, in the Central Black Earth region of the East European Plain.

The data provided in the articles and materials of domestic (mainly Voronezh) archaeologists, historians and foresters were used for the study of this issue. That is, the article used mainly historical, historiographic, comparative, analytical research methods.

3. Results and Discussion

3.1. Human impact on forests of the Voronezh region in the Upper Paleolithic and Mesolithic period
Archaeological excavations along the shores of the Middle Don (concepts that are close in meaning and characterize practically the same territory: the Middle Don River, the Middle Don Pool, the Voronezh Territory) show that the first human settlements appeared here 40-35 thousand years ago, during the late (or upper) Paleolithic [11,12]. This is more than twenty famous sites of the ancient man in the area of the village Kostenki. Traces of wooden products or structures of those times did not survive at all. Perhaps they did not exist, because the Middle Don River was represented by the tundra landscape of the pre-glacial zone at that time, in which the dwarf birch and thorny bushes prevailed.
The end of the last ice age in the 12-10 millennium BC is characterized by Mesolithic period. The territory of our interest has not had traces of human settlements from the Paleolithic to the Mesolithic period. There are no early Mesolithic sites from 10-8 millennia BC. The period of the Late Mesolithic (7-6 millennium BC) on the Middle Don is represented by several sites (Koloskovskaya, Monastery, Verkhnekarabutovskaya, Dronina, Shapkino). In the same period, deciduous forests begin to form in the modern forest-steppe zone [13-15].

It is known that the Mesolithic man used wood in an active way, not only for heating and cooking, but also for building dwellings (dugouts and semi-dugouts) and for making tools (bows, arrows, axes, spears and darts). Due to their small number (Mesolithic settlements were tribal groups of 18-25 people) and lifestyle (hunting and gathering), people hardly had a noticeable influence on the formation and evolution of forest stands.

3.2. Human impact on the forests of the Voronezh region in the Neolithic period

Wood consumption in the Neolithic and Early Neolithic period increased significantly in the 5–3 millennium BC. Tripoli culture was widespread at that time between the Dnieper and the Volga, characterized by the developed cattle breeding and the beginnings of hoe farming.

Judging by the excavations of the Voronezh Neolithic sites (Cherkasy, Kpanishchenskaya, Otrozhskaya, Yarkulovsky Protoki, Fish Lake, Shalaevskaya, Dolgovskaya, Gnilishche, Ustye, Podzorovskaya etc.), in addition to residential buildings (20 m²), shelters for livestock (100 m²), storage rooms for grain and hay (20-40 m²) and other buildings (8-12 m²) were found the purpose of which has not yet been clarified. Perhaps it was ritual, household, guest buildings, etc. (figure 1). Wood, ash, and numerous remnants of the acorns shell found at the site of settlements in the Neolithic layer indicate that oak was the most frequently used tree species at these sites [13]. Among the objects found at that time, there is a large percentage of stone bits and axe-adzes, typical tools for working wood. If, knowing the size of the settlement and the parameters of the buildings, try to calculate how much wood was spent on their construction (the buildings were piled or made of brushwood covered with clay), then it will be in the range of 300-700 m². The appearance of pottery, requiring roasting contributed to an increase in wood consumption. Taking into account the heating (5 m³/person/year), the manufacture of tools and the needs of crafts, we can confidently assume that one settlement consumed about 1000 m³ of thin wood per year.

![Figure 1. Neolithic field complex from the Cherkasy site (reconstruction by A Z Vinnikov).](image-url)
The wood volume in the virgin forests of the forest-steppe zone of those times (Neolithic or Middle Holocene) was usually 400-500 m$^3$/ha. [13,14]. Consequently, the influence of forest management people of the Neolithic and early Chalcolithic periods could be felt only in the immediate vicinity of the settlement and had no forests evolutionary consequences.

3.3. Human impact on forests of the Voronezh region in the Bronze Times

The next stage of increasing forest consumption is associated with the arrival the Bronze Age cultures in the Middle Don region in the 3-2 millennium BC. Not only the appearance of copper and bronze tools, but also the complication of crafts and life contributed to the increase in logging. Foundry and blacksmith's craft appeared. The manufacture of carts, chariots, sledges, skis, boats, tubs and other woodworking products became widespread. Substantial amounts of wood were used at burials. All known cultures of the Bronze Age on the territory of the Voronezh Territory used wood for graves. During the pit culture, the grave was covered from above with round logs in several rolls. The catacomb of logs produced a massive shield that closes the entrance to the burial chamber. Timber-grave culture came in place of the catacomb one, named, like the previous ones, in the predominant form of burial. Burials were made in barrows in the era of timber-grave culture. A log house was put in the foundation of the barrow (“in the paw” with reeling), which was filled with soil in the height from 3 to 12 m and in the diameter from 20 to 100 m (figure 2).

![Diagram of burial placement](image)

**Figure 2.** Placement of burials in the mound: 1 - burial of ancient pit culture, 2 - burial of catacomb culture, 3 - burial of log culture (A - buried soil, B - continental faults, C - early embankment, D - medium embankment, E - wood) (by A. Z. Vinnikov).
There are thousands of such burials on the territory of the Voronezh region [13,16]. However, it is known that the mounds above the graves were the privilege of the nobility. No more than 5% of the dead were buried in them [17], since the construction of the mounds required large labor costs (from 500 to 100,000 man-days). The bulk of the graves were without a mound and expensive things, but often with good-quality "housing" in the form of a wooden crypt. Such burials, for example, were found in the settlements of Borschevo IV, Mosolovsky, Tereshkovsky Val, and others [13]. It is not possible to calculate reliably, at least in the first approximation, how much wood was "buried" over 2,000 years of the logs' existence, since the dynamics of the population density of those times or the percentage of the remaining barrows are unknown. Purely hypothetically, if we assume that the kurgans were about 5% of the graves, and not more than 1% were preserved (known), then the 1000 Voronezh kurgans of the Bronze Age should correspond to 2 million ordinary burials. On average, 2.5 m³ of logs and scaffolds were used per burial, therefore, the ancient inhabitants in our area could use about 5 million m³ of wood only on wooden crypts. It should also be remembered that burials in the kurgans were accompanied by grandiose ritual bonfires. Big bonfires were even raised on small kurgans, as it is evidenced by the lenses of ash and coals on their tops [13].

And it was far from the biggest expense items. Log burial technology is obviously related to the type of the used dwellings. For the sake of justice, it is worth noting that log buildings of those times have not yet been found in the region, but it is well known that burial structures are always a reflection of real dwellings. If, according to the same principle as the funeral forest management, we calculate the costs of housing, household utensils, heating and cooking, crafts, transport, weapons, tools, footwear (based on the average population of 12,000 people - the corresponding ecological capacity of the territory with the appropriate type farm, that is, 500 hectares per person), you get a figure of 120 million m³ for 2 thousand years of the Bronze Age (12,000 people × 2,000 years × 5 m³/person/year = 120 million). Despite the impressive results, this amounts to no more than 10% of the natural wood increment for the period in the forests of the Middle Don basin (1.5 million ha of forests × 4 m³/year/ha average annual increments × 2000 years = 12 billion m³). But, given that the sedentary population was localized in river valleys, and wood was used selectively, probably already in those times there would have been focal degradation of forest biocenoses, expressed in the steppe formation and growth of the ravine system.

3.4. Human impact on forests of the Voronezh region in the Iron Age

In the end of 2-th Millennium BC, however, ploughing agriculture comes with the advent of iron in Eastern Europe, replacing the hoe farming. It sharply increased the areas of the virgin lands developed by the ancient person. The developed agriculture and pastoral cattle breeding of Low Dnieper and the Low Don people stimulated extortionate attacks of the North Black Sea and Caspian hordes of nomads. This forced settled tribes of the Cimmerians, Melanhlems, Budins, Gelon to move to the forest-steppe zone, where they could take refuge in the coastal forests and swamps and build fortified settlements (figure 3).

The result of this process was to increase the population density of the forest-steppe zone. At the beginning of the 1 millenium BC the population of forest-steppe between the Dnieper and the Volga was 2 times higher than in the forest and steppe zones [13]. There was a unique mixture of people and cultures called subsequently "The Voronezh ethnic knot" when nearby multilingual settlements coexisted. It was the danger of cultivating the rich but open Virgin steppes, which resulted in the rapid development of fire farming.

In this form of farming, the forest (exceptionally deciduous) was dug in along the perimeter of the future field for drying (outlined). Trees were ringed (cut) after 2-3 months [15] or after 1-2 years [18], cut and burned. By the way, it was a great art to burn down the undercut area, not having burned parts of the surrounding forest. Not only the lower, but also the upper fires on large areas were burning and during the spring burning of the "undercut" forest. At first, the burnt areas, with still warm ash and smoking rhizomes, were thrown open and sown. Subsequently, the cutting area before the plowing
was rooted out. This is evidenced in particular by the use of tree gum with root paws in the construction and everyday life of ancient Russia.

The landowner produced 50-100 times more grains than he planted (himself-50, himself-100) in the first year in the place of the burnt forest. In the second year, the harvest was already 30 and even 10 times higher [18]. Then the fertility of the land fell sharply, and farmers, after 2-3 years of use of "forest" arable land, had to develop new forest areas. It is known that Voronezh settlements of those times numbered 100-250 inhabitants (Anuchenskoye, Voloshinskoe, Maslovskoe, Podkletenskoe, Chertovitskoe and others). Each settlement had equipped pits for storing grain with a capacity of 60-80 t [17]. If we start from the yield of the main crop, spelt (unpurified wheat) was equal to 10 centners per hectare, it turns out that the arable area of one settlement was about 50 hectares. Approximately the same area of annual arable land of one ancient forest-steppe settlement is obtained by assuming that one family of those times cultivated about 1 hectare [19]. It is easy to calculate that one settlement for 100 years "mastered" about 2,000 ha. According to V P Zagorovsky [18], A Z Vinnikov [13], A D Pryakhin [19] the number of "settlements" in the I century BC on the Middle and Upper Don, Voronezh, Usmanka, Bityuga, Khopra, Tikhaya Sosne and other Voronezh rivers and small rivers ranged from a few dozen to a hundred. The period of slash-and-burn farming in Russia lasted for more than 30 centuries, from the middle of the 2nd millennium BC and up to the XVI century AD [21] (figure 4). For the Voronezh region, this period should be limited and divided into three periods (VIII century BC - IV century AD; VIII - XIII centuries AD and the end of XVI - middle XVII centuries AD) in connection with the specifics of the historical process and known fragments of the dynamics of the population density of the region [13,17].

Slash-and-burn farming is an extremely wasteful economy. It is possible only with an abundance of forest area and a low population density [20]. There is no doubt that first forest forests suffered from slash-and-burn farming were oak forests. They gave more fertile land than the alder, aspen forests and pine forests that were then widespread. Until the nineteenth century, these lands were called "sub-oaks" [15]. According to A V Vinnikov [13] forest cover of the Middle Don region in the 2nd millennium BC accounted for 50%, and the number of oak in these forests, according to the geobotanical studies of M I Neishtadt [14], ranged from 24 to 38%. Thus, it is likely that long before the "chronicle" Russia, the Voronezh near-riverbed and upstream inter-channel forests were completely cut down from two to six times.

Figure 3. Dwellings of the early Iron Age (reconstruction of V N Kovalevsky).
After the termination of cultivation of the uprooted area, it was re-overgrown (and initially with soft-leaved or coniferous species) or, more often, eroded, swamped or turned into the steppe [15].

Figure 4. Fire farming in ancient Russia (by V P Petrov).

However, there are opinions that dispute the global impact of man on nature in ancient times. According to N A Tropin, the impact of the Slavic population on deforestation on the Voronezh River was minor. Most often, people cut down the forest, which was located closer to the settlement or place of the ancient city. The researcher noted a weak concentration of the population in the Middle Ages. Referring to the distribution of different types of soils N A Tropin writes about the rapid regeneration of vegetation, especially in the floodplain of the Voronezh River in the early stages of the Middle Ages [22].

4. Conclusions
According to the data, our ancestors in the territory of the Voronezh region cut down, burned and uprooted from 1.2 to 2.6 million hectares of forest for twelve centuries (VIII century BC - IV century AD). The above calculations and reasoning require a deeper historical, ecological and silvicultural analysis, but in this form they give reason to believe that forest-changing activities of ancient tillers were quite large-scale, and it could have evolutionary effects for such complex and existing millennia of forest ecosystems.

Consequently, the middle of the 2nd millennium BC should be considered the starting point of the history of the Voronezh forest destruction, in our opinion, when slash-and-burn agriculture came to the forest-steppe.

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