András Vadas

Weather Anomalies and Climatic Change in Late Medieval Hungary: Identifying Environmental Impacts

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by
András Vadas
(Hungary)

Thesis submitted to the Department of Medieval Studies,
Central European University, Budapest, in partial fulfilment of the requirments
of the Master of Arts degree in Medieval Studies
Accepted in conformance with the standards of the CEU

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Chair, Examination Committee

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Thesis Supervisor

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I, the undersigned, **András Vadas**, candidate for the MA degree in Medieval Studies, declare herewith that the present thesis is exclusively my own work, based on my research and only such external information credited in notes and bibliography. I declare that no unidentified and illegitimate use was made of the work of others, and no part of the thesis infringes on the copyright of any person or institution. I also declare that no part of the thesis has been submitted in this form to any other institution of higher education for an academic degree.

Budapest, 2010

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Signature

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List of Abbreviations

Dl – Magyar Országos Levéltár Hungarian National Archives] – Diplomatikai Levéltár (Collectio Diplomatica Hungarica) [Archive of Diplomatics]

Df – Magyar Országos Levéltár Hungarian National Archives] – (Collectio Diplomatica Hungarica) [Collection of Diplomatic Photographs]

OSZK – Országos Széchényi Könyvtár [Széchényi National Library]

OSZK App. M. – Országos Széchényi Könyvtár [Széchényi National Library]. Apponyi collection

OSZK TA, TM, TR. – Országos Széchényi Könyvtár [Széchényi National Library]. Térképtár [Collection of maps]

1. Introduction*

Historical climatology has become an increasingly investigated field of study as global warming has come to the fore in political and economic discussions.[1] From the 1980s, research has concentrated on reconstructing the climate of the last 120-150 years to estimate the impact of the greenhouse effect. At the turn of the twentieth century numerous climate scenarios have tried to model the way human activity influences global climate and based on these results created possible future scenarios.[2] To estimate the recent changes in the global climate one should not ignore the investigation of past climatic processes. To develop precise climate scenarios for the next decades and centuries it is not enough to study recent climatic trends. Climatic fluctuations of the whole Holocene period need to be examined.

Although historical climatology is considered a young field of study, the aim of investigating how climate has been changing is not a product of the last century but started around the turn of the eighteenth century.[3] This is the period when the first weather compilations were gathered and the time when the systematic measurement of temperature and air pressure (in some territories precipitation) started in Central Europe, while by that time the measurement of temperature and precipitation had a longer tradition in several territories of the continent. The systematic measurement of temperature in Italy and England started more than a hundred years before it began in Central Europe, and the early instrumental measurements go back to the sixteenth century. In these territories climatic reconstructions of Early Modern and Modern Times are based on historical or scientific data and moreover on instrumental measurements.[4]

From the nineteenth century numerous weather compilations were gathered, although their historical climatological interpretation was not carried out in that period.[5] These

* In the thesis when referring to geographical names I will first give the Hungarian form of them as they appear most frequently in the sources then in brackets I give name form used in the country it is belonging to.

[1] Stephen Daniels and Georgina H. Endfield, "Narratives of Climate Change: Introduction," *Journal of Historical Geography* 35, No. 2 (2009): 215–222.

[2] Ronald E. Hester and Roy M. Harrison, *Global Environmental Change* (Cambridge: The Royal Society of Chemistry, 2002) and the IPCC reports: www.ipcc.ch (last accessed: 12 January, 2010).

[3] One of the first volumes on this subject: Thomas Short, *A General Chronological History of the Air, Weather, Seasons, Meteors in Sundry Places and Different Times; More Particularly for the Space of 250 years. Together with Their Most Remarkable Effects on Animal (Especially Human) Bodies and Vegetables* (London: T. Longman, 1749).

[4] For a summary of the past climatic reconstructions and detailed collection and analysis of secondary literature, see: Rudolf Brázdil, Christian Pfister, Heinz Wanner, Hans Von Storch and Jürg Luterbacher, "Historical Climatology in Europe – The State of the Art," *Climatic Change* 70, No. 3 (2005): 363–430.

[5] On the problems of using these compilations, see: Wendy T. Bell and Astrid E. J. Ogilive, "Weather Compilations as a Source of Data for the Reconstruction of European Climate during the Medieval Period,"

compilations, despite their variable reliability, were fundamental in the period when scientific historical climatological research began as the pioneering works used these compilations as major sources.[6] As these first steps were taken, significant monographs were written on the climate of the past 500 years, 1000 years or on longer periods. However these works had a disadvantage: they did not use the sources critically. They used contemporary evidence and non-contemporary evidence without any consideration of the reliability of the source or investigation of the source material for these data. These works attracted strong criticism and in recent decades the approach to the compilations has changed. Recent research does not use them as main sources; investigations are again focusing on the original sources.[7]

In the recent decades historical climatology evolved and new methods were introduced to understand past climatic processes. Nowadays climatic reconstructions use both historical scientific data. Apart from these two main types of data, a third group of sources, archaeological, may also be relevant although still playing an auxiliary role. Because of poor excavation methodologies and publishing results, for instance archaeological data is less frequently utilized in Hungarian scholarship on historical climatology. From the 1960s on, a few examples of interest can be found although archaeologists have only drawn attention to environmental and climate history in the last few decades.[8]

Climatic Change 1, No. 4 (1978): 331–348, and for the list of the most important weather compilations for Western and Central European territories: 347–348.

[6] As an example see the Hungarian case: the compilations of Antal Réthly have been interpreted by Lajos Rácz, *Climate History of Hungary Since 16th Century: Past, Present and Future* (Pécs: Discussion Papers, 1999), Lajos Rácz, *Magyarország éghajlattörténete az újkor idején* [The climate history of Hungary in Modern Times] (Szeged: JGYF Kiadó, 2001). Climatologists also investigated the collection: Judit Bartholy, Rita Pongrácz and Zsolt Molnár, "Classification and Analysis of Past Climate Information Based on Historical Documentary Sources for the Carpathian Basin," *International Journal of Climatology* 24, No. 14 (2004): 1759–1776, and Judit Bartholy, Rita Pongrácz and Zsolt Molnár, "Extremes and Millenial Trends in the Carpathian Basin Using the Réthly Documentary Collection," in *American Meteorological Society, 17th Conference on Probability and Statistics in the Atmospheric Sciences* (2003), Extended Abstracts: http://ams.confex.com/ams/84Annual /techprogram/paper_73653.htm (last accessed: 12 January, 2010).

[7] For this subject see: Andrea Kiss, "Historical Climatology in Hungary: Role of Documentary Evidence in the Study of Past Climates and Hydrometeorological Extremes," *Időjárás* 113, No. 4 (2009): 315–339, for non-Hungarian examples see Rudolf Brázdil, Petr Dobrovolný, Jürg Luterbacher, Anders Moberg, Christian Pfister, Dennis Wheeler and Eduardo Zorita, "European Climate of the Past 500 Years: New Challenges for Historical Climatology," *Climatic Change* (in press): 7, and Rudolf Brázdil et al., "Historical Climatology." On the problem of using non-contemporary evidence see, for example: Christian Pfister, Jürg Luterbacher, Heinz Wanner, Dennis Wheeler, Rudolf Brázdil, Q. Ge, Zheng Hao, Anders Moberg, Stefan Grab, Maria del Rosario del Prieto, *Documentary Evidence as Climate Proxies. Proxy-specific White Paper Produced from the PAGES/CLIVAR Workshop* (Trieste: PAGES [Past Global Changes], 2008). Online: http://www.pages-igbp.org/cgi-bin/WebObjects/products.woa/wa/product?id=331 (last accessed: 12 January, 2010).

[8] Andrea Kiss, "Historical climatology," 329. See further examples in the following publications and its references: Erzsébet Jerem, *Környezetrégészeti és archeometriai módszerek alkalmazása a településtörténeti kutatásban* [The utilization of environmental archaeology and archaeometry in settlement-historical investigation] (Budapest: Dissertation for the Hungarian Academy of Sciences, 1995) and Csilla Zatykó, Imola Juhász and Pál Sümegi, ed., *Environmental Archaeology in Transdanubia* (Varia Archaeologica Hungarica 20), (Budapest: MTA Régészeti Intézete, 2007).

Based on historical data (textual descriptions, economic information, etc.) monthly, seasonal, and annual temperature and precipitation reconstructions have been carried out for of Western and Central European territories for at least the last 500 years, but in some regions for the last millennium.[9] With the help of these reconstructions the climatic processes of a period for which there are no continuous data can be understood.[10] These data still play a leading role in medieval climatic reconstructions as they provide the most precise dating for weather events.

In this study my primary focus will be on historical data. It is also important however to compare these data with those data derived from scientific investigations, which can be used for evaluating the results of the analysis of written evidence. Historical evidence can provide precisely dated information on weather and related events; it may even permit dating phenomenon to a specific day in some cases although in most cases it is accurate at least to a year. Thus, scientific data can be used to understand decade-long or century-scale tendencies of climate. Archaeological data can also be relevant for indicating both long-term climatic transitions and weather-related extreme events (such as catastrophic flood events).[11]

This thesis is aimed at investigating late medieval climatic changes in the Hungarian Kingdom. Our knowledge of climatic processes in the Carpathian Basin, although growing rapidly in the last decades, is still sketchy. Several aspects of climatic change can be investigated and have been studied in Western Europe; the reconstruction of past climate and climate changes is one issue among a number of others in climate historical research. However it is fundamental for further investigation which is connected to the impact of climate and climate changes. The second field of study uses the results of the first type of

[9] There are territories where the role of historical evidence is still crucial in investigating the climate of the Middle Ages, such as: Switzerland, the German territories, and Low Countries as well as Hungary. Petr Dobrovolný, Anders Moberg, Rudolf Brázdil, Christian Pfister, Rüdiger Glaser, Rob Wilson, Aryan van Engelen, Danuta Limanówka, Andrea Kiss, Monika Halíčková, Jarmila Macková, Dirk Riemann, Jürg Luterbacher and Reinhard Böhm, "Monthly and Seasonal Temperature Reconstructions for Central Europe Derived from Documentary Evidence and Instrumental Records since AD 1500," *Climatic Change* (in press).

[10] See for instance: Rüdiger Glaser, *Klimageschichte Mitteleuropas. 1000 Jahre Wetter, Klima, Katastrophen* (Darmstadt: Primus Verlag, 2001), Marina V. Shabalova and Aryan F.V. van Engelen, "Evaluation of a Reconstruction of Winter and Summer Temperatures in the Low Countries," AD 764–1998," *Climatic Change* 58, No. 2 (2003): 219–242.

[11] Héjj Miklós, "Településföldrajzi megfigyelések. Visegrád XIV–XVI. században," [Settlement-geographical observations. Visegrád in the 14th–16th centuries] in *Visegrád, 1335: Tudományos tanácskozás a visegrádi királytalálkozó 650. évfordulóján: Visegrád, 1985. szeptember 30 - október 1* [Visegrád 1335: conference on the occasion of the 650th anniversary of the royal meeting at Visegrád], ed. József Köblös (Budapest: Pest Megyei Levéltár, 1988), 63–67, and Erzsébet Jerem, József Laszlovszky, Péter Szabó, Zsolt Vásáros and Zsófia Végvári, "A Historical Landscape at The Crossroads of Cultures: A Digital Landscape at The Crossroads of Computer-Aided Reconstructions and GIS Approaches," (accepted, in publication).

scholarship and focuses on socio-cultural impacts of climate.[12] In this field of study the focus is more on the Early Modern Period, when the sources provide quantitative evidence for such investigations. This scholarship focuses on the connection between weather and social tensions.[13] In my study I will investigate the climatic processes themselves because the late medieval sources relating to the weather of the Hungarian Kingdom can only be used with difficulty for discussing the social impact of weather and climatic changes. In my case study it would be speculative to connect the wars, the social tensions to the environmental conditions. For later periods, however, there are studies from the Hungarian Kingdom discussing the impact of climate that can be consulted for comparisons.[14]

Several short periods in Western Europe, for example, the weather of the 1310s, have been thoroughly studied because of their extreme weather and serious environmental conditions, but in the Hungarian scholarship they have not been of scientific interest until recent years. My aim is to investigate the appearance of the serious environmental crisis in the Carpathian Basin in the 1310s. I will use this example to examine the possibility of studying weather anomalies in late medieval Hungary. This decade was selected partly to investigate the degree of a particular crisis in Hungary and partly to demonstrate that despite of the absence of some fundamental types of evidence, such as narratives, it is still possible to understand some patterns of weather and climate in the late medieval period. In this part of my thesis I will focus on charters, which is a type of evidence not frequently used in climate historical scholarship, but which has good research potential. The second goal of this thesis is to adress another question: How long-term climatic processes can be pursued in light of historical data? Here charter evidence will also be employed, but the focus will be on a different sort of evidence: historical maps and, to some extent, archaeological data. This chapter will focus on climatic processes in a narrower geographical area than the Carpathian Basin. The aim here is also twofold, as in the case of the 1310s. I will try to determine whether the environmental conditions and the settlement network in a particular region

[12] Monica Juneja and Franz Mauelshagen, "Disasters and Pre-industrial Societies: Historiographic Trends and Comparative Perspectives," *The Medieval History Journal* 10, No. 1 (2007): 10–12, and Rudolf Brázdil et al., "Historical Climatology," 406–407.

[13] In this study there was an important focus on the connection between climate and wars, uprisings. An other important issue raised is the connection beween witch-hunting and climate: David D. Zhang, Peter Brecke, Harry F. Lee, Yuan-Qing He and Jane Zhang, "Global Climate Change, War and Population Decline in Recent Human History," *Proceedings of the National Academy of Sciences of the United States of America* 104, No. 49 (2007): 19214–19219. It is also important to mention the influential works of the German cultural historian: Wolfgang Behringer should also be mentioned here: *Kulturgeschichte des Klimas* (Munich: C. H. Beck, 2007), and Wolgang Behringer, "Climatic Change and Witch-hunting: the Impact of the Little Ice Age on Mentalities," *Climatic Change* 43, No. 2 (1999): 335–351.

[14] For example: Lajos Rácz, "Az 1830-as évek éghajlati-környezeti válsága Magyarországon" [The environmental crisis in the 1830s in Hungary] *Korall* 9, No. 31 (2008): 132–160.

reflected the large, European-scale climatic changes. I will also discuss how historical maps can be used for climate historical research. By studying of both short-term and long-term processes in the Hungarian Kingdom my aim is to demonstrate that despite scarcity of sources compared to the level of data available for Western European climate reconstructions, it is still possible to understand some processes of climate in late medieval Hungary.

1.1. Methods of understanding past climatic processes

Medieval climate is a relevant topic because this was a period (probably the last in the history of humankind) when human impact on nature was negligible, although this does not mean that in some regions human activity did not have an impact on climatic processes and environmental conditions (for example: forest clearance, overgrazing, draining of meadows to create pasture, damming of rivers).[15] The other main reason why medieval climate is a crucial field of study is that this is the first period in human history when one can find enough documentary sources that scholars can use to attempt to reconstruct past climatic processes. It does not mean that there is no research on the climatic changes in the Roman period, but for this period documentary data are too sporadic and scholarship can not go much further than collecting them.[16] The medieval period is different in this respect. On the one hand, the number of sources starts to increase and, on the other, the types of sources become increasingly diverse.[17] A number of these source materials can be used for understanding climatic processes in the Middle Ages.

With the aid of such sources one can understand the most significant changes and the extremes of the climate in the last 1000 years.[18] The first major pieces of medieval climatological research in Western Europe mostly used narrative sources (chronicles and annals). The collection of these sources has already been completed for Western Europe in a

[15] See the example of ancient civilisations: Hubert H. Lamb, *Climate History and the Modern World* (London: Routledge, 1995 [1982]), 113–125, and J. Donald Hughes, *An Environmental History of the World Humankind's Changing Role in the Community of Life* (New York: Routledge, 2009 [2001]), 30–51 and their references.

[16] James Neumann, "Climatic Change as a Topic in the Classical Greek and Roman Literature," *Climatic Change* 7, No. 4 (1985): 441–454.

[17] For the most recent catalogue of sources and applicable methods used in climate historical investigation, see: Rudolf Brázdil et al., "European Climate,".

[18] Very few case studies go back to earlier periods. For example see Byzantine and Western European climate historical researches for the Early Middle Ages: Dionysios Stathakopulos, "Reconstructing the Climate of the Medieval World: State of the Problem and Case Studies," in *People and Nature in Historical Perspective*, ed. József Laszlovszky and Péter Szabó (Budapest: CEU Press, 2003), 247–261, and Michael McCormick, Paul Edward Dutton and Paul A. Mayewski, "Volcanoes and the Climate Forcing of Carolingian Europe, A.D. 750–950," *Speculum* 82, No. 4 (2007): 865–95.

fundamental work by the Belgian historian Pierre Alexandre.[19] However, in his work he did not use other important sources such as economic data or charters. The reason for that was more practical than theoretical; the annals and the chronicles were edited by the time Alexandre was working on them and their number is incomparably lower than the number of charters or sources of an economic character.[20] The number of known sources is constantly growing and economic and phenological sources (studies of cyclic and seasonal natural phenomena, especially in relation to climate and plant and animal life) are generally used in climatic reconstructions nowadays.[21]

Historical data gathered from the above mentioned sources is significantly different from thew data obtained by scientific methods. While historical data plays a crucial role in understanding weather anomalies, weather-related events (floods, famines), and in some territories (such as England, the Low Countries and Switzerland) long-term climatic processes, the scientific data in most cases provides a basis for the study of long-term fluctuations. Most of the scientific methods were introduced in reconstruction of long-term climatic fluctuations, as most of these methods were used originally in geological investigations and after a while became adapted to investigating the climate of shorter periods. Some of them can be better used for understanding global climatic changes, such as the fluctuation of solar activity and changes in the sun's orbit.[22] Others can be used for investigations of climatic transformations on a macro-regional scale, such as some aspects of faunal analysis (particularly the study of micro-mammal, bird, fish and their scales, insects, and shells), plant macro-remains' analyses, pollen analysis, or borehole temperature

[19] Pierre Alexandre, *Le climat en Europe au Moyen Age. Contribution à l'histoire des variations climatiques de 1000 à 1425, d'après les sources narratives de l'Europe occidentale* (Paris: École des Hautes Études en Sciences Sociales, 1987).

[20] For the types of man-made sources in historical climatology, see: Rudolf Brázdil and Oldrich Kotyza, *History of Weather and Climate in the Czech Lands I: Period 1000–1500*. (Züricher Geographische Schriften 62) (Zürich: Geographisches Institut ETH, 1995), 34–49.

[21] For example: Isabelle Chuine, Pascal Yiou, Nicolas Viovy, Bernard Seguin, Valérie Daux and Emmanuel Le Roy Ladurie, "Grape Ripening as a Past Climate Indicator. Summer Temperature Variations are Reconstructed from Harvest Dates Since 1370," *Nature* 432, No. 7015 (2004): 289–290, Kathleen Pribyl, "Reconstructing April-July Mean Temperatures in East Anglia with the Help of the Beginning of the Grain Harvest, c. 1270 AD–1430 AD," in *European Climate of the Last Millennium. Millennium Milestone Meeting 3. Poster Abstracts*, ed. Giles Young and Danny McCarroll (Swansea: Swansea University Press, 2009), 28–29. Examples from Hungary: Jaroslav Střeštík and Verő József, "Reconstruction of the Spring Temperatures in the Eighteenth Century Based on the Measured Lengths of Grapevine Sprouts," *Időjárás* 104, No. 2 (2000): 123–136, and Andrea Kiss and Rob Wilson, *Analysis of May-June Temperature for Western Hungary, Based on Vine, Grain Tithes and Harvest Records*. (Poster Presentation. European Geosciences Union General Assembly 2009. Vienna, Austria, 19–24 April 2009).

[22] Brázdil–Kotyza, *History of Weather*, 55–61, and Jack A. Eddy, "Climate and the Changing Sun," *Climatic Change* 1, No. 1 (1977): 173–190.

research.[23] There are a few methods which can be used for even more sensitive micro-regional climatological investigations, such as varves, isotope content studies (in stalagmites and ice cores), dendrochronology, and sclerochrononogy.[24]

Methods can be classified by temporal sensitivity as some of them can be used for century-scale investigations (solar activity, borehole temperature), some for decade-scale studies (isotope investigations, pollen analysis and varves), and some can provide even annual data (as varves, dendrochronology, and sclerochrononogy). From my point of view dendrochronology seems to be the most important, although any number of methods could provide some data on the main characteristics and social impacts of the weather and climate in the late medieval period. Dendrochronology and varve investigations provide data on the temperature and the precipitation in a particular period within a year.

Archaeology has the potential to play an important role in the investigation of hydrometeorological events such as floods or inland waters.[25] Information on ground level and the underground water-tables of a certain period can be gained by studying soil-type deposition within medieval wells (and cellars).[26] This infomation would be of help in understanding more general trends in the precipitation in a certain period. Archaeology could also play a crucial role in the study of wetland areas and territories strongly connected to fresh water, such as the Tisza and Danube valleys.[27] Dating methods (both relative and absolute) could yield precise data from the archaeological material by which inundations or catastrophic droughts can be dated. Furthermore archaeology could also be relevant for understanding the

[23] A Hungarian example is: Louise Bodri, Péter Dövényi and Ferenc Horváth, "Két évezred éghajlatváltozásai Magyarországon fúrólyuk-hőmérsékletek alapján," [Climate change of the last 2000 years inferred from borehole temperatures – data from Hungary] in *Környezettörténet – Az utóbbi 500 év környezeti eseményei történeti és természettudományos források tükrében* [Environmental history – The environmental events of the last 500 years in light of historical and scientific evidence], ed. Miklós Kázmér (Budapest: Hantken Kiadó, 2009), 421–436.

[24] For temperature reconstruction based on records, see: Augusto Mangini, Christoph Spötl and Pablo F. Verdes, "Reconstruction of Temperature in the Central Alps During the past 2000 yr from $\delta^{18}O$ Stalagmite Record," *Earth and Planetary Science Letters* 235, No. 4 (2005): 741–751. For dendroclimatological reconstruction of the last millennium and its comparison with other proxies see: Joël Guiot, Antoine Nicault, Cyrille Rathgeber, Jean-Louis Edouard, Frédéric Guibal, G. Pichard and C. Till, "Last-millenium Summer-temperature Variations in Western Europe Based on Proxy Data," *The Holocene* 15, No. 4 (2005): 489–500.

[25] See the historiographical overview in: Andrea Kiss, "Historical climatology," 323–330.

[26] For example: András Pálóczi Horváth, "Kutak Szentkirályon," [Wells in Szentkirály] in *Múzeumi kutatások Bács – Kiskun megyében 1986* [Archaeological research in Bács Kiskun county], ed. István Sztrinkó (Kecskemét: Bács Kiskun megyei Múzeumok Igazgatósága, 1987), 86–98.

[27] See the research on the medieval garden of the royal palace of Visegrád: András Pálóczi Horváth and Torma Andrea, "Environmental Archaeological research at Visegrád in the medieval garden of the Royal Palace," in *Archaeology of the Bronze and Iron Age*, ed. Erzsébet Jerem and Poroszlai Ildikó (Budapest: Archaeolingua Alapítvány és Kiadó, 1999), 343–350. What makes the investigation of this garden especially important for this research is that the original garden was constructed roughly in my focus period in the 1320s and was reconstructed during the reign of Sigismund of Luxemburg. Objects like the original well went out of use by the end of the fourteenth century suggesting changes in the environmental conditions in the garden.

human impact of long-term transformations of climate as settlement pattern changes could reflect climate changes.[28] The climate of a certain period may have had a significant impact not only on the settlement pattern but also on the structures of houses as for instance the milder climate of the Roman period (from the AD first to the fourth century) is reflected in the large open spaces in the entrance rooms of houses at Aquincum and other settlements in Pannonia in this period.[29]

All three methods can and should be used when trying to reconstruct the climate and the weather of a certain period. In this work, I do not intend to ignore or neglect relevant scientific and archaeological data, but my focus will definitely on the historical data which, despite its disadvantages, is still crucial in environmental and climate historical scholarship.

2. The Climate of Europe during the Middle Ages – The Current State of the Field

As noted above, a growing amount of scholarship deals with climatic change and the impact of climate during historical times in the previous decades; and the Middle Ages is an important focus in this research. From the beginning of historic climate research traditional epochs were recognized, which, although largely disputed, are still used in the historiography. The three major medieval epochs are: the cold era of the Migration Period, the Medieval Warm Epoch (hereafter MWE) and the Little Ice Age (hereafter LIA). There have been debates on the validity of this periodization, both in its temporal and spatial dimensions. On the one hand, climatic processes differed significantly in different macro-regions of Europe, and on the other, long periods (such as one of the foci in the thesis) in this periodization are understood as transition periods. In this chapter my aim is to provide a general overview of the climatic processes in the later Middle Ages, with special attention to the climate at the turn of the thirteenth century.

[28] See for example: András Pálóczi Horváth, "Középkori településeink környezetrégészeti kutatásának lehetőségei," [The possibilities of environmental archaeology in researching medieval settlement] in *Táj és történelem: tanulmányok a történeti ökológia világából* [Landscape and history: studies from the field of environmental history], ed. Ágnes R. Várkonyi (Budapest: Osiris, 2000), 273–286, András Pálóczi Horváth, "Középkori települések környezettörténeti kutatása," [Environmental historical research of the medieval settlements of Hungary] in *A Magyar Mezőgazdasági Múzeum Közleményei 2001–2004* [Bulletin of the Hungarian Agricultural Museum], ed. Estók János (Budapest: Magyar Mezőgazdasági Múzeum, 2004) and M. Bálint, "Az Árpád-kori településhálózat rekonstrukciója a Dorozsma-Majsai Homokhát területén," [Reconstruction of the Árpád Period settlement-network in the Dorozsma-Majsa region] (PhD diss., Eötvös Loránd Tudományegyetem, 2006).

[29] András Grynaeus, "Dendrochronology and Environmental History," in Laszlovszky–Szabó, ed., *People and Nature*, 182–186.

2.1. Climatic Conditions of Western Central and Eastern Europe during the MWE

From the ninth and tenth centuries one can find enough written evidence to draw some conclusions about the main characteristics of the climate. This period is not only important for the historical evidence, but also for scientific investigation, as there are some methods which can provide precise data more or less until this period (most importantly dendroclimatological and, in some cases, varves), although these investigations are more precise for later periods.

Scholars surmise that from the ninth century onwards, Northern, and soon after Western Europe, had mild winters and relatively warm summers.[30] This is the period in Western Europe which is characterized by historians as a period of feudal transformation, a period when there were infrequent famines and agricultural production grew significantly. New agricultural techniques were introduced and climatic reasons, amongst others, lay behind this general economic and demographical growth. The winters were more humid than in the preceding periods and the climatic changes created more favorable weather for agricultural activity in Western Europe. According to Hubert H. Lamb, the climate was at least 1°C warmer than in the following period. Apart from the historical evidence, studies of solar activity also verify the existence of a warmer period from the twelfth to the thirteenth century.[31]

The territory where certain mild-climate-loving plants, such as wheat, vegetables, and fruits could be cultivated lay significantly further north than in the Late Middle Ages. Fig trees are attested in Germany, while vineyards flourished in the British Isles up to the thirteenth century.[32] Although there are data about vineyards there until the end of the fourteenth century, the last evidence for the creation of new vineyards dates to the 1310s.[33] The opportunities for agricultural activity in the Scandinavian territories differed dramatically from later epochs of medieval times.[34] From the tenth to thirteenth century, investigations

[30] For a general overview of the MWE, see: Hubert H. Lamb, *Climate History*, 155–170, Neville Brown, *History and Climatic Change. A Eurocentric Perspective* (Routledge Studies in Physical Geography and Environment) (London: Routledge, 2001), 147–181, and Emmanuel Le Roy Ladurie, *Histoire humaine et comparée du climat I. Canicules et glaciers: XIII^{e}–XVIII^{e}* (Paris: Fayard, 2004).

[31] John L. Jirikowic and Paul E. Damon, "The Medieval Solar Activity Maximum," *Climatic Change* 26, No. 2–3 (1994): 309–316, and Neville Brown, *History and Climatic Change*, 147–149.

[32] Hubert H. Lamb, *Climate: Present Past and Future London* (London: Routledge, 1977), 454–455.

[33] Hubert H. Lamb, *Climate, Present, Past*, 460.

[34] For the fluctuation of climate and its human impact in the Northern Atlantic region see: Paul C. Buckland, Thomas Amorosi, Lisa K. Barlow, Andrew J. Dugmore, Paul A. Mayewski, Thomas H. McGovern, Astride E. J. Ogilvie, John P. Sadler and Peter Skidmore, "Bioarchaeological and Climatological Evidence for the Fate of Norse Farmers in Medieval Greenland," *Antiquity* 70, No. 267 (1996): 88–96, Lisa K. Barlow, John P. Sadler,

have demonstrated the existence of wheat fields in this region which almost entirely disappeared in the last centuries of the medieval period and did not return until the Modern Times.

Hubert Lamb supposed that precipitation was higher all over Europe, from Western Europe through the Mediterranean to the East European plain throughout the MWE. He presented the case of two Sicilian rivers, the San Leonardo and the Erminio (see: *Fig* 1), and demonstrated they navigabile in the eleventh and twelfth centuries. In his pioneering work, this British climatologist also discussed the hydrography of Greek valleys and North African wadis, where water flowed more frequently than in the Late Middle Ages.[35] The wetter climate of the Byzantine Empire is verified by more recent studies comprising both documentary evidence and scientific investigations. Studies have demonstrated increasing water levels in both the Dead Sea and the Sea of Galilee from the eleventh to the end of the sixteenth century.[36] In scholarship, the MWE is also used to describe the conditions of Eastern Europe during the high medieval period, although the general conditions of this territory might have been fundamentally different from the climatic tendencies found in Western Europe.[37] While Lamb suggested there was a wet period in the tenth to the thirteenth century, other research shows that the water-levels of the Caspian Sea were partiularly low from 900 to 1250, which presumes drier conditions and lower precipitation in the catchment area of the Volga River, which covers a considerable part of the Eastern European Plain.[38] Similar results were published after the examination of the fluctuation of Aral Sea the levels, which showed low water-levels between 900 and 1150 then, after a shorter humid period, showed its lowest water-level until Modern times in 1220.[39] Paleolimnological records indicate an important turning point around the end of the millennium in the vegetation history of the East European Plain, but it is not clear whether it is more a climate-induced change or can be connected to

Astride E. J. Ogilvie, Paul C. Buckland, Thomas Amorosi, John H. Ingimundarson, Peter Skidmore, Andrew J. Dugmore, and Thomas H. Mcgovern, "Interdisciplinary Investigations of the End of the Norse Western Settlement in Greenland," *The Holocene* 7, No. 4 (1997): 489–499, and James Robert Enterline, *Erikson, Eskimos and Columbus. Medieval European Knowledge of America* (Baltimore: Johns Hopkins University Press, 2002), 86–88.

[35] Hubert H. Lamb, *Climate History*, 165.

[36] Dionysios Stathakopulos, "Reconstructing the Climate," 247–261, and Arie S. Issar, *Climate Changes during the Holocene and their Impact on Hydrological Systems* (Cambridge: CUP, 2003), 28.

[37] For the changing environmental and economic situation of agriculture in the Polish territories: Richard C. Hoffmann, *Land, Liberties, and Lordship in a Late Medieval Countryside: Agrarian Structures and Change in the Duchy of Wroclaw* (Philadelphia: University of Pennsylvania Press, 1989).

[38] Rudolf K. Klige and Sergei Myagkov, "Changes in the Water Regime of the Caspian Sea," *GeoJournal* 27, No. 3 (1992): 299–307.

[39] Hedi Oberhänsli, Nikolaus Boroffka, Philippe Sorrel, Sergey Krivonogov, "Climate Variability During the Past 2,000 Years and Past Economic Irrigation Activities in the Aral Sea Basin," *Irrigation and Drainage Systems* 21, No. 3 (2007): 167. The Modern period water-level changes were predominantly driven by human activity.

anthropogenic intervention.[40] Pollen investigations showed a warm peak around the ninth and tenth centuries (earlier than in Western Europe), but from the mid-twelfth century a strong cooling period can be detected, when the average temperatures decreased by 2-3°C.[41]

Historical records show a less decisive turning point in the mid-twelfth century. Despite short cold periods, the general trend suggests the existence of milder conditions from the tenth to the early fourteenth century similar to Western Europe.[42] Unlike Western Europe, severe winters were frequently recorded in the period of 1200 to 1220, followed by milder winters later. In the 1230s and 1240s favorable weather conditions dominated except for the year 1230, when serious famines occurred in the territory of the Rus.[43] The precipitation conditions in the Eastern European region may have been quite different from those of Western territories. Historical evidence indicates more frequent droughts in the region than in humid years, and paleolimnological data also show that drier conditions were predominant.[44]

A warmer and more humid period in Western Europe can be supposed from the tenth to the thirteenth century with a minor cold period in the twelfth century. Meanwhile, in contrast to the situation in Western Europe, drier climatic conditions appear to have transpired in the Eastern European territories. The historical and scientific data presume a warm climate in the ninth-tenth century in most of Europe although there was a cooling period in the late twelfth century.

2.2. The climate of the fourteenth century – a transition period or beginning of the LIA?

The period which is in Western Europe characterized by milder winters, warm summers, and higher precipitation ended some time at the end of the thirteenth century. Afterwards a period started that can be understood as a slow cooling period that lasted until the sixteenth century, when the LIA begins.[45] This was the viewpoint of the basic monograph

[40] Olga Solomina and Keith Alverson, "High Latitude Eurasian Paleoenvironments: Introduction and Synthesis," *Palaeogeography, Palaeoclimatology, Palaeoecology* 209, No. 1 (2004): 6.
[41] Margarita M. Chernavskaya, "Climate of European Russia over the Past Two Millennia," *Zeszyty Naukowe Uniwersytetu Jagiellonskiego* 102, No. 2 (1996): 493–496.
[42] Solomina–Alverson, "High Latitude Eurasian," 6–7.
[43] Maria Shahgedanova, *The Physical Geography of Northern Eurasia*, (New York: OUP, 2002), 93–94.
[44] Alexander V. Klimanov, "Climatic Changes in the Northern Eurasia during the Historical Period Inferred from Palinological Data," *Material of Meteorological Studies* 16 (1997): 180–193.
[45] For the problems of the periodization see: Christian Pfister, "Five Centuries of Little Ice Age Climate in Western Europe," in *The Little Ice Age Climate*, ed. Takehiko Mikami (Tokyo: Tokyo Metropolitan University, 1992), 208–213, Jean M. Grove, "The Initiations of the 'Little Ice Age' in Regions Round the North Atlantic," *Climatic Change* 48, No. 1 (2001): 53–82, Jean M. Grove, *The Little Ice Age* (London: Routledge, 2003), Raymond S. *Bradley* and Philip D. Jones, "The 'Little Ice Age': Local and Global Perspectives," *Climatic Change* 48, No. 1 (2001): 5–8, Rudolf Brázdil et al., "Historical Climatology," 388–392., Wolfgang Behringer,

by Lamb, but from the 1990s scholars started to classify this as a transitional period within the LIA not only because of its average temperatures and the amount of precipitation but because of the growing frequency of weather anomalies and weather-related environmental crises (famines and floods).[46] Even in the time of the MWE there were periods which were characterized by a colder climate, such as the period between 1090 and 1179, when the winters were colder than the average of the last millennia (see: *Fig* 2).[47] The more general changes in the climatic processes started in the Northern Atlantic zone (Iceland and Greenland principally) from the beginning of the thirteenth century.[48] The edge of the iceberg zone in the North Atlantic moved to lower latitudes than at any time during the preceding millennium. From the thirteenth century onwards Greenland and the Labrador Peninsula started to lose population and by the fifteenth century the European population vanished from these regions and the bishopric of Greenland came to an end.[49] Apart from the general cooling an even more serious phenomenon was the growing number of sea storms in the North Sea and the English Channel (see: *Fig* 3).[50]

In most of Western Europe, signs of enduring climatic change appeared at the turn of the thirteenth century, although some extremes occurred as early as the thirteenth century, i.e. the extremely cold winters of 1204-1205, 1233-1234, and 1241-1242.[51] However, there were also winters characterized by milder weather conditions, such as that of 1236-1237.[52] Following the generally milder thirteenth-century climate in Western Europe, winter temperatures decreased by 1°C between 1300 and 1330 compared to the preceding period.[53]

Kulturgeschichte, 119–120, Stephen C. Porter, "Pattern and Forcing of the Northern Hemisphere Glacier Variations During the Last Millennium," *Quarternary Research* 26, No, 1 (1986): 27–48, and Hubert H. Lamb, *Climate History*, 192–197.

[46] Vladimir Klimenko and Olga Solomina, "Climatic Variations in the East European Plain During the Last Millennium: State of the Art," in *The Polish Climate in the European Context. An Historical Overview*, ed. Rajmund Przybylak, Jacek Majorowicz, Rudolf Brázdil and Marek Kejna (Heidelberg: Springer, 2010), 82.

[47] Christian Pfister, Jürg Luterbacher, Gabriela Schwarz-Zanetti, Christian Pfister, Jürg Luterbacher, Milène Wegmann, "Winter Air Temperature Varations in Western Europe During the Early and High Middle Ages (AD 750–1300)," *The Holocene* 8, No. 1 (1998): 543–544.

[48] Hubert H. Lamb, *Climate, History*, 170, Rudolf Brázdil et al., "European Climate," 22–28., Christian Pfister et al., "Winter Air Temperature," 535–552., Andrea Kiss, "Időjárási adatok a XI–XII. századi Magyarországról," [Weather events in 11th–12th century Hungary] in *"Magyaroknak eleiről"* ["On the beginnings of Hungarians"], ed. Ferenc Piti and György Szabados (Szeged: Szegedi Középkorász Műhely, 2000), 250–252, Rácz Lajos, *Magyarország klímatörténete*, 55–56.

[49] Paul C. Buckland, "Bioarchaeological," 88–96. Robert McGhee, *The Last Imaginary Place. A Human History of the Arctic World* (New York: OUP, 2005), 74–101.

[50] Hubert H. Lamb, *Climate, History*, 174.

[51] Christian Pfister et al., "Winter Air Temperature," 545. On the winter of 1241/1242, see: Andrea Kiss, "*Ecce, in hyenis nivis et glaciei habundantia supervenit* – Időjárás, környezeti krízis és tatárjárás," [*Ecce, in hyenis nivis et glaciei habundantia supervenit* – weather, environmental crisis and Mongol invasion], in *Tatárjárás* [Mongol invasion], ed. Balázs Nagy (Budapest: Orisris Kiadó, 2003), 442–444.

[52] Christian Pfister et al., "Winter Air Temperature," 546.

[53] Christian Pfister et al., "Winter Air Temperature," 541 and 543–545.

Possibly even more important in connection to agricultural activities was that the summer temperatures also decreased, which severely curtails the length of the growing season for several important cultivars.[54] The agricultural potential changed in most parts of Western Europe and probably also in East Central Europe. The most dramatic changes, however, can be detected in Northern and Northwestern Europe and mountainous regions (especially the Alps) where the cultivation territory of certain grains and grapes moved to lower altitudes and lower latitudes. As indicated above, cooling can be detected in the Russian territories from the twelfth century, although based on documentary evidence the late fourteenth century was mostly warm.[55] The early fourteenth century can be considered the beginning of a new climatic epoch. Based on historical evidence, climatic anomalies became more common (severe winters, cold summers) than in the preceding period in both Western European territories and in the territories east of the Carpathian Basin.[56] The first three decades produced several extremes and then, from the 1340s to the 1370s, cold summers and variable winters predominated in Western and Central Europe.[57] Dendroclimatological studies also verify the existence of extremely severe winters and cold summers in Western Europe in the first half of the fourteenth century.[58]

Investigations of glacial ice from the Alps show that glaciers began to grow from the 1250s and reached their largest extent in the middle of the fourteenth century (see: *Fig* 4). The LIA is the last period when growth of glaciers can be demonstrated in various mountain regions of Europe, the Alps, the Caucasus, and until the nineteenth century,[59] in the Carpathians.[60]

Apart from the general decrease of temperature the other main characteristics of the climate of this period was the growing number of extreme weather events. This can be detected in Western Europe as well as in the Russian territories. Historical evidence plays a

[54] On the question of the decrease of temperature at the beginning of the fourteenth century, see: Zhonwei Yan, Pierre Alexandre, Gaston Demarée, "Narrative Warm/Cold Variations in Continental Western Europe, AD 708–1426," *Science in China* (Series D) 40, No. 5 (1997): 514.
[55] Solomina–Alverson, "High Latitude Eurasian," 6.
[56] Klimenko–Solomina, "Climatic Variations," 82.
[57] Christian Pfister, Gabriela Schwarz-Zanetti, Felix Hochstrasser and Milène Wegmann, "Winter Severity in Europe: the Fourteenth Century," *Climatic Change* 34, No. 1 (1996): 91–108.
[58] Joël Guiot et al., "Last-millennium," 496.
[59] Rudolf Brázdil et al., "Historical Climatology," 390.
[60] See a recent glaciological investigation in the territory of the Radnai Mountains (Munții Rodnei, Romania): Péter László and Zoltán Kern, "Az elmúlt 150 év aktív galciális folyamatai a Radnai-havasok nyugati felén," [Active glacial processes in the last 150 years in the Western part of the Munții Rodnei] in Miklós Kázmér, ed., *Környezettörténet* – 2010 [Environmental History – 2010] (Budapest: Hantken Kiadó, 2010), 56.

crucial role in marking these extreme events.[61] Most have been preserved in historical records and only a few anomalies can be detected in, for example, dendrochronological data.[62]

Based on dendroclimatological investigations, the winters at the beginning of the fourteenth century were extremely cold.[63] The same climate characteristics can be concluded based on physical investigations of solar activity.[64] The similar cooling period (from 1282 to 1342) can be identified through C_{14} isotope research.[65] Based on historical evidence, two extremely cold decades occurred in the fourteenth century: the 1310s and the 1340s (see: *Fig*: 5). Special attention has been paid to both of these decades and they are amongst the most frequently studied periods in the whole of the Late Middle Ages (see below). Although after these long cold periods the average winter temperature started to rise, extremely severe winters still occurred, such as those in 1318-1319 and 1322-1323, when, for instance, several boats froze in the water close to Jutland in the Baltic Sea.[66] Also, there was an extremely severe and dry winter in the years 1325-1326 when the cold froze fruit trees; this phenomenon was recorded in several regions in Western Europe such as Alsace and Switzerland. After this period seemingly the frequency of severe winters decreased and milder winter conditions became dominant in Central Europe, such as the summer of 1331-32.[67] This was the situation in 1336-1337 when mild weather ruined the plans of John of Luxemburg to invade Lithuania because he was not able to pass through the deep mud of the marshlands.[68]

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[61] Andrea Kiss, "Some Weather Events from the Fourteenth Century (1338–1358)," *Acta Climatologica Universitatis Szegediensis* 30 (1996): 61–69, Andrea Kiss, "Some Weather Events from the Fourteenth Century II. (Angevin Period: 1301–87)," *Acta Climatologica Universitatis Szegediensis* 32–33 (1999): 51–64, Christian Pfister, *Wetternachhersage. 500 Jahre Klimavariationen und Naturkatastrophen* (Bern: Verlag Paul Haupt, 1999) and Christian Rohr, *Extreme Naturereignisse im Ostalpenraum. Naturerfahrung im Spätmittelalter und am Beginn der Neuzeit* (Köln: Böhlau, 2007).

[62] For examples, see: Katherine K. Hirschboeck, "Frost Rings in Trees as Records of Major Volcanic Eruptions," *Nature* 307, No. 2 (1984): 121–126, Jacques Tardif, "Ice-flood History Reconstructed with Tree-rings from the Southern Boreal Forest Limit, Western Québec," *The Holocene* 7, No. 3 (1997): 291–300, Paul E. Carrara and J. Micheal O'Neill, "Tree-ring Dated Landslide Movements and Their Relationship to Seismic Events in Southwestern Montana, USA," *Quaternary Research* 59, No. 1 (2003): 25–35, Miklós Kázmér, "Lejtőmozgások datálása fák évgyűrűivel," [Tree rings date landslides] *Földtani Kutatás* 40, No. 3 (2003): 3–7.

[63] Ionel Popa and Zoltán Kern, "Long-term Summer Temperature Reconstruction Inferred from Tree-ring Records from the Eastern Carpathians," *Climate Dynamics* 32, No. 7–8 (2009): 1107–1117.

[64] Jack. A. Eddy, "Climate and the Sun,"

[65] Minze Stuiver and Paul D. Quay, " Changes in Atmospheric Carbon-14 Attributed to a Variable Sun," *Science* 207, No. 4426 (1980): 11–18, and Nivaor R. Rigozo, Ezquiel Echer, Luis Eduardo A. Vieira and Daniel Nordemann, "Reconstruction of Wolf Sunspot Numbers on the Basis of Spectral Characteristics and Estimates of Associated Radio Flux and Solar Wind Parameters for the Last Millennium," *Solar Physics* 203, No. 1 (2001): 181.

[66] Christian Pfister, Gabriela Schwarz-Zanetti, Felix Hochstrasser and Milène Wegmann, "The Most Severe Winters of the Fourteenth Century in Central Europe Compared to Some Analogues in the Most Recent Past," in *Documentary Climatic Evidence for 1750–1850 and the 14th Century*, ed. Burkhard Frenzel, Erik Wishman and Mirjam M. Weiss (Stuttgart: Gustav Fisher, 1997), 13–14.

[67] Brázdil–Kotyza, *History of Weather*, 113.

[68] Brázdil–Kotyza, *History of Weather*, 114.

According to dendroclimatological research in the region of the Alps, permanent decrease in average summer temperature started only in the second half of the fourteenth century.[69] Stalagmite records (O_{18} isotope distribution) from the same region indicate a strong positive summer temperature anomaly (1.7°C) compared to the average of the LIA until the 1300s, which contradicts the above mentioned investigations of Eddy and Stuvier.[70] However, according to written evidence, from 1303 to 1328 winter temperatures in the Alps were 1.6-1.7°C below the average of the reference period (1901-1960).[71]

In the beginning of the 1340s, the climate seems to have been cold and wet during the winters and probably also significantly colder during the summers than the average of the twentieth century. The winter of 1341-1342 was severe both in Western and Central Europe. Several chronicles and annals reported serious floods and famines during the summer of 1342.[72] The winter of 1344-1345 was again humid and warm, at least in the Baltic region, as Charles IV of Luxemburg could not lead a military campaign against the Prussians because of the inland waters in the region.[73] In the next year the vegetation period of cultivated plants was extremely long: grapes were still been in bloom close to Lindau (Germany) on the 2 August.[74] The humid weather of the mid-1340s may have strongly influenced the spread of the plague, which caused the most serious demographic crisis of the entire Middle Ages in Western Europe.[75] The weather of this decade was decisive in the seriousness of these epidemics, not only because the bubo bacterium spreads more easily after wet years, but also because the resistence to disease of large parts of the European population had been weakened by the food scarcity of the preceding years.

The weather in the second half of the fourteenth century may have been more stable than in the preceding decades. However, there were some extreme winters in the period, as in the year 1363-1364, which is considered to have been the severest winter in the last millennium. The major lakes of Western Europe froze over (as did the Rhine for 70 days) and

[69] Ulf Büntgen, David C. Frank, Daniel Nievergelt, And Jan Esper, "Summer Temperature Variations in the European Alps A.D. 755–2004," *Journal of Climate* 19, No. 2 (2006): 5613.
[70] Augusto Mangini et al., "Temperature in the Alps,"
[71] Christian Pfister et al., "Winter Severity," 101.
[72] Kiss Andrea, "Weather Events II," 56., Brázdil–Kotyza, *History of Weather*, 114.
[73] Brázdil–Kotyza, *History of Weather*, 115.
[74] Christian Pfister, "Variations in the Spring-summer Climate of Central-Europe from the Middle Ages to 1850," in *Long and Short Term Variability of Climate* (Lecture Notes in Earth Sciences 16), ed. Heinz Wanner and Ulrich Siegenthaler (Berlin: Springer, 1988), 71.
[75] Nils C. Stenseth, Noelle I. Samia, Hildegunn Viljugrein, Kyrre Linné Kausrud, Mike Begon, Stephen Davis, Herwig Leirs, V. M. Dubyanskiy, Jan Esper, Vladimir S. Ageyev, Nikolay L. Klassovskiy, Sergey B. Pole and Kung-Sik Chan, " Plague Dynamics are Driven by Climate Variation," *Proceedings of the National Academy of Sciences of the United States of America* 103, No. 35 (2006): 13110–13115.

sources tell of a cold winter in the Hungarian Kingdom as well.[76] The average temperature of the winters of the second half of the fourteenth century was close to the values of the LIA with some exceptions of extremely cold and humid winters in the latter period.[77] Investigations of glacial ice reveal that weather conditions were a bit more favorable than in the previous period.[78] As in Western Europe in the second half of the century (especially in the period of 1340 to 1370), the climate of Eastern Europe was also dominated by more favorable climatic conditions. Dry and warm weather predominated in the Eastern European Plain and the end of the century was particularly warm.[79] Pollen-based climate reconstructions also suggest relatively high summer temperatures in the Eastern European Plain throughout the whole second half of the fourteenth century. According to a research by Chernavskaya, the average temperatures in the region of the eastern foothills of the Carpathian Mountains were close to the values of the exceptionally warm twentieth century.[80]

Although there are mild winters and extremely warm summers in the first half of the fourteenth century the period can be characterized as having a less favorable climate. The general trends included a marked decrease in temperatures and a large number of weather extremes in both Western European territories and the Eastern European Plain. Although it is tempting to classify this period within the first period of the LIA, in the next one and a half centuries, until the late sixteenth century there was no long-term decrease in the mean temperature. Even though considering the first half of the fourteenth century as the first period of the LIA can be questioned, there is no doubt that the climate in this period can only be compared to the coldest periods of the LIA when the conditions were close to what is attested at the turn of the seventeenth century or the second decade of the nineteenth century.[81]

[76] Christian Pfister et al., "Winter Severity," 101., Christian Pfister et al., "The Most Severe," 14–15, and Andrea Kiss, "Weather Events II,".
[77] Christian Pfister et al., "Winter Severity," 102., Christian Pfister et al., "The Most Severe," 15.
[78] Hanspeter Holzhauser, "Fluctuations of the Grosser Aletsch Glacier and the Gorner Glacier During the Last 3200 Years: New Results," in *Glacier Fluctuations During the Holocene*, ed. Burkhard Frenzel, Geoffrey S. Boulton, Birgit Gläser and Ursula Huckriede (Stuttgart: Gustav Fischer Verlag, 1997), 35–58, and other studies of the volume.
[79] Andrea Kiss, "Weather Events II," 56., Solomina–Alverson, "High Latitude Eurasian," 6.
[80] Margarita M. Chernavskaya, "Botanical Indicators of the Little Ice Age in the Russian Plain," in Takehiko Mikami, ed., *The Little Ice Age*, 69.
[81] Jürg Luterbacher, Ralph Rickli R, Eleni Xoplaki, Chantal Tinguely, Christoph Beck, Christian Pfister and Heinz Wanner, "The Late Maunder Minimum (1675–1715): A Key Period For Studying Decadal Scale Climatic Change In Europe," *Climatic Change* 49, No. 4 (2001): 441–462.

2.2.1. The climate of 1315-1317 in Western and Central Europe

Before turning to the climate history of the Carpathian Basin at the turn of the thirteenth century, data on the weather of neighboring territories in my focus period should be discussed. The 1310s in most of Western Europe were extremely cold, especially in the middle of the decade. The winter temperatures were far below the average for the period; several dozen chronicles and annals provide information about extreme weather in the northwestern part of the continent.[82] In this short subchapter my aim is to present mostly Central European sources referring to the weather events in this decade, but meanwhile I do not want to entirely disregard Western European written evidence to highlight some possible parallels and problems concerning this crisis.

The data from the British Isles tells of very high prices throughout England, where the crises already started a year earlier, in 1314, when the grain yield was poor as a consequence of high precipitation before the beginning of the harvest.[83] River flooding in England was frequent in the years after 1314[84] and the price of cereals grew rapidly all through the decade, resulting in a serious famine in England.[85] According to Emmanuel Le Roy Ladurie, the amount of wheat on the markets of England decreased by at least 40% in 1315 compared to the preceding year and he suggested that in 1316 the harvest in southern England was even smaller.[86] The situation in Ireland was similar England; the annals of Loch in 1315 and the following year report bad weather conditions, high precipitation, and, as aconsequence,

[82] Amongst many authors who dealt with the question, see: Henry Lucas, "The Great European Famine of 1315, 1316 and 1317," *Speculum* 5, No. 4 (1930): 343–377, William C. Jordan, *The Great Famine. Northern Europe in the Early Fourteenth Century* (Princeton: Princeton University Press, 1996), Ian Kershaw, "The Great Famine and Agrarian Crisis in England 1315–1322," *Past & Present* 59, No. 5 (1973): 3–50, Richárd Szántó, "Természeti katasztrófa és éhínség 1315–17-ben," [Natural disaster and famine in 1315–1317] *Világtörténet* 27, No. 1 (2005): 50–64, Richárd Szántó, "Környezeti változások Európában a 14. század első évtizedeiben," [Enviromental changes in Europe in the first decades of the fourteenth century], in *Középkortörténeti tanulmányok 5. Az V. Medievisztikai PhD-konferencia előadásai* [Studies in medieval history 5. The papers presented at the Fifth conference of PhD students], ed. Éva Révész and Miklós Halmágyi (Szeged: Szegedi Középkorász Műhely, 2007), 159–164, and a recent conference paper on the trends of climate change during the medieval period by Christian Pfister, Rudolf Bràzdil, Chantal Camenisch, Dario Camuffo, Rüdiger Glaser, Andrea Kiss, Jarmila Mackova, Kathleen Pribyl and Gabriela Schwarz-Zanetti. *Seasonal climate variability and famines in Medieval Europe (1200 to 1499)*. Available online: http://www.nccr-climate.unibe.ch/conferences/acht_jahre/ pdfs/Pfister.pdf (last accessed: 20 April, 2010).

[83] "Flores historiarum," in *Rerum Britannicarum Medii aevi Scriptores* 95. Vol. III., ed. Henry Richards Luard (London: Longman, 1890) 160. *"Nam in regno Anglorum tantae fuerunt alluviones pluviarum et inundationes aquarum cum intemperie aeris insolita, fructus et victualia consumentes, quod nec in anno septem dies serenitatis simul possent reperiri*" and "Chroniques de Sempringham," in *Rerum Britannicarum Medii aevi Scriptores* 42., ed. John Glover (London: Longman, 1865), 330–332. *"Meisme lan fu leste puviose e grauntz souroundez de ewe parmi tut Engleterre, e les blez sount destrutz, e les feinz ausi*".

[84] Henry Lucas, "Great Famine," 345–346.

[85] Ian Kershaw, "The Great Famine,"

[86] Emmanuel Le Roy Ladurie, *Histoire humaine*, 39.

serious famine in the country.[87] It is noteworthy, however, that there is no source from the Scottish territories which mentions a serious food shortage, extremely high percipitation or bad weather conditions. This phenomenon has been described by scholars as a special feature of the geographical position of the islands and the North Atlantic Drift. It is dangerous to build arguments around parallels between neighboring regions; although I cannot avoid some references to the situation in the Austrian or Czech territories compared to the Carpathian Basin, it must be done with great care.[88]

Several Flemish and French sources mention late harvests or the lack of a wheat harvest in 1315 and especially in 1316, and especially in the Low Countries floods and the standing water on the fields caused serious problems.[89] Serious epidemics decimated the population in the densely inhabited territories in the region, such as in the towns of Ypres and Bruges.[90] Similarly to England, the sources also speak of major floods. Epidemics were also present in the country, which, according to Le Roy Ladurie claimed at least three million victims.[91] Very high cereal prices are mentioned just like everywhere in Northwestern Europe.[92] Based on data from Strassburg, Wilhelm Abel has suggested that the wheat prices were nine times as high during the crisis as before.[93] The *Annales Dervenses* note the failure of the grape harvest every where in the country while an annals from Bretagne, although it mentions the harvest in Quimperlé, dates its beginning to 9 November.[94] There might have been food-shortage in the less heavily popuated areas such as Scandinavia. The king of Norway (Haakon V) prohibited the export of the most important foodstuffs, especially fish.[95] The food shortage in this country is interesting because within the economic system of Norway, the cultivation of cereals was not a basic element of agriculture and there was low

[87] See the Annals of Loch in the Corpus of Electronic Text Editions of the the University of College Cork http:// www.ucc.ie/celt/published/T100010A/index.html (last accessed: 20 April, 2010).
[88] Ian Kershaw, "The Great Famine," 10, and William C. Jordan, *The Great Famine*, 8.
[89] Gerardum de Meestere, ed., *Chronicon Monasterii Evershamensis* (Bruges: Kessinger, 1852), 17. *"Magna fuit inundatio aquarum in Flandria quae omne frumentum corrupit"*.
[90] Emmanuel Le Roy Ladurie, *Histoire humaine*, 42. and on the mortality of the town of Ypres and Bruges in 1316: Emmanuel Le Roy Ladurie, *Histoire humaine et comparée du climat II. Disettes et Révolutions: 1740–1860*. (Paris: Flammarion, 2006), 521.
[91] For example: "Ex annalium Rotomagensium continuationibus," in *Monumenta Germaniae Historica. Scriptores* XXVI., ed. Georg Waitz (Hannover: Hahn, 1882), 505. *"Sed fortuito tanta fuit aquarum inundatio"* and Emmanuel Le Roy Ladurie, *Histoire humaine*, 44.
[92] Hercule Géraud, ed., *Chronique latine de Guillaume de Nangis de 1113 à 1300 avec les continuations de sette chronique de 13000 à 1368* I. (Paris: Société de l'Histoire de France), 426., and "Annales Dervenses," in *Monumenta Germaniae Historica. Scriptores* XVI., ed. Georg Heinrich Pertz (Hannover: Hahn, 1859), 490.
[93] Wilhelm Abel, *Agricultural Fluctuations in Europe: From the Thirteenth to the Twentieth Centuries* (London: Methuen, 1980), 39.
[94] "Annales Dervenses," 490., and "Annales Kemperlegienses," quoted by: Christian Pfister: http://www. nccr-climate.unibe.ch/conferences/acht_jahre/pdfs/Pfister.pdf (last accessed: 20 April, 2010)
[95] William C. Jordan, *The Great Famine*, 181.

population density, even if one takes into consideration the lower carrying capacity of the land.

The data referring to the Central European territories is worth a more detailed analysis regarding my thesis as they provide in some cases crucial data to understand the characteristics of the weather in the Carpathian Basin. Amongst these territories three is be discussed in more details: Austria, the Poligh Kingdom, and the Kingdom of Bohemia. Austria is richest in historical data amongst these three regions. Annals were kept in a number of ecclesiastical institutions in the early fourteenth century and systematic research has been carried out already from the 1950s to collect the weather events preserved in these narrative sources.[96] The first data from the decade which might be relevant to my research is preserved in the *Annales Mattseenses*. It tells of epidemics and famines which may be connected to the harvest.[97] The Salzburg annals support the data from Mattsee as they also mention high mortality from famine and cold weather.[98] In 1312 the weather might have been unusual, again as two independent sources mention food-shortages. The *Annales Zwetlenses* tell of high prices and so do the *Annales Matseenses*.[99] Apart from prices, the former mentions great storms and also flooding of the Danube in the region of Krems (Austria).[100] In the next year, the harvest maight have been much better as the prices are significantly lower than in the preceding period and according to the annals of Zwettl (Austria) the wine was exceptionally good, which may indicate a warmer summer.[101] The good harvest was considered as a compensation by God for the bad harvest of the preceding years.[102] Seemingly the abundance was temporary, as already in 1314 the *Chronica Austriae* indicates that famine has again struck the land. This chronicle, however, is not contemporary but since it uses several annals from the early fourteenth century its results should be taken into consideration as well.[103]

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[96] E. Pautsch, "Elementarereignisse in den Erzählenden Österr. Geschichtsquellen des 14. und 15. Jh." (PhD Diss., Wien, 1953) and more recently the works of Christian Rohr, especially: *Extreme Naturereignisse*.

[97] "Annales Matseenses," in *Monumenta Germaniae Historica. Scriptores* IX., ed. Georg Heinrich Pertz (Hannover: Hahn, 1851), 825. *"pestilentia hominum et pecorum atque pecundum facta est magna"*.

[98] "Annalium Salisburgurgiensis," in *Monumenta Germaniae Historica. Scriptores* XIII., ed. Georg Waitz (Hannover: Hahn, 1881), 821. *"frigus et famem tanta mortalitas hominum est"*.

[99] "Continuatio Zwetlensis Tertia," in *Monumenta Germaniae Historica. Scriptores* IX., ed. Georg Heinrich Pertz (Hannover: Hahn, 1851), 665, and "Annales Matseenses," 825. *"Fames validissiam facta est, ita ut mensura siliginies unius videlicet metrete pro tribus solidus denariorum aut amplius venundetur, mensura vero avene pro nummis 60 venderetur"*.

[100] "Continuatio Zwetlensis Tertia," 665. *"Eodem anno quedam tempestas in Bachovia et in Chremsa repente inundans, aliquos homines et domos quamplurimas subruens et abducens interemit"*.

[101] "Continuatio Zwetlensis Tertia," 665. *"nisi esset egregium vinum"*.

[102] "Annales Zwetlenses," in *Monumenta Germaniae Historica. Scriptores* IX., ed. Georg Heinrich Pertz (Hannover: Hahn, 1851), 680. *"Hoc anno omnipotens et misericors Dominus sterilitatem prioris anni omnium victualium habundancia conpensans, in tantum terram fructifficare fecit"*.

[103] "Chronica Austriae," in *Monumenta Germaniae Historica. Scriptores Rerum Germanicarum Nova Series.* XIII., ed. Alphons Lhotsky (Berlin: Weidmann, 1967), 239. On the sources of the chronicle: T. Körmendi, "Az

The next data is from 1315 and may have great significane. A source mentioned, but not quoted, by Christian Pfister dates the beginning of the grape harvest in the Vienna Basin to 19 November. This is an exceptionally late starting date even though the beginning date depends a great deal on the type of grapes and the quality of the wine desired. In the relatively cold early eighteenth century in the same region the grape harvest started at least three weeks earlier, although these data come from a producer of large quantites (*Buergerspital*) of wine where the sugar content was not as crucial for smaller producers.[104] Even taking into considerationdifferences in the species of grapes and the sugar content the producers expected, 19 November is an extremely late date to begin harvesting and also the Euro-climhist database assigned an index of -3 to the data, which indicates a very cold period in summer and autumn (see: *Fig* 8).[105] In 1316, several rivers in Austria had major floods. Accounts of these events can be found in several annals and chronicles of the period (see the course of events below).

In 1317 the Danube and its tributraries flooded again, as mentioned in the *Annales Zwetlenses*. Even more seriously, the grain harvest failed almost entirely (*ut rarus esset panis siliginis et triticeus*), with the exception of oats. [106] Oats are less sensitive to high percipitation in during their period of growth, which is the reason for better harvests in wet years all over Europe, in the 1310s in England as well as in Austria. The annals of Melk (Austria) also mention floods in Austria, Bohemia, France and Hungary.[107] In the same year, market prices were high, according to the annals of Salzburg, which suggests similar conditions to those in Western Europe. In the next years, there were no references to the weather or the impact of

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Imre, III. László és II. András magyar királyok uralkodására vonatkozó nyugati elbeszélő források kritikája" [Criticism of the Western European narrative sources relating to the reign of Emerich, Ladislas III and Andrew II kings of Hungary] (PhD diss., Eötvös Loránd University, 2008), 76–77.

[104] Christian Pfister, "Variations in the Spring-summer," 66. and Elisabeth Strömmer, *Klima-geschichte: Methoden der Rekonstruktion und historische Perpektive. Ostösterreich 1700 bis 1850*. (Vienna: Deuticke, 2003), 63–66.

[105] The Euro-climhist (E-CH) database is a tool for managing, analysing and displaying climatic (high-resolution) proxy evidence from natural and documentary archives created by Cristian Pfister. Further detailes at the website of the institution: http://www.wsu. hist.unibe.ch/ (last accessed: April 20, 2010).

[106] "Annales Zwetlenses," 681. *"Hoc anno fames et sterilitas inaudita facta est ex nive preteriti anni omnia sata suffocantis, et etiam ex inundatcione Danubii et omnium fluvium, tam ex pluviis quam erupcione veanrum terre, que omnia sata destruxit, ut raro panis triticeus vel siligineus, sed tentum avenacius haberetur"* and "Annales Mellicenses. Continuatio Zwetlensis Tertia," in *Monumenta Germaniae Historica. Scriptores* IX., ed. Georg Heinrich Pertz (Hannover: Hahn, 1851), 666. *"Fames et sterilitas inaudita ex nive preteriti anni omnia sata destruente"*.

[107] "Annales Mellicenses," in *Monumenta Germaniae Historica. Scriptores* IX., ed. Georg Heinrich Pertz (Hannover: Hahn, 1851) 511. *"Facta est inundacio aquarum per totam Almaniam, Ungariam, Bohemiam et Galliam"*.

weather in these annals and chronicles. The last data which might be relevant mentions poor quality wine and a bad grape harvest both in Austria and Hungary in 1321.[108]

In the Czech territories just as in Austria thorough investigation has been done in the last decades to gather sources containing information on the weather.[109] The number of cases of weather extremes in the decade is relatively high both in winters and summers in this region as well as in Austria and Western Europe. In 1310, as in neighboring countries, the grape harvest was poor as the grapevine sprouts were largely destroyed.[110] In November of the same year, the Ohře River flooded, followed by a long and frosty winter.[111] Because of the long-lasting cold weather snow covered the country for a long time causing a wood shortage. The weather was so severe on 7 February that the coronation ceremony of John of Luxeburg could not be held outdoors.[112] In the next years, the amount of harvest was variable. In 1311 and 1312, the harvest seems to have been bad, as the *Chronicon Aulae Regiae* mentions high prices and famines (as does the *Annales Zwetlenses*). In 1313, however, the harvest was good.[113]

The sources relating to the events of 1315-1317 are a little bit different from what is reflected in Western European narratives. In Bohemia, the spring of 1315 was dry, which is different from England or France, where continuous rains were mentioned as early as April. In Prague the drought went on until 25 July, after which, however, great heavy rains, and in consequence floods, caused problems both in the Czech and the Moravian territories.[114] According to Neville Brown, a rise in the water-table in the mines of Bohemia and in German lands started to cause problems from 1315, which was the peak of a several-decade-long process and presumes higher percipitation over a longer period of time.[115] The summer of 1316 brought rains and floods again, which appear in many accounts of Central Europe. The most detailed chronicle of the period mentions floods ravaging in Austria, Poland, Hungary,

[108] "Annales Mellicenses," 511. *"In Austria et Ungaria provenerunt multa vina ferme putrida, fetida, rubea et inmunda"*.
[109] Brázdil–Kotyza, *History of Weather*.
[110] "Chronicon Aulae Regiae," in *Fontes Rerum Austriacarum.* Vol. 1. 8., ed Johann Loserth (Vienna: In commission bei K. Gerold's Sohn Buchhändler der Kais. Akademie der Wissenschaften, 1875), 282. *"Eodem anno vina et vineae quasi penitus perierunt ita quod fere in omnibus regni"*.
[111] "Chronicon Aulae Regiae," 290. *"sed vadum difficulter cum amissione et iactura rerum plurium adinvenit"*
[112] "Chronicon Aulae Regiae," 316.
[113] "Chronicon Aulae Regiae," 292.
[114] "Chronicon Aulae Regiae," 365. *Item anno domini 1315 circa festum sancti Jacobi* [VII. 25.] *facta est tanta post siccitatem nimiam diluviosa aquarum inundatio in quibusdam partibus Bohemiae et Moraviae, qualem raro aliquis meminit nostris temporibus exstitisse.*
[115] Neville Brown, *History and Climatic Change*, 241.

and Meissen (Saxony, Germany).[116] Similar conditions are mentioned in a source from Goerlitz (Saxony, Germany), where the flooding of the Neisse swept away bridges.[117] The winter of that year was severe in Bohemia; it started in Novermber and lasted almost until April, which was typical of the winters during the LIA.[118] There is no narrative from Bohemia 1317 mentioning floods or unseasonable weather, although the *Chronicon Aulae Regiae* mentions famine and epidemics in 1318, which suggests a long-lasting crisis in Bohemia.[119] In the next year, however, the weather was more favourable, which is reflected in a good grape harvest and low prices for cereals.[120]

Apart from the Bohemian and Austrian data, Polish data is also important in my research, espcially in light of the fact that most sources from the Carpathian Basin refer to the weather or the impact of weather in the Upper Hungarian territories (Slovakia) a geographical region which is closely connected with the climate of the Polish territories. The correlation of the climate of the Szepesség (Spiš region, Slovakia) with the Polish territories (see below) is exceptionally high and makes it fundamental to study the situation in the southern Polish territories. However, like Hungary, it is short of detailed contemporary chronicles and annals. The Vistula flooded in 1312 and similar problems occured in 1315, when there were floods in several regions of the country.[121] Famine is also mentioned in sources from the Polish Kingdom. The frequently criticised non-contemporary chronicle of Jan Długosz mentions famines in this period. He explains that they were the result of the rapid increase in temperature in the spring, which melted the snow. The huge amounts of water that was released caused serious floods in the country's rivers. The situation was even worse, as according to Długosz there were also internal wars in the country.[122] The chronicle of Prague

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[116] "Chronicon Aulae Regiae," 379. *In Austria, Polonia, Ungaria et Misna de hoc diluvio omnium hominum querimonia nuntiabat infinita pericula esse facta. Haec aquarum inundatio campos et valles cooperuit, fenum et segetes distruxit, secumque plura, quae rapuit deduxit.*

[117] "Martini Meisteri. Annales Gorlicenses," in *Scriptores Rerum Lusaticarum antiqui et recentiores.* 1. 1., ed. Christian Gottfried Hoffmann (Leipzig: Davidis Richteri, 1719), 8. "*Praecessit eodem Anno Nissi inundation, quae Gorlicii S. Spiritus nosocomium perrupit, pontem urbis et multos alios convulsos abripuit, moletrinis omnibus et aedificiis flumini propinquis multum nocuit, in plateam usque Nissensem pertigit"*.

[118] "Chronicon Aulae Regiae," 379. *"In hac hieme a festo beati Andreae apostoli* [XI. 30.] *usque ad diem Palmarum, qui videlicet quinto Kalendas Aprilis fuerat* [III. 28.]".

[119] "Chronicon Aulae Regiae," 397. *"Consimilis quoque pestilentia in omnibus civitatibus, oppidis et villis exstitit et in universa terra* (…) *in tatnum namque prevaluerat fames."*.

[120] "Chronicon Aulae Regiae," 410. *"Iste annus ex clementia salvatoris nostri uberrimus in vino et blado fuit, in pluribus locis mensura siliginis, quae strich vulgariter dicitur, pro uno grosso Pragensi denario venderebatur"*.

[121] "Annalium Polonorum," in *Monumenta Poloniae Historica*. Tom. III., ed. August Bielowski (Warszawa: Nakł. Akademii Umiejętnośc, 1961), 171. *"Wisla maxime inundavit"* and Neville Brown, *History and Climatic Change*, 250.

[122] Jan Dabrowski, ed., *Annalium Poloniae Jana Długosza*. Vol. V (Wrocław: Zakład narodowy im. Ossolinskich, 1961–1970), 91–92. *"Bellis externis et commotionibus domesticis paulisper in Regno Poloniae sedatis, fames omni bello atrocior Poloniae regiones invasit. Dum etenim, nivibus ultra solitum terram occupantibus, veris dies supervenissent, fruges terrae mandatae, a calore vernali paludimento nivis opertae,*

mentions famine in Poland in 1316 and in the next year a Cistercian annals speak of famines in Silesia and other parts of Poland, which had especially numerous victims in the town of Wroclaw.[123] The comparatively rich Austrian and Bohemian data and the few Polish accounts all have significance for pursuing the effects of a certain environmental crisis in the Carpathian Basin. Information about the climatic processes or the weather of the 1310s from other neighboring territories is incomparably less well known for Central European countries. The Balkan Peninsula has been almost entirely untouched by climate historians and there the destruction of the medieval archives as a consequence of the Ottoman expansion does not allow a detailed view of the processes over a short period of time. Research aiming to reconstruct the climate of the Byzantine Empire has not shown strong climatic anomalies in the Western part of the Empire in the first half of the fourteenth century.[124] It is also important to discuss the climatic situation on the Eastern European Plain. Research there, similarly to the Western European data, indicates the existence of a long crisis with unseasonable weather and a serious famine in the mid-1310s. According to historical data the famine may be attributable to the exceptionally wet climate of these years, paralleling Western and Central European trends.[125]

3. The Climate of the Hungarian Kingdom in the Late Middle Ages

Reconstructing the medieval climate of the Carpathian Basin based on written evidence is very challenging as the appearance of data referring to weather conditions is extremely sporadic. There are periods for which historical data are entirely lacking; for the eleventh and twelfth centuries, for instance, the total amount of data can be estimated at a few dozen references.[126] Although there is a general increase in the amount of data on climate- and weather-related events it is only enough to understand some very general patterns of weather in a few particular cases, such as in the case of the year 1241–1242, the mid-1310s or

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depastae extinctaeque. Ex qua coeli inclementia, contagio famis ad universos perveniens, plures ex agrestibus afflixit, plures atrocitate sua confecit.".

[123] "Annales Cisterciensium in Heinrichow," in: *Monumenta Germaniae Historica. Scriptores* XIX., ed. Georg Heinrich Pertz (Hannover: Hahn, 1866), 546. *"Anno Domini 1317. fames valida Slecziam et totam Poloniam oppressit, per quam innumerabiles Poloni perierunt, ita quod civitate Wratizlavie propter eorum nimiam multitudinem cives eos extra civitatem sepelire fecerunt, et ibidem ecclesiam ad honorem corporis Christi edificaverunt."*.

[124] Ioannis G. Telelis, "Historical-climatological Information from the Time of the Byzantine Empire (4th–15th Centuries AD))," *History of Meteorology* 2, No. 1 (2005): 46.

[125] Klimenko-Solomina, "Climatic Variations," 71–102.

[126] Andrea Kiss, "Időjárási adatok,"

the early 1340s.[127] Despite the low number if texts, however, the historical sources are important for indicating weather anomalies and weather-related events in the Middle Ages. Written evidence plays a fundamental role in understanding the frequency and the course of hydrometeorological events, which were one of the key elements of the crisis in the mid-1310s as reflected in Central European sources.[128]

In recent decades, Lajos Rácz has tried to draw some parallels between Western European climatic processes and climatic changes in the Carpathian Basin.[129] Despite of these efforts there is no comprehensive study on climatic trends in the Carpathian Basin during the Middle Ages. Studies integrating the results from the different fields are rare although the intense research of the past few decades permits some generalizations to be drawn on the main climatic trends throughout the medieval period.[130] The patterns that I present in this chapter are based on the existing literature and may be largely modified in the next few years as the thorough investigation of the historical data in the Carpathian Basin by Andrea Kiss is published.[131]

Research on the long-term trends in the fluctuation of water-levels are important in understanding climatic and environmental conditions in late medieval Hungary.[132] Major research has been carried out on the water-level changes of Lake Balaton and Lake Fertő.[133]

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[127] Andrea Kiss, "Időjárás és környezeti krízis," Andrea Kiss, "Weather Events I," and Andrea Kiss, "Weather Events II,".

[128] Andrea Kiss, "Historical climatology," 315–316.

[129] Among others see: Lajos Rácz, "A Kárpát-medence éghajlattörténete a közép- és kora-újkorban," [The climate history of the Carpathian Basin in the medieval and Early Modern Times] in *Magyar középkori gazdaság- és pénztörténet* [Economic and monetary history of medieval Hungary], ed. Márton Gyöngyössy (Budapest: Eötvös Kiadó, 2006), 31–53, Lajos Rácz, "Éghajlati változások a Kárpát-medencében a középkor idején," [Climatic changes in the Carpathian Basin in the Middle Ages] in *Dixit et salvavi animam meam. Tanulmányok a 65 éves Szegfű László tiszteletére* [*Dixit et salvavi animam meam*. Essays in honor of the 65 year old László Szegfű], ed. Csaba Jancsák, Gábor Kiss, Péter Zakar and András Döbör (Szeged: Belvedere Meridionale), 57–78, and Lajos Rácz, "Éghajlati változások a Kárpát-medencében a középkor idején," [Climatic changes in the Carpathian Basin in the Middle Ages] in *Gazdaság és gazdálkodás a középkori Magyarországon: gazdaságtörténet, anyagi kultúra, régészet* [Economy and farming in medieval Hungary: economic history, material culture, archaeology], ed. András Kubinyi, József Laszlovszky and Péter Szabó (Budapest: Martin Opitz, 2008), 21–36.

[130] On the usage of different methods and main trends in environmental and climate historical researches see: Miklós Kázmér, ed., *Környezettörténet*, and the special issue of *Időjárás* 113, No. 4 (2009), edited by Andrea Kiss.

[131] Andrea Kiss, "A 'Millennium' FP6 EU projekt – Magyarországi írott források az európai ezeréves klímarekonstrukcióban," [The 'Millenium FP6 EU project – Role of Hungarian written sources in the European thousand-year climate reconstruction] in *IV. Magyar Földrajzi Konferencia tanulmánykötet* [Fourth conference of Hungarian geography: studies], ed. Valéria Szabó, Zoltán Orosz, Richárd Nagy and István Fazekas (Debrecen: Debreceni Egyetem, 2008), 163–169.

[132] Kiss Andrea, "Historical Climatology," 327–329.

[133] A long-lasting debate on the water-level fluctuations of Lake Balaton unfolded between Károly Sági and László Bendefy: Károly Sági, "A Balaton vízállás-tendenciái a történeti és kartográfiai adatok tükrében," [Water-level tendencies of Lake Balaton in the light of historical and cartographical data] *Veszprém megyei múzeumok közleményei* 7 (1968): 441–468, Károly Sági, "Egy történeti vita természettudományi kapcsolatai," [Scientific connections of a historical debate] *Földrajzi Értesítő* 19, No. 2 (1970): 200–207, László Bendefy and

Earlier studies suggested that the water level of Lake Balaton showed a tendency to rise from the tenth century until its peak in the sixteenth-seventeenth century. However, in the last few years this simplistic view of fluctuations in lake levels has been criticized based on the investigation of both historical data and scientific research.[134] Although there are frequent debates on the trends in water-level changes of Lake Balaton, historical and paleobotanical investigations both indicate relatively low water levels in the period of the Hungarian Conquest,[135] but show a tendency to rise after this time. In the Later Middle Ages the water level of the lake must have been above the present-day level because, for example, both textual evidence and maps refer to Szigliget as an island on the lake.[136] The higher water-level can be traced on the southern coast as well, reflected in the late medieval settlement network of the coastline.[137] Lake Fertő (Neusiedlersee) has also been investigated frequently because it is rather shallow and hence more sensitive to climatic changes than deeper lakes like Lake Balaton and Lake Velencei. Although the medieval environmental condition of other lakes of Hungary is largely unknown owing to the lack of written evidence, they seem to have had conditions similar to Lake Balaton. Thus, Lake Fertő also showed a tendency to a rising water-levels in the Late Middle Ages.[138] Wetter climatic conditions can be inferred in the Late

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Imre Nagy, *A Balaton évszázados partvonalváltozásai* [Millennial shoreline changes of Balaton] (Budapest: Műszaki Kiadó, 1969) and László Bendefy, "Természeti és antropogén tényezők hatása a Balaton vízállására," [Natural and anthropogenic factors in the water-level tendencies of Lake Balaton] *Földrajzi Értesítő* 21, No. 3 (1972): 335–358. The view of the fluctuation is modified at by recent dendroclimatological investigations: Zoltán Kern, András Grynaeus and András Morgós, "Reconstructed August-July Precipitation for Southern Bakony Mountains (Transdanubia, Hungary) Back to AD 1746 on Ring Widths of Oak Trees," *Időjárás* 113, No. 4 (2009): 299–314.

[134] Andrea Kiss, "*Rivulus namque, qui dicitur Fuk, fluens de prefatu lacu* – Fok, Sár, Foksár," ["*Rivulus namque, qui dicitur Fuk, fluens de prefatu lacu* – Fok, Sár, Foksár,"] in *Antropogén ökológiai változások a Kárpát-medencében* [Ecological changes of anthropogenic origin in the Carpathian Basin], ed. Bertalan Andrásfalvy and Gábor Vargyas (Budapest: Pécsi Tudományegyetem Néprajz–Kulturális Antropológia Tanszék–L'Harmattan, 2009), 49–63, and Kern Zoltán et al., "Reconstructed Precipitation,".

[135] On the environmental and climatic conditions of the eighth and ninth centuries and their role in the collapse of the Avar Empire, see: György Györffy and Bálint Zólyomi, "A Kárpát-medence és az Etelköz képe egy évezred ezelőtt," [The general geographical conditions of the Carpathian Basin and Etelköz in 1000 years] in *Honfoglalás és régészet* [Hungarian conquest and archaeology], ed. László Kovács (Budapest: Balassi, 1994), 13–37, Lajos Rácz, *Magyarország környezettörténete az újkorig* [The environmental history of Hungary until Modern Times] (Budapest, MTA Természettudományi Intézete, 2008), 54–55. For recent criticism of the view of the former article see: Pál Sümegi, Gusztáv Jakab, Péter Majkut, Tünde Törőcsik and Csilla Zatykó, "Middle Age Palaeoecological and Palaeoclimatological Reconstruction in the Carpathian Basin," *Időjárás* 113, No. 4 (2009): 265–298.

[136] For further information on the castle of Szigliget: Orsolya Mészáros, "Szigliget várának története a középkorban," [The history of the castle of Szigliget in the Middle Ages] *Fons* 12, No. 3 (2005): 299–377.

[137] Orsolya Mészáros and Gábor Serlegi, "Környezeti változások hatása a középkori településviszonyokra a Dunántúlon," [The impact of environmental changes on the settlement-structure of the Transdanubian Region] (Paper presented at the Környezettörténet – 2010, [Environmental History conference] Budapest, Hungary, 4–5 February, 2010).

[138] Andrea Kiss, "Weather events II,", Andrea Kiss, "Changing Environmental Conditions and the Water level of Lake Fertő (Neusiedlersee) before the Drainage Works (13th–18th centuries)," in *Annual of Medieval Studies at CEU 1997–1998*, ed. Katalin Szende. (Budapest: Archaeolingua, 1998), 241–248, Andrea Kiss, "Historical

Middle Ages compared to the Árpád Period, especially on the Hungarian Great Plain. According to perambulation charters, several boundary stones could not be approached during the walking due to standing water.[139]

In understanding of the climatic processes of the Middle Ages one can not disregard using scientific and archaeological data. Over the last decades new methods have been introduced in Hungarian scholarship as well and recent research has brought important results.[140] Several major projects have been carried out to investigate climatic processes of the last few thousand years.[141] Amongst the scientific methods used in the Carpathian Basin, climate history investigations were done on the basis of dendroclimatological data, pollen, fauna and borehole-temperature analysis, and stalagmite-isotope records.[142] As mentioned above, archaeological data is also important in understanding long-term climatic processes and the human impact on nature.

As historical climatologists identified climatic periods during the Middle Ages as the MWE and the LIA, similar trends have been identified in the Carpathian Basin, although the periods in this territory had somewhat different weather conditions than those seen in Western Europe and the Eastern European Plain. The climate of the Árpád Period, or at least the end of it, seems to have been predominantly dry, which is attested in archaeological data in several areas of the Carpathian Basin.[143] Although there are questions concerning the mean temperature and precipitation during the Árpád Period, an apparent change in the climate and the environmental conditions of this territory from the mid-thirteenth century can be traced in a wave of abandonment of manors and villages throughout the central area of the Basin. This has traditionally been connected to the Mongol invasion, which undoubtedly influenced this process but may have been only one factor in it.[144]

Study of the Changing Landscape of Fertő during the Later Middle Ages (13th c. – 15th c.)," (MA Thesis: CEU, 1998).

[139] Györffy–Zólyomi, "A Kárpát-medence és az Etelköz," 15.

[140] For a brief overview of recent development of environmental and climate history in Hungary: Kázmér Miklós, "Geológia, archeológia és história – a környezettörténet forrásai," [Geology, archaeology and history – sources of environmental history] in: Miklós Kázmér, ed. *Környezettörténet*, 11–20.

[141] Pál Sümegi et al., "Paleoecological," 265.

[142] For the methods with case studies from Hungary, see: Pál Sümegi, *A régészeti geológia és a történeti ökológia alapjai* [Introduction to the archaeological geology and environmental history] (Szeged: JATE Press, 2003).

[143] Lajos Rácz, *Magyarország környezettörténete*, 54–55.

[144] On the wave of the abandonment of settlements in the Carpathian Basin from the mid-thirteenth to the mid-fourteenth century, see: György Györffy, *Az Árpád-kori Magyarország történeti földrajza* I. [The Historical topography of Hungary in the Árpád Period] (Budapest: Akadémiai Kiadó, 1963), 841–842 and 886–887, and András Pálóczi Horváth, "Középkori településeink környezetrégészeti kutatásának lehetőségei," [The possibilities of environmental archaeology in the medieval settlements of Hungary] in Ágnes R. Várkonyi, ed. *Táj és történelem*, 277–279.

Borehole temperature investigations, as discussed above, are more of use for examining century- or millennium-long trends in climate. Recent investigations in Vál and Kővágóörs showed there was an intensive cooling period between 1300 and 1600. The average temperature, however, shows a peak in the Carpathian Basin around 500 AD then a long and slow cooling that started in the ninth century and lasted until the sixteenth century, something that sharply contradicts other long-term climatic reconstructions for the last millennium.[145] Despite the controversies, like historical and other scientific results borehole temperature investigations suggest a colder period in the Late Middle Ages, but the sensitivity and the precision of this method does not allow drawing conclusions about century-long trends in the climate in the Carpathian Basin.

Paleobotanical and fauna-anlysis investigations are much more important in understanding late Holocene climatic processes.[146] According to recent investigations at Lake Nádas, close to the village of Nagybárkány (Cserhát Mountains, Northern Hungary), a long-lasting drier and seemingly warmer period dominated the climate of the Carpathian Basin until the mid-thirteenth century. In the second half of the thirteenth century, the lake dried up completely, which suggests exceptionally dry weather which is completely different from what was discussed concerning the trends in Western Europe.[147] According to records of Lake Nádas, the cooling in the the Carpathians started in the mid-thirteenth century and lasted for around one hundred years. After a short warming period at the end of the fourteenth century, when the annual mean temperature was higher than the average of the last two millennia, cold weather was dominant until the nineteenth century.[148] Parallel to the decrease of temperature, precipitation showed a tendency to increase and the total amount of annual rainfall reached the average of the last two millennia at the end of the fourteenth century. Based on this study, the drier conditions of the MWE in the Hungarian Kingdom show a closer parallel to Eastern European climatic conditions.[149] Different climate might have dominated in the surroundings of Lake Baláta (Southern Transdanubia, Hungary), where cold and wet conditions were

[145] Louise Bodri et al., "Két évezred éghajlatváltozásai," 429–431. For comparison see the global average temperature of the last millennium see the multi-proxy average temperature reconstruction for Europe: Joël Guiot et al., "Last-millennium,".
[146] On the reults of an exemplary large-scale paleobotanical (paleoenvironmental) investigation, see: Pál Sümegi and Sándor Gulyás, ed., *The Geohistory of Bátorliget Marshland: An Example for the Reconstruction of Late Quaternary Environmental Changes and Human Impact from the Northeastern part of the Carpathian Basin*, (Budapest: Archeolingua, 2004), see further examples: Zatykó–Sümegi, *Environmental Archaeology*.
[147] Pál Sümegi et al., "Paleoecological," 285.
[148] Pál Sümegi et al., "Paleoecological," 286.
[149] Klige–Myagkov, "Changes in the Water Regime," and Hedi Oberhänsli et al., "Climate Variability,".

prevailing from the end of the thirteenth century.[150] Malacofaunal analysis showed the appearance of cold-resistant species (e.g., *Gyraulus riparius*) in the Bátorliget marshland (Upper Tisza Region, Hungary) at the turn of the thirteenth century.[151] Paleobiological investigations and pollen analyses from these three different sites have one important point in common, they all seem to show colder conditions at the time when the Árpád Dynasty came to an end.[152]

Dendroclimatological research also shows an expressly cold period at the turn of the thirteenth century.[153] This is attributed by authors to extraterrestrial causes (the Wolf minimum, which is a short period with an increased number of sunspots and lower solar radiation).[154] However, according to research in the Calimani Mountains (Eastern Carpathians, Romania) long-term trends differ from the results of Western European climatic reconstructions. The stone pine (*Pinus cembra*) records used in reconstruction presume the existence of consecutive warm summers from the 1310s and especially in the year 1325, which might have been amongst the warmest in the climate history of the last millennium (see: *Fig* 6).[155] Unfortunately, continuous oak-based dendroclimatological reconstruction still remains to be done (and because of methodological problems may never be completed) for the central territory of the Carpathian Basin.[156] In addition to the results from the Calimani Mountains, however, dendrochronological investigations were also carried out in the Vienna Basin.[157] Although the dendroclimatological analysis still remains unfinished, pine chronologies do not indicate marked extremes at the turn of the thirteenth century there. The oak chronology (see: *Fig* 7), however, displays a twenty-year period when the growth of oaks was significantly less than the average for the surrounding century. There are no clear trends

[150] Zatykó–Sümegi, *Environmental Archaeology*, 251–253, and Csilla Zatykó, "The Medieval Environment of the Lake Baláta in the Light of Geology and Documentary Sources," in *Human Nature. Studies in Historical Ecology & Environmental History*, ed. Péter Szabó and Radim Hédl (Brno: Institute of Botany of the ASCR, 2008), 126.
[151] Sümegi–Gulyás, ed., *Geohistory of Bátorliget*, 193 and 277.
[152] Similar results can be found at other sites as well, as in the Jász lands: Pál Sümegi, "The Environmental History of the Jászság," in *Environmental Archaeology in North-Eastern Hungary* (Varia Archaeologica Hungarica 19), ed. Erika Gál, Imola Juhász and Pál Sümegi (Budapest: MTA Régészeti Intézete, 2005), 112–114.
[153] Popa–Kern, "Long-term summer Temperature," 1107–1117.
[154] On the Wolf minimum, see: Nivaor R. Rigozo et al., "Wolf Sunspots,".
[155] 2.69°C positive temperature anomaly from the reference period, see: Popa–Kern, "Long-term Summer Temperature," 1113.
[156] András Grynaeus, "Új forráscsoport? A dendrokronológia eredményei és a történettudomány." [New group of evidence? The results of dendrochronology and the history] in Ágnes R. Várkonyi, ed., *Táj és történelem*, 305–325, András Grynaeus, "Dendrochronology and Environmental History," in: Laszlovszky–Szabó, ed., *People and Nature*, 182–186, and András Grynaeus, "Dendrokronológiai kutatások Magyarországon," [Dendrochronological research in Hungary] in Miklós Kázmér, ed., *Környezettörténet*, 337–343.
[157] The researches of the Basin of Wien were carried out at BOKU, the research project was lead by Michael Grabner.

for the beginning of the fourteenth century. Although there are years with more and less growth one can not infer strong extremes in that period. Unfortunately, like the central Basin of the Carpathians, dendroclimatological interpretation of the dendrochronological investigations has not yet been carried out, thus, the only available reconstruction comes from a mountainous region which records the climatic situation above 1000 meters but is not representative for lower elevations and is far from the relatively densely inhabited central territories (and the surviving sources) in the Carpathian Basin.

Stalagmite investigations from the Kiskőhát Shaft (on the northern edge of the Great Hungarian Plain) indicate that there was a relatively warm and dry period at the turn of the first millennium which, according to the authors, may be connected to the more favorable conditions of the early MWE.[158] Although during this period the general trends indicate warm conditions, the stalagmite records show frequent extremes and abrupt changes of climate.[159] There is a significant decrease of temperature in the second half of the thirteenth century, which the scholars have understood as the possible beginning of the LIA or a rapid climatic change brought on by the low solar activity of the Wolf minimum. According to the stalagmite study, this period was characterized by drier weather conditions (around 1280).[160]

Archaeological investigations may also be important in researching long-term trends in climate and its human impacts; resuts from excavations may play a crucial role in researching changes in settlement networks. Connecting changes in the settlement network to climatic changes is very problematic, although such changes surely could have been occurred for climatic reasons. The abandonment of a manor or a village could have been motivated for several reasons from political through local environmental factors to demographic and climatological factors, or various combinations of all of them. The weather as a single determining factor appears to have been important only in extreme cases when a certain natural disaster or epidemic affected a region or a few settlements.

Despite problems in using settlement-network changes to estimate climatic-environmental changes, it is worth mentioning that the first major wave of settlement desertions during the Árpadian Period started in the middle of the thirteenth century and lasted until the middle of the fourteenth century. This period was characterized by continuous internal struggles which definitely affected many aspects of life from the economic system to

[158] Zoltán Siklósy, Attila Demény, István Szenthe, Szabolcs Leél-Őssy, Sebastian Pilet, Yin Lin and Chuan-Chou Shen, "Reconstruction of Climate Variation for the Last Millennium in the Bükk Mts. (NO Hungary) from a Stalagmite Record," *Időjárás* 113, No. 4 (2009): 256–258.
[159] Zoltán Siklósy et al., "Reconstruction of Climate," 256.
[160] Zoltán Siklósy et al., "Reconstruction of Climate," 259.

settlement pattern (see below). In historical demography and history of the settlement pattern in this period, the Mongol invasion of 1241-1242 was an influential turning point.[161] In spite of these two crucial factors, climate change and military incursions, the most frequently mentioned reason for the transformation of the settlement network is the change of agricultural opportunities in this region.[162] This can be seen on the Great Hungarian Plain, where a number of manors and villages were deserted in the late thirteenth and early fourteenth century.[163] This does not mean that there were no new village foundations in this period, but there are areas such as the Great Hungarian Plain, where abandonment is more typical than colonization.[164] Historians and environmental archaeologists suggest that this may have been connected to cooling temperatures at this time, which would have caused serious damage to the agrarian economy of the region. This process has been shown in the territory of the Nagykunság (Eastern Hungary), the Danube Tisza Interfluve, and the Körös Maros Interfluve (see below).[165] Geomorphological investigations have demonstrated that at the turn of the thirteenth century major sand movement was present in different parts of the Great Hungarian Plain as in the environs of Csengele (southeastern Hungary) which can be partly understood as a sign of a changing climate. There are other possible explanations, however, such as over-grazing in the region of the Danube Tisza Interfluve caused by the growth of animal husbandry in the region. This phenomenon may be connected to the newly

[161] On the loss of the population during the Mongol invasion, see the chapter called: "Debate: the Population Loss," in Balázs Nagy, ed., *Tatárjárás*, 484–507.

[162] Szabó István, *A falurendszer kialakulása Magyarországon (X–XV. század)* [The formation of the village-system in Hungary (10th–15th century)] (Budapest: Akadémiai Kiadó, 1966), 185, András Pálóczi Horváth "Középkori településeink," 277, and András Pálóczi Horváth, "Középkori települések környezeti rekonstrukciója," [The reconstruction of the environment of medieval settlements] in *Oktatónapok Százhalombattán* [Educational days in Százhalombatta], ed. Erzsébet Jerem, Zsolt Mester and Fruzsina Cseh (Budapest: Archaeolingua, 2008), 129. On the late mdieval agricultural potential in Hungary: József Laszlovszky, "Földművelés a késő középkori Magyarországon," [Agriculture in late medieval Hungary] in *Gazdaság és gazdálkodás a középkori Magyarországon: gazdaságtörténet, anyagi kultúra, régészet* [Economy and farming in medieval Hungary: economic history, material culture, archaeology], ed. András Kubinyi, József Laszlovszky and Péter Szabó (Budapest: Martin Opitz, 2008), 49–82, and its connections to environmental conditions: József Laszlovszky, "*Per tot discrimina rerum* – Zur Interpretation von Umweltveränderungen im mittelalterlichen Ungarn," in *Umweltbewältigung. (Die historische Perspektive)*, ed. Gerhard Jaritz and Verena Winiwarter (Bielefeld: Verlag für Regionalgeschichte, 1994), 37–55.

[163] András Pálóczi Horváth, "Középkori településeink,", Márta Széll, "Elpusztult falvak, XI–XVI. századbeli régészeti leletek Szeged és Hódmezővásárhely határában," [Deserted villages, 11th–16th century archaeological finds in the borders of Szeged and Hódmezővásárhely] *Dolgozatok (Szeged)* 16, No. 1 (1940): 159–170, Márta Széll, "Elpusztult falvak, XI–XVI. századbeli régészeti leletek Csongrád megye területén," [Deserted villages, 11th–16th century archaeological finds in the Csongrád county] *Dolgozatok (Szeged)* 17, No. 1 (1941): 169–173.

[164] On the new settlements in the Upper Hungarian region during the reign of King Charles I, see: Éva Teiszler, "Adattár a Károly Róbert idejében alapított felvidéki településekről," [Database on the settlements founded in the Upper Hungarian territories during the reign of Charles I] in Révész–Halmágyi, ed., *Középkortörténeti V*, 191–201.

[165] András Pálóczi Horváth, "Középkori településeink," 278–279., and László Blazovich, *A Körös–Tisza–Maros–köz középkori településrendje* [Medieval settlement-network of the Körös–Tisza–Maros Interfluve] (Szeged : Csongrád M. Tcs., 1985), 60.

settled Cuman and Jász population, but the connection between the new settlers and the sand-movement period has not yet been verified by historians or archaeologists.[166]

Although the results of various types of scientific investigation of the climate of medieval Hungary display inconsistencies, some general conclusions may be drawn. Seemingly the climate of the Carpathian Basin was dry at the time of the Hungarian Conquest in the early Middle Ages. During the MWE the annual mean temperature would have been relatively high and, as in Western Europe, the temperature decreased after the second half of the thirteenth century and was low around 1300. The annual mean precipitation during the medieval period however, shows noteworthy differences from what is reflected in the Western European literature. In Western Europe during the MWE wetter climatic conditions might have been dominant, which was followed by the relatively drier LIA. In the Carpathian Basin, however, the Árpád Period (about the same as the MWE in date) seems to have been predominantly dry with a slow increase in precipitation and the amount of rainfall grew significantly only from the turn of the thirteenth century.

3.1. Evidence for an environmental crisis in the Carpathian Basin in the 1310s – a case study of drastic short-term climatic changes

Apart from the above-mentioned Western and Central European accounts of the environmental crisis and the famine of the 1310s, it is fundamental to analyze the sources created within the borders of the Hungarian Kingdom. Although the number of such sources is smaller than the Western European material, these data can still help us to understand some characteristics of the weather and its effects during this decade. Because of the lack of narrative sources one has to confront the problem of how to exploit other kinds of written evidence.[167] Charters are the only sources that have survived in considerable numbers for the medieval Hungarian Kingdom.[168] Charters, as already discussed, are rarely used in historical

[166] M. Bálint, " Az Árpád-kori településhálózat," 60, and Tímea Kiss, Diána Nyári and György Sipos, "Homokmozgások vizsgálata a történelmi időkben Csengele területén," [Investigation of historical time sand-movements in the Csengele region], in *Táj, környezet és társadalom* [Landscape, environment and society], ed. Andrea Kiss, Gábor Mezősi and Zoltán Sümeghy (Szeged: Szegedi Tudományegyetem, 2006), 373–382.

[167] For the narrative sources of medieval Hungarian Kingdom see: Gyula Kristó, *Magyar historiográfia I. Történetírás a középkori Magyarországon* [Hungarian Historiography I. Historiography in Hungary in the Middle Ages] (Budapest: Osiris Kiadó, 2002).

[168] For the number of charters for medieval Hungarian Kingdom see: Imre Szentpétery, *Magyar oklevéltan. A magyar történettudomány kézikönyve*. II. 3. [Hungarian diplomatics. Handbook of Hungarian History II. 3.] (Budapest: Hatágú Síp Alapítvány, 1995 [1930]), Zsolt Hunyadi, "*Scripta manent* – Archival and Manuscript Resources in Hungary," in Katalin Szende, ed *Annual of CEU 1997–1998* (Budapest: Archaeolingua, 1998): 231–240, Iván Borsa, "A Magyar Országos Levéltár középkori gyűjteményei," [The medieval collections of the

climatological research, as in the Western European countries the narrative sources provide enough material for reconstructing the climate of the late medieval period. Since the number of charters is so high scholars tend not to use them, especially since references to weather or weather-related events in them are infrequent compared to chronicles and annals. However, from the fourteenth-century Hungarian Kingdom the number of surviving charters is not so great and it is possible to investigate them from a climate history point of view. Earlier investigations tried to understand patterns of the climate of Hungary in the Angevin Period, but the deeper analysis of the climate, and moreover of climate-related events, await completion.[169] According to these investigations the number of weather events documented in the 1310s is low, but greater than in the preceding and following decades (with the exception of the 1340s, which is a well documented time of crisis in the Carpathian Basin).[170] In the following chapter my aim is to investigate the weather-related events in the Hungarian Kingdom in the period of the great famine of Western Europe.

The earliest charter which could have significance in understanding patterns of climate in the late thirteenth early and fourteenth century is one from 1309 issued in the village of Lehotka (Horná Mičiná, Slovakia).[171] In this charter the inhabitants of Lehotka turn to their landlord with a demand to construct a new cemetery and chapel in their own village. The settlement had not had a church before and the population had been forced to use the church of a village called Rodona (a suburb of Banská Bystrica, Slovakia), situated on the right bank of the Garam River (Hron, Slovakia), while Lehotka is on the left bank. They justified the necessity for the building by emphasizing the distance between the two settlements including the problem of the river itself. The most important reason for having their own church,

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Hungarian National Archive] *Erdélyi Múzeum* 58, No. 3–4 (1996): 314–328. In the last two decades a project initiated by Gyula Kristó was set up which aimed to publish the Hungarian summary of the charters issued in the Hungarian Kingdom during the Angevin Period. Until now the volumes on the period 1301 to 1343 have been completed and published although the quality of the volumes and especially the length of the description of the charters is slightly different: Tibor Almási, László Blazovich, Lajos Géczi, Gyula Kristó, Ferenc Makk, Ferenc Piti and Ildikó Tóth, ed., *Anjou-kori oklevéltár. Documenta res Hungaricas tempore regnum Andegavensium Illustrantia*. I–XXVII. [Angevin Cartulary] (Budapest: Csongrád Megyei Levéltár, 1990–2007). Review of the edition of the charters of the Angevin Period: Ildikó Tóth, "Charters of the Angevin Period," *Chronica* 1, No. 1 (2001): 180–184.

[169] The analysis of climate and weather events in the medieval period based on written evidence is now in process as part of a European-scale project called Millennium led by Andrea Kiss, "A Millennium," 163–169.

[170] Andrea Kiss, "Weather Events I," 61–69, Andrea Kiss, "Weather Events II," 51–64, Szántó Richárd, "Természeti katasztrófa," 50–64, Richárd Szántó, "Az 1315–17. évi európai éhínség," [The famine of 1315–1317] in *Medievisztikai tanulmányok. A IV. medievisztikai PhD konferencia előadásai* [Studies in medieval history. Papers presented at the 4th conference of PhD students], ed. Szabolcs Marton and Éva Teiszler (Szeged: Szegedi Középkorász Műhely, 2005), 135–142, and Richárd Szántó, "Környezeti változások," 159–164.

[171] Dl 63093. Edition: Georgii Fejér, ed., *Codex diplomaticus Hungariae ecclesiasticus ac civilis* VIII. 1. (Buda: Typ. Universitatis, 1829–1844), 351. *"de distancia loci praedicti ac etiam inundationem fluvii memorati per veridicos viros nobis veritas constitit eiudenter in prefata villa ipsorum Lehatha nominata capellam construendi cum cimiterio seu loco sepulturae eisdem duximus concedendam."*.

however, was the problem of the frequent flooding of the Garam, which hindered people from going to church or burying their dead from time to time. The distance itself was not negligible (several kilometers), but the river made access even more difficult.

The village of Lehotka is first mentioned in a charter in 1293, when it appears as the land of Myke. Then, in 1300, *terra comitis Mike* appears in a charter. The third mention of the village is in the charter of my focus from 1309. It is Mike himself who demands the church. The village may have been new, as it is unlikely that the settlement existed without a cemetery for centuries when the closest church was so distant. The name of the village also indicates a later foundation as it means forest-clearing in a Slavic language and appears frequently in thirteenth- and fourteenth-century settlement names in the Upper Hungarian territories.[172] The village seems to have received permission to build as it has an early fourteenth-century Gothic church.[173]

What is most important from my perspective is the question of changes in the flooding of the Garam. If frequent flooding was really the case in the period before 1309, it is important because it might indicate a longer term transition in the flooding, which could have been related to environmental or climatic changes in the catchment area of the river. It must also be noted, however, that emphasizing the distance and the problems of reaching Rodona were convincing reasons for Mike in demanding the new church and may only have been a rhetorical formula in the charter.

The first document from the decade which seems to be relevant here is a charter from 1343, transcribing another document from 1312 that is important for highlighting the food supply in the 1310s. The charter is seemingly a simple document which puts an issue in the sale of an estate on paper. The estate which is sold in this charter is called *Pethunye* (Petenia, Romania), but what has to be emphasized here is that the reason for selling one sixth of this estate complex was supposed shortages in the near future. The charter was issued on 25 June, 1312, exactly the period of the usual date of the grain harvest, which indicates that the harvest was very poor. It does not mean that the harvest was poor over a broader region as the charter does not specify the reason for the supposed shortage or food supply in the coming year, but it is possible that it was due to weather conditions.[174]

[172] János Melich, "Három helynévről: Lehota, Vólya, Ohába," [On three place names: Lehota, Vólya, Ohába] *Századok* 41, No. 4 (1907): 321–324.

[173] According to the website of the Monument Board of the Slovak Republic, the church was built in the late thirteenth century, which is unlikely: www.pamiatky.sk/pamiatky/fondy/ nehnutelne -amiatky/?a=nehnutelne&id =6274 (last accessed: 24 April, 2010).

[174] Dl 71639. Edition: László Bártfai Szabó, ed., *Oklevéltár a gróf Csáky család történetéhez* I/1. [Charters on the history of the Csáky family] (Budapest: without publisher, 1919), 88–92. *"possessionem Pethunye vocatam*

There is no other charter referring to weather or weather-related events from the first half of the 1310s, although for the second half of that decade there are a few significant sources. My aim is not to present only charters, but also foreign narrative sources and non-contemporary chronicles that make reference to the climate of the 1310s. Although there are no other contemporary sources expressly mentioning famine in the first half of the 1310s, a non-contemporary source may be relevant, especially connected to the source from Pethunye in 1312. A chronicle of the history of Szepesség compiled in the seventeenth century by Caspar Hain partly based on local archival evidence indicates that around 1312 there was a famine that lasted three years. Hain even mentions that cannibalism took place among the population.[175] According to, for example, Henry Lucas, this phenomenon was not unique in times of famine, but in this case it might well reflect the vivid imagination of a seventeenth-century author.[176] In spite of probable exaggerations and the fact that it is not a contemporary source, this chronicle has great importance from my point of view. The author of this chronicle was an office-holder in Lőcse (Levoča, Slovakia) and thus, had easy access to the town archives. Some of his references suggest that he was familiar with now lost medieval narratives, so that his descriptions of the medieval period in the town should be considered as well.[177] It is quite probable that Caspar Hain had access to reports referring to an early fourteenth century famine. There are general methodological problems with the use of Early Modern chronicles such as the lack of references and the imaginations of the chroniclers of the period That make it difficult to separate actual fact from fiction. However, Hain seems to have been aware of the need to refer to his earlier sources and precedents. For the period after 1516, Hain specifies which sources he used when compiling the chronicle, including Konrád Sperfogel, Dániel Türk, Márton Frőlich, and others. They were all office-holders and prominent members of the bourgeoisie of Lőcse in the sixteenth and seventeenth century.[178]

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videlicet duorum aratrorum tercie partis dimidiam ipsos contingentem propter anni tunc cernetibus caristiam et sumptus necessarios vendicioni exposuissent".

[175] Jeromos Bal, Jenő Förster and Aurél Kauffmann, ed., *Hain Gáspár lőcsei krónikája* [The chronicle of Caspar Hain from Lőcse] (Lőcse: Reiss Ny., 1910–1913), 13. *"Zu dieser Zeit war auch 3 Jahr lang so groszer Hunger, das die Menschen einander geschlachtet und gessen auch die Diebe von galgen sind vor Hunger abgeriszen worden. Desgleichen war auch undter dem Viehe."*.

[176] On the question of the cannibalism in 1315–1317, see: Henry Lucas, "Great Famine,"343–377, and on cannibalism as a topos in the High Middle Ages, and especially in Early Modern Times, see: Cătălin Avramescu, *An Intellectual History of Cannibalism* (Princeton N. J.: Princeton University Press, 2009).

[177] On the sources and the reliability of the chronicle of Caspar Hain, see: Kálmán Demkó, "Hain Gáspár és krónikája. Első közlemény," [Caspar Hain and his chronicle] *Századok* 16, No. 2 (1882): 133–143, Kálmán Demkó, "Hain Gáspár és krónikája. Második és befejező közlemény," [Caspar Hain and his chronicle] *Századok* 16, No. 3 (1882): 223–235, and the introduction to the edition of the chronicle of Caspar Hain, *Hain Gáspár lőcsei krónikája*.

[178] On the period of their activity in Lőcse, see: Kálmán Demkó, *A Szepes-szombati krónika* [The chronicle of Szepesszombat] (Lőcse: Reiss J. T, 1891), 15–16. Hain himself also refers to early modern humanist chronicles

From my point of view, what is important above all is that it is likely that Hain used medieval annals and he was aware of the earliest works on the history of the Szepesség. This chronicle, however, was not from a clerical milieu and it is quite probable that Hain used some kinds of religious annals or personal notes of a priest as well, since his manuscript contains a large number of references to the foundations of monasteries and religious events, especially in Upper Hungary.[179] He dates the foundation of the Cistercian monastery of Savnik (Spišský Štiavnik, Slovakia) to 1216, which is the generally accepted foundation date for this monastery, but he misdated the foundation of the monasteries of Gölnic (Gelnica, Slovakia) and Eperjes (Prešov, Slovakia).[180] Thus, there are mistakes in the Hain' chronicle but apart from the chapter on the prehistory of the Szepes region, it does not seem to contain intentional mistakes. Therefore, it is quite probable that some time in the early or mid-1310s a famine did take place in Upper Hungary.[181] Although Hain dates this event to three years around and after 1312, he also added that the exact date is not sure.

Antal Réthly, the great mid-twentieth-century compiler of weather and weather-related events in the Carpathian Basin, mentions another Early Modern chronicle which might be relevant in understanding the climatic processes of the 1310s, the chronicle of András Spangár, a Jesuit who edited his *Chronicle of Hungarians* in 1738 based on the work of Gergely Pethő (Spangár used other sources besides Pethő but the two works are almost entirely same).[182] In this chronicle Pethő mentions that the monastery of Székesfehérvár burned down because of great thunderstorms.[183] Unlike the chronicle of Hain, this work does

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such as the *Ortelius* and *Istvánfy* chronicles (*Hain Gáspár lőcsei krónikája*, 3), however these latter ones are sometimes more unreliable than the later works of the dignitaries. Later researchers discovered some medieval and Early Modern sources that the author does not mention but used while compiling his work. In his earlier works the most important scholar studying Hain's text, Sándor Demkó, proposed several possible other sources for the work of Gáspár Hain such as the chronicle of Mart of Michovia or the Leibitzer chronicle (sometimes called the *Chronicle of the Leibitzers*). In a later study, however, he changed his view of the work and suggested that Hain listed all his sources with one exception: the chronicle of Szepesszombat (Spišská Sobota, Slovakia). This chronicle is also a compilation and cotains the fourteenth-century chronicle composition of Hungary (see the edition of the chronicle: "Georgenberger Chronik," in *Scriptores rerum Hungaricarum tempore ducum regumque stirpis Arpadianae gestarum* 2., ed. Emericus Szentpétery (Budapest: Akadémiai, 1938), 273–287, and also: Kálmán Demkó, *A Szepes-szombati krónka*, 19). In a later study Kálmán Demkó, *A Szepes-szombati krónka*, 18–19) Demkó thought that Hain did not know about the chronicle of Leibitzer and supposedly used the data of the chronicle of Szepesszombat, which itself was one of the most important sources for Joachim Leibitzer's work (although Leibitzer might have seen only parts of the chronicle).

[179] *Hain Gáspár lőcsei krónikája*, VI.

[180] For the correct foundation dates see: Beatrix F. Romhányi, *Kolostorok és társaskáptalanok a középkori Magyarországon. Katalógus* [Monasteries and chapters in medieval Hungary] (Budapest: Pytheas, 2000).

[181] For the low historical value of the prehistoric section, see: *Hain Gáspár lőcsei krónikája*, VI and its introduction.

[182] Antal Réthly, *Időjárási események és elemi csapások Magyarországon 1700-ig* [Weather events and natural disasters in Hungary until 1700] (Budapest: Akadémiai Kiadó, 1962), 41.

[183] *Rövid magyar kronika. Sok rendbéli fő históriás könyvekből nagy szorgalmatossággal egybe szedettetet és irattatot Pettő Gergely* [Short Hungarian Chronicle] (Cassa, 1729), 49. *"Ez igen jámbor, és aitatos Király vala:*

not contain any mention of sources and is entirely lacking any kind of source criticism. He probably used the chronicle of Bonfini, which is also a questionable source for researching the history of Hungary, as well as other Early Modern humanist works.[184] Although this chronicle is unreliable, especially in comparison with the work of Hain, the data do not contradict other data referring generally to bad weather conditions in this period.

Although there are few extant charters referring to the weather of the mid-1310s, as noted above accounts were frequently kept in Austrian Benedictine monasteries which refer to the Carpathian Basin as well. Contemporary chronicles from the Czech Kingdom also contain important information on the environmental conditions of this period in Hungary. From 1316, there are data referring to the Hungarian Kingdom from the neighboring territories, such as the accounts in the *Anonymus Leobiensis Chronicon*[185] and the *Chronicon Aulae Regiae*.[186] The former mentions serious floods in the Danube Valley, the latter reflecting rainy weather in Hungary. According to these accounts, serious flood events might have taken place in the Carpathian Basin in the same way as in Western and Central European territories. As already discussed, sources mentioning rainy weather in 1316 are exceptionally common, especially for spring and summer months. In the next chapter I will provide a detailed analysis of flood events in the valley of the Danube in the summer of 1316.

It seems that the weather continued to be unseasonable and the winter of 1316 was extreme, especially in the Sava Valley, according to a charter issued in 1323 that contains the text of a lost charter dating back to 24 February 1317.[187] The charter mentions the military campaign of Charles I, king of Hungary, against Stefan Uroš II Milutin, monarch of Serbia.[188] After a successful campaign against the actual ruler of most of Croatia, King Charles I faced

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építette a' Székes-Fejér-Vári Monostort, melly a 'sok gyuladások miátt mind el-pusztult vala, és azt meg-hejaztatá ón peléhekkel; de mivel nem sok udo múlva ismét megége, másod-szor-is meg csináltatá nagy költséggel…".

[184] Antonius de Bonfinis, *Rerum Hungaricum decades*, ed. József Fógel, Béla Iványi and László Juhász (Leipzig: Teubner, 1936–1976). On the work of Bonifini, see: Kulcsár Péter, *Bonfini magyar történetének forrásai és keletkezése* [The sources and the construction of the Rerum Hungaricum decades of Bonfini] (Budapest: Akadémiai Kiadó, 1975). These works had an entirely different aim – confessional purposes – than the sources I rely on most (charters, annals). One finds a strong tendentiousness in this chronicle to strengthen the position of Roman Catholicism in the Hungarian Kingdom.

[185] Joseph von Zahn, ed., *Anonymi Leobiensis Chronicon nach dem Originale herausgegeben* (Graz: Leutschner & Lubensky, 1865), 33–34. *"Diverse vero aque in Danubio congregate a Patavia per totam Austriam et Ungariam maxima dampna fecerunt in pluribus partibus integras villas cum omnibus suis hominibus submergendo deduxerunt"*. On the chronicles and its Hungarian connections, see: T. Körmendi, *A nyugati elbeszélő források*, 72–75.

[186] See footnote: 116.

[187] Dl 1884.

[188] Pál Engel, "Az ország újraegyesítése. I. Károly küzdelmei az oligarchák ellen (1310–1323)," [Reuniting the country. The fights of Charles I, king of Hungary against the oligarchs (1310–1323)] in *Honor, vár, ispánság. Válogatott tanulmányok* [Honor, castle, county. Collected essays], ed. Enikő Csukovits (Budapest: Osiris Kiadó, 2003), 343. (First published: *Századok* 122, No. 1–2 (1988): 89–147.)

serious problems when he tried to cross the Sava River, probably some time in late January, before he returned to his temporary capital in Temesvár, where he issued this charter.[189] It is important to know why it was difficult to cross the Száva in late January. The obvious answer could be the ice-cover on the river. On the one hand, it would have been difficult to cross a river if the ice-cover was thin, and, on the other, if it were thick it would have helped the crossing.[190] Today, the Sava Valley has a sub-Mediterranean climate which means that in this region long-lasting cold weather is relatively rare, although the average precipitation in winters is higher than today in Hungary. Floods in the Sava Valley could have caused serious environmental crises in this part of the medieval Hungarian Kingdom considering this river's fast current.[191] I suggest that it was more likely a flood which made it hard to cross than river-ice cover, but unfortunately the charter does not state the precise reasons for his failure to cross the river.[192] It is worth trying to draw parallels to understand the winter weather conditions in 1316 in Hungary. The *Chronicon Aulae Regiae* speaks of an extremely cold winter in 1316 in the Czech Kingdom, which reinforces the idea of a cold winter in the southern parts of Hungary as well, although as mentioned above, winters with sustained cold spells creating a thick ice cover would have helped rather than hindered military campaigns.[193]

Apart from this charter there is no other written evidence referring to weather or weather related events for 1317. One can only rely on foreign sources and data referring to the situation in neighboring countries. The *Annales Mellicenses*, an above mentioned Austrian source, tells of great floods in several parts of Europe, with mentions of German and French territories, the Czech Kingdom, and Hungary.[194] Although this data is quite general, based on this evidence and the accounts of the weather in the neighboring countries, there is reasonable

[189] Pál Engel, "Az ország újraegyesítése," 343.
[190] For example, see Salamon I, king of Hungary's, crossing of Tisza River in 1074: Andrea Kiss, "Időjárási adatok," 257, and on the climate historical connections of the Mongols crossing of the Danube in the winter of 1241–1242 during the invasion of the Hungarian Kingdom: Andrea Kiss, "Időjárás és környezeti krízis," 442–443.
[191] For an analogue, see an Early Modern flood event of Drina and Sava. Andrea Kiss, Zoltán Sümeghy and Zoltán Zsolt Fehér, "A Maros 18. századi áradásai és egy jellemző téli árvizének területi hatásai," [The eighteenth century floods of the Maros River and the territorial consequences of a typical ice flood] in *A táj változásai a Kárpát-medencében. Az erdélyi táj változásai* [Landscape changes in the Carpathian Basin. The changes of the landscape of Transylvania], ed. György Füleky (Gödöllő: Szent István Egyetem, 2008) and Andrea Kiss, Zoltán Sümeghy and György Danku. "Az 1783–1784. évi szélsőséges tél és a Maros jeges árvize," [Severe winter of 1783–1784 and the iceflood on the Maros River] in Andrea Kiss et al., ed., *Táj, környezet*, 353–362.
[192] Dl 1884. *"difficils transitus fluvii Zave per algorem hiemalis temporis"*. The term *algorem hiemalis temporibus* can mean either serious winter weather conditions and or serious stormy weather. As the charter refers to an event in late February, the scribe was apparently referring to winter conditions.
[193] "Chronicon Aulae Regiae," 379.
[194] See footonote: 107.

data that, just as in Western and Central Europe, the climate of the Carpathian Basin was cold and wet, especially in the summer of this year.

One charter from 1318 is important in understanding the impact of weather in the Hungarian Kingdom in the 1310s. The charter mentions a certain Stephen who gave proof of his charity when he helped his family during a time of serious famine.[195] This is the only unquestionable contemporary written evidence from the Carpathian Basin which refers to famine in the preceding period. It does not specify when the famine took place, but the charter is a continuation of another document dating back to 1311, which means the famine mentioned in the charter took place some time between 1311 and 1318.[196] The charter from 1318 was issued by the monastery of Várad (Oradea, Romania) concerning an estate called Keserű (Cheşereu, Romania). Seemingly, there was a famine in that region, which does not mean that it touched the whole country. However, the fact that the scribe did not specify which famine the charter refers to may indicate that it was a well known event and affected a broader geographical area.

The last significant data referring to the Carpathian Basin with relevance to my research is a note in the *Annales Mellicenses* which mentions the poor quality wine in 1321.[197] Poor wine is often closely connected to a cold, wet summer that leaves the sugar content in grapes low.[198] In several territories in Western Europe the environmental crisis of the mid-1310s lasted until the first years of the 1320s.[199] This data does not provide enough evidence to suppose that the environmental crisis lasted longer in the Carpathian Basin, but it seems likely that the weather conditions in 1321 were not the best during the year's growing season.

Charter evidence for the 1310s frequently mentions poverty or impoverishment, but such references appear time after time in medieval textual material. It is possible, however, that some of these cases were connected to weather conditions in the period.[200] After discussing the sources referring to weather and weather-related events in the Hungarian Kingdom, it seems that although compared to Western European the source material on the

[195] Dl 50333. *"Idem Stephanus quod hoc temporem fames vallido ipsam dominam M(argaretam) sororem suam cum tribus liberis suis"*.
[196] *Anjou-kori oklevéltár,* III. 13-14/11. (Although the original charter is now lost, it had been transcribed: Dl 50333).
[197] See footnote: 108.
[198] On the connection between climate and sugar content of grapes, see: Erich Landsteiner, "The Crisis of Wine Production in Late Sixteenth-Century: Climatic Causes and Economic Consequences," *Climatic Change* 43, No. 1 (1999): 323–334 and its references.
[199] See the case of England: Ian Kershaw, "The Great Famine," 3–50.
[200] For examples, see: *Anjou-kori oklevéltár,* II/827; III/16; III/109; III/132; III/133; III/178; III/356; III/387; III/395; III/443; III/470; III/471; III/480; III/532; III/611; III/629; III/698; III/803; IV/ 73; IV/ 73; IV/80; IV/87; IV/91; IV/132; IV/293; IV/339; IV/434; IV/445; IV/478; IV/501; IV/570.

Hungarian Kingdom is short of clear evidence and the data is very sporadic (see: *Fig* 9), enough still exists to suggest that the environmental crisis of the 1310s also touched the Carpathian Basin to some extent.

3.1.1. The Danube flood of 1316 and its possible climatic circumstances based on modern analogies

Although there are no sources relating to flooding of the Danube from the Hungarian Kingdom in 1316, there is evidence for floods of the river in Austrian territories. Apparently, several rivers with sources in the Alps and the Danube itself suffered catastrophic floods in this year. The annals from Salzburg speak of a *triplex inundatio* on the Danube River. According to this account, floodwaters peaked on 23, 24, and 28 June.[201] These close together dates may reflect a more long-lasting culmination rather than three different waves of flood waters. Apart from this annals, another work (which shows strong connections to the Salzburg annals), the *Annales Burghausenses*, also refers to this event, dating it to 28 June.[202] The flood of the Danube and its tributaries also appears in the *Annales Zwettlenses*. The *Annales Mellicenses*, too, writes about the floodwaters and mentions the destruction caused by it.[203] All these annals, although copied several times, are reliable and the data can be accepted. Besides these sources, later chronicles also mention this event. The *Chronica Austriae* of Thomas Ebendorfer mentions the event, but it is likely that the author here used the annals of Zwettl here.[204] The last source, although not contemporaneous, is nonetheless important. The chronicle entitled *Anonymus Leobiensis Chronicon*, and dated to a period after the 1340s, gives a detailed account of the events. There are several questions around the author and the origin of the work. The most probable origin is a house of the Augustinian order seemingly located in the proximity of the Carpathian Basin;[205] the chronicle mentions the flooding of the Danube and the territories swamped by the river.[206] Besides the Danube, a similar situation occurred in the Mura Valley, where the flooding caused great damage by destroying

[201] "Annalium Salisburgurgiensis," in *Monumenta Germaniae Historica. Scriptores* XIII., ed. Georg Waitz (Hannover: Hahn, 1881).
[202] "Annales Burghausenses," in *Monumenta Germaniae Historica. Scriptores* XXIV., ed. Georg Heinrich Pertz (Hannover: Hahn, 1866), 62. *"Facte sunt inundaciones aquarum in vigilia Petri et Pauli de qua mundus totus turbabatur*.".
[203] "Continuatio Zwetlensis Tertia," 666, *inundantia maximi Danubi ac omnium fluviorum tam ex pluviis quam eruptione venarum terre*.".
[204] "Chronica Austriae," 241. *"quam gravis inundacio Danubii ex crebis pluviis subsequitur, ut primum sata perirent, deinde anno MCCCXVII valida fames, sequenti anno, oritur"*.
[205] *Anonymus Leobinesis*, 73.
[206] See: footnote 185.

bridges.[207] The Salzach also flooded in the same year, which caused damages around the town of Werfen (Austria). Here, the chronicler emphasizes the problem of the waters remaining in the fields after the flood receded. [208] The seriousness of this event can be argued from the account of the source from Zwettl. The flood may have caused serious famine in Austria, as the monks of the Cistercian monastery compared the event to Biblical famines. Christian Rohr has emphasized that such events were rare in this period.[209]

The Danube flood probably took place in late June (occurring in the first third of July taking into account the differences between the astronomical calendar and the Julian calendar by the fourteenth century). The watershed of the Salzach and the Mura covers major parts of the Eastern Alps. Thus, apparently the precipitation was higher in the High Tauern Mountains as well as in the region of the Danube valley, although the *Anonymus Leobiensis* chronicle specifies neither the month nor the season of these events. Supposing that both territories were wetter than usual in the summer, the presence of an extended wet air mass in the territory of the Eastern Alps can be presumed, which was probably transferred by a temperate zone cyclone. Such a phenomenon could clearly have affected the weather of the Carpathian Basin.

Even if one does not assume an increase of precipitation in the Carpathian Basin on the rivers coming from the Western European region (particularly the Danube and Drava), a significant excess of water is clearly likely. Rising water-levels of rivers coming from Western Europe would have caused floods and rising water-table levels in the territory of the Little Hungarian Plain. The swollen rivers meant rises in the rise of the water-level of Lake Fertő and the Hanság marshy plain, which according to research by Andrea Kiss, started to rise in the first half of the fourteenth century.[210]

It is important to understand which climatic situations may be connected to high precipitation in late June and early July in the Central European region. The typical peak of precipitation in the twentieth century in Western Hungary is in June, although in the sub-

[207] *Anonymus Leobinesis*, 33. *"in terra Stirie Mura fluvius XIII pontes destruendo evertit et nisi iste in Leuben cum paucis aliis remansi"*.
[208] *Anonymus Leobinesis*, 33. *"ita quod fluvius Salzach prope circa Werffen in clausula, ubi foramen munitionis existit, in petra ibidem fluvius predicatm clausulam ex inundacione replevit supra usque ad solam scalam per quam intratur ad prenominatum foramen, clausulam obruendo lignis ita, quod post torrentem inundacionis via eadem permansit immeabilis, donec per longum tempus ab hominibus terre purgaretur*.".
[209] "Continuatio Zwetlensis Tertia," 659. *"Stella que cometa dicitur visa est per continos LXXX dies; que secundum Bedam et alios doctores ostenat verl famen aut pestilenciam vel mortalitem vel mutacionem regni vel aeris intemperiem aut ventorum immanitatem"* and Christian Rohr, "The Danube Floods and Their Human Response and Perception (14th to 17th C)," *History of Meteorology* 2, No. 1 (2005): 74.
[210] Andrea Kiss, "Changing Environmental," and Andrea Kiss, "Historical Study,".

Mediterranean territories there is another, smaller, peak in October-November.[211] In most cases, floods are connected to snowmelt in the Alps. Emma Bodolainé Jakus developed a typological system for understanding the most common climatic situations resulting in extreme precipitation in the Danube watershed. Her monograph (based on a reference period lasting from 1951-1980) revealed three major climatic situations which can be connected to precipitation increase: Western cyclone situations (most common in June), Centrum situations (regular from April until July), and occasionally Western border storm types of situations.[212]

The Centrum type of situation causes continuous rainfall in the Carpathian Basin as in these cases a temperate zone cyclone remains immobile over the Carpathians, receiving its water-supply from the Mediterranean Sea basin. This situation causes floods most frequently in the watershed of the Tisza and the Danube and is the most common of these weather factors related to flooding.[213] The Western-cyclone type of situation, although not so common, still causes wetter weather than average for the reference period. This kind of event causes more rain to fall west of Hungary, especially in the region of the Eastern Alps. Thus, it can also affect the weather of this region when there is much evidence for an extremely wet spring and summer with serious river floods. This type of situation causes high precipitation in the whole of Western Europe, as was the case in 1316.[214] The third possible circumstance that could have caused higher precipitation in the Hungarian kingdom is the Western cyclone situation. This transports wet air masses from the region of the Mediterranean during the winter season or, in some cases, in the springtime. This Western cyclone would be more likely to affect the watershed of the Sava and to some extent those of Drava and the Raba. However, but the valley of the Danube in Austrian and German territories would not have been affected by a West cyclone.[215]

Water-level changes in the Danube never display such extremes as those of the Tisza River which is located on a flat plain.[216] The Danube floods subside much more slowly than Slovakian rivers or watercourses in the Alps. In the twentieth century the most dangerous Danube floods were connected to snowmelt in the Alpine region, but in historical times ice-

[211] György Péczely, *Éghajlattan* [Climatology] (Budapest: Tankönyvkiadó, 1979), 277–282.
[212] Emma Bodolainé Jakus, *Árhullámok szinoptikai feltételei a Duna és a Tisza vízgyűjtőjén* [Synoptical conditions of flood-waves in the basin of the Danube and the Tisza] (Budapest: Országos Meteorológiai Szolgálat, 1983).
[213] Emma Bodolainé Jakus, *Árhullámok*, 53–56.
[214] Emma Bodolainé Jakus, *Árhullámok*, 56–57.
[215] Emma Bodolainé Jakus, *Árhullámok*, 48–50.
[216] Alfréd Zawadowski, *Magyarország vizeinek statisztikája. I.* [Statistics on Hungarian waters] (Budapest: Statisztikai Hivatal, 1891), 23.

floods may have been even more catastrophic.[217] The best known and most frequently studied case is the ice-flood of the Danube in 1838, which produced the highest water-level ever measured (919 cm) at Buda.[218] According to the research of Alfréd Zawadowski, summer floods of the Danube were rare in Early Modern and Modern Times. Zawadowski collected data on 64 major Danube floods from 1732 to 1882. None of them occurred in July and only four happened in June. [219] In the twentieth century, however, several serious flood events took place in July. After systematic river regulations and dyke constructions, however, the destruction was negligible compared to what took place in the Middle Ages and Early Modern Times.[220]

During the Middle Ages there were several significant Danube floods, and in the fourteenth and fifteenth century summer floods were probably the most common.[221] Not only is there written evidence of flooding, but archaeological investigations also reveal that such catastrophic events did indeed take place.[222] River floods might have caused serious damage during the Late Middle Ages, which explains the numerous regulations concerned with flood control of the Danube in the sixteenth-seventeenth centuries.[223] In the 1569 law, apart from the importance of flood prevention, the problem of regulating floods on the Danube was also mentioned.[224] In the sixteenth century, flood prevention was not planned on a regional or

[217] For the examples of ice-floods of the Danube at Pest in a short period of the Early Modern Times, see: Andrea Kiss, "*Suburbia autem maxima in parte videntur esse deleta* – Danube Ice floods and the Pitfalls of Urban Planning: Pest and its Suburbs in 1768–1799," in *From Villages to Cyberspace*, ed. Csaba Kovács (Szeged: Szeged University Press, 2007), 271–282. For the floods of Danube, József Déri, "A Duna jeges árvizei évezredünkben," [The icefloods of Danube in the last millennia] *Hidrológiai Közlöny* 69, No. 3 (1989): 151–158, Dénes Ihrig, "Az 1956. évi dunai jeges árvíz Magyarországon," [The ice flood of the Danube in Hungary in 1956] *Vízügyi Közlemények* 38, No. 4 (1956): 389–424, and Woldemár Lászlóffy, "A folyók jégviszonyai, különös tekintettel a magyar Dunára," [The ice conditions of Hungarian rivers with special regard to the Danube] *Vízügyi Közlemények* 16, No. 3 (1934): 369–435.

[218] Data from 1740 indicates a rise in flood waters of 1024 centimeters. However, the validity of this number is questionable.

[219] Zawadowski Alfréd, *Magyarország vizeinek*, 30–31.

[220] The flood on the 18 July, 1954, produced the fourth highest water-level of the last 120 years in Budapest (805 cm) and the one that peaked on 8 July, 1975, produced the eighth highest level for the same period (776 cm).

[221] For example, those of: 1377 or 1378, 1414, 1440, 1458, 1481. On the damage and the perception of Danube floods in Austria, see: Christian Rohr, "The Danube Floods," 71–86, Christian Rohr, *Extreme Naturereignisse*, and E. Pautsch, "Elementarereignisse in den Erzählenden,".

[222] Traces of a catastrophic flood on the Danube in the late fourteenth century was observed during archaeological excavations at Nagymaros – András Pálóczi Horváth (personal communication, 2009). On the problem of the water-level changes on the Danube in the region of the Danube bend, see: Erzsébet Jerem et al. "A Historical Landscape," and József Laszlovszky, "Királyi palota, ferences kolostor és városi település (Gondolatok a késő középkori Visegrád településfejlődéséről," [Royal palace, Franciscan Friary and urban settlement – Ideas on the late medieval settlement development of Visegrád] in *Es tu scolaris – Ünnepi tanulmányok Kubinyi András 75. születésnapjára* (Monumenta Historica Budapestinensia XIII) ["*Es tu scolaris*". Studies in honor of András Kubinyi on his 70th birthday], ed. Beatrix F. Romhányi, András Grynaeus, Károly Magyar and András Végh (Budapest: Budapesti Történeti Múzeum, 2004), 64.

[223] Laszlovszky József, "Királyi palota," and see for example the regulations of 1569. No. 3. and the 1618. No. 65.

[224] 1569. No. 3. §.21. Quoted by: Alfréd Zawadowski, *Magyarország vizeinek*, 156.

national scale, although the presence of a few dikes around settlements regularly touched by floods can be documented. Even more often, flood control was limited to efforts to protect villages and towns during the inundations.[225] It can be assumed that Danube floods caused serious damage during the Middle Ages and the flood of the year 1316 would have been no exception.

The course of the flood of 1316 can be compared to modern floods such as those in 1884 and 2009. Both floods peaked in the Carpathian Basin in the last days of June, as was probably the case in 1316. In 1884, the flood reached the town of Pozsony (Bratislava, Slovakia) on 24 June, peaked on 27 June at Budapest, and on the 7 July in Újvidék (Novi Sad, Serbia). A better comparison is perhaps the more serious summer flood of the Danube in 2009.[226] The flood peaked on 25 June at Passau (Germany), then reached the Carpathian Basin on June 26 at Dévény (Devín, Slovakia) and peaked on 29 June at Budapest. Based on the course of these two inundations, the peak of the Danube might have occurred around 3 July at Visegrád and Buda. There was a smaller summer flash-flood in 1879 as well. This flood is interesting because it helps demonstrate how devastating a summer flood can be. This flood caused the inundation of more than 12,500 acres of agricultural land around the town of Titel (Titel, Serbia) despite the fact that by that time several major flood prevention works had been carried out. This shows that a flood in 1316 could have caused serious damage in the summertime (probably before the harvest). Given a rather cold spring, the beginning of the harvest would have taken place after the arrival of the flood in 1316, which would have had serious negative consequences across the Carpathian Basin.

3.1.2. The climatic conditions of the Szepesség and its possible connections to other territories

Of all the available data from the Carpathian Basin the most concrete data referring to an environmental crisis and a famine is the data found in the chronicle of Caspar Hain. In most cases his chronicle refers to the Szepesség and the Upper Hungarian territories (Slovakia). Although when mentioning the famine of 1312 he did not specify where the famine took place it is important to discuss the region which was the focus of his work. In this section I will investigate the main characteristics of the climate of this region and which

[225] On the history of the flood regulation of the Danube: Alfréd Zawadowski, *Magyarország vizeinek*, 154–171.
[226] For the data see the website of the VITUKI Országos Vízjelző Szolgálat (VITUKI: National Water-level Indication Service): http://www.hydroinfo.hu/Html/hidinfo/akt_eves_tb.html (last accessed: 12 January, 2010).

territories correlate most strongly to this region. It is also essential to discuss what the most important cultivated plants of the region were and what kinds of climatic situations could have resulted in serious famine.

The climate of the Szepesség is significantly wetter and colder than the average for other territories in the Carpathian Basin.[227] It can be characterized by the precipitation maximum in the summer (38% of precipitation falls in these three months).[228] The highest average mean temperature in the twentieth century was measured in Szepesolaszi (Spišské Vlachy, Slovakia), 6.7°C, which is 4°C below the average for the central part of the Basin.[229] The prevailing wind directions are north and northwest, which means that the climate of this region displays strong correlations with southern Polish territories, which is also verified by Early Modern instrument measurements.[230] The average temperature changes based on the altitude of the different parts of the Szepesség (from 350 to 700 meters above sea-level), while the relative humidity is high; the average being around 80%.

The cultivated plants grown in such climatic conditions nowadays are rye, oats, and potatoes. Rye and oat were already cultivated in the fourteenth century; rye is not especially sensitive to higher precipitation in the growing season.[231] Based on English parallels, the amount of wheat grown displayed more extreme fluctuation in the mid-1310s than rye.[232] The plants which may have been present in the region of the Szepesség in the Late Middle Ages were not very sensitive to precipitation anomalies raising important questions concerning possible reasons of the famine in the region.[233] If it is not precipitation-related there could be several other explanations, such as a military campaign (see below), a locust invasion, fungus diseases and so on, but given the lack of sources the most probable explanation is still the increase in precipitation and the cold summers, which was – at the time of the famine in the

[227] Antal Réthly and Nándor Bacsó, *Időjárás-éghajlat és Magyarország éghajlata* [Weather-climate and the climate of Hungary] (Budapest: Magyar Meteorológiai Társaság, 1938), 293–295.
[228] Réthly–Bacsó, *Időjárás-éghajlat*, 294.
[229] Martin Homza and Stanisław A. Sroka, ed., *Historia Scepusii Vol. 1.* (Bratislava: Katedra slovenských dejín, 2009), 54–55.
[230] Rudolf Brázdil, Andrea Kiss, Jürg Luterbacher and Hubert Valášek, "Weather Patterns in Eastern Slovakia 1717–1730, Based on Records from the Bresslau Meteorological Network," *International Journal of Climatology* 28, No. 12 (2008): 1645.
[231] László Aujeszky, Dénes Berényi and Béla Béll, *Mezőgazdasági meteorológia* [Agricultural meteorology] (Budapest: Akadémiai Kiadó, 1951), 446–451.
[232] Emmanuel Le Roy Ladurie, *Histoire humaine*, 39.
[233] Both plants are attested throughout the Middle Ages: Ferenc Gyulai, *Archaeobotanika. A kultúrnövények története a Kárpát-medencében a régészeti-növénytani vizsgálatok alapján* [Archaeobotany. The history of cultivated plants in the Carpathian Basin based on bioarchaeological investigations] (Budapest: Jószöveg Műhely Kiadó, 2001), 170–179.

Szepesség – a reoccurring phenomenon in the Polish territories in the middle of the 1310s.[234] The existence of a serious famine might indicate that there was food-scarcity in the Carpathian Basin in general although two other factors must be considered. First, the climatic conditions of the Szepesség are fundamentally different from other parts – especially the central basin – of the Carpathian Basin and, second, as a consequence, the cultivated plants must have been different from what can be attested elsewhere in most parts of medieval Hungary.

4. Charters and climate

As indicated above, Western European climatic reconstruction using historical data does not integrate all possible written evidence. The reconstructions especially tend to compile data only from narrative sources. In recent decades there has been an increasing amount of research using economic sources, playing an increasingly important role in late medieval and Early Modern climate reconstructions.[235] However, charters are underrepresented in the scholarship although, as demonstrated in the case of the environmental crisis of the 1310s, they can be utilized very nicely to understand weather anomalies. In this chapter my aim is to present the idea that charters may be used to indicate more than short-term weather events; perhaps even the basic characteristics of weather may be understood by researching charters and the issuing of charters over long periods.

The issuing of charters went through fundamental changes at the beginning of the fourteenth century. The number of surviving charters rapidly increased after the new reigning family of the Hungarian Kingdom, the Angevins, arrived from Western Europe where the use of written records was much more widespread as early as the tenth and eleventh centuries. This led to essential changes in the forms and types of charters.[236] The chancery started to function more regularly and the issuing of charters at places of authentication also grew from

[234] Annals are informing on serious floods in Poland in 1312: "Annalium Polonorum," in *Monumenta Poloniae Historica* Tom. III., ed. August Bielowski (Warszawa: Państwowe Wydawn. Naukowe, 1961), 171. *"Wisla maxime inundavit"* and "Annales Cisterciensium in Heinrichow," see footnote 123.
[235] Petr Dobrovolný et al., "Temperature Reconstructions," and an example of new type of economic (log books) evidence can be used to reconstruct climate of a certain period: Lotta Leijonhufvud, Rob Wilson, Anders Moberg, Johan Söderberg, Dag Retsö and Ulrica Söderlind, "Five Centuries of Stockholm Winter/Spring Temperatures Reconstructed from Documentary Evidence and Instrumental Observations," *Climatic Change* (in press).
[236] Imre Szentpétery, *Magyar oklevéltan*, 152–154.

year to year.[237] Royal charters underwent certain changes; some were more common in the Árpád Period and became rare in the Angevin Period, such as the *litterae annales*. Some types, however, like *litterae armales* were issued regularly from the beginning of the fourteenth century.[238] Apart from the royal charters, the issuing at *loci credibili* became increasingly important. Among the charters issued by these institutions a considerable number can be classified as perambulation charters (*reambulatio*) which, although present from the beginning of the use of written record in the Hungarian Kingdom, became one of the most common types of document in the Late Middle Ages.[239] Apart from that, the process of placing in possesion (*statutoriae* and the *restatutoriae*) and estate division (*divisionales*) a are interesting from the point of view of environmental historical research as they were also strongly connected to methodical walks around individual estates.[240] The number of charters referring to perambulation grew more rapidly than the issue of royal charters. During the first half of the Middle Ages around of 8% of the total number of charters can be categorized as perambulation charters, which creates a solid basis for scholarship.[241]

The charters from the period 1315–1317 have already been investigated by Richárd Szántó, but he limited his investigation to the sources which contained concrete references to an environmental crisis or its human impact.[242] In my opinion, perambulation charters can still contain important information on the climatic and environmental conditions of a certain period. Here I aim to analyze the temporal and spatial distribution of the perambulation charters in the period 1301–1330. According to the regesta collection of the *Anjou-kori oklevéltár* (Angevin cartulary), around 10,300 charters have survived from this period of the

[237] Imre Szentpétery, *Magyar oklevéltan*, 161–162. On the activity of the places of authentication (*loci credibili*) see: István Balló, "A hiteleshelyek néhány kérdése hazánk okleveles gyakorlatában (XIII–XIV. század)," [Some questions of places of authentication in Hungarian diplomatics (13th–14th centuries)] *Turul* 67, No. 4 (1994): 117–123, and on the case of Pannonhalma: G. Dreska, "A pannonhalmi konvent hiteleshelyi tevékenysége 1321–1500," [The performance of the credible place of the convent of Pannonhalma] (PhD diss., Eötvös Loránd Tudományegyetem, 2008).

[238] Imre Szentpétery, *Magyar oklevéltan*, 204–205.

[239] See one of the earliest example of the perambulations in the foundation charter of the Benedictine abbey of Tihany from 1055: István Hoffmann, *A tihanyi alapítólevél mint helynévtörténeti forrás* [The foundation charter of Tihany as a source of placename-history] (Debrecen, Dissertation for the Hungarian Academy of Sciences, 2007), and the localization of the placenames in the charter of Garamszentbenedek (Hronský Beňadik, Slovakia) from 1075: József Laszlovszky, "*Dedi etiam terram, que adiacet circa aquam, que vocatur Tiza* (Adatok az 1075-ös garamszentbenedeki oklevél helyneveinek lokalizálásához)," [*Dedi etiam terram, que adiacet circa aquam, que vocatur Tiza* Data to the localization of the placenames in the charter of Garamszentbenedek from 1075] *Zounuk* l, No. 1 (1986): 9–24.

[240] Imre Szentpétery, *Magyar oklevéltan*, 206.

[241] Imre Szentpétery, *Magyar oklevéltan*, 213, Péter Szabó, "Medieval Trees and Modern Ecology: How to Handle Written Sources," *Medium Aevum Quotidianum* 46, No. 1 (2002): 7–25, especially: 12–17, and Péter Szabó, *Woodland and Forests in Medieval Hungary* (Oxford: Archaeopress, 2005), 29–31.

[242] Richárd Szántó, "Az 1315–17. évi éhínség," 138–142.

medieval Hungarian Kingdom.[243] Meanwhile it should be taken into consideration that the number of surviving charters may display extreme fluctuation owing to several different factors that affected the number of charters issued in a certain period. Amongst the most important factors was a change in the ruler and especially a change in the ruling dynasty. Towns, the nobility, and the ecclesiastical institutions all tried to strengthen their privileges by renewing the documents referring to them. Similarly to the change of the person of the king, the change of the palatine or new bailiff in a county could also be influential. The behavior of the oligarchs in certain parts of the country also influenced the issuing of charters because the nobles in the territories under the authority of the oligarchs had to ensure their lands. The issuing of charters also depended on the timing of agricultural work such as planting and the harvest. Among other factors which may be less connected to seasons or particular months, the environmental factors which may have had an important impact on the issuing of charters will be the focus here.

Although the general tendency was a continuous growth in the number of charters (see: *Fig* 10), there are years when the low number (as in the year 1316) cannot be explained by the political context or any other reason. In the first decade of the fourteenth century the low number of charters could be easily explained by the troubled political situation. The continuous military campaigns and the questionable royal authority made it less necessary to insure the estates of noble families. Even if a lawsuit was undertaken there were several cases when one of the involved persons did not appear during testimony or did not bring the needed documents to the attestation because of the dangers on the roads.[244] This situation seems to have changed after the 1310s, when the Hungarian nobility tried to strengthen their position, which is reflected in the written records of the period. Although there were several military campaigns in Hungarian Kingdom, the person of the king became more important and familial privileges had to be renewed. There are years when one finds mention of several military campaigns and while the king was on these campaigns his chancery issued charters throughout the country. Apart from the 1310s a similar wave of charter transcription can be demonstrated for the mid-1380s, when the reigning branch of the Angevin dynasty died out and the nobility wanted to preserve their privileges and estates in the new situation.

[243] I will use this collection in my analysis of the monthly distribution of perambulation processes.
[244] Amongst others: *Anjou-kori oklevéltár*, I. 171., 193., 331., 691., 737., II. 51., 64, 85., 343.

4.1. Perambulation charters as indicators of weather and climate

The perambulation is a unique type of source that can be found everywhere where medieval private ownership existed. By their very nature perambulations are strongly connected to natural circumstances and to the lands. For this reason, perambulation charters can be used in a number of different kinds of historical investigations. Environmental historians have made use of these data and so have ethnographers.[245] The most important characteristics of the perambulation charters of the Hungarian Kingdom is that they are among the few kinds of sources which can be used for quantitative analysis.[246] Although many of the perambulation charters date to the last 100 years of the Middle Ages, as discussed above there are more than 800 from the period of my investigation (1301–1330) or around 8% of the total charters from the period. A case study of the charters of the bishopric of Veszprém showed that approximately 6% of the documents contain perambulations. The author projects this data to the total number of such documents in the Middle Ages and concludes that at least 11,500 such charters must have existed, which may even be an underestimation in light of the number of charters in the Angevin cartulary.[247]

Perambulations are connected to all estate donations or any kind of dispute connected to the ownership of a certain piece of land. During perambulations the persons involved in the issue appeared at the estate and walked around its borders in the presence of a credible person. They identified the most important boundary markers, including boundary stones, trees, ditches, and so on.[248] A notary recorded these features and then, at the end of the procedure, based on his notes, prepared a charter which was issued on the spot, in which all the borders were identified. The process itself was heavily influenced by the actual weather conditions. The feasibility of a perambulation depended greatly on the weather until techniques were introduced for constructing a passable road network in Modern Times. The perambulation

[245] See the ethnographic approach in: Lajos Takács, *Határjelek, határjárás a feudális kor végén Magyarországon* [Boundary signs, perambulations at the end of the feudal age in Hungary] (Budapest: Akadémiai Kiadó, 1987), the ecological historical approach: Péter Szabó, *Woodland and Forests*, and the usage of perambulation charters in historical geographical and placename studies: Andea Kiss, "Study on the Historical Geography of the First Extent Perambulation Sketch from the Carpathian Basin," *Zbornik Odsjeka za povijesne znanosti ZPDZ HAZU* 19, No. 1 (2002): 127–41.

[246] Péter Szabó, "Medieval Trees," 11.

[247] Péter Szabó, "Medieval Trees," 15–16.

[248] On the types of boundary signs, see: Péter Szabó, "Ancient Woodland Boundaries in Europe," *Journal of Historical Geography* (in press), Péter Havassy, " Határjárások és határjelek a középkori Békés vármegyében," [Perambulations and boundary marks in medieval Békés county] *A Békés Megyei Múzeumok Közleményei* 23 (2002): 459–480, and Péter Havassy, "Az Alföld középkori határjeleinek kérdéséhez," [To the question of the medieval boundary marks of the Great Hungarian Plain] in *Tanulmányok Farkas József tiszteletére* (Studia Szatmariensia 1) [Studies in honor of József Farkas], ed. László Cservenyák (Mátészalka: Szatmári Múzeum, 2001), 39–45.

process is particularly important as it was usually connected to one single aspect of the weather: precipitation. Investigations have shown that the period of the activity of *credibilitas loci* did not influence these kinds of legal processes and the scribes were made to work in the worst possible conditions if the land was at all accessible.[249] Perambulation charters can be used for investigating the periods that are the most suitable for for studying these processes, which may help to understand some aspects of climate in particular seasons and months although they primarily reflect long-term trends. It is likely that the weather and environmental conditions represented recurring problems during the perambulation procedure. T The impassibility of the land prevented perambulations from being carried out on several occasions. Not only could rain cause problems, but in rare cases mild winters were an obstacle to carrying out perambulations because of mud.[250]

I confronted several methodological problems while investigating the temporal distribution of perambulations in the first third of the fourteenth century. The first was that in the first half of the fourteenth century charters rarely contain information on the exact day of the procedure it records. In most cases, only the day the charter was issued is found at the end of the charter and there are only a few cases when the *actum* itself is noted. This tendency seems to change after the 1320s and by the 1330s in most cases both the *actum* and the *datum* were both included in the text of the charters.[251] In the cases where the date of the *actum* is included there is no problem with identifying the specific day of the perambulation process, but when the date the charter was issued is all the data available it makes it uncertain in which month the process took place. In some cases there may have been several months between the *actum* and the *datum*. Although there are extreme examples, the general tendency was that the charter was issued relatively close to the perambulation process. Because of the fact that in most cases the perambulation process had taken place a maximum of three to four days before the charter was written down, I made a methodological decision that if the document was issued in the first three days of a month (and the *actum* was not indicated) I considered the process to have been carried out the preceding month.

The distribution of perambulations in a year may reflect the weather in a certain period. Weather and the climate have two determining factors: temperature and precipitation.

[249] Enikő Csukovits, "A középkori írástudók 'munkaideje'," [The working hours of medieval literates] *Levéltári Közlemények* 63, No.1–2 (1992): 3–14.
[250] For example: *Anjou-kori oklevéltár*, XII. 255–256/482. (original is lost, transcribed: Df 282744.), *Anjou-kori oklevéltár*, XIII. 390–391/658. (original: Dl 87005.).
[251] On the problem of *datum* and *actum* in the later Angevin Period in Hungary: Szilárd Süttő, "*Datum* és *actum* késő Anjou-kori uralkodói okleveleinkben," [*Datum* and *actum* in Hungarian royal documents of the Late Angevin Period] *Studia Miskolcinensia* 3 (1992): 84–92.

The temperature may have affected the holding of a perambulation process, especially in the Carpathians and the hilly regions within the Basin. In these territories the mean temperature in the winter season frequently falls below -5°C. However, this does not mean that legal processes were not carried out in these months since there were perambulations in December or January when the ground would befrozen hard.[252] Despite the fact that legal processes took place each month, examination of these charters nevertheless reveals a marked seasonality. In the period 1301 to 1330 most of the perambulations were held in three consecutive months, from April to June; in these three peak months they number above eighty (see: *Fig*11 to 41). In the winter the number of total perambulations fell to around forty in each month. This could mean that the winter season caused difficulties in carrying out such processes. Typically, it was not the low temperature which affected the perambulations, but other situations such as thick snow cover. Snow made it difficult to walk around the boundaries and, even more important, some of the boundary markers would not have been visible because of the snow. The infrastructure of the period, especially in the Carpathian Basin, might have made it problematic to travel to some destinations, which would also have made it difficult to carry out legal processes. There were weather circumstances, however, which helped carry out perambulations to be carried out even in wintertime. For example, a charter from 1362 refers to the postponement of a perambulation process.[253] The reason, according to the charter, is that the weather in the region was too mild. This is a marshy area belonging to the water complex of Lake Fertő and in this area the estate could have been reached was if there was a low water level or in wintertime when the lake or marsh froze over. In wetland territories it was not rare that these processes were carried out in winter or in some cases in dry summers.

The peak of frequency of perambulations, as noted above, was in late spring and early summer, which may be interpreted in different ways, but there has been no comprehensive study on the reasons for this peak. Presumably it can be attributed to bad weather conditions in the winter season, after which the boundary disputes could have been resolved. It may also be important that the general infrastructure was much better in May or June. Although precipitation in the Carpathian Basin is relatively high during late spring and summer it might have caused less problems in wetland territories than autumn rainfall, when there is less

[252] Enikő Csukovits, "A középkori írástudók," 3–14.
[253] Gábor Dreska, ed.., *A pannonhalmi konvent hiteleshelyi működésének oklevéltára. I. (1244–1398)* [Archives of the performance of the convent of Pannonhalma I. (1244–1389)] (Győr: Győri Egyházmegyei Levéltár, 2007), 121–122 (No 114).

sunlight than in the summer.[254] After a peak in early summer, the number of perambulations significantly decreased with the number of perambulations dropping to close to the numbers in winter. There are different possible explanations for this drop in the number of these processes, but perhaps the most convincing is that legal issues which arose during the winter and the spring were resolved then while during the harvest legal issues were limited to the most important and necessary ones. After the harvest and summer work the number of legal processes from the middle of August did not decrease and remained steady: around 50-60 perambulations per month. It is worth noting that in Hungarian tradition the official day for royal lawsuits was 20 August, which may also be connected to the end of the harvest.[255] The relatively lower number in September might be connected with a new period of agricultural work (such as the grape harvest). Although the fluctuation in the numbers of perambulations could have several causes, this rather large difference between the number of such lawsuits in the winter and the summer is also likely to be connected to the weather conditions in the different seasons.

It is worth studying the perambulation processes carried out in the mid-1310s although there is a methodological problem; the low number of cases does not allow me to draw general conclusions (see: *Fig* 42). For 1315, the total number of surviving perambulation charters is only twenty-two and four of these do not contain the day or the month of the process itself so they could not be used in this investigation. The distribution of the eighteen remaining charters is much more problematic than the distribution of the overall number of charters of the thirty years investigated. Due to the low numbers, the survival of even one or two documents can modify conclusion concerning the weather of these particular years. It is still worthwhile, however, to give a short overview of the charters from these years since a strong positive anomaly might contradict the existence of bad weather conditions in certain parts of the year, especially in the cases of perambulation charters that can be connected to riverbanks where a flood could have occurred. The above discussed *Chronicon Aulae Regiae* tells of serious flood events in the summer of 1315 caused by continuous rainfall. In this period, two perambulation procedures were carried out or at least there were two which have survived in written form. The first dates to 25 July and the other to 2 August. The first, issued in Turóc (Turiec, Slovakia) on an estate called Szentmárton, mentions a muddy stream. This does not mean that the weather was wet, but means that there was water in a fresh-water body which did not have a name at that time, meaning that the weather might not have been

[254] Lajos Rácz, *Magyarország klímatörténete*, 68–69.
[255] It appears in the Golden Bull of Andrew II in 1222 which puts down an already existing tradition in writing.

particularly dry.[256] The other charter was issued in the first days of August, but it is more likely that the procedure itself took place at least a few days earlier. The charter was issued in front of the Holy Trinity monastery of Hévíz, although the estate, which was being sold by a certain Miklós, was in Fejér County close to the Danube, at least a three-day distance from Hévíz. The charter does not refer to any kind of specific circumstances such as a problem of swampiness or flooding dispite of its proximity to the Danube.[257]

In 1316, the distribution of perambulations may also be relevant, as in Central Europe serious floods related to high precipitation occurred over widespread territories. It is remarkable, however, that in the Hungarian Kingdom three perambulations were conducted in each month of April, May, and June and there is no sign of a problem in a period which saw the most serious environmental crisis in large parts of the macro-region of the Carpathian Basin in the fourteenth century. Some of these perambulation processes were carried out on estates which lay quite close to riverbanks, such as an estate in the Upper Hungarian territories where one of the boundaries mentioned was the confluence of the Iztebna stream and the Árva River, which may have been a marshy area at the time of flooding.[258] No perambulation charter has survived from July 1316, which is the period when supposedly the flood of the Danube reached the countryside. Amongst other reasons for this, such as the harvest or a military campaign, one of the possible explanations may have been the impact of the environmental crisis in the Carpathian Basin, but this is an extremely doubtful conclusion. Only one perambulation fell in August and September, which is relatively low compared to the general trends for 1301-1330. Then, in October, there were again three perambulations, as in June.

In 1317, the number of perambulations again seems low, with only sixteen perambulation charters preserved. It may be noteworthy that the winter of this year, as discussed above, was especially long and severe and there is no charter mentioning a perambulation taking place in the first two months of the year. However there are two charters referring to the Upper Hungarian territories from March. The number of charters is relatively high – four – in May and this could mean that the weather became more favorable for such processes. This suggestion is strengthened by a perambulation process which is dated to 4 May. It is not particularly interesting because of the perambulation itself, but because of a charter dating to 1 March that contains a command from King Charles I to the monastery of

[256] Df 259256.
[257] Dl 86933.
[258] Dl 40361.

Csanád (Cenad, Romania) to conduct perambulations.[259] The weather might not have been the only cause for delaying the perambulation, but internal struggles can probably be ruled out as a factor as the territory was not very much affected in that period. The region of Temes County lay at the center of Charles I's kingdom at that time. There might be other explanations for why it took two months to carry out the perambulation, but one of them could well be the weather and local environmental conditions.

The weather and weather-related events certainly affected legal processes all through the Middle Ages, which could best be illustrated in the *Tripartitum* of Stephen Werbőczy, which mentions floods as a factor which might cause the postponement of a legal process: *unde rationabilis excusatio est… aquarum vehemens indundatio*.[260] Although the weather must have affected the distribution of perambulations within a given year it is impossible to estimate the impact of weather on such processes as the number of charters is not sufficient for deeper quantitative analysis. Perhaps in later periods, such as the 1340s or in the Sigismund Period, this method could provide more results. From the sixteenth century and even more from the seventeenth century there are more-or-less continuous climate reconstructions which provide great opportunities for comparing the distribution of perambulation processes year by year and parallelling the result with actual weather conditions.[261]

5. The political situation in the Hungarian Kingdom in the 1310s and its possible role an environmental crisis

It is relevant to understand the exact political situation in the Hungarian Kingdom in the period which is in the focus of this thesis. The military campaigns in a certain area would have had a great impact on the people living there, as the passage of an army could have caused crop damage, especially around the time of the harvest. In the years of my focus these campaigns were frequent. An interesting royal charter was issued on 19 May, 1317 in which the king gave estates to János, son of Peter Popdi, as a compensation for the damage caused by the royal armies at his other estates.[262] Although not documented from this decade, there are cases at other times when the lack of food in a certain region is connected to the

[259] The Dl 1889 contains the previous charters referring to this issue.
[260] "Werbőczy István Hármaskönyve," [The *Tripartitum* of István Werbőczy] in *Magyar törtvénytár* [Hungarian Laws], ed. Sándor Kolozsvári and Kelemen Óvári (Budapest: Frankiln, 1897), II. 59. 2.
[261] See the climate reconstructions: Lajos Rácz, *Magyarország klímatörténete*, and Petr Dobrovolný et al., "Temperature reconstructions,".
[262] Imre Nagy and Gyula Tasnádi Nagy, ed., *Anjoukori Okmánytár. Codex diplomaticus Hungaricus Andegavensis* I. [Angevin cartulary] (Budapest: Magyar Tudományos Akadémia, 1878–1920), 424–425.

continuous military campaigns, which might have been the case in the 1310s as well. [263] Although in these military expeditions the number of soldiers was significantly less than in the campaigns in Early Modern Times, they could still have had serious consequences in smaller areas, especially if they passed through during crucial times in the agricultural cycle: in late spring, early summer, or at harvest-time.

Although unseasonable weather conditions were not completely absent from the Carpathian Basin, there is only one case when it can be demonstrated conclusively that it was the weather or the impact of weather which kept an army from setting off on an expedition. This is particularly interesting because in this period the flood prevention system was sporadic and in most cases was restricted to the time of inundations. In a more humid spring or summer, major areas could have become impassable owing to standing water, especially in territories through which expeditions regularly traveled, such as the area along the Danube, the Tisza, and the Drava. Higher precipitation could have made smaller areas inaccessible for weeks or months in that period of the Middle Ages.[264] Even in Western Europe, where the water management system of the period may have been somewhat more developed,[265] there were cases when continuous rainfall stopped military campaigns or at least contributed to their lack of success.

In the investigation of the climate history of a certain period one cannot void understanding political processes. In Early Modern Times most famines were connected to the co-occurrence of environmental crises and political problems, but in the Middle Ages, in many cases, just one of these factors might have caused serious situations in certain regions. The political situation in this period is particularly important and creates a different context for understanding the possible effects of the weather events in the decade. It is important in this case whether it was oligarchs or the king who ruled in a certain territory; the type of political control may have influenced the taxation of the peasants or may have affected commercial opportunities. In some cases, the markets, which were indispensable elements of

[263] A charter from 1321: *Anjou-kori oklevéltár*, VI. 145/387 (Original: Df 209129. Edited: Imre Nagy, ed., *Hazai okmánytár. Codex diplomaticus patrius* IV. [Hungarian cartulary] (Budapest: Franklin, 1865–1891), 130–131.
[264] For an analogy, see: Andrea Kiss et al., "A Maros árvize,".
[265] On the water-management system of Central and Western Europe, see: Richard C. Hoffmann, "Economic Development and Aquatic Ecosystems in Medieval Europe," *The American Historical Review* 101, No. 3 (1996): 631–669 and its references, and Hungarian researches: Károly Takács, "Árpád-kori csatornarendszerek kutatása a Rábaközben és a Kárpát-medence egyéb területein I. rész" [The channel-systems of the Rábaköz and other territories of the Carpathian Basin] *Korall* 1 (2000): 27–62; Károly Takács, "Árpád-kori csatornarendszerek kutatása a Rábaközben és a Kárpát-medence egyéb területein II. rész," [The channel-systems of the Rábaköz and other territories of the Carpathian Basin] *Korall* 3–4 (2001): 297–314, Károly Takács: "Árpád-kori csatornarendszerek kutatásáról," [On research of Árpád Period water channel systems], in Ágnes R. Várkonyi, ed., *Táj és történelem*, 78–106.

the economic system of thirteenth- and fourteenth-century Hungary, did not even function, which in the case of a food shortage might have had serious consequences for the populations of the hilly regions, towns of the Upper Hungarian territories or elsewhere.

After the end of the Árpád dynasty, the Hungarian throne stood empty. The following period was one of the most anarchic in the history of the medieval Hungarian Kingdom. The oligarchs had great powers and several dynasties tried to take the Hungarian throne. The consolidation of the rule of Charles Robert was a long process of which his third coronation, on 27 August, 1310, was just the starting point. However, this third, and now legal, coronation did not mean that his position was strengthened against the oligarchs (see: *Fig* 43). The following period, although it raises many questions, was not studied much until the 1960s. Before that, most studies focused on the role of the third coronation and the battle of Rozgony (Rozhanovce, Slovakia) (on 5 July, 1312) in the consolidation of the position of Charles I. The political situation in the period from 1310 to 1323 (which is the date most accept as the end of internal struggles) only became of interest from the second half of the 1960s, when Gyula Kristó started to investigate the political history of the early Angevin Period in Hungary.[266] Pál Engel, the other prominent historian of late medieval Hungary, studied the reign of Charles I in the 1980s and wrote one of the most important articles on the political history of the 1310s in which he identified this period as "a third state foundation."[267] This study still represents the most important framework for the political history of the Hungarian Kingdom during the years of the decision, although at some points Engel's results have been criticized by Gyula Kristó and some minor remarks added by Ferenc Piti.[268]

The charters of the period refer to a very confused political situation with despotic measures and violence against the population. So does a charter from 1311, issued by Legate Gentilis, who, on the one hand, notes the despotism of Máté Csák and, on the other hand,

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[266] Gyula Kristó, *Csák Máté tartományúri hatalma* [Territorial reign of Máté Csák] (Budapest: Akadémiai Kiadó, 1973), Gyula Kristó, *A rozgonyi csata* [The battle of Rozgony] (Budapest: Akadémiai Kiadó, 1978), Gyula Kristó, *A feudális széttagolódás Magyarországon* [The feudal anarchy in Hungary] (Budapest: Akadémiai Kiadó, 1979), Gyula Kristó, *Csák Máté* [Máté Csák] (Budapest: Gondolat, 1986), and Gyula Kristó, *Az Anjou-kor háborúi* [The wars of the Angevin Period] (Budapest: Zrínyi Kiadó, 1988)

[267] Pál Engel, "Az ország újraegyesítése," 320.

[268] Gyula Kristó, "I. Károly király harcai a tartományurak ellen (1310–1323)," [The battles of King Charles I against the oligarchs (1310–1323)] *Századok* 137, No. 2 (2003): 297–347 and Ferenc Piti, "Szabolcs megye Anjou-kori archontológiájához," [To the archontology of Szabolcs county in the Angevin Period] in *Középkortörténeti tanulmányok. A III. Medievisztikai Phd-konferencia előadásai* [Studies in medieval history. The papers of the 3rd PhD conference of medievalists], ed. Boglárka Weisz (Szeged: Szegedi Középkorász Műhely), 113–124, and Ferenc Piti, "Egy Károly Róbert-kori oklevél keltezése és a dévai csata időpontja," [The dating of an charter from the regin of Charles I and the date of the battle of Deva], in *Studia professoris – professor studiorum. Tanulmányok Érszegi Géza hatvanadik születésnapjára* [*Studia professoris – professor studiorum*. Studies in honor of the 60th birthday of Géza Érszegi], ed. Tibor Almási, István Draskóczy and Éva Jancsó (Budapest: Magyar Országos Levéltár, 2005): 281–284.

announces a papal *interdictum* against the oligarch.[269] The first major victory of Charles I against an oligarch was at the battle of Rozgony. [270] It was not only important because of the fact that he defeated the most powerful oligarch, Máté Csák, as his dominance in the Upper Hungarian territories did not end until his death in 1321, but it was essential because he defeated the Amádé sons, whose territories were regained by the king after the battle. Hain's chronicle mentions this battle and a famine in this very region around 1312. He does not make connection between the two events but we can not preclude that the two events were connected.

In the next year Charles again led a military campaign to Upper Hungary, during which he succeeded in re-capturing the town of Nagyszombat (Trnava, Slovakia). Although this campaign seriously affected Csák's territories, a charter issued by Gentilis in the very same year mentions the great devastation caused by Csák in some dioceses, including the archbishopric of Esztergom.[271] The political history of the next years is rather unclear. In 1314, King Charles went to Vienna in July to renew his alliance with Frederic the Fair; according to Engel, King Charles met John the Blind, king of Bohemia, during the same visit. This was particularly important because in the following year the Bohemian and the Hungarian army attacked the Csák territory together and supposedly during this meeting the two kings made their plans to destroy the territory of the oligarch. The two armies probably attacked at the same time, some time in late spring or early summer of 1315.

Seemingly, 1314 was one of the most difficult years during the whole reign of Charles I. He issued only a few charters and in a short period of time changed his whole noble entourage. Probably there was only one major royal military campaign in this year, in November, against Csák in the region of Árva (Orava, Slovakia). The following years seem to have been the most decisive for strengthening the position of the king. More military campaigns were led than at any time before. In 1315, there were small battles around the fortress of Siklós (Sotuher Transdanubia) when the Kőszegi family tried to seize the estates of László Kán, the voivode of Transylvania. In the meantime, several major royal military actions took place in the country. The first of them led to the estates of the Borsa family and touched the Tisza valley. The specific battle site is unknown, but King Charles issued a charter in a certain *Kureu*. This could be either identified as Tokaj, as György Györffy did, or it could also refer to Nagykörű, which seems more likely as the charter refers to other

[269] Vincent Sedlák, ed., *Regesta diplomatica nec non epistolaria Slovaciae* (Bratislava: Sumptibus Academiae Scientiarum Slovacae, 1980) I. 380–383.
[270] On the battle, see: Gyula Kristó, *A rozgonyi*.
[271] Georgii Fejér, ed., *Codex diplomaticus*, VIII. 1. 504–506.

geographical names in the vicinity of this village.[272] The campaign took place at a time when great storms and floods are mentioned in sources from Western Europe and the Czech territories, but it seems that the Tisza Valley, or at least part of it, was readily passable in this period. At the same time, a successful military campaign was carried out by Tamás Jánki, the count of Bereg, who recovered Ugocsa County for the king from the Borsas. As a result of these two considerable attacks against the Borsa territories, the family had to swear an oath to the king as early as the first quarter of the year. The campaign did not end when the Borsa family was successfully made to concede. The king moved on against László Kán, again in the Tisza Valley. He reached Becse (Bečej, Serbia) while his allies attacked Kán from the vicinity of Temesvár, Charles I's temporal center. The campaign touched Hátszeg (Haţeg, Romania), the fortress of Déva (Deva, Romania), and Szeged (Southeastern Hungary). According to Engel, the decisive battle between the king and Kán's army was somewhere around Déva in the Maros valley.[273] However, the date of the battle of Déva and, also the whole campaign, has been questioned in recent years after Ferenc Piti studied an undated charter. He argues that the battle took place at least a year later, in 1316, which could create a totally different chronology for the events of the mid-1310s.[274] Charles distributed the newly gained territories as far as the River Tisza to his allies, and apart from their original estates, the Kán family lost all their territory. At the end of the military campaign the king designated Miklós Meggyes of the Pok gens as the voivode of Transylvania. According to a royal charter issued in Lippa (Lipova, Romania) on 1 August, 1315, Miklós immediately started a campaign in the territory of his new voivodship to provide for the king's rule in Transylvania.[275] This military campaign of the two Central European kings, Charles and John the Blind, against the Csák territories started at the same time. According to the Bohemian chronicles, the campaign of the John started on 21 May, while Charles I issued a charter in Visegrád on 24 June, 1315, which leaves no doubt that the Hungarian king had set off for the campaign as well.[276] However, both armies had difficulties during their advance towards the inner parts of Upper Hungary. The Bohemian army had to stop at the castle of Veseli (Veselí

[272] Vincent Sedlák, ed., *Regesta diplomatica* II. 23–24, and on the question of Kureu: György Györffy, *Az Árpád-kori*, III. 110, Pál Engel, "Az ország újraegyesítése," 363, and Gyula Kristó, "I. Károly harcai," 317.
[273] Gyula Kristó, "Erdély 1315-ben," [Transylvania in 1315] in *Emlékkönyv Jakó Zsigmond születésének nyolcvanadik évfordulójára*, [Studies in honor of the 80th birthday of Zsigmond Jakó], ed. András Kovács, Gábor Sipos and Sándor Tonk (Kolozsvár: Erdélyi Múzeum-Egyesület, 1996), 341–342 and Pál Engel, "Az ország újraegyesítése," also puts the campaign to 1315. A different opinion is in: Béla Köpeczi, ed., *Erdély története* [The history of Transylvania] (Budapest: Akadémiai Kiadó, 1986), 321 and Gyula Kristó, "I. Károly harcai," 332 and 345 dates the battle of Deva to 1317.
[274] For Dl 97742 and its interpretation: Ferenc Piti, "A dévai csata," 281–284.
[275] Vincent Sedlák, ed., *Regesta diplomatica*, II. 42–43.
[276] Vincent Sedlák, ed., *Regesta diplomatica*, II. 36.

nad Moravou, Czech Republic) according to the detailed commentary of the chronicler of the military campaign.[277] In the meantime, King Charles I could not cross the Danube River, which he probably attempted soon after the above-mentioned charter was issued in Visegrád in late June. No evidence is attested that would explain the problem of crossing the river with the army, but one answer might be high water on the Danube. The bad weather conditions – high precipitation and in consequence of it floods – in Western and Central Europe at the beginning and mid-summer in 1315 could have affected the water-level of the Danube as well.[278] In the autumn of 1315 Charles I made an unsuccessful attempt to get back parts of the Transdanubian territories from the Kőszegi family; during this campaign the king's armies ravaged a great deal of Tolna County. In the following year Charles lead a much better planned military expedition against the Kőszegi estates. First, he demolished the castle of Somogyvár, and then occupied Tolna County, captured its fortresses, in the end taking Kőszeg as well.[279] This expansion played an outstandingly important role in Charles I's consolidation of power, as this was the first case when Charles I managed to occupy and entirely demolish the territory of an oligarch, pushing him to the periphery of the country. The strengthening of Charles' position is apparent, as in this case he had enough power to send a small army to the Drávántúl (Transdravia) region to disband the remaining parts of the Kőszegi family's allies.[280] It is worth mentioning that these seemingly extraordinarily successful campaigns took place in a period when, according to Austrian, Bohemian and other Western European data, there was continuous rainfall in most of Europe, including the Alps, which might have a serious affect on the Drava valley and its environs where these events took place. As mentioned above, in 1316, there is evidence for the flooding of the Mura as well (a tributary of the Drava), although the exact date is not mentioned in the *Anonymus Leobiensis Chronicon*. On other fronts the position of Charles was not good, particularly along the southern borders of the kingdom. Here, he had to face a new enemy, this time not an oligarch but a king, the Serbian monarch, Stefan Uroš II Milutin, who led an army against the Szerémség (Srijem, Croatia) in collaboration with Teodor Vejtechi, an oligarch in the southern Hungarian territories. [281] At the same time, – seeing the serious position of the king in the south – the Borsas managed to get back part of their power base and started to organize a major uprising against Charles I, which burst out in the winter of 1317. The royal campaign

[277] Gyula Kristó, *Az Anjou-kor*, 42–44.
[278] Gyula Kristó, *Csák Máté,* 189–191.
[279] Pál Engel, "Az ország újraegyesítése," 341.
[280] Gyula Kristó, *Csák tartományúri*, 206.
[281] Pál Engel, "Az ország újraegyesítése," 343.

against Uroš took place in the first months of 1317, at the same time as the uprising provoked by the Borsa family started. By that time Charles had the power – with his allies – to lead more than one major campaign simultaneously. The army of Charles crossed the Sava River in the winter of 1317, and after a long siege took the castle of Macsó (Valjevo, Serbia), a key fortress which was in the hands of Uroš. In late February the king returned to his seat at Temesvár.[282] By this time the allies of the king – led by the counts of Szepes and Sáros County – were already at war with Peter, son of Petenye, in the Upper Hungarian territories and captured the *oppidum* of Gönc and the castle of Regéc (both in Zemplén County, Hungary). The recaptured estates were granted to Philip Drugeth, of French origin, a member of a prominent new family in the Hungarian Kingdom. This was later one of the most important families in Hungary during Angevin rule. Máté Csák tried to intervene in the Upper Hungarian campaigns starting a military expedition during which he ravaged Szepsi (Moldava nad Bodvou, Slovakia), but after that the Drugeth family managed to stop the oligarch's army.[283]

Major uprisings took place in the area of the Kopasz Borsa territories along the left bank of the Tisza River. Mojs – who was defeated at the battle of Déva – Pál Gútkeled, and Beke Borsa joined the oligarch Kopasz Borsa. Although supposedly the battle was not amongst the biggest during the campaigns of the royal army, after the battle Dózsa of Debrecen sent the flags of the Gútkeled and Kopasz family to the king, along with nine heads of the participants in the uprising. Despite of the numerous sources referring to these events in historiography raised several questions concerning this event.[284] It is likely that the battle took place near Debrecen, but the date is much more questionable. It might have taken place some time in March or April, as a royal charter issued on 8 March, 1317, mentions the victory at Debrecen. [285] Explained by the donations of King Charles in early springtime, Engel puts the battle in the last days of March, which seems to be the most acceptable date.[286] By the end of the same year Dózsa and other allies of King Charles occupied the whole Borsa estate complex, while Charles himself led a military expedition against the most powerful oligarch, Máté Csák. This action seems to have been a success, as the power of the Csák family in the Upper Hungarian territories had been greatly weakened by an uprising of the lower nobility

[282] Pál Engel, "Az ország újraegyesítése," 343 and ap.
[283] Pál Engel, "Az ország újraegyesítése," 344.
[284] Gyula Kristó, *Csák tartományúri*, 205–206, Engel Pál, "Az ország újraegyesítése," 344. and ap.
[285] Vincent Sedlák, ed., *Regesta diplomatica*, II. 99.
[286] Pál Engel, "Az ország újraegyesítése," 344.

(*serviens regis*) in the territory he controlled.[287] Based on this uprising in the Csák territories, Kristó puts the royal campaign in 1316 as well, but also raises the question of the political history from 1316 to 1319. [288] Although the king had important allies – amongst them the German king, Frederick the Fair – he only had a small army during the campaign because he was at war in the Transylvanian territories and on the other bank of the River Drava at the same time. Despite the smaller number participants in the royal campaign, he was able to regain the castles of Visegrád and Komárom. In October 1317, Charles and the Csáks concluded an armistice which put an end to the ten-month-long continuous war in the Upper Hungarian territories.[289] In the same year there were minor campaigns, such as the one against the Amádés which marked the closing stage of the conflicts with this family. There were royal actions in Transylvania, as well. Here, soon after Voivode Miklós seized territory, he was defeated and pushed out of this region. In the winter of 1317, Miklós attempted to recapture Transylvania from the Kán family and Mojs, but the campaign was largely unsuccessful and the eastern part of the country remained in the hands of the oligarchs. The last major expedition was to the territory under the authority of the Kőszegi family. With the aid of Frederick, Charles constrained András Kőszegi to swear an oath to him. At the same time, Demeter Nekcsei got back some territories on the right bank of the Drava, although this territory remained politically unstable until the beginning of the 1320s.

The people in the Hungarian Kingdom in the 1310s, apart from the seemingly unfavorable weather conditions, had to face another problem: almost continuous military campaigns. During the wars to reunite the kingdom almost all parts of the country were touched by military expeditions, which might have caused serious damage to the fields or prevented the peasants from working them. No mention was made of problems connected to the weather during the military campaign except for the case in the Sava Valley in the winter of 1317. However, the environmental case is that during the years of the European-scale weather crisis, royal armies could march along the valleys of the major Hungarian rivers, which may indicate that there were no serious floods or high precipitation in these regions.

[287] Pál Engel, Gyula Kristó and András Kubinyi, *Magyarország története 1301–1526* [The history of Hungary 1301–1526] (Budapest: Osiris Kiadó, 2003), 340.
[288] Gyula Kristó, *Az Anjou-kor*, 45–46.
[289] Pál Engel, "Az ország újraegyesítése," 346.

6. Late medieval environmental changes on the southern Great Hungarian Plain – a case study

Apart from indicating the existence of short-term weather events and their impact in the Hungarian Kingdom it is also useful to study how long-term climatic processes can be traced in the later medieval period. As noted above, the shortage of narrative sources makes it impossible to reconstruct the climate of the Hungarian Kingdom. Although it plays an important role in understanding weather anomalies, long-term changes are hard to reconstruct based on charter data. Nonetheless, scholars have been able to reach some important conclusions.[290] In this chapter my aim is to discuss how long-term change of climate is reflected in another group of sources: historical maps. Here, I will analyze a narrower geographical region over a longer period of time. The focus is on the Great Hungarian Plain, as this area seems to have been more sensitive to climatic changes than the hilly regions or the mountain areas.

Apart from the few scientific methods discussed above which highlighted some patterns in the climate of late medieval Hungary, knowledge about the impact of possible climatic trends in this region of the Carpathian Basin is quite superficial. According to the paleobiological research and stalagmite record analysis, the climate became colder and wetter from the early fourteenth century. My aim is to discuss some general characteristics of the environment of the Great Hungarian Plain in a period when supposedly the precipitation was higher than in the preceding period and the winter temperatures were lower than during the Árpád Period. These two factors must have had serious consequences for the stability of the settlement network, the agricultural system, flood prevention system, and the natural environment, although it is somewhat difficult to show the impact of the weather and climate on them.[291]

It is a commonplace that the plain of the Carpathian Basin is more sensitive to climatic and environmental changes than the hilly regions or the mountain areas. The extent of the water-covered or temporarily water-covered areas on the Great Hungarian Plain has changed radically over the last millennium.[292] This does not mean, however, that the hilly

[290] Andrea Kiss, "Historical Study,"
[291] Markus Dotterweich, "The History of Soil Erosion and Fluvial Deposits in Small Catchments of Central Europe: Deciphering the Long-term Interaction between Humans and the Environment — A Review," *Geomorphology* 101, No. 1–2 (2008): 192–208.
[292] On the debates around the extent of these areas and their change in historical times, see the differences in the maps of: György Györffy, *Az Árpád-kori*, Woldemár Lászlóffy, *Magyarország vízborította és árvízjárta területei az ármentesítő és lecsapolási munkálatok megkezdése előtt (falitérkép, M=1:600000)* [The water-covered and periodically flooded areas of Hungary before the water-regulations and the drainage works – map] (Budapest,

regions were more subject to erosion as the result of climatic changes, as in the fourteenth century when major erosion has been detected in many parts of Europe.[293] Despite this, the Great Hungarian Plain still provides a good opportunity to detect climatic and environmental changes in the late medieval period.

In the past two centuries the most important factor in the fluctuation of marshlands and agricultural land on the Great Hungarian Plain was the water regulation of the major rivers of the region, the Danube, the Körös and, especially, the Tisza.[294] It is difficult to find an unaffected study area on the Great Hungarian Plain where it is possible to reconstruct the late medieval environmental conditions and trace the changing conditions over the centuries.[295] Archaeological investigations have been sporadic and, in most cases, the environmental conditions have not been the focus of major investigations. However, there are smaller study areas where the climatic and environmental historical consequences were studied in more detail.[296] Micro-regional investigations of the medieval settlement history on the Great

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1938), Györffy–Zólyomi, "A Kárpát-medence és az Etelköz,", Sándor Somogyi, "Hazánk vízrajza a honfoglalás idején és változásainak tájrajzi vonatkozásai," [The hydrography of Hungary in the age of the Hungarian conquest and the geographical consequences of its changes] in *A táj változásai a Honfoglalás óta a Kárpát-medencében* [Landscape changes of the Carpathian Basin since the Hungarian conquest], ed. György Füleky (Gödöllő: Gödöllői Agrártudományi Egyetem MSZKI, 1997), 41–58, György Györffy and Bálint Zólyomi, "A Kárpát-medence és Etelköz képe egy évezred előtt," [The Carpathian Basin and the Etelköz one thousand years ago] *Magyar Tudomány* 8, No. 8 (1996), 899–918. and the maps of Békés county in the *Magyarország régészeti topográfiája* [Archaeological topography of Hungary).

[293] Hans-Rudolf Bork, Helga Bork, Claus Dalchow, Berno Faust, Hans-Peter Piorr, and Thomas Schatz, *Landschaftsentwicklung in Mitteleuropa: Wirkung des Menschen auf Landschaften* (Gotha: Klett-Perthes, 1998), 215–252, meanwhile it is interesting to note an example of active grape cultivation on the slopes of a study area in Hungary (Nagymaros), where cultivation started in the same period as major soil erosion in Central Europe: Andrea Kiss, Zoltán Sümeghy, Anett Czinege and Zoltán Karancsi, "Wine and Land Use in Northern Hungary – A Case Study from the Danube Bend," *Acta Climatologica et Chorologica Universitatis Szegediensis* 38–39, No. 1 (2005): 97–109.

[294] On the regulation and its impact on the microclimate, fauna, flora, soils, and agricultural system, see: Emánuel Antal, Zoltán Járó, Sándor Somogyi and György Várallyay, *A XIX. századi folyószabályozások és ármentesítések földrajzi és ökológiai hatásai Magyarországon* [The geographical and ecological consequences of nineteenth-century water regulation and flood prevention systems in Hungary] (Budapest: MTA Földrajztudományi Kutatóintézet, 2000), László Fejér and Imre Kaján, ed., *Mérlegen a Tisza-szabályozás: egy XIX. századi mérnöki természetátalakító munka, mai szemmel: előadások és vita a Budapesti Műszaki Egyetemen: Budapest, 1992. március – május* [The Tisza regulation on a scale: the environmental consequences of nineteenth century engineering in light of the present: papers and discussion at the University of Technology of Budapest: March – May, 1992] (Budapest: Magyar Hidrológiai Társaság and Országos Vízügyi Főigazgatóság, 1992), and Dénes Ihrig, ed., *A magyar vízszabályozás története* [The history of water-regulation in Hungary] (Budapest: Országos Vízügyi Hivatal, 1973).

[295] Sándor Somogyi, "Az Alföld természeti képe a honfoglalás és az ezredforduló időszakában," [The natural conditions of the Great Hungarian Plain at the turn of the first millennium] in *Földrajzi tanulmányok dr. Frisnyák Sándor hatvanadik születésnapja tiszteletére* (Észak- és Kelet-Magyarországi Földrajzi Évkönyv 1) [Geographical studies in honor of the 60th birthday of dr. Sándor Frisnyák], ed. Zoltán Dobány and Árpád Hanusz (Nyíregyháza: BGYTF, 1994), 61–76, Sándor Somogyi, "Hazánk vízrajza," and Györffy–Zólyomi, "A Kárpát-medence és az Etelköz,".

[296] Most of the archaeological investigations, with few exceptions, are connected to highway construction. For example, see: Pál Raczky, Tibor Kovács and Alexandra Anders, ed., *Utak a múltba. Az M3-as autópálya régészeti leletmentései* [Paths into the past, Rescue excavations on the M3 motorway] (Budapest: Eötvös Loránd Tudományegyetem Levéltár, 1997).

Hungarian Plain are key to understanding how the natural environment (and climate) changed in this period. Several regions have been investigated in the last decades where the environmental patterns were taken into consideration. The most important from my point of view is the research of Marianna Bálint. Her PhD on the medieval settlements of the Dorozsma-Majsa Region (Danube Tisza Interfluve, Hungary) revealed the existence of several smaller settlements on the margins of ponds in the Árpád Period which she attributes to the wetter climate of the MWE.[297] The existence of a long-lasting wetter period in the Árpád Period is, however, questionable, as discussed above. Despite this, Bálint demonstrates that this part of the plain was rich in water in the first half of the medieval period and, although it is not discussed in detail, this situation might have changed from the fourteenth century. Her results on the deserting of settlements in the late Árpád Period are important as she demonstrated in this sample area a generally accepted theory that the major period of this process was not in consequence of the Mongol invasion but happened in the fourteenth century, which must have been connected in part to environmental reasons. Recent research by Szabolcs Rosta has been in the Kiskunság (Danube Tisza Interfluve, Hungary), another area close to this territory. Although Rosta focused on the routes through the region, he made some interesting remarks concerning the late medieval topography of Akasztó. As he explains, the environmental situation of the area surrounding the settlement is quite problematic as the roads leading to Kiskunhalas would have had to cross the so-called Nagy-Sár (Big Swamp), a marshy area in the late medieval period, which raises questions concerning the existence of the marshland in the earlier part of the Middle Ages.[298] Other investigations around the town of Kiskunhalas have yielded somewhat different results than discovered by Bálint. György V. Székely and Piroska Biczó inferred the crucial role of the Mongol invasion in the desertion of the surroundings of Kiskunhalas and they thought that only a few villages were abandoned in the second half of the thirteenth century.[299] László Szekeres also carried out regional-scale research on the settlements in the northeastern region of the Bácska (Bačka) and collected the settlements mentioned in perambulations, donations

[297] M. Bálint, " Az Árpád-kori településhálózat," 45–46 and 70; Bálint assumed conditions were wetter based on Western European investigations.

[298] Szabolcs Rosta, "A Kiskunsági Homokhátság középkori település- és úthálózata," [The medieval settlement and road network in medieval Kiskunsági Homokhátság] in *Középkori mozaikok* [Medieval mosaics], ed. Balázs Nagy (Budapest: Eötvös Loránd Tudományegyetem Történettudományi Intézete, in press).

[299] György V. Székely, " Árpád-kori települések a történeti Halas határában," [Árpád Period settlements in the borders of Kiskunhalas] in *Kiskunhalas története I. Tanulmányok Kiskunhalasról a kezdetektől a török kor végéig* [Studies from Kiskunhalas from the beginnings to the end of the Turkish Period] ed. József Ö. Kovács and Aurél Szakál. Available online: http://www.halas.hu/kiskunhalas/tort1/index.html (last accessed: 12 April, 2010).

and so on. His settlement pattern reconstruction also showed the crucial roles of minor steams, rivers, and, in several cases, small lakes such as Lake Kelebia or Lake Gyékény on the shores of which there were settlements in the late medieval period.[300]Apart from the archaeological results from the western region of the Danube-Tisza Interfluve, archaeologists drew attention to landscape changes in a few other excavations at the sites of Szentkirály and Monostorossáp.[301] Changes in climate and their impacts on the former landscape were considered at these sites, unlike most other cases, where archaeologists disregard this factor. Although there are several settlement-pattern investigations from the Great Hungarian Plain, there have been no major attempts recently to summarize the changes in the network of villages in this region of the Carpathian Basin and to understand the impact of changes in the natural environment on the settlement structure.[302]

With regard to suspected changes in the water-covered area it is crucial to choose a study area to trace late medieval environmental changes where water played an important role in the formation of the settlement structure. In this respect a good study area may be the Temesköz (Banat, Serbia and Romania),[303] as in this region based on visual and textual data, there were wetland areas and even an extent lake. It was marked as a lake in the first phases of Early Modern Times and dried up completely during Modern Times, but may be a good marker of past environmental conditions. Apart from that, the extent of the water-covered area in the region was large, especially around the two major watercourses of the region, the Temes (Timiş, Romania; Tamiš, Serbia) and the Bega (Bega, Romania; Begej, Serbia) Rivers.

The other small geographical unit I will refer to is in the Körös Maros Interfluve. Here, similar factors were decisive in my choice. On the one hand, this is one of the few regions in the Carpathian Basin where a full archaeological topography has already been carried out, which is a key aid in understanding changes in settlement patterns in the late

[300] László Szekeres, *Középkori települések Északkelet-Bácskában* [Medieval settlements in Northeastern Bácska] (Újvidék: Forum, 1983), 26–27 and 33. Similar conclusions were drawn based on historical data: Györffy–Zólyomi, "A Kárpát-medence és az Etelköz," 15.

[301] See the research of András Pálóczi Horváth, "A késő középkori Szentkirály határhasználata és gazdálkodása," [The land-management and farming in late medieval Szentkirály] in *Gazdálkodás az Alföldön. Földmûvelés* (Arany János Múzeum Közleményei 9) [Farming at the Great Hungarian Plain], ed. László Novák (Nagykőrös: Arany János Múzeum, 2002), 53–68, András Pálóczi Horváth, "Régészeti és településtörténeti adatok a kunok letelepedéséhez. Egy középkori kun falu, Szentkirály feltárásának eredményei)," [Archaeological and settlement-historical data on the settling of the Cumans. A medieval Cuman village: Szentkirály] in *Falvak, mezővárosok az Alföldön* (Arany János Múzeum Közleményei 4) [Villages and small towns in the Great Hungarian Plain], ed. László Novák and László Selmeczi (Nagykőrös: Arany János Múzeum, 1986), 215–236, and other publications of the author. On the history of Monostorossáp, see: Miklós Rácz and József Laszlovszky, *Monostorossáp egy Tisza menti középkori falu* (Dissertationes Pannonicae III. 7.) [Monostorossáp, a Deserted Medieval Village and its Landscape] (Budapest: Eötvös Loránd tudományegyetem, 2005).

[302] The research focussed on towns, such as András Kubinyi's publications on the importance of towns.

[303] The geographical unit of Temesköz is the same as the historical Bánát region.

Middle Ages. The other factor is that, like the Temesköz, this is a marshy area where considerable areas were covered with water after floods. After a brief description of the environmental conditions of the southern and southeastern part of the Great Plain, I will focus on the environmental changes of these two regions in the Hungarian Kingdom.

6.1. The present environmental conditions of the Körös-Maros Interfluve and the Temesköz

When discussing the environmental conditions of a region, it is traditional to cover geographical and historical works and to start with a description of the climate, the fauna, the flora, the geomorphology, and, within this the major rivers and lakes. In the twenty-first century in this part of Europe the hydrogeography is only one amongst the elements of the environment that needs to be discussed, but in a geographical and environmental analysis of the late medieval plains of the Hungarian Kingdom hydrogeography may be one of the most important elements, if not the most important. Water management was a basic element in the economic system of different areas on the plains. The system of *fok* seems to have been a crucial factor in the economic system of settlements which were connected to living waters and in some cases lake-side villages as well.[304] The regularly flooded low plains were the best fishing areas in medieval times as they were good spawning grounds for many of the fishes, a stream connecting two water-bodies was also a good place for milling, and the territories in between could be exploited for grazing or planting fruit trees. Sándor Frisnyák, one of the most prominent scholars of Hungarian historical geography, drew attention to another characteristic of the medieval and Early Modern economic system of lowland areas, the constant driving of the animals from higher flood plains to lower flood plains – he called it meadow transhumance – which ensured territories for animal husbandry all year long.[305]

[304] The most fundamental literature on the system of *fok* is: Bertalan Andrásfalvy, *A Sárköz és a környező Duna-menti területek ősi ártéri gazdálkodása és vízhasználatai a szabályozás előtt* [The ancient economic system and water use on the flood plain of the Danube and the Sárköz before water regulation] (Budapest: Vízdok, 1973), Zsigmond Károlyi and Gerzson Nemes, *Az ősi ártéri gazdálkodás és a vízi munkálatok kezdetei (895–1846)* [The ancient economic system of flood plains and the beginnings of water works] (Budapest: Vízdok, 1975), Zoltán, Fodor "Az ártéri gazdálkodást tárgyaló elméletek és alkalmazhatóságuk a magyarországi Tisza-szakasz kéziratos térképein szereplő fokok alapján," [The theories and the applicability of the flood plain economic systems of the Hungarian Tisza valley in light of *fok*s on maps] *Agrártörténeti Szemle* 43, No. 1 (2001): 89–149, and on futher literature and a case study of the *fok* of the Fertő Lake, see: Andrea Kiss and Ferenc Piti, "A fertői fok," [The *fok* of Fertő] *Soproni Szemle* 59, No. 2 (2005): 164–184.

[305] Sándor Frisnyák, *Magyarország történeti földrajza* [The historical geography of Hungary] (Budapest: 1992, Tankönyvkiadó). The fundamental geographical structure presented by Frisnyák has been somewhat criticized; geographers have offered different geomorphological categorizations of the Great Plain: Pál Beluszky, *A Nagyalföld történeti földrajza* [The historical geography of the Great Hungarian Plain] (Pécs: Dialóg Campus, 2001), 36–47, and Gábor Csüllög, "A Kárpát-medence vízrajzának szerepe Magyarország középkori településhálózatának kialakulásában," [The role of the hydrography of the Carpathian Basin in the formation of

Marshland was not only an important factor in the economic system, but was also used as a mean of natural protection. The marshlands represented buffer zones on the Little Hungarian Plain as well as in the southern part of the Great Hungarian Plain in the border-protection system of the medieval Hungarian Kingdom. Several castles and fortifications profited from these natural obstacles, such as the town of Temesvár itself in the Temesköz region and the castle of Becskerek (Zrenjanin, Serbia), which is interestingly situated on an island in a lake (to be discussed in detail below).[306]

The territory of these two regions was morphologically quite structured despite their general plain characteristics (see: *Fig* 44). In some cases there is only a few meters' difference in the elevations of micro-regions, but this can nevertheless lead to fundamentally different possibilities for agricultural activity, settlement or trade. In the short description of the micro regions I will use the most widespread categorization based on geomorphology (and soil types).[307] The highest elevations in the Great Hungarian Plain are the sand-hills such as the so-called Deliblát sand dunes in the Temesköz.[308] The higher flood plains are generally covered with loess and they provide the best opportunity for agricultural activity in the region; in the Körös-Maros Interfluve and the Temesköz these territories are almost entirely missing and only the loess plateau of Csanád can be classified within this morphological unit. As only a narrow zone in these regions is entirely protected from high water, huge territories of the Temesköz and the Körös-Maros Interfluve were regularly flooded. The remainder of the region belongs to the lower flood plains, such as the Temes lowlands, but considerable areas – the flood plains of the major rivers – were flooded regularly by the Temes, the Bega, the Tisza, the Danube, or the Körös.[309]

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the settlement network of medieval Hungary] in *A táj változásai a Kárpát–medencében – A víz a tájban* [Landscape changes in the Carpathian Basin – the water in the landscape], ed. György Füleky (Gödöllő: Szent István Egyetem, 2004), 56–58.

[306] On the role of Temesvár in the fourteenth century, see: István Petrovics, "The Fading Glory of a Former Royal Seat: the Case of Medieval Temesvár," in *The Man of Many Devices, Who Wandered Full Many Ways. Festschrift in Honor of János M. Bak*, ed. Balázs Nagy and Marcell Sebők (CEU Press: Budapest, 1999), 527–538, and István Petrovics, "Royal Residence and Urban Development During the Reign of the Anjou Kings in Hungary," *Historica Urbana* 5, No. 1 (1997): 39–66, especially: 49–53. However neither of the two studies discusses in detail the role of the location of the castle of Temesvár in becoming the center of the Hungarian Kingdom in the mid-1310s.

[307] This geographical categorization is referred to both by Pál Beluszky, *A Nagyalföld*, and György Györffy, *Az Árpád-kori*.

[308] In the Middle Ages and the Early Modern period it was called Maksond, or Campus Maron, as on the Lazarus map: László Blazovich, "Az Alföld domborzati képe Szent Gellért korában," [The morphology of the Great Plain in the age of Saint Gerhard] in *Szent Gellért vértanúságának 950. évfordulóján* [On the 950th anniversary of the martyrdom of Saint Gerhardus], ed. András Döbör, Csaba Jancsák, Gábor Ferenc Kiss, Tamás Nagy and László Szegfű (Szeged: Belvedere Meridionale, 1998), 21.

[309] László Blazovich, *A Körös-Maros-köz*, 17–30.

When attempting to reconstruct the medieval environmental conditions of a certain region it is dangerous to project its present state back to the Middle Ages; in the case of the Körös-Maros Interfluve, and especially in the Temesköz, this is particularly true. In Early Modern Times both regions were subject to major landscape changes due to radical human intervention. In the next subchapters my main focus will be to discuss the main environmental changes in the region before the drainage works and to focus on the changes which can be connected to climatic changes although climate is only one of several factors which affected landscape on the Great Hungarian Plain.

6.2. Tracing environmental changes in the Temesköz and the Körös-Maros Interfluve

As discussed above, both regions in my focus were deeply affected by the presence and nature of watercourses and one of the determinant factors in landscape formation was the hydrography. In such an area – supposing that the water-system has changed greatly during the last millennium – the environmental and climatic changes must somehow have been reflected in housing, settlement structure, the settlement network, and in the natural landscape. These changes can be traced in different types of sources. In these regions the archaeological record could play a crucial role because of the relative dearth of charter evidence. However, apart from archaeology and written evidence, maps have great significance in the study of long-term changes of the region, especially in wetland areas.

6.2.1. Environmental changes as reflected in the maps of the Temesköz

The role of maps as historical evidence should be highlighted in this subchapter. Although maps are extremely rare in the late Middle Ages, there area considerable number of maps from the sixteenth century which can help in understanding the late medieval environmental conditions in these two selected regions.[310] Amongst these maps the most frequently discussed is that produced by Lazarus from 1528. It is considered to be the first precise map made of the whole Carpathian Basin.[311] This map has frequently been used in

[310] On medieval maps from Hungary, see: Árpád Papp-Váry and Pál Hrenkó, *Magyarország régi térképeken* [Hungary on old maps] (Budapest: Gondolat Könyvkiadó, 1990).
[311] Lazarus Secretarius, *Tabula Hungariae ad quatour latera*. OSZK App. M. 126, Lajos Stegena, ed., *Lazarus Secretarius: The First Hungarian Mapmaker and His Work* (Budapest: Akadémiai Kiadó, 1982).

disciplines from history to cartography to linguistics. Geographers and historians have started to discuss the environmental historical information provided by maps only in the last few years.[312] Small sections of early maps – and in some cases especially the Lazarus map – have been selected in order to examine their reliability in reflecting local environmental conditions, as in a recent case study for the region of the mouth of the River Garam.[313] Besides settlements, the Lazarus map, depicts the main features of the natural environment including mountain ranges, significant rivers, and several lakes. Lazarus depicts three lakes: *Balaton lacus*, the *Neusidler See* (or *Ferteu*), and a *See* in the Temesköz region (see: *Fig* 45). The first two appear on all the maps from the Roman period to Modern Times, but the third one is much more problematic. What makes the investigation of this lake more interesting is that the size of the lake is shown as more or less equal to the Fertő, although the projection also enlarges the region where the lake is situated.[314] The Lazarus map is not the only one to depict this lake; it appears on most of the maps from the sixteenth to the eighteenth century and was called *Lacus Becskerek*; in the second half of the eighteenth century, however, the lake disappears.[315] During this period all the maps referring to this territory indicate the presence of a stable lake, as on the second map of the Hungarian Kingdom by Giacomo Gastaldi (1546) (see: *Fig* 46).[316] The lake is shown on the map of Lazius (1552) and it also appears the map of Matthias Zündt (1567) (see: *Fig* 47). The lake is shown to have a similar extent on the rather precise map by Alexander Mair (1595), which, like its predecessors depicts Lake Becskerek as occupying the main parts of the Temes-Bega Interfluve area (see: *Fig* 48).[317] Although it must be emphasized that this decade might have been exceptionally humid, the

[312] Amongst others, see: Gábor Molnár, Gábor Timár and Balázs Székely, "Lázár térképének georeferálásáról," [On the geo-referring of the Lazarus map] *Geodézia és Kartográfia* 4, No. 1 (2008): 26–30, Gábor Timár, Balázs Székely, Gábor Molnár, Csaba Ferencz, Anikó Kern, Csilla Galambos, Gábor Gercsák and László Zentai, "Combination of Historical Maps and Satellite Images of the Banat Region – Re-appearance of an Old Wetland Area," *Global and Planetary Change* 62, No. 1–2 (2008): 29–38, Balázs Székely, Gábor Molnár and Gábor Timár, "Tabula Hungariae (1528): errors in mapping or surface evolution rearranging the watercourses?," *Geophysical Research Abstracts* (2006) 8., 04854. On the recent trends of the study of historical maps in Hungary, see the special issue of *Acta Geodetica et Geophyisica Hungarica*: 44, No. 1 (2009).

[313] Balázs Székely, Gábor Molnár and Gábor Timár, "Lázár deák és a folyódinamika – térképezési hibák vagy valós mederváltozás?," [Lazarus and river-dynamics – mapping fault or real morphological change?] in Kázmér Miklós, ed., *Környezettörténet*, 75–98.

[314] Gábor Molnár et al., "Lázár térképének," 28–30.

[315] The most complete collection of these maps: Lajos Szántai, *Atlas Hungaricus. Magyarország nyomtatott térképei (1528–1850) I-II.* [Atlas Hungaricus. The printed maps of the Hungarian Kingdom (1528–1850)] (Budapest: Akadémiai Kiadó, 1996). For examples of the maps from the eighteenth century where the lake is not marked, see: Lajos Szántai, *Atlas*, I/88, 117, 130, II/459, 541, 587, 641.

[316] On this map: Pál Hrenkó, "Magyarország Gastaldi térképén," [Hungary on the Gastaldi map] *Geodézia és Kartográfia*, 27, No. 2 (1975): 110–121, and Katalin Plihál, "Magyarország Giacomo Gastaldi "La vera descrittione di tutta la Ungheria ..." című térképén.," [Hungary on the map of Giacomo Gastaldi] *Cartographica Hungarica* 6, No. 1 (1998): 2–8.

[317] Alexander Mair, *Hungariae Regni superioris noua et accurata descriptio emendata et evulgata Anno 1595*. App. M. 139.

lake is shown quite similarly on all the maps.[318] Its eighteenth century disappearance is partly the result of the water-control drainage works and water regulation in the region. The presence of such extensive regulation work in the late medieval and Early Modern Period is worth a more detailed discussion.

The Lazarus map has recently been made an important subject of investigation by Hungarian cartographers. In a new study, a research project led by Gábor Timár and his colleagues refers to Lake Becskerek as a marshland, which was not a constantly water-covered area in the Early Modern period.[319] The authors, however, do not attempt to explain why it might have been only temporarily inundated. Despite the lack of references to later descriptions of the region, the authors have pointed out that Lake Becskerek reappeared during the flood of the Temes in 2005 (see: *Fig* 49). This flood produced the highest water-level ever recorded on the Temes River. Satellite photographs from 2005 show a major flooded area in the Temes Valley, which, according to scholars, marks the re-filling of the basin of the former marshland and lake north of the town of Becskerek.[320] Based on investigations of the micro-topography of the territories affected by the flood, research has indicated the existence of a low – once regularly flooded area or a constantly water-covered – area north of Becskerek, partly connected to Lake Becskerek. This research revealed the fact that the two water-covered areas although not entirely identical have common territories.[321] The problem of the permanent existence of the medieval Lake Becskerek is still unresolved and despite detailed modeling of the Temesköz the authors of the study have not explained why they think that the area of the former lake and the lake caused by the inundations of 2005 are at least partly identical. In their research, Timár and his fellows used only the Lazarus map from among the sixteenth-century maps, although several maps from the same period also marked Lake Becskerek.

Another frequently investigated map, made by Lazius (1552), also referred to the region between the Bega and the Temes as a lake and placed the fortress and the town of Becskerek in the middle of it.[322] There is little medieval written evidence referring directly to the environmental conditions in this region. However, one noteworthy mention of Becskerek comes from a French diplomat, Bertrandon de la Broquière, who wrote a detailed vernacular

[318] Lajos Rácz, *Magyarország klímatörténete*, 256.
[319] Gábor Molnár et al., "Lázár térképének," 26–30.
[320] Gábor Timár et al., "Re-appearance of an Old,"
[321] Gábor Timár et al., "Re-appearance of an Old," 36–37.
[322] Wolfgang Lazius, *Regni Hungariae descriptio vera*, OSZK Térképtár, TA 7107/14. Becskerek had a minor fortification, but during the nineteenth-century excavations environmental information was not taken into consideration: Jenő Szentkláray, *A becskereki vár* (Értekezések a történettudomány köréből. XII. 10) [The castle of Becskerek] (Budapest: Magyar Tudományos Akadémia, 1886).

account of his travel to the Holy Land and back again called *Voyage d'Outremer et retour* in 1433.[323] He describes how he stopped on his way from Belgrade (Serbia) to Szeged in the town of *Beuxquerel* (Becskerek) after crossing the Temes (it is probably the Temes, but Broquière does not mention the name of the river). Then he continued his journey towards Becse. However, before arriving in the town – according to his chronicle – he had to cross two bridges over other rivers.[324] One of the rivers he crossed might have been the Bega, but the other is less apparent, perhaps another branch of the same river (discussed below) or a smaller steam which could have been swollen because of the Danube flood (also mentioned by Broquière).[325] Broquière did not have to cross by boat; he mentions bridges, which suggests quite a stable hydrography in this region. What makes this stability even more likely is a sixteenth-century economic account book on the incomes in Becskerek during Turkish rule. In this list one of the most important sources of income are the tolls paid at certain bridges.[326]

Most of the sixteenth century maps were drawn to show the border areas and the battlefields between the Hungarian Kingdom and the Ottoman Empire. In this period the Temesköz region was far from the frontlines; it was relatively quiet with a low population density.[327] From the late seventeenth century, new surveys were carried out and the Temesköz region and Lake Becskerek was depicted differently, such as on a map by De Wit from 1680.[328] On this map the lake itself is shown as a wider segment of the Temes River and what makes it even more interesting is that the map no longer shows Becskerek as an island, but as a peninsula only partly surrounded by the water. This is particularly interesting in light of the fact that according to research on the water-level tendencies in the major lakes of the Hungarian Kingdom, lake levels started to decrease some time from the late sixteenth to the early seventeenth century. In the case of Lake Balaton, Károly Sági has suggested a peak at

[323] On his route in Hungary: Balázs Nagy, "The Towns of Medieval Hungary in the Reports of Contemporary Travelers," in *Segregation – Integration – Assimilation. Religious and Ethnic Groups in the Medieval Towns of Central and Eastern Europe*, ed. Derek Keene, Balázs Nagy and Katalin Szende (Farnham: Ashgate, 2009), 177.
[324] Bertrandon de la Broquière, "Voyage d'Outremer et retour" in *Monumenta Hungariae Historica. Magyar történelmi emlékek. Első osztály: Okmánytárak* 4. [Hungarian history], ed. Mihály Hatvany (Pest: Magyar Tudományos Akadémia Történelmi Bizottmánya, 1859), 310. *"Item de la je vins une ville leu nomme Beuxquerel* [Becskerek] *que est audit despot et je passay la deux rivieres a pont, et de la je vins a une ville qui est audit despot, qui a nom Verchet* [Becse]*, et la passay une tres grosse riviere et moult parfonde que leu nomme la Tisce* [Tisza]*."*.
[325] István Szamota, ed., *Régi utazások Magyarországon és a Balkán-félszigeten, 1054–1717* [Ancient travels in Hungary and the Balkan Peninsula, 1054–1717] (Budapest: Franklin Társulat, 1891), 90–91.
[326] Géza Dávid, "Vámok és kincstári bevételek a temesvári vilájetben," [Taxes and fiscal incomes in the vilayet of Temesvár] in *Pénztörténet – Gazdaságtörténet. Tanulmányok Buza János 70. születésnapjára* [Monetary history – Economic history. Studies in honor of János Buza on his 70th birthday], ed. József Bessenyei and István Draskóczy (Budapest: Mirio, 2009), 83.
[327] Géza Dávid, "Vámok és kincstári bevételek," 77–98.
[328] Frank de Wit, *Regnum Hungaria In Omnes Suos Comitatus*, OSZK Térképtár, TR 7095.

the turn of the sixteenth century and then assumed a slow drop in water-levels (see: *Fig* 50). In the case of Lake Fertő, Andrea Kiss has drawn attention to a source which indicates very low water in the lake in 1683, only three years after De Wit's map was published, which seems to parallel the shrinking tendency displayed by Lake Becskerek (see: *Fig* 51).[329] De Wit's map can be compared to another map from the period by General Marsigli, whose maps are surveys of the border regions of the Hungarian Kingdom made during the expulsion of the Turks from the country.[330] There are major differences on the maps of the region drawn by Marsigli. The lake, or some form of the lake, is present on all the maps, but the extent of the lake changes from one map to another. On the map from 1697 showing the surroundings of the castle of Becskerek the water-level seems to be extremely low (see: *Fig* 52). Parts of the basin of a larger and deeper lake can be identified, which might have been closely connected with the protection of the castle, but this lake is almost entirely dried out. This fact may have been related to the fact that in the same year, 1697, the castle was destroyed by the Habsburgs and the water may have been drained from the moat. The protective role of the lake ceased, but the low water-level of the Temes might also have caused such conditions.[331] On a map also drawn by Marsigli from 1702-1703 the environmental conditions are quite similar from what can be seen on his map from the preceding years (see: *Fig* 53). The town of Becskerek – although the map is not very precise about its location – is shown situated on the bank of a small branch of the Bega River, which surrounds an island. In the basin of the former Lake Becskerek there is only a small marshland, not fed by a river from which it could have gotten water, which seems to be the remnant swamp of a once-more-extensive lake.[332] In Broquière's travel account, he mentions that while he was heading to Becse (Novi Bečej, Serbia) from Becskerek he had to cross two rivers (or more likely two branches of the same watercourse). These two branches can be identified clearly on both maps of Marsigli, which might indicate similar environmental conditions in the early fifteenth and the late seventeenth century. If one accepts that the two situations are comparable it might indicate that the late fourteenth and early fifteenth century was not so wet, but more like the late seventeenth century, because the lake in the seventeenth century situation was less significant than on the maps of Lazarus and his successors in the sixteenth century, when it may have been close to its highest water-level.

[329] For example, see the data from Boz, Fertő region: Andrea Kiss, Changing environmental," 243, and for the main tendencies of Balaton, see: Károly Sági, "A Balaton vízállás-tendenciái,".
[330] The maps referring to the Temesköz region: György Kisari Balla, *Marsigli tábornok térképei* [The maps of General Marsigli] (Budapest: Kisari Balla György, 2005), No. 29, 53, 69, 83, 101, 102, 126.
[331] György Kisari Balla, *Marsigli térképei*, 183.
[332] György Kisari Balla, *Marsigli térképei*, 69–70.

The whole Temesköz region – inspite of the occupation of a considerable part of it during the late seventeenth century military expansion of the Habsburgs – was recaptured only in 1718 with the treaty of Pozsarevác (Požarevac, Serbia). Shortly after the reoccupation of the region, as early as the first third of the eighteenth century, major water regulation projects were carried out which fundamentally changed the landscape of the Temesköz. From the eighteenth century onwards the hydrography of the region was changed. Huge territories were drained to free land for agriculture and to provide a more regulated flooding of the water-courses. As early as the maps of Müller (1769) the lake itself has entirely vanished and although smaller marshlands are indicated they are north of the location of the former lake; the whole region has different characteristics (see: *Fig* 54). Like Müller's map, the maps of the second military survey in this region of the country also show an entirely different hydrographical, and in some smaller areas even orographical, situation. Based on the seventeenth century maps, however, it is worth reconsidering the statement of Gábor Timár that Lake Becskerek might have been a floodway area and thus, not flooded throughout the whole year. All the maps before the end of the seventeenth century depict what seems to be a major lake in the interfluve of the Bega and Temes rivers. Even after a supposedly drier decade like the 1540s, the Lazius map shows either a lake (not a marshland) or the basin of a once existing lake.[333]

For this thesis it is even more relevant to investigate the environmental conditions of the region in the fourteenth century, which can better be traced by the examination of textual data and archaeological results than maps (although the general trends can be seen on early maps, as discussed above). It is difficult to draw general conclusions or assume water-level tendencies; the situation in the region of the lake might be understood better in relation to the Early Modern situation. The Temesköz region in the Árpád Period was under the authority of three counties: Temes, Keve, and Krassó. The territory of the late medieval Lake Becskerek marked the border between Temes and Keve counties. The historical topography of Árpád Period Temes County has not yet been carried out, but György Györffy collected written evidence from this period referring to the settlements of Keve.[334] There is no major settlement near Lake Becskerek in the Árpád Period.[335] None of the few settlements mentioned by Györffy – such as Batka, Petre, and Csorog – can be localized and these villages are only

[333] Lajos Rácz, *Magyarország klímatörténete*, 297.
[334] György Györffy, *Az Árpád-kori*, III. 305–313.
[335] György Györffy, *Az Árpád-kori*, III. (app.)

known from charters from the period of Sigismund's reign.[336] This territory is lacking in detailed perambulations from the Árpád Period. There is no evidence from this period for the existence of a lake or a marshland, although the absence of settlements in this region might indicate poor agricultural conditions which could be attributed to the wetness of this area. However, Keve County was quite densely inhabited by the late medieval period. The region where the lake is drawn on the Lazarus map is, more or less, the territory of Becskerek almost as far as the town of Temesvár. Apparently here, because of the projection, the lake appears even larger on the map although the distance between the two points is almost eighty kilometers and, even more important, the difference in altitude above sea level of Becskerek and Temesvár is almost ten meters.[337] Although there might have been minor isostatic adjustments in this region, as is the case generally in alluvial territories, the relative difference in altitude between these two towns was probably constant. Such a difference would reflect the presence of a deep lake, which is unlikely. There might have been a smaller lake closer to the town of Becskerek as early as the fourteenth century, which, however, does not necessarily coincide with the territories inundated during the flood of 2005 as supposed by Timár and his fellow authors and by Kisari Balla György.[338] This lake could have served more as a protective area for the earthen castle of Becskerek in which case it could have been partly man-made or sustained by man.

The existence of a smaller lake around and east of Becskerek might also be confirmed by the investigation of the late medieval settlement pattern as reflected in charters. Pál Engel examined late medieval land ownership and settlements in the Carpathian Basin.[339] There is a major gap of any permanent settlement in his database located east of the town of Becskerek. The village of Szentmárton is very close to Becskerek and might have been situated on the shores of the lake, while the closest village to the northeast is Klek (later called Begafő) while to the east Kenderes lies almost eighteen kilometers away from Becskerek. The differences in

[336] On Batka and Pethe, see: Dl 8512. Both villages and, according to György Györffy, Csorog as well were at least twenty kilometers away from the castle of Becskerek. The major basin of the lake itself on the sixteenth-century maps is positioned east of the settlement, which suggests that the villages were quite distant from the wetland area. György Györffy, *Az Árpád-kori*, III. 312.

[337] According to http://www.earthtools.org (last accessed: 12 April, 2010), the height of Nagybecskerek is 80 meters while Temesvár is located 88 meters above the sea level.

[338] Gábor Timár et al., "Re-appearance of an Old," and a short report on the opinion of György Kisari Balla: Zoltán Pósa, "Iszonyú károkat okozhat az ökológia lebecsülése," [The underestimation of ecology might cause serious destruction] *Magyar Nemzet*. Available online: http://www.mn.mno.hu/portal/293346 (last accessed: 12 April, 2010).

[339] Pál Engel, *Magyarország a középkor végén* [Hungary at the end of the Middle Ages] (Budapest: Térinfo BT, 2001; CD-ROM).

elevation within this territory of the Temesköz are not significant and could have lain within the basin of a significant lake.

Many questions about the existence and the characteristics of Lake Becskerek remain to be answered, but it seems quite probable that some parts of the lake already existed in the Árpád Period. However judging from the late medieval, and especially the sixteenth- and seventeenth-century state of the lake, it might have been most extensive at the end of the Middle Ages. Several other aspects could have been taken into consideration to estimate the size of this wetland such as the examination of the soil structures in the region and the archaeological remains[340] in this territory, but the aim here was to discuss the possibility of tracing climatic and environmental changes on historical maps, to show how the landscape might have changed in this region of the Carpathian Basin throughout the Middle Ages, and to show out that lowlands, especially the wetland territories on the Great Hungarian Plain, might have a crucial role in understanding the long-term climatic processes.

6.2.2. Environmental changes in the Körös-Maros Interfluve in the late medieval period

The Körös Maros Interfluve area, as noted above, similarly to the Temesköz, was a region that was also very sensitive to climatic changes, above all to precipitation changes. Huge parts of this unit were regularly flooded by the rivers in this region, the Körös, the Maros, and the Tisza. The flood plain of the Tisza was at least ten kilometers wide and in some regions, as in the Tiszazug, the extent of the flooded area might have been much larger during major inundations. The Körös water system was even more complex.[341] The interfluve of the branches of the Körös were regularly fed by floods and huge, in some cases uninterrupted, marshlands and lakes came into existence at least for some parts of the year. The territories between the Túr River (almost the same as the present-day Berettyó) and the Fehér-Körös flooded recurrently with marshlands being the main features of the landscape throughout the Middle Ages. The inhabited regions included the small loess plateaus which

[340] Because of the border land position of the territory between Serbia and Romania there earthworks were constructed in the region (such as major dikes), but there have been no systematic archaeological investigations or else such results were not yet published.

[341] Dénes B. Jankovich, "Adatok a Körösvidék középkori vízrajzához és a vizek hasznosításához," [Data to the hydrography and the water-management of the medieval Körös-region] *Békés Megyei Múzeumok Közleményei* 16 (1996): 305–349, and Ferenc Scherer, *Gyula város története I. A földesúri város* [The history of the town of Gyula I. The town of landlords] (Gyula: Gyula M. Város, 1938), 24–27.

rose above the swampy areas, such as the slight elevations around Szeghalom or Békés.[342] In the medieval period several charters refer to marshlands such as the so-called Szerep or Tordasára.[343] These two great marshlands existed during the whole medieval and even into Early Modern Times and were often mentioned during the examined period. The wetland which surrounded Gyula is another marshy area which needs to be discussed here although its presence is not evident from historical records. What makes the investigation of this area important is that it changed over the centuries; unlike other regions the territory is depicted in several ways in different periods. For example, no lake is indicated in this region on the Lazarus map.[344] It must be noted, however, that this part of the map is quite inaccurate in general, especially compared to the average quality of this map. For example, the Túr River is just indicated as a short river and most of its course is entirely unmarked. On Alexander Mair's (1595) map, however, this region of the Carpathian Basin was much more precisely described; more settlements were indicated and on this map the castle of Gyula, like Becskerek, is shown surrounded by a major lake. The area immediately surrounding Gyula might have been more easily defended if it had been surrounded by water, but, environmental and natural environmental processes would also have been involved in the formation of a major lake. New surveys were made during battles to regain the region in the late seventeenh century. Amongst these one of the earliest is from 1686, done by Giacomo Cantelli da Vignola, which discusses and shows Lake Sarkad as an existing lake with Gyula on its shores (see: *Fig* 55).[345] One map in the collection of the maps made by Marsigli refers to the Körös-Maros Interfluve in a more detailed manner.[346] The map deserves particular attention because it comes with a quite detailed written description provided by the draftsman himself, where Marsigli explains the endless marshlands around Sarkad and other settlements of the region. According to the general, Gyula also lay in a marshy area, but Marsigli refers to it as a territory which could have been easily inundated in case of danger, which indicates that without human intervention it was not permanently water-covered in the late seventeenth century, which is somewhat different from what is shown on the map of da Vignola. The rivers also have several branches here, the one called Gyepes is explained by the general as a partly artificial water-way which was created by a Turkish bey and meant to protect the city

[342] In most the cases, these elevations are very small and only served as a place for a few houses, not a village or a town. For the role of these areas in the settlement network and the ecosystem, see: József Laszlovszky, "Tanyaszerű települések az Árpád-korban," [Farmsteads in the Árpád period] in Novák–Selmeczi, ed., *Falvak, mezővárosok*, 136–139.
[343] György Györffy, *Az Árpád-kori*, III. 494.
[344] Lazarus did not mark marshlands, only living waters.
[345] Giacomo Cantelli da Vignola, *L' Ungaria nuouamente descritta*. OSZK TM 25 153.
[346] György Kisari Balla, *Marsigli térképei*, 213.

from Christian armies by making it possible to flood the surrounding region (see: *Fig* 56-57).[347] It is important that, according to Marsigli, a permanent lake did not exist in the late seventeenth century around Gyula, which is quite similar to the situation in the Temesköz and makes a decrease in precipitation a more likely scenario in Early Modern Times, although this idea is not confirmed by the map of da Vignola.

Written sources refer to the existence of the lake until the late eighteenth century and even in this relatively dry period the descriptions are refer to a permanent lake. In the beginning of the eighteenth century the author of the *Notitia Hungariae*, Mátyás Bél, describes the existence of Lake Sarkad. He refers back to two sixteenth-century authors, Petrus Bizarus and Christianus Schesaeus. While Bizarus notes the existence of a lake, Schesaeus notes endless marshes and waterways around the castle of Gyula.[348] The relatively high precipitation and the impact of the LIA seem to be a reason for the existence of a permanent lake in the late medieval and Early Modern Period, but as the branches of the Körös flows through areas of intensive mining activity, an increase in water levels in the watercourses. The high underground water-table may also be explained by forest clearance. Medieval written evidence from the region also confirms the existence of a huge marshy area in the surroundings of the Körös River.[349] The toponyms in the region frequently refer to marshlands and bridges. According to Jankovich, perambulations recurrently mention mud or muddy dikes in the region in the late medieval period. Even in this region there were territories almost entirely protected from floods on the higher flood plain and loess plateaus, the living spaces ("életkamrák") as referred to by historical geographers.[350] These territories stood in swampy areas as islands and in some cases were good for agriculture. Some of them were covered with oak trees and were important centers for making masts, such as the village of Doboz, mentioned as early as the eleventh century.[351] Some of the villages profited from the endless swamps, river branches, *fok*s or ponds and lived from fishing, which is noted in

[347] György Kisari Balla, *Marsigli térképei*, 213.
[348] Mátyás Bél, *Békés vármegye leírása* [The description of Békés county] (Gyula: Békés Megyei Levéltár, 1993), 15 and 36.
[349] Dénes Jankovich B., "Adatok a Körösvidék,"
[350] The notion "életkamra" comes from: Lajos Glaser, "Az Alföld régi vízrajza és a települések," [The ancient hydrography of the Great Hungarian Plain and the settlements] *Földrajzi Közlemények* 67, No. 4 (1939): 297–307, and used frequently by the Nyíregyháza school of historical geography: Sándor Frisnyák, "Magyarország kultúrgeográfiai korszakai (896–1920)," [The cultural geographical periods of Hungary (896–1920)] *Tér és Társadalom* 1, No. 1 (1996): 29–49.
[351] György Györffy, *Az Árpád-kori*, III. 505, Dénes Jankovich B., "Adatok a Körösvidék," 307, and Júlia Kovaloszki, "Árpád-kori települések Doboz határában," [Árpád Period settlements within the borders of Doboz] in Novák–Selmeczi, ed., *Falvak, mezővárosok*, 105–116.

several charters from the fourteenth and fifteenth centuries.[352] Numerous lakes are mentioned as fish-ponds used regularly, not only after flooding as the '*fok*' or some of the branches of the Körös water system were. Dénes Jankovich raises the question of bridges in the Körös region. He mentions very few bridges, which might be important. In a region with permanent water-courses there are several wooden-bridges all through the medieval period (as around Becskerek), but in the Körös region, where several thousand hectares are marshy for at least part of the year, it would have been much more difficult to construct something similar. In the region of Szarvas the archaeological topography mentions only one or two bridges, but it is noteworthy is that one of them might have crossed over a seemingly small insignificant steam, which suggests a higher general water-level of the stream than in the Modern Times.[353] It is likely that the water-level of the Körös complex fluctuated more and was less stable than the Temesköz, where bridges might have stood for several centuries, such as the one mentioned by Broquière and then more than two hundred years later in the Turkish accounts studied by Géza Dávid. The less stable hydrography is also confirmed by the instability of the boundary markers in this region.[354]

The extent of the marshlands is hard to estimate from historical data, but unlike the case of Temesköz there is a detailed archaeological topography for Békés County which is a helpful tool for understanding the extent of the areas regularly touched by floods.[355] Three districts of the Körös-Maros Interfluve – the environs of Szeghalom, Szarvas, and Békés-Békéscsaba – have been investigated by archaeologists. The environs of Szarvas and Békéscsaba were rich in waterways and it is noteworthy that both regions were relatively densely inhabited throughout the Middle Ages.[356] Dénes Jankovich suggested a long-lasting process of desertion after the mid-thirteenth century in the Szarvas district. He drew attention

[352] Dénes Jankovich B., "Adatok a Körösvidék," 325–328.
[353] János Makkay, *Szarvasi járási*, 298. (6/8). These may indicate a higher permanent water-level. For a parallel see the above-mentioned case of Sicilian medieval bridges: Hubert H. Lamb, *Climate History*, 165.
[354] Péter Havassy, " Határjárások és határjelek,"
[355] István Torma, ed., *Békés megye régészeti topográfiája. Szeghalmi járás* [Magyarország régészeti topográfiája 6) (The arcaheological topography of Békés county: Szeghalom] (Budapest: Akadémiai Kiadó, 1982), János Makkay, ed., *Békés megye régészeti topográfiája. A Szarvasi járás* (Magyarország régészeti topográfiája 8) [The arcaheological topography of Békés county: Szarvas] (Budapest: Akadémiai Kiadó, 1989) and Dénes Jankovich B., ed., *Békés megye régészeti topográfiája. Békés és Békéscsaba környéke* (Magyarország régészeti topográfiája 10) [The arcaheological topography of Békés county: Békés and Békéscsaba] (Budapest: Akadémiai Kiadó, 1998).
[356] László Blazovich, *A Körös-Maros-köz*, László Blazovich, "Megjegyzések a Körös-Tisza-Maros köz középkori településrendjéhez (X–XIV. század)," [Contributions to the medieval settlement-system of the territory between Körös-Tisza and Maros rivers (10^{th}–14^{th} centuries)] in Novák–Selmeczi, ed., *Falvak, mezővárosok*, 263–278., and László Blazovich, "Dél-alföldi városok a 14–16. században," [Towns of the southern part of the Great Hungarian Plain] in *A középkori Dél-Alföld és Szer* (Dél-alföldi évszázadok 13) [The medieval Southern Great Hungarian Plain and Szer], ed. Tibor Kollár (Szeged: Csongrád Megyei Levéltár, 2000), 17–40.

to the length of this process, which was not general in the 1980s, when most scholars attributed the process to the Mongol depredations. The archaeological topography research group assumed that this process continued until the end of the fourteenth century, during which at least 70% of the settlements in the region were abandoned. This high proportion can be explained partly by environmental reasons, although the authors of the volume did not refer to them.[357] The relatively small number of fourteenth- and fifteenth-century settlements makes it difficult to draw general conclusions about the changes in the settlement pattern and the relationship between the floodplains and the settlements. Settlements can still be found on the margins of standing water, just as in the Árpád Period.[358] There is one case worth noting in this context. A medieval site in Kardos (No. 7/99) was situated on the shore of a small body of water which is now filled with alluvial sediment. There are several small Árpád Period sites along the shores, but late medieval finds were identified on only one site on the lakeshore, situated at the most elevated point along the shoreline of the lake. Unfortunately, more detailed data on the elevation of this site compared to others is not available, but the recurrence of this phenomenon on other sites of the region might indicate higher water-levels (although it is speculative to draw a general conclusion from a single site).[359]

The settlement pattern of the Békés and Békéscsaba district was even more impacted by water-courses than the Szarvas region because the branches of the Körös River formed continuous water-covered areas like the territories around the confluence of the Fekete and the Fehér Körös or by the mouth of the Büngösd and the Kis-Körös. As the archaeological topography of this territory took place recently, more attention was paid here to the environmental-historical connections of the sites. Some cases are worth discussing and can help in understanding the main tendencies of the climate (or environmental changes) on the Great Hungarian Plain. The first to be discussed is an excavation near present-day Telekgerendás.[360] Surveys were carried out on a sand-hill close to a silted up valley; Árpád Period and late medieval elements were unearthed, including a church which was used both in the earlier medieval then restored in the late Middle Ages. The village functioned throughout the medieval period and close to the church another part of the village was discovered. What makes this site important is that this part of the village only existed from the fourteenth

[357] They refer to the opinion of István Szabó on the desertion, but they emphasize the political, economicand social historical reasons and omit Szabó's note on the growth of natural hazards as an element of this process: János Makkay, *Szarvasi járás*, 31. István Szabó, *A falurendszer*, 169–183.
[358] For example: János Makkay, *Szarvasi járási*, 79. (I/33), 306 (6/42) or 367. (7/99).
[359] Similar tendencies can be traced in the village of Szer: Katalin Vályi, "Szer középkori településtörténete a régészeti leletek tükrében," [The medieval history of Szer in light of archaeological data] in Novák–Selmeczi, ed., *Falvak, mezővárosok*, 119–124.
[360] Dénes Jankovich B., *Békés és Békéscsaba*, 673–677. (12/8, 12/9).

century and its houses stood in the bed of the water-course which had existed until the thirteenth century but then dried up. Although water regulation could have been carried out it can more likely be attributed to the lack of a natural water-supply for this water body.

The major villages and towns were located on higher loess plateaus entirely protected from flooding, like the castle of Békés, which existed all through the medieval period. In the region, however, there are settlements which did not exist at all in the Árpád Period but were inhabited in late medieval times including the village of Ölyved (or the site believed to be that village).[361] There are several cases when there are no Árpád Period finds, but a few late medieval pot sherds were present and there are cases when new settlements can be found on the banks of smaller steams in the late medieval period, which supposes their constant existence throughout this period.[362] Changes are hard to trace. There is a general gap between the finds of the two main periods in this district which can be attributed to the destruction of the settlements in 1241 and desertions of the fourteenth century. There are other examples, however, which raise the question of whether major environmental change, perhaps changes in precipitation in the region, might be implicated in the abandonment of settlements.

As already mentioned, it is difficult to understand the main tendencies in the fluctuation of the precipitation or the temperature over a longer period without instrumental data. The environmental conditions at different sites, even for small distances, could differ as a consequence of reasons ranging from landslide movements to destruction of forest. Despite several factors which must be taken into consideration, major fluctuation in the wetland areas of the Great Hungarian Plain can be argued for by investigating historical maps and archeological data. Based on the historical maps in the region there may have been a peak in precipitation in the sixteenth century. Before that, a drier climate might have dominated in the mid-fifteenth century; similar conditions can be suggested for the time the Hungarian Kingdom was recovered from the Turks. On a local scale, however, these major trends are extremely hard to trace. It is dangerous to assume a general tendency in the amount of precipitation or the mean temperature on the fourteenth-century Great Hungarian Plain although based on individual sites it appears likely that precipitation increased in the late medieval period since most of the settlements were moved further from the shores of lakes or riverbanks and the lakes were more extensive in the sixteenth century than at any time in Early Modern Times.

[361] Dénes Jankovich B., *Békés és Békéscsaba*, 428–429. 5/13, and further example: 441. (5/34).
[362] For example: Dénes Jankovich B., *Békés és Békéscsaba*, 228. (2/229) or 295. (2/500). This has parallels in the settlement structure in the area studied by Marianna Bálint in the Danube-Tisza Interfluve.

7. Conclusions

The aim of this thesis was to examine the climate history of the Hungarian Kingdom in the late medieval period. The focus here was two-fold. On the one hand, I selected a short period in the fourteenth century in order to discuss weather events in detail. This period in Western, Central, and also Eastern Europe is considered to be a period with extremely cold weather conditions when severe winters and cold summers predominated. Precipitation was high, especially in the spring and summer, causing serious floods in throughout the temperate climatic zone in Western and Central Europe.

My aim was to trace the appearance and the possible occurrence of this environmental crisis in the 1310s. The main source was a group of charters which, although used in environmental historical research for decades, has not been in the focus of climate historians until recently. Although the number of sources relating to the weather events of the period is low, these sources combined with narrative sources from the neighboring countries (especially Austria and the Kingdom of Bohemia) provide enough evidence to suggest that this region suffered a crisis like the rest of Europe. However, it must be emphasized that most of the data are indirect and only mention the effects of the weather. To avoid to draw too general conclusions based on the possible environmental situation I also investigated the political situation in the Hungarian Kingdom which, combied with the unseasonable weather, could have caused an environmental crisis in the region.

The aim of the investigation was partly to study the weather events of this decade and partly to examine the possibility of tracing the same environmental crises in the Carpathian Basin which have been systematically studied in Western and Central Europe. By the thorough study of the written evidence from the Carpathian Basin, despite the scarcity of narrative sources, it is possible to show the major environmental crises of the late medieval period. Apart from the 1310s, a comprehensive investigation of the climate history of the Carpathian Basin the 1340s would be equally important.

This thesis also deals with a short period of time as a test case to see whether it is possible at all to study the climate history of the Carpathian Basin using charter evidence. The answer seems to be affirmative. Further investigation of the appearance of the Western and Central European weather anomalies in the Carpathian Basin may help us learn how protective the geographical structure of this region was and how much it helped to fend off the negative weather anomalies suffered in other parts of Europe in this time period.

The most important lesson learned is that although reconstructing the medieval climate based on textual data from the Carpathian Basin is impossible, the weather anomalies can be studied and by putting together numerous case studies using a variety of kinds of data, some general climatic characteristics could be defined and understood. As already mentioned, it is a common saying in historiography that because of the location and the relatively low population density of the medieval Hungarian Kingdom famines and weather-related crises were rare; this may only be partly true. It would be premature to draw sweeping conclusions on how late medieval environmental crises affected the Hungarian Kingdom based on one single short period of time. The research here has demonstrated that the systematic study of these periods within the context of power struggles and environmental change will yield important results regarding the historical demography of the Hungarian Kingdom.

The other focus of this thesis was to trace long-term processes of climate change. Here, charters were more difficult to use as a primary source. I selected historical maps as a source for tracing environmental changes. Changes in the environment might have been connected with climatic changes in the Carpathian Basin. It was important to choose a study area which would have been sensitive to climatic changes, such as the plains area. The two territories which were studied are both connected to watercourses on the Great Hungarian Plain and both territories went through radical changes in different periods of the later Middle Ages and Early Modern Times. I had to disregard environmental conditions from Modern Times because many changes in this period were closely connected to human intervention (especially water regulation) with natural environmental and climatic changes playing only an auxiliary role in this process. Historical maps also represent a group of sources which have not been much used by scholars of environmental changes in historical periods until the last few years. My aim in this chapter was less to discuss the environmental changes around Lake Sarkad and Lake Becskerek then to parallel these changes with the main climatic tendencies from the late medieval period to the late seventeenth century and to show that historical maps can be used to trace environmental and climatic changes in the Carpathian Basin.

All in all, my aim throughout the thesis was partly to investigate short-term weather processes in the late medieval period in light of historical sources, which in this case meant charters from the Carpathian Basin (and some non-contemporary narrative sources) and narrative sources from neighboring countries. It was also partly to trace long-term processes of climate as reflected in another type of historical evidence: historical maps. Both goals could have been pursued using additional sources such as charters from neighboring territories in the case of the 1310s or archaeological data in the case of the historical maps, but

the focus here was to discuss the possibilities of studying climatic processes of the late medieval Hungarian Kingdom using different interdisciplinary historical data in a critical manner.

8. Bibliography

8.1. Primary Sources

"Annales Burghausenses." In *Monumenta Germaniae Historica. Scriptores* XXIV. Ed. Georg Heinrich Pertz. Hannover: Hahn, 1866.

"Annales Cisterciensium in Heinrichow." In *Monumenta Germaniae Historica. Scriptores* XIX. Ed. Georg Heinrich Pertz. Hannover: Hahn, 1866.

"Annales Dervenses." In *Monumenta Germaniae Historica. Scriptores* XVI. Ed. Georg Heinrich Pertz. Hannover: Hahn, 1859.

"Annales Matseenses." In *Monumenta Germaniae Historica. Scriptores* IX. Ed. Georg Heinrich Pertz. Hannover: Hahn, 1851.

"Annales Mellicenses. Continuatio Zwetlensis Tertia." In *Monumenta Germaniae Historica. Scriptores* IX. Ed, Georg Heinrich Pertz. Hannover: Hahn, 1851.

"Annales Mellicenses. Continuatio Zwetlensis Tertia." In *Monumenta Germaniae Historica. Scriptores* IX. Ed. Georg Heinrich Pertz. Hannover: Hahn, 1851.

"Annales Mellicenses." In *Monumenta Germaniae Historica. Scriptores* IX. Ed. Georg Heinrich Pertz. Hannover: Hahn, 1851.

"Annales Mellicenses." In: Monumenta Germaniae Historica. Scriptores IX. Ed. Georg Heinrich Pertz. Hannover: Hahn, 1851.

"Annales Zwetlenses." In *Monumenta Germaniae Historica. Scriptores* IX. Ed. Georg Heinrich Pertz. Hannover: Hahn, 1851.

"Annalium Polonorum." In *Monumenta Poloniae Historica*, Vol. III. Ed. August Bielowski. Warszawa: Nakł. Akademii Umiejętnośc, 1961.

"Annalium Salisburgurgiensis." In *Monumenta Germaniae Historica. Scriptores* XIII. Ed. Georg Waitz. Hannover: Hahn, 1881.

"Annalium Salisburgurgiensis." In *Monumenta Germaniae Historica. Scriptores.* XIII. Ed. Georg Waitz. Hannover: Hahn, 1881.

"Chronica Austriae." In *Monumenta Germaniae Historica. Scriptores Rerum Germanicarum Nova Series* XIII. Ed. Alphons Lhotsky. Berlin: Weidmann, 1967.

"Chronicon Aulae Regiae." In *Fontes Rerum Austriacarum.* Vol. 1. 8. Ed. Johann Loserth. Vienna: In commission bei K. Gerold's Sohn Buchhändler der Kaiser Akademie der Wissenschaften, 1875.

"Chroniques de Sempringham." In *Rerum Britannicarum Medii aevi Scriptores* 42. Ed. John Glover. London: Longman, 1865.

"Continuatio Zwetlensis Tertia." In *Monumenta Germaniae Historica. Scriptores* IX. Ed. Georg Heinrich Pertz. Hannover: Hahn, 1851.

"Ex annalium Rotomagensium continuationibus." In *Monumenta Germaniae Historica. Scriptores* XXVI. Ed. Georg Waitz. Hannover: Hahn, 1882.

"Flores historiarum." In *Rerum Britannicarum Medii aevi Scriptores* 95. Vol. III. Ed. Henry Richards Luard. London: Longman, 1890.

"Georgenberger Chronik," In *Scriptores rerum Hungaricarum tempore ducum regumque stirpis Arpadianae gestarum* 2. Ed. Emericus Szentpétery. Budapest: Akadémiai, 1938.

"Martini Meisteri. Annales Gorlicenses." In *Scriptores Rerum Lusaticarum antiqui et recentiores* 1. 1. Ed. Christian Gottfried Hoffmann. Leipzig: David Richter, 1719.

"Werbőczy István Hármaskönyve." [The Tripartitum of István Werbőczy]. In *Magyar törtvénytár* [Hungarian laws]. Ed. Sándor Kolozsvári and Kelemen Óvári II. Budapest: Frankiln, 1897.

Almási, Tibor, László Blazovich, Lajos Géczi, Gyula Kristó, Ferenc Makk, Ferenc Piti and Ildikó Tóth, ed. *Anjou-kori oklevéltár. Documenta res Hungaricas tempore regnum Andegavensium Illustrantia* [Angevin Chartulary]. Budapest: Csongrád Megyei Levéltár, 1990–2007.

Annals of Loch (Annala Loch Ce) In *Corpus of Electronic Text Editions of the the University of College Cork* http:// www.ucc.ie/celt/published/T100010A/index.html (Last accessed: April 20, 2010)

Bal, Jeromos, Jenő Förster and Aurél Kauffmann, ed. *Hain Gáspár lőcsei krónikája* [The chronicle of Caspar Hain from Lőcse]. Lőcse: Reiss Ny., 1910–1913.

Bártfai Szabó, László, ed. *Oklevéltár a gróf Csáky család történetéhez* [Charters on the history of the Csáky family]. Budapest, 1919.

Bél, Mátyás. *Békés vármegye leírása* [A description of Békés county]. Gyula: Békés Megyei Levéltár, 1993.

Cynthio [Zündt], Matthia. *Nova totius Ungariae descriptio. Accurata et diligens desumpta ex pluribus aliorum editis cosmographicis chartis et typis aereis incisa a Matthia Cynthio*. 1567. OSZK App. M. 134.

de Bonfinis, Antonius. *Rerum Hungaricum decades*. Ed. József Fógel, Béla Iványi, and László Juhász. Leipzig: Teubner, 1936–1976.

da Vignola, Giacomo Cantelli, *L' Ungaria nuouamente descritta*. OSZK Térképtár, TM 25 153.

Dabrowski, Jan, ed. *Annalium Poloniae Jana Długosza*. Vol. 5. Wrocław: Zakład narodowy im. Ossolinskich, 1961–1970.

de la Broquière, Bertrandon. "Voyage d'Outremer et retour." In *Monumenta Hungariae Historica. Magyar történelmi emlékek. Első osztály: Okmánytárak.* 4. [Hungarian History]. Ed. Mihály Hatvany. Pest: Magyar Tudományos Akadémia Történelmi Bizottmánya, 1859.

de Meestere, Gerardum, ed. *Chronicon Monasterii Evershamensis*. Bruges: Kessinger, 1852.

de Wit, Frank. *Regnum Hungaria In Omnes Suos Comitatus*. 1688. OSZK Térképtár, TR 7095.

Dreska, Gábor, ed. *A pannonhalmi konvent hiteleshelyi működésének oklevéltára* [Archives of the performance of the monastery of Pannonhalma I. (1244–1389]. Győr: Győri Egyházmegyei Levéltár, 2007.

Fejér, Georgius, ed. *Codex diplomaticus Hungariae ecclesiasticus ac civilis*. Buda: Typ. Universitatis, 1829–1844.

Géraud, Hercule, ed. *Chronique latine de Guillaume de Nangis de 1113 à 1300 avec les continuations de sette chronique de 13000 à 1368*. Vol. 1. Paris: Société de l'Histoire de France.

Lazarus Secretarius. *Tabula Hungariae ad quatour latera*. OSZK App. M. 126.

Lazius, Wolfgang. *Regni Hungariae descriptio vera*. OSZK Térképtár, TA 7107/14.

Mair, Alexander. *Hungariae Regni superioris noua et accurata descriptio emendata et evulgata Anno 1595*. OSZK App. M. 139.

Nagy, Imre and Gyula Tasnádi Nagy, ed. *Anjoukori Okmánytár. Codex diplomaticus Hungaricus Andegavensis* [Angevin cartulary]. Budapest: Magyar Tudományos Akadémia, 1878–1920.

_____. ed. *Hazai okmánytár. Codex diplomaticus patrius* [Hungarian cartulary]. Budapest: Franklin, 1865–1891.

Rövid magyar kronika. Sok rendbéli fő históriás könyvekből nagy szorgalmatossággal egybe szedettetet és irattatot Pettő Gergely [Short Hungarian Chronicle]. Kassa, 1729.

Sedlák, Vincent, ed. *Regesta diplomatica nec non epistolaria Slovaciae*. Bratislava: Sumptibus Academiae Scientiarum Slovacae, 1980.

Speede, John. *The mape of Hungari*. 1626. OSZK Térképtár, TR 1521.

Szamota, István, ed. *Régi utazások Magyarországon és a Balkán-félszigeten, 1054–1717* [Ancient travels in Hungary and the Balkan Peninsula, 1054–1717]. Budapest: Franklin Társulat, 1891.

von Zahn, Joseph, ed. *Anonymi Leobiensis Chronicon nach dem Originale herausgegeben*. Graz: Leutschner & Lubensky, 1865.

Zenoi, Domenico. *Az 1566. évi magyarországi hadműveletek térképe*. 1566. OSZK App. M. 127.

8.2. Secondary sources

Abel, Wilhelm. *Agricultural Fluctuations in Europe: From the Thirteenth to the Twentieth Centuries*. London: Methuen, 1980.

Alexandre, Pierre. *Le climat en Europe au Moyen Age. Contribution à l'histoire des variations climatiques de 1000 à 1425, d'après les sources narratives de l'Europe occidentale*. Paris: École des Hautes Études en Sciences Sociales, 1987.

Andrásfalvy, Bertalan. *A Sárköz és a környező Duna-menti területek ősi ártéri gazdálkodása és vízhasználatai a szabályozás előtt* [The ancient economic system and water usage of the flood plain of the Danube and the Sárköz before water regulation]. Budapest: Vízdok, 1973.

Aujeszky, László, Dénes Berényi and Béla Béll. *Mezőgazdasági meteorológia* [Agricultural meteorology]. Budapest: Akadémiai Kiadó, 1951.

Avramescu, Cătălin. *An Intellectual History of Cannibalism*. Princeton: Princeton University Press, 2009.

Bálint, Marianna. "Az Árpád-kori településhálózat rekonstrukciója a Dorozsma–Majsai Homokhát területén." [Reconstruction of the Árpád Period settlement network in the Dorozsma–Majsa region] PhD diss., Eötvös Loránd Tudományegyetem, 2006.

Balló, István. "A hiteleshelyek néhány kérdése hazánk okleveles gyakorlatában (XIII.–XIV. század)." [Some questions of places of authentication in Hungarian diplomatics (13th century to 14th century)] *Turul* 67, No. 4 (1994): 117–123.

Barlow, Lisa K., John P. Sadler, Astride E. J. Ogilvie, Paul C. Buckland, Thomas Amorosi, John H. Ingimundarson, Peter Skidmore, Andrew J. Dugmore, and Thomas H. Mcgovern. "Interdisciplinary Investigations of the End of the Norse Western Settlement in Greenland." *The Holocene* 7, No. 4 (1997): 489–499.

Bartholy, Judit, Rita Pongrácz and Zsolt Molnár. "Extremes and Millenial Trends in the Carpathian Basin Using the Réthly Documentary Collection." *American Meteorological Society, 17th Conference on Probability and Statistics in the Athmospheric Sciences* (2003), Extended Abstracts http://ams.confex.com/ams/84Annual/techprogram/ paper_73653.htm (Last accessed: 12 April, 2010).

Bartholy, Judit, Rita Pongrácz and Zsolt Molnár."Classification and Analysis of Past Climate Information Based on Historical Documentary Sources for the Carpathian Basin." *International Journal of Climatology* 24 (2004): 1759–1776.

Behringer, Wolfgang. “Climatic Change and Witch-hunting: the Impact of the Little Ice Age on Mentalities.” *Climatic Change* 43, No. 2 (1999): 335–351.

_____. *Kulturgeschichte des Klimas*. Munich: C. H. Beck, 2007.

Bell, Wendy T. and Astrid E. J. Ogilive. “Weather Compilations as a Source of Data for the Reconstruction of European Climate During the Medieval Period.” *Climatic Change* 1, No. 4 (1978): 331–348.

Beluszky, Pál. *A Nagyalföld történeti földrajza*, [The historical geography of the Great Hungarian Plain]. Pécs: Dialóg Campus, 2001.

Bendefy, László and Imre, Nagy. *A Balaton évszázados partvonalváltozásai* [Millennial shoreline changes of Balaton]. Budapest: Műszaki Kiadó, 1969.

_____. “Természeti és antropogén tényezők hatása a Balaton vízállására.” [Natural and anthropogenic factors in the water-level tendencies of Lake Balaton] *Földrajzi Értesítő* 21, No. 3 (1972): 335–358.

Blazovich, László. “Az Alföld domborzati képe Szent Gellért korában.” [The morphology of the Great Hungarian Plain in the age of Saint Gerhard] In *Szent Gellért vértanúságának 950. évfordulóján* [On the 950th anniversary of the martyrdom of Saint Gerhard], ed. András Döbör, Csaba Jancsák, Gábor Ference Kiss, Tamás Nagy, and László Szegfű, 17–25. Szeged: Belvedere Meridionale, 1998.

_____. “Dél-alföldi városok a 14–16. században.” [Towns in the southern Great Hungarian Plain] In *A középkori Dél-Alföld és Szer* [The medieval Southern Great Hungarian Plain and the Szer], ed. Tibor Kollár, 17–40. Dél-alföldi évszázadok 13. Szeged: Csongrád Megyei Levéltár, 2000.

_____. “Megjegyzések a Körös-Tisza-Maros köz középkori településrendjéhez (X–XIV. század).” [Contributions to the medieval settlement system of the territory between the Körös-Tisza and Maros rivers (tenth to fourteenth centuries)] In *Falvak, mezővárosok az Alföldön* [Villages and *oppida* on the Great Hungarian Plain], ed. László Novák and László Selmeczi, 263–278. Arany János Múzeum Közleményei IV. Nagykörös: Arany János Múzeum, 1986.

_____. *A Körös-Maros-köz középkori településrendje* [The medieval settlement network of the Körös Maros Interfluve]. Szeged: Csongrád Megyei Tanács, 1985.

Bodolainé Jakus, Emma. *Árhullámok szinoptikai feltételei a Duna és a Tisza vízgyűjtőjén*. [Synoptical conditions of flood waves in the basin of the Danube and the Tisza]. Budapest: Országos Meteorológiai Szolgálat, 1983.

Bodri, Louise, Péter Dövényi, and Ferenc Horváth. “Két évezred éghajlatváltozásai Magyarországon fúrólyuk-hőmérskletek alapján.” [Climate change of the last 2000 years inferred from borehole temperatures – data from Hungary] In *Környezettörténet– Az utóbbi 500 év környezeti eseményei történeti és természettudományos források tükrében* [Environmental history – The environmental events of the last 500 years in

light of historical and scientific evidence], ed. Miklós Kázmér, 421–436. Budapest: Hantken Kiadó, 2009.

Bork, Hans-Rudolf, Helga Bork, Claus Dalchow, Berno Faust, Hans-Peter Piorr, and Thomas Schatz. *Landschaftsentwicklung in Mitteleuropa: Wirkung des Menschen auf Landschaften*. Gotha: Klett-Perthes, 1998.

Borsa, Iván. "A Magyar Országos Levéltár középkori gyűjteményei." [The medieval collections of the Hungarian National Archives] *Erdélyi Múzeum* 58, No. 3–4 (1996): 314–328.

Bradley, Raymond S. and Philip D. Jones. "The 'Little Ice Age': Local and Global Perspectives." *Climatic Change* 48, No. 1 (2001): 5–8.

Brázdil, Rudolf and Oldrich Kotyza. *History of Weather and Climate in the Czech Lands I: Period 1000–1500*. Züricher Geographische Schriften 62. Zürich: Geographisches Institut ETH, 1995.

_____. Christian Pfister, Heinz Wanner, Hans Von Storch, and Jürg Luterbacher. "Historical Climatology in Europe – The State of the Art." *Climatic Change* 70, No. 3 (2005): 363–430.

_____, Andrea Kiss, Jürg Luterbacher, and Hubert Valášek. "Weather Patterns in Eastern Slovakia 1717–1730, Based on Records from the Bresslau Meteorological Network." *International Journal of Climatology* 28, No. 12 (2008): 1639–1651.

_____, Petr Dobrovolný, Jürg Luterbacher, Anders Moberg, Christian Pfister, Dennis Wheeler, and Eduardo Zorita. "European Climate of the Past 500 Years: New Challenges for Historical Climatology." *Climatic Change* (in press)

Brown, Neville. *History and Climatic Change. A Eurocentric Perspective*. Routledge Studies in Physical Geography and Environment. London: Routledge, 2001.

Buckland, Paul C., Thomas Amorosi, Lisa K. Barlow, Andrew J. Dugmore, Paul A. Mayewski, Thomas H. McGovern, Astride E. J. Ogilvie, John P. Sadler and Peter Skidmore. "Bioarchaeological and Climatological Evidence for the Fate of Norse Farmers in Medieval Greenland." *Antiquity* 70, No. 267 (1996): 88–96.

Büntgen, Ulf, David C. Frank, Daniel Nievergelt, and Jan Esper. "Summer Temperature Variations in the European Alps A.D. 755–2004." *Journal of Climate* 19 (2006): 5606–5623.

Carrara, Paul E. and J. Micheal O'Neill. "Tree-ring Dated Landslide Movements and Their Relationship to Seismic Events in Southwestern Montana, USA." *Quaternary Research* 59, No. 1 (2003): 25–35.

Chernavskaya, Margarita M. "Botanical Indicators of the Little Ice Age in the Russian Plain." In *The Little Ice Age Climate*, ed. Takehiko Mikami, 65–70. Tokyo: Tokyo Metropolitan University, 1992.

_____. "Climate of European Russia over the Past Two Millennia." *Zeszyty Naukowe Uniwersytetu Jagiellonskiego* 102 (1996): 493–496.

Chuine, Isabelle, Pascal Yiou, Nicolas Viovy, Bernard Seguin, Valérie Daux, Emmanuel Le Roy Ladurie. "Grape Ripening as a Past Climate Indicator. Summer Temperature Variations are Reconstructed from Harvest Dates Since 1370." *Nature* 432, No. 7015 (2004): 289–290.

Csukovits, Enikő. "A középkori írástudók 'munkaideje'." [The working hours of medieval literates] *Levéltári Közlemények* 63, No.1–2 (1992): 3–14.

Csüllög, Gábor. "A Kárpát-medence vízrajzának szerepe Magyarország középkori településhálózatának kialakulásában." [The role of the hydrography of the Carpathian Basin in the formation of the settlement network of medieval Hungary] In *A táj változásai a Kárpát–medencében – A víz a tájban* [Landscape changes in the Carpathian Basin – the water in the landscape], ed. György Füleky, 56–58. Gödöllő: Szent István Egyetem, 2004.

Daniels, Stephen and Georgina H. Endfield, "Narratives of Climate Change: Introduction." *Journal of Historical Geography* 35, No. 2 (2009): 215–222.

Dávid, Géza, "Vámok és kincstári bevételek a temesvári vilájetben." [Taxes and fiscal incomes in the vilayet of Temesvár] In *Pénztörténet–Gazdaságtörténet. Tanulmányok Buza János 70. születésnapjára*. [Monetary history–Economic history. Studies in honor of János Buza on his 70th birthday], ed. József Bessenyei and István Draskóczy, 77–98. Budapest: Mirio, 2009.

Demkó, Kálmán. "Hain Gáspár és krónikája. Első közlemény." [Caspar Hain and his chronicle. First paper] *Századok* 16, No. 2 (1882): 133–143.

_____. "Hain Gáspár és krónikája. Második és befejező közlemény." [Caspar Hain and his chronicle. Second paper] *Századok* 16, No. 3 (1882): 223–235.

_____. *A Szepes-szombati krónika* [The chronicle of Szepesszombat]. Lőcse: Reiss J. T, 1891.

Déri, József. "A Duna jeges árvizei évezredünkben." [The icefloods of Danube in the last millennia] *Hidrológiai Közlöny* 69, No. 3 (1989): 151–158.

Dincauze, Dena. F. *Environmental Archaeology – Principles and Practice*. Cambridge: CUP, 2000.

Dobrovolný, Petr, Anders Moberg, Rudolf Brázdil, Christian Pfister, Rüdiger Glaser, Rob Wilson, Aryan van Engelen, Danuta Limanówka, Andrea Kiss, Monika Halíčková, Jarmila Macková, Dirk Riemann, Jürg Luterbacher and Reinhard Böhm. "Monthly and Seasonal Temperature Reconstructions for Central Europe Derived from Documentary Evidence and Instrumental Records since AD 1500." *Climatic Change* (in press)

Dotterweich, Markus. "The History of Soil Erosion and Fluvial Deposits in Small Catchments of Central Europe: Deciphering the Long-term Interaction between Humans and the Environment — A Review." *Geomorphology* 101, No. 1–2 (2008): 192–208.

Dreska, Gábor. "A pannonhalmi konvent hiteleshelyi tevékenysége 1321–1500 [The performance of the credible place of the convent of Pannonhalma]. PhD diss., Eötvös Loránd Tudományegyetem, 2008.

Earthtools. http://www.earthtools.org. Copyright 2005–2008, Jonathan Stott. (Last accessed: 12 April, 2010).

Eddy, Jack A. "Climate and the Changing Sun." *Climatic Change* 1, No. 1 (1977): 173–190.

Engel, Pál. "Az ország újraegyesítése. I. Károly küzdelmei az oligarchák ellen (1310–1323)." [Reuniting the country. The fights of Charles I, king of Hungary, against the oligarchs (1310–1323)] In *Honor, vár, ispánság. Válogatott tanulmányok* [Honor, castle, county. Collected essays], ed. Enikő Csukovits, 320–408. Budapest: Osiris Kiadó, 2003) (First published: *Századok* 122, No. 1–2 (1988): 89–147).

_____, Gyula Kristó, and András Kubinyi. *Magyarország története 1301–1526* [The history of Hungary 1301–1526]. Budapest: Osiris Kiadó, 2003.

_____. *Magyarország a középkor végén* [Hungary at the end of the Middle Ages]. Budapest: Térinfo BT, 2001 (CD-ROM).

Enterline, James Robert. *Erikson, Eskimos and Columbus. Medieval European Knowledge of America*. Baltimore: Johns Hopkins University Press, 2002.

Euro-Climhist database: http://www.wsu.hist.unibe.ch/. Universität Bern, Historisches Institut. (Last accessed: April 20, 2010).

Fodor, Zoltán. "Az ártéri gazdálkodást tárgyaló elméletek és alkalmazhatóságuk a magyarországi Tisza-szakasz kéziratos térképein szereplő fokok alapján." [The theories and the applicability of the flood plain economic systems of the Hungarian Tisza Valley in light of *fok*s on maps] *Agrártörténeti Szemle* 43, No. 1 (2001): 89–149.

Frisnyák, Sándor. "Magyarország kultúrgeográfiai korszakai (896–1920)." [The cultural geographical periods of Hungary – 896–1920] *Tér és Társadalom* 1, No. 1 (1996): 29–49.

_____. *Magyarország történeti földrajza* [The historical geography of Hungary]. Budapest: 1992, Tankönyvkiadó.

Glaser, Lajos. "Az Alföld régi vízrajza és a települések." [The ancient hydrography of the Great Hungarian Plain and the settlements] *Földrajzi Közlemények* 67, No. 4 (1939): 297–307.

Glaser, Rüdiger. *Klimageschichte Mitteleuropas. 1000 Jahre Wetter, Klima, Katastrophen*. Darmstadt: Primus Verlag, 2001.

Grove, Jean M. “The Initiations of the ‘Little Ice Age’ in Regions Round the North Atlantic.” *Climatic Change* 48, No. 1 (2001): 53–82.

_____. *The Little Ice Age*. London: Routledge, 2003.

Grynaeus, András. “Dendrochronology and Environmental History.” *People and Nature in Historical Perspective*, ed. József Laszlovszky and Péter Szabó, 175–193. Budapest: CEU Press, 2003.

_____. “Dendrokronológiai kutatások Magyarországon.” [Dendrochronological research in Hungary] In *Környezettörténet – Az utóbbi 500 év környezeti eseményei történeti és természettudományos források tükrében* [Environmental history – The environemental events of the last 500 years in light of historical and scientific evidence], ed. Miklós Kázmér, 337–343. Budapest: Hantken Kiadó, 2009.

_____. “Új forráscsoport? A dendrokronológia eredményei és a történettudomány.” [A new group of evidence? The results of dendrochronology an the history] In *Táj és történelem: tanulmányok a történeti ökológia világából* [Landscape and history: studies from the field of environmental history], ed. Ágnes R. Várkonyi, 305–325. Budapest: Osiris, 2000.

Guiot, Joël, Antoine Nicault, Cyrille Rathgeber, Jean-Louis Edouard, Frédéric Guibal, G. Pichard and C. Till. “Last-millenium Summer-temperature Variations in Western Europe Based on Proxy Data.” *The Holocene* 15, No. 4. (2005): 489–500.

Györffy, György and Bálint Zólyomi. “A Kárpát-medence és az Etelköz képe egy évezred ezelőtt.” [The general gographical conditions of the Carpathian Basin and Etelköz over 1000 years] In *Honfoglalás és régészet* [The Hungarian conquest and archaeology], ed. László Kovács, 13–37. Budapest: Balassi, 1994.

_____ and Bálint Zólyomi. “A Kárpát-medence és Etelköz képe egy évezred előtt.” [The Carpathian Basin and the Etelköz one thousand years ago] *Magyar Tudomány* 8, No. 8 (1996): 899–918.

_____. *Az Árpád-kori Magyarország történeti földrajza I–IV* [The Historical topography of Hungary in the Arpad period]. Budapest: Akadémiai Kiadó, 1963–1987.

Gyulai, Ferenc. *Archaeobotanika. A kultúrnövények története a Kárpát-medencében a régészeti-növénytani vizsgálatok alapján* [Archaeobotany. The history of cultivated plants in the Carpathian Basin based on bioarchaeological investigations]. Budapest: Jószöveg Műhely Kiadó, 2001.

Fejér, László and Imre Kaján, ed. “Mérlegen a Tisza-szabályozás: egy XIX. századi mérnöki természetátalakító munka mai szemmel: előadások és vita a Budapesti Műszaki Egyetemen: Budapest, 1992. március – május.” [The scale of regulating the Tisza: The environmental consequences of nineteenth century engineering in light of the present: papers and discussion at the University of Technology of Budapest: March – May, 1992]. Budapest: Magyar Hidrológiai Társaság and Országos Vízügyi Főigazgatóság, 1992.

Havassy, Péter. "Határjárások és határjelek a középkori Békés vármegyében." [Perambulations and boundary markers in medieval Békés county] *A Békés Megyei Múzeumok Közleményei* 23 (2002): 459–480.

_____. "Az Alföld középkori határjeleinek kérdéséhez." [On the question of medieval boundary markers on the Great Hungarian Plain] In *Tanulmányok Farkas József tiszteletére* [Studies in honor of József Farkas], ed. László Cservenyák, 39–45. Studia Szatmariensia 1. Mátészalka: Szatmári Múzeum, 2001.

Héjj, Miklós. "Településföldrajzi megfigyelések. Visegrád XIV–XVI. században." [Settlement-geographical observations. Visegrád in the fourteenth to sixteenth century] In *Visegrád, 1335: Tudományos tanácskozás a visegrádi királytalálkozó 650. évfordulóján: Visegrád, 1985. szeptember 30 - október 1* [Visegrád 1335: conference on the occasion of the 650th anniversary of the royal meeting at Visegrád], ed. József Köblös, 63–67. Budapest: Pest Megyei Levéltár, 1988.

Hester, Ronald E. and Roy M. Harrison. *Global Environmental Change*. Cambridge: The Royal Society of Chemistry, 2002.

Hirschboeck, Katherine K. "Frost Rings in Trees as Records of Major Volcanic Eruptions." *Nature* 307, No. 2 (1984): 121–126.

Hoffmann, István. "A tihanyi alapítólevél, mint helynévtörténeti forrás." [The foundation charter of Tihany as a source of placename history] Debrecen, Dissertation for the Hungarian Academy of Sciences, 2007.

Hoffmann, Richard C. "Economic Development and Aquatic Ecosystems in Medieval Europe." *The American Historical Review* 101, No. 3. (1996): 631–669.

_____. *Land, Liberties, and Lordship in a Late Medieval Countryside: Agrarian Structures and Change in the Duchy of Wroclaw*. Philadelphia: University of Pennsylvania Press, 1989.

Holzhauser, Hanspeter. "Fluctuations of the Grosser Aletsch Glacier and the Gorner Glacier During the Last 3200 Years: New Results." In *Glacier Fluctuations During the Holocene*, ed. Burkhard Frenzel, Geoffrey S. Boulton, Birgit Gläser and Ursula Huckriede, 35–58. Stuttgart: Gustav Fischer Verlag, 1997.

Homza, Martin and Stanisław A. Sroka, ed. *Historia Scepusii*. Bratislava: Katedra slovenských dejín, 2009.

Hrenkó Pál. "Magyarország Gastaldi térképén." [Hungary on the Gastaldi map] *Geodézia és Kartográfia*, 27, No. 2 (1975): 110–121.

Hughes, Donald J. *An Environmental History of the World Humankind's Changing Role in the Community of Life*. New York: Routledge, 2009 (first published: 2001).

Hunyadi, Zsolt. "*Scripta manent* – Archival and Manuscript Resources in Hungary." *Annual of Medieval Studies at CEU 1997–1998* 5 (1998): 231–240.

Ihrig, Dénes, ed. *A magyar vízszabályozás története* [The history of water regulation in Hungary]. Budapest: Országos Vízügyi Hivatal, 1973.

_____. "Az 1956. évi dunai jeges árvíz Magyarországon." [The Danube iceflood in Hungary in 1956] *Vízügyi Közlemények* 38, No. 4 (1956): 389–424.

Ionel Popa and Zoltán Kern. "Long-term Summer Temperature Reconstruction Inferred from Tree-ring Records from the Eastern Carpathians." *Climate Dynamics* 32, No. 7–8 (2009): 1107–1117.

IPCC reports: www.ipcc.ch. Intergovernmental Panel on Climate Change (Last accessed: 12 January, 2010)

Issar, Arie S. *Climate Changes during the Holocene and their Impact on Hydrological Systems*. Cambridge: CUP, 2003.

Jankovich, B. Dénes, ed. *Békés megye régészeti topográfiája. Békés és Békéscsaba környéke* [The archaeological topography of Békés county: Békés and Békéscsaba]. Magyarország régészeti topográfiája 10. Budapest: Akadémiai Kiadó, 1998.

_____. "Adatok a Körösvidék középkori vízrajzához és a vizek hasznosításához." [Data to the hydrography and the water-management of the medieval Körös-region] *Békés Megyei Múzeumok Közleményei* 16 (1996): 305–349.

Jerem, Erzsébet. *Környezetrégészeti és archeometriai módszerek alkalmazása a telelpüléstörténeti kutatásan* [The utilisation of environmental archaeology and archaeometry in settlement-historical investigation]. Budapest: Dissertation for the Hungarian Academy of Sciences, 1995.

_____, József Laszlovszky, Péter Szabó, Zsolt Vásáros, and Zsófia Végvári. "A Historical Landscape at the Crossroads of Cultures: A Digital Landscape at the Crossroads of Computer-Aided Reconstructions and GIS Approaches." (in press)

Jirikowic, John L., and Paul E. Damon. "The Medieval Solar Activity Maximum." *Climatic Change* 26, No. 2–3 (1994): 309–316.

Jordan, William C. *The Great Famine. Northern Europe in the Early Fourteenth Century*. Princeton: Princeton University Press, 1996.

Juneja, Monica, and Franz Mauelshagen. "Disasters and Pre-industrial Societies: Historiographic Trends and Comparative Perspectives." *The Medieval History Journal* 10, No. 1 (2007): 1–31.

Károlyi, Zsigmond and Gerzson Nemes. *Az ősi ártéri gazdálkodás és a vízi munkálatok kezdetei (895–1846)* [The ancient economic system of flood plains (895–1846) and the beginnings of water-works]. Budapest: Vízdok, 1975.

Kázmér, Miklós. "Geológia, archeológia és história – a környezettörténet forrásai." [Geology, archaeology and history – sources of environmental history] In *Környezettörténet – Az utóbbi 500 év környezeti eseményei történeti és természettudományos források*

tükrében [Environmental history – The environmental events of the last 500 years in light of historical and scientific evidence], ed. Miklós Kázmér, 11–20. Budapest: Hantekn Kiadó, 2009.

_____. "Lejtőmozgások datálása fák évgyűrűivel." [Tree Rings Date landslides] *Földtani Kutatás* 40, No. 3 (2003): 3–7.

Kern, Zoltán, András Grynaeus and András Morgós. "Reconstructed August-July Precipitation for Southern Bakony Mountains (Transdanubia, Hungary) Back to AD 1746 on Ring Widths of Oak Trees." *Időjárás* 113, No. 4 (2009): 299–314.

Kershaw, Ian. "The Great Famine and Agrarian Crisis in England 1315–1322." *Past & Present* 59, No. 5 (1973): 3–50.

Kisari Balla, György. *Marsigli tábornok térképei* [The maps of General Marsigli]. Budapest: Kisari Balla György, 2005.

Kiss, Andrea. "Historical Study of the Changing Landscape of Fertő during the Later Middle Ages (13th c. – 15th c.)." MA Thesis, CEU, 1998.

_____. "Study on the Historical Geography of the First Extant Perambulation Sketch from the Carpathian Basin." *Zbornik Odsjeka za povijesne znanosti ZPDZ HAZU* 19 (2002): 127–41.

_____ and Ferenc Piti. "A fertői fok." [The *fok* of Fertő] *Soproni Szemle* 59, No. 2 (2005): 164–184.

_____ and Rob Wilson. *Analysis of May-June Termperature for Western Hungary, Based on Vine, Grain Tithes and Harvest Records*. Poster Presentation. European Geosciences Union General Assembly. Vienna, Austria, 19–24 April 2009.

_____, Zoltán Sümeghy, and György Danku. "Az 1783–1784. évi szélsőséges tél és a Maros jeges árvize." [The severe winter of 1783–1784 and the iceflood on the Maros river] In *Táj, környezet és társadalom* [Landscape, Environment and Society], ed. Andrea, Kiss, Gábor Mezősi, and Zoltán Sümeghy, 353–362. Szeged: Szegedi Tudományegyetem, 2006.

_____, Zoltán Sümeghy, and Zoltán Zsolt Fehér. "A Maros 18. századi áradásai és egy jellemző téli árvizének területi hatásai." [The eighteenth- century floods of the Maros River and the territorial consequences of a typical iceflood) In *A táj változásai a Kárpát-medencében. Az erdélyi táj változásai* [Landscape changes in the Carpathian Basin. The changes of the landscape of Transylvania], ed. György Füleky. Gödöllő: Szent István Egyetem, 2008.

_____, Zoltán Sümeghy, Anett Czinege, and Zoltán Karancsi. "Wine and Land Use in Northern Hungary – A Case Study from the Danube Bend." *Acta Climatologica et Chorologica Universitatis Szegediensis* 38–39, No. 1. (2005): 97–109.

_____. "*Suburbia autem maxima in parte videntur esse deleta* – Danube Icefloods and the Pitfalls of Urban Planning: Pest and its Suburbs in 1768–1799." In *From Villages to Cyberspace*, ed. Csaba Kovács, 271–282. Szeged: Szeged University Press, 2007.

_____. "A 'Millennium FP6 EU projekt – Magyarországi írott források az európai ezeréves klímarekonstrukcióban" [The Millenium FP6 EU project – the Role of Hungarian written sources in European thousand-year climate reconstruction]. In *IV. Magyar Földrajzi Konferencia tanulmánykötet* [Fourth conference on Hungarian geography: studies], ed. Valéria Szabó, Zoltán Orosz, Richárd Nagy and István Fazekas, 163–169. Debrecen: Debreceni Egyetem, 2008.

_____. "Changing Environmental Conditions and the Waterlevel of Lake Fertő (Neusiedlersee) before the Drainage Works (13th–18th centuries)." *Annual of Medieval Studies at CEU 1997–1998* 5 (1998): 241–248.

_____. "*Ecce, in hyenis nivis et glaciei habundantia supervenit*," – Időjárás, környezeti krízis és tatárjárás." [*Ecce, in hyenis nivis et glaciei habundantia supervenit* – weather, enviornmental crisis and Mongol invasion] In *Tatárjárás* [Mongol invasion], ed. Balázs Nagy, 439–452. Budapest: Orisris Kiadó, 2003.

_____. "Historical Climatology in Hungary: Role of Documentary Evidence in the Study of Past Climates and Hydrometeorological Extremes." *Időjárás* 113, No. 4 (2009): 315–339.

_____. "Időjárási adatok a XI–XII. századi Magyarországról." [Weather events in eleventh- and twelfth-century Hungary] In *"...Magyaroknak eleiről..."* ["…On the Beginnings of Hungarians…"], ed. Ferenc Piti and György Szabados, 249–263. Szeged: Szegedi Középkorász Műhely, 2000.

_____. "*Rivulus namque, qui dicitur Fuk, fluens de prefatu lacu* – Fok, Sár, Foksár." [*Rivulus namque, qui dicitur Fuk, fluens de prefatu lacu* – Fok, Sár, Foksár] In *Antropogén ökológiai változások a Kárpát-medencében* [Ecological changes of anthropogenic origin in the Carpathian Basin], ed. Bertalan Andrásfalvy and Gábor Vargyas, 49–63. Budapest: Pécsi Tudományegyetem Néprajz–Kulturális Antropológia Tanszék–L'Harmattan, 2009.

_____. "Some Weather Events from the Fourteenth Century I (1338–1358)." *Acta Climatologica Universitatis Szegediensis* 30 (1996): 61–69.

_____. "Some Weather Events from the Fourteenth Century II (Angevin Period: 1301–87)." *Acta Climatologica Universitatis Szegediensis* 32–33. (1999): 51–64.

Kiss, Tímea, Diána Nyári and György Sipos. "Homokmozgások vizsgálata a történelmi időkben Csengele területén" [Investigation of historical time sand movements in the Csengele region]. In *Táj, környezet és társadalom* [Landscape, Environment and Society], ed. Andrea Kiss, Gábor Mezősi and Zoltán Sümeghy, 373–382. Szeged: Szegedi Tudományegyetem, 2006.

Klige, Rudolf K. and Sergei Myagkov. "Changes in the Water Regime of the Caspian Sea." *GeoJournal* 27, No. 3 (1992): 299–307.

Klimanov, Alexander V. "Climatic Changes in Northern Eurasia during the Historical Period Inferred from Palynological Data." *Material of Meteorological Studies* 16 (1997): 180–193.

Klimenko, Vladimir and Olga Solomina. "Climatic Variations in the East European Plain During the Last Millennium: State of the Art." In *The Polish Climate in the European Context. An Historical Overview*, ed. Rajmund Przybylak, Jacek Majorowicz, Rudolf Brázdil, and Marek Kejna, 71–102. Heidelberg: Springer, 2010.

Kovaloszki, Júlia. "Áprád-kori települések Doboz határában." [Árpád period settlements within the borders of Doboz] In *Falvak, mezővárosok az Alföldön* [Villages and *oppida* on the Great Hungarian Plain], ed. László Novák and László Selmeczi, 105–116. Az Arany János Múzeum Közleményei IV. Nagykörös: Arany János Múzeum, 1986.

Köpeczi, Béla, ed. *Erdély története* [The history of Transylvania]. Budapest: Akadémiai Kiadó, 1986.

Körmendi, Tamás. "Az Imre, III. László és II. András magyar királyok uralkodására vonatkozó nyugati elbeszélő források kritikája." [Criticism of Western European narrative sources relating to the reigns of Emerich, Ladislas III and Andrew II, kings of Hungary] PhD diss., Eötvös Loránd University, 2008.

Kristó, Gyula. "Erdély 1315-ben" [Transylvania in 1315]. In *Emlékkönyv Jakó Zsigmond születésének nyolcvanadik évfordulójára* [Studies in honor of the 80th birthday of Zsigmond Jakó], ed. András Kovács, Gábor Sipos and Sándor Tonk, 333–342. Kolozsvár: Erdélyi Múzeum-Egyesület, 1996.

_____. "I. Károly király harcai a tartományurak ellen (1310–1323.)." [The battles of King Charles I against the oligarchs (1310–1323)] *Századok* 137, No. 2 (2003): 297–347.

_____. *A feudális széttagolódás Magyarországon* [Feudal anarchy in Hungary]. Budapest: Akadémiai Kiadó, 1979.

_____. *A rozgonyi csata* [The battle of Rozgony]. Budapest: Akadémiai Kiadó, 1978.

_____. *Az Anjou-kor háborúi* [The wars of the Angevin Period]. Budapest: Zrínyi Kiadó, 1988.

_____. *Csák Máté* [Máté Csák]. Budapest: Gondolat, 1986.

_____. *Csák Máté tartományúri hatalma* [Territorial reign of Máté Csák]. Budapest: Akadémiai Kiadó, 1973.

_____. *Magyar historiográfia I. Történetírás a középkori Magyarországon* [Hungarian historiography I. Historiography in Hungary in the Middle Ages]. Budapest: Osiris Kiadó, 2002.

Kulcsár, Péter. *Bonfini Magyar történetének forrásai és keletkezése* [The sources and construction of the *Rerum Hungaricum* decades of Bonfini]. Budapest: Akadémiai Kiadó, 1975.

Lamb, Hubert H. *Climate History and the Modern World*. London: Routledge, 1995 [1982].

_____. *Climate Present, Past and Future*. London: Routledge, 1977.

Landsteiner, Erich. "The Crisis of Wine Production in the Late Sixteenth Century: Climatic Causes and Economic Consequences." *Climatic Change* 43, No. 1 (1999): 323–334.

László, Péter and Zoltán Kern. "Az elmúlt 150 év aktív galciális folyamatai a Radnai-havasok nyugati felén" [Active glacial processes in the last 150 years in the Western part of the Munții Rodnei]. In *Környezettörténet – 2010* [Environmental History – 2010], ed. Miklós Kázmér, 56. Budapest: Hantken Kiadó, 2010.

Lászlóffy, Woldemár. "A folyók jégviszonyai, különös tekintettel a magyar Dunára" [The ice-conditions of Hungarian rivers with special regard to the Danube]. *Vízügyi Közlemények* 16, No. 3 (1934): 369–435.

_____. *Magyarország vízborította és árvízjárta területei az ármentesítő és lecsapolási munkálatok megkezdése előtt (falitérkép, M=1:600000)* [The water-covered and periodically flooded areas of Hungary before the water regulations and drainage work – map]. Budapest, 1938.

Laszlovszky, József. "*Dedi etiam terram, que adiacet circa aquam, que vocatur Tiza* (Adatok az 1075-ös garamszentbenedeki oklevél helyneveinek lokalizálásához) [*Dedi etiam terram, que adiacet circa aquam, que vocatur Tiza*. Data for the localisation of the placenames in the charter of Garamszentbenedek from 1075]. *Zounuk* l (1986): 9–24.

_____. "Királyi palota, ferences kolostor és városi település (Gondolatok a késő középkori Visegrád településfejlődéséről." [Royal palace, Franciscan friary, and urban settlement – Ideas on the late medieval settlement development of Visegrád] In *Es tu scolaris - Ünnepi tanulmányok Kubinyi András 75. születésnapjára* ["*Es tu scolaris*." Studies in honor of András Kubinyi on his 70th birthday], ed. Beatrix F. Romhányi, András Grynaeus, Károly Magyar, and András Végh, 61–71. Monumenta Historica Budapestinensia XIII. Budapest: Budapesti Történeti Múzeum, 2004.

_____. "Földművelés a késő középkori Magyarországon." [Agriculture in late medieval Hungary] In *Gazdaság és gazdálkodás a középkori Magyarországon: gazdaságtörténet, anyagi kultúra, régészet* [Economy and farming in medieval Hungary: economic history, material culture, archaeology], ed. András Kubinyi, József Laszlovszky, and Péter Szabó, 49–82. Budapest: Martin Opitz, 2008.

_____. "*Per tot discrimina rerum* – Zur Interpretation von Umweltveränderungen im mittelalterlichen Ungarn." In *Umweltbewältigung. (Die historische Perspektive)*, ed. Gerhard Jaritz and Verena Winiwarter, 37-55. Bielefeld: Verlag für Regionalgeschichte, 1994.

_____. "Tanyaszerű települések az Árpád-korban." [Farmsteads in the Árpád period] In *Falvak, mezővárosok az Alföldön* In *Falvak, mezővárosok az Alföldön* [Villages and *oppida* on the Great Hungarian Plain], ed. László Novák and László Selmeczi, 131–150. Az Arany János Múzeum Közleményei IV. Nagykörös: Arany János Múzeum, 1986.

Le Roy Ladurie, Emmanuel. *Histoire humaine et comparée du climat I. Canicules et glaciers: XIII^{e}–XVIII^{e}*. Paris: Fayard, 2004.

_____. *Histoire humaine et comparée du climat II. Disettes et Révolutions: 1740–1860*. Paris: Flammarion, 2006.

Leijonhufvud, Lotta, Rob Wilson, Anders Moberg, Johan Söderberg, Dag Retsö and Ulrica Söderlind. "Five Centuries of Stockholm Winter/Spring Temperatures Reconstructed from Documentary Evidence and Instrumental Observations." *Climatic Change* (in press).

Lucas, Henry. "The Great European Famine of 1315, 1316 and 1317." *Speculum* 5, No. 4 (1930): 343–377.

Luterbacher, Jürg, Ralph Rickli R, Eleni Xoplaki, Chantal Tinguely, Christoph Beck, Christian Pfister, and Heinz Wanner. "The Late Maunder Minimum (1675–1715): A Key Period for Studying Decadal Scale Climatic Change in Europe." *Climatic Change* 49, No. 4 (2001): 441–462.

Makkay, János, ed. *Békés megye régészeti topográfiája. A szarvasi járás* [The archaeological topography of Békés county: Szarvas]. Magyarország régészeti topográfiája 8. Budapest: Akadémiai Kiadó, 1989.

Mangini, Augusto, Christoph Spötl, and Pablo F. Verdes. "Reconstruction of Temperature in the Central Alps During the Past 2000 Years from $\delta^{18}O$ Stalagmite Record." *Earth and Planetary Science Letters* 235 (2005): 741–751.

McCormick, Michael, Paul Edward Dutton and Paul A. Mayewski. "Volcanoes and the Climate Forcing of Carolingian Europe, A.D. 750–950." *Speculum* 82, No. 4 (2007): 865–95.

McGhee, Robert. *The Last Imaginary Place. A Human History of the Arctic World*. New York: OUP, 2005.

Melich, János. "Három helynévről: Lehota, Vólya, Ohába." [On three place names: Lehota, Vólya, Ohába] *Századok* 41, No. 4 (1907): 321–324.

Mészáros, Orsolya and Gábor Serlegi. "Környezeti változások hatása a középkori településviszonyokra a Dunántúlon." [The role of environmental crises in the settlement structure of the Transdanubian Region] Unpublished paper presented at the Környezettörténet – 2010 [Environmental History conference]. Budapest, February 4–5, 2010.

_____. "Szigliget várának története a középkorban." [The history of the castle of Szigliget in the Middle Ages] *Fons* 12, No. 3 (2005): 299–377.

Molnár Gábor, Gábor Timár and Balázs Székely. "Lázár térképének georeferálásáról." [On the geo-referencing of the Lazarus map] *Geodézia és Kartográfia* 4, No. 1 (2008): 26–30.

Monument Board of the Slovak Republic. www.pamiatky.sk/pamiatky/fondy/nehnutelne-amiatky/?a=nehnutelne&id=6274 (Last accessed: 24 April, 2010).

Nagy, Balázs, ed. *Tatárjárás* [Mongol invasion]. Budapest: Osiris Kiadó, 2003.

_____. "The Towns of Medieval Hungary in the Reports of Contemporary Travelers." In *Segregation – Integration – Assimilation. Religious and Ethnic Groups in the Medieval Towns of Central and Eastern Europe*, ed. Derek Keene, Balázs Nagy, and Katalin Szende, 169–179. Farhham: Ashgate, 2009.

Neumann, James. "Climatic Change as a Topic in the Classical Greek and Roman Literature." *Climatic Change* 7, No. 4 (1985): 441–454.

Oberhänsli, Hedi, Nikolaus Boroffka, Philippe Sorrel, and Sergey Krivonogov. "Climate Variability During the Past 2,000 Years and Past Economic Irrigation Activities in the Aral Sea Basin." *Irrigation and Drainage Systems* 21, No. 3-4 (2007): 167–183.

Pálóczi Horváth, András. "Középkori települések környezettörténeti kutatása." [Environmental historical research of the medieval settlements of Hungary] In *A Magyar Mezőgazdasági Múzeum Közleményei 2001–2004*, ed. János Estók, 73–92. Budapest: Magyar Mezőgazdasági Múzeum, 2004.

_____. "A késő középkori Szentkirály határhasználata és gazdálkodása." [The land-management and farming in late medieval Szentkirály]. In *Gazdálkodás az Alföldön. Földművelés* [Farming on the Great Hungarian Plain], ed. László Novák, 53–68. Az Arany János Múzeum Közleményei IX. Nagykőrös: Arany János Múzeum, 2002.

_____ and Andrea Torma. "Environmental Archaeological Research at Visegrád in the Medieval Garden of the Royal Palace." In *Archaeology of the Bronze and Iron Age*, ed. Erzsébet Jerem and Ildikó Poroszlai, 343–350. Budapest: Archaeolingua Alapítvány és Kiadó, 1999.

_____. "Középkori településeink környezetrégészeti kutatásának lehetőségei." [The possibilities of environmental archaeology of the medieval settlements of Hungary] In *Táj és történelem: tanulmányok a történeti ökológia világából* [Landscape and history: studies from the field of environmental history], ed. Ágnes R. Várkonyi, 273–286. Budapest: Osiris, 2000.

_____. "Középkori települések környezeti rekonstrukciója." [Reconstructing the environments of medieval settlements] In *Oktatónapok Százhalombattán* [Educational days in Százhalombatta], ed. Erzsébet Jerem, Zsolt Mester, and Fruzsina Cseh, 129–139. Budapest: Archaeolingua, 2008.

_____. "Régészeti és településtörténeti adatok a kunok letelepedéséhez. Egy középkori kun falu, Szentkirály feltárásának eredményei." [Archaeological and settlement history data on the settling of the Cumans. A medieval Cuman village: Szenkirály] In *Falvak, mezővárosok az Alföldön* [Villages and oppida in the Great Hungarian Plain], ed. László Novák and László Selmeczi, 215–236. Az Arany János Múzeum Közleményei IV. Nagykörös: Arany János Múzeum, 1986.

Papp-Váry, Árpád and Pál Hrenkó. *Magyarország régi térképeken* [Hungary on old maps]. Budapest: Gondolat Könyvkiadó, 1990.

Pautsch, Eveline. "Elementarereignisse in den Erzählenden Österr. Geschichtsquellen des 14. und 15. Jh." PhD Diss., Vienna, 1953.

Péczely, György. *Éghajlattan* [Climatology]. Budapest: Tankönyvkiadó, 1979.

Petrovics, István. "Royal Residence and Urban Development During the Reign of the Anjou Kings in Hungary." *Historica Urbana* 5, No. 1 (1997): 39–66.

_____. "The Fading Glory of a Former Royal Seat: the Case of Medieval Temesvár." In *The Man of Many Devices, Who Wandered Full Many Ways. Festschrift in Honor of János M. Bak*, ed. Balázs Nagy and Marcell Sebők, 527–538. CEU Press: Budapest, 1999.

Pfister, Christian, Gabriela Schwarz-Zanetti, Felix Hochstrasser and Milène Wegmann. "Winter Severity in Europe: the Fourteenth Century." *Climatic Change* 34, No. 1 (1996): 91–108.

_____, Gabriela Schwarz-Zanetti, Felix Hochstrasser and Milène Wegmann. "The Most Severe Winters of the Fourteenth Century in Central Europe Compared to Some Analogues in the Most Recent Past." In *Documentary Climatic Evidence for 1750–1850 and the 14th Century*, ed. Burkhard Frenzel, Erik Wishman and Mirjam M. Weiss, 45–61. Stuttgart: Gustav Fisher, 1997.

_____, Jürg Luterbacher, Gabriela Schwarz-Zanetti, Christian Pfister, Jürg Luterbacher, Milène Wegmann. "Winter Air Temperature Varations in Western Europe During the Early and High Middle Ages (AD 750–1300)." *The Holocene* 8, No. 1 (1998): 535–552.

_____, Rudolf Bràzdil, Chantal Camenisch, Dario Camuffo, Rüdiger Glaser, Andrea Kiss, Jarmila Mackova, Kathleen Pribyl, Gabriela Schwarz-Zanetti. *Seasonal Climate Variability and Famines in Medieval Europe (1200 to 1499)*. Conference presentation: World Conference of Environmental History 2009, Copenhagen. www.nccr-climate.unibe.ch/conferences/ acht_jahre/ pdfs/Pfister.pdf (Last accessed 20 April, 2010).

_____, Jürg Luterbacher, Heinz Wanner, Dennis Wheeler, Rudolf Brázdil, Q. Ge, Zheng Hao, Anders Moberg, Stefan Grab, Maria del Rosario del Prieto. *Documentary Evidence as Climate Proxies. Proxy-specific White Paper Produced from the PAGES/CLIVAR workshop*. Conference presentation: PAGES (Past Global Changes),

Trieste 2008. http://www.pages-igbp.org/cgi-bin/WebObjects/products.woa/wa/product ?id=331 (Last accessed: 12 January, 2010).

_____. "Five Centuries of Little Ice Age Climate in Western Europe." In *The Little Ice Age Climate*, ed. Takehiko Mikami, 208–213. Tokyo: Tokyo Metropolitan University, 1992.

_____. "Variations in the Spring-summer Climate of Central Europe from the Middle Ages to 1850." In *Long and Short Term Variability of Climate* ed. Heinz Wanner and Ulrich Siegenthaler. Lecture Notes in Earth Sciences 16. Berlin: Springer, 1988, 57–82.

_____. *Wetternachhersage. 500 Jahre Klimavariationen und Naturkatastrophen*. Bern: Verlag Paul Haupt, 1999.

Piti, Ferenc. "Egy Károly Róbert-kori oklevél keltezése és a dévai csata időpontja." [The dating of an charter from the reign of Charles I and the date of the battle of Deva] In *Studia professoris – professor studiorum. Tanulmányok Érszegi Géza hatvanadik születésnapjára* [*Studia professoris – professor studiorum*. Studies in honor of the 60th birthday of Géza Érszegi], ed. Tibor Almási, István Draskóczy, and Éva Jancsó, 281–284. Budapest: Magyar Országos Levéltár, 2005.

_____. "Szabolcs megye Anjou-kori archontológiájához." [On the archontology of Szabolcs county in the Angevin Period] In *Középkortörténeti tanulmányok. A III. Medievisztikai Phd-konferencia előadásai* [Studies in medieval history. The papers of the 3rd PhD conference of medievalists], ed. Boglárka Weisz, 113–124. Szeged: Szegedi Középkorász Műhely.

Plihál Katalin. "Magyarország Giacomo Gastaldi "La vera descrittione di tutta la Ungheria ..." című térképén." [Hungary on the map of Giacomo Gastaldi] *Cartographica Hungarica* 6, No. 1 (1998): 2–8.

Porter, Stephen C. "Pattern and Forcing of the Northern Hemisphere Glacier Variations During the Last Millennium." *Quarternary Research* 26, No, 1 (1986): 27–48.

Pósa, Zoltán. "Iszonyú károkat okozhat az ökológia lebecsülése." [Underestimating the ecology might cause serious destruction] *Magyar Nemzet online*: http://www.mn.mno.hu/portal/293346 (Last accessed: 12 April, 2010).

Pribyl, Kathleen. "Reconstructing April-July Mean Temperatures in East Anglia with the Help of the Beginning of the Grain Harvest, c. 1270 AD–1430 AD." In *European Climate of the Last Millennium. Millennium Milestone Meeting 3. Poster Abstracts*, ed. Giles Young and Danny McCarroll, 28–29. Swansea: Swansea University Press, 2009.

Rácz, Lajos. "A Kárpát-medence éghajlattörténete a közép- és kora-újkorban." [The climate history of the Carpathain Basin in medieval and Early Modern Times]. In *Magyar középkori gazdaság- és pénztörténet* [Economic and monetary history of medieval Hungary], ed. Márton Gyöngyössy, 31–53. Budapest: Eötvös Kiadó, 2006.

_____. "Az 1830-as évek éghajlati-környezeti válsága Magyarországon." [The environmental crisis in the 1830s in Hungary] *Korall* 9, No. 31 (2008): 132–160.

_____. "Éghajlati változások a Kárpát-medencében a középkor idején." [Climatic changes in the Carpathian Basin in the Middle Ages] In *Dixit et salvavi animam meam. Tanulmányok a 65 éves Szegfű László tiszteletére* [*Dixit et salvavi animam meam*. Essays in honor of the 65-year-old László Szegfű], ed. Csaba Jancsák, Gábor Kiss, Péter Zakar and András Döbör, 57–78. Szeged: Belvedere Meridionale.

_____. "Éghajlati változások a Kárpát-medencében a középkor idején." [Climatic changes in the Carpathian Basin in the Middle Ages] In *Gazdaság és gazdálkodás a középkori Magyarországon: gazdaságtörténet, anyagi kultúra, régészet* [Economy and farming in medieval Hungary: economic history, material culture, archaeology], ed. András Kubinyi, József Laszlovszky, and Péter Szabó, 21–36. Budapest: Martin Opitz, 2008.

_____. *Climate History of Hungary Since the 16th Century: Past, Present and Future*. Pécs: Discussion Papers, 1999.

_____. *Magyarország éghajlattörténete az újkor idején* [The climate history of Hungary in the Modern Times]. Szeged: Juhász Gyula Főiskola Kiadó, 2001.

_____. *Magyarország környezettörténete az újkorig* [The environmental history of Hungary until the Modern Times]. Budapest: Magyar Tudományos Akadémia Természettudományi Intézete, 2008.

Rácz, Miklós and József Laszlovszky. *Monostorossáp egy Tisza menti középkori falu* [Monostorossáp, a deserted medieval village and its landscape]. Dissertationes Pannonicae III. 7. Budapest: Eötvös Loránd Tudományegyetem, 2005.

Raczky, Pál, Tibor Kovács, and Alexandra Anders. *Utak a múltba. Az M3-as autópálya régészeti leletmentései* [Paths into the past, Rescue excavations on the M3 motorway]. Budapest: Eötvös Loránd Tudományegyetem Levéltár, 1997.

Réthly, Antal and Nándor Bacsó. *Időjárás-éghajlat és Magyarország éghajlata* [Weather-climate and the climate of Hungary]. Budapest: Magyar Meteorológiai Társaság, 1938.

_____. *Időjárási események és elemi csapások Magyarországon 1700-ig* [Weather events and natural disasters in Hungary until 1700]. Budapest: Akadémiai Kiadó, 1962.

Rigozo, Nivaor R., Ezquiel Echer, Luis Eduardo A. Vieira and Daniel J. R. Nordemann. "Reconstruction of Wolf Sunspot Numbers on the Basis of Spectral Characteristics and Estimates of Associated Radio Flux and Solar Wind Parameters for the Last Millennium." *Solar Physics* 203, No. 1 (2001): 179–191.

Rohr, Christian. "The Danube Floods and Their Human Response and Perception (14th to 17th C)." *History of Meteorology* 2, No. 1 (2005): 71–86.

_____. *Extreme Naturereignisse im Ostalpenraum. Naturerfahrung im Spätmittelalter und am Beginn der Neuzeit*. Cologne: Böhlau, 2007.

Romhányi, Beatrix F. *Kolostorok és társaskáptalanok a középkori Magyarországon. Katalógus* [Monasteries and chapters in medieval Hungary]. Budapest: Pytheas, 2000.

Rosta, Szabolcs. "A Kiskunsági Homokhátság középkori település- és úthálózata." [The medieval settlement and road network in medieval Kiskunsági Homokhátság] In *Középkori mozaikok* [Medieval mosaics], ed. Balázs Nagy. Budapest: Eötvös Loránd Tudományegyetem Történettudományi Intézete (in press)

Sági, Károly. "A Balaton vízállás-tendenciái a történeti és kartográfiai adatok tükrében." [Water-level tendencies of Lake Balaton in the light of historical and cartographical data] *Veszprém megyei múzeumok közleményei 7* (1968): 441–468.

_____. "Egy történeti vita természettudományi kapcsolatai." [Scientific connections of a historical debate] *Földrajzi Értesítő* 19, No. 2 (1970): 200–207.

Scherer, Ferenc. *Gyula város története I. A földesúri város* [The history of the town of Gyula I. The town of landlords]. Gyula: Gyula M. Város, 1938.

Shabalova, Marina V., and Aryan F.V. van Engelen."Evaluation of a Reconstruction of Winter and Summer Temperatures in the Low Countries, AD 764–1998." *Climatic Change* 58, No. 2 (2003): 219–242.

Shahgedanova, Maria. *The Physical Geography of Northern Eurasia*. New York: OUP, 2002.

Short, Thomas. *A General Chronological History of the Air, Weather, Seasons, Meteors in Sundry Places and Different Times; More Particularly for the Space of 250 years. Together with TheirMost Remarkable Effects on Animal (Especially Human) Bodies and Vegetables*. London: T. Longman, 1749.

Siklósy, Zoltán, Attila Demény, István Szenthe, Szabolcs Leél-Őssy, Sebastian Pilet, Yin Lin, and Chuan-Chou Shen. "Reconstruction of Climate Variation for the Last Millennium in the Bükk Mts. (NO Hungary) from a Stalagmite Record." *Időjárás* 113, No. 4 (2009): 256–258.

Solomina, Olga and Keith Alverson. "High Latitude Eurasian Paleoenvironments: Introduction and Synthesis." *Palaeogeography, Palaeoclimatology, Palaeoecology* 209, No. 1 (2004): 1–18.

Somogyi, Sándor. "Az Alföld természeti képe a honfoglalás és az ezredforduló időszakában." [The natural conditions of the Great Hungarian Plain at the turn of the first millennium] In *Földrajzi tanulmányok dr. Frisnyák Sándor hatvanadik születésnapja tiszteletére* [Geographical studies in honor of the 60th birthday of dr. Sándor Frisnyák], ed. Zoltán Dobány and Árpád Hanusz, 61–76. Észak- és Kelet-Magyarországi Földrajzi Évkönyv 1. Nyíregyháza: Bessenyei György Tanárképző Főiskola, 1994.

_____. "Hazánk vízrajza a honfoglalás idején és változásainak tájrajzi vonatkozásai." [The hydrography of Hungary in the age of the Hungarian conquest and the geographical consequences of its changes] In *A táj változásai a Honfoglalás óta a Kárpát-medencében* [Landscape changes of the Carpathian Basin since the Hungarian

conquest], ed. György Füleky, 41–58. Gödöllő: Gödöllői Agrártudományi Egyetem MSZKI, 1997.

Stathakopulos, Dionysios. "Reconstructing the Climate of the Medieval World: State of the Problem and Case Studies." In *People and Nature in Historical Perspective*, ed. József Laszlovszky and Péter Szabó, 247–261. Budapest: CEU Press, 2003.

Stegena, Lajos, ed. *Lazarus Secretarius: The First Hungarian Mapmaker and His Work*. Budapest: Akadémiai Kiadó, 1982.

Stenseth, Nils C., Noelle I. Samia, Hildegunn Viljugrein, Kyrre Linné Kausrud, Mike Begon, Stephen Davis, Herwig Leirs, V. M. Dubyanskiy, Jan Esper, Vladimir S. Ageyev, Nikolay L. Klassovskiy, Sergey B. Pole and Kung-Sik Chan. "Plague Dynamics are Driven by Climate Variation." *Proceedings of the National Academy of Sciences of the United States of America* 103, No. 35 (2006): 13110–13115.

Střeštík, Jaroslav and Verő József. "Reconstruction of the Spring Temperatures in the Eighteenth Century Based on the Measured Lengths of Grapevine Sprouts." *Időjárás* 104, No. 2 (2000): 123–136.

Strömmer, Elisabeth. *Klima-geschichte: Methoden der Rekonstruktion und historische Perpektive. Ostösterreich 1700 bis 1850*. Vienna: Deuticke, 2003.

Stuiver, Minze, and Paul D. Quay. "Changes in Atmospheric Carbon-14 Attributed to a Variable Sun." *Science* 207, No. 4426 (1980): 11–18.

Sümegi, Pál and Sándor Gulyás, ed. *The Geohistory of Bátorliget Marshland: An Example for the Reconstruction of Late Quaternary Environmental Changes and Human Impact from the Northeastern Part of the Carpatian Basin*. Budapest: Archeolingua, 2004.

_____, Gusztáv Jakab, Péter Majkut, Tünde Törőcsik, and Csilla Zatykó. "Middle Age Palaeoecological and Palaeoclimatological Reconstruction in the Carpathian Basin." *Időjárás* 113, No. 4 (2009): 265–298.

_____. "The Environmental History of the Jászság." In *Environmental Archaeology in North-Eastern Hungary*, ed. Erika Gál, Imola Juhász, and Pál Sümegi, 112–114. Varia Archaeologica Hungarica 19. Budapest: Magyar Tudományos Akadémia Régészeti Intézete, 2005.

_____. *A régészeti geológia és a történeti ökológia alapjai* [Introduction to archaeological geology and environmental history]. Szeged: József Attila Tudományegyetem Press, 2003.

Süttő, Szilárd. "*Datum* és *actum* késő Anjou-kori uralkodói okleveleinkben" [*Datum* and *actum* in Hungarian royal documents of the Late Angevin Period]. *Studia Miskolcinensia* 3 (1992): 84–92.

Swetnam, Thomas W. "Fire History and Climate Change in Giant Sequoia Groves." *Science* 262, No. 42 (1993): 886–889.

Szabó, István. *A falurendszer kialakulása Magyarországon (X–XV. század)* [The formation of the village-system in Hungary – tenth to fifteenth century]. Budapest: Akadémiai Kiadó, 1966.

Szabó, Péter. "Ancient Woodland Boundaries in Europe." *Journal of Historical Geography* (in press)

_____. "Medieval Trees and Modern Ecology: How to Handle Written Sources." *Medium Aevum Quotidianum* 46 (2002): 7–25.

_____. *Woodland and Forests in Medieval Hungary*. British Archaeological Reports International Series 1348. Oxford: Archaeopress, 2005.

Szántai, Lajos. *Atlas Hungaricus. Magyarország nyomtatott térképei (1528–1850) I-II* [Atlas Hungaricus. The printed maps of the Hungarian Kingdom (1528–1850)]. Budapest: Akadémiai Kiadó, 1996.

Szántó, Richárd. "Az 1315–17. évi európai éhínség." [The famine of 1315–1317] In *Medievisztikai tanulmányok. A IV. medievisztikai PhD konferencia előadásai* [Studies in medieval history. Papers presented at the 4th conference of Phd students], ed. Szabolcs Marton and Éva Teiszler, 135–142. Szeged: Szegedi Középkorász Műhely, 2005.

_____. "Környezeti változások Európában a 14. század első évtizedeiben." [Environmental changes in Europe in the first decades of the fourteenth century] In *Középkortörténeti tanulmányok 5. Az V. Medievisztikai PhD-konferencia előadásai* [Studies in medieval history 5. The papers presented at the 5th conference of PhD students], ed. Éva Révész and Miklós Halmágyi, 159–164. Szeged: Szegedi Középkorász Műhely, 2007.

_____. "Természeti katasztrófa és éhínség 1315–17-ben." [Natural disaster and famine in 1315–1317] *Világtörténet* 27 (2005): 50–64.

Székely, Balázs, Gábor Molnár, and Gábor Timár. "*Tabula Hungariae* (1528): Errors in Mapping or Surface Evolution Rearranging the Watercourses?." *Geophysical Research Abstracts* (2006) 8, 04854.

Székely, Balázs, Gábor Molnár, and Gábor Timár. "Lázár deák és a folyódinamika – térképezési hibák vagy valós mederváltozás?." [Lazarus and river-dynamics – mapping faults or real morphological change?] In *Környezettörténet – Az utóbbi 500 év környezeti eseményei történeti és természettudományos források tükrében* [Environmental history – The envrionemntal events of the last 500 years in light of historical and scientific evidence], ed. Miklós Kázmér, 75–98. Budapest: Hantken Kiadó, 2009.

Székely, György V. "Árpád-kori települések a történeti Halas határában." [Árpád Period settlements in the borders of Kiskunhalas] In *Kiskunhalas története I. Tanulmányok Kiskunhalasról a kezdetektől a török kor végéig* [Studies from Kiskunhalas from the beginnings to the end of the Turkish Period], ed. József Ö. Kovács and Aurél Szakál.

Available online: http://www.halas.hu/kiskunhalas/tort1/ index.html (last accessed: 12 April, 2010)

Szekeres, László. *Középkori települések Északkelet-Bácskában* [Medieval settlements in Northeastern Bácska]. Újvidék: Forum, 1983.

Széll, Márta. "Elpusztult falvak, XI–XVI. századbeli régészeti leletek Szeged és Hódmezővásárhely határában." [Deserted villages, eleventh- to sixteenth- century archaeological finds on the borders of Szeged and Hódmezővásárhely] *Dolgozatok Szeged* 16 (1940): 159–170.

_____. "Elpusztult falvak, XI–XVI. századbeli régészeti leletek Csongrád megye területén" [Deserted villages, eleventh- to sixteenth- century archaeological finds in the Csongrád county]. *Dolgozatok Szeged* 17 (1941): 169–173.

Szentkláray, Jenő. *A becskereki vár* [The castle of Becskerek]. Értekezések a történettudomány köréből. XII. 10. Budapest: Magyar Tudományos Akadémia, 1886.

Szentpétery, Imre. *Magyar oklevéltan*. A magyar történettudomány kézikönyve. II. 3. Budapest: Hatágú Síp Alapítvány, 1995 (first printing: 1930).

Takács, Károly. "Árpád-kori csatornarendszerek kutatása a Rábaközben és a Kárpát-medence egyéb területein I. rész." [The channel systems of the Rábaköz and other territories of the Carpathian Basin] *Korall* 1 (2000): 27–62.

_____. "Árpád-kori csatornarendszerek kutatása a Rábaközben és a Kárpát-medence egyéb területein II. rész." [The channel-systems of the Rábaköz and other territories of the Carpathian Basin] *Korall* 3–4 (2001): 297–314.

_____. "Árpád-kori csatornarendszerek kutatásáról." [Research on Arpad Period water channel systems] In *Táj és történelem: tanulmányok a történeti ökológia világából* [Landscape and history: studies from the field of environmental history], ed. Ágnes R. Várkonyi, 78–106. Budapest: Osiris, 2000.

Takács, Lajos. *Határjelek, határjárás a feudális kor végén Magyarországon* [Boundary signs, perambulations at the end of the feudal age in Hungary]. Budapest: Akadémiai Kiadó, 1987.

Tardif, Jacques. "Ice-flood History Reconstructed with Tree-rings from the Southern Boreal Forest Limit, Western Québec." *The Holocene* 7, No. 3 (1997): 291–300.

Teiszler, Éva. "Adattár a Károly Róbert idejében alapított felvidéki településekről." [Database on the settlements founded in the Upper Hungarian territories during the reign of Charles I] In *Középkortörténeti tanulmányok 5. Az V. Medievisztikai PhD-konferencia előadásai* [Studies in medieval history 5. The papers presented at the 5th conference of PhD students], ed. Éva Révész and Miklós Halmágyi, 191–201. Szeged: Szegedi Középkorász Műhely, 2007.

Telelis, Ioannis G. "Historical-climatological Information from the Time of the Byzantine Empire (4th–15th Centuries AD)." *History of Meteorology* 2, No. 1 (2005): 41–50.

Timár, Gábor, Balázs Székely, Gábor Molnár, Csaba Ferencz, Anikó Kern, Csilla Galambos, Gábor Gercsák and László Zentai. "Combination of Historical Maps and Satellite Images of the Banat Region – Re-appearance of an Old Wetland Area." *Global and Planetary Change* 62, No. 1–2 (2008): 29–38.

Torma, István, ed. *Békés megye régészeti topográfiája. Szeghalmi járás* [The arcaheological topography of Békés county: Szeghalom]. Magyarország régészeti topográfiája 6. Budapest: Akadémiai Kiadó, 1982.

Tóth, Ildikó. "Charters of the Angevin Period." *Chronica* 1 (2001): 180–184.

Vályi, Katalin. "Szer középkori településtörténete a régészeti leletek tükrében." [The medieval history of Szer in light of archaeological data] In *Falvak, mezővárosok az Alföldön* [Villages and *oppida* on the Great Hungarian Plain], ed. László Novák and László Selmeczi, 119–124. Az Arany János Múzeum Közleményei IV. Nagykörös: Arany János Múzeum, 1986.

VITUKI Országos Vízjelző Szolgálat [VITUKI National Water-level Indication Service]. http://www.hydroinfo.hu/Html/hidinfo/akt_eves_tb.html (Last accessed: 12 January, 2010).

Yan, Zhonwei, Pierre Alexandre, Gaston Demarée. "Narrative Warm/Cold Variations in Continental Western Europe, AD 708–1426." *Science in China (Series D)* 40, No. 5 (1997): 509–517.

Zatykó, Csilla, Imola Juhász and Pál Sümegi, ed. *Environmental Archaeology in Transdanubia*. Varia Archaeologica Hungarica 20. Budapest: Magyar Tudományos Akadémia Régészeti Intézete, 2007.

_____. "The Medieval Environment of Lake Baláta in the Light of Geology and Documentary Sources." In *Human Nature. Studies in Historical Ecology & Environmental History*, ed. Péter Szabó and Radim Hédl, 124–129. Brno: Institute of Botany of the ASCR, 2008.

Zawadowski, Alfréd. *Magyarország vizeinek statisztikája. I* [Statistics on Hungarian waters]. Budapest: Statisztikai Hivatal, 1891.

Zhang, David D., Peter Brecke, Harry F. Lee, Yuan-Qing He, and Jane Zhang. "Global Climate Change, War and Population Decline in Recent Human History." *Proceedings of the National Academy of Sciences of the United States of Ameria* 104, No. 49 (2007): 19214–19219.

9. Appendicies

Fig 1: The medieval bridge at Palermo, Sicily, built in 1113
(after: Hubert H. Lamb, *Climate, History,* 167.)

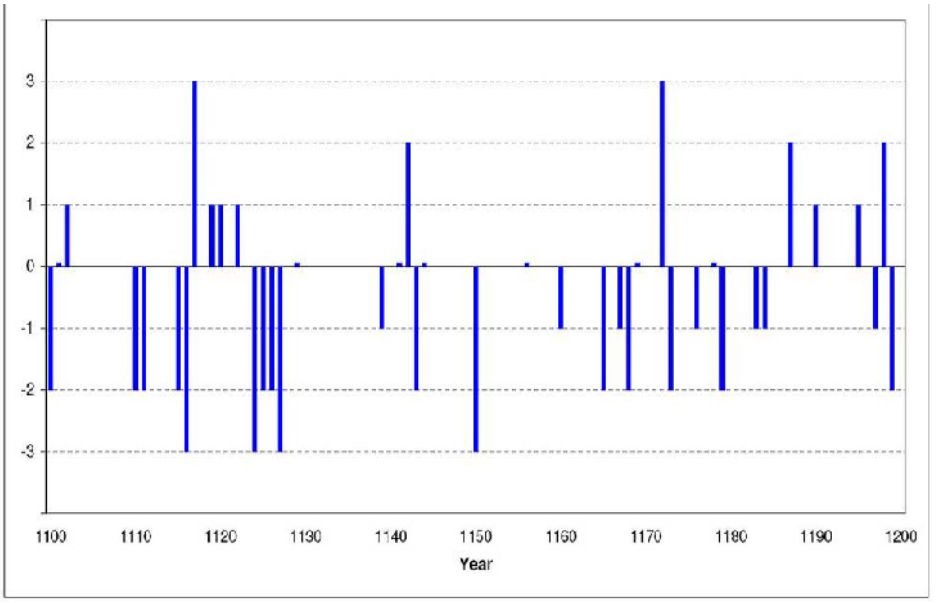

Fig 2: The temperature indices for the twelfth century based on historical records
(after: Christian Pfister, et al. "Seasonal Climate,")

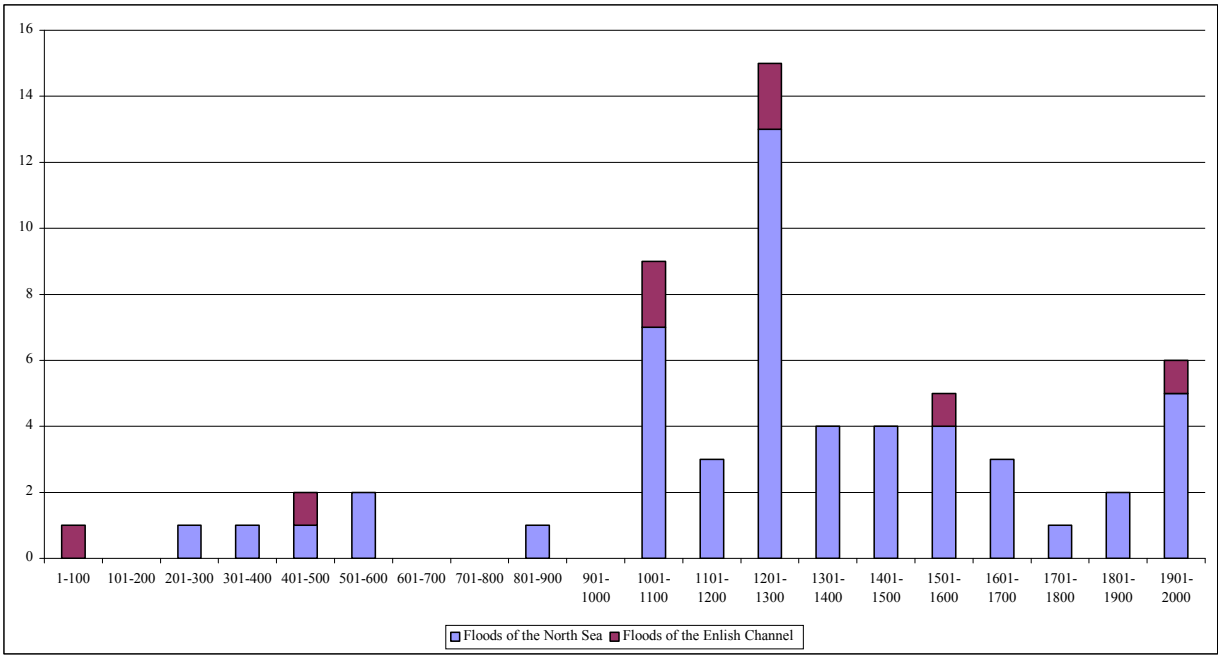

Fig 3: The sea floods in the region of the North Sea and the English Channel in last 2000 years
(after: Hubert H. Lamb, *Climate, history*)

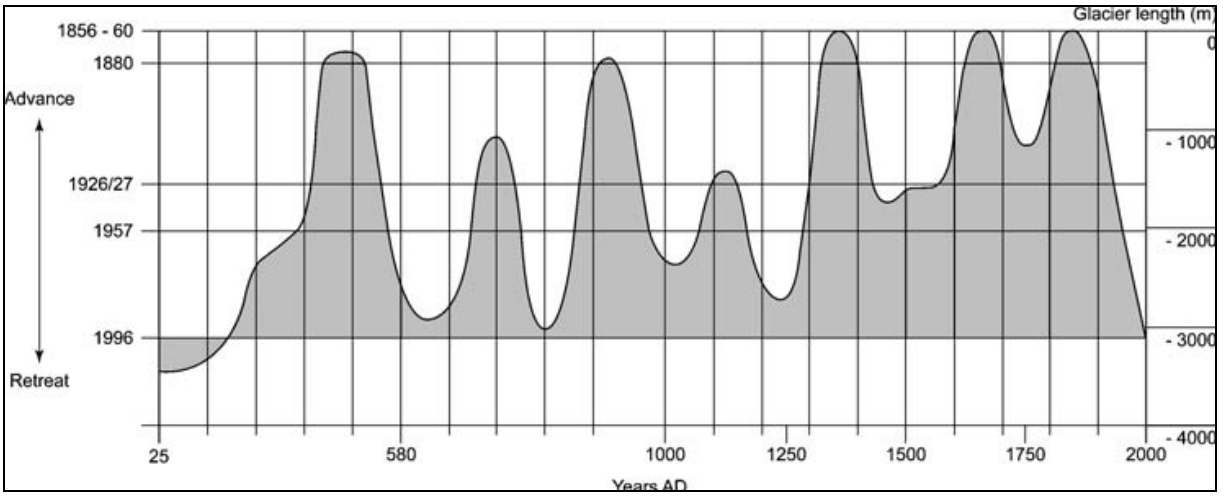

Fig 4: The fluctuation of the Grosser Aletsch glacier (Alps, Switzerland) in the last 2000 years
(after: Rudolf Brázdil et al., "Historical climatology,")

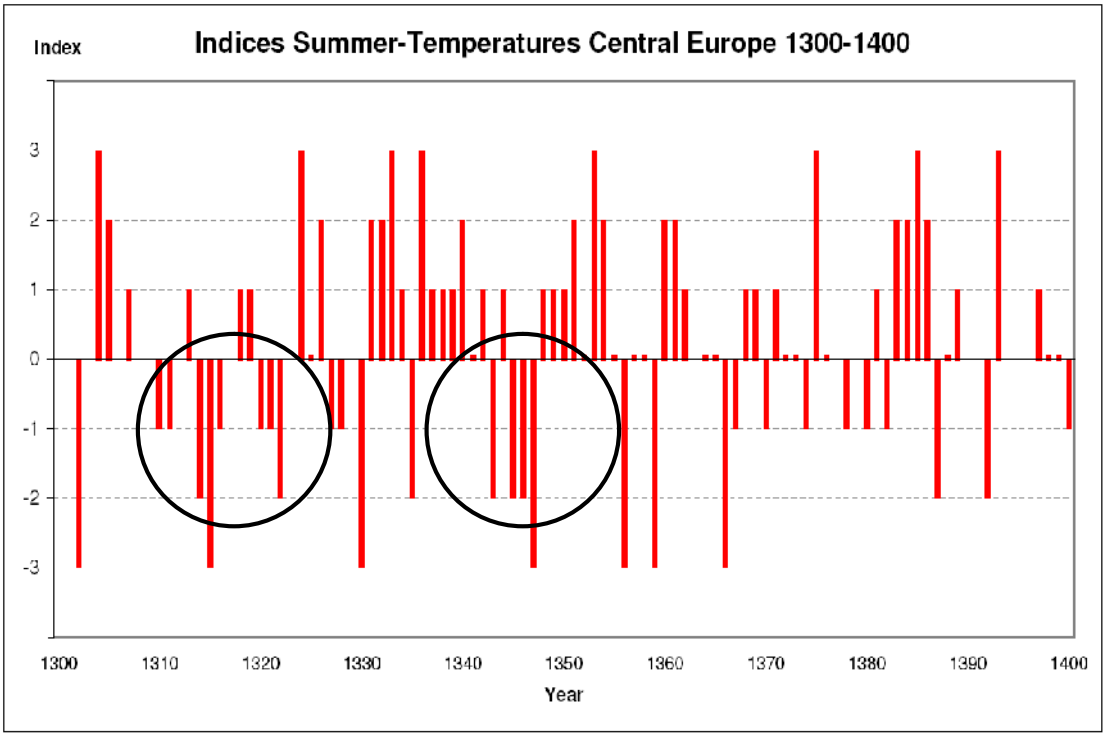

Fig 5: The indices of summer tempearute in the fourteenth century based on historical records from Western and Central Europe. The highlighted two decades, the 1310s and the 1340s are the coldest in the decade (after: Pfister Christian, "Seasonal climate variability,")

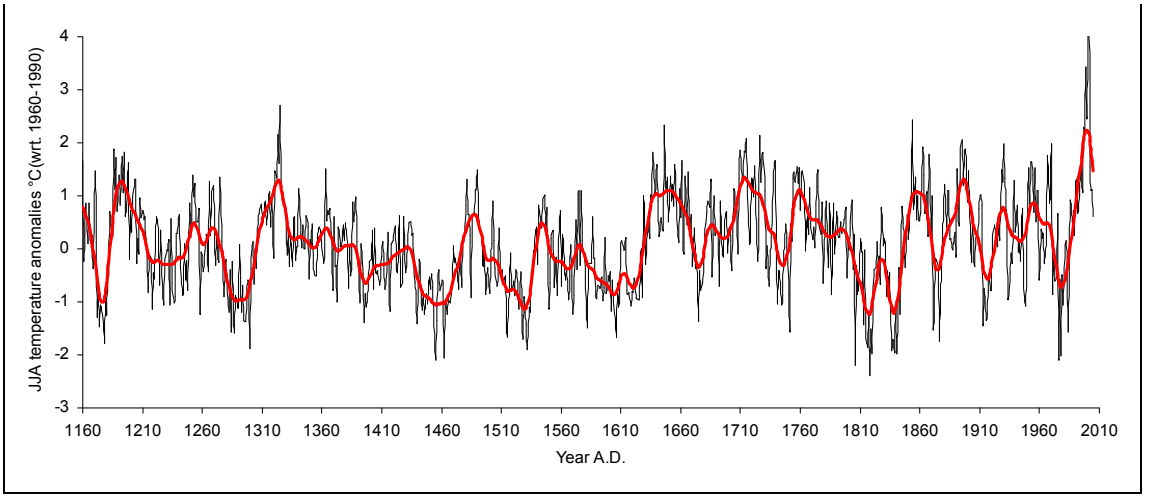

Fig 6: Temperature reconstruction of the last 860 years based on stone pine (*Pinus cembra*) from the Calimani Mountains (Romania)
(after: Popa–Kern, "Long-term summer Temperature,")

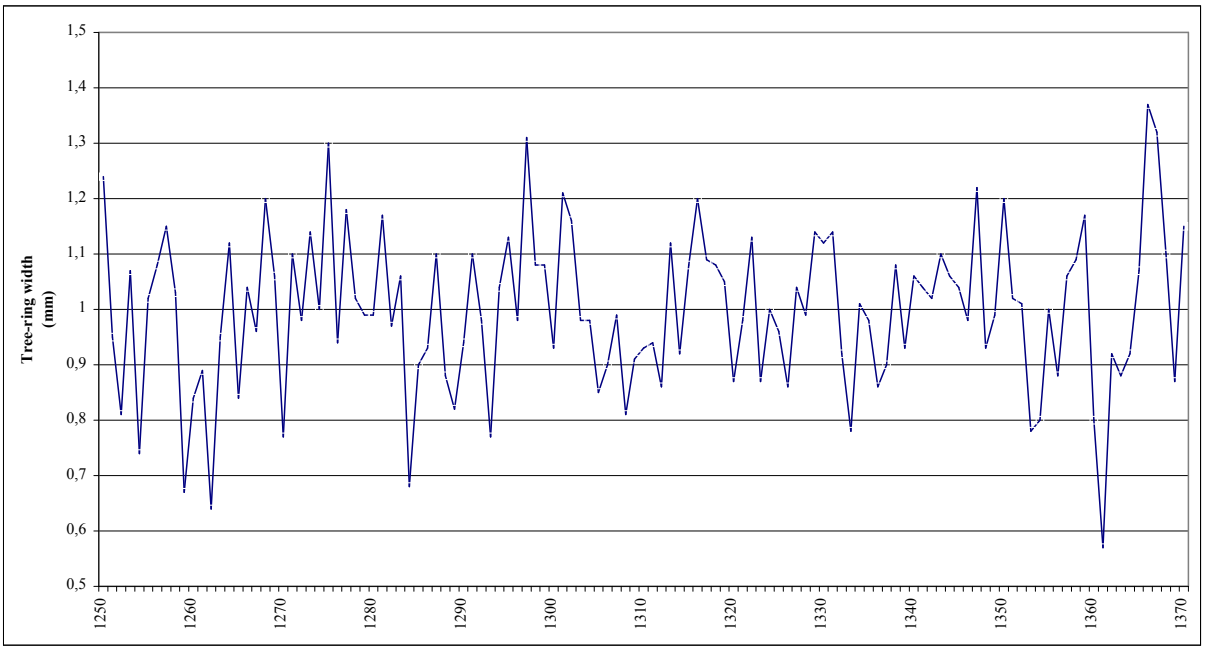

Fig 7: Tree-ring widths from Eastern Austria based on mean annual growth of oak trees (*Quercus Robur*)
(data from: Mchael Grabner – BOKU)

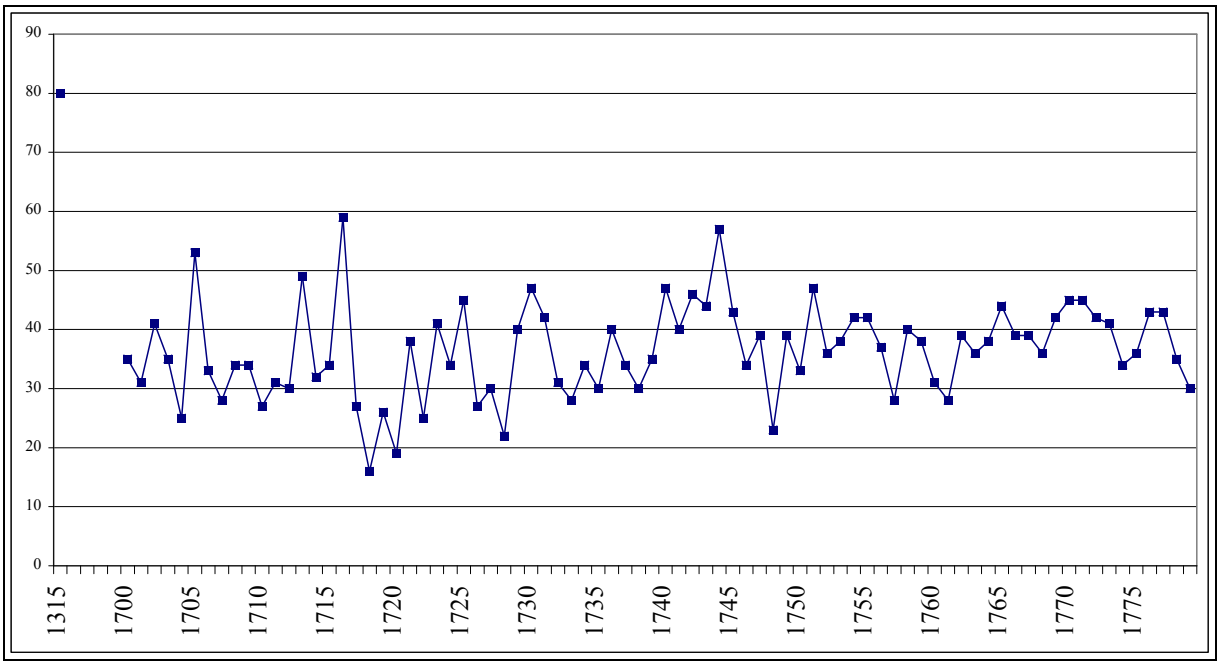

Fig 8: The beginning of grape harvest in the Vienna Basin: days after 1 September
(after: Elisabeth Strömmer, *Klima-geschichte* Christian Pfister, "Variation in Spring-summer,")

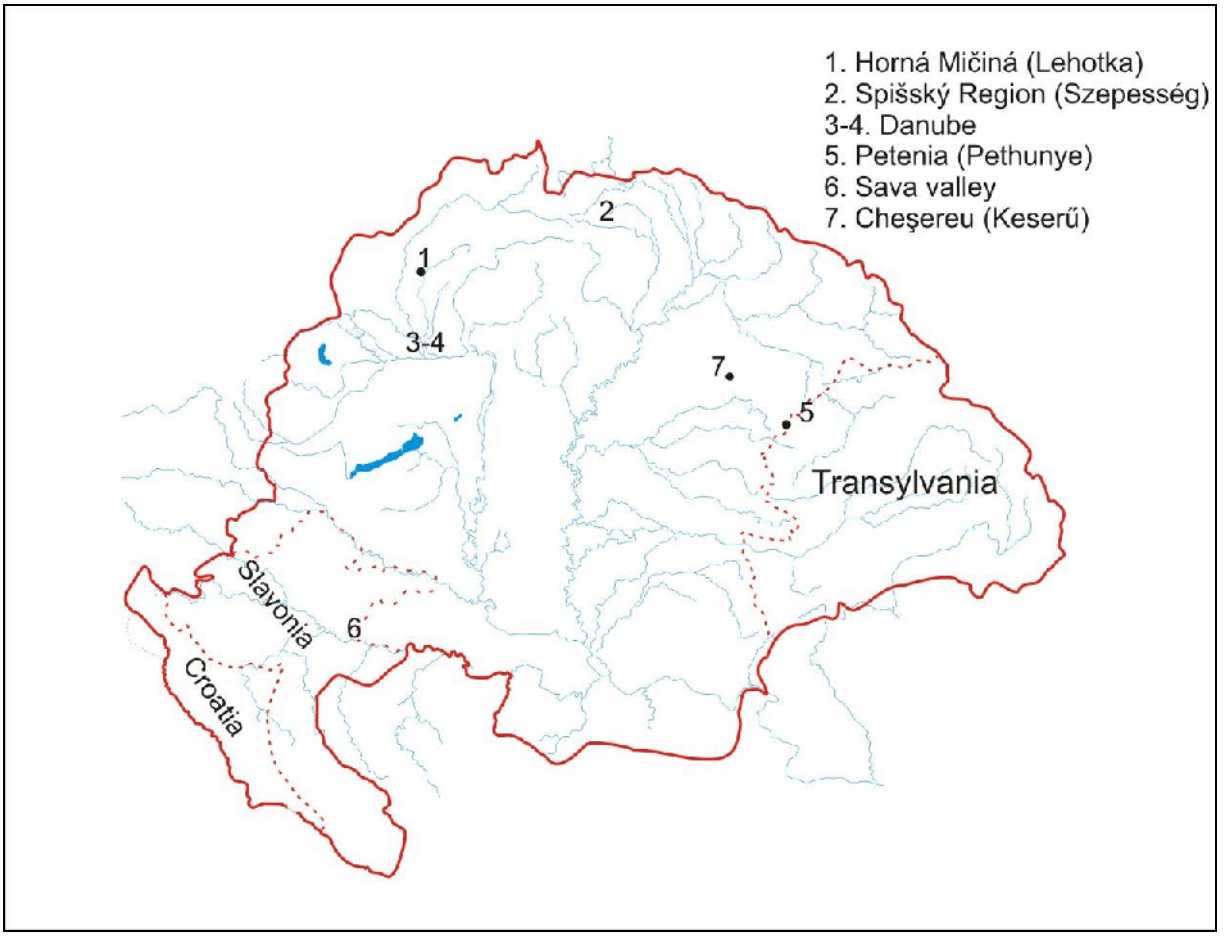

Fig 9: The spatial distribution of the references to weather events in the 1310s based on charters and chronicles

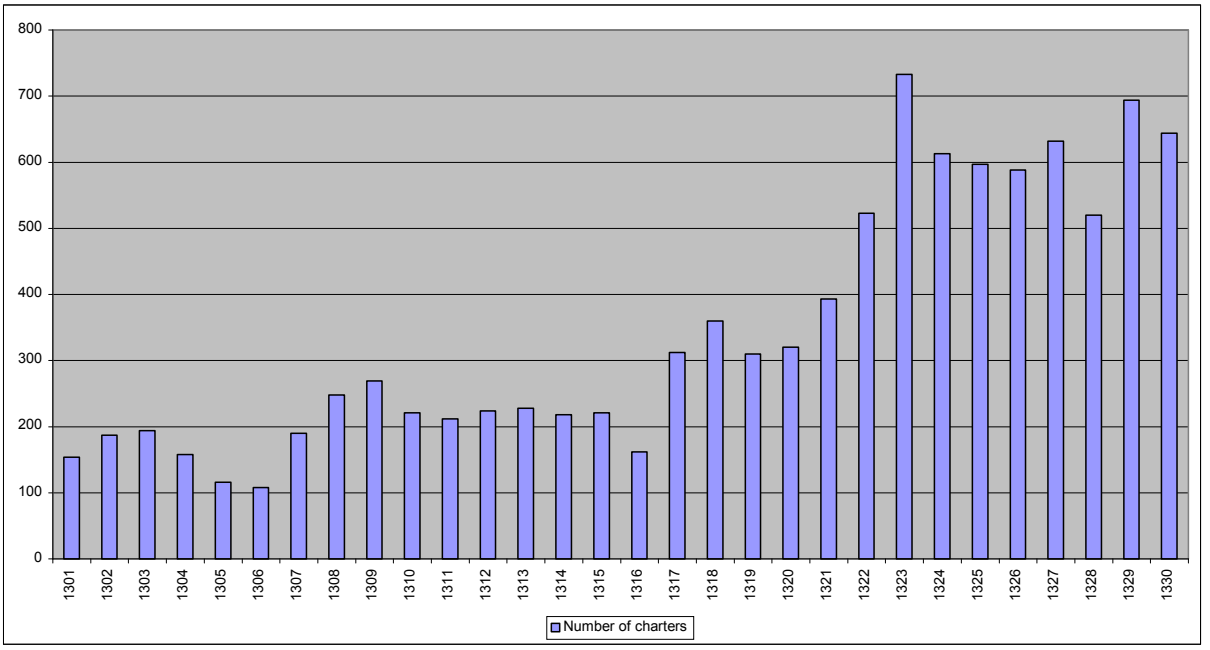

Fig 10: The number of charters issued in the Hungarian Kingdom (1301–1330)

No. (Angevin Cartulary I.)	*Datum* (1301)	*Actum* (1301)
21.	4 March	
33.	18 April	
34.	21 April	
38.	29 April	
43.	18 May	
44.	21 May	
45.	21 May	
50.	1 June	
58.	30 June	
59.	1 July	
79.	4 October	
85.	6 October	
92.	20 October	
101.	5 November	November 2
124.	1 December	
138. (forgery [?])	30 December	
146.	-	

No. (Angevin Cartulary I.)	*Datum* (1302)	*Actum* (1302)
155.	4 January	
158. (forgery [?])	7 January	
193/b.	1 April	
198.	16 April	March 14
208.	1 May	
251.	26 July	
258.	2 August	
265.	17 August	
269.	23 August	
272.	1 September	
273.	1 September	
277.	7 September	
282.	15 September	
292.	6 October	
300.	9 November	
302.	10 November	
313.	21 December	
314.	21 December	
321.	-	
326.	-	

No. (Angevin Cartulary I.)	*Datum* (1303)	*Actum* (1303)
349.	16 January	
355.	11 February	
358.	26 February	
365.	17 March	
368.	4 April	
372.	24 April	
373.	26 April	
381.	18 May	
400.	9 June	
401.	9 June	
410.	23 June	
428.	1 August	
463.	16 October	
484. (forgery [?])	18 November	
490.	8 December	
492.	9December	
512.	-	
516.	-	
529.	-	
530.	-	

No. (Angevin Cartulary I.)	*Datum* (1304)	*Actum* (1304)
547.	30 January	
548.	31 January	
551.	9 February	
552.	10 February	
555.	13 February	
572.	15 March	
585.	9 April	
594.	27 April	
614.	26 May	
622.	6 June	
630.	23 June	
633.	4 July	
645.	29 August	
667.	1 December	30 November
672.	24 December	
678.	-	
683.	-	
685.	-	
689.	-	
692.	-	

No. (Angevin Cartulary I.)	*Datum* (1305)	*Actum* (1305)
710.	17 February	
727.	26 April	
739.	23 May	
768.	13 September	
773.	13 October	
778.	08 November	
782.	18 November	

No. (Angevin Cartulary II.)	*Datum* (1306)	*Actum* (1306)
3.	10 January	
7/b.	25 January	
19.	26 February	
23.	31 March	31 March
28.	19 April	
30.	1 May	
34. (forgery [?])	20 May	19 April
35.	25 May	
46.	06 July	
68.	10 September	
72.	16 September	15 September
78.	18 October	
79.	18 October	
104.	-	

No. (Angevin Cartulary II.)	*Datum* (1307)	*Actum* (1307)
130.	2 March	
133.	5 March	
144.	24 April	
147.	27 April	
152.	1 May	25 April
177.	20 June	
181.	24 June	
183.	26 June	
185.	1 July	
227.	22 August	
228.	23 August	
233.	7 September	
234.	9 Septmber	
241.	6 October	
249.	14 October	
272.	-	
285.	-	
290.	-	
293.	-	

No. (Angevin Cartulary II.)	*Datum* (1308)	*Actum* (1308)
299.	5 January	
328.	25 March	
330.	29 March	
345.	23 April	
349.	30 April	
354.	1 May	29.ápr
367.	25 May	
403.	6 July	
466.	6 October	
490.	19 November	19 November
537.	-	
540.	-	

No. (Angevin Cartulary II.)	*Datum* (1309)	*Actum* (1309)
547.	1 January	
564.	21 January	
570.	1 February	
579.	23 February	
593.	23 March	
608.	19 April	
623.	1 May	20 April
628.	3 May	
630.	4 May	
647.	17 May	
648.	21 May	
690.	4 July	
701.	22 July	
747.	22 September	
771.	23 November	
773.	23 November	
784.	11.December	
795.	-	
797.	-	
802.	-	
810.	-	
812.	-	

No. (Angevin Cartulary II.)	*Datum* (1310)	*Actum* (1310)
819.	13 January	
834.	5 February	
852.	17 March	
860.	1 April	
861.	2 April	
864.	12 April	
881.	25 May	
899.	9 June	
923.	25 July	3 July
942.	21 August	
943.	21 August	
985.	3 November	
986.	4 November	
987.	5 November	
994.	18 November	
998.	29 November	
1000.	6 December	
1020.	-	
1025.	-	
1034.	-	

No. (Angevin Cartulary III.)	*Datum* (1311)	*Actum* (1311)
3.	13 January	
7.	23 January	
11.	9 February	
26.	17 March	
40.	19 April	
57.	8 May	
59.	10 May	
73/b.	3 June	
91.	27 June	
99.	29 June	
106.	7 July	
168.	9 November	
185.	20 December	18 December
190.	-	
202.	-	
203.	-	

No. (Angevin Cartulary III.)	*Datum* (1312)	*Actum* (1312)
216.	13 January	
231.	11 February	
239.	1 March	
269.	19 April	
274.	24 April	
278.	1 May	
285.	8 May	
286.	8 May	
296.	21 May	
297.	25 May	
299.	26 May	
305.	31 May	
307.	4 June	
312.	14 June	
314.	23 June	
353.	2 August	
359.	10 August	
365.	August	
379.	13 October	
402.	6 December	
418.	-	
421.	-	
427.	-	
437.	-	

No. (Angevin Cartulary IV.)	*Datum* (1313)	*Actum* (1313)
449.	2 February	
453.	17 February	
454.	18 February	
460.	7 March	
461.	8 March	7 March
501.	1 May	
507.	5 May	
522.	29 May	
523.	31 May	29 May
529.	7 June	
552.	24 June	
562.	June	
563.	1 July	30 June
575.	1 August	
616.	21 October	
636.	10 December	
642.	20 December	
663.	-	
665.	-	

No. (Angevin Cartulary IV.)	*Datum* (1314)	*Actum* (1314)
672.	6 January	
675.	16 January	
677.	16 January	
679.	20 January	
680.	20 January	
681.	20 January	
711.	27 March	
722.	3 April	
738.	25 April	
745.	1 May	
749.	6 May	
757.	4 June	
763.	9 June	
768.	24 June	
805.	29 July	
806.	1 August	
821.	22 August	
833.	21 September	
840.	19 October	
851.	27 November	
852.	30 November	
855.	13 December	
857.	15 December	
865.	31 December	
874.	-	
875.	-	
877.	-	
881.	-	

No. (Angevin Cartulary IV.)	*Datum* (1315)	*Actum* (1315)
2.	2 January	
13.	13 January	
45.	30 March	
54.	18 April	17 April
61.	1 May	
62.	1 May	
77.	13 May	
107.	25 June	
128.	25 July	
133.	2 August	
146.	23 August	
157.	22 September	
158.	22.szept	
160.	26.szept	24 September
176.	08.nov	16 October
178.	09.nov	
179.	13.nov	
204.	-	
212.	-	
213.	-	
216.	-	

No. (Angevin Cartulary IV.)	*Datum* (1316)	*Actum* (1316)
246.	1 March	
253.	22 March	
265.	19 April	
268.	25 April	
271.	1 May	
278.	5 May	
285.	20 May	
290.	1 June	
293.	11 June	
296.	23 June	
298.	26 June	
315.	23 August	
325.	25 September	
339.	16 October	
342.	22 October	
347.	27 October	
366.	11 December	
377.	-	

No. (Angevin Cartulary IV.)	*Datum* (1317)	*Actum* (1317)
413.	1 March	
429.	24 March	
434.	28 March	
449.	30 April	26 April
457.	6 May	4 May
461.	8 May	
466.	-	12 May
478.	29 May	
494.	15 June	
516.	8 July	
529.	2 August	
531.	2 August	
572.	25 September	
592.	13 October	
626.	5 November	
630.	10 November	
662.	17 December	
679.	-	
681.	-	

No. (Angevin Cartulary V.)	*Datum* (1318)	*Actum* (1318)
22.	22 January	17 January
91.	31 March	
101.	14 April	
102.	14 April	
104.	16 April	
106.	25 April	
114.	1 May	
116.	1 May	
133.	21 May	
137.	25 May	
138.	25 May	
139.	25 May	
141.	25 May	
142.	27 May	
144.	30 May	
155.	8 June	
168.	19 June	
220.	29 July	
230.	3 August	
236.	10 August	
240.	21 August	
260.	16 September	
265.	22 September	
290.	14 October	
291.	14 October	
293.	22 October	
294.	2 October	
335.	16 December	
336.	21 December	
342.	-	
354.	-	
356.	-	

No. (Angevin Cartulary V.)	*Datum* (1319)	*Actum* (1319)
369.	13 January	
380.	31 January	
403.	14 March	
404.	15 March	10 March
412.	24 March	
432.	15 April	
447.	6 May	
450.	8 May	
455.	14 May	
463.	22 May	9 May
464.	24 May	
482.	10 June	
488.	16 June	11 June
508.	27 June	
509.	27 June	
570.	29 August	10 August
615.	26 November	November
625.	12 November	
655.	-	

No. (Angevin Cartulary V.)	*Datum* (1320)	*Actum* (1320)
690.	2 February	
705.	21 February	
712.	1 March	25 February
714.	3 March	28 February
725.	17 March	
741.	4 April	
749.	6 April	
754.	8 April	17 March
760.	19 April	13 April
765.	24 April	
771.	3 May	
781.	15 May	
799.	29 May	
810.	13 June	
850.	13 July	
851.	13 July	
863.	21 July	
895.	27 September	
902.	6 October	
925.	8 November	29 October
951.	7 December	5 December
972.	-	
988.	-	

No. (Angevin Cartulary VI.)	*Datum* (1321)	*Actum* (1321)
17.	22 January	21 December, 1320
37.	9 February	18 November, 1320
44.	22 February	
72.	26 March	
84.	9 April	
88.	13 April	
134.	15 May	
153.	-	28 May
159.	4 June	
162.	6 June	
199.	12 July	29 June and 1 July
241.	11 September	2 September
246.	19 September	
248.	22 September	
270.	ca. 2 October	
271.	ca. 2 October	
356.	20 December	14 December
387.	-	
391.	-	
392.	-	

No. (Angevin Cartulary VI.)	*Datum* (1322)	*Actum* (1322)
396.	1 January	
399.	4 January	
424.	25 January	
464.	22-28 January	
483.	14 March	
494.	19 March	
497.	21 March	
510.	2 April	
522.	14 April	
530.	19 April	
537.	23 April	
538.	23 April	
540.	24 April	
550.	1 May	
568.	12 May	
569.	12 May	
578.	22 May	15 May
603.	1 June	
604.	2 June	
616.	6 June	
647.	24 June	
662.	1 July	20 June
674.	6 July	
679.	8 July	8 July
698.	24 July	
701.	24 July	
708.	26 July	
729.	7 August	
735.	15 August	8 August
751.	22 August	
783.	29 September	
876.	24 December	
911.	-	
916.	-	

No. (Angevin Cartulary VII.)	*Datum* (1323)	*Actum* (1323)
73.	17 March	
152.	30 April	29 April
164.	2 May	
201.	18 May	
223.	22 May	
254.	2 June	
278.	18 June	
280.	18 June	
282.	18 June	
291.	20 June	
312.	26 June	
329.	1 July	12 June
353.	9 July	14 June
354.	11 July	
356.	13 July	
402.	8 August	9 July
413.	19 August	
426.	27 August	11 August
440.	1 September	
446.	3 September	24 August
460.	15 September	
462.	18 September	
478.	22 September	
480.	23 September	21 September
521.	25 October	18 October
542.	29 October	
557.	5 November	
579.	17 November	9 November
586.	20 November	
594.	23 November	
623.	30 November	
624.	30 November	
627.	5 December	28 November
639.	9 December	2 December
643.	10 December	
683.	24 December	14 December
706.	-	
708.	-	
715.	-	
721.	-	
724.	-	
730.	-	

No. (Angevin Cartulary VIII.)	*Datum* (1324)	*Actum* (1324)
4.	3 January	October 29, 1323.
6.	6 January	July 6, 1323.
57.	7 February	
59.	8 February	
74.	20 February	11 February
88.	3 March	
91.	6 March	4 March
97.	10 March	9 March
100.	11 March	
102.	12 March	
107.	14 March	
110.	15 March	
114.	17 March	
145.	29 March	
147.	29 March	
162.	5 April	2 April
196.	25 April	
198.	26 April	
230.	7 May	
236 .	8 May	
243.	10 May	
254.	14 May	
270.	22 May	
274.	23 May	
275.	23 May	16 May
276.	23 May	
296.	2 June	
302.	7 June	
332.	6 July	
390.	31 August	
409.	26 September	
417.	28 September	
430.	6 October	
432.	6 October	14 September
434.	9 October	
442.	14 October	
456.	21 October	
458.	23 October	10 October
459.	25 October	
477.	31 October	30 October
478.	31 October	26 October
499.	9 November	
503.	10 November	5 November
516.	20 December	22 November
522.	3 December	
590.	-	
595.	-	
598.	-	
604.	-	
606.	-	
607.	-	

No. (Angevin Cartulary IX.)	*Datum* (1325)	*Actum* (1325)
7.	10 January	
56.	20 February	
65.	23 February	
95.	14 March	12 March
114.	21 March	
116.	22 March	
134.	13 April	11 April
159.	25 April	
178.	From 6 May to 2 December	
186.	9 May	8 May
194.	12 May	11 May
204.	24 May	
248.	12 June	
256.	15 June	
265.	19 June	
287.	29 June	13 June
288.	30 June	
296.	1 July	
320.	14 July	29 June
353.	8 August	
397.	7 September	3 September
413.	20 September	19 September
423.	28 September	16 September
435.	4 October	
450.	8 October	6 October
475.	16 October	
503.	1 November	
517.	15 November	8 November
546.	6 December	
566.	-	
568.	-	
569.	-	
572.	-	
580.	-	
583.	-	

No. (Angevin Cartulary X.)	*Datum* (1326)	*Actum* (1326)
12.	11 January	
17.	13 January	
117.	4 April	3 April
125.	8 April	
128.	10 April	
136.	21 April	17 April
143.	20 April	
154.	25 April	20 April
174.	1 May	
182.	8 May	
185.	8 May	
203.	17 May	15 May
223.	29 May	30 May
237.	8 June	
263.	-	June 24
268.	29 June	27 June
275.	5 July	4 July
281.	-	July
282.	9 July	7 July
290.	15 July	24 July
292.	15 July	6 July
330.	10 August	
332.	12 August	
333 .	12 August	
336.	14 August	
343.	17 August	
344.	17 August	
354.	26 August	
355.	-	27 August
357.	1 September	
376.	13 September	8 July
377.	13 September	
384.	-	17 September
386.	18 September	15 September
404.	6 October	
415.	16 October	
425.	26 October	16 October
437.	1 November	
467.	8 November	7 November
468.	8 November	3 November
469.	8 November	
470.	8 November	
471.	11 November	
485.	21 November	12 November
487.	22 November	19 November
510.	2 December	
537.	11 December	2 December
538.	13 December	12 December
539.	13 December	
549.	18 December	
553.	20 December	13 December

565.	-	
573.	-	
574.	-	
575.	-	
577.	-	
578.	-	
584.	-	

No. (Angevin Cartulary XI.)	*Datum* (1327)	*Actum* (1327)
20.	13 January	
44.	28 January	June 18, 1325.
46.	29 January	
52.	December 7, 1320.	December 2, 1320.
54.	31 January	September 21, 1326.
74.	11 February	
76.	13 February	
98.	26 February	16 February
99.	28 February	27 February
110.	6 March	
128.	19 March	
131.	20 March	
137.	25 March	
139.	27 March	20 March
156.	-	19 April
161.	24 April	
198.	6 May	26 April
228.	21 May	December 11, 1326.
247.	26 May	22 May
250.	28 May	
252.	28 May	
267.	4 June	27 May
268.	4 June	25 May
269.	4 June	26 May
272.	5 June	30 May
273.	5 June	23 May
274.	6 June	1 June
279.	7 June	
332.	27 June	
333.	28 June	25 June
344.	1 July	
355.	-	4 July
361.	8 July	
376.	18 July	
387.	1 August	25 July
388.	-	1 August
399.	10 August	
406.	19 August	11 August
407.	19 August	22 July
446.	14 September	9 September
455.	22 September	20 September
457.	22 September	
480.	6 October	
490.	13 October	
527.	-	7 December
532.	18 November	
552.	29 November	
567.	6 December	
571.	7 December	
590.	23 December	
592.	-	

612.	-	
613.	-	

No. (Angevin Cartulary XII.)	*Datum* (1328)	*Actum* (1328)
54.	-	3 February
91.	25 February	23 February
97.	27 February	25 February
100.	29 February	27 February
108.	5 March	8 February
125.	13 March	9 March
128.	14 March	13 March
130.	17 March	
143.	20 March	15 March
144.	22 March	
218.	17 April	7 April
228.	24 April	
240.	3 May	
280.	26 May	
284.	28 May	
306.	3 June	
310.	6 June	
320.	14 June	10 June
328.	23 June	
341.	29 June	26 June
358.	7 July	
392.	29 July	22 July
394.	1 August	
400.	12 August	6 August
424.	21 September	
433.	29 September	24 September
435.	30 September	
441.	6 October	29 September
459.	2 November	29 October
463.	8 November	
467.	13 November	8 November
520.	-	

No. (Angevin Cartulary XIII.)	*Datum* (1329)	*Actum* (1329)
26.	14 January	10 January
43.	24 January	
56.	1 February	27 January
57.	1 February	
59.	-	2 February
78.	11 February	10 February
83.	16 February	9 February
87.	20 February	
126.	15 March	14 March
129.	-	15 March
141.	22 March	
151.	27 March	23 March
169.	4 April	28 March
179.	10 April	19 March
192.	17 April	30 March
204.	-	29 April
238.	10 May	8 May
239.	11 May	8 May
240.	11 May	
243.	12 May	14 March, 1328.
249.	13 May	12 May
260.	21 May	18 May
325.	20 June	15 June
328.	22 June	
338.	25 June	
343.	26 June	18 June
349.	-	June 27
363.	2 July	25 June
377.	8 July	
385.	12 July	10 July
386.	13 July	
402.	22 July	
417.	28 July	25 July
432.	1 August	1 August
443.	4 August	
454.	10 August	10 August
519.	22 September	
521.	23 September	22 September
548.	9 October	
559.	18 October	13 October
563.	20 October	20 October
584.	8 November	10 January
605.	20 November	18 November
632.	3 December	
653.	17 December	14 December
657.	20 December	
680.	-	
681.	-	

No. (Angevin Cartulary XIV.)	*Datum* (1330)	*Actum* (1330)
6.	3 January	2 January
33.	13 January	
51.	20 January	
55.	24 January	
62.	26 January	
99.	23 February	5 February
110.	28 February	28 February
124.	7 March	28 February
149.	14 March	14 March
152.	16 March	14 March
159.	21 March	21 March
160.	21 March	21 March
168.	25 March	
182.	5 April	
183.	6 April	6 April
207.	17 April	
208.	18 April	15 April
209.	18 April	15 April
221.	25 April	
226.	27 April	
231.	30 April	
235.	1 May	
243.	1 May	
294.	19 May	
298.	21 May	
300.	28 May	20 May
311.	3 June	
320.	5 June	4 June
322.	7 June	5 June
349.	17 June	
359.	-	24 June
362.	25 June	14 June
363.	25 June	
374.	29 June	19 June
375.	-	29 June
398.	8 July	
405.	10 July	8 May
412.	13 July	6 July
416.	13 July	
424.	21 July	
430.	24 July	
436.	26 July	25 July
437.	26 July	
461.	8 August	1 August
471.	8 August	1 August
477.	14 August	6 August
498.	31 August	24 August
499.	1 September	26 August
514.	12 September	30 August
584.	12 November	17 November
610.	5 December	

621.	-	
631.	-	
632.	-	

Figs 11 to 40: The temporal distribution of perambulation charters based from 1301 to 1330

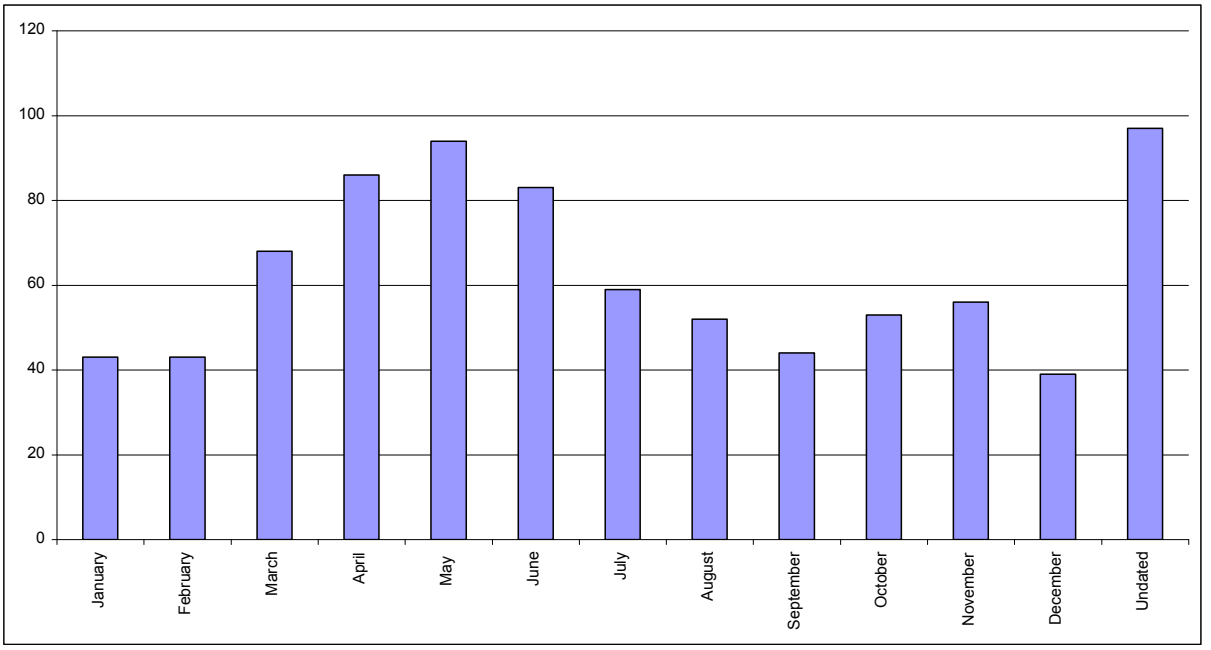

Fig 41: The monthly distribution of perambulations in the period 1301–1330

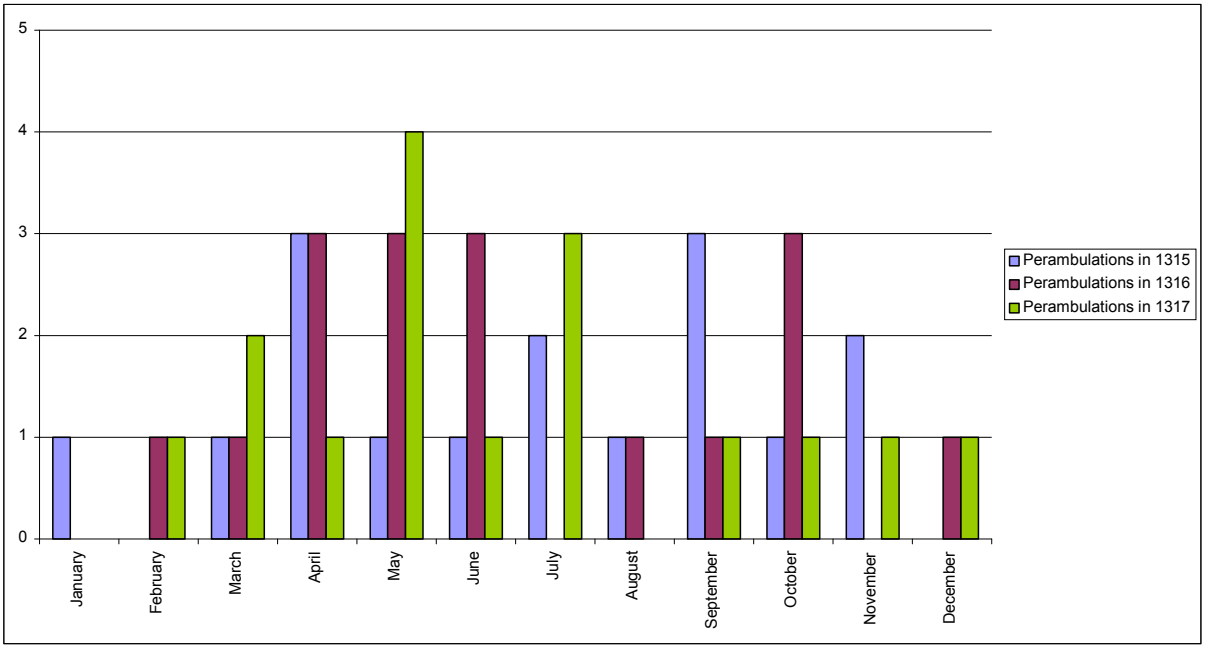

Fig 42: The monthly distribution of perambulations in 1315, 1316 and 1317

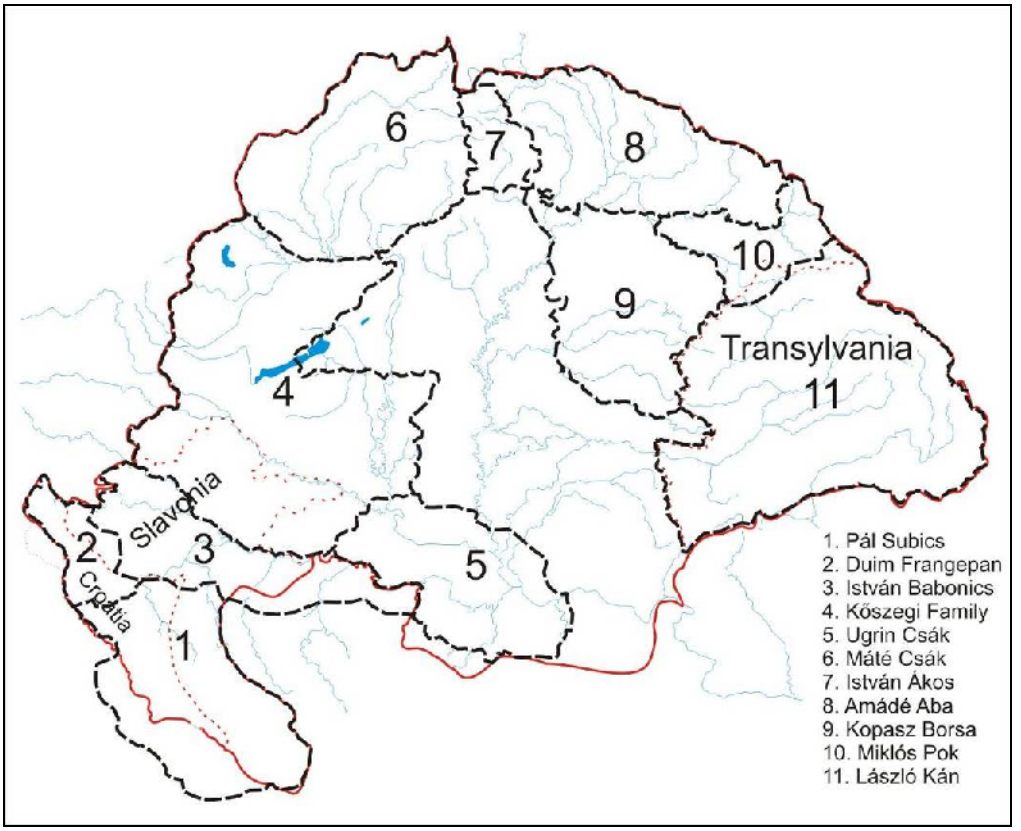

Fig 43: Territories under the authority of oligarchs in the beginning of the fourteenth century

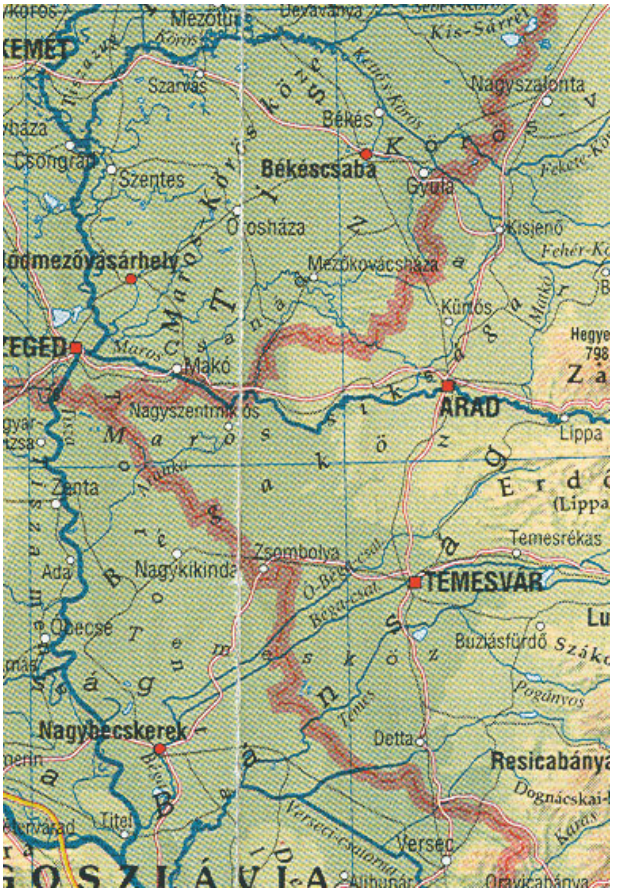

Fig 44: The present-day geographical conditions of the Southern Hungarian Plain

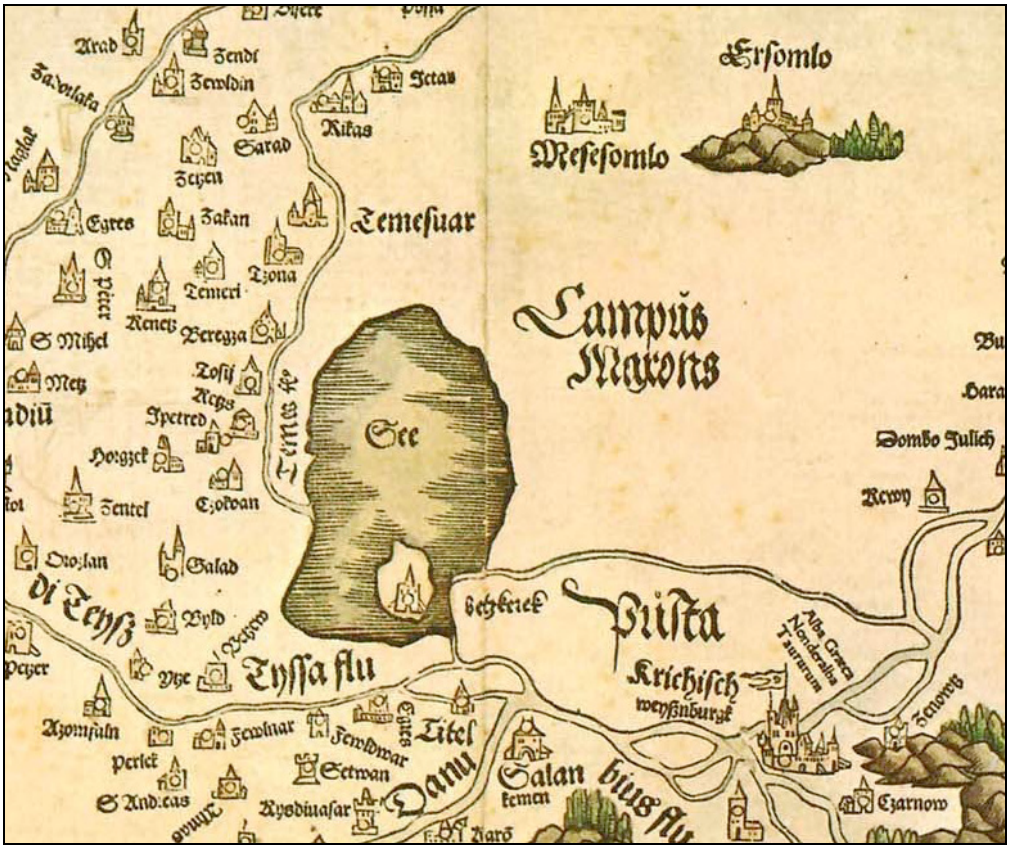

Fig 45: The Lake Becskerek and its surroundings in the map of Lazarus Secretarius (1528)

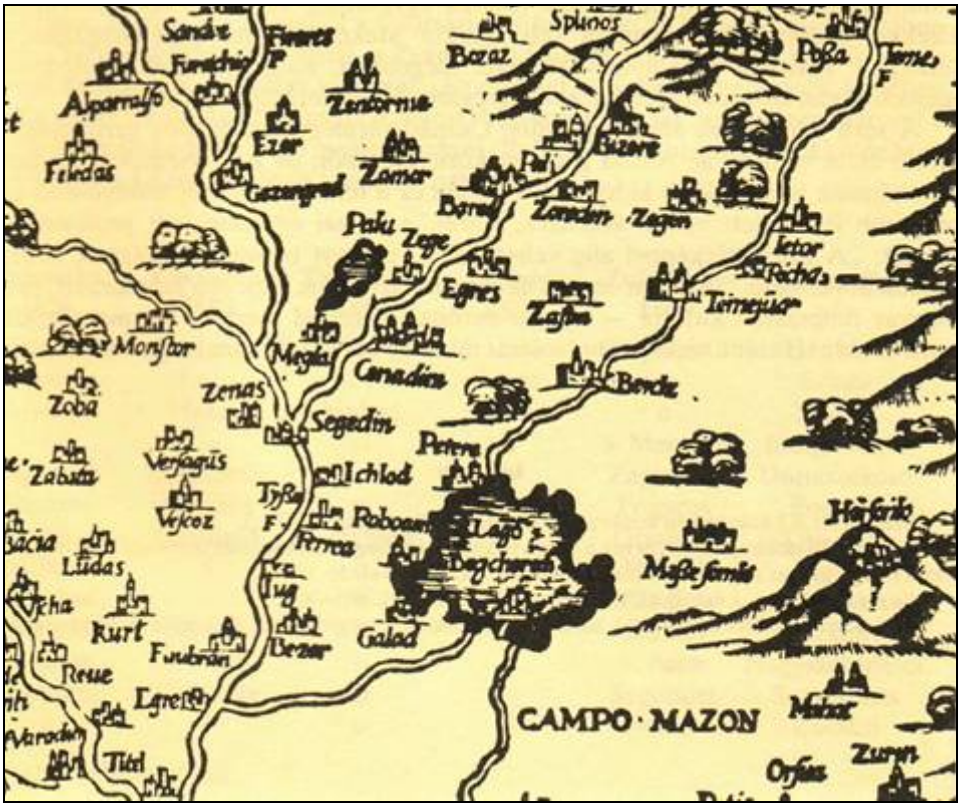

Fig 46: The Lake Becskerek and its surroundings in the map of Giacomo Gastaldi (1546)

Fig 47: The Lake Becskerek and its surroundings in the map of Matthias Zündt (1567)

Fig 48: The Lake Becskerek and its surroundings in the map of Alexander Mair (1595)

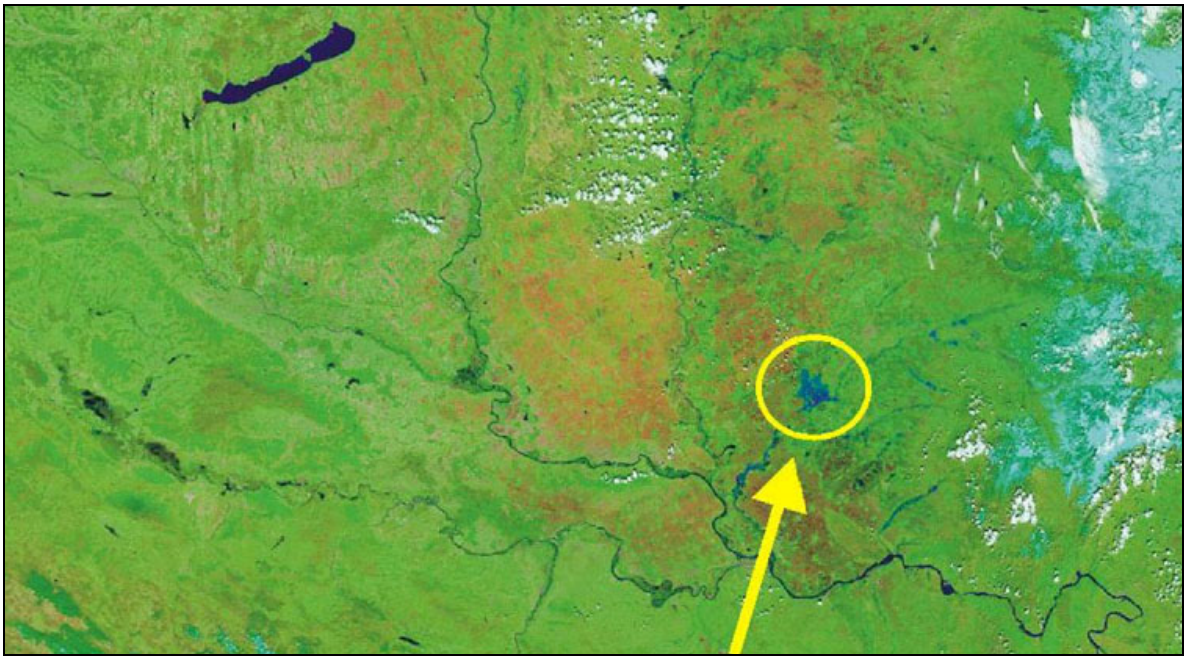

Fig 49: The flooded area on 23 April, 2005, during the centennial Banat flood of the Temes
(after: Gábor Timár et al., "Re-appearance of an old,")

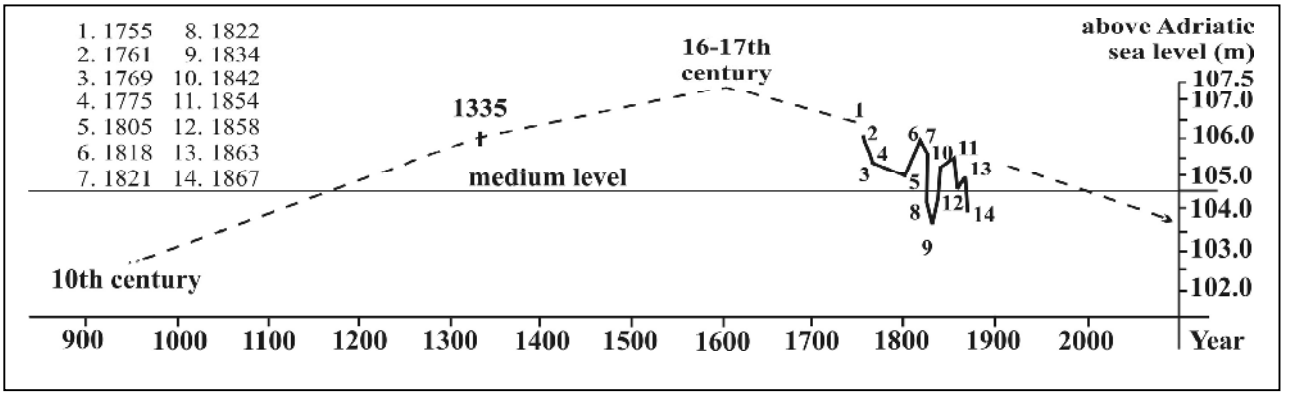

Fig 50: The water-level changes of Lake Balaton in the past millennium
(after: the studies of Károly Sági)

Fig 51: The Lake Becskerek and its surroundings in the map of Frank de Wit (1680)

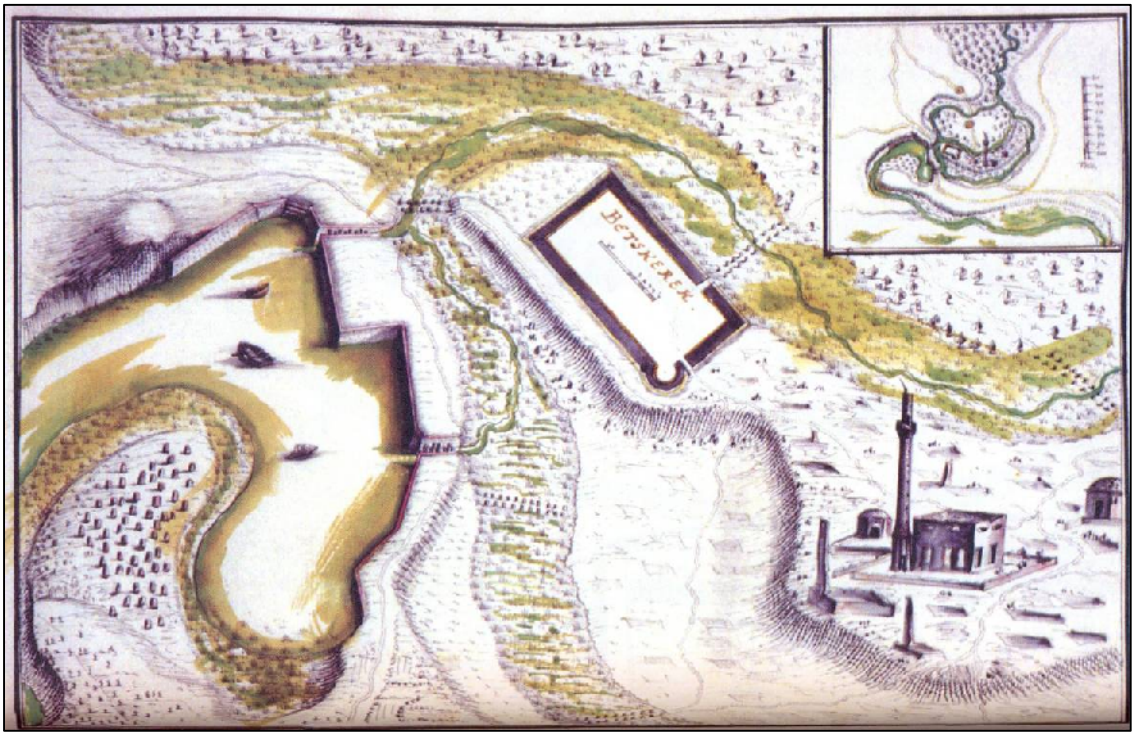

Fig 52: The castle of Becskerek and its surroundings in the map of General Marsigli (1697)
(after: György Kisari Balla, *Marsigli térképei*, 69–70)

Fig 53: The Lake Becskerek and its surroundings in the map of General Marsigli (1702–1703)
(after: György Kisari Balla, *Marsigli térképei*, 183)

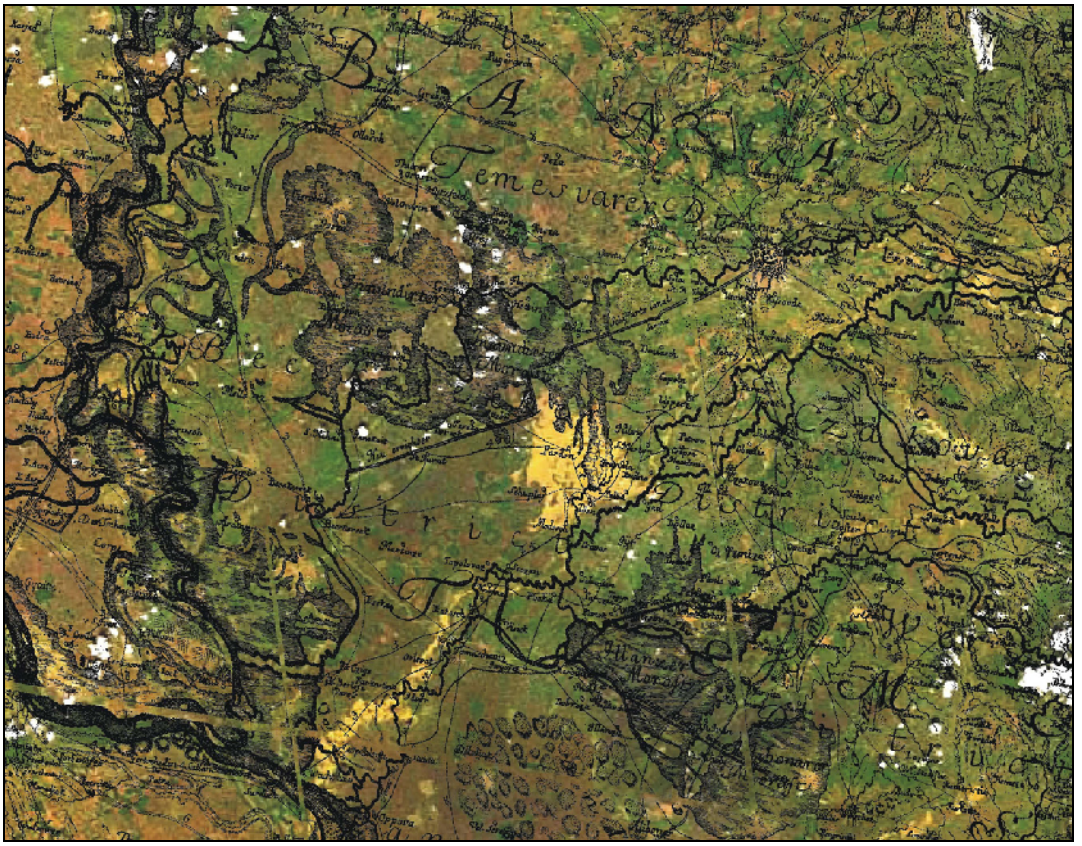

Fig 54: The desiccated basin of the Lake Becskerek and its surroundings in the map of Müller (1769)
(after: Gábor Timár et al., "Re-appearance of an old,")

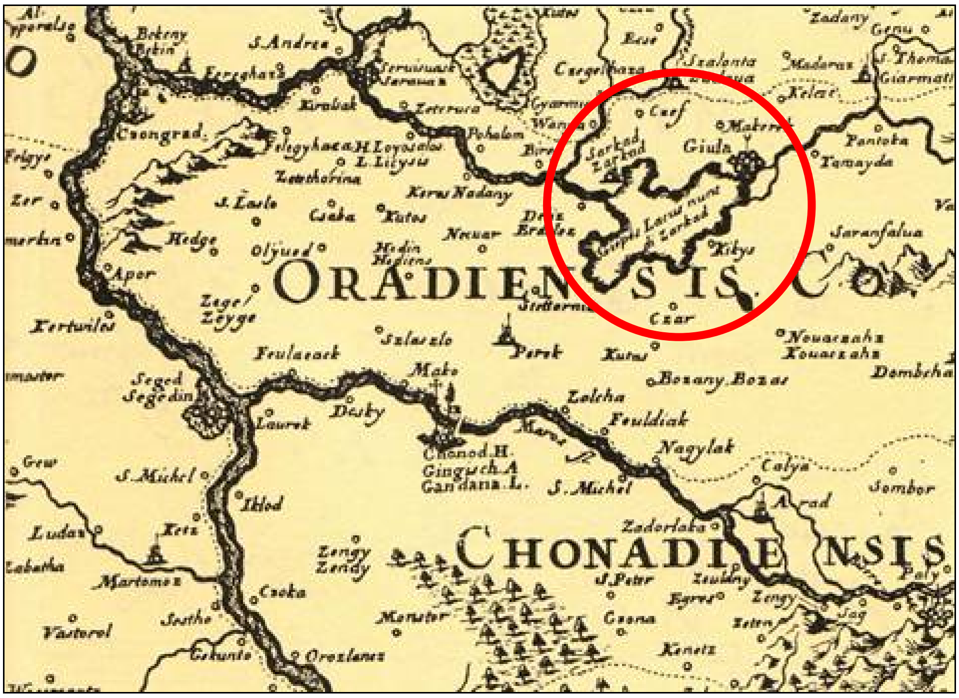

Fig 55: The Lake Sarkad and its surroundings in the map of Giacomo Cantelli da Vignola (1686)

Fig 56: The surroundings of the branches of River Körös and its surroundings in the map of General Marsigli (1690s)
(after: György Kisari Balla, *Marsigli térképei*, 213)

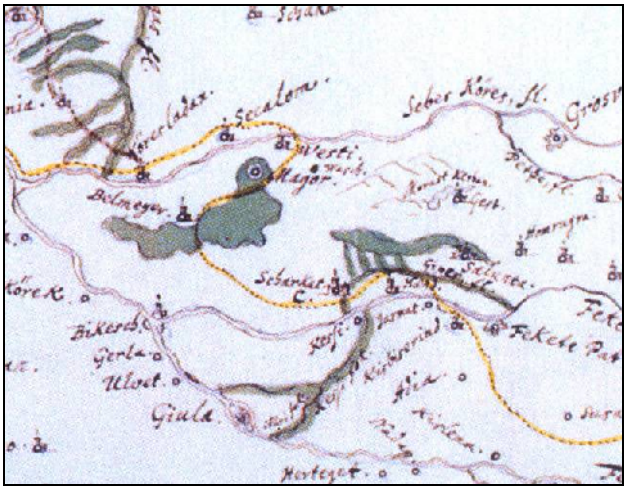

Fig 57: The surroundings of Gyula in the map of General Marsigli (1690s)
(after: György Kisari Balla, *Marsigli térképei*, 213)