



SPATIAL DEVELOPMENT OF THE 1507–1510 PLAGUE IN POLAND AND ITS CONSEQUENCES. KALISZ DISTRICT CASE STUDY

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Abstract

The article discusses the causes and effects of the plague which is said to have spread over many Polish towns in 1507. The focus is on its possible causes, related to the occurrence of droughts and floods in Central Europe in the late 15th and early 16th century. Available sources from the late mediaeval period have also been analysed for the recorded perceptions of the extreme climatic and weather conditions. Special attention has been paid to the issues of intensity and spatial distribution of the effects of the plague on the example of one district. The analysis covered a variety of issues such as settlement changes, prices of basic goods or even some pollen data. The main results of the study indicate that the climatic extremes at the turn of the 16th century exerted a long-term impact on the society and economy of the region. They also contributed to the abandonment of settlements on rural sites.

Keywords: historical geography, plague, Late Medieval Poland, spatial distribution, droughts, floods, weather extremes

INTRODUCTION

According to the present state of research, the lands of Poland were not affected by the Black Death in the 14th century (Guzowski et al., 2016), however various parts of the country were regularly struck by plagues, which appeared and subsided at quite steady intervals (Karpinski, 2000; Walawender, 1957). According to scholars, their outbreaks are connected to the occurrences of natural disasters, such as droughts, floods, hail, flooding, frosty or warm winters, which contributed to crop failures, rise of food prices and, consequently, famine, which weakened the overall condition of the society (Karpinski, 2000). A good example to illustrate this point was the great plague of Cracow, which was probably a long-term consequence of the drought of 1540 and which in the period between July and November 1543 took the lives of at least 10 thousand persons (which constituted roughly 1/3 of the city's population) (Follprecht and Noga, 2014; Sowina, 2016). Similarly, in Western Europe, numerous periodic plagues appeared at steady intervals and were also likely related to various weather extremes or climatic changes. One particularly difficult time, abundant in plagues, was the period of armed conflicts in the 17th and 18th centuries, which was also the coldest period of the Little Ice Age (Maunder Minimum) (Alfani, 2013; Alfani and Percoco, 2019; Curtis, 2016; Owens et al., 2017). Records contain accounts of economic and demographic consequences of the plagues (Campbell, 2016; Cummins et al., 2016), but attention should also be paid to their socio-cultural dimension (Martín-Vide and Barriendos Vallvé, 1995). Thus, the investigation of the causes and effects of the plagues should be considered one of the fundamental topics

in the study of the history of former societies as well as the history of climate and environment. However, recent works have shown that the pre-industrial society (mainly agrarian) was able to deal with crises quite efficiently (Büntgen et al., 2011). They became problematic only when a sudden accumulation of extreme events (natural disasters, famine, wars, etc.) took place, which disturbed every-day balance of the society (Haldon et al., 2018).

Study of extremes and their potential consequences – plagues – are, therefore, complex and interdisciplinary by nature, touching upon various research fields. The basic ones include studies on the problem of disease spread, social reactions to plague, temporary practices of depopulating villages, towns, etc. (Lagerås, 2016). Such studies refer both to the spatial and to the environmental aspects, all of which were as important as the economic elements. The fundamental question which thus arises concerns the relationships between individual crisis events, both climate- and disease-driven.

The main aim of this article is to discuss three major research problems: 1) the extension of the plague in the context of the climatic and weather extremes which contributed to it; 2) the changes to the spatial distribution of the plague on the basis of a case study of the district of Kalisz; 3) the duration of the plague and its impact on the economy of the said area. Answers to the formulated research questions will be given based on the analysis of some of the available materials from the southern part of the Greater Poland region (Fig. 1). For this area, some of the oldest preserved tax registers are available – for the years 1507–1510 – offering lots of data concerning the spread of the disease (Związek, 2013). As regards the extension of the plague, I am assuming that its level can be calculated using a couple of indices: 1) the number of deceased and isolated

people; 2) the number of fugitives from urban and/or rural sites; 3) the degree of abandonment of fields and villages; and 4) the fluctuations of the economic indicators.

The plague of 1507 – written evidence

Chronicles feature numerous pieces of evidence confirming that in 1507, the Kingdom of Poland was struck by a plague which affected many towns („*per multa oppida Poloniae pestis erat*”) (Walawender, 1932). The plague reached as far as Vilnius (in the Great Duchy of Lithuania); it was also recorded in far Rus’ – in Novgorod – and in Silesia, where it appeared in 1507 and slowly captured subsequent parts of the region together with the towns located there. It struck Wrocław (Breslau) and its vicinity, claiming lives of many people between September 1507 and the beginning of January 1508. Examples based on chronicle mentions can be easily multiplied, but they cannot represent the exact severity of the occurring disease (apart from the frequently exaggerated narratives). Neither are we able to specify its nature. It could have been the pestilence or typhoid – historical sources are very imprecise in this respect (Karpiński, 2000). The severity of the disease given in the narrative sources as well as in sources related to taxes seems to suggest that this was a contagious disease, the germs of which were transmitted between humans and/or animals. One of the chronicles of Novgorod recorded in 1508 that in this year in the city over 5000 men and women died („*w lęto 7016, pomre ljudi mužska polu i ženska tma i 5000 dusz’ i 400 bez czetyrech czelowěk*”, (Walawender, 1932). The number should not be taken literally but rather as a proof that this was indeed a great plague, exceeding the comprehension abilities of the contemporaries. In this

respect, chronicle sources are by no means able to offer us a precise picture of the epidemic.

Plague as a possible consequence of climatic and natural hazards

According to Christian Pfister’s preliminary model of the economic impact of climatic events (Pfister, 1988), it is very likely that the outbreak of the plague at the beginning of the 16th century in Poland could have been, at least partly, a long-term effect of weather events in the preceding years. In short, they had created a climatic pressure (e.g. great hunger) which, in subsequent steps, could have led to another crisis, such as the plague (ELL, 1985; Kiss, 2020). The issue is, however, more complicated, and it is also connected with the land use changes over time as well as the scale and range of human impact on the environment during the period of the development of the so-called German Law in Central Europe. Recently archaeologists have pointed out that intensified land use, forest clearance as well as increase in crop production and breeding strongly affected the daily life of the Medieval and Early Modern societies (Schreg, 2011, 2019). In this model, intensive anthropopressure led to microclimatic changes, where floods, droughts or heavy rains were becoming more noticeable in daily life. For instance, extremes such as floods could have caused high soil erosion and bring about the long-term effect of food production drop, rendering the society more vulnerable to diseases. High water could have also caused serious pollution that was dangerous for people and animals, ultimately leading to development of typhoid fever, cholera, etc (WHO).



Fig. 1 Study area in the context of the past and contemporary Poland with modern neighbouring states. Basemap source from NaturalEarthData.com

Hungarian and Czech context

Recently Kiss (2017) has shown that some source materials on Hungary definitely point to the occurrence of a drought in 1502 and 1503. She has also indicated that the dry year 1502 had contributed to the aggravation of the consequences of the drought in the following year, which is especially visible in the Old World Drought Atlas (OWDA) model (Cook et al., 2015). This was a period of particularly destructive hail storms and crop failures – affecting cereals, vine and honey alike. In this case, as demonstrated by Kiss (2017), bees ‘*may act as indicator of weather-, and probably (spring-summer, or earlier) drought-related problems*’. On the other hand, data from the Eger diocese from 1506 have shown that many agricultural fields and vineyards were destroyed within its borders; the income from the tithes was significantly smaller; there was a shortage of fish. It has also been proven that subjects in general suffered from poverty. Thus, the calamities which affected Hungary at that time were complex, and their occurrence can be traced thanks to many types of written records as well as environmental indices (proxies).

On the territory of the Czech Crown, the beginnings of the 16th century were not recorded as an extremely dry period (Brázdil, Dobrovolný et al., 2013). Narrative sources mentioned very cold winters at the turn of almost every year and frequent spring floods. Like in the rest of Central Europe, in 1503 a 30-days drought and low level of crops were recorded. The subsequent years (1505, 1506 and 1507) were also described as periods of drought Brázdil, Kotyza et al., 2013). According to the decadal frequencies of droughts in the Czech territory (Brázdil, Dobrovolný et al., 2013), we can describe the beginning of the 16th century as a period of sinusoidal weather changes with frosty and long winters, frequent floods in springtime and repeatable drought period in summers.

SOURCES

The main sources which have been used in this study can be divided into two basic groups: written records and climatic/environmental archives (tree rings and pollen data). The written sources consist of narrative data (chronicles, memories), which can also be treated as literary texts; this means that they can be used in the context of climatological research only with difficulty due to the personal reception of the phenomena by the authors. The main collection of narrative texts used in this study came from the book by Walawender (1932). The main idea behind his research was to offer as comprehensive view on the climate history and changes as possible based on the contemporary set of published sources. The biggest advantage of this book is that the second part of each volume has been supplemented by the author with extensions from various source editions. Thanks to this, Walawender’s works help one reach the basic material and compare his climatic interpretations with the original records written in old-Polish, old-German, Latin and old-Russian.

Another source of materials were the tax registers from the 16th century, which were obtained from the Central Archive of Old Records in Warsaw (AGAD). The registers from the districts of Konin and Kalisz were

included in the archive unit no. ASK I 12. The tax registers contain information about the main settlement structure of the late Jagiellonian period of the Polish Crown (Słoń, 2011). They also provide a lot of valuable economic and demographic data on the rural sites and towns of the Early Modern state (Gieysztorowa, Żaboklicka, 1955; Boroda, 2007; Boroda, Guzowski, 2016). Nevertheless, the basic sources were the oldest, and unpublished, tax registers (1507–1510) from southern Greater Poland.

The environmental archives which were used in this study consist of the tree rings data model from the ‘Old World Drought Atlas’ (ODWA) (Cook et al., 2015) and preliminary pollen data from one of the peatlands in central Greater Poland (Czerwiński et al., 2019). The pollen data had been collected for one of historical and environmental projects in Poland, and at the time when I was doing my research, only one set of proxies (Kazanie peatland) had been elaborated and, therefore, available for me to use. The main difficulty with pollen data concerns the chronology of such materials. In the Kazanie peatland, the resolution of the core appeared in 10-year intervals, hence the analysis made it possible to look only at the beginning and the end of the plague period. Secondly, in general, the data from peatlands are strictly limited to the nearest study area, up to 5 or 10 km away from the reservoir (Birks, Birks, 1980; Theuerkauf, Couwenberg, 2017). For this reason, the final results are more local than in the case of analysis from lake cores. However, the pollen database from Polish lakes and peatlands, which is worthy of application in historical research (with proper ¹⁴C chronology), is expected to grow (cf. with Izdebski et al., 2016)

METHODOLOGY

The main methodological idea behind this research was to understand, both in spatial and quantitative terms, the mutual relations between climatic or environmental events (in this case mostly droughts and floods as well as their short- and long-term effects) and the history of the past societies. In this approach, I intend not only to examine past events, but also to pursue some recent climate history research proposals (Camenisch, 2015) which deal with narrative sources as primary materials for the investigation of past climate changes. My main assumption has been to describe and analyse one fairly well-known example of a crisis using the methods of spatial and economic analysis and to compare the preliminary results with the accessible proxies from recent projects published in Poland. In this case, the final result would not be very comprehensive, mostly because of the lack of source materials and proxies at this stage of research. The general idea is also in line with the direction of landscape change studies connected with climate research (among others, the analysis of the process of abandonment of settlements).

RESULTS

OWDA – climatic event and tree-rings data

A comparison of the weather conditions in Hungary, Czechia and in Poland at that time (OWDA) indicates clearly that in the years 1501–1504, there could have been a long-lasting drought (Cook et al., 2015). This scenario

can be supported by weather observations from Cracow (Limanówka, 2001), which show that at that time, the weather was perceived as rather chilly (in the spring) or warm (in the summer). None of the spring days in the years 1503–1507 was considered extraordinarily warm, while days of heat in the summer constituted a tiny fraction of all the observations: in 1503 – 5%, in 1504 – 3%, in 1506 – 11% and in 1507 – 16%. The significant accumulation of dry years in the late 15th and early 16th century (Fig. 3) is also visible in the last studies using tree-rings data from Poland (Przybylak et al., 2019). Looking at the narrative sources in this period, there is much more data pertaining to floods mainly sudden ones occurring on the main rivers of the Kingdom (the Warta, the Vistula) (Walawender, 1932). It should be noted, however, that the information about the dry periods, even though theoretically more acute in Poland than in Hungary, did not translate to the reception of these events in the written records in Poland, in which there is a major gap between before 1500 and after 1505 (Fig. 3). In this period, the number of chronicle mentions was bigger for floods (Fig.

2) than for droughts, so one can assume that the perception of the Late Medieval Polish society could have been more sensitive to all water-connected weather events (such as floods, heavy rains, hail storms). Despite the hard weather conditions, the last decade of the 15th century could not be treated in Poland as a breakthrough (cf. with Camenisch, 2018). It is likely that especially the period of very intensive floods and droughts and related with them other weather extremes of approx. 1500–1507 can be treated as the starting point of the later plagues (Fig. 4) in the first decade of the 16th century (Kiss, 2019, 2020; Yue, Lee, 2020).

The weather extreme from the sight of the tax records

The long-term drought, confirmed in all Central Europe (Kiss, 2017, 2019; Kiss, Nikolić, 2015; Brázdil, Dobrovolný et al., 2013) together with numerous instances of flooding caused by sudden rains, had most likely resulted in the outbreak of the epidemic in the Kingdom of Poland and Great Duchy of Lithuania in 1505 (Walawender, 1932). Starting from this year, the plagues repeatedly struck the Polish territories in the subsequent

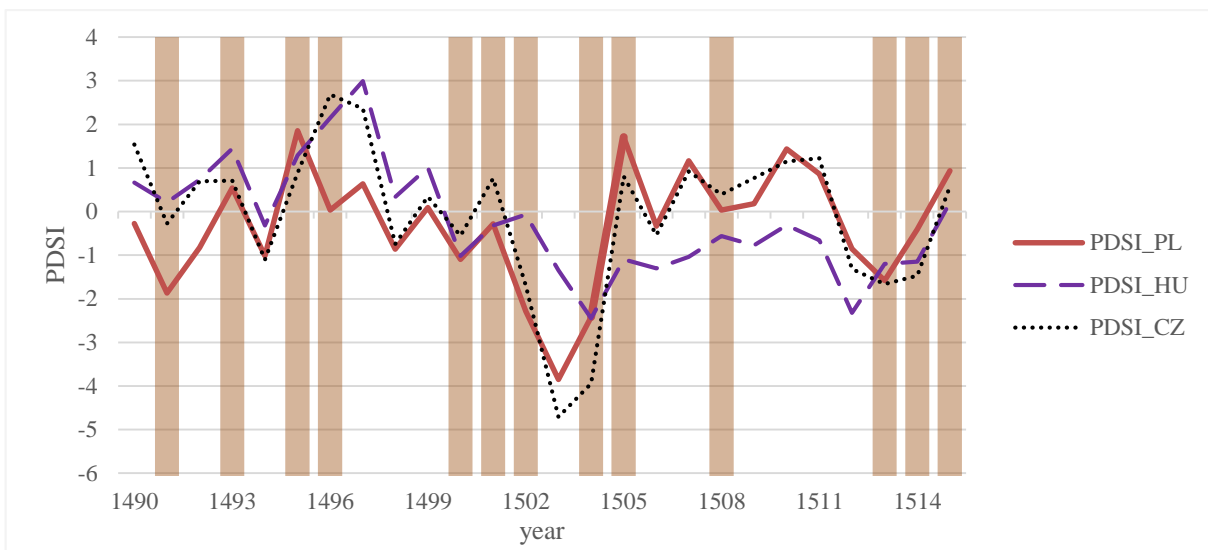


Fig. 2 Potential relationship between data from written records (vertical bars) on floods in Poland and OWDA. Sources (Cook et al., 2015) and (Walawender, 1932)

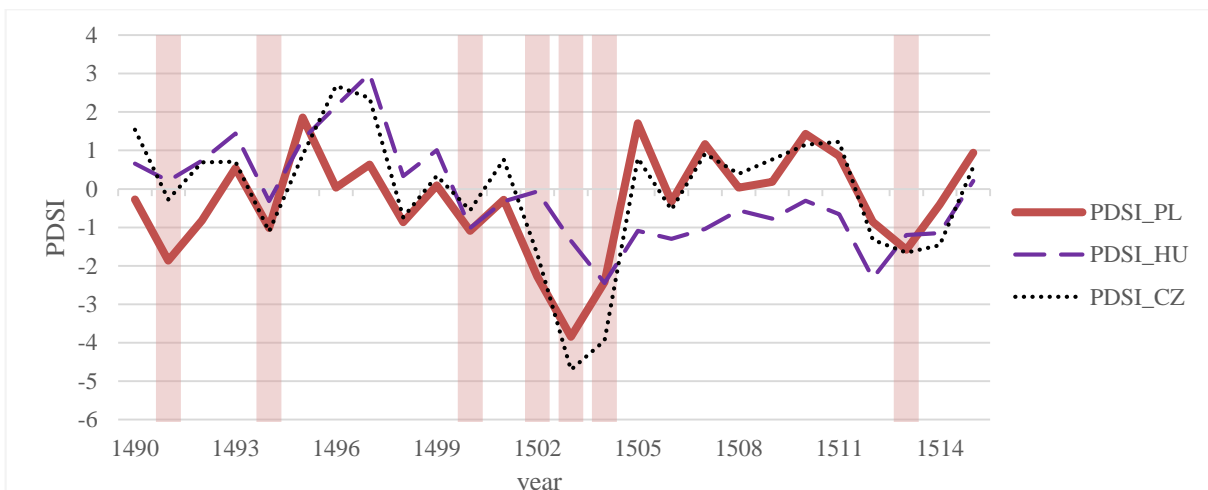


Fig. 3 Potential relationship between data from written records on droughts (vertical bars) in Poland and OWDA. Sources as in Fig. 2

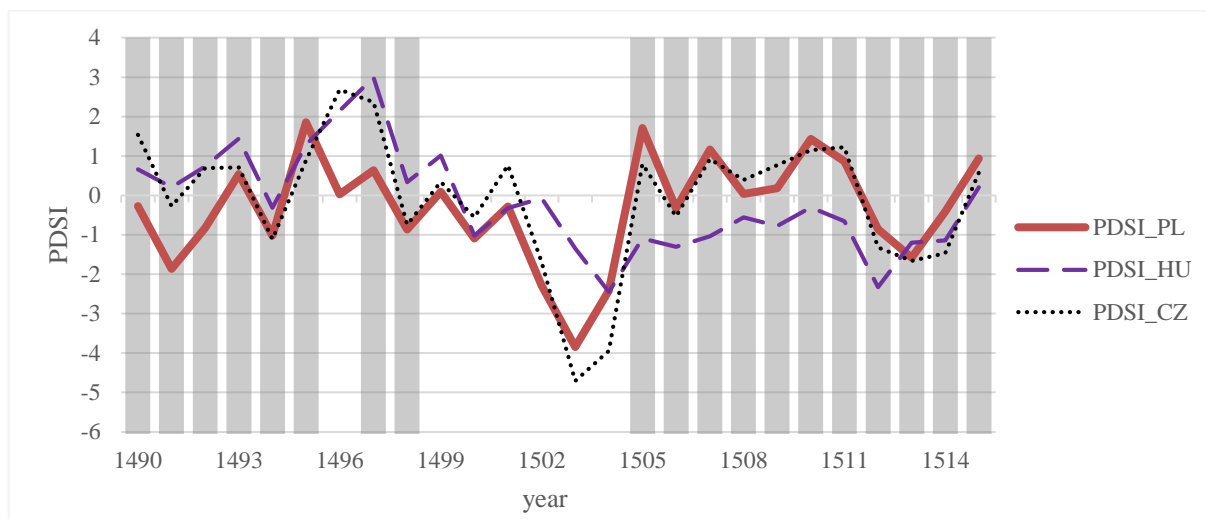


Fig. 4 Information from written records about diseases in Poland (vertical bars) with data on droughts or wet periods from OWDA. Sources as in Fig. 2

decades of the 16th century. When analysing the data from the district of Konin, one can clearly see that information about the disease was recorded in tax-related sources in three main ways: 1) direct mention about the plague striking villages (e.g. “*medius mansus per pestem desertus est*”); 2) mentions of peasants fleeing in connection with the disease (“*duo mansi ... per profugos deserti sunt*”); 3) information about peasants dying (“*tribus mansis deserti sunt a tres annis per mortem kmethonis*”). Thus, we are dealing with consequences of a persisting disease given in sources *post factum*. Such data do not make it possible to determine specifically when the disease broke out. It is only clear that it happened in the summer-autumn months of the year.

The analysis of the yearly distribution of data from the period 1507–1510 (Fig. 5) from the district of Konin shows that the disease was most acute in the early autumn (September) of 1507 (Gochna, Związek, 2019). It was then that the greatest percentage of flights and deaths due to the disease was recorded, however it was not until one year later that the greatest part of arable fields became unused. In 1509–1510, the plague was clearly subsiding to practically disappear in the autumn of 1510. Observations based on the data from the Konin district suggest that in this case, we are dealing with consequence-laden diseases (in all likelihood,

contagious), which in the view of the contemporary people were so lethal that they forced peasants to flee from their farms. Escape was generally quite a common means of dealing with plague; it was commonly practiced by the contemporary societies (Karpiński, 2000; Sowina, 2020).

In the context of the phenomena in question, however, the manner in which the contemporary tax offices of the state recorded such information seems to be of more importance. In the 15th and 16th century Poland, every village was obliged to pay mandatory, extraordinary taxes, which were set as lump sums. In general, taxes were paid on the basis of the cultivated land, forest clearance, water- and windmills. The amount of the main tax burden in relation to the income was not large (Guzowski, 2005), however failure to pay it was punished with imposition of a penalty upon the entire village (as a community of residents) which in the late 15th and early 16th century amounted nearly 60 times as much as the initial fee per one łan (Latin: *mansus*) of cultivated land (Gochna, Związek, 2019). For this reason, in the preserved tax registers, tax clerks paid a lot of attention to record the reasons for failure to pay the tax by individual villages. In tax registers from different districts, such information was recorded in various ways.

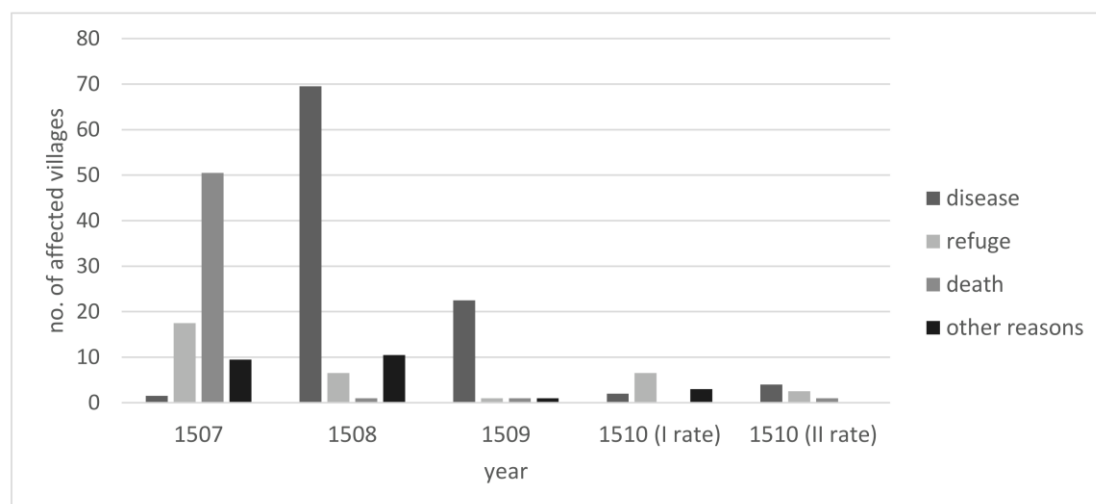


Fig. 5 Information about the disease in 1507–1510 in the Konin district with causes of field desertion. Source: AGAD, ASK I 12

While in the Konin district, each entry in the tax register was accompanied by an appropriate comment, in its southern neighbour – Kalisz district – such notes are not to be found. It is rather puzzling that as far as the registers from Kalisz are concerned, the source sheets often include blank fields (Fig. 6). An analysis of all such fields from the registers from 1507–1510 (Table 1) suggests that they should be interpreted as a direct testimony to the plague spreading over the district. The villages struck by the plague did not pay taxes because the peasants ran away (or possibly died) (*non habet kmethones*) or the villages were simply deserted (*desertum*). A quantitative analysis has made it possible to note that the plague in the vicinity of Kalisz – unlike in the Konin district – was a constant threat for 3 years, from 1508 to 1510, with practically identical impact on the settlement structures (approx. 30% of all villages remained empty).

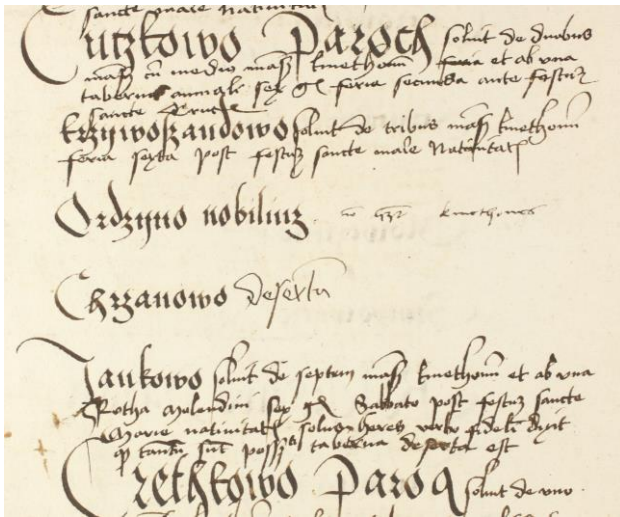


Fig. 6 Fragment of a tax register page from 1507 with two empty records. Source: AGAD, ASK I 12, f. 11v

Plague and the roads network

Tax registers also make it possible to study the spatial development of the plague. Using the available data concerning the settlement in the 16th century Poland (Polish Territories of the Crown in the 16th century. Spatial Database, 2015), one can trace the distribution of the villages affected by the plague in the period in question (Table 1, Fig. 7). Due to its transit character, the district of Kalisz communicated the areas of Lesser and

Central Poland (provinces of Sieradz and Łęczyca) with western Greater Poland and German duchies; it also played an important role in the North-South dimension (from Pomerania to Silesia) (Związek, 2017). Wiping the plague out from the outbreak sites – especially given the high mobility at that time – was a very difficult task. The disease affected most acutely the central and eastern parts of the district. The persistence of the disease in this area should also be connected to the existence of a relatively dense and old settlement network, which originated in the early Middle Ages (Dunin-Wąsowicz, 1960). When analysing the map of the development of the plague in the district, it makes one wonder why the plague did not affect so much the areas located to the north-west of Kalisz. The only reasonable explanation of this phenomenon is the proximity of the Prosna – a river splitting the district into two equal parts. It runs through the district from the South-East, via Kalisz, to North-West, supplying the Warta near Pyzdry, and then heading for Poznań. This means that a large portion of the contemporary transit (of items and people) must have been completed using the Prosna, which must have helped mitigate the effects of the plague in this area (Fig. 7).

Economic impact

Background – Crops prices in Cracow

In many Western researches, climatic events are explained using data on fluctuations of crops prices (Campbell, 2016; Pribyl, 2019). However, there is no collection of prices of basic agricultural products available for Greater Poland for historical periods. The best and most comprehensive sets have been elaborated for Cracow (Pelc, 1935), Warsaw, Lublin and Gdańsk (cf. with Boroda, 2019). Due to its state-of-the-art character and the retained source base (e.g. price series for Warsaw start only from 1526 or 1540–1545), only prices from Cracow – as the most important city in the southern part of the Crown – have been used here (Fig. 8). Prices from Lublin have been preserved only starting from the second half of the 16th century, while the market of Gdańsk was connected more with the economic situation in Amsterdam and other Hanseatic cities than with the rest of the Polish state. The dataset for Cracow is not complete and includes many gaps but the prices of rye can suggest that some kind of fluctuation occurred between 1499 and 1507. It is possible that the price fluctuation was caused by climatic pressure, however without further examples

Table 1 Quantitative comparison of data concerning entries in tax registers from the Kalisz district from 1507–1510. Source: AGAD, ASK I 12

Register [year] w/ potential rate number	No. of entries	No. of all villages	No. of deserted villages (<i>desertum</i>)	No. of all empty entries	Percentage of empty entries
	A	B	C	E	$E/A \times 100\%$
1507	601	434	25	66	11%
1508	518	431	30	129	25%
1508 (rents)	543	422	23	164	30%
1509	499	430	28	136	27%
1510 (I)	460	419	11	132	28%
1510 (II)	471	424	13	144	30.57%

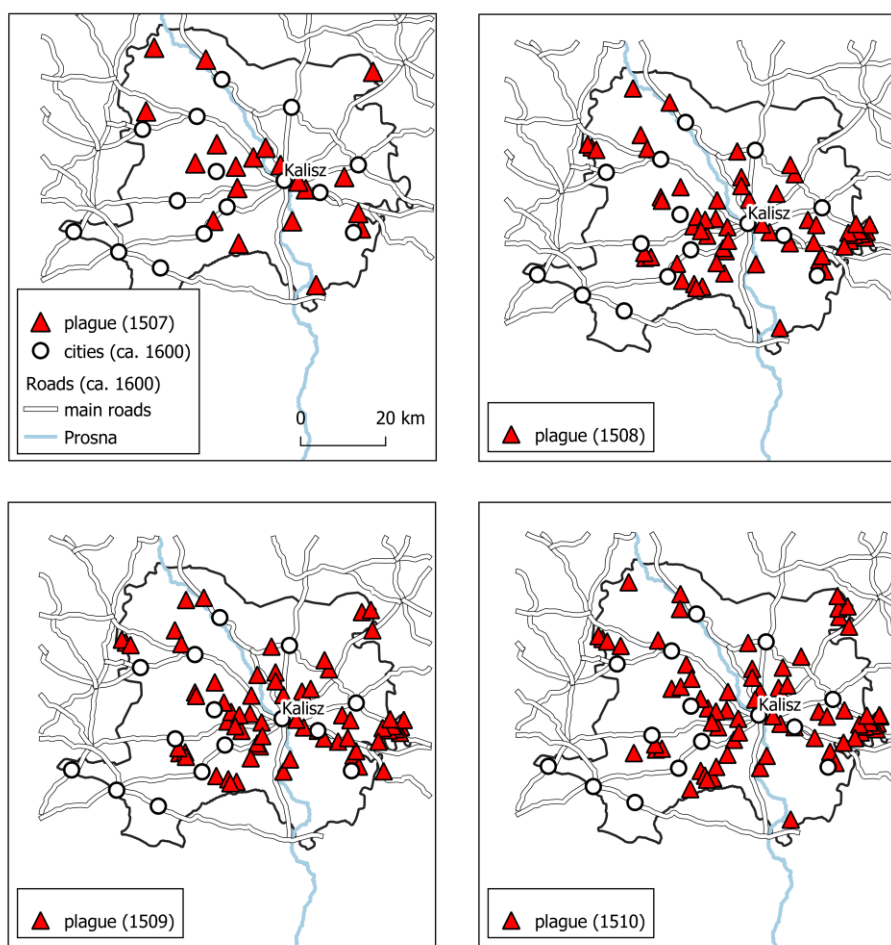


Fig. 7 The spatial development of the plague in Kalisz district villages (1507–1510) according the main roads network. Source ASK I 12

from other cities in the region (Czechia, Hungary, Slovakia) and other studies on prices in Poland in the later centuries, this observation cannot be treated as certain.

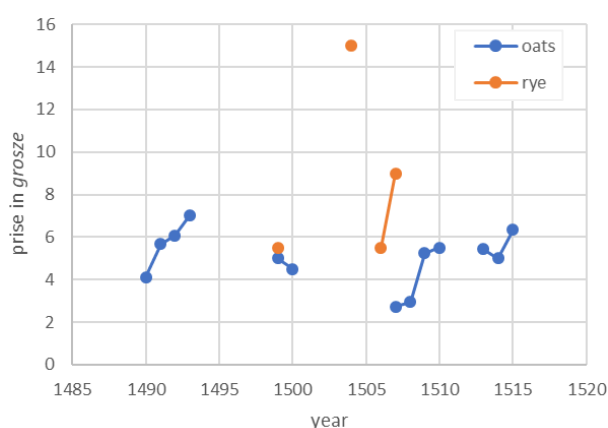


Fig. 8 Recorded prices of oats and rye between 1490 and 1515 in Cracow. Source: (Pelc, 1935).

In towns

The investigation of the impact of the plague upon the economy of the Kalisz district is heavily constrained. There are no comparisons of crop prices available for this area. Changes to the economic structure can be traced using the data included in tax registers or data on potential fluctuations of the prices of rural property (villages,

village parts, individual fields, etc.). While the analysis of tax-related data is relatively easy, analysing the prices of property poses problems related to the amount and partial dispersion of the available source material (Gąsiorowski, 1970; Pośpiech, 1989). Such studies also call for a much broader context (territorial and temporal).

The data on the spreading plague can also be studied from the perspective of the economic power of towns in the given district. For years 1507–1509 and 1552, we only have data concerning the liquor tax (Polish: *czopowe*, literally – bung tax) (Table 2), which was a tax paid on the propination – the exclusive right to produce alcoholic beverages in the towns (and sometimes villages) of the former Crown (Boroda, 2016). The data indicate that the plague exerted an unfavourable impact on all the towns of the district, as the income from the liquor tax dropped in 1508 (in relation to the previous year) by approx. 20%. This state of affairs was not long-lasting though, as in the subsequent years the total income from the tax exceeded the amount from before the plague by approx. 6%. On the other hand, when one inspects the impact of the plague on the towns in the context of their overall social, demographic, economic and institutional potential (Słoń, 2017), it turns out that the smaller towns (S) within the district could experience the effects of the plague to a significantly smaller extent than the large (L) and medium (M) towns, such as Kalisz, Pleszew or Stawiszyn. In the times of plague, small towns could successfully compete

with the past production leaders, increasing their own production. The increase in their production could be driven by migrations of craftsmen – temporary escape from one town to another. However, this supposition has not been confirmed in the urban sources for the region. In a longer perspective, it is visible that during the first half of the 16th century, the main urban centres of the district failed to maintain their position. There was a significant economic dispersion in this area, which benefitted small towns, whose economic potential grew in 1552. It is not clear, however, to what extent this effect was caused by the plague of 1507, because there are no sources for the period between the plague in question and the liquor tax register of 1552.

Table 2 Amount of the liquor tax from the towns of the Kalisz district in 1507–1509 and 1552. Source AGAD, ASK I 12

Town / Year	Classification	1507	1508	1509	1552
Kalisz (capital city)	L	13200	10076	12432	6721.5
Pleszew	M	1716	1264	1428	864
Stawiszyn	M	1046	786	3791	2100
Sulmierzyce	S	228	127	168	864
Koźminek	M	226	259	0	768
Zduny	S	222	58	0	192
Iwanowice	S	124	132	126	318
Dobrzyca	S	117	146	66.5	519
Raszków	M	91	596	69	150
Odolanów	S	88	70	74	96
Sobótka	S	48	160	48	96
Kwiatków	S	29	37	13	192
Ostrów Wielkopolski	S	20	70	49	216
TOTAL (in grosze)		17155	13781	18264.5	13096.5

The possibility that the Polish economy of the late 15th and early 16th century functioned in the state of the so-called Late Mediaeval Crisis (Guzowski, 2008) is firmly rejected. Instead, it is argued that this period was one of prosperity, lasting without interruptions from the end of the war against the Teutonic Order (1466) until the so-called Deluge (1655–1660) – a period marked by the catastrophic war against Sweden. As far as this interval is concerned, the vast majority of Polish towns were small or medium-sized (Bogucka, Samsonowicz, 1986). Some towns (reaching 1–2 thousand residents) were clearly agricultural, which was evidenced not only by the small share of crafts and trade, but also by the functioning of a limited economic market in their closest vicinity and existence of many inner gardens (*intra muros*). It appears that this relatively weak urban structure on the Polish territory, disadvantageous in the longer perspective of overall economic development of the country, made it easier to deal with the effects of natural disasters – mainly plagues. It should not come as a surprise that Kalisz, being a medium-sized town and the centre of the region, was most seriously affected by the consequences of the plague

in 1507–1510 (Fig. 9). On the other hand, smaller towns benefitted from the situation at this time, offering population running from bigger towns a safe refuge.

In the countryside

The plagues might also cause the significant landscape changes resulting, for example, desertation of arable land or entire villages (Żytkowicz, 1969). In this respect tax registers offer an opportunity to observe the spatial spread of the plague in the countryside areas of the Kalisz district. As far as the general tendencies are concerned, one can see that the size of the agrarian land (Latin: *mansus*, Polish: *łan*) in peasants' [Polish: *kmieć*] and village leaders' [Polish: *sotys*] farms decreased year on year (Fig. 10). The effects of the plague were becoming more severe, as in the period between 1507 and 1510, approx. 18% of all peasants' farms were completely deserted (Schreg, 2020). The median of the abandonment of the remaining villages in the district was 0.33% of the agrarian land. The crisis affected over half of the villages in the Kalisz district – 186 villages can be considered affected by the disease (52% of all). Their *łan* area dropped from 4.25 *łan* to 2.5 (median). In the case of 128 villages (36% of all), no direct correspondence with the plague effects has been noted. It has also been observed that for 40 villages (11% of all), an increase in the number of *łans* was recorded between 1507 and 1510 (the median of the number of *łans* from 3 to 4.5). The available data for the Kalisz district do not make it possible to make specific judgements concerning the immediate impact of the disease and its consequences. Apart from following directly from the peasants' death, the phenomena in question could have resulted from their flights as well. The countryside could have also been suffering from overall economic slow-down in this period. It is particularly interesting to note that the unused fields were taken over by neighbouring peasant farms and this practice was of considerable size.

Data from pollen (Kazanie peatland)

In spite of the foregoing, it should be noted that written records alone cannot render the full picture. What can be done about localities for which no tax registers have been preserved? They too were probably struck by the plague; the question is: to what extent? In order to extend the scope of the analysis, some palynological data have been included which can also reflect the economic changes brought about by the plagues with the accompanying transformation of the past landscapes (Mordechai et al., 2019; Słowiński et al., 2019). The peatland is located almost 100 km away from Kalisz, but it can significantly contribute to the data on landscape changes for areas for which we do not have any quantitative written records (in this case Gniezno and Poznań districts). To this end, in order to illustrate the problem and offer a preliminary interpretation, one palynological site was selected, namely the Kazanie peatland (Fig. 1), which reflects environmental changes of a local character (Czerwiński et al., 2019). The chronology of the site was prepared in a 10-year resolution; thus, the paleoecological observations can be made for the period before the climatic extreme year 1505 and after a few-years spread of the plague in the

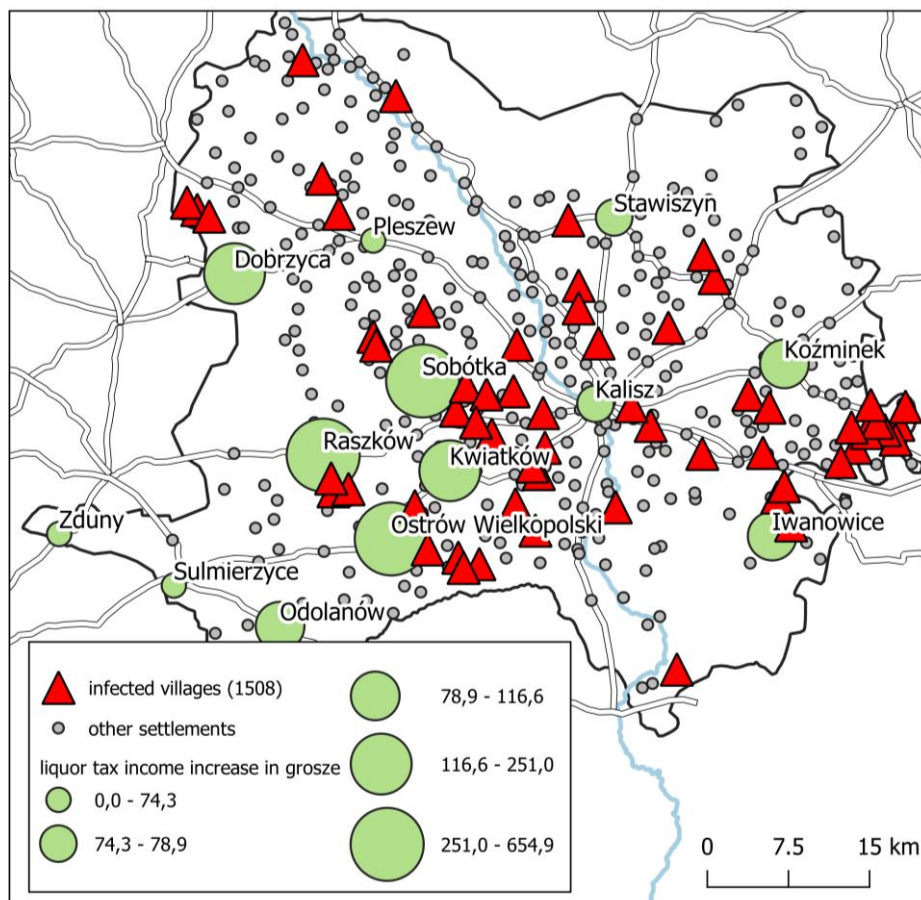


Fig. 9 Increase in income from the liquor tax in 1508 in relation to 1507 – as a percentage. Source AGAD, ASK I 12

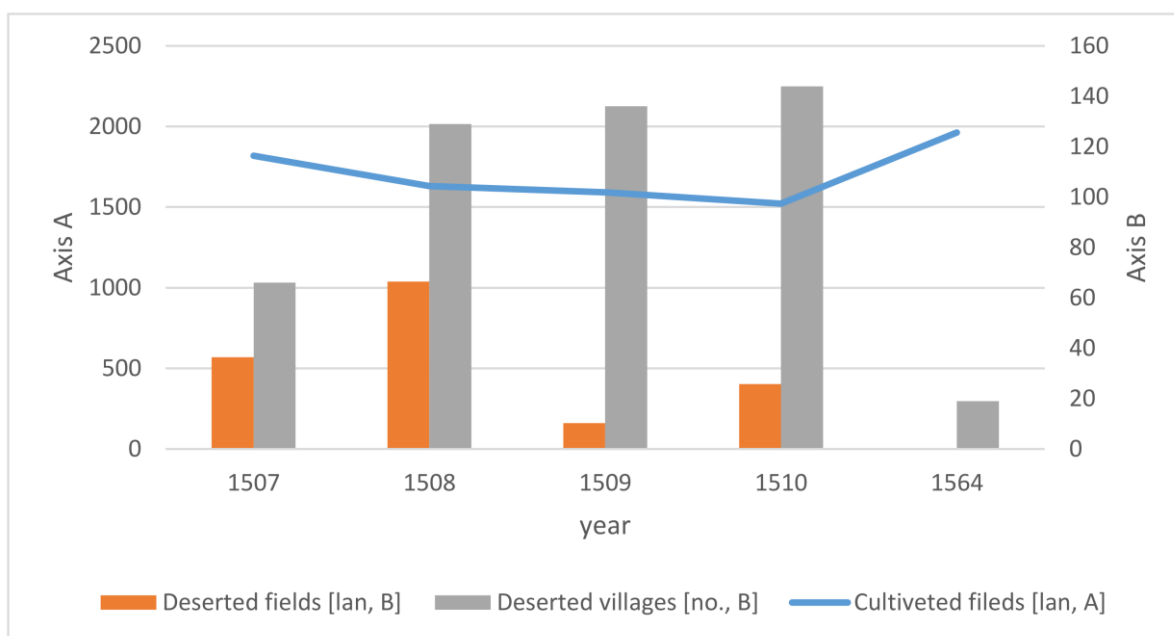


Fig. 10 Decrease of the number of arable land in Kalisz district during the plague 1507–1510 with comparison of 1564. Source: AGAD, ASK I 12 and (Kuc et al., 2015).

Polish Kingdom. However, these limited data can offer us the first preliminary look at the environmental and economic impact of the plague on the rural sites in Central Poland. At present, this is the only site in Greater Poland available with reliable absolute chronology and continuous palynological sampling

(improving time-resolution of paleoenvironmental interpretation) described by a joint team of historians and paleoecologists.

On the basis of the preliminary materials prepared at the Kazanie site (Fig. 11), one can see (in particular based on the anthropogenic indicators, like cereals and meadow-

pasture plants) that at the beginning of the 16th century, there was a small drop of the pollen share in the analysed samples. It was not rapid, however, reaching for example approx. 1% for cereals in the interval ca. 1501–1511 and nearly 2% in the interval 1501–1521. There is also an almost simultaneous increase of meadow and pasture pollen share, which could indicate the considerable size of the practice of abandoning cultivated fields and transforming them into areas not used in the production of grain crops. One can also note the long-term drop of the percentage value of ruderal plants, which accompany humans' settlement in the given area. Particularly relevant proxies are pollen of cereal and ruderal plants, which declined around 1511. Simultaneously, the level of birch pollen, which is a pioneer species, was rising. In this case, the paleo-proxies should be applied in combination with the written records (abandonment of settlements and fields) in another region. Comparing paleo-data with written evidence, one can assume that the settlement changes in the Kalisz region can be interpreted as a long-term result of the plague, and also, indirectly, as the result of the climate changes during the Little Ice Age (cf. with Schreg, 2011; White 2014).

A detailed analysis of the palynological data from other sites with reliable absolute chronology of sediment would make it possible to offer more accurate observations connected with the reaction of rural communities to all sorts of extreme events – including the plague. The Kazanie fen discussed above offers an example which is limited in terms of range, as it applies at maximum to an area within several kilometres from the site centre. A larger reservoir could even show processes on a regional scale. Secondly, a bigger body of water from which pollen data could be extracted would also be less prone to local environmental transformations (e.g. forest clearing). The observations from the Kazanie peatland are promising when it comes to the use of pollen data analysis in the study of changes brought about by plagues, floods, or droughts in historical-environmental research. But in

order to develop a comprehensive narrative about the direct impact and relations between human societies and local environs, it is necessary to build a substantial database of paleo-archives.

CONCLUSION AND RESEARCH PERSPECTIVES

The article has demonstrated that simultaneous application of quantitative and spatial research approaches makes it possible to achieve a deeper understanding of the studied phenomena. Furthermore, the employment of data obtained from nature archives allows one to conduct analyses in a more complex manner. As far as the description of the phenomena in question is concerned, mentions from narrative sources have been proven to be exaggerated. The manner in which they present information is also affected by the problem of the individual perception of the described events – which is difficult to account for. The preliminary analysis of other materials (mainly tax-related and natural) has shown that indeed one can speak of the spread of the plague in the Polish territory at the beginning of the 16th century. Its impact on rural and urban communities was visible in written records (the growing number of deserted villages and fields) and in paleo-data. In particular, the pollen data analysis has shown that settlement abandonment and economy drops in the rural sites can be observed after approx. 1511.

What is definitely needed are further studies of the reactions of pre-industrial societies to various climatic and weather extremes causing plagues. In the subsequent steps, we should focus on the possibility to correlate the data on plagues with the trade in rural property. The same should be carried out for urban areas as well. The analysis of the Polish territories should be extended to cover other provinces – for example Rus' and Mazovia. It would also be advisable to consider the problem of potential economic fluctuations in individual towns within the Polish territory more broadly.

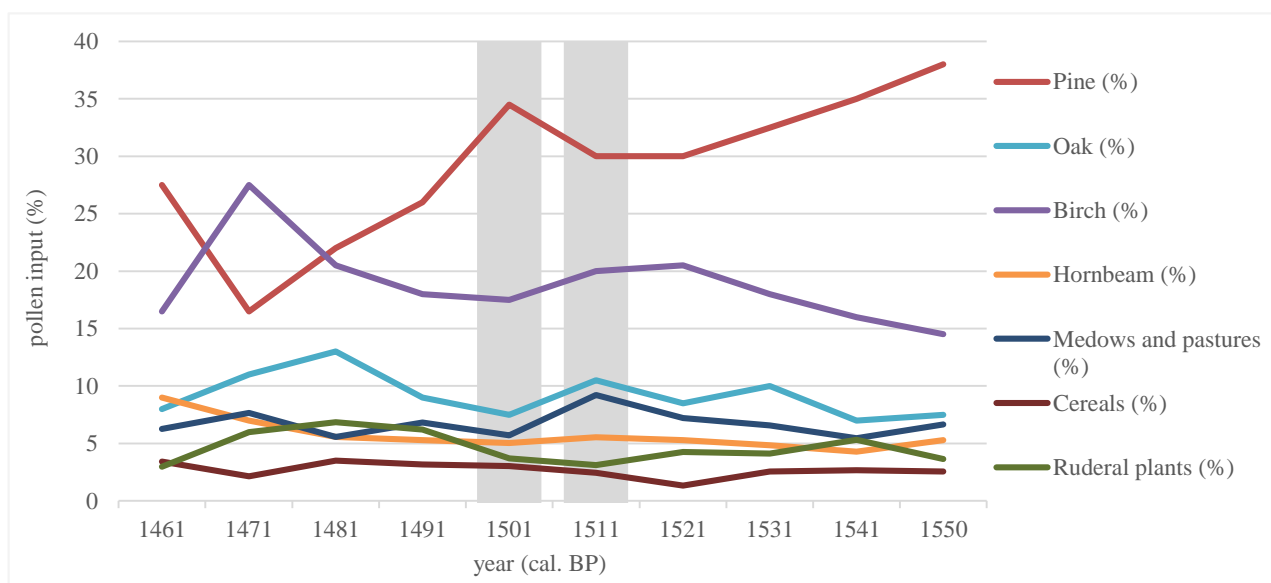


Fig. 11 Simplified pollen data from Kazanie peatland in 10-year resolution. Source (Czerwiński et al., 2019)

In the Polish literature so far, the postulated economic fluctuations have been attributed, among others, to the crisis of feudalism and the resulting general crisis of production in the pre-industrial economy; this seems to call for a reinterpretation. A new approach to the study of factors which shaped the economic changes should consider the mutual relations between the former societies and the changes of environment and climate.

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