



Environmental Impacts of Medieval Uses of Natural Resources in the Carpathian Basin

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Various natural resources were abundant in medieval Hungary, and contemporary sources offer a portrait of the kingdom as rich because of these natural conditions. The different forms in which these resources were put to use were decisive for the history of the Carpathian Basin, including its environmental history. In the Middle Ages, there were two key economic activities which played an especially significant role both in the sphere of local production and in foreign trade and which also had a significant environmental impact: livestock farming on the Great Plain (primarily but not exclusively of cattle) and mining, including the processing of primary metals, which was closely related to mining in certain mountain areas. On the basis of analyses of sources drawn from the monastic network, medieval rural churches, and selected archaeological findings and written evidence, we examine the environmental consequences of these activities with particular focus on the changes in the settlement network and relative population density. Our data suggest that the long-term effect of the prevailing practices in the most lucrative, export-oriented economic sectors of the late medieval Kingdom of Hungary—both of which contributed to the ability of the country to withstand pressures from the advancing Ottoman for about 130 years and to some extent even beyond—was serious environmental degradation in the affected regions. The environmental problems caused by these practices could not be fully overcome for a long time. Certainly, the impact was increased by the consequences of the Ottoman wars and the changing climatic conditions of the Little Ice Age, but the process began well before the Early Modern crisis, in some respects as early as in the late thirteenth and early fourteenth centuries.

Keywords: natural resources, environmental impact, settlement network, medieval mining regions, Middle Ages, Kingdom of Hungary

The three most important economic sectors of late medieval Hungary were crop farming, animal husbandry, and mining.¹ Regarding productivity in these sectors and their importance in foreign trade, sources prove that huge incomes

1 The research on which this article is based was made possible with the support of the National Research, Development, and Innovation Fund of Hungary (NKFIH) PD-128970 research grant, and it is a contribution to the PAGES' LandCover6k project. Some other aspects of this article were developed within the framework of another project led by the same organization (NKFIH K-128880), which considered the long-term effects of the Mongol Invasion on population density and extensive animal husbandry.

were generated by the export of both cattle and non-ferrous and precious metals, mainly copper. Although there are some hints that these sectors became strategic earlier, there is little written evidence before the fifteenth century and even less in the Árpád age (1000–1300). Since animal farming and mining became large-scale in the fourteenth century and continued to increase throughout the fifteenth and sixteenth centuries in the Carpathian Basin, both had deep impacts on the natural environment, and triggered big human pressure leading to a large-scale transformation in the ecosystem. Certainly, there was a third sector of the economy that exerted similar pressures and that was also present, if to different extent, throughout the kingdom. The transformation of the natural environment to ploughland or to areas in which the populations engaged in various agricultural activities was a much longer process. The large-scale extension of cultivated areas started well before the Mongol Invasion (1241–1242), and it went hand-in-hand with the colonization of areas that had been uninhabited until then. However, written, and archaeological evidence suggests that the regenerative ability of the mosaic-like medieval agricultural landscape was considerably stronger than that of later land use systems, including both modern field systems and industrial agriculture. Therefore, our hypothesis is that the environmental impact of the agricultural practices which prevailed at the time was not as long-lasting as, for instance, that of mining. Furthermore, grain and wine played a limited role as exports in the foreign trade of the Kingdom of Hungary before the mid-sixteenth century, meaning that the royal treasury had lower expectations when it came to potential profits. Therefore, we do not touch on this subject in this paper.² Here, we trace the pressures put on the ecosystem by animal farming and mining by drawing on direct evidence concerning the economic activities we discuss and some available indirect sources concerning shifts in settlement patterns, namely sources concerning the rural church network and the spatial distribution of monasteries. We focus on the late medieval period, though we also include the sixteenth century, because most of the practices that had come to prevail before the fall of the medieval Kingdom of Hungary in 1526, including economic and ecologic practices, continued without interruption until the 1560s or the 1570s. Furthermore, the character of sixteenth-century written data is very similar to the fifteenth-century data, and the number of written sources relevant from the perspective of our research increased in the first half of the

2 On the history of agricultural production and its role in the medieval economy of Hungary, see Laszlovszky, “Agriculture in Medieval Hungary.” On the general issues of environmental changes in the context of the medieval economy in Hungary see Ferenczi et als., “Long-Term Environmental Changes.”

sixteenth century. It has also been shown in the earlier secondary literature that, for example, *defterler* and other tax lists from the first decades of the Ottoman period in Hungary can be used in a regressive way to reconstruct the settlement systems of the different regions.³

Methods and Source Material

Given the scarcity of direct written evidence concerning the territorial impact of animal farming and mining on the settlement pattern and the environment, traditional historical methods do not lead us very far. Therefore, indicators and models based on analyses of phenomena that are not directly connected to our topic are needed to get closer to the process under investigation. Changes in the central elements of the settlement network can be interpreted as a measure of human pressure on the ecosystem and the exploitation of the available natural resources. We must remain aware of the nature of the sources at our disposal, so we emphasize that the results of this study refer to tendencies and our models can only be used to further an interpretation of the general picture, as one might arrive at significantly different results in particular regions if one were to have additional sources or to use the sources we have drawn on in a different way.

The settlement network cannot be fully reconstructed for the Middle Ages in Hungary, and this statement is valid for all the medieval periods, even for the Late Middle Ages, a period on which we have considerably more sources. Various significant attempts to reconstruct the whole settlement system of the kingdom represent outstanding scholarly work from different generations of medievalists, although they had to work with very fragmented written source materials, particularly in the study of the earlier centuries of the Middle Ages. The first large scale attempt to reconstruct the settlement network of the second half of the fifteenth century was a major contribution from the first positivist period of Hungarian medieval research. However, Dezső Csánki's enterprise remained unfinished, and large parts of the medieval kingdom were never covered.⁴ The

3 Engel, *A temesvári és moldovai*. For the sixteenth-century Ottoman tax registers on the territory of Medieval Hungary, see also Káldy-Nagy, *A budai szandzsák 1559. évi összeírása*; Ágoston, "A szolnoki szandzsák 1591–92. évi összeírása"; Káldy-Nagy, *A gyulai szandzsák 1567. és 1579. évi összeírása*; Káldy-Nagy, *A budai szandzsák 1546–1590. évi összeírásai*; Káldy-Nagy, *A csanádi szandzsák települései*; Káldy-Nagy, *A szegedi szandzsák települései*; Blazovich, "A Dél-Alföld települései."

4 Csánki, *Magyarország történeti földrajza*.

work of György Györffy, who aspired to publish a historical geography of the Carpathian Basin in the eleventh–thirteenth centuries, is similarly incomplete, although the data on most of the counties have been published.⁵ A third publication worth mentioning is the digital database compiled by Pál Engel on the landed estates in the Late Middle Ages.⁶ This work is the most complete of the above, covering the whole territory of the kingdom. Its aim, however, was to reconstruct the domains, not the settlement network. Therefore, from our point of view, it is similarly incomplete. Furthermore, archaeological field surveys have shown that there were many settlements—some of them were farmsteads or temporary dwellings, other were villages—that never appeared in any of the written sources.⁷ In the villages in the Árpád Era, we have to keep in mind that the pit-houses of the period were certainly not built to stand for centuries. The timespan for which these houses were used was probably between thirty and fifty years. Since there are hardly any houses that were renovated in that period, we have to take into consideration the possibility that many of the villages we know from the Árpád Era were homes to one or two generations of rural communities, and we also have to keep in mind that there may well have been a certain level of mobility when it came to the rural settlements. Another problem is—partly related to the above—that we do not have direct sources on population numbers, either.⁸ Consequently, we have to use diverse indicators when seeking the answers to the questions we pose.

In this context, it is important to note that there are datasets closely related to population density and economic activity in the Middle Ages. Almost all of them are at our disposal: the network of church institutions.⁹ While the network of rural or parish churches is mainly linked to population density, the monastic network is relevant from the perspective of economic activity. As a third element, we can use the data on late medieval Orthodox churches (sometimes together with data on villages the populations of which belonged to the Orthodox faith) where this data are relevant, since in this case, religion was quite closely connected to their economic pursuits, namely to transhumance, even if some communities may have been comprised

5 Györffy, *Az Árpád-kori Magyarország*.

6 Engel, *Magyarország a középkor végén*.

7 Laszlovszky, “Tanyaszerű települések”; Laszlovszky, “Space and place.”

8 Kubinyi and Laszlovszky, “Demographic Issues.”

9 F. Romhányi, “Kolostorhálózat”; F. Romhányi, “A középkori magyar plébániák.”

of different social groups.¹⁰ There is also a fourth limited set of data: the eleventh-century and twelfth-century estates of monasteries, donated by the rulers. The rulers donated these estates not exclusively for religious reasons, but also as part of their royal “regional policies.” Often, the donation charters refer to the uses of natural resources, but even when they did not or when the document itself did not survive, the spatial distribution and the environmental conditions of the landed estates may reveal how the lands were used.

Because of its very nature, foreign trade—both export and import—can also be seen as a good indicator of ways in which natural resources were used. As royal power was generally strong in medieval Hungary, regulations related to foreign trade appear in written records. Thus, the appearance of certain goods (metals, cattle, etc.) in the written sources connected to foreign trade activity can be interpreted as a sign of the importance of these goods and the growing volume in the economic output of the country. In this context, we can use the commercial goods mentioned in diverse privileges given to different towns and trading companies, as well as toll lists and account books. Even international conflicts which imply clashing economic interests can be interpreted as indicators of the ways in which natural resources were put to use.

Documented Historical Processes

In a discussion of natural resources and particularly mineral ores in the context of the medieval Kingdom of Hungary, gold and silver come first in mind. Historical data and extensive academic literature and significant scholarly debates on the roles and impact of mineral mining and trade confirms this general picture.¹¹ Therefore, we do not discuss these questions in detail here, but rather merely summarize a few of the more important conclusions from the secondary literature which are relevant to the questions we are raising concerning economic indicators and environmental impact. Certainly, both gold and silver played an important role in the economy of the country, especially after the

10 The case of Ráckeve and some other villages with Serbian populations on Csepel Island, today to the south of Budapest, is an exception. These villages were settled in the second half of the fifteenth century under completely different circumstances.

11 On the economic history of medieval Hungary in general, see *The Economy of Medieval Hungary*, edited by József Laszlovszky, Balázs Nagy, Péter Szabó, and András Vadas (Leiden: Brill, 2018). On the history of mining and metallurgy in Europe cf. Ian Blanchard, *Mining, Metallurgy and Minting in the Middle Ages: Continuing Afro-European Supremacy, 1250–1450 (African Gold Production and the Second and Third European Silver Production Long-cycles)* (Stuttgart: Franz Steiner, 2005).

economic reforms of King Charles I of Anjou in the early fourteenth century.¹² The colonization of the peripheries of the kingdom and other marginal areas itself was a long process, and ore mining was one of the most important drivers of this process from the outset. Ores and raw metals were important export goods of the Hungarian Kingdom as early as around 1200. The toll regulation of Stein issued by Duke Otakar of Styria and Duke Leopold of Austria in 1190 mentioned copper, tin, plumb, and iron, along with salt, among the imported goods, and copper was mentioned in the toll regulation of Hainburg (1245), as well.¹³ After the Mongol Invasion, however, the mining regions experienced intensive development. Many of the major mining towns received their royal privileges in that period, including Besztercebánya (today Banská Bystrica, Slovakia) Körmöcbánya (today Banská Kremnica, Slovakia), and Selmecebánya (today Banská Štiavnica, Slovakia; in Latin *Argentifodina*), although the mine in the latter had existed nearly two centuries earlier.¹⁴

Copper, which was produced in great quantities (especially in the late fifteenth and early sixteenth centuries), is usually also on the list. As for iron production (including bog iron), researchers tend to make less frequent mention of it. Written and material evidence concerning the production sites has been collected and evaluated by Gusztáv Heckenast and Gábor Vastagh.¹⁵ The exploitation and smelting of iron, mainly bog iron in the tenth and eleventh centuries, has been studied by the archaeologist János Gömöri,¹⁶ but the iron production met with less interest later.¹⁷ At the same time, these studies were mainly connected

12 Batizi, “Mining in Medieval Hungary.”

13 Wenzel, *Magyarország*, 23. However, Gusztáv Heckenast expressed his doubts concerning Hungarian iron exports to Austria in the twelfth century, see Heckenast, “A kora Árpád-kori,” 149.

14 Györfly, *Az Árpád-kori Magyarország*, vol. 3, 243–47. The region belonged to the estate of the Benedictine Abbey of Garamszentbenedek (today Hronský Benadik, Slovakia), founded in 1075 by King Géza I, which was given Baka as well, where another mine existed in the Árpád Era. The settlement was first mentioned in a charter in 1217 under the name *Bana* (mine). The name *Argentifodina* (i.e. silver mine) first occurred in 1240, when the parson of the settlement was also mentioned. The fact that both names were used without an adjective suggests that Selmecebánya was the first and most important royal silver mine in the whole region. On the mining privileges issued in the fourteenth and fifteenth centuries, see Weisz, “A bányaváros, mint önálló”; Weisz, “Mining Town Privileges”; Weisz, “Az alsó-magyarországi bányavárosok,” (about issues connected to the use of wood: 38–40).

15 Heckenast, *A magyarországi vaskohászat*; Vastagh, *Tanulmányok a kohászat*.

16 Gömöri, *Az avarokori és Árpád-kori*.

17 The first important interdisciplinary monograph on this topic: Heckenast, Gusztáv, Gyula Nováki, Gábor Vastagh, and Elemér Zoltay, *A magyarországi vaskohászat története a korai középkorban* [History of iron smelting in Hungary in the Early Middle Ages] (Budapest: Akadémiai Kiadó, 1968). For the latest summary on the topic based on the earlier secondary literature, see: Batizi, “Mining in Medieval Hungary.”

to the production sites in present-day Hungary, and they focused on the earlier period. This aspect of their research is crucial to the general picture, because very important mining areas and production centers were situated outside the modern political borders of the country, and for the late medieval period, one must assume considerably larger amounts of iron products. This can be confirmed by the much bigger population of the country and also by the significant spread of iron objects and building materials in the Late Middle Ages.

Iron mining and smelting are much less documented in the Late Middle Ages compared to other activities and ores in the context of mining. Iron was much more common than non-ferrous metals, and it was often produced in the same regions as gold, silver, and copper. Therefore, written evidence survived mainly about the latter, although there are hints concerning iron production, too. The toll regulation of Stein, issued in 1190 by Prince Otakar of Styria and Prince Leopold of Austria, listed iron among the goods imported from Hungary. The intensification of iron mining can be traced back to the second half of the thirteenth century, and not only in the northern mountain region. In 1291, for instance, German miners from Eisenerz in the Alps settled in Transylvania, more specifically in Torockó (today Râmetea, Romania), to work in the iron mines there (the German name of the settlement, Eisenburg, also referred to the presence of iron ore).¹⁸ Based on the contemporary written sources, there were at least six sites where iron ore was mined in the Carpathian Basin in the Middle Ages: the Aggtelek-Rudabánya Mountains, the Slovak Ore Mountains (known in Hungarian as the Gömör-Szepes Mountains, Slovakia), the region of Belényes (today Beiuș, Romania), the eastern part of Temesköz (in Romanian Banatul Montan), the area surrounding Torockó, and the Apuseni Mountains (known in Hungarian as Erdélyi-szigethegység) in central Romania, including the region of Hátszeg (today Hațeg, Romania) with Vajdahunyad (today Hunedoara, Romania) as its center.¹⁹ Though the data from written sources are scattered, the fact that

18 Szentpétery, *Regesta regum*, no. 59. The German name of the settlement, Eisenburg, is also telling. Medieval Styrian iron production probably began in the eighth and ninth centuries. It then intensified around 1100 and remained important until the nineteenth century. Cf. Sperl, Gerhard, *Steirische Eisenstraße*, edited by Montanhistorischer Verein für Österreich Leoben, 1984.

19 Sources indicate iron mining and metallurgy around Rudabánya from the tenth century, based on archaeological findings. Török, "Vasérc, vasbuca, vastárgy." Several iron mines and furnaces functioning in the mountainous region of northern Hungary were mentioned as early as in the thirteenth century, after the Mongol Invasion (1241), cf. Heckenast, "A vashámor," 2–4. The hammer mill in Csetnek (today Šútňik, Slovakia) was first mentioned in 1344 (Heckenast, "A vashámor," 10). On the developing metallurgy of the region see also the privilege of Master Konrad, the bell-casting master of King Louis I (1357: MNL OL

many of these mines remained or became royal property during the Late Middle Ages indicates the importance of iron mining and iron production in these regions. Certainly, written sources from the fifteenth and sixteenth centuries do not say anything about the beginning of mining activity in these areas, and none of the various archaeological investigations which have been done have yielded any meaningful findings concerning the early periods of medieval iron ore mining. The presence and accessibility of mineral resources does not necessarily mean that these resources were used. However, the evolution of the settlement networks—indicated by different types of written sources—in the areas where these kinds of mineral resources were found could be interpreted as evidence of the economic importance of these resources and may further a more subtle understanding of the changes in population density in a mining region over time. It can also offer an indirect proof for the growing importance of mining activity in less documented areas, as relatively well-documented mining areas can be compared with regions from which we have fewer written sources but about which we know that they had similar natural resources. If so, indicators can confirm—or actually call into question—the importance of some mining regions based on the evaluation of the local settlement system.

The list of important natural resources continues with salt, the mining of which was recorded since the late eleventh century. Alongside ores, salt was another important mineral that was exploited in large quantities. Salt played a significant role in the trade and commercial activities of this earlier period, and it continued to be mined and sold on the same scale in the Late Middle Ages. This also put significant pressure on the ecosystem, as we can clearly see from

DF 280773; on master Konrad, see Szőke et als., “Konrád mester,” and the company of the Thurzó family, see Izsó, *Szemelvények*, 45, 48, 56, 58 etc. Iron mines in Upper Hungary were mentioned e.g. in Dobsina, Gölnic, Igló, Jolsva, and Vihnye (today Dobšina, Gelnica, Spišská Nová Ves, Jelšava, and Vyhne, Slovakia), too. Sources indicate iron mining and processing in the region of Besztercebánya and Selmecebánya, as well. Heckenast, “A vashámor,” 3. In the Temesköz, a charter issued by King Sigismund of Luxembourg concerning the acquisition of the castle of Kövesd mentioned the iron mine of Boksánbánya (today Bocea Montană, Romania); 1395: Wenzel, *Magyarország*, 124. Medieval iron slag was found in the area of Vaskoh (today Vașcău, Romania) during an archaeological survey, and an eighteenth-century description of ores and other mineral resources of Hungary described the iron ore of the region as one of the best raw materials, though there is no written evidence of its medieval or early modern use, cf. Tóth, “Az első magyar nyelvű,” 130. In Vajdahunyad (today Hunedoara, Romania), there is data from the fifteenth and sixteenth centuries (1493, 1509) indicating the mining of iron (and gold) (MNL OL DL 29875, 24348, 24364, 26508, 26510, short summary in Hungarian: Izsó, *Szemelvények*, 137–38). We do not enumerate here the smaller mining regions with more limited metal production (e.g. Nagybörzsöny, Telkibánya), but they too contributed to the processes described below.

the better documented later periods. Salt production seems to have increased step by step. The first medieval intensification of salt mining took place around or shortly before 1100, when shipping on the Maros River was established. On the northern border of Transylvania, the monastery of Meszes was founded by Duke Álmos, brother of King Coloman, at the older salt road, which went through the Meszes Pass, during the same period (1102). Its connection to salt transportation is attested by the privilege it received in the 1130s.²⁰ In a second phase, between the 1170s and the 1210s, King Béla III and King Andrew II contributed to the development of salt production and trade by employing Jewish and Muslim officials (*comes camerae*) and by granting privileges to different churches and monasteries.²¹ A further increase in the quantities transported necessitated the navigability of the Szamos River. Most of the riverbed was probably cleared by the last decades of the thirteenth century, when shipping was mentioned in charters.²² It is difficult to estimate the quantity of salt that was mined, but data suggest that it increased gradually throughout the Middle Ages, and sources suggest that the incomes of the royal treasury from salt represented a large fraction of the royal incomes.²³

Similarly, sources from the early fifteenth century document large-scale cattle trade, but as early as 1255, the toll list of Buda mentioned live cattle and cattle skin as important tariff articles.²⁴ Considering that the Cumans were settled in the mid-thirteenth century on a territory that became the center of cattle farming, one may suspect that the story must have begun earlier.²⁵ This type of extensive animal husbandry was made possible by at least two factors which transformed the region: the destruction of the area caused by the Mongol invasion of 1241–1242 and environmental changes due to changing hydrological conditions, both of which resulted in a significant process of settlement desertion. It should also be noted that extensive animal husbandry, dominated by cattle breeding,

20 1165: Szentpétery, *Regesta regum*, no. 107.

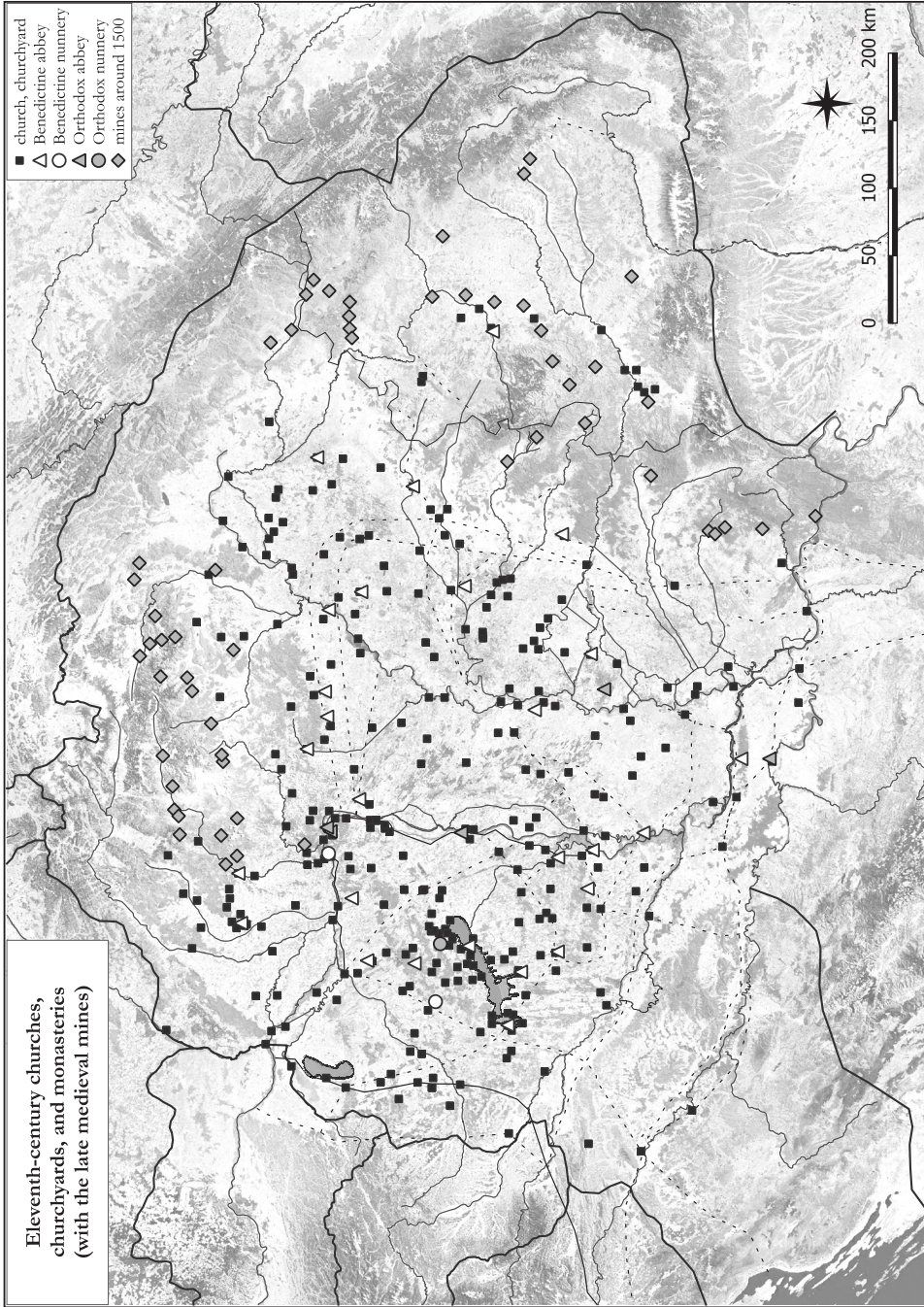
21 In 1233, the conflict resulted in the issuing of the Oath of Bereg, which was intended to regulate the participation of Church institutions in the commercialization of salt. Cf. F. Romhányi, “Salt Mining.”

22 1292: Szentpétery, *Regesta regum*, no. 3878. On salt shipping and the levy of tolls in the Árpád Era, see Weisz, “Megjegyzések az Árpád-kori.”

23 In addition to the article by B. F. Romhányi (footnote 21), see also Draskóczy, “Salt Mining.”

24 Szűcs, *Az utolsó Árpádok*, 103–4. Szűcs emphasizes that there was a clear turning point in the structure of Hungarian exports. Beginning in the 1280s, Hungarian cattle, copper, and grain began to dominate (333).

25 There are some hints of early thirteenth-century cattle exports (see the toll regulation of Radkersburg and the circulation of Friesach deniers in the first half of the thirteenth century), but large-scale cattle farming and cattle trade began after the Mongol Invasion. Cf. Lyublyanovics, *New Home, New Herds*; Sárosi, *Deserting villages*.



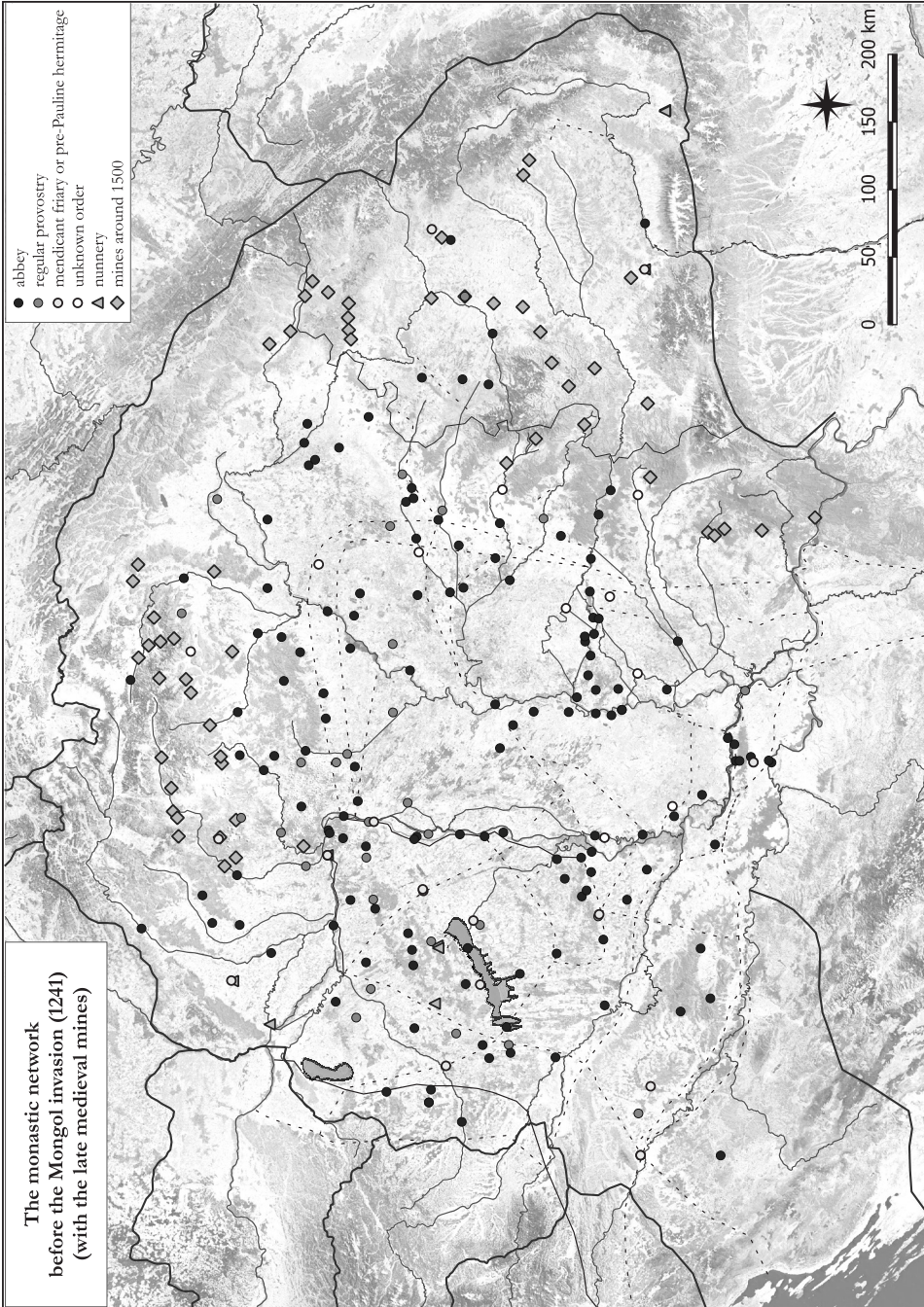
Map 1. Eleventh-century churches, churchyards and monasteries (with late medieval mines). Map drawn by Beatrix F. Romhányi

was still characteristic of large areas of the Great Plain in the eighteenth and nineteenth centuries, and historical and ethnographic studies shed light on the ecological pressures caused by these activities and on their impact on the local environment. Particularly the *puszta*-type of animal husbandry can be studied well in this context. Another branch of animal husbandry was transhumance, which sources indicate was a prevailing practice in certain areas of the Carpathian Basin as early as the thirteenth century, though it is difficult to determine the phases of its spread. In this case, changes in the settlement network can help us establish a more thorough chronology, too.

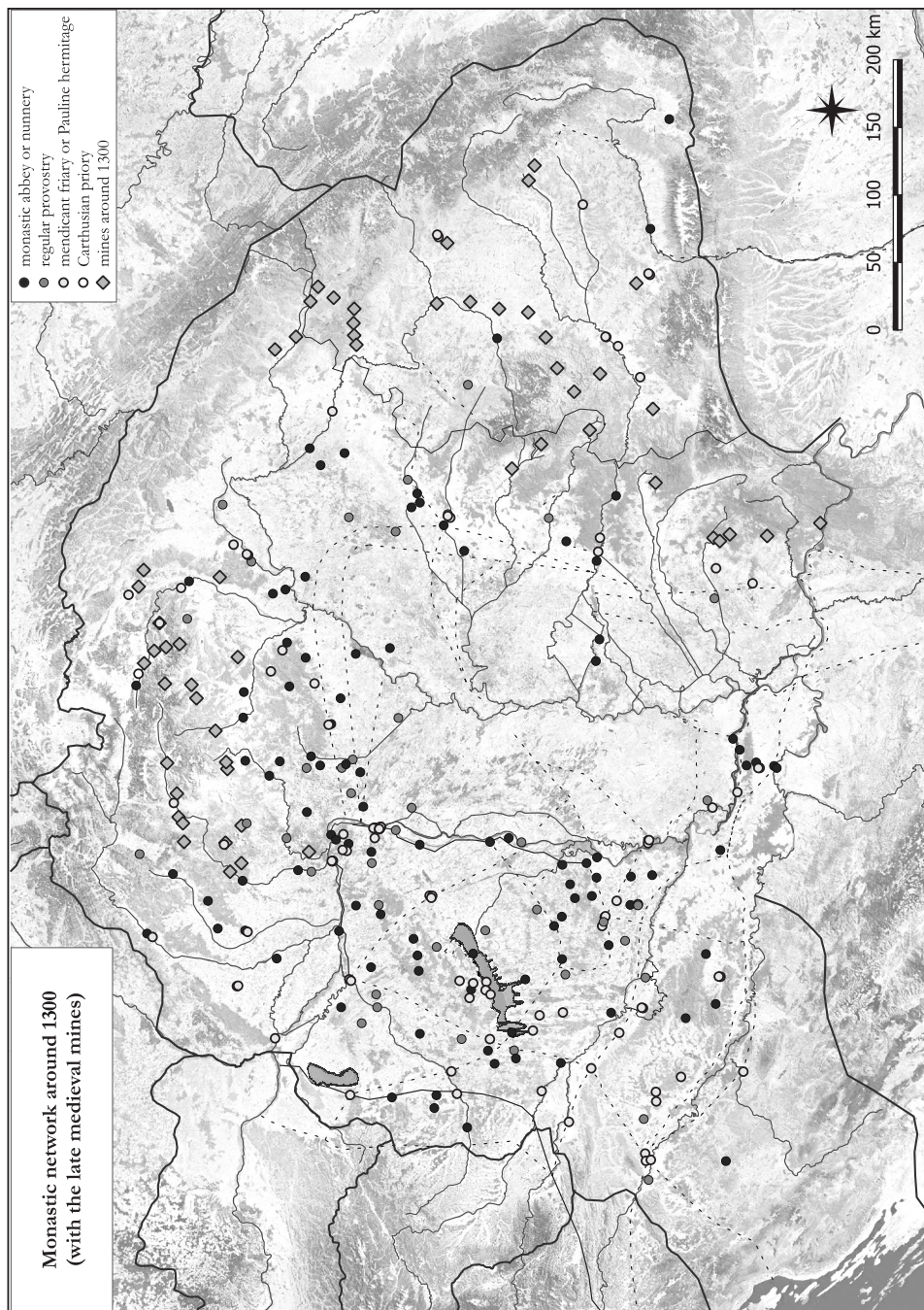
Changes in the Settlement Network

On the basis of the data connected to the spatial distribution of settlements and the indicators for this network, combined with the long-term processes described above, two major transformations of the settlement network can be observed in the Carpathian Basin between the eleventh and the sixteenth centuries (Maps 1–5). There were other significant aspects of inland colonization, but they are not so related to the two main issues discussed in this article: mining activity and extensive cattle production. The territorial expansion of areas under ploughland cultivation and other forms of agriculture was also an important process, but in most of the regions, it involved the extension of new field systems within the boundaries of the existing villages.²⁶ In other words, these were previously settled areas with an existing settlement system, and they started to be transformed by the more active and regular use of previously uncultivated areas. This inner colonization was also connected to the changes in the settlement network in the form of settlement dispersion or in the process of nucleation. The first major colonization process involving areas that had not previously been settled started with the mountainous regions around 1100 and lasting until the end of the Middle Ages or even into Early Modern times (mid-sixteenth century). Due to this process, large areas with their original forest coverage and without a significant settlement network started to be settled in a more intensive way. The main element of the transformation process was the clearing of forests. The Transdanubian Mountains and the North Hungarian Mountains were settled in a more intensive way in the first period, and here, woodland clearing led mainly to the emergence of agrarian settlements and villages. In the second phase,

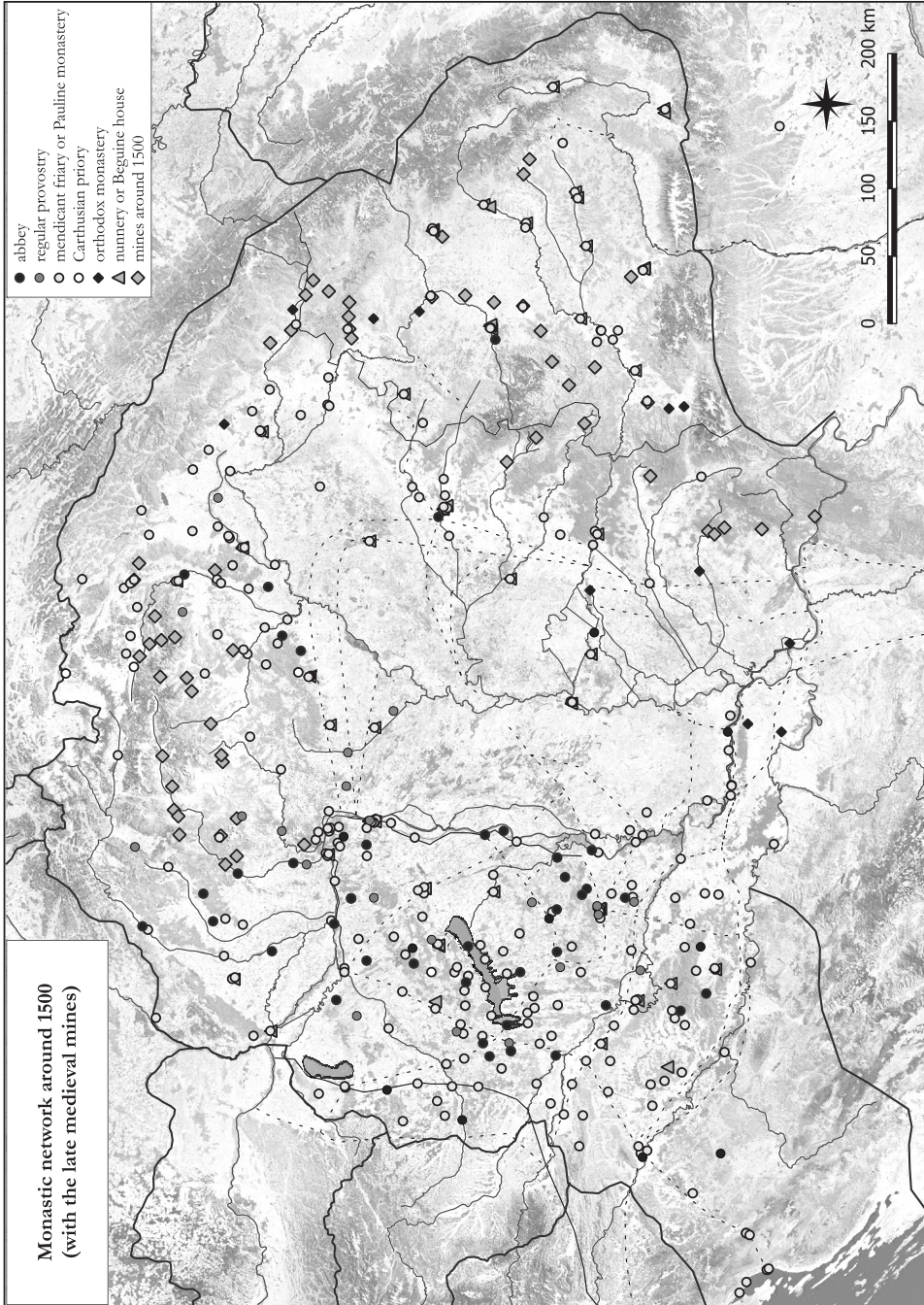
26 On the field systems in this context, see Laszlovszky, “Field Systems.”



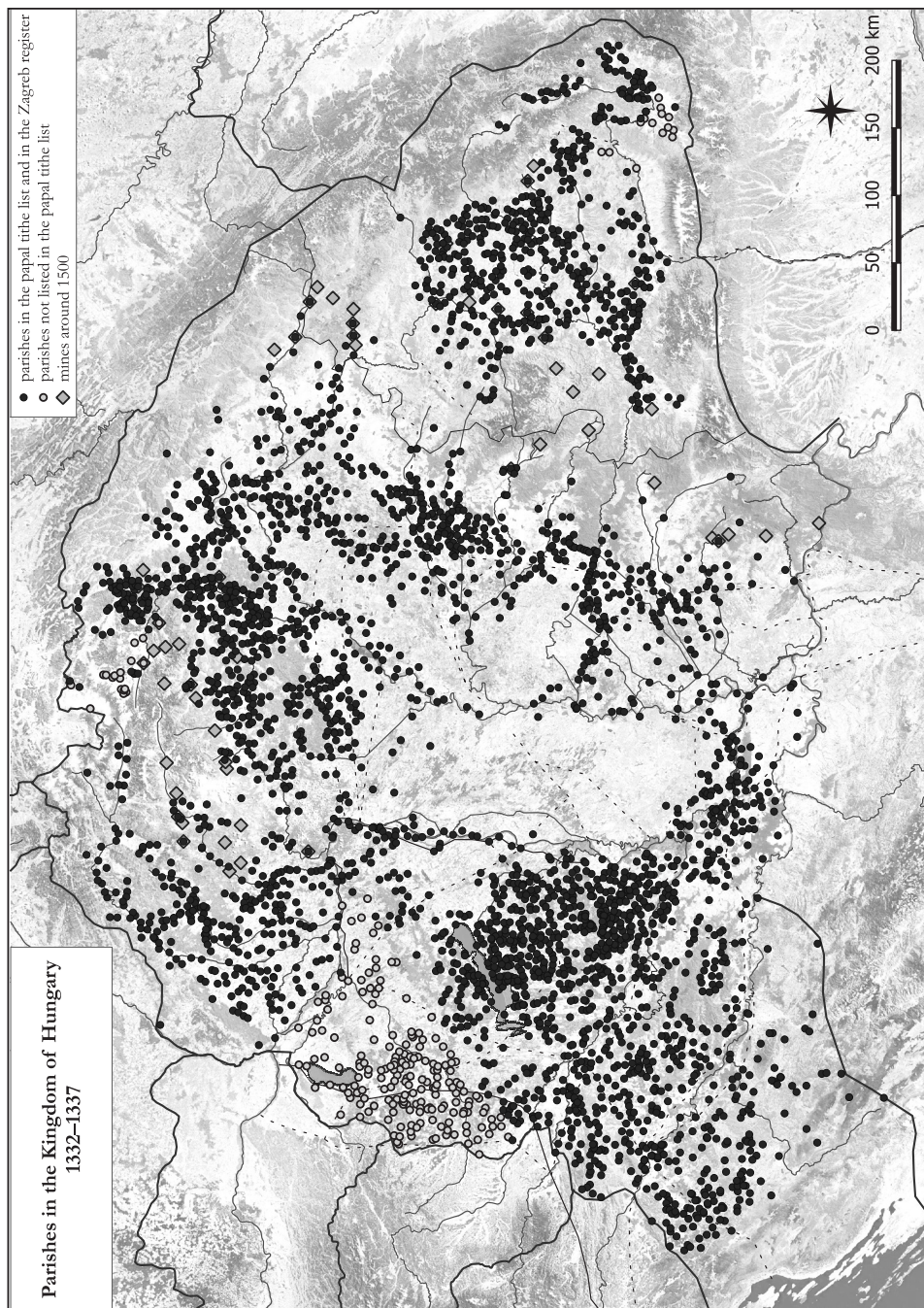
Map 2a. The monastic network before the Mongol Invasion, 1241 (with the late medieval mines). Map drawn by Beatrix F. Romhányi



Map 2b. The monastic network around 1300 (with the late medieval mines). Map drawn by Beatrix F. Romhányi



Map 2c. The monastic network around 1500 (with the late medieval mines). Map drawn by Beatrix F. Romhányi

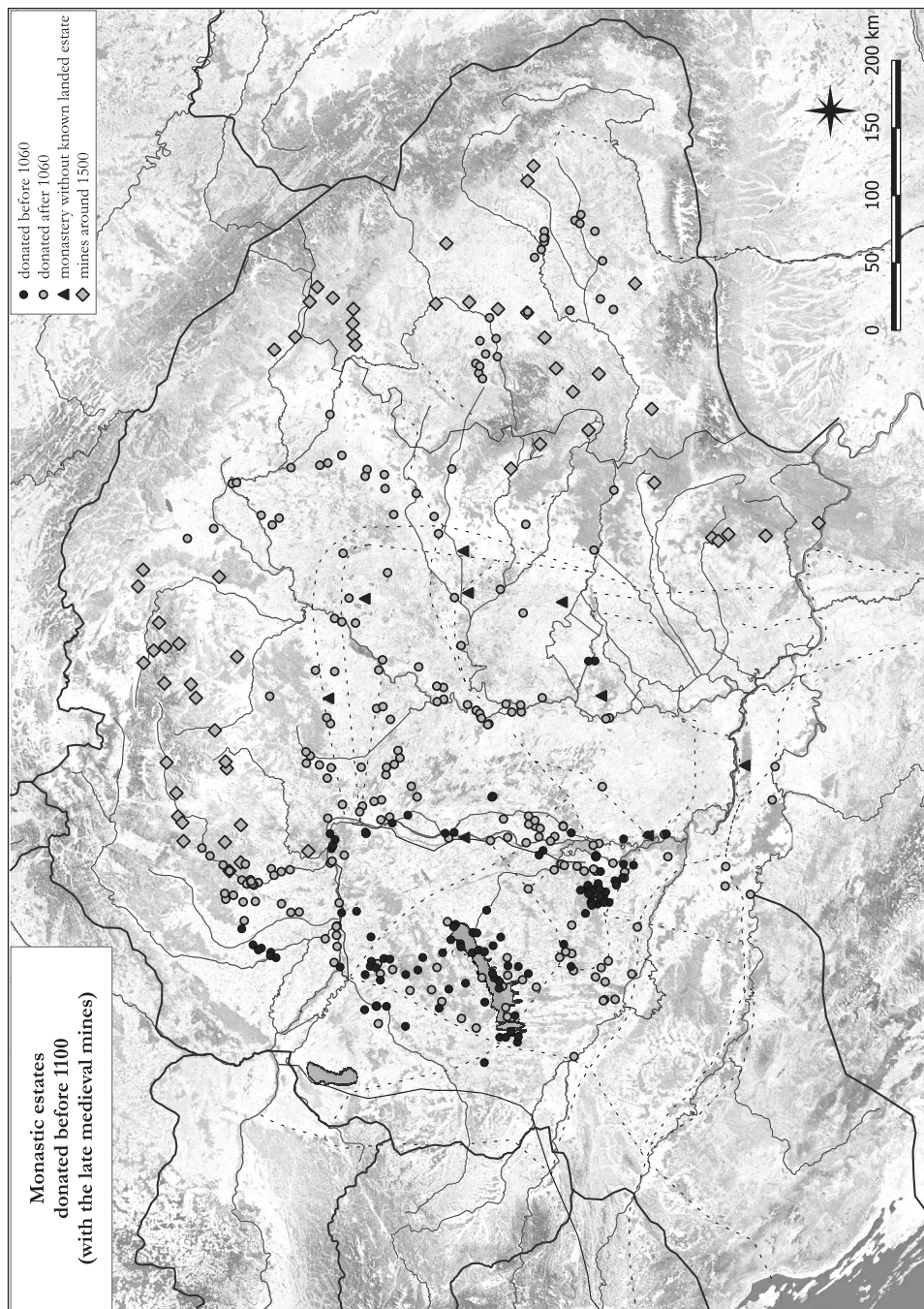


Map 3. Parishes in the Kingdom of Hungary, 1332-1337. (with the late medieval mines). Map drawn by Beatrix F. Romhányi

particularly from the thirteenth century, high mountain regions with dense forest coverage started to be exploited as well, with different goals and in various forms of settlement expansion. In these mainly peripheral regions of the kingdom, minerals were increasingly exploited, and pasture lands were created on a large scale in the mountains, especially for sheep and goat breeding. Parallel to this, the other transformation that took place on the Great Hungarian Plain seems to have started in the first decades of the thirteenth century, but it was accelerated in a radical way by the Mongol Invasion of 1241–1242.²⁷ As a result of these events and processes (the process of nucleation, urban development, expansion to the peripheral areas, and the Mongol invasion), the area between the Danube River and Csörsz-árok (or “Devil’s Dyke,” a line of Roman fortifications in the eastern Pannonian plain) became a very loosely settled region. Before this period, the settlement patterns and probably the population density were rather similar to settlement patterns and population densities in the other lowland and plain regions of the kingdom, but in the Late Middle Ages, a very different settlement structure emerged (Map 2a-c). The parish network concentrated on the rivers (the Tisza, Körös, Maros, and Zagyva Rivers), while the monastic network was almost completely missing from the territory (Map 3). The only monastic institutions in this region were the Franciscan and Dominican friaries in Szeged, the Benedictine abbey—later Observant Franciscan friary—of Csanád (today Cenad, Romania), and the Cistercian monastery of Egres (today Igrış, Romania). This institutional pattern was a mark of a livestock-raising society of the plain, where the dominant elements of economic production in the local rural communities were extensively reared cattle, horses, swine, and sheep.

The situation which prevailed in the area earlier can be reconstructed by using written sources mentioned in a previous part of this article. The special use and probably the special estate structure of that central part of the Great Hungarian Plain is referred to by the distribution of the estates given to royal abbeys. The monasteries themselves, especially those founded in the eleventh century, were usually outside the region in question (Map 1). Looking at the map of monastic estates donated before 1060, it is clear that the Great Hungarian Plain was not the region where this type of estate would have been present in the first decades of the Hungarian kingdom. The first monastic estates appeared on the territory after 1060, and the only abbey that received extensive landed estates there was Garamszentbenedek (today Hronský Beňadik, Slovakia),

²⁷ Laszlovszky et als., “Contextualizing,” 432.



Map 4. Monastic estates donated before 1100 (with the late medieval mines). Map drawn by Beatrix F. Romhányi

which was founded in 1075 by King Géza I.²⁸ The monastery's estates in the region concentrated on the Tisza River between Szolnok and Csongrád (Map 4). Monastic estates remained largely absent from the region discussed even in the twelfth century, when a large number of monasteries emerged along the Maros River. One of them was the Cistercian Abbey of Egres, founded by King Béla III in 1179. It was one of the wealthiest abbeys before the Mongol Invasion, but it had very few landed estates, and they were scattered along the river.²⁹

At the same time, recent archaeological research in the region of Kiskunfélegyháza and especially in Bugac has revealed that a rich pre-urban settlement site connected to a monastic complex existed there before 1241.³⁰ Different types of indicators (monastic buildings, import objects, finds connected to trade, etc.) at these sites show that the region also reached a high level of development with a relatively dense settlement network and with emerging central sites. Other findings, for instance in the region of Orosháza, similarly reflect intensive economic activity and higher population density than after the Mongol Invasion.³¹ These data and the specific character of the region's monastic network and the almost missing monastic estates suggest that both the estate structure (ownership) and the use of the territory were specific in the eleventh–thirteenth century. Furthermore, data from different parts of the territory imply that changes in land use had begun before the Mongol Invasion, resulting in the radical transformation of the settlement system, while large parts of the territory became pasture for extensive cattle farming.³² Parallel to this transformation, the Árpád Era monastic network of the region disappeared almost completely.³³

The settlement pattern that became characteristic of the Carpathian Basin in the Late Middle Ages first appeared in the papal tithe list of 1332–1337, which is a good indicator of the spatial distribution of the settlements³⁴ (Map 3). Big empty regions can be identified for a major part of the Great Hungarian Plain in this period, and large parts of the Transylvanian Apuseni Mountains, including

28 On the estates of the abbey in the Tisza region, see Laszlovszky, “Dedi eciam.”

29 Hervay, *Repertorium historicum*.

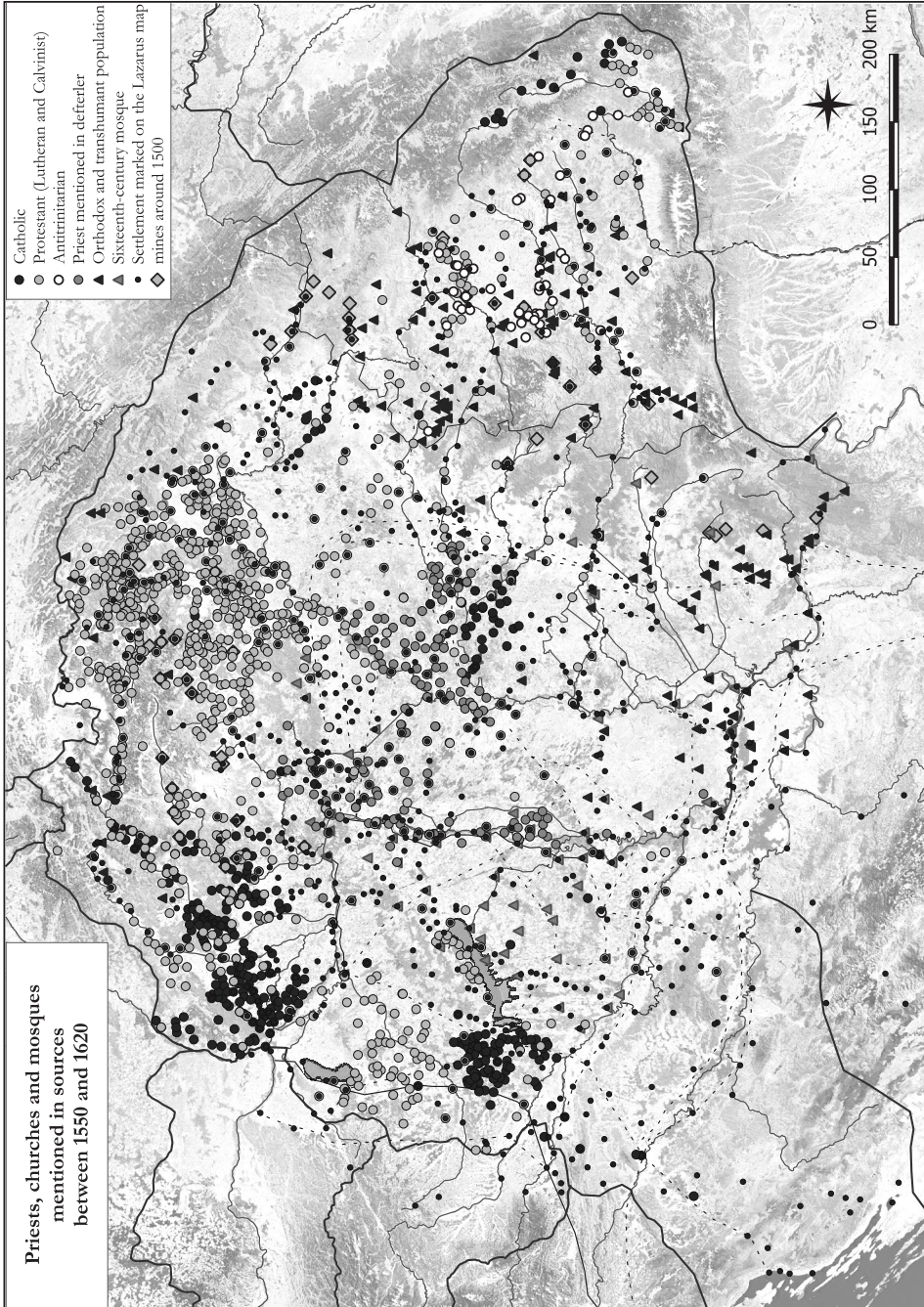
30 Rosta, “Egy elfeledett nemzetségi.”

31 Rózsa et als., “Árpád Period.”

32 Pinke et als., “Zonal assessment,” 102; F. Romhányi, “Changes in the Spatial.”

33 The reasons underlying the procedure are complex, including the transformation of church property after the Fourth Lateran Council, demographic changes in the region due to the Mongol Invasion, environmental and economic changes, etc. Cf. F. Romhányi, “Kolostorhálózat.”

34 F. Romhányi, “A középkori magyar plébániák.”



Map 5. Priests, churches and mosques mentioned between 1550 and 1620 (with the late medieval mines). Map drawn by Beatrix F. Romhányi

the Metaliferi Mountains, also seem not to have had a parish church network. At the same time, a very dense parish network can be observed in southern Transdanubia and medieval Slavonia (which are out of our present scope), but also in some parts of Transylvania and in the northern part of the Carpathian Basin, especially on the territory of the Eger Diocese. From the second half of the fourteenth century, an increasing number of new towns appeared in the mountainous areas. The number and size of the new churches suggests that the populations in these towns was growing, much as the growing number of monastic institutions from the fifteenth century indicates population growth in the region, although the network did not cover the mining regions evenly (Map 2b-c). In northern Hungary, pastoral care was offered by Franciscan (mainly Observant) friaries, while in the mountains between Transylvania and the Great Hungarian Plain, both Franciscan friars and orthodox monks assumed this task among the mixed Catholic and Orthodox population.

Concerning the periods after the Late Middle Ages, various groups of sources can be used in this context. They are of mixed character and comprise several registers, tithe lists, and canonical visitations of the sixteenth and early seventeenth centuries, referring to priests of diverse denominations. This set of data is especially useful for the northern part of the Carpathian Basin, but to a lesser extent also for Transylvania. As for the other parts of the Carpathian Basin, some limited conclusions can also be formulated. Although the lists were compiled over a longer period of time, between the 1550s and the 1620s, they give a fairly good picture of the effects of the Ottoman wars, namely increasing population density in the less affected parts of the country. Furthermore, the ongoing colonization of the mountainous areas can also be seen on the map (Map 5).

Environmental Impacts of Animal Husbandry

The (almost) monocultural animal husbandry on the plain had a serious impact on the environment and the settlement pattern. The indicators which we have used in our research show some of these effects. As we have argued before, a structural transformation took place in the settlement pattern of the Great Hungarian Plain in the thirteenth century. While the plain was densely sprinkled with rural churches, which indicates a relatively large, albeit dispersed human

population on the landscape, during the eleventh century (Map 1),³⁵ most of the region, especially within the Devil's Dyke, had been abandoned by inhabitants and ecclesial institutions by the early fourteenth century. The papal tithel list of 1332–1337 and regional settlement reconstructions show a vast uninhabited region in the middle of the plain.³⁶ If we consider this area, three basic soil regions characterize the prevailing land use patterns and settlement structures over the late Middle Ages. Loess soils are the most fertile, and where loess soils were found, the lands were tilled and population density was at its highest.³⁷ In contrast, animal husbandry prevailed in the almost entirely deserted areas with sand and clay soils.³⁸ In Homokhátság (which means “Sandy Ridge”), a sand soil region which has been the subject of thorough study, the settlement pattern became dense in the early Árpád Era and collapsed by the fourteenth century.³⁹ The settlements in the region suffered disastrous losses because of the Mongol invasion (1241–1242), and most of them were never resettled. Shortly after the Mongol invasion, Cumans who engaged in animal breeding were settled in the region. In the fourteenth and fifteenth centuries, the region was characterized by intensive aeolian processes, thus, wind very much reshaped the landscape.⁴⁰ The same happened in other sandy regions of the plain between the thirteenth and the fifteenth centuries. Interestingly, similar processes occurred in previous periods, too, e.g. under the Sarmatians (first–fifth centuries AD) and the Avars (sixth–ninth centuries), when animal husbandry cultures colonized the landscape.⁴¹ At the same time, this economic transformation of the area may have put increasing pressures on the local ecosystem. Local settlement research and studies on wind-blown sand deposits partly excavated by recent large-scale archaeological investigations confirmed the scale and importance of these environmental changes. One particular archaeological site has also clearly demonstrated that a briefly used ploughland area, which was probably created as a consequence of the internal colonization process described above, was abandoned for agricultural use, and the sand-covered region was probably

35 According to István Méri the population in the upper Trans-Tisza region began to grow dramatically in the tenth and eleventh centuries. Méri, “Beszámoló,” 51–52.

36 Györffy, *Az Árpád-kori Magyarország*, vols. 1 and 3.

37 Pinke et als., “A hajdúsági várostérség,” 138.

38 Nyári et als., “Investigation of Holocene blown-sand,” 46, 52–53; Vadas, “Late Medieval,” 54.

39 Bálint, “Az Árpád-kori településhálózat,” 1.

40 Kiss et als., 711, and 704–8.

41 Gábris, Túri, “Homokmozgás,” 241, 245; Nyári et al., “Investigation of Holocene blown-sand,” 54.

used for extensive animal husbandry.⁴² The growing number of cattle and other animals kept in these areas significantly contributed to the richness and economic boom of some local urban settlements, the so-called *oppida* (market towns), but this spread of animal breeding also may have led to the emergence of huge *puszta* areas around the big rural settlement centers. Thus, one may well conclude that overuse of the land and, more specifically, the sensitive vegetation which grows in sandy soils to support animal breeding led to changes in the hydroclimatic regime which made the land more vulnerable to aeolian processes.

One question remains, however: what was the reason for the massive abandonment of the settlements that preceded the arrival of the Cumans in the area? Can the mid-thirteenth century Mongol Invasion be blamed for this, as is widely believed?⁴³ Curiously, massive settlement abandonment also took place in deep alluvial floodplains covered by clay soils according to a similar chronology. Clay soil indicates the sites of wetlands, which covered almost one-third of the plain. A multifactorial spatio-statistical investigation suggested that the settlement pattern of an extensive wetland landscape was located in the plain, shrunk and moved vertically, from the Árpád Era (which almost completely covered the Medieval Climatic Anomaly, beginning in 900 and ending in 1300) to the late Middle Ages (1301–1541), thus overlapping the first phase of the Little Ice Age.⁴⁴ The massive settlement abandonment was concentrated in the low-lying zones of the region (which were vulnerable to floods) and took place before 1300. To summarize the written sources related to forms of land use, the permanently inhabited flood-free loess ridges were used for diverse forms of farming, while the inhabitants of the rather temporary settlements of the low-lying and clay-covered floodplains dealt mainly with animal husbandry and fishery or other activities linked to the benefits of waters.⁴⁵ During the Late Middle Ages, floodplains were entirely abandoned, and the population concentrated mainly in the market towns and the few villages of the loess ridges or on the edge of the floodplain, which had a similar soil structure. The fields of the deserted settlements merged into the area of the emerging market towns, and a specific type of urban settlement, the cattle-breeding market town,

42 Nyári et als., “Multidisciplinary analysis.”

43 Györffy, *Az Árpád-kori Magyarország*, vol. 3, 34; Pálóczi-Horváth, “Túrkeve története,” 53.

44 Pinke et al., “Zonal assessment,” 101. For a more comprehensive overview of the medieval climatic history of the Carpathian Basin, see Vadas and Rácz, “Climatic Changes.”; Vadas, “The Little Ice Age.”

45 Györffy, *Az Árpád-kori Magyarország*, vol. 1, 510; Jankovich and Szatmári, *Régészeti kutatások*; Szabó, “A dömösi prépostság”; Szabó, *A dömösi adománylevél*.

evolved, where animal husbandry became the core sector of the local economy.⁴⁶ An archaeobotanical investigation of the plain revealed that the proportion of species with high moisture demand increased significantly from the first centuries of the Árpád Era (1000–1241) to the last (1242–1301).⁴⁷ Like other paleoclimatic examinations, this finding suggests that rapid climate change took place in the second part of the thirteenth century,⁴⁸ when climatic extremities, e.g. long-lasting droughts and severe winters became more frequent⁴⁹ and caused higher humidity on the plain and higher flood levels on the floodplains. At the same time, interdisciplinary research based in part on a wide range of written sources has clearly demonstrated that the first decades of the fourteenth century were the most serious period of this climatic change, which bore witness to significant increases in areas covered with water.⁵⁰

The Use of the Woods

Woodland areas in medieval Hungary were used in many different ways, and historical and interdisciplinary studies have reconstructed the relevant aspects of the uses to which woodlands were put in a complex way. Hungarian historical research has identified the importance of this natural resource and the related source materials in the nineteenth century.⁵¹ Ethnographic studies on the eighteenth century also contributed to our understanding of traditional forms of woodland exploitation and of the clearing process.⁵² At the same time, the complex and interdisciplinary understanding of the uses to which woodlands were put in medieval Hungary is a result of more recent studies.⁵³ For the particular discussion points of the present article, it should also be noted that woodland and forest management in the mining regions of Hungary in the seventeenth and (even more so) eighteenth centuries has been very intensively

46 Makkai, “A pusztai állattartás,” 31–32.

47 Pinke et al., “Zonal assessment,” 102.

48 Kern et al., 111, 114, 121–24.

49 Kiss, “Weather and Weather-Related.”

50 For data and further literature, see Andrea Kiss, *Floods and Long-Term Water-Level Changes in Medieval Hungary* (Cham, 2019). Another aspect of environment-driven crises has been addressed by Andrea Fara, “Production of and Trade in Food Between the Kingdom of Hungary and Europe in the Late Middle Ages and Early Modern Era (Thirteenth to Sixteenth Centuries): The Roles of Markets in Crises and Famines,” *Hungarian Historical Review* 6 (2017): 138–79.

51 Tagányi, *Magyar erdészeti oklevéltár*.

52 Takács, *Egy irtásfalur*; Takács, *Irtásgazdálkodásunk emlékei*; Hegyi, *A népi erdőkielés*.

53 Szabó, *Woodland and Forests*.

studied. The basic concepts of modern woodland management were developed in some of these regions, particularly in Selmecebánya (today Banská Štiavnica, Slovakia). However, this geographical overlap with the medieval mining regions does not mean that forest management practices can be seen automatically in a strong continuity context, as major legal and institutional development only began in the eighteenth century. Thus, the medieval use and exploitation of woodlands in the mining regions should be seen in a different way. This aspect is also crucial for a discussion of the pressures put on and changes which took place in the relevant ecosystems.

Medieval documents or the written sources do not enable us to reconstruct the forest coverage of the areas around the mining towns or in the mining regions. In a similar way, the amount of wood extracted from these areas cannot be calculated with the help of documentary evidence. It should also be noted that forests were used in the mining regions for several purposes: as timber in the construction of mines, to prepare charcoal, or to build ore crushers, etc. Therefore, we have to take into consideration all possible sources connected to these regions concerning woodland. The connection between mining and the use of wood was referred to in a donation charter issued in 1263 by King Béla IV when he gave Andrew, the judge of Besztercebánya, a forest as a reward for his merits in silver mining. From then on, the forests around the Northern Hungarian mining towns were usually in the hands of the richest burghers.⁵⁴ Trip-hammers and ore crushers were mentioned in the region of Kőrmöcbánya (today Banská Kremnica, Slovakia) as early as 1331.⁵⁵ According to a register from 1468, there were 29 ore crushers and four furnaces in Banská Kremnica alone.⁵⁶ Another register says that in 1522 there were 43 mines, five furnaces, and five ore crushers in Selmecebánya (today Banská Štiavnica, Slovakia), employing 918 workers. There was a significant increase in metal production compared to the previous decades.⁵⁷ Parallel to this, the mining towns, taking advantage of their royal privileges,—aimed to expand the territory where they could harvest the wood necessary for the mines and furnaces.⁵⁸

54 Szentpétery, *Regesta regum*, no. 1332.

55 Wenzel, *Magyarország*, 45.

56 Izsó, *Szemelvények*, 67. On the ore crushers and mills in the Kremnica region, see Vadas, “A középkori Magyar Királyság.”

57 Izsó, *Szemelvények*, 81.

58 Weisz, “Az alsó-magyarországi bányavárosok,” 40. For examples of local regulation of logging and woodland clearing see Weisz, “Mining Town Privileges,” 305.

The mines also contributed to the financing of the royal treasury. Indeed, the decrees issued by King Louis I in 1351 mention the *urbura* in connection with iron.⁵⁹ Iron was mentioned along with gold, silver, tin, and plumb in 1427 when King Sigismund of Luxembourg donated the *urbura* collected in certain mining towns to Queen Barbara, though he retained the incomes from copper.⁶⁰ In the late-fourteenth century, King Sigismund exchanged certain royal domains for castles of the Csáki family in Temes County, one of which was the castle of Kövesd (today Cuișed, Romania), which had an iron mine that was mentioned explicitly in the charter.⁶¹ The region in question is better known today as Resica (Reșița, Romania), and it was one of the major metallurgical centers of Romania from the mid-eighteenth century until recently. However, iron production can be traced back in the region to as early as the twelfth century: an iron smelting workshop was excavated by Dumitru Țeicu in Felsőlupkó (today Gornea, Romania),⁶² and different forms of iron ores were identified at several sites of the region that belonged to the royal domain of Illyéd (today Ilidia, Romania) in the Middle Ages. Further mines in the region which were mentioned in the fourteenth and fifteenth centuries include Székesbánya (north of today Dognecea, Romania), Bényes (today Biniș, Romania), Boksánbánya (today Bocșa Montană, Romania), and further to the northeast Galadna (today Gladna Română, Romania). These localities were royal estates throughout the Middle Ages or became royal estates in the Late Middle Ages.⁶³

Rulers were very concerned with running the mines. As early as 1349, King Louis I granted a privilege for merchants from Genoa in the copper trade, and in 1376 the same privilege was granted to Florentine merchants, too.⁶⁴ Four years later, merchants connected to the Medici family acquired a share in Hungarian copper mining, and in 1385, the company made a contract with Venice, the center of the European copper trade, according to which the major share of the copper produced in Hungary would be sold in Venice (except for the part exported to Flanders).⁶⁵ In the early fifteenth century, a shift can be seen in the trading network. It was connected to the person of Mark of Nuremberg, who,

59 Izsó, *Szemelvények*, 19.

60 Wenzel, "Okmányi adalék."

61 Wenzel, *Magyarország*, 124.

62 Țeicu, *Banatul montan*, 261 and 267.

63 F. Romhányi, "The Banat region."

64 Wenzel, *Magyarország*, 158.

65 Izsó, *Szemelvények*, 41. Sources indicate regular commercial contacts with and the economic presence of Venetian merchants in Hungary as early as the 1220s, when one of the most important goods was

for instance, prohibited the import of Polish (medieval Ilkusz, today Olkusz, Poland) plumb in 1405 because of conflicts in copper production.⁶⁶

One also finds direct orders concerning the mines from the fifteenth century. In 1426, King Sigismund ordered George of Jolsva, the bailiff of Zólyom castle (today Zvolen, Slovakia), to secure the necessary wood supply for the new plumb mines,⁶⁷ and he regulated the use of the forests around Gölnicbánya (today Gelnica, Slovakia) in 1437.⁶⁸ His successor, King Albert, took the miners of Offenbánya (today Baia de Arieș, Romania), Körösbánya (today Baia de Criș, Romania), Zalatna (today Zlatna, Romania), and Körösfő (today Izvoru Crisului, Romania) under his special protection.⁶⁹ In 1475, the Thurzó Company made a contract with the Northern Hungarian mining towns. According to this contract, the company would establish water lading machines (Wasserkunst) in exchange for which it would receive one sixth of the mined ore as payment. The contract was confirmed and complemented by King Matthias in the same year, by that the necessary wood should be given to the company free of charge.⁷⁰ In 1479, King Matthias allowed the town of Selmezbánya to harvest the wood needed for mining from the royal forest free of charge. This permission was expanded by King Wladislaus II, who ordered in 1496 that the wood had to be given to the town free of charge by any landowner.⁷¹ In 1500 and 1502, Wladislaus II confirmed the right of the Lower Hungarian mining towns to harvest the necessary wood in the royal forests, and this privilege was given to the Upper Hungarian mining towns in 1504 and 1507, as well.⁷² Wood was also needed in the salt mines, if in lower quantities. In 1498, for instance, King Wladislaus II donated salt worth 100 guilders to the Cathedral Chapter of Gyulafehérvár (today Alba Iulia, Romania) and in compensation gave the salt mine officials of Torda (today Turda, Romania) the right to cut timber with which to build salt ships in the forest of the Chapter.⁷³ The intensive

Hungarian silver transported as far as the Levant. Szűcs, *Az utolsó Árpádok*, 323. On the importance and scale of medieval Hungarian copper mining, see Paulinyi, *A középkori magyar réztermelés*.

66 Paulinyi, *A középkori magyar réztermelés*, 36–37.

67 Tagányi, *Erdészeti oklevéltár* 1, 25.

68 Wenzel, *Magyarország*, 331–33.

69 *Ibid.*, 126–27.

70 Izsó, *Szemelvények*, 45.

71 Tagányi, *Erdészeti oklevéltár* 1, 30.

72 Tagányi, *Erdészeti oklevéltár* 1, 30; Izsó, *Szemelvények*, 46.

73 Tagányi, *Erdészeti oklevéltár* 1, 30. However, wood for the ships built in Dés (today Dej, Romania) were sometimes transported from as far as the region of Radna (today Rodna, Romania). Draskóczy, *A magyarországi kőszó*.

royal interventions to provide wood for the mining sector is absolutely understandable. Hungary and Bohemia were the major suppliers of gold and silver in late medieval Europe, and the kingdom's copper production was also significant. In the 1380s, the Hungarian copper export can be estimated at 8–10 thousand tons per year. In 1495, when John Thurzó made his contract with the Fugger family on copper production within Hungary, the production of the planned kiln of Besztercebánya (today Banská Bystrica, Romania) was set at 300 quintals per week, giving a total of approximately 920 tons per year. Thus, that kiln alone would produce about 10 percent of the fourteenth-century export. The investment was intended to increase the quantity of the copper produced by the company and also to improve the quality, which meant multiple smelting, which demanded more energy. According to the accounts of the Fugger family, the company had invested 277,500 guilders by 1499, and profits reached roughly 2.5 million guilders between 1496 and 1546.⁷⁴ The Thurzó company was involved in copper and precious metal production in areas outside of northern Hungary. The mines of Belényes (today Beiuș, Romania), where both silver and copper were mined, were restarted, and reorganized by John Thurzó in the early-sixteenth century.⁷⁵

Large-scale logging, however, took its toll. In 1347, King Louis I allowed the miners of Nagybánya (today Baia Mare, Romania) and Zazár (today Săsar, Romania) to cut the necessary timber for the mines in any forest, be it royal or noble property, in part since there was no suitable material anymore in the town's surroundings.⁷⁶ Sources also indicate conflicts between miners and owners of forestlands. In 1459, the towns of Szomolnok (today Smolník, Slovakia) and Svedlér (today Švedlár, Slovakia) turned to the king, since the bailiffs of the castles of Krasznahorka (today Krásna Hôrka, Slovakia) and Szádvár hindered the work of the charcoal-burners, destroying their kilns and causing other damages, as well.⁷⁷ Between 1479 and 1503, a long-lasting conflict emerged between the

74 Izsó, *Szemelvények*, 57–59.

75 Wenzel, *Magyarország*, 118. The silver mines of the Bishop of Várad around Belényes (Beiuș) were first mentioned in 1297 (Györffy, *Az Árpád-kori Magyarország*, vol. 1, 599), then, in 1374 (Izsó, *Szemelvények*, 127).

76 Tagányi, *Erdészeti oklevéltár* 1, 20; Izsó, *Szemelvények*, 117–18. About this case, see also Weisz, “Mining Town Privileges,” 304. Another charter issued in 1376 (Fejér, *Codex diplomaticus Hungariae*, IX/5. 98.) may indicate that there was already wood of suitable quality in the closer vicinity of the mines, too, though it seems to have been wood used as building material for different edifices (*cives et hospites... molendinum, casas, fornaces, balnea, allodia, et alias quaslibet haereditates aedificari facientes*), and not for the mines directly or to burn as charcoal.

77 MNL OL DL 24901 (short summary in Hungarian: Izsó, *Szemelvények*, 106).

miners of the region of Nagybánya on the one side and the Drágfi family and their bailiffs of Kővár Castle near Kővárremete (today Remetea Chioarului, Romania) on the other because of forest use.⁷⁸ The miners of Offenbánya (today Baia de Arieș, Romania) and the Romanian knezate of Nagylupsa (today Lupșa, Romania) had a similar conflict between 1485 and 1487, where both the felling of timber for mines and the making of charcoal were mentioned.⁷⁹

The first indication of rafting on the Hron/Garam River dates from 1209 (*tributum lignorum, quae feruntur super Gran*) and on the Váh/Vág River from 1206 and 1271, referring to the use of wood from the high mountains.⁸⁰ Similarly, wood was a major source of income in the mountainous regions of the Drugeth domains in Ung County. As Pál Engel has pointed out, the former border zone (*gyepüelvé*), which was settled in the fourteenth and fifteenth centuries, was mainly used for logging (*silva dolabrosa*). This is also supported by the presence of numerous mills on different streams in an area where ploughland was very limited at the time.⁸¹ However, the first clear evidence of the use of rafts in shipping other goods, in this case salt, is a charter issued in 1507.⁸² Before this, only reusable boats (often log boats) were used in salt transport, as written sources from the late eleventh century indicate.⁸³ The territory where, as the charter says, rafts were used in a new way is the salt region of Máramaros County, where this practice continued into the 1860s.⁸⁴

The intensive use of forests suggests that deforestation reached a critical rate in the mining regions. However, the same environment was affected by another economic activity, the grazing of sheep. Sources indicate that as early as the thirteenth century, transhumant shepherds used the lands in the Apuseni

78 Izsó, *Szemelvények*, 121–22.

79 MNL OL DL 32505 (short summary in Hungarian: Izsó, *Szemelvények*, 132–33).

80 Alexander Fehér, *Vegetation History and Cultural Landscapes: Case Studies from South-west Slovakia* (Cham: Springer, 2018); Richard Marsina, ed., *Codex diplomaticus et epistolaris Slovaciae*, vols. 1–2 (Bratislava: SAV, 1971–1987); Bratislava Obzor, and Veronika Novák, “Mátyusföldi települések az okleveles források tükrében” [The settlements of the Mátyusföld region as reflected in the charters], in *Mátyusföld* vol. 2, edited by László Bukovszky 45–61 (Komárom: Fórum Kisebbségkutató Intézet; Dunaszerdahely: Lilium Aurum Könyvkiadó, 2005); Ferdinand Uličný, *Dejiny Slovenska v 11. a 13. storočí* (Bratislava: Veda, 2013).

81 Engel, “Ung megye,” 956.

82 The expression is *super struibus lignorum*. Iványi, *A római szent birodalmi*, no. 450. Before that, *strues* meant only a raft the wood of which was sold as building material or other raw material, but nothing else was shipped on it.

83 F. Romhányi, “Salt trade.”

84 Paládi-Kovács, *Magyar néprajz*, vol. 2, 979. In early modern times, rafting—especially of building material—was wide-spread on other rivers, too, e.g. on the Vág and Maros.

mountains to graze their herds.⁸⁵ Their gradual movement towards the north is reflected partly in the foundation of small orthodox monasteries and churches built from the second half of the fourteenth century⁸⁶ and partly in the increasing number of Wallachian villages, especially after the 1420s, when Ottoman raids destroyed large parts of southern Transylvania.⁸⁷ Similarly, Orthodox, mainly Ruthenian settlers arrived from territories beyond the northeastern and northern Carpathians. Their presence can be traced back to approximately the same period. In 1337, Palatine William Druget settled orthodox peasants in the village of Korumlya (today Koromľa, Slovakia).⁸⁸ Large groups of Ruthenian (Podolian) settlers came to the region after Prince Fyodor Koriatovych was forced into exile (1392) and became the lord of the Munkács and Makovica Castles (today Mukachevo in Ukraine and Zborov in Slovakia) and count of Bereg and Sáros Counties.⁸⁹ The donation charter of Queen Mary issued in 1390 offers further evidence of the presence of transhumant shepherds in Szatmár County. It gave Terebes (today Racova, Romania) to the ancestors of the Drágfi family, Balk, Drag, and John. Three years later, they came into conflict with another local landlord, Ban Simon of Medgyes, whose tenants killed their tenants' sheep (*iobagionum seu Olaborum*).⁹⁰ The conflict must have involved the use of the land, more specifically the use of the pastures. The spread of these settlements continued in the fifteenth and sixteenth centuries.⁹¹ In 1437, several Orthodox

85 Miskolczy, *Románok*, 17–31.

86 Rusu, *Dicționarul mănăstirilor*.

87 Köpeczi, *Kurze Geschichte*, 186–95.

88 Engel, “Ung,” 974 (1337: *olabos descendere fecisset*). Ruthenians were often called *valachi* in the charters because of similarities in their lifestyles, but in the case of Koromlya, a charter of 1437 says clearly that they were Ruthenians and that at the time they even had a priest of their own.

89 Kuczyński, “Fedor Koriatowicz.” The prince spent time in Hungary in the 1360s and 1370s. The monastery of Saint Nicholas, which he founded near Munkács (today Mukachevo, Ukraine), was called a parish of the Ruthenian (i.e. Greek Orthodox) rite in 1458. Its priest, Lucas, was confirmed by King Matthias Corvinus (*Collectio Kaprinai*, series B, vol. 6, no. 42). This means that the church was a recognized center of pastoral care for the Orthodox population after the Union of Florence.

90 Németh, *A középkori Szatmár*, 301.

91 For the fifteenth century see Mihályi, *Máramarosí diplomák*, 223 (1418: *duas capellas ligneas, unam videlicet Christianorum et aliam Ruthenorum* in two villages in Máramaros County); Németh, *A középkori Szatmár*, 268 (1424, Szakasas—*capella Olaborum*). Németh's book contains considerable data on the Wallachian population in Szatmár County. A further example from 1516: MNL OL DL 86750 (a conscription of a domain on the border of Bereg and Máramaros Counties lists three wooden churches—*capella lignea more volachorum*—in Ruszkova, Polyána, and Rosálya). In Zemplén County, new Orthodox chapels were built in the sixteenth century, e.g. in Felsőcsébény and Oroszsebes (today Vyšné Čabiny and Ruská Bystrá, Slovakia), in the mountains to the north and east of Nagymihály (Samu Borovszky, *Magyarország vármegyéi és városai: Zemplén vármegye és Sátoraljai hely r.t. város* [The counties and towns of Hungary: Zemplén County and the town

chapels were listed beyond the Vihorlat Mountains in Zemplén County.⁹² By the late-fifteenth century, shepherds of Romanian and Ruthenian origin had reached the western Carpathians, Árva, Trencsén, and Turóc Counties.⁹³ The expanded grazing significantly contributed to deforestation.

In addition to the above, the Ottoman wars between the fifteenth and seventeenth centuries also affected the territories in question, if in an indirect way. On the one hand, a significant part of the population fleeing the devastated southern regions and the Hungarian plain took refuge in the Carpathians. The first Protestant registers listing the pastors and the communities between the 1560s and the 1620s indicate a population density which would have been unthinkable before the Ottoman wars and which began to decline after the 1660s.⁹⁴ The situation was slightly different in Transylvania, but immigration from Moldavia, and Walachia was almost uninterrupted, and for the most part targeted areas which were suitable for pasture. In other parts of the country, in the frontier zones of the region occupied by the Ottomans, fortifications needed a continuous supply of wood, which accelerated the process of deforestation in the frontier zones. Ágnes R. Várkonyi has emphasized that the maintenance of the Ottoman period defense system of Hungary put tremendous additional pressures on the forests in the mountainous regions (e.g., in the 1680s, the domain of Likava Castle regularly had to deliver large amounts of timber, poles, stakes, roof shingles, etc. for different fortifications

of Sátoraljaújhely] (Budapest–Sátoraljaújhely, 1905) 42 and 96). In Ugocsa County, a charter issued in 1471 listed thirteen villages inhabited by Wallachians and Ruthenians (MNL OL DL 70956). In 1491, the Orthodox population of Máramaros County and the surrounding mountainous region had a bishop who resided in the monastery of Körtvélyes (today Hrusheve, Ukraine). MNL OL DL 36886.

92 Engel, “Ung,” 974.

93 The *valachi* living on the territory of the Árva and Likava Castles received a privilege from King Matthias Corvinus in 1474. Wenzel, *Magyarország mezőgazdaságának*, 330–31. On the colonization process of Trencsén County, see Fekete Nagy, “Trencsén megye,” in Csánki, *Magyarország történeti földrajza*, vol. 4, 61–62.

94 Csepregi, Zoltán, *Evangelikus lelkészek Magyarországon 2: a zsolnai zsinattól (1610) a soproni országgyűlésig (1681)* [Lutheran pastors in Hungary part 2: from the synod of Zsolna, 1610 till the diet of Sopron, 1681] (Budapest, 2018). I would like to thank Professor Csepregi for his additional information about the database. Furthermore, see Dienes, Dénes ed., *Református egyházlátogatási jegyzőkönyvek, 16–17. század* [Protocols of canonical visitations of reformed churches, sixteenth and seventeenth centuries] (Budapest: Osiris, 2001); Tomisa, Ilona ed., *Katolikus egyházlátogatási jegyzőkönyvek, 16–17. század* [Protocols of canonical visitations of Catholic churches, sixteenth and seventeenth centuries] (Budapest: Osiris, 2002). On the mosques established on the territory under Ottoman rule in the sixteenth century, see Sudár, Balázs, *Dzsámik és mecsetek a hódolt Magyarországon* [Mosques in Ottoman Hungary] (Budapest: MTA Történettudományi Intézete, 2014).

which were 150–200 kilometers distant Likava itself), which had already been largely depleted by the mines and furnaces.⁹⁵

Medieval Transformation of the Land Cover in the Mining Regions of the Carpathian Basin

In this section, we offer a short review of the main directions of land cover changes that took place between the eleventh and the sixteenth centuries in the ca. 50,000 km² mountainous regions of the northern and eastern part of the medieval Kingdom of Hungary. By the eleventh century, most of the lower regions and foothills, the environment of the mines in use in the Apuseni Mountains and the Northern Middle Mountains (northern Hungary and eastern Slovakia), became cultural landscapes. The ratio of open lands increased gradually due to human use, mainly grazing and forest clearance for charcoal production (for instance). Moreover, pastoral activities were associated with forest burning, which was a drastic form of clearance, as indicated in many pollen reconstructions of the Carpathians.⁹⁶ This happened in the central part of the Apuseni Mountains, where the ratio of herbaceous pollen increased permanently from the Iron Age (eighth–sixth century BC) in a site situated at 1240 meters a.s.l. (above sea level) and in the environment of a bog (1400 meters a.s.l.) from the late Roman Period (fourth century AD).⁹⁷ The presence of cereal pollens was stable, but their ratio was low in the total pollen profile in ten of the sites studied in the mountains from the late fifth century to the end of the sixteenth.⁹⁸ In contrast, the first cereals are found in the 4280–3570 BC deposit layer of the Ponor karst area (1040 meters a.s.l. Apuseni Mountains) and in a layer of the Iaz peat bog dated to 4300–3700 BC (300 meters a.s.l. Apuseni Mountains).⁹⁹ The earliest evidence of forest grazing and farming culture was identified at 4740–4620 BC in the Căpățâna peat bogs (1220 meters a.s.l. Apuseni Mountains), but major deforestation began only around 1400 AD, linked to a migration wave of the transhumant Orthodox population reaching the area, as well as the rapidly rising demand for wood in the industrializing mining region.¹⁰⁰

95 R. Várkonyi, “Környezet és végvár,” esp. 17.

96 Feurdean, Tanțâu, “The Evolution,” 81.

97 Bodnariuc et als., “Holocene vegetation.”

98 Törőcsik and Sümegi, “Pollen-based reconstruction.”

99 Fărcaș and Tanțâu, “The Human Presence.”

100 Fărcaș and Tanțâu, “The Human Presence”; Grindean et als., “Middle to Late Holocene,” 34.

Similar temporal dynamics appear in the paleo-ecological records of sites in the Aggtelek-Rudabánya Mountains, very close to an important iron mine.¹⁰¹ The ratio of cereal pollens, however, increased here significantly from the late tenth century to the end of the eleventh and showed a consistently high proportion until the late sixteenth century.¹⁰² Human use was reconstructed in the Western and Northern Carpathians, including the Tatra Mountains and Szepesség Region (today the Spiš Region, Slovakia) from the early phase of the Migration Period (fifth century), but the ratio of cereals began to grow only towards the end of the eleventh century.¹⁰³ As a result of the colonization policy of King Béla IV, thousands of settlements and dozens of new towns began to emerge in the Carpathians, including the Tatra Mountains, over the course of the fifty-year period beginning in the mid-thirteenth century.¹⁰⁴ In other words, there was a dramatic increase in human pressure on the ecosystems in the mountains beginning in the thirteenth century. Rapid colonization following extensive pastoral and mining activity reduced the forest coverage in Sáros and Zemplén Counties (in the northern Carpathians) and Borsod and Gömör Counties (in the northern middle mountains) by the late fifteenth century to an estimated 41–60 percent, 21–40 percent, 41–60 percent, and 21–40 percent, respectively.¹⁰⁵ As it has been discussed in literature with regard to the Northern Middle Mountains in the fourteenth and fifteenth centuries, “the forests came to an end there, and the neighboring counties began to eliver their forests to the mining regions.”¹⁰⁶

The traces of small-scale forest clearance were recorded in the Bronze Age peat deposit at 1143 meters a.s.l. in the Lápos (Romanian Lapuș) Mountains, close to the northern Transylvanian mining region.¹⁰⁷ Then, the human impact gradually intensified beginning in the twelfth century. The fourteenth and the fifteenth centuries, when the modern cultural landscape evolved in the region, bore witness to large-scale logging and intensive agricultural activity. In the neighboring Gutai Mountains, the first sign of grazing is found in the ca. eleventh deposit layer of the crater lake Steregoiu (ca. 800 meters a.s.l.), but serious human impact appears only from the 1700s.¹⁰⁸ In contrast, Fărcaș and

101 Sümegi et als., 42.

102 Törőcsik and Sümegi, “Pollen-based reconstruction.”

103 Törőcsik and Sümegi, “Pollen-based reconstruction”; Mályusz, *Turóc megye*, 1922.

104 Szűcs, *Az utolsó Árpádok*, 316.

105 Szabó, “Changes in woodland,” 111.

106 Mályusz, *Turóc megye*; Weisz, “A bányaváros mint önálló”, 49–50.

107 Peters et als., “Holocene vegetation,” 15.

108 Feurdean et als., “A paleo-ecological,” 132.

Tanțău found pollen evidence of minor cereal production here in the layer dated to 820 ± 75 AD.¹⁰⁹ The deposit in the crater lake Preluca Țiganului is situated in the Gutăi Mountains, and it has the earliest evidence of a human-driven decrease in forest diversity in a 2,300-year-old deposit. In other words, forest clearance and grazing may have started in the late Iron Age (300 BC).¹¹⁰ According to a historical estimate based on late-fifteenth-century common estimations (*aestimatio communis*) that covers nearly 3,000 km² (almost one percent of the Carpathian Basin),¹¹¹ forest coverage may have been 76–100 percent in Máramaros County, where important salt and precious metal mines were in operation, and 21–40 percent in Közép-Szolnok County, which covered the northeastern part of the Apuseni Mountains.¹¹²

Conclusion

Both written sources and changes in the settlement system prove that the mountainous areas of the Carpathian Basin that are rich in ores and—in Transylvania and Maramureș—in salt were increasingly exploited from the second half of the thirteenth century, after the Mongol Invasion. Mining was intensified in at least three periods: first in the first half of the fourteenth century, then in the last decades of the fourteenth century, and finally at the end of the fifteenth century. The increasing quantities to be shipped and the extremely expensive transportation costs of the time¹¹³ led to a transformation in transport infrastructure: around 1500, rafts began to be used instead of boats, and the use of rafts became widespread in the following centuries, especially on the Tisza and its tributaries, thus contributing to the decline of forests. As the documents cited above indicate, the forest maintenance that accompanied land use management in the majority of the medieval communities was not characteristic of the mining regions studied here during the fifteenth and early sixteenth centuries.¹¹⁴ However, forest management, including maintenance, belonged to the eminent interest of local communities, since forests (wood) were the main energy resource before the Industrial Revolution in the

109 Fărcaș and Tanțău, “The Human Presence,” 34.

110 Feurdean, “Holocene forest,” 442.

111 Vadas and Szabó, “Not Seeing the Forest,” 478.

112 Szabó, “Changes in woodland,” 111.

113 Braudel, *Civilization and Capitalism*, 362–68.

114 Szabó, “The Extent,” 221.

eighteenth century. However, the melting ores offered such impressive profits for companies and the royal treasury that it was in the interests of the state to provide adequate wood to meet the needs of the mines. At the end of the Middle Ages, royal power tended to neglect the ownership and interest of local communities and landlords by allowing mining companies to clear forests. This step opened the gate for deforestation of huge areas in the Carpathians. When the destruction reached an extreme in certain mining regions in the sixteenth century, the central administration tried to correct its former stance and issued decrees that were intended to protect forestlands for instance by prohibiting iron mining in certain regions in 1564¹¹⁵ and issuing a new regulation concerning the forests used by the lower Hungarian mining towns in 1565.¹¹⁶ These efforts, however, proved useless, because of the conflicts with the Ottoman Empire and the civil wars of the sixteenth and seventeenth centuries, when the protection of lands, including forests, was hardly the primary concern. Moreover, as was the case in Transdanubia, influxes of refugees from the Ottoman wars led to a population increase in the mining regions from the mid-sixteenth century, thus putting increased human pressure on the forests in the mountains.¹¹⁷ Alongside mining, transhumance also became more widespread in the regions, reaching the westernmost part of the Carpathians in the fifteenth century. These economic activities resulted in the gradual deforestation of the regions. The process was probably hastened by the needs of military constructions, which were also a consequence of the Ottoman wars.

Our hypothesis is that the increasing number and intensity of hydroclimatic extremities linked to the medieval climate change that preceded the Little Ice Age may have contributed to or driven the desertion of settlements in the sandy ridge and floodplain regions of the Great Hungarian Plain in the thirteenth century. The Mongol Invasion merely ended a crisis which affected the farming system of the plain. The form of land use that became dominant in the region in the late Middle Ages—extensive grazing of cattle and sheep—remained the most prevalent practice until the eighteenth century. However, the increasing use of pastures, the partial extension of pastures towards the hills, the changing runoff coefficient due to deforestation in the bordering mountain regions, and the effects of warfare may have contributed to the aridity of the Hungarian

115 Tagányi, *Erdészeti oklevéltár*, vol. 1, 77.

116 Heckenast, *A magyarországi vaskohászat*, 109–10.

117 Vadas and Szabó, “Not Seeing the Forest,” 478.

Plain in the Early Modern era and the decreasing profitability of large-scale animal husbandry in the region.

Thus, the lucrative, export-oriented economic activities of the late medieval Hungarian kingdom, which contributed to the ability of the country to withstand Ottoman pressure for about 130 years (before the 1520s) and, in a more limited way, even longer (into the wars of the sixteenth and seventeenth centuries), led in the long run to serious environmental degradation the effects of which could not be fully overcome for a long time. Certainly, this impact was increased by the effects of the Ottoman wars themselves and the changing climatic conditions of the Little Ice Age, too, but the process began well before the Early Modern crisis, in some respects, as early as the late thirteenth and early fourteenth centuries.

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