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Landscape-and-climate dynamics and land use in Late Holocene forest-steppe ecotone of East European Plain (upper Don River Basin case study)

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ABSTRACT

Results of lithological and palynological data of key sequences of the forest-steppe region in the Upper Don River basin, notably, the Kulikovo Battle-Field area, are presented. The obtained evidence shows the occurrence of open forest-steppe and steppe landscape in the Late Holocene. Climate reconstructions failed to demonstrate any drastic changes in the second half of the Holocene. However, even small reductions in annual precipitation, from 400 to 500 mm in the Atlantic, to 300–400 mm in the Subboreal period, accompanied by the rise of summer temperature, from 20–22 °C to 22–24 °C, respectively, were sufficient to cause landscape changes from the forest-steppe to typical steppe. The paper discusses various aspects of human impact on the landscape.

1. Introduction

The Holocene dynamics of forest-steppe zone of the East European Plain and the history of its agricultural land use remain fascinating topics of scholarly studies. This ecotone, being an intermediary between the steppe and forest zones, is highly sensitive to even minor climate changes. Its principle cause resides in the 'null area', an important bio-climatic entity, featuring the precipitation/evaporation balance, being located within its limits. As follows from previous investigations, the present-day forest-steppe, generically linked to the Pleistocene periglacial forest-steppe, had been formed during the Middle and Late Holocene (Serebryannaya, 1976, 1981; Khotinski et al., 1979; Folomeev et al., 1990; Spiridonova, 1991; Glasko et al., 2000).

The landscape diversity and reach natural resources made these areas attractive for early humans, causing their regional peculiarities, which became apparent in Late Holocene. According to the available records, the Upper River Don area includes Mesolithic, Neolithic and Bronze Age sites, early Slavic settlements of the 9th and mid-10th centuries AD, and more then 200 Old Russian settlements, hill-forts and 'flat' cemeteries dating from late 12th until late 14th centuries AD. Starting with 10th–12th centuries, the forest-steppe developed into one of the Russia's main farming areas with an advanced agriculture and stock-breeding (Gonyanyi, 2003).

For the last 30 years, the archaeological and palaeogeographical studies in the area which includes the Upper Don, the Nepryavda, its tributary, and their interfluves, are being conducted by the State Museum of History, Institute of Geography of Russian Academy of Sciences (both in Moscow), and the State Historical-Military and Natural Reserve 'Kulikovo Battle Field'. The multidisciplinary studies of that area were initially focused on the reconstruction of natural landscapes that would correspond to the Kulikovo Battle of 1380 (the historically important military engagement in which the Russians defeated the Tatar-Mongol forces). The present paper discusses the newly available lithological–stratigraphical and pollen evidence resulting from the study of two key sequences on the 'Kulikovo Battle Field', as well as the reconstruction of landscapes and climate for the time-span ranging from the Mid-Atlantic period to the present.

2. Study area

The 'Kulikovo Battle Field' (53.65°N, 38.79°E) is located in the middle part of the East European Plain, on the northern slopes of Central Russian Upland (Fig. 1). The present-day landscape consists of small-size evenly undulating watershed plateaus 210–234 m high, separated by prolonged narrow valleys. Gentle watershed slopes are dissected by numerous ravines, often steep, with evidence of recent erosion, and, rarely, landslides.

The present-day climate is moderately continental, an intermediate between moderately wet North–West and warm and dry South–East of European Russia. Mean annual temperature is +4.5 °C, with that of January and July, −10 and +19 °C, respectively. Mean annual precipitation, 445 mm.

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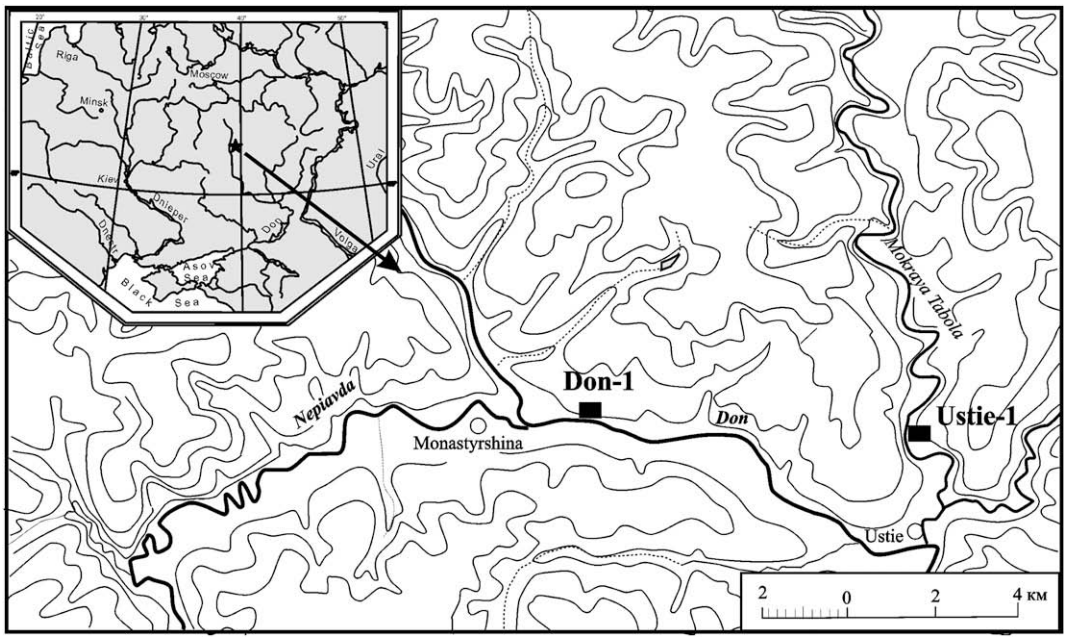

Fig. 1. Geographical position of the investigated area. Contour interval 20 m.

The vegetation cover of the northern regions combines the forest and herb communities. Large areas of broad-leaved forests still exist in the Upper Don basin and its tributaries. They have a character of steppe forests with blackthorn (*Prunus spinosa*) and ground cherry (*Cerascus fruticosa*) on the edges. However, both the natural vegetation and animal world were greatly transformed by anthropogenic processes over the past 300 years. The present-day landscape is almost entirely treeless, with natural forest and herb communities being transformed into either functioning or abandoned agricultural cenoses.

3. Methods

As shown by previous temporal and spatial reconstructions of the local geosystems in the Holocene, river floodplains are most suitable objects for the study of landscape dynamics (Khotinski et al., 1979; Folomeev et al., 1990; Glasko et al., 2000). In the present research the sequences of the Don floodplain were chosen as the study objects: the section Don-1 near Monasatyrshchina-Tatinki village, and the section Ust'ye 1 on the River Tabola, near Ust'ye village (Fig. 1). The sites' chronology was controlled by the radiocarbon dates obtained at the Radiocarbon Laboratory of the Institute of Geography RAS (Table 1), as well as archaeological materials (in the case of the Ust'ye 1 sequence).

The pollen samples were processed in accordance with the standard techniques of the Institute of Geography RAS, with the use of heavy liquid (the specific gravity, 2.2 gram/cm^3, Grichuk, 1940) and the solution of cadmium iodine. The pollen samples from the cores were taken at 10 cm intervals. In each sample c. 500 terrestrial pollen grains were counted. The TILIA2 and TILIA GRAPH2 programs (Grimm, 1990) were used to plot pollen diagrams.

The reconstruction of main parameters of past climate (mean July and January temperature and annual precipitation) was carried out with the use of Klimanov's (1984) information-statistical technique, based on the comparison of fossil pollen assemblages with their modern analogies by transfer function. The calculations were made for the Don-1 sequence and controlled by those for the Ust'ye 1. Climatic characteristics were calculated for the spectra of several samples for each zone. This technique being based on the proportion of the arboreal pollen, its application for the forest-steppe environment is rather limited. Therefore, only the spectra with the participation of arboreal species were used, viewed by Klimanov (1984) as highly (oak) or medium (elm, lime) climate relevant. The estimated temperature and precipitation values calculated from various spectra for each zone proved to be similar within standard error. Considerable deviations shown in the uppermost spectra are due to nearly total absence of broad-leaved species apparently resulting from anthropogenic landscape changes. Historical records were used for the reconstruction of the aspects of climate of that period.

4. Geological setting

The River Don valley in the studied area is asymmetrical, the river-bed coming close to its right abrupt bank and forming a narrow stony beach (Fig. 1). The floodplain is restricted mainly to the Don's left bank. It adjoins the first terrace and consists of alternating hollows, oxbows and relics of older flood-plain generations. The upper terraces are not conspicuous in the relief. The Don-1 sequence is located on the main flood-plain level at the confluence of the Don and Nepryavda, in front of the eastern end of Monastyrshchina village.

The Don-1 sequence, 5 m thick (Fig. 2), exposes the bottom stratum overlain by ox-bow sediments. Following its isolation, the

Table 1
Results of radiocarbon dating of sediments from the section Don-1 and Ust'e-1.

Depth of sample, cm	Material dated	Lab. N IGRAN	Age, ^{14}C BP.	Cal. Age, BP.
Profile Don-1				
480–500	Wood remains	2905	5780 ± 60	Cal BP 6670 (6624) 6590
210–215	Humic acids	2906	2760 ± 60	Cal BP 2927 (2851) 2776
170–175	Humic acids	2907	1570 ± 40	Cal BP 1519 (1415) 1402
Profile Ust'ye 1				
340–350	Humic acids	2908	3440 ± 70	Cal BP 3823 (3689) 3624