PROBLEMS

Climate as a Factor Affecting the Human Environment in the Middle Ages

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> *«L'histoire ne vit pas, ne doit pas vivre que de parchemins noircis ou de vieilles pierres. Les paysages aussi sont, à leur manière, des documents».*
>
> M. Bloch

Man's interference with his natural environment has occurred ever since human beings have inhabited the earth. *Homo sapiens* brought the earth into cultivation, but in the course of this he has also been destroying the natural environment, which is as much the source of his sustenance as it is a threat to his survival.

The cultivation and destruction of the environment seem to occur in cycles. When destruction threatens to become catastrophic, then comes the realisation that the environment must be safeguarded and restored.

Undoubtedly, the second half of the twentieth century is a critical time in the long history of man's destruction of his natural environment, but it also marks a high point in man's concern for the preservation of that environment. Time will show whether this concern will predominate, and to what extent. If the description *sapiens* is rightly attributed to man, this concern should triumph.

The example of the Mediterranean area, the cradle of European culture and civilization, illustrates only too well the truth that the advance of human settlement and the development of technology lead inevitably to the destruction of the natural environment. The example of Greece, Sicily and the

South of France — once areas of earthly paradise in terms of climate and natural environment — illustrate only too well how an intensive und uncontrolled settlement during the first millenium A.D. has resulted in a devastation of the environment of these regions. Today, man armed with the instruments of twentieth-century technology, puts great effort into re-forestation, irrigation, and scientific cultivation of these areas. It proves very difficult, however, to bring back water to the now dry river beds of Sicily, forests to the bare mountains of Provence, and a fertile soil to the rocky mountains of Greece.

The Greek tourists of today like to spend their holidays on the island of Andros, where foreign tourists, industrial and commercial development have not yet arrived, and where one can still find forests, clean sand on the beaches and unpolluted water.

Some archaeologists from Palermo, much to the astonishment of their colleagues in related disciplines, have discovered traces of thriving economic life in early medieval Sicily. They have discovered that the streams of the island abounded in fish, the water was used to work water-mills, which ground the wheat from the surrounding fields and, on a modest scale, the country was self-sufficient.

Provence is a similar example although, there, realisation of the devastation which was resulting came earlier. Attempts to control this devastation were, however, only moderately successful.

The late Maurice Lombard,[1] who believed that timber was Europe's most valuable natural resource and that this resource has always been wastefully exploited, was certainly right. This can also be said of water, considered in its widest sense to include stagnant, flowing and ground water, as well as the sources of drinking water, so essential for human settlement. The interconnected problems of forests and water resources will provide the focal topic for our discussion on the various changes witnessed in the natural environment of mediaeval Europe. These, however, cannot be treated separately from still another important aspect of the natural environment — the climate, which is inseparably connected with both water resources and forests. Furthermore, hydrographic conditions in a given area are directly dependent on the climate. The most decisive influence on the three basic climatic determinants, the most important of which has always been rainfall, has been the degree of forestation. The two further factors determining the climate are air temperature and, related to this, the degree of atmospheric humidity, i.e. the amount of water vapour in the air. An additional factor are the number, the force and the directions of prevailing winds. The important role played by forests in acting upon these factors is something that we are aware of from everyday experience.

[1] LOMBARD, M., *Espace et réseaux du haut Moyen Age*, Paris, 1972.

The research carried out by English and American geophysicists [2] into the changes which took place in the natural environment of Europe during the Middle Ages, is corroborated by the work of Polish researchers on climatic changes and on the effect of these changes on the patterns of human settlement in Europe during the same period.[3] Their research enables us to put forward certain hypotheses. I would like to draw special attention to two: the first concerns the effect of human activity in the field of irrigation in forested lowland areas; closely related to this is the exploitation of natural resources. The other pertains to the general climatic changes which have taken place irrespective of man.

The comprehensive research of geographers, historians and archaeologists carried out during the last twenty years has charted the pattern and evolution of early mediaeval settlement in the lowlands of Central and Eastern Europe. The works of Z. Hilczer,[4] S. Kurnatowski,[5] and J. Herrmann [6] provide evidence that human settlement during the early Middle Ages gradually moved from river valleys and marshy areas onto higher land.

This trend was significantly intensified during the middle of the 13th century, although a pattern of migration to areas of higher land can be detected earlier. At one time this pattern was thought to have been induced by dramatic floods, recorded in the annals and chronicles of the period. It seems more likely, however, that it was brought about by changes in the systems of irrigation. These in turn reflected a more intense settlement in mountain regions which had led to large-scale cutting down of forests. According to some geographers and climatologists these extensive high-altitude forests had regulated the degree of rainfall and atmospheric humidity. It has recently been demonstrated, however, that the most extensive cutting down of forests (if this can be measured statistically) took place during the 16th and 19th centuries, although during these centuries no major climatic changes took place. The cutting down of forests, if it exceeded a certain level — which could have been quite low in the context of a millenium — had none-

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[2] *Les changements du climat.* Actes du colloque de Rome organisé par l'UNESCO de l'Organisation Météréologique Mondiale, Paris, 1963; *World Climate from 8000 to 0 B.C.*, Proceedings of the International Symposium held at Imperial College, London, 18 and 29 April 1966, London, 1966.

[3] Dunin-Wasowicz, T., *Zmiany w topografii osadnictwa wielkich dolin na nizu środkowo-europejskim w XIII w.* [Changes in the Topography of Settlement in the Great Valleys Over the Central European Lowland in the 13th Century]. Wroclaw-Warszawa, 1974.

[4] Hilczer, Z., *Dorzecze górnej i środkowej Obry od VI w. do początków XV w.* [Basin of the River Obra High and Middle Course from the 6th to the Beginning of the 15th Century]. Wroclaw, 1967.

[5] Kurnatowski, S., *Études sur l'habitat du haut Moyen Age dans la région de l'Obra inférieur*, « Archaeologia Polona », Vol. 6, pp. 261-278.

[6] Hermann, J., *Wasserstand und Siedlung im Spree-Havel Gebiet in Frühgeschichtlicher Zeit*, « Ausgrabungen und Funde », Vol. 4, pp. 90-106.

theless an adverse effect on the European hydrographical system. There may, however, have been other factors at work as well.

The theory of J. Schove who estimated the maximum degree of solar activity and ascribed it to climatic changes (i.e. the theory of the spectrum of time [7]), in conjunction with the findings of the American scholars A. E. Douglas [8] and E. Huntington,[9] have made possible the construction of a graph depicting solar activity over a long period of time. According to this interpretation the years of reduced solar activity are associated with natural disasters and, possibly, with periods of social upheaval. For our purposes it is especially relevant, that solar activity is found to have been at its lowest level three times during the course of the Middle Ages: for a short time in the middle of the 11th century; for almost the whole of the 13th century and the beginning of the 14th century, and throughout the 15th century. For Poland, as well as for some other parts of Europe, these were periods of successive natural disasters.

The large-scale migrations of people from the lowlands to higher-lying regions would seem to indicate not only a high degree of atmospheric humidity and flooding in the river valleys, but also a general improvement of agricultural conditions in the highlands. In the southern regions of Poland these migrations also coincided with the first cultivation of *loess* soils — extremely fertile depending on favourable water conditions. Since this was the case from the 13th century on, it acted as a great stimulus to the development of agriculture in these regions, whilst the valleys became more utilised for stock-breeding.

The fact that for the period from the 9th to the 15th centuries the finding of Polish geographers, historians and archaeologists [10] corroborate the theoretical graph of J. Schove is so striking, that the records of solar activity must be treated with respect as a serious method for testing changes in the geographical environment of Europe. This approach might also be extended to the whole Central European Plain. The necessity of having an agricultural area to draw on was almost always an important consideration, which conditioned the possibility of growth into larger settlements. Since during the 13th century water resources in Central Europe were lower than today, such conditions existed only in the river valleys of the area i.e. (taken from west to east) the basins of the rivers Loire, Rhine, Danube, Oder and

[7] Schove, D. J., *The Sunspot Cycle, 649 B.C. to 2000 A.D.*, « Journal of Geophysical Research », Vol. 60, pp. 127-146.

[8] Douglas, E., *Climatic Change and Tree Growth*, Washington, 1919.

[9] Huntington, E., *Civilisation and Climate*, New Haven, 1924.

[10] Radwanski, K., *Stosunki wodne wczesnośredniowiecznego Okólu w Krakowie, ich wplyw na topografię osadnictwa i próby powiązania tych zjawisk ze zmianami klimatycznymi* [Water Conditions in the Early Mediaeval Okole of Kraków and their Influence on the Topography of Settlement and Attempts at Connecting those Phenomena with Climatic Changes]. Materialy Archeologiczne, Vol. 13, pp. 5-40.

Vistula. It was the increase in water resources in the catchment basins of smaller rivers (Seine, Moselle, Spree, Warta, Pilica) that made possible their development into agricultural areas.

In the higher lands, however, it is only from the 13th century that an agricultural base existed for extensive settlement. In Poland, at this time the areas of high land in Little Poland and Silesia, especially those of fertile *loesses* — hitherto less productive — rose in value, and from the 13th century on they came to be some of the most fertile and productive regions of Poland.

At the same time, the fertile silt valleys of the larger rivers and the depression basins surrounding lakes became unsuitable for permanent settlement as a result of the marked rise of the ground-water table; violent and unpredicted floods, intensified in the mid-13th century, destroyed the crops in the valleys. In view of this, new settlements avoided these areas. A safer location on a raised bank or terrace was chosen instead.

Changes in Natural Environment as a Result of Human Acitivity. Forests.

The cutting down of forests in the Central European plain had important consequences for the natural environment. Geographical research has emphasized the fundamental relationship between diminishing stands of forests and the hydrography of an area. The progress of settlement in the higher regions of Central Poland involving the cutting down of forests at the sources of mountain rivers, caused changes in the amount and type of rainfall and also affected melting of snow and ice. All these factors contributed towards causing sudden floods recorded in historical sources from the 13th century. A cessation in the destruction of forests, however, was not possible since timber was the basic building material for the inhabitants of the area. On the contrary, the demand for timber was steadily increasing with the advance of settlement and the erection of fortifications ensuing from the formation of states. It would be interesting to estimate the acreage of oak forests needed for the construction of the early mediaeval settlement of Gniezno, Kruszwica, Lad, Konin, Giecz and Poznań. A close look at the map of the area between the rivers Vistula and Pilica is very instructive in this regard. One can easily detect the blank spaces once covered by forests around mediaeval settlements; the region of Radom, Skrzynno and Sieciechów are good examples. Even the more important routes of communication in the 13th century led from one forest clearing to another, and these were inhabited

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[11] Dunin-Wasowicz, T., *Questions ouvertes sur le milieu géographique des états situés sur la Grande Plaine Européenne*, in « Międzynarodowy Kongres Archeologii Slowiańskiej », Vol. 4, Wroclaw, 1968, pp. 156-8, also: *Remarques sur les changements dans l'hydrographie et la topographie de la région où se situe actuellement Berlin*, in « Internationaler Kongress für Slavische Archeologie », Berlin, 1973, Vol. 3, pp. 119-124.

by much scattered settlement. Prior to the 13th century these routes had led through forests, most often over watershed ridges. Water transport of heavy materials such as timber was relatively easy; even in wintertime, when the rivers were frozen, timber could still be moved more easily over the ice than overland. The importance of forests in early mediaeval transport and communication was also of another kind. By extensive archaeological research, carried out over large areas of Poland, Germany, Russia and Czechoslovakia, it has been established that timber was a basic material in road-building. It is almost impossible to estimate the amount of wood utilised for such work. Stone was rarely used for housing in these areas. It was only used for building jetties in rivers and lakes and at river crossings to keep the fords passable. Elsewere archaeology has revealed the exclusive use of timber structures for bridges, dams and roads, some of them quite small, others stretching for miles along important routes, including roads leading as causeways to human settlements on islands. Classic examples of the latter, often mentioned in relevant literature, are the bridges in Teterov in Mecklenburg [12] and in Ostrów Lednicki in Poland. As settlements grew, they also required more and more timber. Archaeological research in Gdańsk and Opole has revealed that the timbered roadbeds needed replacing every twentyfive years, excluding normal, current repairs. Timbered street sub-grades had to be replaced every fifty years.

Apart from fortifications and roadbuilding, there was a further use of timber in this period as the material out of which almost all everyday utensils were made. Besides peat, it also served as the main source of fuel.

The destruction of deciduous forests in the post-glacial European plain, particularly in densely populated river valleys, is further confirmed by diagrams compiled by F. Firbas [13] revealing a dramatic decline in the amount of alder pollen and an increase in the amount of grass pollen. This reflects not only a considerable change of the climate (which all of Europe underwent at that time), but also the development of settlements in Europe north of the Alps.

Hydrography

The problems of hydrography, conceived in their widest sense, are closely interconnected with those of forests. Here we are particularly concerned with the importance of water for changes in the natural environment. Our task is to try to establish the degree of man's interference in hydro-

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12 SCHULDT, E., *Slavischer Strassen und Brückenbau in Mecklenburg im fruhen Mittelalter*, in « Liber Iosepho Kostrzewski octogenario a venatoribus dicatus quem Konrad Jazdzewski redigentum curavit », Wroclaw, 1968, pp. 355-362.

13 FIRBAS, F., *Spät- und nacheiszeitliche Waldgeschichte Mitteleuropas nördlich der Alpen*, Vol. 1-2, Jena, 1949-50.

graphic conditions during the early Middle Ages. Apart from flowing and stagnant water, there are two other important categories: groundwater and springs giving drinking water. It is difficult to establish the degree of interference in the first two cases. The other two have tended to be neglected by historians studying the development of settlements.

Historians have always agreed about the importance of river valleys and the basins of channel-valley lakes as primary locations for settlement. It is the archaeological evidence of settlements in low-lying areas, sometimes even in floodland and marshland, which has been more controversial. On the basis of the assumption accepted by historical geographers that the climate was generally milder — particularly due to being more damp — and that water levels were generally higher than they are today, it has been difficult to explain this pattern of settlement. The present writer has arrived at different conclusions.

We know relatively little about climatic changes in the early Middle Ages. From some specialized research it can be deduced that there were at least two very dramatic changes during this period. J. Schove's graph indicates that they took place in the 11th and in the 13th centuries. These changes coincided with topographical shifts in settlement patterns. They can also be deduced from the studies of water conditions in the areas under discussion at the same time. The changes in micro-regions and micro-climates affected the general climate to a large degree. We must therefore allow for local variations which were dependent on the lie of the land and its morphology, the development of settlement and the degree of interference with hydrographic conditions. Here we touch upon a further controversial point, which is whether the construction of weirs and water-mills did alter the drainage patterns in mediaeval Poland, or not.

This must have been the case, but to what a degree is difficult to judge. Generally speaking these constructions interfered with the natural water flow in the area, by diverting some of the water to irrigate the surrounding land. They also affected the speed of water run off at certain periods.

Closely connected with hydrography is the problem of waterways and their use during the early Middle Ages. We see more and more clearly how closely interconnected were land routes and waterways. They frequently complemented each other over long distances.[14] In the North-European plain they were certainly fully used for transport purposes. The capitals of early mediaeval states often lie at points of convergence of natural routes of communication, i.e. roads and waterways. Waterways were used for the transport of heavy goods such as timber and rocksalt. It may seem that in the higher regions, particularly in the mountains, lakes and streams played a

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14 Dunin-Wasowicz, T., *Research on the Mediaeval Road System in Poland*, « Archaeologia Polona », Vol. 2, 1959, pp. 125-140.

lesser role. West European specialists, however, have supplied evidence that mountain streams and high-lying lakes were used for purposes of transport.[15] This greatly reduced the cost of transport. For some years now Swiss geographers [16] have been providing evidence that an extensive communication network existed between the Alpine lakes, with relatively short stretches of roads. It seems, however, that an abrupt change took place in the network of waterways in the North-European plain during the 13th century. This was probably due to the interference by man with the natural course of rivers and with the development of transport by land. The latter was facilitated by the more widespread use of modern horse-drawn vehicles. This also meant an increase in the total amount of transported goods. A further factor was the economic development of cities, which were often without natural waterways.

The role of the sources of drinking water and the importance of suitable springs remain to be discussed in the advance of settlements. The gradual shifting of the city centre of mediaeval Warsaw from Bródno to Kamion and Solec and then to Jazdów and what eventually became the old town, provides an excellent example of a shift, which took place probably because of the need of new sources of drinking water.[17] Some of the springs discovered at that time are used to this day.

Agriculture and stock-breeding

Issues connected with agriculture and stock-breeding have long been considered of great importance by European historians and archaeologists. Geological and pedological research has been fully utilised here, but there still remains a lot to be investigated. The studies of E. Le Roy-Ladurie [18] (mainly dealing with France and the Alpine countries) have proved that the yield of harvest depended much more on adequate water supply to the crop, than on intensive methods of cultivation. It is therefore the question of climatic changes which provides a key to the problems of agriculture and stock-breeding, and these changes can be deduced from hydrographical records. There has been controversy amongst specialists for many years about whether in the early Middle Ages lands less fertile but easier for cultivation were utilised in preference to richer loess or humus soils, requiring much more labour; the results have so far been inconclusive. We can assume that in

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15 Lopez, R.S., *The Evolution of Land Transport in the Middle Ages*, « Past and Present », No. 9.

16 Bergier, J.F., *Les foires de Genève et l'économie de la Renaissance*, Paris, 1963.

17 Gieysztor, A., *Aux origines de Varsovie*, in « Miscellanea mediaevalia in memoriam Jan Frederik Niermeyer », Groningen, 1967, pp. 177-186.

18 Le Roy Ladurie, E., *Histoire et Climat*, Paris, 1968.

Poland also the key factor was the amount of soil humidity because, as has already been suggested, this is often more important to the fertility of the soil than the quality of the soil itself. Soil fertility was critically affected by the cutting down of forests. The next important factor was the introduction of cultivation and the increase in stock-breeding. The topography of certain small settlements (such as Sieciechów, Pultusk and Lad) seems to confirm this theory. It is relevant here to mention the current debate about the scale and degree of innovation exhibited prior to the 13th cent. by the agriculture practised by monastic estates. T. Manteuffel [19] and his co-workers have proved, for instance, that the Cistercians were not such innovators in agriculture as has often hitherto been supposed. On the contrary, the Cistercians did not have a system of farm management differing substantially from the system widely practised in Poland during most of the 12th and 13th centuries. Against the prescriptions of their rule they accepted endowments of villages together with tenants, and only after a time re-organized their estates so that they formed granges in the charge of stewards. It is only about the mid-13th century that they introduced some improvements in lands already cultivated. The drainage and irrigation works they carried out on their estates can only be traced from sources dating from the late 13th century. These activities are well-documented for the region of the Vistula delta and it is clear that they were chiefly carried out by the monks from Oliwa. One can only guess that these works had to be done because of changes which took place during the 13th century in the hydrographic network of the Vistula. As for the region of Lad or Lekno, also of the Benedictine estate of Sieciechów, there is no evidence of drainage works or of any strengthening of lake and river banks dating from early mediaeval times. Probably until the mid-13th century the monks acted on the principle of minimum interference with the natural environment in low-lying lands. However, the establishment of the Cistercian monastery at Lad, on a middle river terrace, and the location of the monastery at Lekno on top of a hill (whereas the location typical of Cistercian monasteries in western and southern Europe was on lowlands) suggest that the monks did not feel altogether safe from floods of the Warta river and the lake at Lekno. We know, of course, today of many examples of the disappearance of lakes as a result of dehydration of the land and of an extensive use of river water.

Horticulture, and especially viticulture of early mediaeval Poland provides one more argument in support of the thesis that the climate used to be considerably milder, and that a climate suitable for viticulture existed. Viticulture was not only practised in the region of the upper Oder and the valley of the Nida rivers, but in the whole of southern and central Poland,

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[19] MANTEUFFEL, T., *Papiestwo i cystersi* [The Papacy and the Cistercians], Warszawa, 1955.

as proved by local place-names, e.g. Winiary, Winna Góra, Winnica.[20] To this day viticulture continues in the Zielona Góra region on account of its relatively mild climate.

Pastoral farming had better conditions in the low-lying areas of central Poland than in the higher lands to the south. The marshy areas covering a large proportion of available land in the central plains, presented conditions particularly favourable for pastoral farming. Topographers have associated the name of Lad with "meadow", meaning an area of dry land situated amidst watermeadows and marshes. Topographical names of early mediaeval settlements very often betray their early geographical location, e.g. Krosno, Lad, Kopanica, Gniezno.

Saline waters and bog-ironstones

Salt, its location and the methods used to obtain it, provide a key to understanding the patterns of settlement. There has been much recent research on the subject of rock salt. At present work is being concentrated on the early mediaeval distribution of saline waters — their extent and the ways in which they were utilised. Let us examine how these questions relate to the problems of changes in the natural environment. As in the case of the exploitation of deposits of bog-ironstone in early mediaeval Poland, it is extremely difficult to date these things. Despite extensive research, it is often impossible to decide with any degree of certainty whether a particular source of saline water, or a smelting furnace for bogiron, was in use during the first millenium or only during the second millenium A.D. The profusion of sites of these ancient smelting furnaces in Poland testifies today to the fact that they were in common use. A similar case can be made with respect to saline waters. Geological maps, and maps of the distribution of natural resources, are as useful to the researcher by their toponymy. The line of deep mine workings, following traces of bitumen and salt deposits, runs diagonally across Poland from Kolobrzeg to the range of the Swietokrzyskie Mountains. Apart from this, we find deep deposits of rock salt in the middle reaches of the Warta river and again in the Warta river valley north of Poznan. Areas rich in bog ironstone are situated particularly north of Radom, towards the valley of the Pilica river and in southern Masovia, in the basins of the Utrata and the Bzura rivers; next, also in the large region of Konin-Kalisz and Sieradz; and yet another, situated in the area north of Poznan in the basins of the Warta and Welna rivers.

This distribution leads to far-reaching conclusions. The concentration of relatively easily accessible basic minerals like salt and bog ironstone was

[20] Modzelewski, K., *La division autarchique du travail à l'échelle d'un État: l'organisation "ministeriale" en Pologne médiévale*, « Annales », Vol. 19, pp. 1125-1138.

an essential prerequisite for the development of the political and economic centre of northern Poland.

From toponymy we also gain some helpful hints. The names of localities obviously deriving from salt can be clearly divided into two groups: the first imply trading in salt, the other (e.g. Solnica, Solanka, Slona etc.) refers almost certainly to actual exploitation of saline waters. Exploitation of the Kolobrzeg salines and trade in Ruthenian salt in Poland in the period before the 13th century have been established without any doubt and have been the subject of many publications. We dare to suggest that saline waters were widely utilised in the areas of Great and Central Poland. This, however, has yet to be verified on both local and regional scales. It seems that, apart from the saline waters in the Kujawy region, salt for local consumption was also produced in other low-lying regions. The effects of this large-scale exploitation of both bog ironstone and saline waters must have had a considerable effect on the natural landscape. The area of the Swietokrzyskie Mountains serves as an illustration of the way in which great changes occurred in the natural landscape as the result of exploitation of local deposits of bog ironstone. In addition to utilising local timber stands, smelting furnaces affected the level of groundwater which, after smelting had ceased, collected in the excavated ground and caused waterlogging of the soil. The same phenomenon can be observed in the regions of Radom and Konin.

Full research into the impact of the exploitation of saline waters on the natural landscape has not yet taken place, apart from studies of the coastal saline deposits, which vary widely between the Baltic, the Atlantic and the Mediterranean. Otherwise the exploitation of saline waters has almost certainly resulted in depressions, both in the region of the middle stretch of the Warta river and in the Kujawy region. Salt deposit on neighbouring fields may well have adversely affected the vegetation. The effect it had on the productivity of pastoral land is not clear. It seems likely that the vegetation was stunted, but the grazing pasture might well have been richer in minerals, important in stockbreeding.

To conclude, we would suggest that all the factors which we have mentioned above as constituting a natural environment, viz. timber, water, soil, salt and bog ironstone, were there for men to exploit to the point of creating devastation through their exhaustion, since they were requisites for the very existence and development of the early mediaeval settlements. All these resources were available in the low-lying lands, and thus it was in these areas that there was a concentration of settlements resulting in the devastation of this natural environment — a process which reached a certain threshold in the thirteenth century. After this date, settlement shifted increasingly to other, often high-lying areas.

The evidence of increasing devastation — both that caused by man and that resulting from general climatic changes in Europe — is expressed in the increasing number of references to floods found in documentary sources from the thirteenth century. Floods had been recorded previously, especially at the turn of the 10th-11th centuries in the territories outside the Polish heartland, but then they were noted as extraordinary phenomena. On the contrary, references from the thirteenth century describe floods in terms of a common natural disaster, like military invasion or epidemics. This is almost certainly how floods were viewed by the populace at that time. As from this time, the threat of floods was a primary consideration in the minds of settlers when founding their homes on the banks of great rivers, since what they had to reckon with were not the regular, yearly Spring and Autumn inundations — which irrigated and enriched the soil — but flood disasters, which threatened life and livelihood.

The topographical pattern of settlement must therefore have been affected by these considerations.

Changes in the natural environment of Central Europe as a result of climatic changes

In mediaeval Europe, and elsewhere in the world, interest in research into climatic and hydrographic changes has been growing in recent years. It has brought new hypotheses and controversies. Overall generalisation has been replaced by an increased awareness of the need to assess each case individually. The results of regional studies ought to be compared; often these comparisons will be drawn between very disparate areas. The published results of the Rome conference of 1963,[21] which was devoted to problems of climatic changes, highlighted the dangers inherent in heedless comparisons of changes taking place simultaneously in regions as distant from each other as Japan and Canada. The London Congress of 1966 [22] reached similar conclusions. At a symposium held in Aspen in 1962,[23] in which many European historians and geographers took part, attention was drawn to some other pitfalls, e.g. neglect of the importance of microclimates. The investigation into the role they play is a necessary prerequisite for understanding the changes of climate and the shifting patterns of settlement in early mediaeval Europe. This is the view held by the French historian E. Le Roy-Ladurie,[24] who, in his numerous papers, stresses the importance of small Alpine glaciers on the quality and quantity of agricultural crops in the late Middle Ages and in the early 16th century. The subject of European microclimates has also been considered in numerous papers and in the doctoral thesis of J. Schove,

[21] Cf. footnote 2.

[22] *Ibid.*

[23] Le Roy Ladurie, E., *op. cit.*

[24] Cf. footnote 18.

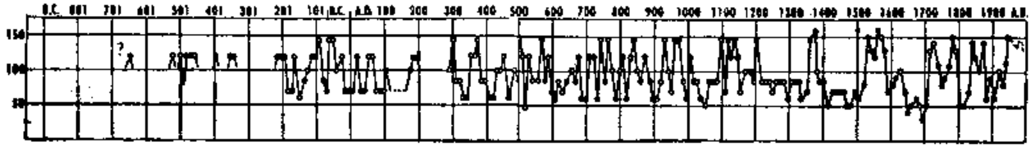

Figure 1. Diagram presenting changes in the solar activity over centuries. « The Sunspot Cycle: Curves Showing Intensity and Phases B.C. 650 - to A.D. 2000 ». After D.J. Schove.

who compiled an interesting graph of maximum solar activity throughout several centuries. These two scientists have provided the essential inspiration for the present study, which is an attempt to consider these problems within the strictly defined chronological and topographical limits of early mediaeval Poland.

In the more recent literature on the subject two works deserve particular attention. The first is the extensive and multi-volume work edited by C. Weikinn and published 1958-63, which utilises and systematises information on the subject of climatic changes in Europe, obtained from chronicles and narrative sources.[25] The other is the work of J. Titow,[26] published in 1960 and 1970, in which this author analyzes climatic changes in the Bishopric of Winchester between 1209 and 1450 A.D. This latter attempt is particularly interesting, because the author utilizes very detailed sources from this period.

To discuss these problems in the context of Eastern Europe, which is rather poorer in sources for this period than mediaeval England, presents greater difficulties. The archaeological evidence from the vast plain between Warsaw and Berlin supports the scanty written evidence on hand. Publications such as those of J. Herrmann and H.D. Kahl[27] deal with problems related to the climatic and hydrographic changes in the region of greater Berlin, i.e. the early mediaeval settlements around Spandau, Kopanik (today Köpenick), Brema and Brandenburg. It seems that their conclusions corroborate those of Polish researchers on this subject.

In attempts at defining the nature of the connection between hydrographical and climatic changes in Europe as a whole, all the regions of this continent must be included. What so far has been done in this field on a global scale, was presented at the Aspen Congress and later published in

[25] WEIKINN, C., *Quellenteste zur Witterungsgeschichte Europas von der Zeitwende bis zum Jahre 1850*, Berlin, 1958.

[26] TITOW, J., *Le climat à travers le rôles de comptabilité de l'évéché de Winchester (1350-1450)*, « Annales », No. 2, 1970.

[27] HERMANN, J., *op. cit.*; KAHL, H.D., *Slawen und Deutsche in der Brandenburgischen Geschichte des zwölften Jahrhunderts. Die letzten Jahrzehnte des Landes Stodor*, Vols. 1-2, Köln, 1964. DUNIN-WASOWICZ, T., *Remarques ...*

the works of E. Le Roy Ladurie.[28] These changes are more readily demonstrable for the prehistoric period. For the modern period, one can only consider them beginning with the 16th century. At the Aspen Congress, a working diagram was presented — it compared some information about climatic changes in Europe, America and Asia in the eleventh century. For Africa, only data about the Nile floods were included. The very attempt of a comprehensive approach to the problem in this working diagram reveals the great lacunae existing in our present knowledge. All information is available only on a purely local scale, and even then it is incomplete; whilst the changes in the natural environment are so complex that climatic changes represent only one element in the process. At some future conference, concerned with climatic changes in historical times, it would be interesting to see a diagram illustrating the state of knowledge on this subject for the thirteenth century. At present the lack of coordination of research on the subject makes it very difficult to compare even the data concerning changes within the same hemisphere. Japanese research[29] into climatic changes, which have occurred in the patterns of cherry-tree flowering, leads to the conclusion that, even in this instance, a major change took place during the thirteenth century, a change which seems clearly related to interference with the natural environment. In the case of Canada during this time, however, the effects of human activity must be discounted and the climatic disturbances charted by J. Schove must therefore have resulted from elemental changes. The question arises whether, in the present state of knowledge, the graph of J. Schove is sufficiently supported by historical evidence to warrant wider application to the progress of human settlement. Only further systematic investigation with regard to the northern hemisphere can test the validity of Schove's hypothesis with respect to all climatic changes during the course of the last millenium. At present his work provides encouragement for further investigations along these lines. These will need to be checked, wherever possible, against concrete historical, archaeological and geographical evidence. In the case of Poland, such an attempt has been made only in regard to Cracow. K. Radwanski's research[30] on the region of Okole tallies with the diagram of J. Schove; but it remains only an isolated case and therefore one cannot generalise from it on a world-wide, European, or even a Polish scale.

This support for J. Schove's diagram has found a further striking confirmation in the work of Z. Biernacki concerning the whole of the valley of the Vistula. This seems to supply additional evidence in support of the hypothesis that about this time a dramatic climatic change, affecting other

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[28] Le Roy Ladrie, E., *op. cit.*

[29]. Arakawa, H., *Climatic change as revealed by the blooming dates of the cherry blossom at Kyoto*, « Journal of Meteorology », Vol. 13, No. 6, pp. 599-600.

[30] Radwanski, K., *op. cit.*, p. 35.

Figure 2. Sieciechów. Space system of a marketing settlement in the Vistula valley.

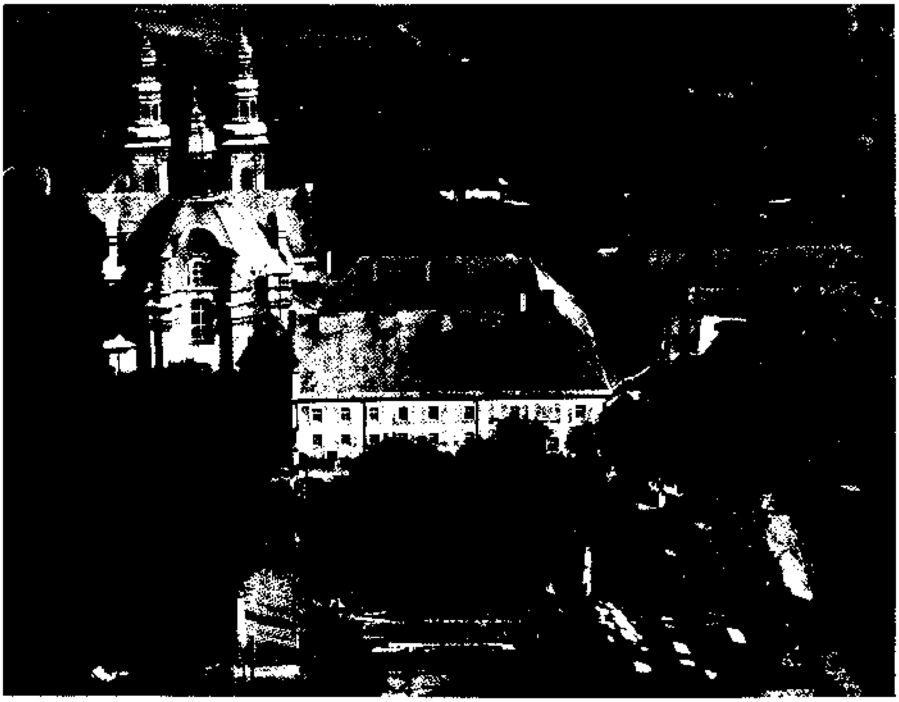

Figure 3. Ląd. Church and post-Cistercian monastery in the locality Ląd on the river Warta.

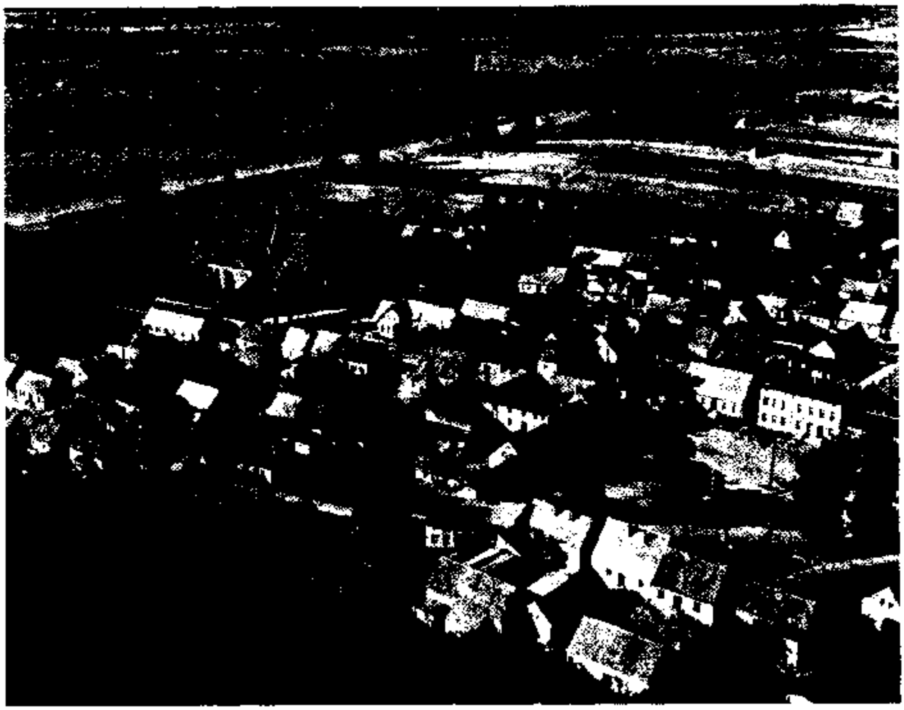

Figure 4. Łekno. Cistercian church at Łekno lake.

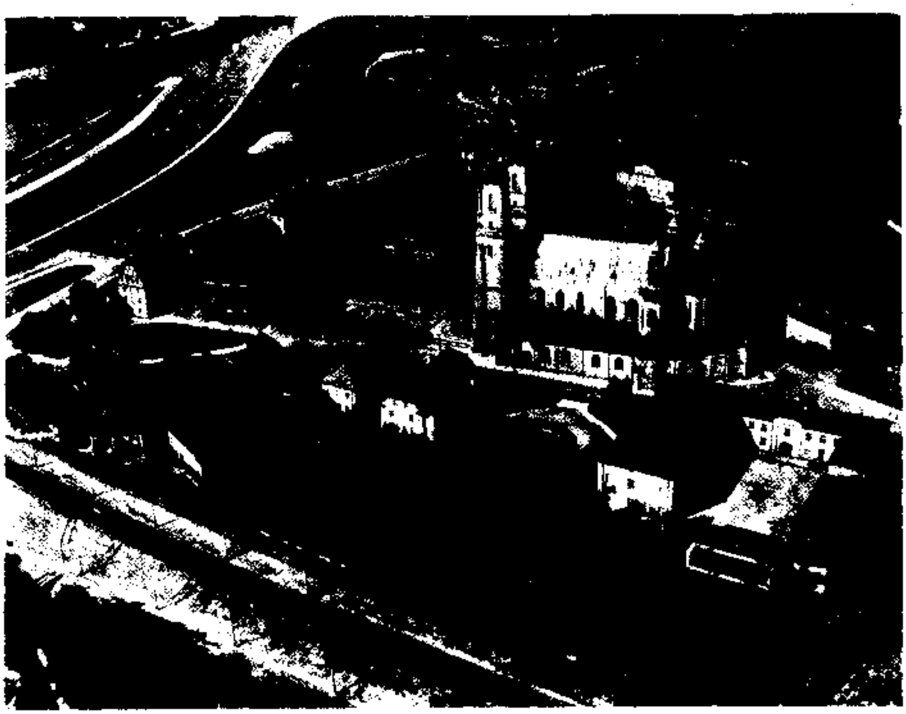

Figure 5. Poznan. Cathedral temple and the Blessed Virgin's church on Ostrów Tumski, on the river Warta bank.

areas of the world, took place. This coincided with a time of considerable economic development in Central Europe, which by then had already adversely affected the natural environment.

The combination of these two factors — the small-scale destruction brought about by human settlement, and the sudden deterioration of the climate — brought about great changes in hydrographic balance which reached the proportions of a natural disaster during the course of the thirteenth century.

It would be interesting to compare the situation in regions morphologically different, but geographically close, e.g. in the *loess* areas of the basin of the Black Sea and in the drainage area for the Dniester river, especially if one could find examples in areas less intensively economically developed.

Geophysical research, especially that of J. Schove, has drawn the attention of historians to periods of intense climatic changes which, it now seems, took place all over the northern hemisphere. These effects on the natural environment were different in different parts of the world: e.g. in Japan compared with Canada and Europe. Why should this be so? Climatic changes used to be only one amongst several factors which affected the natural environment of a given region. Regional studies made in the area of Central Europe and particularly in the area of the Central European plain have proved that, besides climate, man was the most instrumental factor in bringing about permanent changes in the microclimates and microregions. Only from merging these several particular studies will the full picture emerge.

Increases in population, the advance of settlement into forested areas, the progress of economic activities in terms of agriculture, pastoral farming and the utilisation of water resources, exploitation of salt deposits and mining of bog ironstone and iron ore — all these factors contributed towards upsetting the balance in the hydrography of Central Europe. They also interfered with local microclimates, which were among the greatest natural resources of the area.

The ability properly to utilise a specific microclimate was an attribute of the ancient Greeks and of other ancient societies displaying a high level of civilisation. It seems that the population of early mediaeval Europe lacked this ability. One can assume that it was the new settlers arriving in Central Europe from the west, south and east who introduced certain improvements and skills into this area. After the invasions by nomadic peoples who, as we know, brought considerable contributions to the material culture of Europe with them, but rather less towards the management of a settled economy — the time came when the specific skills of the settled indigenous peoples could be utilised. Ancient skills and values, which had come down from societies of a higher stage of development, were now revived. Knowledge of the proper utilisation of natural resources had been preserved in various parts of the Byzantine empire and in the monasteries of Scotland and Ireland. It is therefore not surprising that we first discover the introduction of viticulture in these monastic estates, and that the first attempts at reclamation of boglands and irrigation of dry land in Central Europe were first started by cultivated monks. The clergy and the nobility followed examples given by the monastic estates. Horticulture and fruit farming which can be well traced from archaeological evidence, are further examples of the proper utilisation of a specific microclimate.

A microclimate is, however, very susceptible to changes brought about by human activity. The present-day cases of Venice and Rome can be cited here. Man's interference in the natural balance of forests and water systems is an obvious example. Irrational intervention by man has always resulted in the destruction of particular microclimates. It may seem that this is unlikely to affect world climate, yet it must be remembered that the world climate consists of a multitude of microclimates. It may be, therefore, that man's interference with his environment, even on a local scale, can bring about a total "climatic crisis". In certain areas of Central Europe it seems that the thirteenth century has been a threshold in this respect.

The present author is not very familiar with the archaeological evidence for this period for Canada and Japan. Historical sources testify, however, to the fact that for Japan this was a period of intense economic development. It is not yet possible to decide, whether the rapidity of change in the pattern of cherry-tree blossoming in this period was not just caused by climatic changes, but was also due to interference with the microclimate by Japanese settlers. As for Canada, one can assume that the pace of change in the natural environment was slower than in Europe and Japan, since natural forces alone operated there until the relatively late arrival of man. Witnessing today the destruction of the natural environment which man has brought about in various areas of the World (especially in Europe, Asia and North America), the Canadians will no doubt attempt to preserve their environment from such deterioration. Will they be successful? The monster of today's technology, like the dragon of ancient and mediaeval mythology, demands more and more victims and becomes increasingly voracious.