ПУБЛИКАЦИИ

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CLIMATE CHANGE IN CENTRAL EURASIA AND THE GOLDEN HORDE

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This essay offers an original interpretation of the climate history of the Golden Horde. Following an overview of the ecological zones of the territory of the Golden Horde, it contextualizes the climate of the 13th–14th centuries against the larger picture of the 9th–19th centuries, since the period of the Golden Horde coincides with the transition from the "Medieval Warm Period" to the beginning of the "Little Ice Age". The essay offers an overview of the kind of data available for a discussion of climate change and how they provide indirect evidence. It then turns to an examination of the data for temperature, precipitation, dendrochronology and climate change. It argues that while vegetation zones did not change, there was apparently an end to the warm and wet period in the southern zones of the Golden Horde in the 1280s, the beginning of the transition to the Little Ice Age, which could have affected agriculture in the Golden Horde, possibly resulting in grain production shifting to the north.

Keywords: climate change, precipitation, temperature, dendrochronology, Medieval Warm Period, Little Ice Age.

This essay considers the question of climate and climate change in Central Eurasia during the time of the Golden Horde (13th–14th centuries). Focusing exclusively on two centuries, however, would not really give us meaningful insights into the climate history of Central Eurasia in this period. In order to contextualize this period of climate history, it would be more meaningful to consider a broader period of time. For this reason in this essay I will try briefly to set the 13th–14th centuries against the backdrop of the larger picture of climate change from the 9th–19th centuries. The reasons for choosing this longer period of time is because the Golden Horde coincides with a period of transition from the era known as the "Medieval Warm Period" to the later cooling trend which is known as the "Little Ice Age".

1. The Ecological Zones of the Territories of the Golden Horde

As is well known, the territory of the Golden Horde, which stretched from the Zaysan Pass in the east to various lands in Eastern Europe in the west, and from Khwarezm and the Pontic and Kazakh steppes in the south to Siberia in the north, can be divided into roughly three ecological zones. The southern-most vegetation zone, that of desert-oasis [14, p. 95–96], is a well-known example of variation within a single zone resulting from the sharp segregation of habitable areas from uninhabitable areas. Today, the part of this zone which fell under the domination of the Golden Horde, namely Xwarezm, receives 30 cm mean annual precipitation or less (with much lost to dessication), and it is only along the southeastern piedmonts of Central Asia (in the 13th–14th centuries forming a part of the Chagatay Khanate) that this figure rises [14, p. 77–78]. In those parts of this zone forming a part of the Golden Horde, sedentary human habitation would be possible only within the irrigated oases of Xwarezm.

The next zone to the north is the steppe zone [14, p. 94–95], the grassland known to medieval travelers as the "wilderness" [23, p. 112] and home to the nomadic population of the Golden Horde and the so-called "empires of the steppe" throughout history. The steppe begins in the east in Manchuria and extends west through Mongolia in a band roughly 300–1100 km wide to as far west as Romania, beyond where the Danube River empties into the Black Sea, and the Alföld or Great Hungarian Plain. This zone extends westward from Mongolia in only two spots: the elevated southern steppe passing through the Dzungar Gate [14, p. 50] and encircling Lake Issyk-kul (this area formed a part of the Chagatay Khanate) and the northern steppe gate passing through the Altay Mountains along the Black Irtysh River to Lake Zaysan and then continuing northwest along the Irtysh River. One must also add to this the figures for the adjacent mixed forest-steppe north of the steppe zone, since this transition zone of grasslands and trees roughly 200–500 km in width [14, p. 93–94] often offered easy access for nomads, though there were also sedentarists inhabiting this zone.

Beyond the forest-steppe is the mixed forest zone, a cone expanding northwest from east of the Ural Mountains to the Baltic Sea and stretching north. This mixed deciduous-coniferous forest eventually turns into coniferous forest in those regions where the climate is sufficiently wet and cool. Together, the forest-steppe and the mixed forest constitute one of the most important zones of medieval agriculture, even though the forest-steppe was shared with the nomads. In the east the forest-steppe changes rapidly from mixed forest or swamp into the tayga coniferous forest zone, while west of the Volga River the forest-steppe and forest zones head southwest.

There are four distinctive sub-zones running through the zones traveled by pastoral nomads running latitudinally from the southern edge of the steppe zone to the forest-steppe in the north. At the southern edge of the steppe zone is the first sub-zone of semi-desert (sometimes considered a part of the desert-oasis zone), the vegetation of which alternates seasonally between desert (in the summer) and steppe vegetation (in the winter) [9, p. 175]. This sub-zone swings around the northern shore of the Caspian Sea and follows the course of the Volga River from two-thirds of the way up to Volgograd, where the line of 30 cm mean annual precipitation crosses the Volga, to as far as Volgograd itself. The second sub-zone of dry steppe (sometimes considered to be part of a separate semi-desert zone) [14, p. 95] extends from the great bend of the Volga near Volgograd, where the line of 40 cm mean annual precipitation crosses the Volga, to south of Saratov. Cultivation in the sub-zones of semi-desert is generally not possible without irrigation.

The third sub-zone, that of true steppe, extends northward along the Volga River from south of Saratov to Samara (Kuybyshev), where there is another bend of the Volga River. The largest area of this steppe is a cone extending northeast from the Black Sea littoral and the western half of the North Caucasus foreland towards Samara. This zone receives more precipitation than the sub-zone of dry steppe (or semi-desert) to the south. Even though it is still too arid and subject to drought for trees to develop, the cultivation of cereals such as wheat is possible without irrigation[1]. Precipitation continues to increase as one proceeds northward to the end of the sub-zone of true steppe at Samara, where the line of 50 cm mean annual precipitation crosses the Volga. This is the beginning of the sub-zone of forest-steppe (often considered a separate zone) extending along the Volga River from Samara to just south of the confluence of the Volga and Kama Rivers. This zone offers the best agricultural lands from the standpoint of heat, precipitation, and fertility. The forest-steppe zone ends and the mixed forest zone begins where the line of 60 cm mean annual precipitation crosses the Volga. The forest sub-zones continuing to the north correspond not only to areas of increasing mean annual precipitation, but to ever-shorter growing seasons as well.

Additional factors to consider for the steppe and forest-steppe zones include the length and depth of winter snow cover, which are critical factors for the pastoral nomad and his herds [18, p. 22ff.]. To the east of the Ural Mountains the grass of the northern steppe can be covered with snow for up to 180 days per winter, and this far east even the southern steppe of the Golden Horde (not including the elevated southern steppes which would fall under the Chagatay Khanate) can be covered with snow over 120 days per winter. On the other hand the grass of the lush northern part of the steppe zone west of the Urals is covered with snow over 140 days per winter, while along the Black Sea the southern edge of the steppe this figure drops to as little as 40 days. Around Azerbaycan and in the Crimea the duration of winter snow cover can be even less [14, p. 85; 2, p. 117].

[1] Smith offers a more detailed account, including an excellent description of the vegetation of the steppe zone [18, p. 22–24].

A related consideration is the depth of winter snow cover. Although the horses native to this area have adapted to snow up to about 40 cm in depth, cattle, sheep, and goats can survive in snow-covered pasturage only if there is tall grass and it is not covered by snow deeper than about 20 cm[2]. For this reason it is also worth considering the data on the depth of winter snow cover: the line of 20 cm mean maximum depth of snow cover crosses the Volga River south of the great bend of the Volga, thus including within it most of the southern-most sub-zone of steppe and all of the dry steppe. On the other hand the situation further to the east is far worse: the line of 20 cm mean maximum depth of snow cover dips somewhat to the southeast, skirting the Aral Sea and running parallel to the Syr Darya [14, p. 83], which can only mean that all the sub-zones of steppe east of the Ural Mountains fall north of this crucial line.

The modern data presented so far on variation within the steppe zone are useful (insofar as they are applicable to the medieval period) for reconsidering a major question that has been debated inconclusively by historians of the *Völkerwanderungen* or great Eurasian migrations, namely why there was a constant series of historical migrations of nomadic populations from east to west. I would argue that there is at least one significant consideration which seems to be absent from the traditional scholarship: early nomadic populations to the east of the Ural Mountains must have been well aware that the winters were less harsh in the southern winter pastures just north of the Black Sea and the Caucasus Mountains and that the pasturage west of the Ural Mountains was far richer. They surely understood that the same area of pasturage could support a far greater animal population and therefore human population to the west of the Ural Mountains than to the east. A pastoral nomad concerned with feeding his flocks during the winter also understood that a southern winter pasture with as little as 20–40 days of snow cover in the west had great advantages over a southern winter pasture in the east with 140 days or more of snow cover, most of which would probably be 20 cm or deeper for an extended period of time. Medieval travelers have also remarked that the steppe east of the Caspian was inhabited much less densely and confirm the inability of the eastern steppe zone to support its population as well as the steppe zone in the west [8, p. 58]. Therefore the more plentiful water and food resources and the milder winters of the west should be considered one of the significant factors attracting pastoral nomads to the west from various regions to the east throughout historical time. One additional factor which must be considered, however, is that climate was not constant and changed over time, which means it could also affect these conditions just described above.

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[2] "Kirghiz" (Kazakh?) foals are unable to paw food buried deeper than 25 cm, while adult horses find 30 cm of snow hard to paw, and 40 cm is the maximum for adult animals [18, p. 22].

2. Climate Change in the Territories of the Golden Horde

The description of environmental zones offered above is based on data for the modern period. Researchers in a variety of disciplines now recognize, however, that climate has not been constant throughout historical time and that present-day climatic conditions are not necessarily representative of earlier periods even in our own millenium. Therefore, any examination of the environment of these territories in the medieval period should at least attempt to confront the problem of climatic variation over longer and shorter periods of time as discussed in the scientific literature.

Climatic change can be studied in terms of long-term and short-term variation. Evidence for changes in global climate over longer periods of time (over millenia and the even longer glacial periods) is provided by changes in the advance and retreat of glaciers, changes in the vegetation patterns covering the earth, and many other categories of so-called "proxy" evidence[3]. Scientists have associated climatic change on earth over the larger periods with variations in the earth's orbit, the effects of which differ above and below 43 degrees N and S latitude. More recently scientists have concluded that climatic change can now be considered the result of changes in global weather patterns which result from the changes in solar luminosity and other phenomena[4]. Occasionally factors affecting global weather patterns such as the dust spewed forth by major volcanic eruptions must also be considered. Evidence for more recent short-term climatic variation (over centuries, decades, and individual years) is offered by the lower-scale advance and retreat of glaciers; variation in layers of tree ring growth; variation in isotope readings in a variety of sources such as datable layers of ice core samples or tree ring growth; written sources; and certain other categories of "proxy" evidence.

It is instructive to recall that short-term variation in the climate of the territories of the Golden Horde can be viewed against the backdrop of long-term trends in the climate of the territory formerly known as the "European part of the USSR". The analysis of pollen from successive layers of peat bogs (which cannot be dated precisely) shows that the center of this territory north of Moscow experienced a significant warming trend beginning roughly 6,500 BCE which peaked roughly 4,000–3,000 BCE and that we are currently in the continuing phase of cooler and wetter climate which followed [31, p. 87; 16, p. 122]. Data for the Middle Volga region also reveal a warming trend ending in the cooler phase of today[5]. This is further

[3] The first attempt at a history of global climate change is offered by Brooke [1].

[4] See the essays in the volume edited by Wigley et al. [22]. See also the essays in the volume edited by Pecker and Runcorn [15] for an important collection of essays on the problem of climatic change and the sun; a summary of some of these points is found in an article by Wigley and Kelly in the same volume [21, p. 547–549].

[5] Peat bogs 4,000–7,000 years old in the Middle Volga region reveal a pine-birch phase, followed by a warmer alder–broad-leaved (or coniferous–broad-leaved) phase, ending in the cooler pine–broad-leaved phase of today. Areas further to the southwest

confirmed by data for the basin of the Malyy Cheremshan (east of the Volga-Kama confluence), which also indicate that the earlier climate of this territory was warmer and drier than present, followed by a period of increased temperature and precipitation, culminating finally in the modern era's cooler and wetter climate [42, p. 255–258][6].

It would be important to know what conclusions can be drawn from these data regarding the climate of the second millenium CE and especially the period of the 13th–14th centuries. If we are to judge by a series of vegetation maps by Neyshtadt vividly illustrating these long-term changes over the past 12,000 years, we can see only that the boundary between steppe and forest-steppe has advanced somewhat to the north over the past 2,500 years in the territory west of the Volga river [36]. This can be taken as an indication that while the exact composition of vegetation within the various environmental zones has changed over time, there could have been at best only minor changes in the boundaries of the various zones over the past millenium[7]. For the southern regions, it can be seen that during the past millenium there has been an increase in birch or pine at the expense of warmer weather plants such as broad-leaved trees in the northern parts of the Caucasus mountains [36]. In the Middle Volga region the final phase down to our own day, which consists only of the uppermost 50–75 cm of the peat bogs from this area, is characterized by an increase in pine and birch, with a corresponding decrease in broad-leaved trees. Some of these changes could result from the intervention of man, but they are also consistent with the notion of a period of cooling continuing through the past millenium [16, p.107–110][8]. It is worth noting that the uppermost layers of pollen data for the basin of the Malyy Cheremshan corresponding to the most recent times show an increase in spruce, though by the 19th–20th centuries this tree no longer grew in the basin of the Malyy Cheremshan. These same uppermost layers also indicate a decrease in broad-leaved trees [42, p. 259][9]. Thus, these data suggest that the climate may have been somewhat warmer earlier in the past millenium, with certain changes in evidence even for the past few centuries. Unfortunately such data do not permit chronologically more precise conclusions regarding the 13th–14th centuries.

For more precise information regarding the period of the Golden Horde, it is necessary to examine data which can be dated accurately to the 13th–14th centuries. There is far less data available for short-term variation in climate in the territories of the Golden Horde than for Western Europe,

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reveal the former presence of trees such as hornbeam and beech preferring more warmth [16, pp. 107–110].

[6] I am not considering the contemporary concern over global warming in this essay.

[7] See, however, Buchinskiy's discussion of Grichuk 1946 [27, pp. 49–50].

[8] The data for Estonia also indicate that this long-term cooling trend has continued through our own millennium [36, p. 42].

[9] Shalandina attributes this change in tree patterns to human intervention.

nor would it would be possible to derive the climate of the Golden Horde from the data for the climate of the rest of Europe in this same period[10]. Nevertheless, certain categories of "proxy" data offer important evidence regarding the climatic history of the territories of the Golden Horde in the 13th–14th centuries. These data include explicit references to temperature, precipitation, and famine in sources such as the Russian chronicles; written and physical evidence on the changing level of the Caspian Sea; the physical record of annual sediment deposits in Lake Saki in the Crimea; analysis of pollen from datable archeological sites; and certain other sources[11]. Even so, I must caution that there is no consensus regarding all the basic facts relating to the climatic history of this territory and that I am offering in this work an original synthesis which will no doubt require extensive revision as scientific research proceeds[12].

3. Temperature and Climate Change in the Territories of the Golden Horde

To begin with temperature, although the precise regional and local variations in temperature in the territories of the Golden Horde may never be known, the application of *global* trends is a very attractive working hypothesis for which certain other correlations can also be established. One study has assembled data to suggest that the uniform advance and retreat of glaciers around the world is indicative of shorter-term global trends of cooling and warming, including the following cold intervals over the past two millenia[13] [21, p. 550–551]:

[10] It is believed that fluctuations of rainfall and run-off in the Crimea and much of southeastern Europe are generally inverse to those of northern, western, and central Europe [10, p. 84]. However, the detailed studies of climatic change in Western Europe during this period cannot be considered applicable to the territories of the Golden Horde. Moreover, the Golden Horde covered such a vast area of Eurasia that there was significant variation within its territories.

[11] Additional evidence for the climatic history of Russia is offered by dendrochronology (the study of annual tree ring growth patterns), but the sudden declines in ring growth for this region are not related to the long-term trends in precipitation discussed here. They are more likely to be indicators of periods of cold or drought [33].

[12] I will not attempt a detailed discussion of this literature because it enters into areas where I am strictly an amateur. I would observe, however, that much of the data on which this research is based is culled from the Russian chronicles. Since the interpretation of these data is still open to debate (see the perceptive comments of Lyaxov [35, p. 69]), historians should approach reconstructions of the climate of the European part of the USSR (and the equations applied to these data in some of this literature) with great caution.

[13] It should be remembered that these data may not reflect other undetected cooling trends, nor are the suggested minima intended to be regarded as highly accurate.

Cold Periods	**(Suggested Minimum Date)**
570–660 CE	(640 CE)
850–1040 CE	(930 CE)
1280–1400 CE	(1330 CE)

Conversely, maximum temperatures during *global* periods of warmer climate would fall between these cooler periods (so between 660–850 CE and 1040–1280 CE). Based on these data, it seems that more or less the first eight decades of the 13th century were the latest part of a *global* warming trend. The year 1280 marks the period of the beginning of a global cooling trend through the end of the 14th century centered around 1330 CE. Many scientists and scholars believe that this is, in fact, the beginning of the cooling period known as the "Little Ice Age" (with 1650, 1770, and 1850 CE marking the beginning of three particularly cold intervals) [13].

This periodization should be contrasted, however, with studies suggesting a somewhat different series of pessima (periods of cooling) alternating with optima (periods of warming) in Western Europe over the past two millennia[14]. These divergent views result not only from the introduction of new data, but also from the fact that variation in climate was not uniform over the whole of the European continent, let alone over the entire planet[15]. For example, Fagan argues that the medieval warming period from 800 CE to about 1200 CE offered unusually mild and stable weather conditions in Northern Europe and created favorable ice-free sailing con-

[14] See Le Roy Ladurie and Lamb for different earlier periodizations [11, p. 245–246; 10, p. 117–271]. Other scholars use the terms Medieval Warm Epoch (1000–1400) and the Little Ice Age (1400–1800) [6, p. 16–17].

[15] Climatic change and shorter-term changes in weather patterns do not occur uniformly (or predictably, for that matter) over the entire world [6, p. 16–17; 10, p. 21–66, especially 34–36]. For example, periods of warmer weather in Antarctica in 1250–1450 and 1670–1840 correspond to pessima, or periods of cooler weather, in Western Europe [10, p. 36–37]. Great differences arose between wet and dry and between warm and cold weather over longer periods of time in different parts of the same latitude zone around the planet [10, p. 35]. One explanation of the phenomenon of inverse climatic fluctuation already mentioned above is the organization of summer weather systems into a series of cold troughs. A system of four cold troughs (over the Bering Strait, the Atlantic coast of North America, Finland to the Adriatic, and Lake Baykal) is considered representative of an optimum or warm period in Western Europe such as during the 11th or 20th centuries, while a system of five cold troughs (two over North America, one each over England, the Aral Sea, and Manchuria) is considered representative of a pessimum such as during the 16th–17th centuries or the period of the Golden Horde. For additional details see Leroy Ladurie's summary of the works of Lamb and a series of other scholars [11, p. 297–304, especially 299]. (The specialist will note that I have considerably oversimplified the description of these complex phenomena).

ditions in the northern seas. This allowed the Vikings to sail across the Atlantic to Iceland, Greenland, and Labrador as well as to venture over a far broader range of territories across Eurasia than they ever had earlier [3, p. 3–21]. I would add that the warmer conditions in the Middle Volga region was probably a contributing factor in the migration of the Bulgars to the north, resulting in the establishment of the Volga Bulgarian state.

The suggested minimum date of 1330 CE for the cold period 1280–1400 CE coincides with the beginning of the spread of the Black Death, highlighting the nexus between climate change and disease which is only now beginning to be appreciated by scholars. As we know from Europe and North America, the Little Ice Age had a dramatic impact on the daily life and economy of the local populations and led to the abandonment of many settlements in marginally viable ecological zones. Yet the implications of the most severe periods of the Little Ice Age for sedentary regions such as the Middle Volga region or for the nomads of the Eurasian steppe have yet to receive serious scholarly attention. As I have noted elsewhere, the Middle Volga region is susceptible to poisoning of rye crops during times of poor growing conditions and extremes of weather are associated with climate change [45, p. 16]. The problem of nomads in Central Eurasia enduring a food crisis during the period of the Little Ice Age also requires special attention[16].

4. Precipitation and Climate Change in the Territories of the Golden Horde

In contrast to the question of temperature, abundant precise data exist for the study of precipitation in the territory of the Golden Horde in the 13th–14th centuries. For the southern territories remarkable evidence on climatic history over the past four millenia is to be found in the sediment layers of Lake Saki in the Crimea. Although these data are famous among historians of climate, they have not been considered so far by historians of the Golden Horde. According to Schostakowitsch, who pioneered the study of these deposits, 250–790 was a dry period and 1090–1280 was a period of rather thick deposits [17, p. 179 and graph, p. 177]. Lamb considers that unusually thick layers in 805 CE and a series of very thin layers in the 1280s mark the beginning and the end of the medieval period of moist climate in the Crimea [10, p. 83–84 and Figure 34, "Thickness of the yearly mud layers (varves) in the bed of Lake Saki in the Crimea, indicating rainfall variations in the area since 2300 BC"][17]. Lamb further observes that

[16] White offers a comprehensive study of the problem of climate change and food supplies in this period for the Ottoman Empire [20].

[17] According to Lamb, after the unusually thick layer of 805 (or 800) there was another peak in 1130. Cf. Smith [18, p. 27]. Zolotokrïlin et al. consider that the evidence from Lake Saki as measured against actual figures for the 19th century suggests that it is useful only for discussing 10–30 year trends rather than discussing actual precipitation levels for shorter periods of time [30, p. 30–31].

periods of warmer climate in western and northwestern Europe (in this case what he considers to have been the optimum of the 8th–12th centuries) correspond to periods of wetter climate in the Mediterranean, the Crimea, the Caspian Sea region, and Central Asia [10, p. 173][18].

The significance of this amount of precipitation is better understood if it is considered that during this period the Pontic steppe (north of the Black Sea) was receiving rainfall equivalent to what the southern part of the forest zone receives [38, p. 15]. Additional supporting evidence for such a scenario in the south in this period is seen in the decline of the upper limit of the food line in the Caucasus mountains, which would correspond to a .7–.8 degree C drop in temperature or to a 250 mm rise in precipitation [30, p. 32]. Of course, it is not clear for how large a territory one can generalize based on the data for Lake Saki, but one may assume that such major increases in precipitation would have led to increased growth in grasses in the drier southern zones of semi-desert and dry steppe; conversely the end of this wet period would lead to decreased growth in grasses in those zones.

The level of the Caspian Sea is another indirect source for the climatic history of the Golden Horde. Gumilev, one of many scholars to have examined this question (though the only one with an interest in Eurasian history), follows the view that the level of the Caspian Sea has varied by as much as 8 m above and below its current level[19]. Conservative estimates by respected scholars such as Berg, on the other hand, consider that it has not varied more than 4 m above or below its present level [24, 25]. Whichever view is correct, it is clear that by the beginning of the 14th century the level of the Caspian Sea had risen to a historic high (that is 4 or 8 m above its present level from a low of 4 or 8 m below its present level in the 3rd–4th centuries BCE). More recently, the Caspian reached a record low in 1977, after which it quickly rose again. A careful study of this abrupt change has made it possible to confirm that the level of the Caspian Sea is directly linked to precipitation and other climatic factors in the catchment basin (the upper and middle course) of the Volga River, since this river contributes 81% of the inflow to the Caspian Sea [39; 14, p. 114]. For this reason the level of the Caspian Sea itself can be considered "proxy" evidence regarding precipitation in the north (possibly including the Volga-Kama confluence) but not as evidence for precipitation in the area of the Caspian Sea. Thus the level of the Caspian Sea can be taken as an indication of the fact that there was very little precipitation in the catchment basin of the Volga River leading up to

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[18] Lamb also links drought in the Mediterranean, North Africa, and Asia characterized by two maxima of 300–400 CE and 800 CE with the Caspian Sea falling to low levels at the same time [10, p. 159]. The broad reference to Central Asia, however, should be more localized to retain any validity. Cf. Jenkins [7].

[19] Gumilev links the rise in the level of the Caspian Sea with dessication in the steppe in the general area of Lake Balxash and the Aral Sea [5; 29; 28; 4, p. 20–24]. See also the articles in the volume devoted to this topic [32].

the 3rd–4th centuries BCE and that there was an unusually high amount of precipitation along there by the beginning of the 14^{th} century. This increase in precipitation probably contributed to richer vegetation in the steppe zone.

It should not be forgotten that one of the possible sources of additional inflow into the Caspian Sea is the Uzboy River, which in the 13^{th}–16^{th} centuries (but with greatest volume during the 13^{th}–14^{th} centuries) led a significant portion of the waters of the Amu Darya into the Caspian Sea. Although this may not be a result of climatic conditions, the changes in the life of the Uzboy must have had devastating consequences for the environment of the surrounding areas. No doubt its waters contributed to the rising level of the Caspian Sea in this period, but its contribution is not considered to have been the most important factor affecting the rise in the level of the Caspian Sea. In such a case, the contribution of the Amu Darya does not weaken the argument for increased precipitation in the catchment basin of the Volga River feeding into the Caspian [12, p. 455–458].

Certain additional evidence regarding precipitation is offered by an examination of the pollen record from archeological excavations. Although this involves the same methodology of pollen analysis as utilized to study long-term climatic phenomena, the pollen studied comes from specific layers excavated at a site which Soviet scholars identify with Bilär, which they further consider to have been the capital of Volga Bulgaria. The conclusion is that this site east of Bolgar was drier during the time of its existence (10^{th}–13^{th} centuries) than it is today [46, p. 250]. This assessment appears to support the notion of drier conditions prior to the heavy precipitation of the early 14^{th} century along the middle and northern course of the Volga River.

As for the remaining territories of the Golden Horde, it has been considered that Western Siberia and Central Asia also received extensive precipitation in the 14^{th}–15^{th} centuries [27, p. 100–101]. Beyond such a characterization it would be premature to make a detailed statement for Xwarezm or the other eastern territories of the Golden Horde (the patrimony of Orda) during this period. Although the level of the Aral Sea has also varied significantly over historical time, these changes owe more to changes in the course of its sources (for example the aforementioned Uzboy) than to climatic factors.

On the basis of these important data we can confidently offer the working hypothesis that there were long-term trends of high precipitation in the southern territories of the Golden Horde until 1280, followed by a decline. There was another small peak in 1310, followed by another, even worse drop in precipitation in 1320. It is only after 1360 that there was a recovery in elevated levels of precipitation peaking in 1370 and bottoming out in 1420. In the north, there may have been a dramatic rise in precipitation along the upper and middle course of the Volga River by the beginning of the 14^{th} century. (One could speculate that this might have begun in the 1280s). It is not clear, however, if we can relate extremes of precipitation in this period to extremes of temperature, even though it is known that the optima in Western Europe were accompanied by warmer weather and pessima were accompanied by cooler, wetter temperatures. After all, it has been observed that there is a different relationship between temperature and precipitation north and south of 50 degrees N latitude in the territory formerly known as the "European part of the USSR" [30, p. 34][20].

5. Dendrochronology and Climate Change in the Territories of the Golden Horde

Earlier discussions of the relationship between climate and history in the former "European part of the USSR" have relied exclusively upon climatic data in the written sources for medieval Russia. These data, including reports of droughts, floods, and cold winters, and other phenomena, have been assembled and studied by modern scholars [27, p. 65–72; 37, p. 87–94]. The written data for medieval Russia offer an incomplete picture, however, since there are gaps of many years between most reports. For example, it is very difficult to document based on these sources any general worsening of conditions that might have resulted from the pessimum beginning around 1280[21]. Certain additional categories of proxy data such as tree ring data are also available for medieval Russia [33], but these data are just as problematic as the written sources. It cannot be ascertained on the basis of the written sources whether the decline in tree ring widths in the Novgorod area in certain years was due to extremes of temperature or precipitation. Declines in certain years seem to correspond to years in which locusts were reported (1008, 1094, 1103) [33, p. 80 and elsewhere], which can be taken as an indication of high levels of precipitation[22]. Other years of decline correspond to years for which excessive precipitation is explicitly reported (1155, 1162, 1176, 1186, 1219, 1351). However, it is difficult to establish any firm correlation between the tree ring data and the written data on precipitation for Novgorod alone[23]. It is not certain that the additional data on floods and famines would clarify this relationship, especially since it is often not possible to ascertain the exact causes of famine in a given year.

It is even less likely that we might be able to establish a correlation between the evidence for Novgorod and for Lake Saki in the Crimea. The closest possible correlation for the 13th–14th centuries is between an ex-

[20] There is even significant variation in patterns of rainfall within the Ukraine itself [26, p. 256–263].

[21] See, however, Buchinskiy [27, p. 101–102].

[22] The sudden plagues of locusts can serve as an indication of unusually wet conditions coupled with a specific temperature range [10, p. 304; 19].

[23] Tree ring layers have been studied for this area because of their significance for dating archeological sites; but in order to be useful for the study of climatic variation, the trees should be in some marginal area in order to test variation in one specific variable condition.

tended period of unusually low precipitation in Lake Saki during the period 1281–1285 and a decline in tree ring growth in Novgorod and other towns in the same region over a similar period (approximately 1282–1284 or 1283–1285) [33, p. 43, 44, 57, 59, 60, 62, 72, and the discussion and comparative charts on 85–87]. An earlier extended period of unusually low precipitation in Lake Saki (902–907) may also correspond to a decline in tree ring growth in 902–904 [33, p. 45]. The sources do not report extremes of precipitation or temperature for Novgorod during this time. A counterexample is provided by the decline in tree ring growth for 1279, since it corresponds to a year of excessive rain in Lake Saki. (Although the sources list famine in this year, it is not clear what the cause might have been). One must conclude that the earlier dendrochronological data are insufficient for any precise formulation of the relationship between climatic information for the core Russian territories and the territories of the Golden Horde [7]. Since this is a burgeoning field of research, it may be that we will have more data allowing more meaningful analysis in the future.

6. Tentative Conclusions on Climate Change in the Territories of the Golden Horde

A consideration of climatic change begs the question of how climatic change might have affected the environmental zones already described. The possible impact on human beings of climatic variability in various periods is the subject of debate in a growing body of literature[24]. The results of the debate on the effects of climatic variation in Western Europe and elsewhere can serve as a guide to our own attempt at a description of climatic conditions in Central Eurasia during the time of the Golden Horde. Scholars disagree on the full range of effects of the period of warming in Western Europe but these can be considered to include the expansion of cultivation in marginal areas which could not have been cultivated earlier due to excessive cold, major changes in the kinds of crops cultivated in other areas, and often lower precipitation. Some scholars have even equated advances in Western European civilization during this period with favorable climatic conditions, which may also have been partially responsible for a rising population in Western Europe during this time. The onset of the cooling trends, however, had the opposite effects: increased storm activity, cooler and wetter growing seasons often resulting in failed harvests and famine, illnesses from moldy grain, the abandonment of marginal agricultural lands, epidemics, and increased glaciation[25]. In Western Europe it was not uncommon for communi-

[24] While certain scholars, most notably Leroy Ladurie, have questioned the impact of a decline of as little as 1 degree Celsius in mean temperature, other scholars now point out that such small figures can mask a greater frequency of extreme conditions [6, p. 32–33].

[25] For these examples for the period of warming in Western Europe (according to Lamb from 750–1150/1200) see Lamb [10, p. 162–200, 272–309]. It is instructive to

ties to be forced to abandon their previous areas of habitation because of worsening conditions. On the other hand, worsening growing conditions in Italy after 1280 would contribute to an economic boom in the Golden Horde because of an increased demand for grain exports to the Italian maritime republics[26].

It is difficult to provide a complete description of how changing climatic conditions affected the Golden Horde, since so much of the past research is still entrenched in a notion of the unchanging nature of climate[27]. In the broadest terms, it seems that the boundaries of the environmental zones themselves may not have shifted significantly or at all in the past millenium. The vegetation within these zones might have changed, however. Hudson suggested long ago in response to earlier theories regarding the eastern end of the steppe zone that dessication in the south could lead to the creation of new pasturage in the north in forest areas which had previously depended on higher precipitation [7, p. 219 n. 12]. It is also not to be excluded that the increased moisture of the 9th–13th centuries might have served to expand the lush pasturage west of the Ural Mountains (and conversely that drier conditions from 250–790 might have had the opposite effect). The same levels of precipitation could also have stimulated agricultural production in lands that otherwise would have been inhabited by nomads.

Changing climatic conditions must have had significant consequences for the sedentary population within the traditionally agricultural territories of the Golden Horde as well, since changing precipitation levels could and did wreak havoc with grain production, as we know from the history of Western Europe. The expected effects of extreme conditions on sedentary communities in the territories of the Golden Horde would only be amplified because such large portions of the Golden Horde consisted of marginal lands. In the Volga-Kama confluence more lentils, vetch, and peas were cultivated in Bolgar than in Bilär to the east, where oats, rye, and flax were more common [40, p. 243][28]. Though differing soil conditions could also play a role, this can also serve as one indication that Bolgar was close to the northern limit of production of these crops. Such conditions, which also exist today, should be taken as another fact pointing to the marginal or near-marginal agricultural conditions this far north, including the danger of the poisoning of food supplies by rye mold[29]. The

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compare the work of Lamb with Leroy Ladurie's evaluation of his findings [11, p. 309–319].

[26] See my article on the commerce of the Golden Horde for the grain exports of the Golden Horde [43].

[27] Such a view is based, for example, on the absence of any major redistribution in the plant cover of Western Eurasia over the past 5000 years [18, p. 15].

[28] See also Tuganayev for a general description of this problem for Volga Bulgaria [41].

[29] See my article for a discussion of this topic [45, p. 16].

Volga-Kama region was vulnerable to insufficient heat and especially to too much precipitation, just as the sedentary areas north of the Black Sea were sensitive to too little precipitation. In fact, the medieval Arabic geographer al-Bakrī states quite clearly that in all the lands of the north hunger is a result not of a lack of rain, but from excessive rain and dampness [34, p. 39/54; 27, p. 48].

Finally, the apparent end to the wet period in the southern regions of the Golden Horde in the 1280s could have led to a decline in grain production in the south, with a likely shift of grain production to areas with the greater precipitation required for grain production than the semi-desert or dry steppe could afford. In that case, we can imagine that beginning in the 1280s grain production could have shifted to (or expanded) further to the north, to the region around Saratov (site of the Golden Horde city Ükek), which today is an important center of grain production. As noted above, there is a basis for believing that there was increased precipitation in the north after the 1280s, but it is not clear how much temperatures might have have fallen over the course of the 14th century. Based upon global trends, however, it was still very far from experiencing the significant decline in temperatures associated with the Little Ice Age in the mid–17th century and later.

It has been the goal of this essay to introduce the topic of climate change to the historiography of the Golden Horde. It is possible to study this topic on the basis of sources and methods used for the study of other world regions. Even though the data may be far sparser than for Western Europe, there is still more than enough to make a start to integrate the science of climate change with the study of the history of the Golden Horde. There is a basis in the evidence to take seriously the idea that there was some kind of change in the climate of the territories of the Golden Horde beginning in the 1280s. It seems likely that this change had an effect on both nomadic and sedentary populations. It would also have had an important relationship to the economic history of the Golden Horde, especially a possible shift in the regions supplying grain for export to the Italian maritime states. It is likely that the climatic downturn beginning in the 1280s later had some role in the spread of bubonic plague in the mid–14th century as well[30]. The emergence of the Khanate of Kazan, the Crimean Khanate, and the other khanates of the Later Golden Horde period in the mid–15th century would have taken place during a period in which the climate was becoming cooler, but it probably would not pose a crisis until later. We cannot be sure when the nomads and sedentarists of Central Eurasia – especially those living in the northern regions – began to experience a crisis, but it is likely that they were experiencing a severe crisis by the mid–17th century.

[30] See my article for a discussion of the Black Death [44].

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ИЗМЕНЕНИЕ КЛИМАТА В ЦЕНТРАЛЬНОЙ ЕВРАЗИИ И ЗОЛОТОЙ ОРДЕ

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Настоящая статья предлагает оригинальную интерпретацию истории климата на территории Золотой Орды. Представив обзор экологических зон на территории Золотой Орды, автор рассматривает климат XIII–XIV столетий в более широком контексте IX–XIX веков, так как золотоордынский период совпадает с переходом от «средневекового теплого периода» к началу «малого ледникового периода». Статья содержит как обзор доступных данных, делающих возможным рассмотрение изменения климата, так и анализ того, каким образом эти данные предоставляют косвенные свидетельства. Далее автор переходит к рассмотрению данных о температуре, осадках, дендрохронологии и изменении климата. Он утверждает, что, в то время как растительные зоны не менялись, в 80-х годах XIII столетия наблюдалось очевидное окончание теплого и влажного периода в южных зонах Золотой Орды – начало перехода к малому ледниковому периоду, – что могло повлиять на сельское хозяйство Золотой Орды и возможное смещение производства зерна на север.

Ключевые слова: атмосферные осадки, температура, дендрохронология, средневековый теплый период, малый ледниковый период.

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